Thank you very much for your interest in our research focus on gear and transmission technology.

The research area “Gear and Transmission Technology” has existed at the RWTH Aachen since the late 1930s. Founding the WZL Gear Research Circle in the year 1956 has laid the foundation for research in the field of gear and transmission technology based on application and industrial requirements. Every year, Aachen is the meeting place for gear manufacturers when 250 participants discuss the latest research findings in gear technology. Many of those research projects originate from discussions with our industry partners. Thanks to our research partners such as the DFG, the AiF, the VDW and last but not least the FVA, research in the field of gear technology is uninterrupted at the WZL.

Based upon this solid basis, more than one hundred dissertations have been concluded in the last decades. We are equally proud of the countless student research theses and final theses in the area of gear technology.

With this brochure, we want to draw your attention to our research activities and invite you to research together with us.

Please feel free to contact us!

Best regards

Prof. Dr.-Ing. Dr.-Ing. E.h. Dr. h.c. Fritz Klocke
Prof. Dr.-Ing. Christian Brecher

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1906 Prof. Dr. Ing. E.h. Adolf Wallichs is appointed professor at the Chair of Machine Tools and Production Engineering at the RWTH Aachen.

1936 Lead by Prof. Dr.-Ing. Herwart Opitz, the WZL evolves to be one of the most modern and most important research facilities of its kind.

1948 After reconstruction, the first Aachen Machine Tool Colloquium (AWK) is held.

1956 Upon initiation of industrial companies, the WZL Gear Research Circle is founded with the objective of advancing research in the area of gear technology.

1973 Before retiring, Prof. Opitz structures the WZL into individual chairs:
- Production Systems (Prof. W. Eversheim)
- Manufacturing Technology (Prof. W. König)
- Machine Tools (Prof. M. Weck)
- since 1988: Production Metrology and Quality Management (Prof. T. Pfeifer)

1980 Initiated by the direction of the WZL, the Fraunhofer Institute for Production Technology (IPT) is founded.

2004 After retirement, the chair holders of the WZL are as follows:
- Production Systems (Prof. G. Schuh)
- Manufacturing Technology (Prof. F. Klocke)
- Machine Tools (Prof. C. Brecher)
- Production Metrology and Quality Management (Prof. R. Schmitt)
- Production Management (Prof. A. Kempker)

2005 The professors move into the new 9000 m² building which is named after Prof. Manfred Weck.

2006 The WZL celebrates the 100 year anniversary. About 1300 guests from science and industry participate in the festivities.

2007 With the Campus Melaten, an area of 193,000 m² is made accessible on the extending area of the RWTH Aachen University. Up to 150 companies in association with research institutes are expected to settle in in the coming years.

2010 The Werkzeugbau Akademie (WBA), the academy for tool making, emerged from the “Aachener Werkzeug- und Formenbau”, which focuses on the design of tools and molds at the WZL and the IPT Fraunhofer Institute. The WBA excels especially in application-based research in the area of tool making.

2015 Currently, 77 companies are members of the Gear Research Circle.
In the field of transmission technology, 80 employees research gears. The current research projects revolve around gear manufacturing, gear testing and the simulation of transmissions as well as production processes. Therefore, the WZL is the only research institute in Europe where the gear is investigated and researched as a whole. Focus of current research activities is the investigation of the influence of the gear manufacturing process on the running behavior of gears.

Facing the current sociopolitical goals, the serial production of large gears for wind turbines is an important challenge of current research projects. Light weight construction, high efficiency as well as minimal noise and excitation behavior are also topics of research projects currently conducted at the WZL. In the coming years, high velocity transmissions for electric vehicles make high demands on design and the manufacturing of gears. These demands can only be faced with the development of custom-made simulation software.

The philosophy of the WZL Gear Department is to qualify young academics for challenges of drive technology. Every employee has the task of passing on the gained insights. The most important instrument besides publications is the education of students. The lecture Gear Transmission Technology and the mentoring of final theses are the core for success.

Please feel free to contact us!
For questions and further information, the leader of the group is gladly at your disposal.

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**Research Focus**

**Research Topics**
- Manufacturing-related running behavior of gears
  - Manufacturing-induced tooth flank topology
  - Surface topology
  - Surface properties (e.g. boundary layer)
- Innovative measuring methods for gear acoustics
  - Quasistatic (transmission error)
  - Dynamic (angular acceleration)
- Local load carrying capacity calculation
- Alternative testing methods
  - Pulsetests (friction coefficient, pitting strength)

**Test Rig Solutions**
- Mechanical back-to-back test rigs
  - Load capacity tests (tooth root, tooth flank)
  - Variable center distance
  - Oil tests (scuffing, micro pitting, pitting)
- Analogy test rigs
  - Pulsator test rigs
  - Two-disc test rigs (friction coefficient, pitting strength)
- Analysis of the part quality and surface properties.

**Manufacturing Technologies**
- Five axis milling

**Gear Testing**

**Focus**
Experimental safeguarding of gear designs in terms of load carrying capacity, excitation behavior and efficiency is obligatory for most cases of transmissions developing.

The research and development work of the gear testing group directs the focus on the application and optimization of testing methods. Besides the key aspect of analyzing the influence of manufacturing-related properties on the running behavior, the determined values are used to validate calculation models for load carrying capacity and excitation behavior.

The running behavior of cylindrical gears, bevel gears as well as special gears (e.g. beveloids) is analyzed.

**Gear Manufacturing Technology**

**Focus**
Due to the high complexity of the components as well as high demands on workpiece quality, gear manufacturing is a particular challenge in the field of production engineering.

The group of gear manufacturing technology concentrates on detailed research on almost all gear manufacturing processes. This applies to soft machining as well as hard finishing.

The different topics are investigated in basic research projects or industrial projects. We are supported by numerous German and international companies.

**Research Focus**

**Research Topics**
- Analyzing and optimizing gear manufacturing processes
  - Testing tools, tool materials and coatings
  - Tool lifetime optimization
  - Gear quality improvement
  - Optimizing the process chain technologically and economically
  - Process analysis based on simulation
  - Tool and workpiece analysis
  - Wear assessment
  - Quality analysis
  - Specification and evaluation of gear manufacturing tools
  - Analogy trials on several test rigs
  - Analysis of chip forming
  - Process force measurement
  - In-process temperature measurement

**Manufacturing Technologies**
- Soft machining
  - Gear hobbing and shaping
  - Form milling
  - Bevel gear cutting
  - Power skiving
  - Hard finishing
  - Continuous generating gear grinding
  - Discontinuous profile gear grinding
  - Gear honing
  - Powder metallurgy

**Test Rigs (Selection)**
- Electrical Power Circle
- Mechanical Power Circle
- Pulsators
- Two Disk Test Rigs

**Machine Equipment (Selection)**
- Kapp KX500flex
- Klingelnberg C29
- Liebherr LC120
- Liebherr LCS 380
- ProfiDie PR15HP

**Please feel free to contact us!**
For questions and further information, the leader of the group is gladly at your disposal.

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Idea

Initiated by industrial companies, the WZL Gear Research Circle was founded in 1956 with the objective of advancing joint research in the field of gears and transmission engineering. The Gear Research Circle represents the first practical example of joint research in gear and transmission engineering for which the industry is directly integrated to ensure a high practical relevance of the research activities.

Today, the Gear Research Circle consists of 77 companies and represents one of the most important networks for transmission engineering in Europe.

Organization of the Gear Research Circle

The WZL Gear Research Circle is characterized by an interdisciplinary exchange between the two chairs for machine tools and for manufacturing technology. Investigating the machine element gear as a whole is made possible by this close cooperation.

The annual WZL Gear Conference provides the opportunity to present gained insights of the past research period to our member companies. Furthermore, the conference provides an opportunity for discussions in which current challenges can be identified and transferred to research projects.

Topics

- Productivity increase by optimizing the technology and developing new machining strategies
- Developing and applying FEA software for accurate calculation of gears and transmission systems
- Optimizing the load carrying capacity and the root bending strength
- Simulating manufacturing processes with regard to flank modifications and chip formation
- Influence of the manufacturing technology on the running behavior of gears
- Advancing of hard and soft finishing processes with defined and undefined cutting edges
- Acoustic measurements and noise reduction

Your Benefit

The membership in the WZL Gear Research Circle offers you exclusive access to current research in the fields of design, manufacturing and testing of gears as well as generic issues.

A membership offers many advantages:

- Access to software for designing and manufacturing gears
- Adaptation of the software to your requirements
- The annual WZL Gear Conference is held exclusively for our members
- At the Gear Conference, the working groups and the working group meetings of the Gear Research Circle you can discuss the latest research results with us
- We carry out projects for our members financed by funds of the Gear Research Circle
- At our seminars, you have the opportunity to present your research results to your customers
- Attending our seminars and advanced training sessions, you receive favorable conditions
- For our national and international research projects, you are preferred in the selection of the consortium

We answer your questions

We initiate bilateral research projects at short notice and on favorable terms for members of the WZL Gear Research Circle. For this, we respond exactly to your problems.

Examples for such research projects are:

- Optimizing transmissions and manufacturing processes by means of our software which enhances the potential for design significantly by regularly implementing current research results
- Investigating and assessing the cutting conditions of cutting materials, customized to your application
- Assessing and optimizing of processes and process chains for your gear production
- Evaluating failure mechanisms and supporting the product design
- Analyzing the noise behavior on our test rigs or on site
- Investigating and assessing the load carrying capacity and the root bending stress of your gear set
- …

Please feel free to contact us!

For questions and further information, the Chief Engineer is gladly at your disposal.

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The WZL Gear Conference

A deep-seated platform for an active exchange of experience and a close collaboration of the WZL Gear Research Circle is the annual Gear Conference that takes place every spring at the Eurogress of the town of Aachen. At this conference, the latest insights of the field of transmission technology are presented by the research assistants to the member companies on two days.

The presentations are completed by panel discussions or technical presentations on current key topics during which challenges of the transmission technology are discussed including members of the Gear Research Circle from the viewpoint of industrial application.

Inherent parts of the Gear Conference are also the presentation of our software and a tour of the WZL shop floor and the Manfred-Weck-Haus with its multitude of different test rigs and machine tools.

Especially in the environment of said presentations and tours, numerous interesting expert discussions arise between representatives and the research assistants of the WZL.

With currently over 250 participating national and international representatives, the Gear Conference has been a recognized and yet largest annual event for transmission technology for 50 years.

Events and Seminars

Basic Seminar Gear and Transmission Technology
For the Basic Seminar Gear and Transmission Technology, basic properties of the gear as a machine element, gear manufacturing technologies, methods for quality control as well as testing and analysis of load carrying capacity and running behavior are presented. The event sets the focus on methods of interpretation, analysis and solving challenges in manufacturing and application of gears.

Trends in Gear Soft Manufacturing
November 09-10, 2016
In our seminar “Trends in Gear Soft Manufacturing”, today’s developments regarding manufacturing processes and strategies for soft gear production as well as the capabilities and limits are introduced. For this purpose, experts of renowned machine tool manufacturers, tool suppliers and drive train technologists speak about their experiences, opinions and visions. The concept of the seminar focuses on industrial presentations that are completed by fundamental scientific topics. Additionally, the seminar provides much room for discussions and the exchange of experience.

Innovations in Bevel Gear Technology
March 16-17, 2016
The center of the Seminar “Innovations in Bevel Gear Technology” is taken by application-oriented contributions regarding the topics of the designing and calculation, manufacturing, quality assurance and the running behavior of bevel gears. Insights into the state of the art as well as current questions are delivered and future development tendencies regarding bevel gears are presented. The seminar is organized in close collaboration with renowned partners in the field of machine tools and drive train technologies.

Gear Finishing Technology
November 3-4, 2015
The seminar “Gear Finishing Technology” provides an overview over the current development of soft machining and finish machining. Additionally, challenges and possibilities of these areas are shown. Experts in the areas of development and production introduce advantages and disadvantages of certain production chains. Furthermore, the influence of the tool design and the process strategy is shown. In order to provide a full overview of the process chain of grinding gear flanks, basics regarding quality control and testing of grinding burn as well as innovative developments in the area of heat treatment are presented.
Member Companies of the Gear Research Circle (June 2015)

Laboratory for Machine Tools and Production Engineering of RWTH Aachen University

Gear Department
Chair of Machine Tools
Prof. Dr.-Ing. Christian Brecher

Chair of Manufacturing Technology
Prof. Dr.-Ing. Dr.-Ing. E.h. Dr. h.c. Dr. h.c. Fritz Klocke

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