Technology

Prof. Dr.-Ing. Peter Gutzmer
Chief Technology Officer
1 Overview
Technology – At a glance

Key aspects
- 6,650 R&D staff worldwide at 17 R&D centers and additional locations in 19 countries
- Unrivalled experience and expertise in product and systems development
- State-of-the-art R&D and testing facilities
- Widespread network of partners and co-operations

Selected Innovation Awards
- PACE-Award (Torque Converter with Centrifugal Pendulum Absorber)
- Innovation of the Year (E-Wheel Drive)
- Eurobike Award (FAG-VELOMATIC)
- German Innovation Prize 2016 (Anti-roll stabilizer)
- Greentec Award 2016 (E-clutch)

Best-in-class innovation platform
No. of patents registered¹)

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>1,832</td>
<td>1,854</td>
<td>2,100</td>
<td>2,518</td>
<td>2,334</td>
</tr>
</tbody>
</table>

Rank in Germany
- 2011: #4
- 2012: #4
- 2013: #4
- 2014: #2
- 2015: #2

¹) German Patent and Trademark Office

R&D expenditure
EUR mn

<table>
<thead>
<tr>
<th>Year</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>495</td>
<td>593</td>
<td>611</td>
<td>622</td>
<td>720</td>
</tr>
</tbody>
</table>

in % of sales
- 2011: 4.6%
- 2012: 5.3%
- 2013: 5.5%
- 2014: 5.1%
- 2015: 5.4%
Global R&D network

- Germany
  - Bühl
  - Herzogenaurach
  - Homburg
  - Schweinfurt

- Hungary
  - Szombathely
  - Haguenau

- Romania
  - Brașov
  - Slovakia
  - Kysucké Nové Mesto

- Mexico
  - Puebla

- Brazil
  - Sorocaba

- USA
  - Fort Mill
  - Troy
  - Wooster

- China
  - Anting

- Japan
  - Yokohama

- South Korea
  - Changwon

- India
  - Pune

17 R&D centers worldwide
1 Overview

Increasing complexity and digitalization

Increasing complexity

- **Number of components**
  - **Product complexity**
  - **Mechanical components**
  - **Mechanical systems**
  - **Mechatronic systems and services**

Digitalization

- **907**
  - Billions US$
  - Annual global investments for Industry 4.0 in 2020. 50% Software, 30% Hardware and 20% Education.
  - Source: PwC, 2016

- **10**
  - Times
  - More globally generated data in 2020 compared to 2013.
  - Source: EMC, 2014

- **90**
  - Percent
  - Of decisions are data controlled in 2020 compared to 52% in 2016.
  - Source: PwC, 2016

- **82**
  - Percent
  - Digital added value in Germany in 2020 (33% in 2016).
  - Source: PwC, 2016

- **4.1**
  - Percent
  - Annular efficiency increase by Industry 4.0 in Germany till 2020.
  - Source: PwC, 2016

Source: PwC, 2016

Source: EMC, 2014

Source: PwC, 2016
1 Overview

Our strategic concept "Mobility for tomorrow"

Key mega trends

Society trends
- Urbanization
- Population growth

Technology trends
- Increasing complexity
- Digitalization

Environmental trends
- Renewable energies
- Availability of resources

Economic trends
- Globalization
- Affordability

4 focus areas

Eco-friendly drives

Urban mobility

Interurban mobility

Energy chain
Key challenges...

- Increasing complexity and digitalization require...
  - ... adaption of R&D processes
  - ... new and extended competencies
  - ... working in R&D networks

... and how we meet them

1. Early identification of trends
2. Mechanical, electronical and software know-how
3. Strong global network of partnerships and collaborations
2 R&D excellence

Early identification of trends – Deep systems understanding and component knowledge

Deep understanding of application and systems environment

- We understand the end customers' needs
- We understand our customers' requirements
- We understand the application environment for our systems

Advanced Research

Understanding and development of systems

- We are an early-stage development partner
- We develop solutions for the mobility for tomorrow
- We deliver high-quality, cost-efficient solutions

Research & Development

Continuous component optimization down to the last detail

- We have unique and broad components expertise
- We continuously optimize our components
- We deliver high-quality, cost-effective designs
Early identification of trends – Example: E-Mobility

Early build-up of E-Mobility expertise

1999
1st Schaeffler E-Mobility Symposium

- E-Clutch
- Hybrid Module
- E-Axle
- E-Clutch
- Hybrid Module
- E-Axle

Grade of electrification

- Mild hybrid vehicles
- Hybrid vehicles
- Electric vehicles

Next steps

Initiation within Corporate R&D Department, then transfer to R&D Automotive Division

Initiation within Corporate R&D Department
Mechatronics and software
- Electronics and software know-how already in-house
- Pilot solutions
- Prototype electrics and electronics

Digitized business models and analytics
- Digitized use cases
- Smart products
- Smart processes

Today: 1,200 employees

2020: 1,200 additional employees
### Highlights

- **Creation of "Schaeffler Hub for Automotive Research in E-Mobility"** at the Karlsruhe Institute of Technology with around 60 engineers
- More than 30 publicly funded research projects in Germany alone
- Partnership research with renowned Tongji University in Shanghai focusing on China-specific technologies since 2006
- Numerous research collaborations working on topics around digitalization

### Organizations

- FVA
- FAT
- EPTDA Member
- VDMA
- FVV
- APM
- MTZ
- IHK
- VDI
- ATZ
- Stifterverband für die Deutsche Wissenschaft

### Universities

- KIT
- Fraunhofer
- Universität Stuttgart
- FAU
- RWTH Aachen University
- TU Clausthal
- Technische Universität Ilmenau
- Hochschule Karlsruhe Technik und Wirtschaft
- Hochschule Offenburg University of Applied Sciences
- Universität Bremen
- TU Kaiserslautern

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**2 R&D excellence**

**Strong global network of partnerships and collaborations**
3 Flagship initiative "Digitalization"

Schaeffler’s Digital Agenda

Customer

Digital Business Models

Products
Development of products that are able to generate signals (sensorized bearings)

Machines
Development of partly autonomous machines

Processes
Integration of partners into the Schaeffler Development System

Analytics & Simulation

Digital User Experience

Digital Platform

Big Data

2 Examples

Examples

Big Data
3 Flagship initiative "Digitalization"

New products with architecture for networked driving applications

**Anti-roll stabilizer**

- **Roads**
  - Sensing: Road profile and road damages
- **Cloud**
- **Other vehicles**
  - Use of road data for predictive chassis control
- **Infrastructure**
  - Tailored road maintenance

**Acting**

- Driving comfort
Bearing as a sensor

Tracks

Sensing
Track conditions

Acting
Monitoring for safety at high speed

Surveillance
Track conditions

Cloud

Infrastructure
Predictive maintenance
6 new or extended R&D centers until 2020

- **USA**
  - Fort Mill
  - Troy
  - Wooster

- **Mexico**
  - Puebla

- **Brazil**
  - Sorocaba

- **Europe**
  - Germany
    - Bühl
    - Herzogenaurach
    - Homburg
    - Schweinfurt
  - Hungary
    - Szombathely
  - France
    - Haguenau
  - Romania
    - Brașov
    - Slovakia
    - Kysucké Nové Mesto

- **Asia**
  - **China**
    - Anting
  - **South Korea**
    - Changwon
  - **Japan**
    - Yokohama

- **India**
  - Pune
  - Expansion
  - New R&D Center
  - **Hosur**
  - **Skalica**
4 Outlook

R&D expenditures in percent of sales expected to remain stable

R&D expenses

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2020</th>
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<tbody>
<tr>
<td>5.5% of sales</td>
<td></td>
<td></td>
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<tr>
<td>10% of Automotive R&amp;D for E-Mobility</td>
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<tr>
<td>5 – 6% of sales</td>
<td></td>
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<tr>
<td>30% of Automotive R&amp;D for E-Mobility</td>
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Key aspects

- Total R&D spending expected to remain at 5 to 6% of sales
- R&D spending for E-Mobility will increase from 10% to 30% of total Automotive R&D (EUR 500 mn accumulated from 2016 to 2020)
- R&D spending in Industrial and Bearing and Components Technologies will shift from hardware design to mechatronics and software driven solutions
- 1,200 additional employees in R&D and manufacturing of mechatronics, hybrid technologies and e-mobility to be hired until 2020

July 20, 2016

5 Summary and key statements

Key messages

1. R&D for E-Mobility and environmentally friendly solutions will be further enhanced.

2. R&D for standard product business will shift to mechatronics and software driven solutions.

3. Our R&D ratio is expected to remain stable at 5 – 6% of sales until 2020.

4. With our Digital Agenda we are gradually becoming a solution provider for digital business models.