Digitalization@Schaeffler: Smart Factory Solutions

Condition Monitoring approach for machine tools

Matthias Hafner| Director Digitalization Greater China
Schaeffler China
Schaeffler at a glance

**Schaeffler in facts — Strong starting point**

- **Strong customer base**
  - With approx. 11,800 customers

- **Strong organic growth**
  - 5% p.a.
  - Ø Sales growth 2006-2017

- **Nearly 2,400 patents filed in 2017**

- **More than 170 locations in 50 countries**

- **1.1 m tons of processed steel p.a.**

- **74 plants**

- **18 R&D centers**

- **More than 10,000 different products**

- **92,000 employees worldwide**

---

1) Before one-off effects
2) As at June 30, 2018

---

2 Digitalization@Schaeffler | ICSM 2018 | November 2018 | Shanghai, China
Schaeffler at a glance

**Strategy**

### Key mega trends

- **Society trends**
  - Urbanization
  - Population growth

- **Technology trends**
  - Increasing complexity
  - Digitalization

- **Environmental trends**
  - Renewable energies
  - Availability of resources

- **Economic trends**
  - Globalization
  - Affordability

### Focus areas

- **E-Mobility**
- **Industry 4.0**
- **Customer Excellence**
- **Digitalization**
Schaeffler at a glance

From Mechatronical to Digital World: Driving Industry 4.0 and Digitalization

Combination of Mechatronics and Digitalization

Industry 4.0

- Initiative "Industry4.0" as operational unit
- Focus on Mechatronic and Digital Services

Digitalization

- Digital Office as key driver
- Digital Transformation along the entire value chain
- New Digital Solutions

Strategic Pillar

Digitalization@Schaeffler | ICSM 2018 | November 2018 | Shanghai, China
Digitalization will be an integral part of our People

Products

Machines

Processes

Services
Requirements for Smart Factories

Schaeffler Digitalization: overview

- Factory’s layout
- Organization

Processes/Flow
- Production process
- Material process
- Information process

Building
- Building form
- Construction
- Characteristics/design

Areas/Functions
- Layout areas
- Other infrastructure

Technical Infrastructure
- Energy and Media supply
- Building Technology

Information system

Software
- Basic Software
- Specific software

Hardware
- Computer
- Output
- Input
- Memory
- Connectivity
- Security

Machine / Work Station
- Machine concept/machinery
- Connectivity
- Transparency
- Steering
- Network Optimization
Schaeffler Digitalization: overview

Smart Factory approach: requirements from Connectivity to Network Optimization

Network Optimization
Holistic value stream optimization across physical and organizational borders

Steering
Combining data out of different sources and feedback into running processes

Transparency
Monetary benefits by reducing effort for data generation and preparation

Connectivity
Standardized connectivity of machines and equipment to the digital platform

Quality
Traceability

Cost
Productivity

Delivery Reliability
Availability

Diagram: Production plant flowchart with stages like pre-processing, heat treatment, final processes, and assembly.
Schaeffler digital agenda towards customer-centric approach

Advanced Business Models

Products & Services

Machines & Processes

Analyses & Simulations

User Experience & Customer Value

Digital Platform
Schaeffler digital platform will integrate the entire Schaeffler value chain

Integration of Schaeffler value chain based on data and information

Product Development
Supply Chain Management
Manufacturing
Sales
Service
Aftersales
Schaeffler Digitalization: overview

Digitalization @ Production Technology

Productivity in production

Connector for sensorization
- Edge Computing

Connectivity
- Machines and IT Services

Standard HMI
- Unified Operating System

Information Management
- User Specified Needs

Sensorization & Optimization
- Production Processes

Holistic Process Optimization
- Optimization Process Chain via Machine Communication

Technology Configurator
- Optimal Requirement Based Value Stream

Enabler

Visualization

Transparency

Single Machine

Production Lines

Know-How Database

Turns

Grinding

Heat Treatment

Plastics

Milling

Forming

Joining

Additive Manufacturing

Edge Computing

Unified Operating System

User Specified Needs

Production Processes

Optimization Process Chain via Machine Communication

Optimal Requirement Based Value Stream

Enabler

Visualization

Transparency

Single Machine

Production Lines

Know-How Database

Turning

Grinding

Heat Treatment

Plastics

Milling

Forming

Joining

Additive Manufacturing

Enabler

Visualization

Transparency

Single Machine

Production Lines

Know-How Database

Turning

Grinding

Heat Treatment

Plastics

Milling

Forming

Joining

Additive Manufacturing
Digitalization @ Schaeffler

The Machine Tool 4.0 as a part of a digitalized production cell

Digital connection of all physical cell objects and sensors enables big data and analytics

Digitalization@Schaeffler | ICSM 2018 | November 2018 | Shanghai, China
### Components and solutions for turnkey solutions

<table>
<thead>
<tr>
<th>Mechanics</th>
<th>Mechatronics</th>
<th>Digital Solutions</th>
</tr>
</thead>
</table>
| ▪ Mechanic components | ▪ Mechatronic products  
▪ Mechatronic systems | ▪ Condition Monitoring  
▪ Predictive Maintenance |
Project i4.TP: Turnkey approach focuses on configuration, implementation and operation for turnkey systems.
**autinityCCS: focus on control and optimization of manufacturing processes**

- **Connected World**
  - Condition-based Control System
  - Process Analysis
  - Control Functions
  - Data Analytics
- **ERP-Systems**
- **Field Control Service**
  - Integration of PLC
  - Pre-Processing Data
- **Field**
  - Vibration Sensors
  - Vibration Recording

**autinityCMS: focus on condition monitoring**

- **Server**
- **IPC**
- **PLC**
- **Condition Monitoring**
- **Predictive Maintenance**
- **Damage Pattern recognition**
- **Time signals, Event Monitor**
- **Transfer to PLC (Recording Part Type, Spindle Speed, Work step)**
- **Integration of PLC**
- **Pre-Processing Data**
- **Four different Sensors**
- **Recording Sensor Data**
Use cases within Schaeffler production sites (samples)

**autinityCMS – Vibro Control**

- **Logging number of valve circuits for air**
  - OFF
  - ON

- **Vibration and Temperature**

- **Vibration and Temperature**

- **Vibration Monitoring**

<table>
<thead>
<tr>
<th>Metal forming</th>
<th>Logging number of valve circuits for air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection and prediction of cushion wear</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metal cutting</th>
<th>Vibration and Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early detection of spindle crash/breakdown</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metal cutting</th>
<th>Vibration Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early detection of spindle bearing defects (Roll bearing)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heat Treatment</th>
<th>Vibration Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early detection of motor bearing defect</td>
<td></td>
</tr>
</tbody>
</table>

**Customer Benefits**

- **Lower Repairing Costs**
  - Save planned machine downtime
  - Faster schedule maintenance
  - saving compressed air

- **Lower Inventory Costs**
  - Avoidance consequential defects
  - Avoidance consequential crash
  - Repearing/Replacement of spindle in planned time

- **Avoid Bottleneck Production**
  - Repearing/Replacement of spindle in planned time
  - Avoidance of consequential crash of spindle

- **Optimization Maintenance Tasks**
  - Avoidance on spontaneous production loss
  - Avoidance of maintenance tasks during production time

- **Avoid Production standstill**
- **Process Optimization**
Schaeffler Technologies AG & Co. KG | Schaeffler China

Matthias Hafner
Director Digitalization Greater China