Industry 4.0
Path of Digitalization
Industry 4.0
What is industry 4.0

Industry 4.0 the 4th Industrial revolution

1st industrial revolution:
Introduction of the mechanical production with the help of steam power

End of 18th century

2nd industrial revolution:
Introduction of the mass production with the help of the conveyer belt and electrical energy

Early 20th century

3rd industrial revolution:
Automated production due to SPS and Robotics

Early 1970s

4th industrial revolution:
Communication between factory machines for automatic process optimization

Today
Industry 4.0
Industry 4.0
Opportunities for engineering

Production

Machine
Industry 4.0
@ our production plant
Industry 4.0
Shopfloor monitor – connected

Logistics
Warehouse
Production planning
Design Department
Sourcing
Sales
Industry 4.0
Shopfloor monitor – functions

Order Information
› Bill of material (BOM)
› Customer specific design details
› Sales order
› Missing parts
› Technical documents

Workflow
› Electronical material call
› Escalation management
› Complaints management
› Report of operation

Operational acquisition
› Working time
› Down time
› Additional times

Status information
› Order status
› Order progress
› Current operation
Industry 4.0

**CELOS** - the I/F to the digital factory

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**COLOUR CODING**

*Summary of the five groups:*

- Production
- Utilities
- Support
- Configuration
- Machine Views
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CELOS – Messenger APP

APP MENU

MESSENGER

NEW!
Industry 4.0
PROCESS CHAIN

1. preparation
- DMG MORI Process chain
- DMG MORI Virtual Machine

2. manufacturing
- Job Manager
- Performance Monitor
- Condition Analyzer

3. machining
- Technology Cycles
- Surface Analyzer
- Industry 4.0 package

4. service
- Service Agent
- Developer
- Update
3. MACHINING

- Ergonomics and time savings
- Measurement cycles workpiece quality
- Machining cycles technology integration
- Monitoring cycles process reliability

Selected examples

- Tool sort cycle
- 3D Quickset®
- Grinding 2.0
- MPC 2.0 – Machine Protection Control®

- Technology Cycles
- Surface Analyzer
- Industry 4.0 package
Industry 4.0
PROCESS CHAIN

4. MAINTENANCE

- Service Agent
- Developer
- Update

<table>
<thead>
<tr>
<th>Condition Analyzer</th>
<th>Service Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal yellow</td>
<td>Purchase, maintenance or DMG MORI direct</td>
</tr>
<tr>
<td>Condition Analyzer</td>
<td>Installation</td>
</tr>
<tr>
<td>Signal green</td>
<td>With documentation or video guided</td>
</tr>
<tr>
<td>Maintenance of customer</td>
<td>Delivery of goods</td>
</tr>
</tbody>
</table>

Installation With documentation or video guided
Industry 4.0
Condition Analyzer | Performance

**Highlights**

Platform for visualising, analysing and predicting machine statuses across all machines

› **Data storage interface**
  Central storage (Cloud) of the status data

› **Visually status diagnostics**
  - Individual machine level (My Machine)
  - Factory level (All Machines)
  - Across all factories (All Factories)

› **User dependent access rights**
  Information and reports
Industry 4.0
Condition Analyzer | Contents

**Display**
- Machine condition

**Increase availability**
- Recognizing machine problems early and avoiding it
- Optimized exploitation and maintenance
- Target Information to maintenance

**Trend of measurements**
- Process Monitoring
  - Direct monitoring and controlling at the plant
  - Short-term reactions when recognizing overloads
  - Customization of machining operations

**Analyse / certification**
- NC-programs
  - Optimizing / Quality check
    - Analyse and improvement of machining operations
    - Process certification / quality check
    - Improvement of production and machine indicators

**Integrated service videos**
- Guided maintenance
  - Integrated maintenance videos for an easy independent maintenance
  - Fast and easy machine maintenance
  - Cost cutting
Display machinery condition

Increase availability

› Engine problems at an early stage detect and avoid
› Optimized utilization and maintenance
› Targeted information on maintenance on maintenance and repair
Industry 4.0
Condition Analyzer

APP Condition Analyzer

Highlights

Increase of the overall equipment effectiveness (OEE)
Through recording, analyze and execute of machine data with direct feedback to customers and services

› Improved machine availability

› Projectable maintenance intervals and service costs

› Guides maintenance by service videos
  › guided machine
**Industry 4.0**

**Condition Analyzer | Sensors - milling**

### Coolant system
- Rest of the paper band filter*
- Pollution of the double switch filter*
- Coolant level*
- Quality of coolant

### Hydraulic
- Fluid level*
- Temperature*
- Pressure*
- Filter contamination
- Interval oil exchange*

### Pneumatic
- Air pressure*
- Air flow
- Filter contamination

### Coolant aggregate
- Fill level*
- Temperature*
- Filter pollution*

### Spindle
- Temperature spindle bearing*
- MPC: Machine protection control

### Ball screw drive
- Pretension
- Temperature

### Control cabinet
- Temperature*
- Filter pollution*

* Already prepared
Industry 4.0 Condition Analyzer | Sensors - turning

Control of linear axes
- Easy Tool Monitoring 2.0
- Force, Speed
- Temperature

Pneumatic
- Air pressure*
- Air flow

Coolant aggregate
- Fluid level*
- Temperature*
- Filter pollution*

HSP / GSP
- Torque, speed
- Temperature

Energy control
- Energy consumption
- Air consumption

Hydraulic control
- Pressure, level
- Temperature

Coolant lubricant management
- Pressure, flow rate
- Filter check
- Coolant quality

Clamping control
- Digital clamping pressure
- Clamping position sensor

* already prepared
Industry 4.0
Sensors: Spindle – MPC (i4.0)

Spindle - MPC

Performance
› In Process vibration monitoring
› Machine quick shutdown in case of a crash
› Torque monitoring during drilling and threading

Advantages
› Increased availability through:
  › Avoidance of drill breaks through determination of tool wear
  › targeted maintenance due to bearing condition diagnosis of spindle
  › Imbalance analysis for Tools
› Error analysis by visual display in Condition Analyzer (lights)
› Avoidance of machine interruption
› Cost savings by reducing of damages in case of a crash

Representation in Condition Analyzer

Specific report to maintenance department
Industry 4.0

Sensor package milling i4.0

**Machine protection**
- MPC (Machine Protection Control)
  Preventive machine protection by quick shutdown

**Accuracy**
- SGS (Spindle Growth Sensor)
  Spindle displacement sensor for determining and compensating the stem extension due to bearing kinematics and temperature

**Process safety**
- IKZ flow rate control
  Measuring the flow rate of the coolant supply pump to ensure the required cooling capacity and for certification of processes and components

**Function in Sensor package i4.0**
- Process monitoring, certification, optimize and analyze
- Machine and tool protection
- Spindle bearing diagnosis
- Precision
- Process optimize, analyze and certification
- Machine and tool protection
Customer benefits
- Energy an air consumption (DIN5001, energy-audit)
- Media control for preventive maintenance (flow rate, level, lubrication condition)

Advanced sensor control
Advanced sensor analysis

State control

Accuracy check
- Temperature control
  Temperature-analysis-system

Customer benefits
- relocation compensation
- precision drilling; 50% tolerance utilization
- Data-Logger for temperature fingerprint

Temperature control

Machine protection
- MPC
  Machine Protection Control

Customer benefits
- machine and tool protection
- diagnosis of the spindle bearing
- Process monitoring

Process monitoring

Easy Tool Monitor 2.0
Tool monitoring

Customer benefits
- Tool breakage and wear monitoring
- process optimization an analysis
Industry 4.0

The platform of DMG MORI with new innovations

10 new APPs - 50 new functions

- Partner APPs - In 7 steps to your own app
- More intuitive
Industry 4.0
Expansion stages of networking

MyMachine

allMachine

allFactory

CELOS App Condition Analyzer

Machine server

PC

Company server

Smart Data

Factory A

Factory B