Competitive advantages – made by digital & intelligent engineering & manufacturing

Bosch Manufacturing Solutions | BMG
Steffen Gottwald @ Automatica 2025

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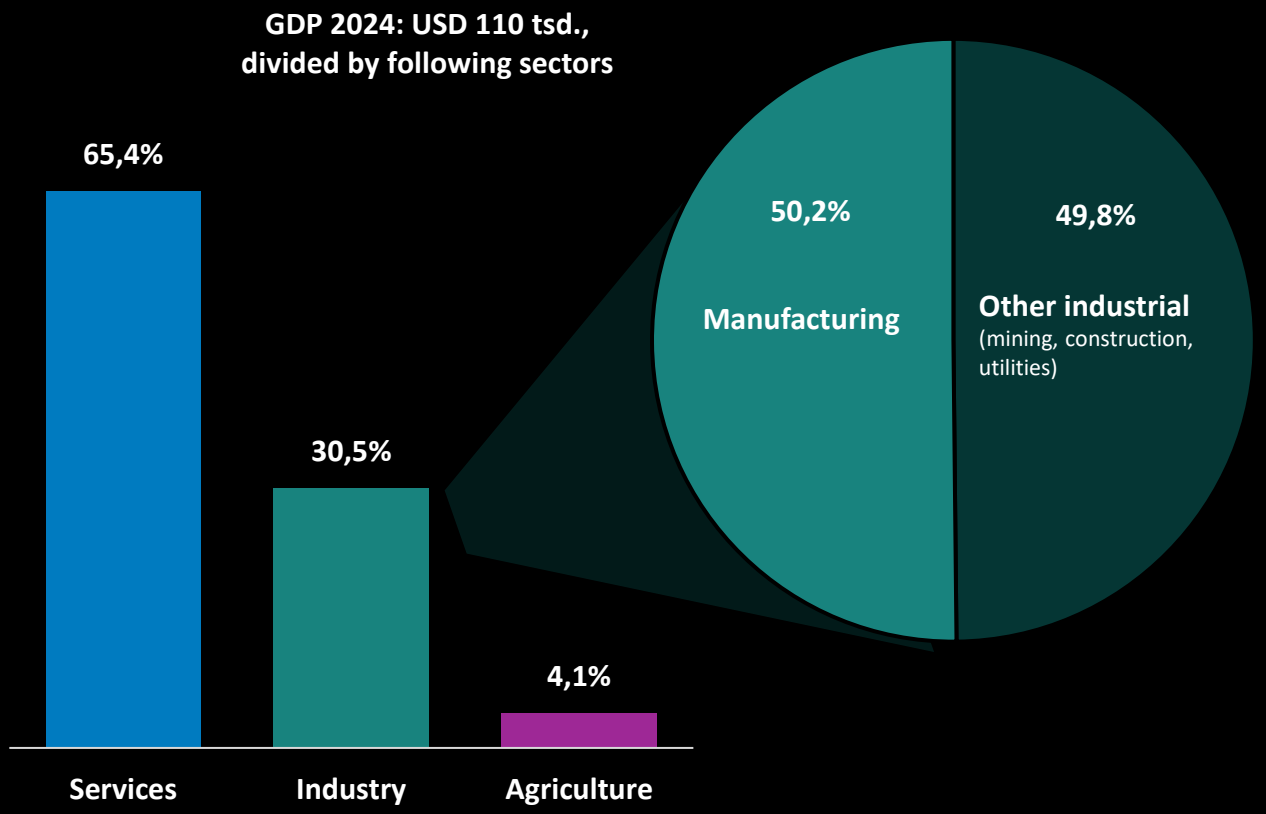
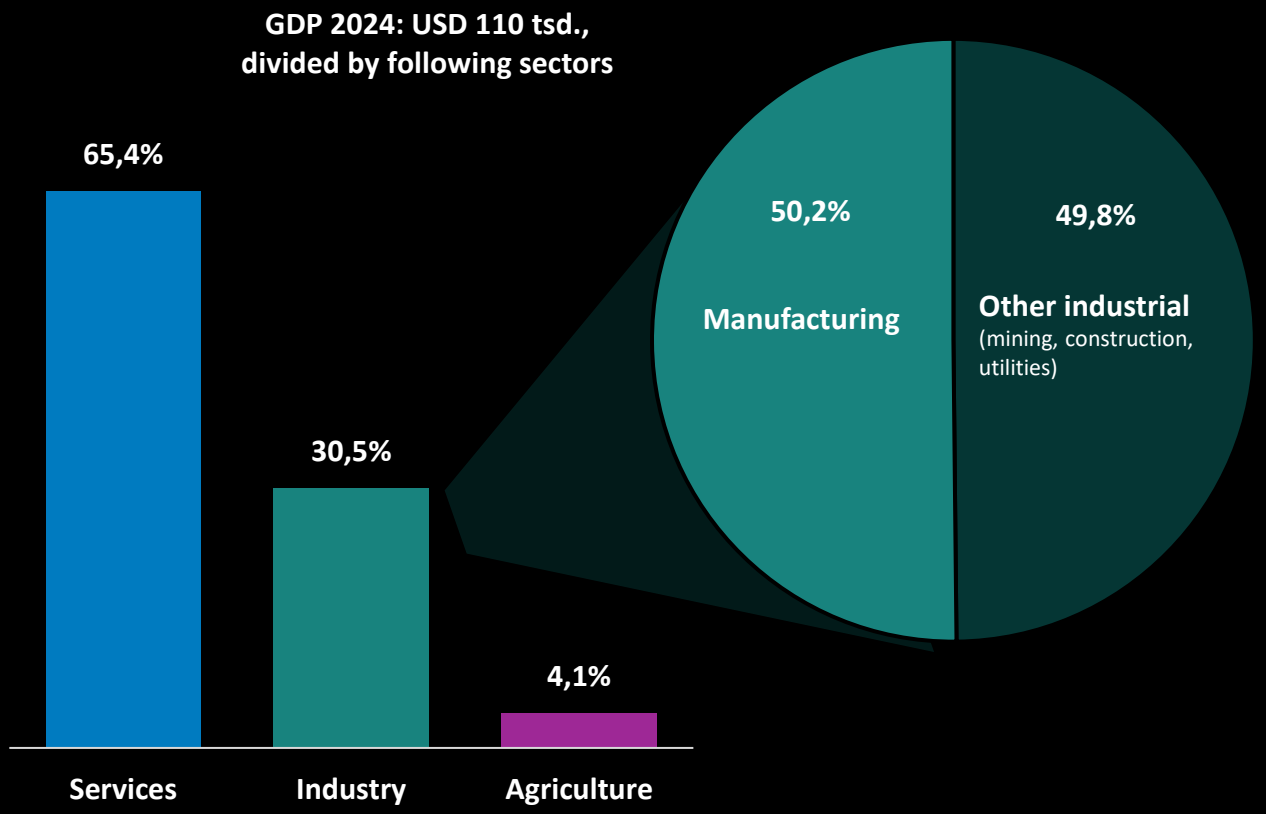
Industrial Manufacturing – global economic driver is facing major challenges



Industrial Manufacturing – global economic driver is facing major challenges



Challenges: Faster, cheaper and customized

Fast changing, more complex products

→ More complex manufacturing processes

→ Rising demand for flexibility

→ Decreasing demand for longevity

Rising costs vs. cost-pressure in product markets

→ Demand for efficiency in production, reduced investments, increased automation, …

Skill gaps & increasing regulation

… and many more

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Industrial Manufacturing – main cost drivers in industrial manufacturing are operational, not investment-related

- **40%** of manufacturers: downtime is the biggest source of operational cost
- **Ø 300 hours / year** of unplanned downtime
- Average cost of **~ $260,000 / h**
- **~ 21%** is caused by equipment failure
- **~ 50%** is caused by manual data entry errors & administrative delays

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Industrial Manufacturing – cost competitiveness by TCO optimization made by digital & intelligent engineering & manufacturing

Intelligent machinery can improve product performance and predict necessary maintenance

- **Digital Twin:** Up to **$27B median annual impact globally**; 19% cost savings, 15% CO_2 reduction, 22% ROI
- **Virtual Commissioning:** **30% shorter commissioning time**, **20% cost reduction** for shop-floor system rollout
- **Predictive Maintenance:** Potential to **reduce unplanned downtime by up to 35%** & **Cost Savings of 20–40%** using AI-based Predictive Maintenance

… clear! … but HOW?

BMG | **who we are**

Bosch Manufacturing Solutions | BMG –

Global industrialization partner & turnkey special machinery provider for production equipment & automation

- > 30 years of experience as special machinery supplier
- > 4.000 assembly & testing systems
  > 10.000 small & services projects
- Automation level adjustable,
  semi- to fully automated solutions
- Digital planning & process to digital engineering & i4.0 applications

>17
Locations

Full-liner
portfolio

Several industries & product areas

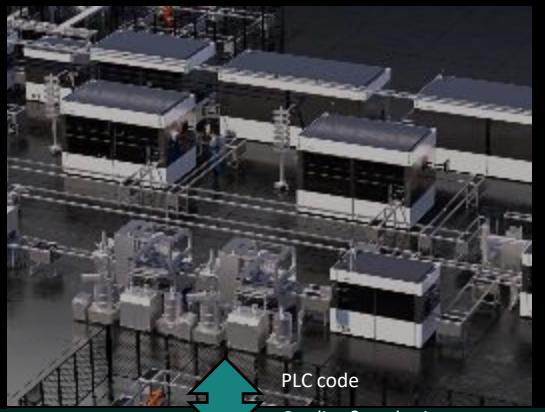
1.900
Employees

~680
TNS m€

Digital & intelligent engineering & manufacturing

Seamless data flow as foundation for closed-loop engineering

Physical Equipment



Field Data
Design Drawings

Real dimensions
Assembly exp.

PLC code
Quality & cycle time exp.

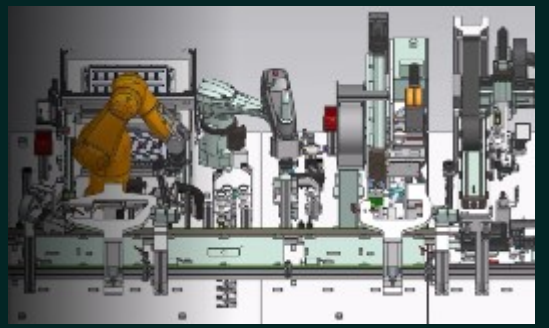
Process & Maintenance Optimization

Field Data
Operation Support

Digital Twin

Digital Engineering

Design Drawings
Obstacle Clearance
Cycle time
Feasibility



Virtual Material Flow and Commissioning

Field Data
Interface & GUI verification

Data-driven Solutions & Services

Life cycle

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BMG | **our portfolio**

Engineering Consulting & Digital Engineering

Seamless Digital Toolchain
- Automation of engineering tasks
- Bi-directional change management
- Highly efficient global collaboration

Mechatronic Modular Standards
- Effective reuse in engineering
- Creators are provided right content at right time
- Exchange of standards across organizations

Functional Machine Structure
- Structured requirement engineering
- One perspective for all domains
- Parallelized work

Field Data Leverage & model-based Engineering
- Digital machine twins
- Product understanding and improvements

Digital & intelligent engineering & manufacturing

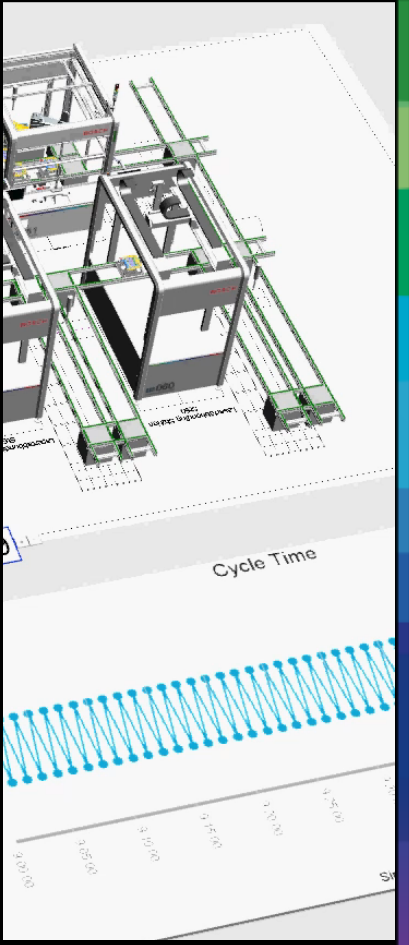
Digital Engineering | material flow simulation

Validated line concepts lead to a considerable risk reduction, even before the equipment is fully designed

- Analysis of cycle time to reach target of xx s
- Standard and custom-tailored line & logistics KPIs, e.g. cycle time, utilization, throughput-time etc.
- Decoupling analysis within and between segments
- Bottleneck identification and optimization analysis considering technical availabilities & additional losses

Benefits

- Overall concept verification including external MAE
- Optimized number of WPCs → Reduction of up to 25 %
- Optimized station concepts e.g. additional buffer position
- Optimized decoupling concept regarding buffer type, size and position



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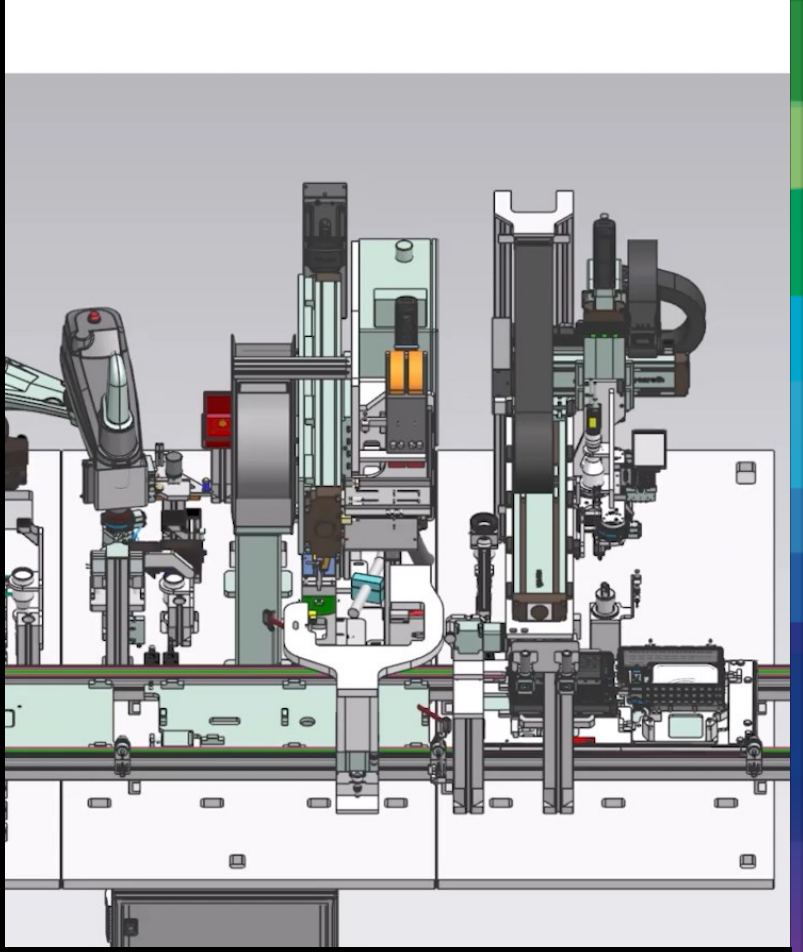
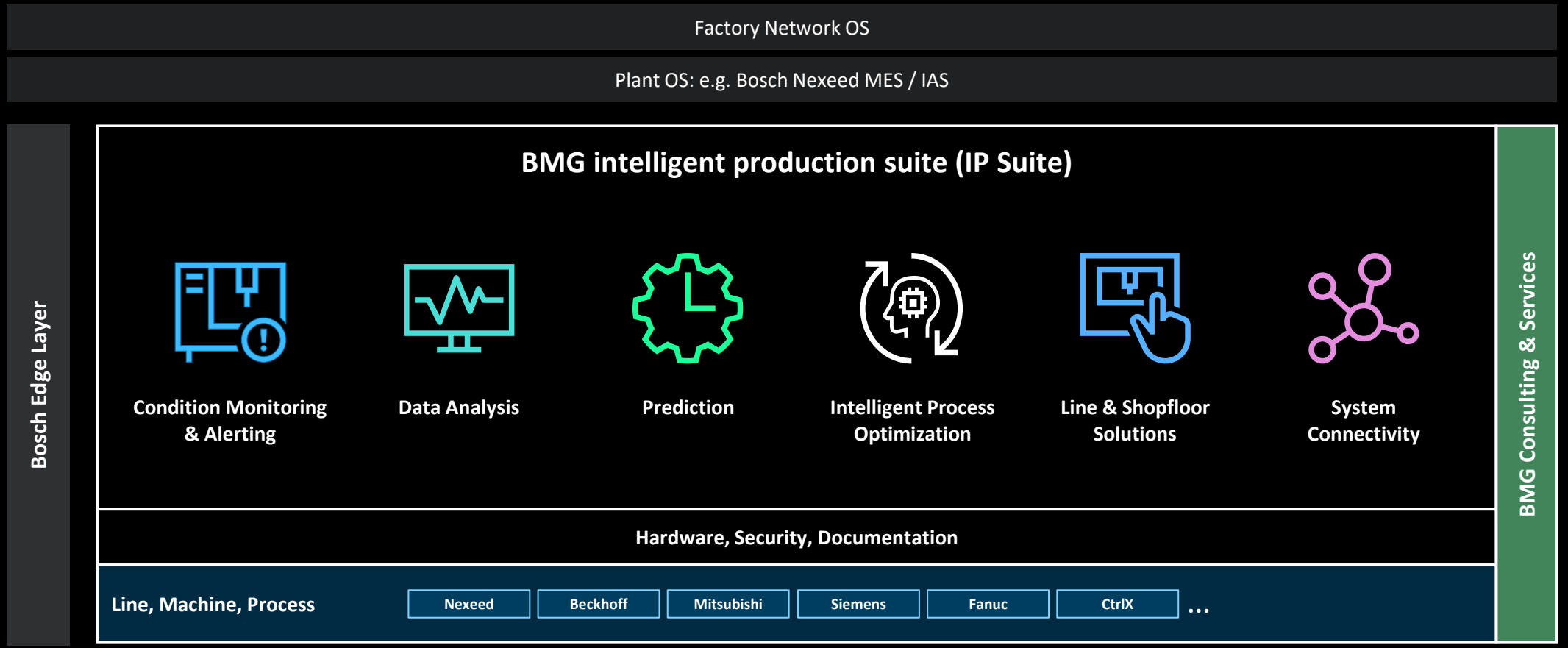
Digital & intelligent engineering & manufacturing
Digital Engineering | virtual commissioning (ViC)

- Kinematic 3D simulation
- Risk & failure cost reduction
- Reduction of commissioning time & time to market
- Parallel mechatronic engineering in early project phases
- Basis for further optimizations and maintenance support during the machine life cycle



Digital & intelligent engineering & manufacturing

Digital & Intelligent Solutions | IP Suite environment



Digital & intelligent engineering & manufacturing

Digital & Intelligent Solutions | IP Suite modules overview

BMG intelligent production suite (IP Suite)

Condition Monitoring & Alerting

- Process Monitoring
- Health Report
- Cycle Time Assist
- Cycle Time Analysis
- uHMI (universal HMI)
- Dolphin

Data Analysis

- AI-based Anomaly Detection
- AI-based Root Cause Analysis
- MathEngine

Prediction

- MathEngine

Intelligent Process Optimization

- PPO (Process Parameter Optimization)
- MathEngine

Line & Shopfloor Solutions

- DashCam (Event-based Video Monitoring)
- KPI-Views / Digital Twin
- MTS (Maintenance Ticket System)

System Connectivity

- UMC (Universal Machine Connector)

Hardware, Security, Services & Documentation

- Experience Share System (ESS)
- EFA (Embedded Field Application)
- Digital Manuals

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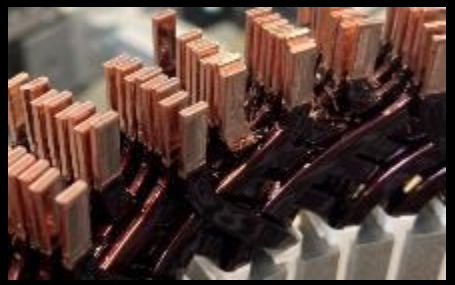
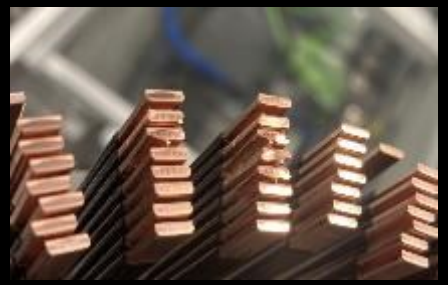
Digital & intelligent engineering & manufacturing
Predictive Maintenance & Anomaly Detection for Twisting

Motivation

- Reduce **tool cost** at least by **100T€/a per MAE** (depends on utilization rate)
- **Avoid unplanned downtime of 4h** per event & increase production output by **ca. 500 Pts**
- Minimize failure cost and rework

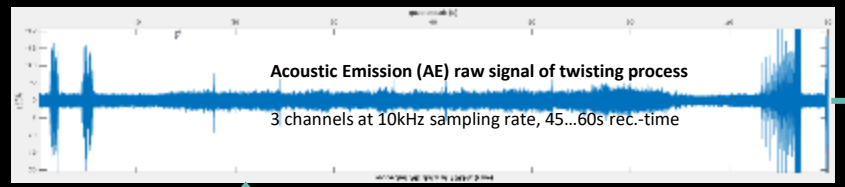
Approach

- Pre-emptive detection of gear tooth fractures
- Real-time identification of missing products during twisting
- Prevention of pin jamming during tool insertion & retraction
- Optimize maintenance intervals


Digital & intelligent engineering & manufacturing

Predictive Maintenance & Anomaly Detection for Twisting



sampling, filtering

UMC

log.csv server

MES server

Universal Machine Connector (UMC)

PLC twisting machine

MQTT Broker

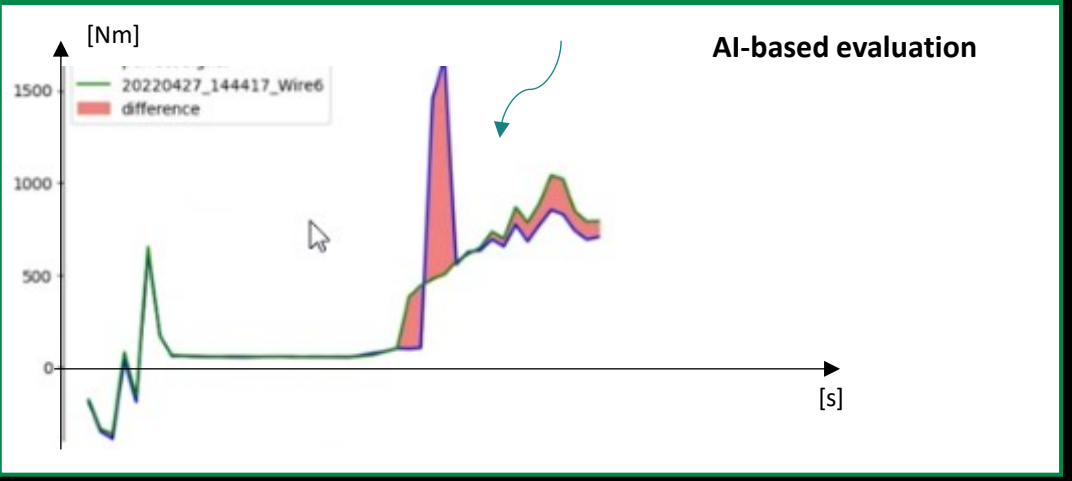
merge and distribute data

KPIview

Maintenance Ticket System

GUI

Anomaly Detection & Predictive Maintenance
(Math Engine - Python Backend)



Inputs: **1.** AE signals of twisting

2. all currently available data from station plc & MES

Outputs: AI-based data processing and evaluations for predictive failure prognosis / maintenance and alerting via MTS

Digital & intelligent engineering & manufacturing
User Centric Data- & Result Visualization

KPI View (digital twin)

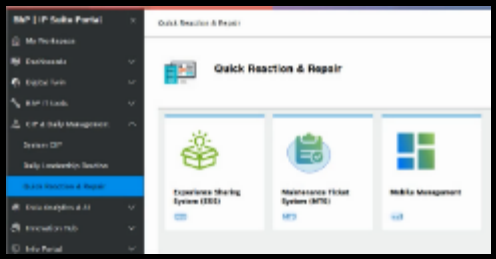
- Customized and real-time visualization
- Middleware between machine and data platform
- Easy data collection to support setup of plant big data platform
- Data-based maintenance using edge computing with low code programming
- Immediate reduction of machine downtimes as well as long term competence build up

Process Monitoring

- Visualization of process parameters
- Basis for deciding when and with which technical measures to intervene in production processes
- Reduced commissioning time
- Increased machine productivity by promptly notifying operators of issues for fast resolution
- 85% of time effort saved during failure analysis
- Avoiding additional material cost by preventing e.g. tool damage

AI-based Anomaly Detection & Root Cause Analysis

- AI model is trained on time-series data for causality inference in real manufacturing use-cases
- Discovering causal relationships by understanding and identifying interdependencies amongst individual variables
- Top causes for deviation in quality parameters, thus resulting in scrap generation will be determined
- Learns trends from historical data and applies it to newer data to regulate the processes using AI/ML algorithms



Maintenance Ticket- & Experience Share System

- Efficient solution for reducing unplanned machine downtime
- More machine error detail can be sent to technicians
- Technicians are immediate informed
- Experiences are easier share between technicians
- Short response time in machine unplanned stop
- Knowledge & Date based maintenance
- Transparent problem-solving process

My Workspace
All Modules
Department View
Business Intelligence
Digital Twin
Plant View
Area/Section View
Line View
Station View
test
testlink
CIP & Daily Management
Customer Interface
Supplier Interface
Info. Portal
CORE.SIDEBAR.CONFIGURATION
CORE.SIDEBAR_ACCESS.CONFIG
CORE.SIDEBAR.INSIGHTS
CORE.SIDEBAR.IMPRINT

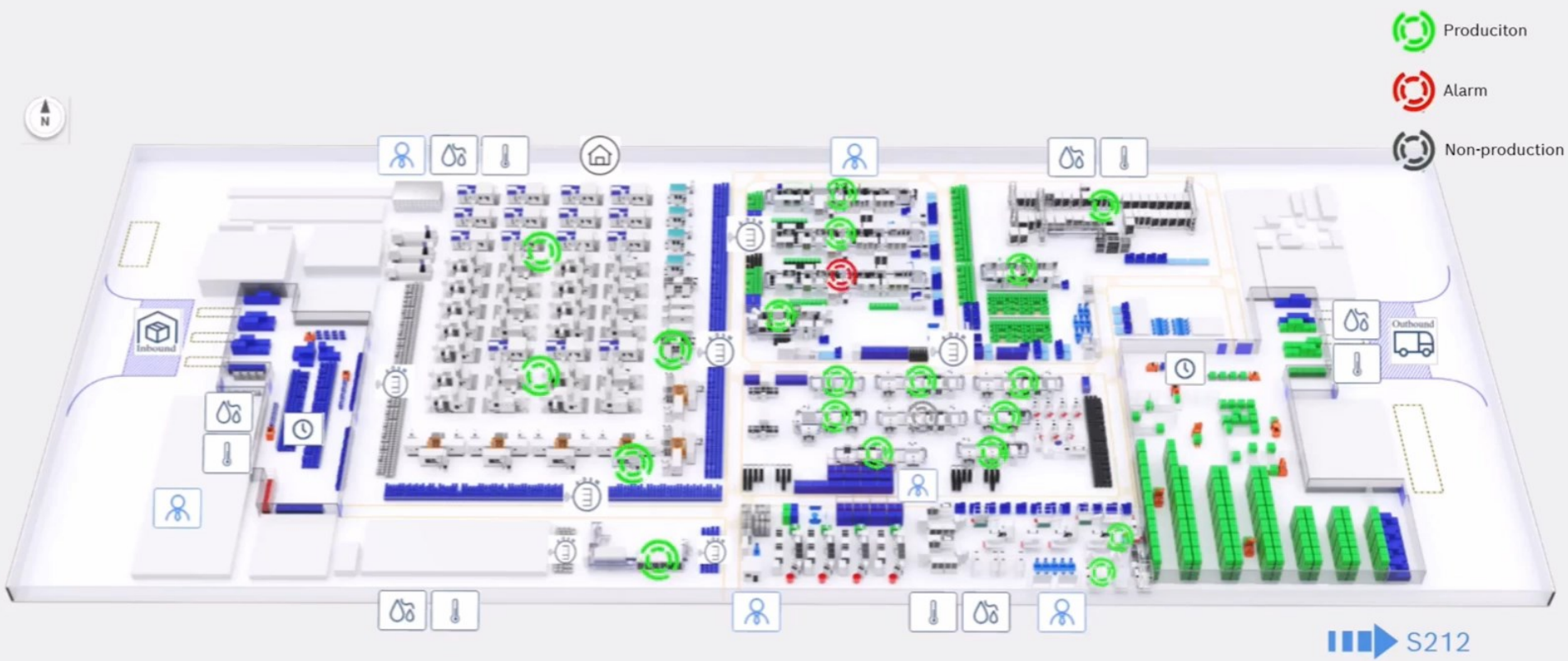
DEMO

S 1,314 days w/o reportable safety accidents

Q 314 days w/o related customer complaints

D 00,000,000,000 pcs IPB delivered

P 36677 Szh2 Associates



Competitive advantages – made by digital & intelligent engineering & manufacturing

Challenges:

Faster, cheaper and customized

→ Cost competitiveness by TCO optimization, made by digital & intelligent engineering & manufacturing

→ Closed-loop engineering as basis for seamless data flow

→ Smart digital solutions for sustainable, data-driven manufacturing

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