Simulation based Digital Twins

for Predictive Maintenance, Optimal Operation & New Business Models

Teresa Alberts, Christof Gebhardt, CADFEM Group & ITficient
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20+ COMPANIES
500+ EMPLOYEES
17+ COUNTRIES

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Overview ITficient

Digitale Service Models

Digital Twins

Analytics
What do you understand by a Digital Twin?

- Simplified simulation model
- Behaviour model
- Find useful life
- Replica
- Magic
- Data models
- Big Data
- System model
- Physikalisches Abbild
- Digital Factory
- A copy of a full system
- Mathematical modelling
Digital Twin

Connection between the physical and digital world

- Sensors + Analytics (+)  
  Simulation / Machine Learning
- Realtime Condition Monitoring
- Predictions and What-if-Scenarios
Optimal operation

- Secured availability
  - Condition based monitoring
  - Cost reduction by optimized service and spare parts
- Balancing of operation time, performance & operation costs

Smart Products / Services

New revenue streams

- New business models
  - Maintenance as a Service
  - Recommendations as a Service
  - Machine as a Service
- Customer specific solution sales
  - Configuration as a Service

Customer loyalty

- Competitive positioning
- Customer satisfaction
- Trust
- Innovation power
Digital Twin Use Case
Verbund Hydro Power
Verbund Hydro Power

- Austria's leading electricity company
- Gain 90% of generation in 130 hydropower plants
- Regulation controlled via 7 central bases
Motivation: Fatigue fracture of control rod of turbine blades of vertical Kaplan runner
Challenges

Downtimes

- Loss of production
- Procurement service and spare parts
- High cost
- Maintenance at fixed defined intervals

High operating costs

- Risk minimization (quality, contracts, ...)

High operating costs
„Our goal are transparent power stations („gläsernes Kraftwerk“) for which we know the exact current status of all components, to avoid downtimes by unpredicted failures.“

Karl Heinz Gruber
CEO, VERBUND Hydro Power GmbH
Project Approach

Digital Twin 1.0
Realtime Monitoring
MS 1  MS 2  MS 3  MS 4

Workshop Digital Twin

2019
Q2  Q3  Q4  Q1  Q2

Digital Twin 2.0
What-if Scenarios
MS 1  MS 2  MS 3

Workshop Digital Twin 2.0

Implementation
VERBUND IT Infrastructur
Real-time Monitoring of Remaining Service Life

Digital Twin Generation

3D-Geometry

Finite Element Analysis
Real-time Monitoring of Remaining Service Life

Digital Twin Generation

Finite Element Analysis: Determination of the hotspots

Hotspot 1

Hotspot 2

Reduced Order Model (ROM)
Real-time Monitoring of Remaining Service Life

Digital Twin in Operation

Online measurement data ➔ ROM ➔ Rainflow counting ➔ Fatigue analysis
Technical Implementation of the Prototype

**Sensors**
- Physical Sensors
  - eg. Speed, flow rate, power
- Import Sensor Data in IoT-Platform

**IoT Platform**
- Device Management & Security
- Transfer Sensor Data to Simulation Model (ANSYS TwinBuilder)

**Simulation**
- Virtual Sensors & Lifetime Analysis
  - Generation of the simulation model in ANSYS TwinBuilder
  - Determination of the hotspots
  - Reduced Order Model (ROM)
  - Integration of Fatigue Analysis through sensors and virtual sensors

**Analytics**
- Visualization of sensors, virtual sensors, and remaining lifetime in Verbund Dashboard
Prototype Development: What-if Scenarios

- Provide greater insight into how to operate the system in a system-friendly way
- Provide insights what it means for the lifetime if the system is operated under very high or low loads (synthetic load spectrum)
What-if Scenarios: Balance of Plant Performance & Degradation
"In addition to achieving the highest possible availability of hydropower plants, we also aim to get a more well-founded forecast of their remaining service lives. We also expect benefits in terms of the condition-based servicing and the avoidance of expensive repairs."

Dipl.-Ing. Dr. Bernd Hollauf
Project Manager Digital Hydro Power Plant at Verbund Hydro Power

„This process of asking ‘what if X happens’ can provide us with greater insight into how to operate the system in a system-friendly way or what it means for the service life if the system is operated under very high loads."

Dipl.-Ing. Michael Artmann
Project Manager Digital Twin at Verbund Hydro Power
Our definition of a Digital Twin

- Virtual Model
- Connection between the physical and virtual world
- Realtime Condition Monitoring
- Lifetime prediction: measured loads
- Lifetime prediction: synthetic loads
Condition based Operation

- Evaluation of plant operation
- Fulfill GHG regulations
- Minimize losses
- New service by valve OEM
Virtual Sensor for Medium Released

• Equip safety valve with additional pressure sensor
• Engineering knowledge and simulation model from OEM development process
• Track pressure over time → quantify medium released
• Virtual sensor as digital service for operator, managed by valve OEM
Optimal operation

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<table>
<thead>
<tr>
<th>Topic</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Development of smart Products and smart Services</td>
<td>83%</td>
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<tr>
<td>Predictive Maintenance for your End Customer</td>
<td>67%</td>
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<tr>
<td>Condition Monitoring for your End Customer</td>
<td>50%</td>
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<tr>
<td>Condition Monitoring for your Production</td>
<td>8%</td>
</tr>
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Ecosystem
How arises an ecosystem right now?

Operator

General Contractor

OEM Sub-Subsystem 1 e.g. pump

OEM Subsystem 2 e.g. electric drive

OEM Subsystem 3 e.g. armatures

... OEM Subsystem n e.g. safety systems
Supporting your customers in the development of new digital service models

Technical support for the creation of your digital twin
Contact

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