AGENDA - SMART INDUSTRY 4.0

1. INTRODUCTION - DATATRONiQ
2. PREDICTIVE MAINTENANCE - LEADEC INDUSTRIAL SERVICES
3. PREDICTIVE QUALITY - CONTITECH
4. Q&A
In complex shop floor environments relevant data is not integrated and still locked away.

- Each connected machine creates Gigabytes of data per hour.
- That’s why big data technologies and machine learning automation is crucial.

DATATRON IQ BUILDING BLOCKS
INTELLIGENCE FOR MACHINES

DATATRON
Smart Data Hub

DATATRON IQ Dashboard

KNIME Connector
DATATRONIQ – Our USPs

- Higher Availability
- Better Performance
- Improved Quality
- Reduced Costs

CONTINUOUS MACHINE LEARNING LOOP
HUMAN MACHINE INTERFACE FOR ACTIVE UNSUPERVISED LEARNING

ACTIVE LEARNING

ROOT CAUSE ANALYSIS
Use case Leadec DATATRONiQ Predictive Maintenance
Berlin, March 2018
Leaded in numbers.
An overview.

- Sales €851 million
- In more than 200 sites
- In 14 countries
- More than 50 years of experience in the automotive industry
- More than 16,600 employees

Who gives you the benefit of their experience? We do at Leaded.

1962
Foundation of company in Munich, Germany.
Core activity: technical cleaning and maintenance

1985
Company renamed Deutsche Industriewartung GmbH & Co. KG (DIW)

2000
Voith acquires DIW and establishes the division Voith Industrial Services

2005
Expansion into America through the acquisition of Premier Group, Cincinnati, USA

2006
Majority takeover of Hörmann Industrietechnik, Kirchseeon, Germany

2009
Expansion into Asia through the establishment of company in China

2013
Takeover of ThyssenKrupp Services in the UK

2014
Acquisition of Helix Systems, Bessemer, USA

2017
Voith Industrial Services will become Leaded, owned by private equity firm Triton

Stand: Fiscal year 2016
Company – Services – Benefits
Where will you find us?
Wherever you need us.

North America
- Employees: 3,300
- Sales: 205 Mio. €

South America
- Employees: 2,100
- Sales: 44 Mio. €

Asia
- Employees: 2,400
- Sales: 45 Mio. €

Europe
- Employees: 8,800
- Sales: 556 Mio. €

Stand: Fiscal year 2016

How do we satisfy stringent requirements?
With comprehensive services.
As experienced industry insiders we anticipate future technological developments and create the optimum conditions for our customers in good time to secure them a decisive competitive edge.

- We collect and process information about your production processes in digital form and work with you to develop digital business models
- Thanks to our IT systems and tools your processes not only become paperless and more efficient but also more transparent – so that unexploited potential can be identified more rapidly

### Site Leadeck Mamming Overview

<table>
<thead>
<tr>
<th>Production / capacity</th>
<th>Complexity</th>
<th>Technology</th>
<th>Logistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 2 automated assembly lines (Hofmann), JIT and JIS-production: 275 complete wheels per hour (max.) per line</td>
<td>• Directional wheels</td>
<td>• Camera based, automated DOT-DOM-recognition</td>
<td>• Rims and tires:</td>
</tr>
<tr>
<td>• Finished parts storage with automatic warehousing (Güdel): 480 complete wheels per hour (max.)</td>
<td>• Mixed-sized tires</td>
<td>• fully automated matching station</td>
<td>• 295 rim variants</td>
</tr>
<tr>
<td>• currently 2 shift operation, reserve night shift and weekend</td>
<td>• Steel and aluminum rims</td>
<td>• Seat optimization: optimum seat of the rim within the tyre bead</td>
<td>• 276 tyre variants</td>
</tr>
<tr>
<td>• 2,000 complete wheels per shift and line</td>
<td>• Summer and winter tires as well as run-flat tires</td>
<td>• Uniformity: measuring the concentricity</td>
<td>• Pass-through shelves and single trays</td>
</tr>
<tr>
<td></td>
<td>• Directional rims</td>
<td>• fully automated balancing machine</td>
<td>• Block storage</td>
</tr>
<tr>
<td></td>
<td>• Inch size: 16&quot;-21&quot;</td>
<td>• Fully automated sequencing</td>
<td>Small parts:</td>
</tr>
<tr>
<td></td>
<td>• Offset: max. 41</td>
<td></td>
<td>• 25 part numbers small material</td>
</tr>
<tr>
<td></td>
<td>• Currently: 1,122 different complete wheel variants</td>
<td></td>
<td>• Block storage</td>
</tr>
</tbody>
</table>

Period: 01/09/2014 – 31/08/2022
2. Pilot project (sensor installation) with DATATRONiQ in Mamming

- Installation of 6 acceleration sensors at the lift table and the spindle axis of the balancing machine
- Integration of function block in PLC and Kuka robots (6 robots) → Collection of failures, signals and conditions
2. Data overview

vibration data:
- 6 single axis acceleration sensors
- frequency range 1Hz - 20KHz
- sampling rate 10 times per hour (10 sec duration)

Kuka robot data:
- collecting of 30 different values and conditions (e.g. drive currents, turning moments, temperature, etc.)
- sampling rate 1sec (1Hz)

PLC Data and failure messages:
- collecting about 600 different values and conditions (e.g. error messages, status values, motor currents etc.)
- sampling rate 10ms (100Hz)

Camera:
- HD-Camera for failure support
- real time view and archiving for trouble shooting

3. Dashboard & KPI’s

Dashboard functions:
- real time KPI’s
- individual reportings
- shift book and failure documentation
- MS Excel export
- ...

Use case Leadec Datatroniq Predictive Maintenance Mamming / Berlin / March 2018
5. Interactive root-cause analysis to catch on cycle time variations

- Period of observation: April - September 2017 (795 different variations)
- 320,000 mounted wheels with 20 different attributes
- Average cycle time of 13.59s \( \rightarrow \) 88.24% performance
- Rims > 470mm need 0.5s longer
- Rims with more than 25.5g counterweights take 0.5s longer
- The valve type has an effect on the cycle time
- Tires which are wider than 270mm are 0.5s slower

With the data evaluation and failure analysis, a supplier- and component development is possible.

Use case Leadec Datatroniq Predictive Maintenance Mamming / Berlin / March 2018
4. Anomaly-detection on a Kuka robot in Mamming

- anomaly indication 10 hours before crash
- the readout of the Kuka log was not activated in the function block of the app → no information if the program was changed
- cooperation with the internal Leade robotic center in Chemnitz → simulation of crashes and other untypical motion sequences to train the algorithms
- idea: scaling of this trained model to other similar systems for example robots

A different perspective – Root Cause Analysis

Indicators for abnormal behavior detected several hours before failure
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Machine Learning Automation in quality environments

Thomas Zipf
CT MFS / AIS / ContiTech MGW GmbH

Organization Overview

Continental Corporation

Division

- Rubber Group
- Tires
- ContiTech
- Chassis & Safety
- Powertrain
- Interior

Automotive Group

- ContiTech China
- ContiTech North America
- ContiTech South America

Rubber Group

- GBS
- Communications
- Controlling
- Engineering
- Human Relations
- Information Technology
- Quality & Environment
- R & D

ContiTech

- Air Spring Systems
- Barocke-Kalke Group
- Compounding Technology
- Conveyor Belt Group
- Elastomer Coatings
- Industrial Fluid Solutions
- Mobile Fluid Systems
- Power Transmission Group

- CV Original Equipment
- CV Independent
- Aftermarket
- EU OEM
- CV Industry
- BMW, MEC
- GM Ford, Chrysler
- China OEMs

Business Unit

- Mining EAA
- Mining Latin America
- Industrial Filtration Systems
- Fuel Cells
- NAFTA
- China

Continental ContiTech MGW GmbH
Eisenacher Landstraße 70
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Status 02/2017

Thomas Zipf
Who I am and where do we come from?

I’m Quality Planning Engineer

- Root cause analysis (manually) and long term improvements (internal and external) for Design Processes
- Production Processes
- Management Processes

Our Products are: Turbo Charge Air Tubes & Hoses

- Plastic related Process environment such as:
  - Blow Molding
  - Injection Molding
  - Plastic Welding

Our Product: Turbo charged air systems

Temperature
Pressure
Quality
Material
Processes
Elastomer
Weight
Costs
Design
Metal
Installation space
Extrusion
Connection
Tensile member
Lengths
Acoustics
Process capability
Operational reliability
Tests
Functional integration
Injection molding
Blow-molding
Wrapping
Which kind of tools do we use?

- Six Sigma toolbox
  - DMAC/PDCA (Define, Measure, Analyze, Control)
  - Design of Experiment
  - Ishikawa, CE-Matrix, 5Why
  - Hypothesis Testing, Regression
  - SIPOC (Supplier, Input, Output, Customer)
- Statistical Process Control, Control Charts
- Methods for Risk Management
- FMEA (Failure Mode and Effect Analysis)
- Design for Six Sigma

Abstract View:

1. All processes record and enrich data to make better decisions and assumptions
2. DMAC is the centered approach to achieve progress.

(Other Tools are considered “supportive” to DMAC)

Experiences from first predictions
Loop speed is key for learning.

- FMEA
- CE-Analysis
- other Q-Tools
- Revise input based on previous analysis (Showstopper)
- Measure Data
- Read Data Input sources
- Transform Data
- Deploy model and / or revise input data to increase model performance
- Initiate Retraining based on deteriorating model performance or feedback from shop floor
- Internal
- Space for Sender Information
- Explore new features from data
- Check significance of input data
Past experiences from first predictive trails...

- We started with KNIME
  - Easy to use
  - Low initial barrier esp. no costs
  - Good tutorials and information available
  - Huge potential for reporting
- But, bad data coming in.
  - Revise input data

Data Density and Acquisition costs

<table>
<thead>
<tr>
<th></th>
<th>Product Data</th>
<th>Process Data</th>
<th>High Res. Process Data</th>
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<tbody>
<tr>
<td>Costs</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Trust</td>
<td>High</td>
<td>Med</td>
<td>High</td>
</tr>
<tr>
<td>Availability</td>
<td>Low</td>
<td>Med</td>
<td>High</td>
</tr>
<tr>
<td>Operational Risk</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

How to create trusted process data?
Industrial I.o.T. Data for machine learning. Concrete application

- Feed machine Data controlled/selected by Dashboard setting
- Feed Data per serial number from
  - Quality
  - Maintenance
- Create Score for maintenance
- Create Score for Quality
- Feedback to machine / operator

Expected Results – better Risk driven Process
Key Benefit of Machine Learning

Key Benefit of Analytics and Machine Learning
(with KNIME and DATATRONIQ):
› Dramatically faster improvement loops

Use Case related:
› minimized risk while operation
› fast system optimization
› massive cost reduction

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Thank you for listening.
Enjoy the 2018 KNIME Summit.