# Achieve Operational Efficiency in Car Manufacturing with Advanced Analytics

Dr. Sebastian Schmerl | Solution Manager Cyber Defense for Production and IoT Philipp Drieger | Sr. Sales Engineer | SME BA IoT ML

28. September 2017 | Washington, DC

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#### Your 3 key takeaways from this session



Understand challenges in industrial production and data driven approaches Learn how to collect low layer data from production environments Get insights how to gain operational efficiency with data analytics









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#### Agenda

- Some brief words about us
- Challenges in industrial production environments based on car assembly lines
- Production data acquisition
  - High and low layers of production data
  - Active & passive data capturing
- Data collection infrastructure
- Data analytics for different levels of production data
  - Analysis of layer 3&4 data MES, Historian Data
  - Analysis of layer 1&2 data raw sensor and actuator data
- Some Splunk numbers
- Summary, Q&A

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#### WHAT WE DO



Manage & Transform





Users Supported

Source &





#### Dr. Sebastian Schmerl

Head of Production Data Analytics, Industrial Security, Cyber Defense

#### Subject Matter Expert for:

- SOCs
- **ICS & SCADA Security**
- Industry 4.0 & Data Science

#### Contact: Sebastian.Schmerl@computacenter.com

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#### Bio: Philipp Drieger Sr. Sales Engineer

- Splunker since 2015.
- Subject Matter Expert for Business Analytics, IoT and Machine Learning
- Before Splunk: lots of software development, data analytics and visualization
- Enjoys this year .conf with 2 talks:
  - Automating Thread Hunting with Machine Learning (tomorrow 1:10pm!)
  - Achieve Operational Efficiency in Car Manufacturing with Advanced Analytics
- Good chance to meet me at ML or IoT Booths
- Questions? Feedback? Let me know: <a href="mailto:philipp@splunk.com">philipp@splunk.com</a>





# Challenges in industrial production environments based on car assembly lines



## **Digitization of Production**

Analytics as main value drivers



Industrie 4.0 - increase in productivity over 20 percent

# **Plants and Analytics are in Focus**

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common sense in all market analysis reports

Source: Industry 4.0 How to navigate digitization of the manufacturing sector

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## **Challenges in Car Production Environments**

- Large and complex systems with plenty of components, e.g.:
  - Conveyor systems, robots, gripping systems, welding systems, cluing systems, screwing systems, and safety-system
- Unique systems, tailored to the production process
- Build by system integrators
- Long lifespan ~10 years
- Maintenance problems can't be known at construction time.

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 Leverage data analysis for process optimization



Sources: taqplayer.info, cnsanf.com, castrol.com



## **Production Analytics Challenges**

No Data - No Analytics | No Analytics - No Progress



# Production data acquisition

From data layers and non-invasive production data extraction



#### **Production Data Layers**

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Better prediction results

& higher forecast precision

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**Production floor and process Layer** 

Fine grained temporal & sensor values

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#### **Active and Passive Data Acquisition**

	ACTIVE	PASSIVE			
PRO	<ul> <li>no data transformation</li> <li>no data dissection</li> </ul>	<ul> <li>non invasive</li> <li>no changes on automation cells</li> <li>no discussions, no re-certifications</li> <li>easy rollout</li> </ul>			
CON	<ul> <li>configuration changes</li> <li>polling of information</li> <li>PLC CPU time &amp; memory</li> </ul>	more complex			
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#### **PDEX – Extraction of Production Data**



#### **PDEX – Extraction of Production Data**



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#### **PDEX**

#### Extraction of production data from network traffic

**Production data in Splunk** 

#### Raw network traffic with production data

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# Data collection Infrastructure

From aggregation and dissection of network traffic



#### **Production Data Collection Infrastructure**

for layer 1 & 2 data



#### **Splunk Analytics Infrastructure**



# Analysis of working cycles and PLC errors

Analysis of layer 3&4 data production data from automation cells



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#### **Predict Production Incidents on Assembly Line**

Conveyors, screwing, gluing, robots, humans ... in one line

- Assembly line with 19 automation cells and 160 PLCs
- 1 year data
- 350MB logs from shift books, maintenance protocols etc.
- Goal: Predict incidents at least 8 hours ahead and reduce maintenance costs

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## **Analysis of Working Cycles of an Automation Cell**

Shift in histogram of average working cycles in week by week comparison



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#### **N-gram Analysis to Detect Frequent Error Chains**

- N-gram analyses let us construct combinations of sequential categorical events in a given window in time
- Statistics can be applied to count frequencies, detect frequent patterns
- Correlate subsequent event patterns to identify more complex root cause



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#### **N-Gram Statistics**

#### What happens when and how often



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#### **N-gram Analysis**

#### Which error chains causing production impacts?

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# **Predictive Maintenance** for Electro Motors

Analysis of layer 1 production data from automation cells



#### **Analysis of Motor Profiles**

Wear of mechanics detected by RPM monitoring

Lag in mechanic transmission is detected with continuous RPM monitoring



#### **Analysis of Motor Profiles**

10 Hz frequency raw data from the motor

Screen?product id=FL-DSH-01&JSE

we have 8 OK & 3 NOK motor runs which look very similar





#### **Framing and Slicing Motor Profiles**



#### **Analysis of Motor Profiles**

- 10 Hz frequency raw data from the motor
- we have 8 OK & 3 NOK motor runs which look very similar



#### **Compare frames against the normal profile**

A non-conform motor run



/product.screen?product\_id=FIL-DSH-01&JSESSIONID=SD1SL4FF10ADFF10 //product.screen?product\_id=FL-DSH-01&JSESSIONID=SD5SL7FF6ADFF9

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26&JSESSIONID=SD5SL9FF1ADFF3 HTTP

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#### How we can visualize it...

... and how we visualize it to the customer mainly



/product.screen?product id=FL-DSH-01&JSESSIONID=SD1SL4FF10ADFf10ADFf10ADFf10ADFf10ADFf10ADFf10ADFf10ADFf10ADFf10ADFf10ADFf10ADFf10ADff10AD

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#### How we can visualize it...

... and how we visualize it to the customer mainly

But information reduction is key ③



#### Motor run conformity





# Wrap up



#### **Data Volume – Business Value**

1 assembly line with 160 PLCs a ~4 electric motors-> 400 ~ 800 GB per day



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#### **Summary** Key takeaways

- Analytics of layer 3&4 data:
  - Data often already exist
  - This layer is good to identify the pain
  - Data often not sufficient for prediction
- Analytics of layer 1&2 data:
  - Active data collection results often in configuration, service, guarantee discussions
  - Passive data collection is complex
  - The data volume is challenging
- Data analytics
  - n-grams, wave transformations, differences, profiles, ...

# Thank You!

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