

# **GREAT DESIGNS IN STEEL**

**Presentations will be available for  
download on SMDI's website on  
Wednesday, May 22**

# GREAT DESIGNS IN **STEEL**

## **REAL TIME PROCESS MONITORING FOR HOT STAMPING LINES**

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# MACHINE MONITORING SYSTEM

## Agenda

1. Motivation – Data Mining
2. Schuler Machine Monitoring System
3. Special technical features – Hot Stamping
4. Process Monitoring for Hot Stamping Applications
5. Use Cases
6. Summary and Outlook

# DIGITAL NETWORKING

- Most of our private and business actions produce digital data
- The data exchange is usually taking place over cloud computing services, P2P data exchange is reducing more and more
- **A single record** contains the information of a single operation
- **The combination of several records** contains the information about course of action, movement patterns, characters, and other information...
- Schuler is developing new sources of data mining and analytics for machine learning purposes



Digital data is collected everywhere around the world

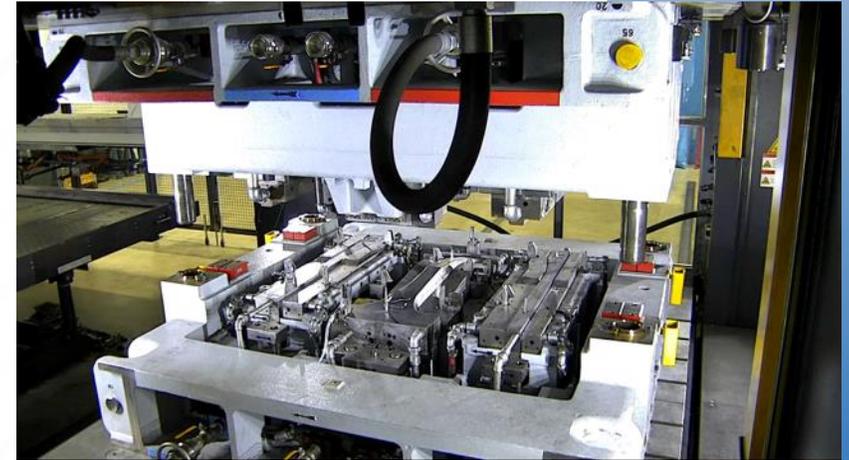
# DATA ANALYTICS – METHODS

## Classical Analysis

$$x \rightarrow f \rightarrow y$$

Already available in different Tools and Solutions

Need of domain experts



## Enabler technologies from other branches

Autonomous driving, GPU, TPU (nVidia, intel, waymo,...)

Machine Learning (MS Azure, Google DeepMind, IBM Watson,...)

## New Approaches – Tasks

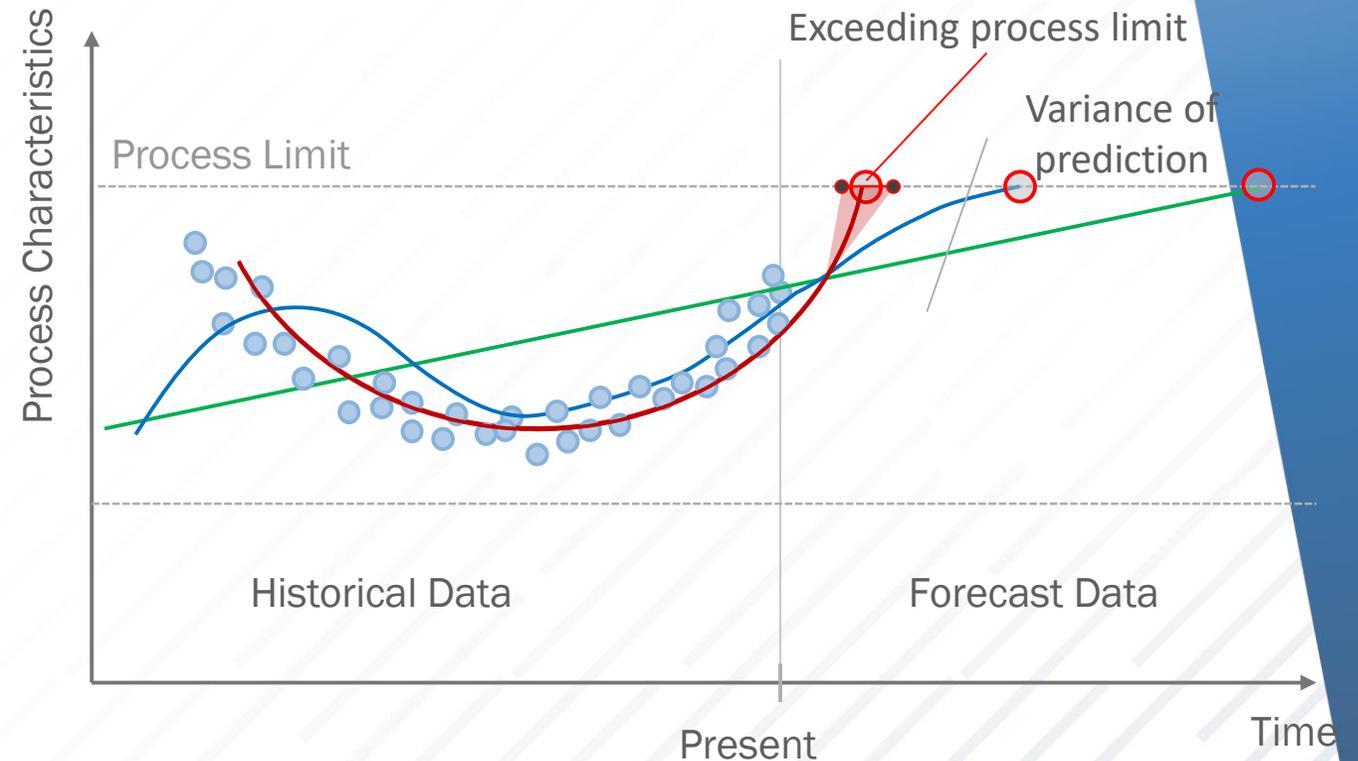
Through a continuous data acquisition and data extraction new functionalities can be created by deep learning



# PREDICTIVE DATA-ANALYTICS

## WHAT IS THE RIGHT MODEL?

- Data records processed and analyzed in real time can be compared with historic data analysis. With this combination we are able to forecast specific events.
- Predictive Analysis has a high potential in the industrial manufacturing context
- By using this information we can forecast: machine failure, malfunction of production, ...
- Preventive actions of appropriate countermeasures, aimed adjustment of machine parameters to avoid machine failure and malfunction
- Integration of machine learning algorithms
- Advantage: Knowledge generation about cause and effect of machines and manufacturing processes



# WHAT IS SCHULER MACHINE MONITORING SYSTEM (MMS)

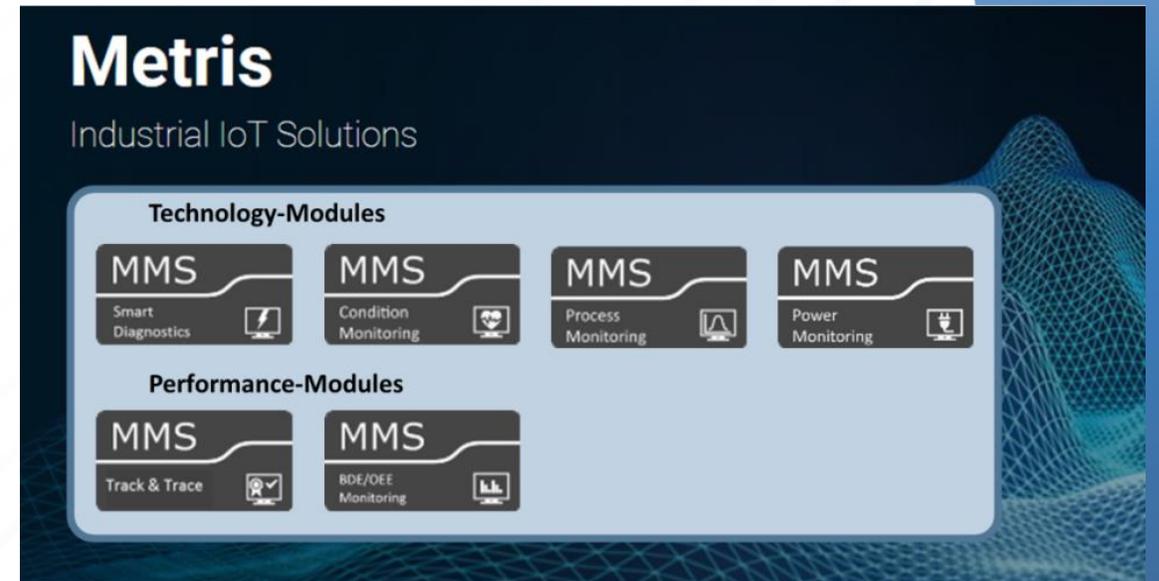
Schuler MMS is part of Andritz Metris Industrial IoT Solutions  
 MMS is a platform strategy to acquire and analyze digital data.  
 The purpose is to create an added value for smart operation  
 It consists of 2 main clusters with several solutions.

## Technology-Cluster

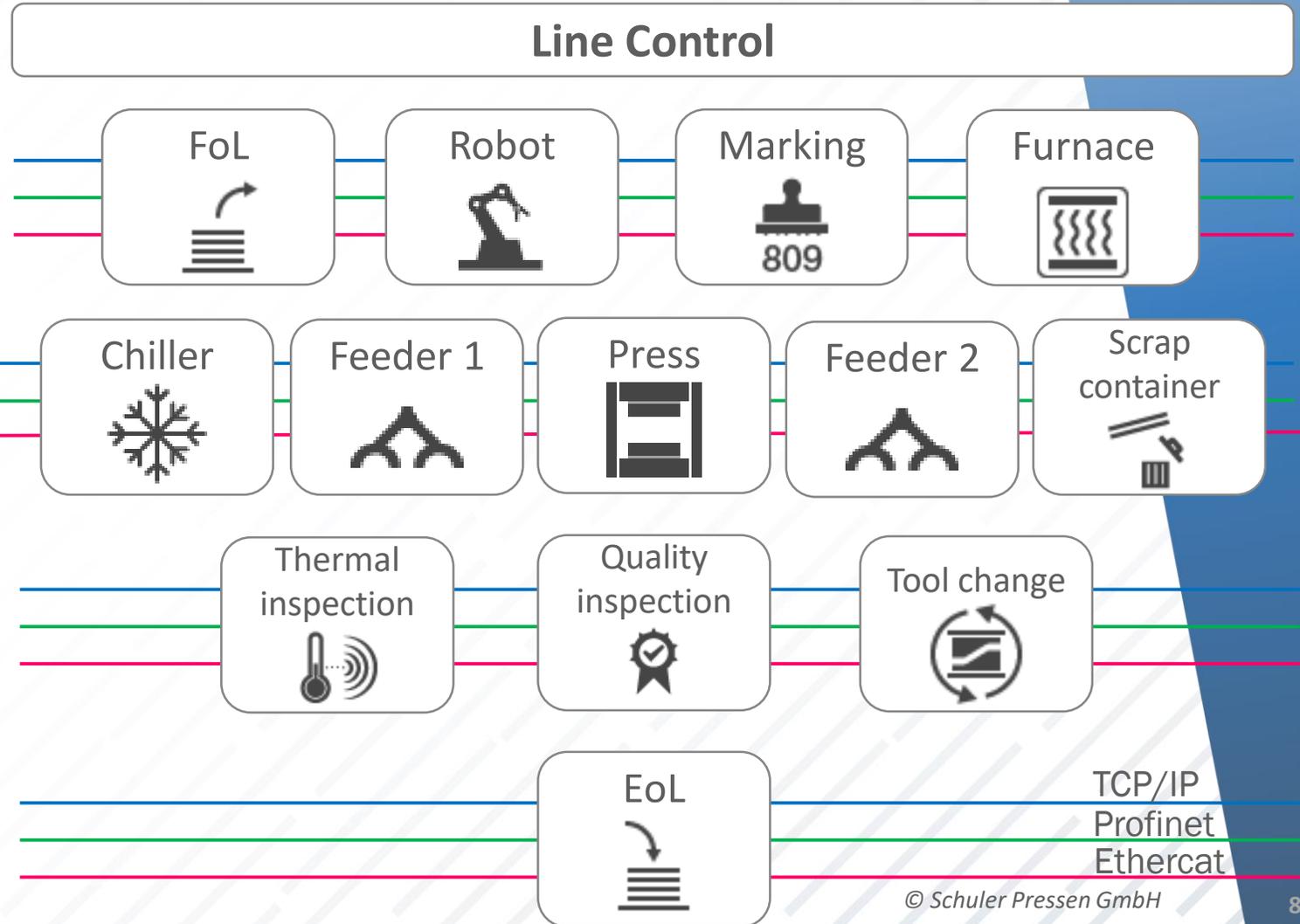
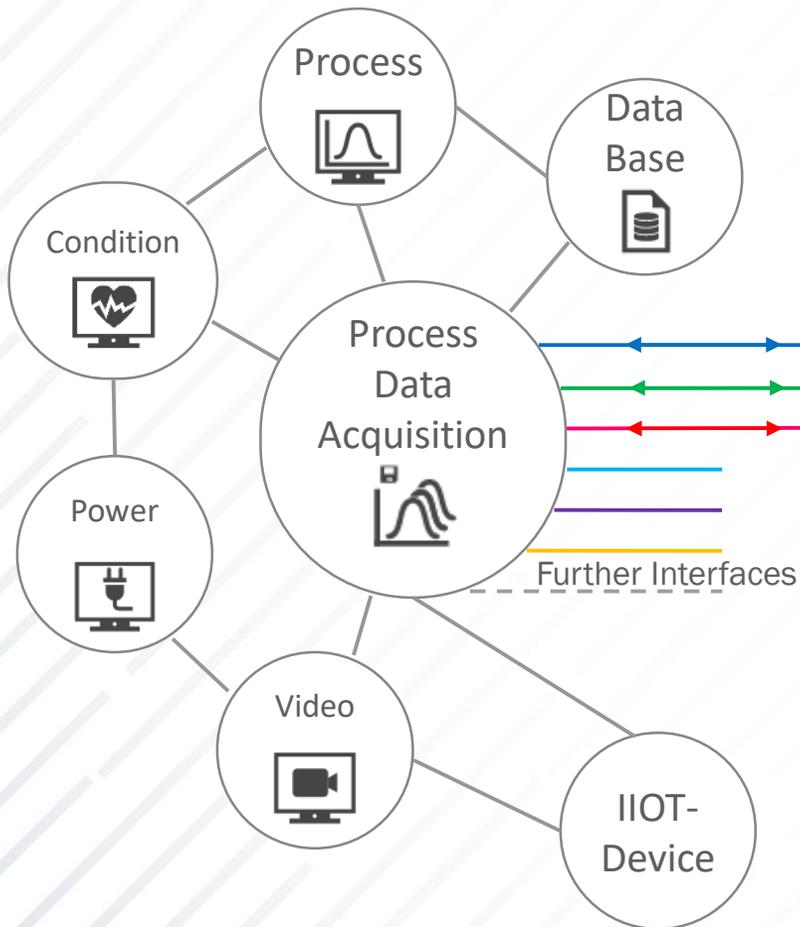
- Smart Diagnostics
- Condition Monitoring
- Process Monitoring
- Power Monitoring

## Performance-Cluster

- Track & Trace
- BDE/OEE Monitoring

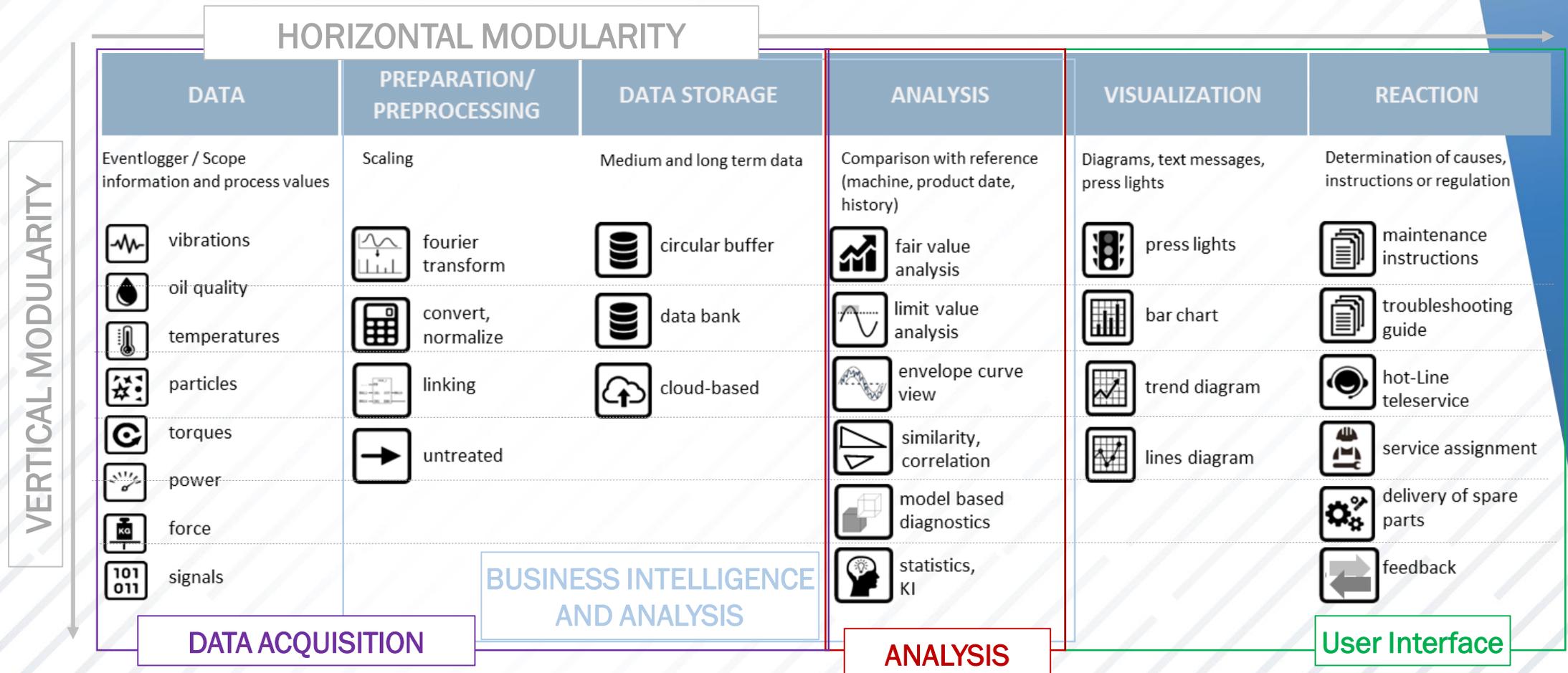


# MMS DATA ACQUISITION



TCP/IP  
Profinet  
Ethercat

# THE ARCHITECTURE OF SCHULER MMS



# PROCESS MONITORING FOR HOT STAMPING LINES

## CHARACTERIZATION

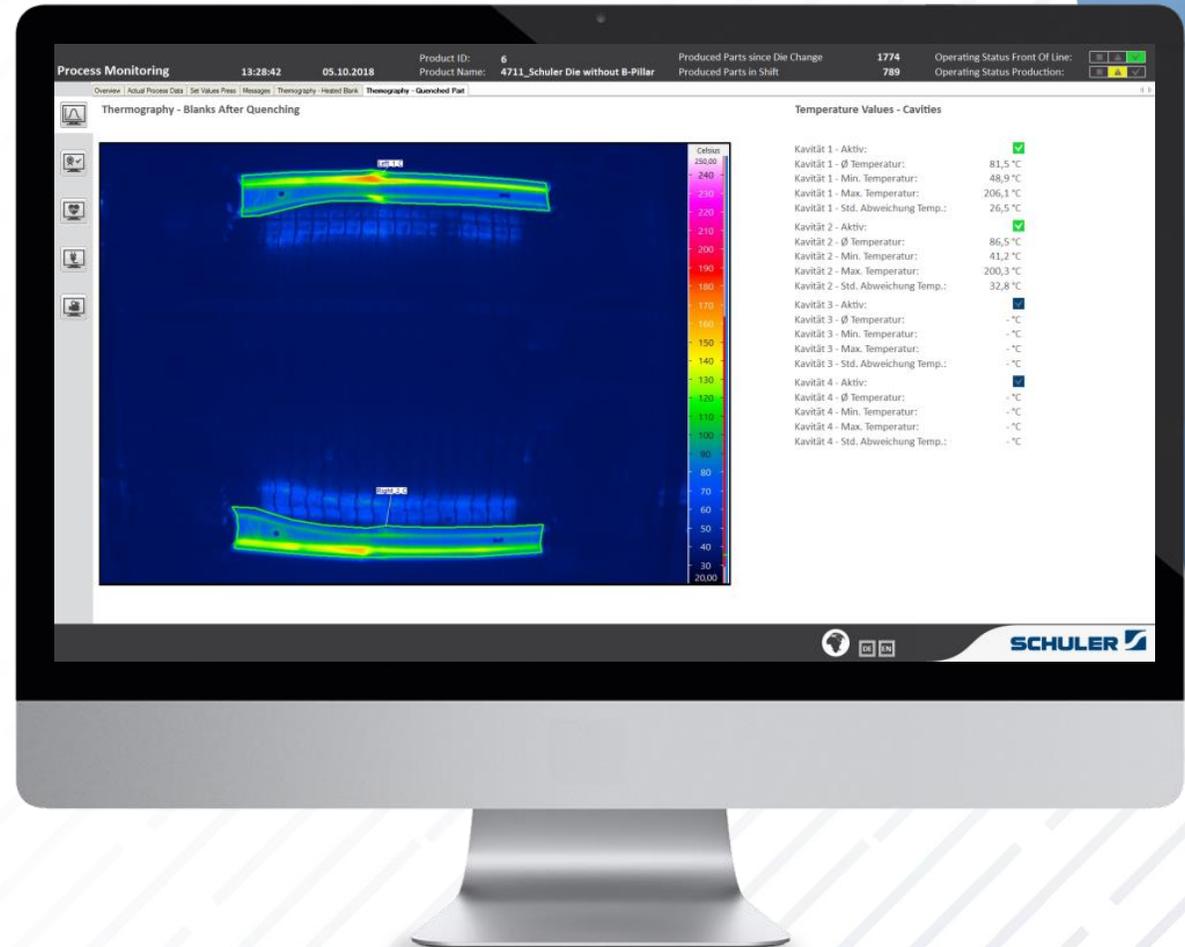
- Collecting data from all line components
- Fast data acquisition in real time with sampling rates of 10 ms and lower
- Circular buffer with high definition data of every source approximately 2 month
- Up to 2000 connected sensors and sources
- Time synchronization of all collected data
- Live visualization and histograms in Schuler style
- Fast data analytics with response time < 50 ms



# PROCESS MONITORING FOR HOT STAMPING LINES

## FEATURES

- Recording and visualization of all process relevant data.
- Integration of: press, automation, furnace, chiller, thermographic- system, cameras, sensors etc.
- Evaluation of process specific data: CQI-9
- Transfer of data to a quality database with long-term memory
- Analysis and visualization of historic data (Trends, Reports,...)
- Alerts in case of the detection process faults with prioritization



# USE CASE: INLINE QUALITY CONTROL

## EVALUATION OF PROCESS RELEVANT DATA

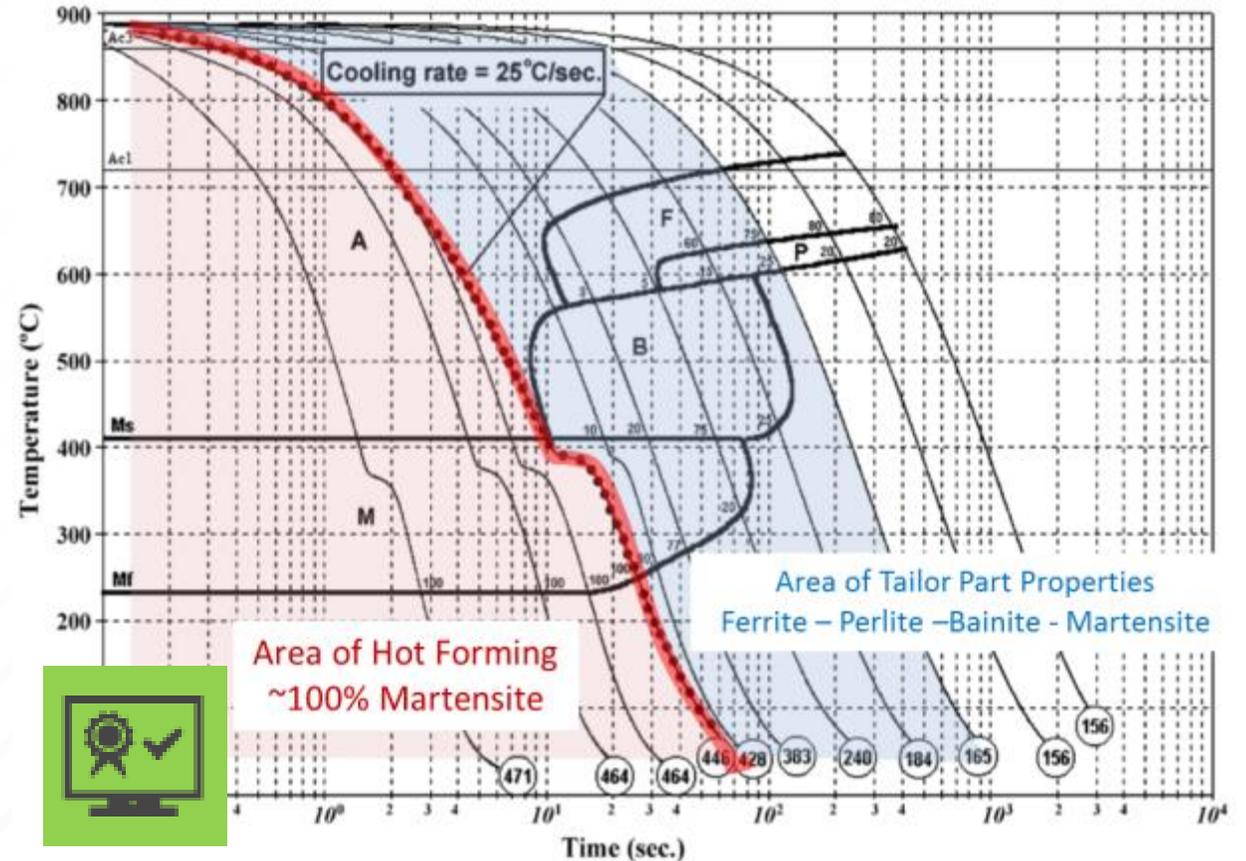
Furnace Zone Temperatures, Dew Point, Time in Furnace, Time in Air, Forming time, Press force in BDC, Quenching Time, Start forming temperature, Temperature analysis of pressed parts,...

Clear allocation of values with time or Part ID

Analysis of live and historic data

Limit value monitoring

CQI-9 conformity



## TARGETS FOR TRACK & TRACE ADDED VALUE FOR OUR CUSTOMERS

- Better production standards for hot stamping lines
- Intelligent linking of data records, quality assurance for the customers (complete part documentation)
- Reducing the total effort of the mechanical inspection (at the moment from \$500 up to \$2,000 per day and line)
- Increase of productivity through predictive maintenance (early detection of malfunction)
- Real-time processing of data and return flow in line control

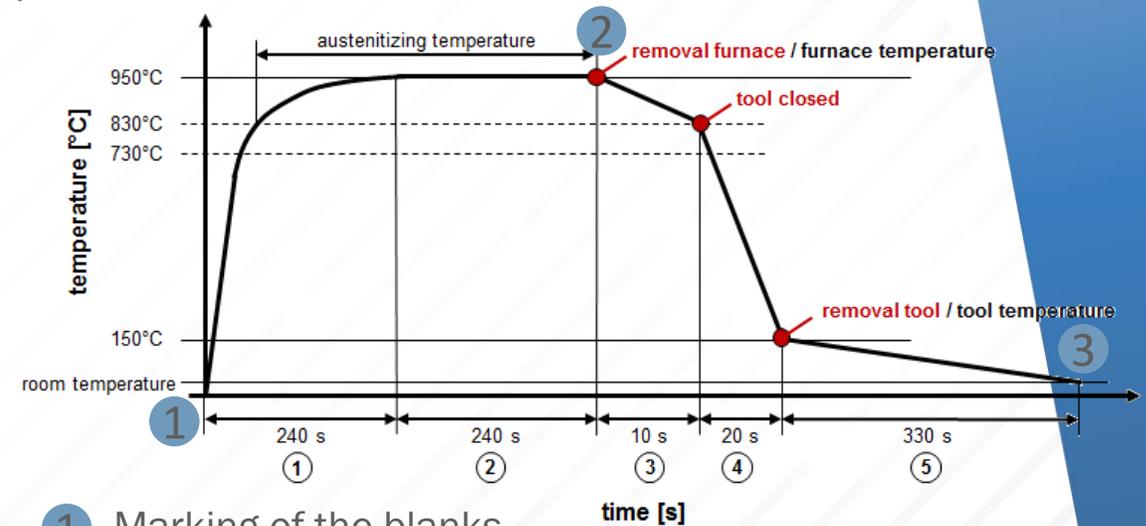


Hot Stamping Tech Center - Göppingen

# CHALLENGE TRACK & TRACE

## PART IDENTIFICATION IN HOT STAMPING

- Part marking with unique identity (clear type or QR-code)
- Identifying of the part ID before / after stamping
- Recording of the production data
- Linking of the ID and the processing data
- Hand over of quality assurance data and storing
- Hand over of production data to ERP system



- 1 Marking of the blanks
- 2 Part identification after furnace - optional
- 3 Part identification after stamping

Marking and identification during hot stamping process

# TRACK & TRACE– FURNACE DATA

Track and Trace
Produktnummer: 6  
Produktname: 4711\_Schuler Die without B-Pillar
Produzierte Teile seit Werkzeugwechsel: 10730  
Produzierte Teile in Schicht: 38
Status Bereich Beladung: ■ ▲ ▼  
Status Bereich Produktion: ■ ▲ ▼

Zustand Ofen
Zustand Presse

Nachverfolgung: Bauteil ID - Prozessdaten  
Zustand Ofen

	Bauteil ID	Temperaturen der Zonen [°C]								Taupunkt der Zonen [°C]			Prozess Zeiten [s]		Stationärer Zustand
		1	2	3	4	5	6	7	8	Einlauf	Mitte	Auslauf	Verweilzeit Ofen		
1	20181115_153810_10730	933,1 °C	932,9 °C	932,5 °C	929,3 °C	933,5 °C	931,4 °C	931,4 °C	933,4 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
2	20181115_153755_10729	933,7 °C	932,4 °C	931,9 °C	928,6 °C	933,5 °C	931,8 °C	930,3 °C	935,2 °C	-7,60 °C	-7,26 °C	-6,60 °C	178 s	✓	
3	20181115_153740_10728	933,2 °C	930,9 °C	930,8 °C	927,6 °C	932,7 °C	932,1 °C	930,3 °C	932,7 °C	-7,60 °C	-7,26 °C	-6,68 °C	178 s	✓	
4	20181115_153725_10727	931,0 °C	929,3 °C	929,3 °C	926,8 °C	931,4 °C	932,1 °C	931,8 °C	928,3 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✗	
5	20181115_153711_10726	928,4 °C	927,8 °C	928,2 °C	926,2 °C	929,6 °C	931,0 °C	933,6 °C	929,3 °C	-7,60 °C	-7,26 °C	-6,04 °C	178 s	✗	
6	20181115_153655_10725	926,1 °C	926,6 °C	927,5 °C	925,7 °C	928,4 °C	929,4 °C	934,8 °C	932,3 °C	-7,60 °C	-7,26 °C	-5,41 °C	178 s	✗	
7	20181115_153641_10724	924,5 °C	925,8 °C	927,3 °C	925,9 °C	927,8 °C	928,0 °C	934,1 °C	934,7 °C	-7,60 °C	-7,26 °C	-5,95 °C	178 s	✗	
8	20181115_153625_10723	923,8 °C	925,9 °C	928,1 °C	926,9 °C	928,1 °C	928,2 °C	929,8 °C	936,0 °C	-7,60 °C	-7,26 °C	-7,31 °C	178 s	✗	
9	20181115_153610_10722	924,9 °C	927,1 °C	929,6 °C	928,4 °C	929,0 °C	928,7 °C	929,4 °C	932,1 °C	-7,60 °C	-7,26 °C	-7,81 °C	178 s	✗	
10	20181115_153558_10721	928,1 °C	929,6 °C	931,5 °C	930,4 °C	930,2 °C	929,6 °C	931,0 °C	928,3 °C	-7,60 °C	-7,26 °C	-7,62 °C	181 s	✗	
11	20181115_153540_10720	932,0 °C	932,1 °C	933,1 °C	931,7 °C	930,8 °C	930,3 °C	933,1 °C	929,9 °C	-7,60 °C	-7,26 °C	-7,62 °C	178 s	✗	
12	20181115_153040_10719	929,2 °C	931,0 °C	928,7 °C	931,3 °C	931,9 °C	929,6 °C	933,6 °C	935,3 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
13	20181115_153026_10718	927,8 °C	931,6 °C	929,8 °C	930,8 °C	932,5 °C	930,2 °C	929,4 °C	934,8 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
14	20181115_153011_10717	927,1 °C	932,4 °C	930,9 °C	930,2 °C	932,7 °C	930,9 °C	928,8 °C	929,7 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
15	20181115_152955_10716	927,6 °C	932,7 °C	931,8 °C	929,5 °C	932,7 °C	931,4 °C	930,3 °C	929,1 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
16	20181115_152941_10715	929,4 °C	932,5 °C	932,3 °C	928,9 °C	932,2 °C	931,3 °C	931,3 °C	931,6 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
17	20181115_152926_10714	931,2 °C	932,0 °C	932,3 °C	928,4 °C	931,4 °C	931,4 °C	931,5 °C	934,2 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
18	20181115_152910_10713	932,7 °C	930,5 °C	931,6 °C	928,2 °C	930,1 °C	931,4 °C	930,0 °C	935,5 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
19	20181115_152856_10711	933,3 °C	929,3 °C	930,4 °C	928,1 °C	929,2 °C	931,3 °C	930,4 °C	932,2 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	
20	20181115_152841_10711	932,8 °C	928,5 °C	929,2 °C	928,8 °C	928,7 °C	930,9 °C	932,0 °C	928,1 °C	-7,60 °C	-7,26 °C	-6,58 °C	178 s	✓	

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# USE CASE: REAL TIME FAILURE ANALYSIS AND COUNTERACTION

## Problem:

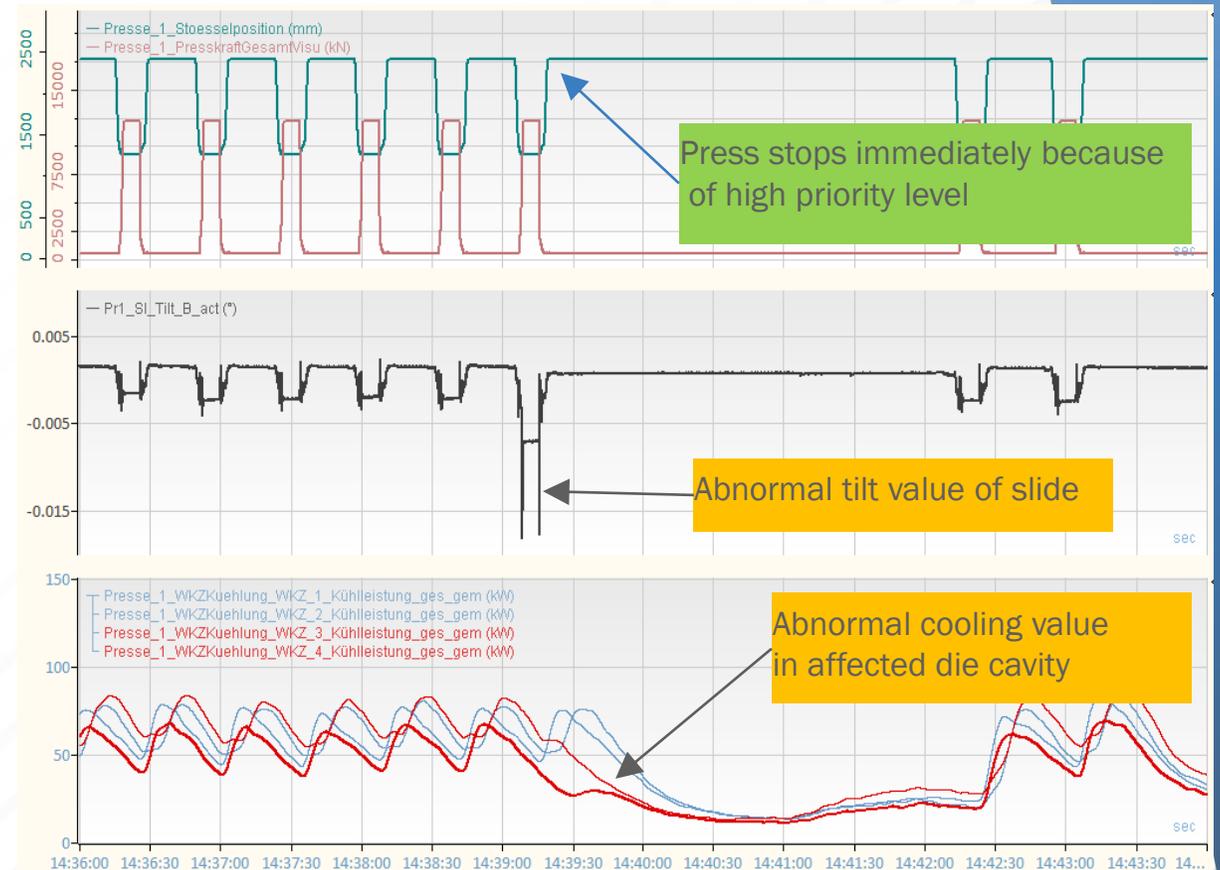
- Cutting scrap particle sticks on blanks
- Double blank sensor would not register this case

## Negative Effects:

- Improper forming and cooling of batch
- hot spot will be shown in thermographic analysis
- No answer for cause of problem

## Fast Failure Analysis with Process Monitoring:

- Tilt of the slide is detected as abnormal in relation to the last strokes
- The cooling power drops significantly
- Machine stops immediately to prevent damage



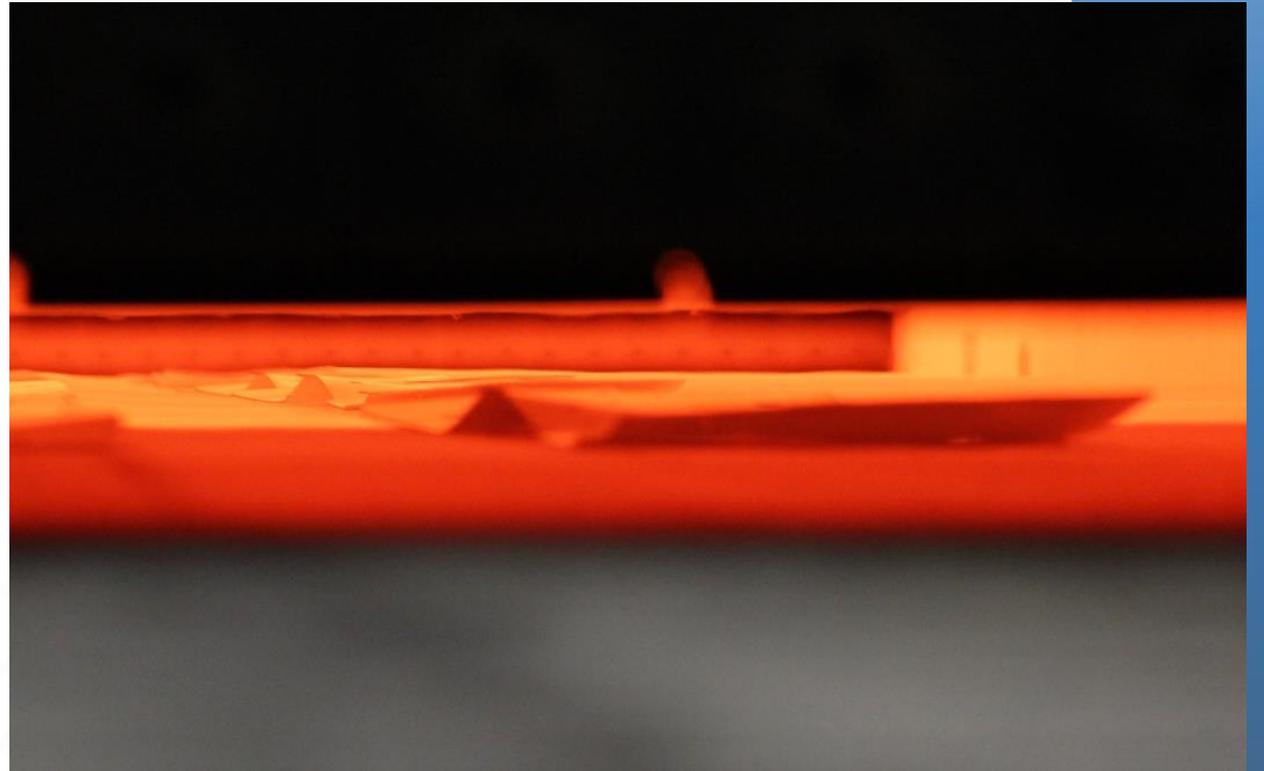
# USE CASE: VIDEO ANALYSIS OF DIE DAMAGE



# PROCESS MONITORING IN HOT STAMPING

## SUMMARY

- Recording of the overall time-temperature history
- Furnace monitoring
- Transfer monitoring
- Press and die monitoring
  - Forming start temperature
  - Cooling rate
  - Evaluating phase transformation
- Monitoring after quenching
  - Analysis of hot spots and temperature distribution
- Linking with machine recordings
- Feedback to line control
- Quality assurance - database



Roller hearth furnace – heating of the blanks

**THANK YOU VERY MUCH FOR YOUR ATTENTION!**



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