From LEAN SIX SIGMA to Operational Intelligence

Manufacturing in a digital world

Frank Kleinert

Overview

- **Kloeckner Pentaplast** as global film producer
- The way from **5S to LEAN SIX SIGMA**
- **Example:** Increase of black point level in film
- From **LEAN SIX SIGMA** to **Operational Intelligence**
- Historical **infrastructure** in manufacturing
- **Example:** Correlation of black point with machine data
- **Challenges** and limitations in manufacturing
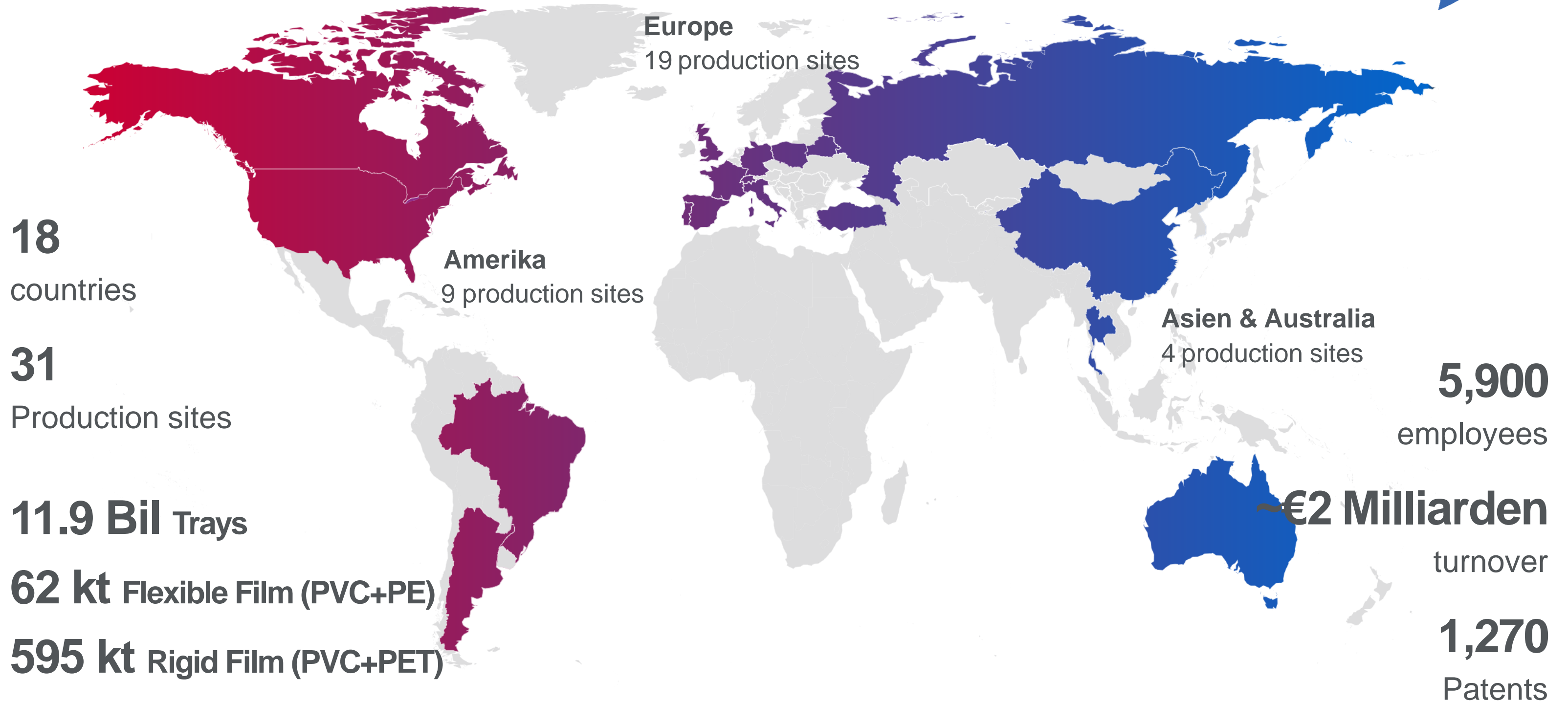- **Summary** and conclusion

Kloeckner Pentaplast as a global polymer film producer

31 production sites with 6000 employees

The transformation in manufacturing is a long journey (based on automotive industry)

Global footprint

Europe
19 production sites

Amerika
9 production sites

Asien & Australia
4 production sites

18
countries

31
Production sites

11.9 Bil Trays

62 kt Flexible Film (PVC+PE)

595 kt Rigid Film (PVC+PET)

5,900
employees

~€2 Milliarden
turnover

1,270
Patents
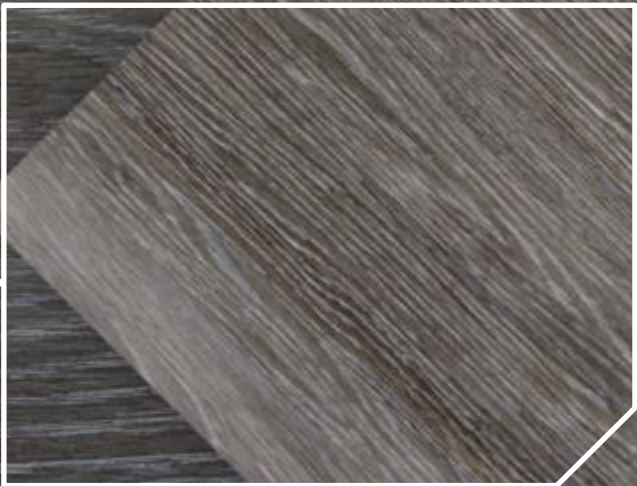
Pharma, Health & Specialties

Health

Pharma
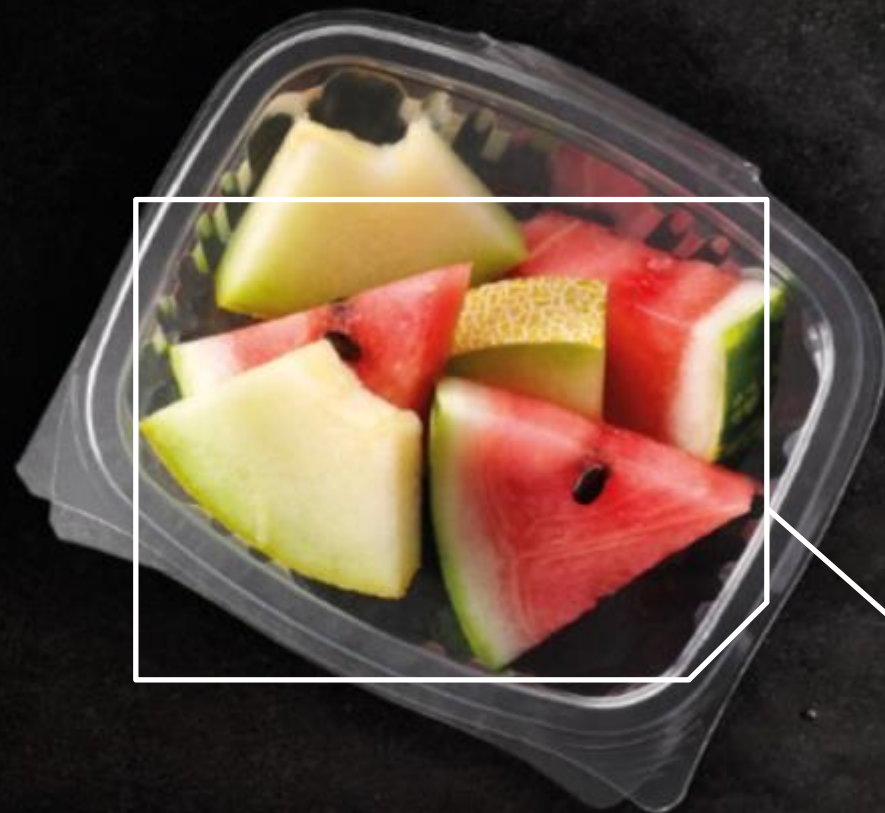
Home, building and constructions

Cards and graphics

Labels

kp

Food Packaging
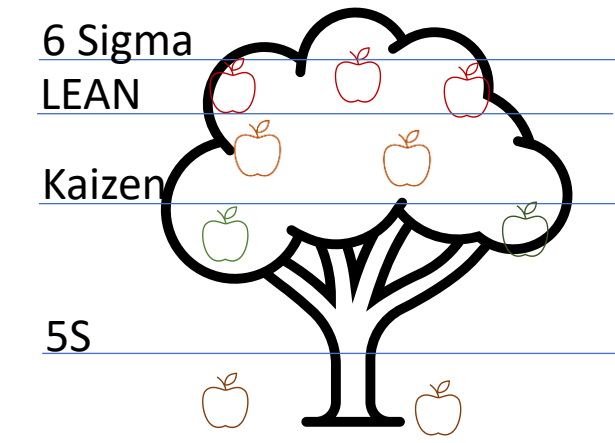
Fruit and produce

Protein
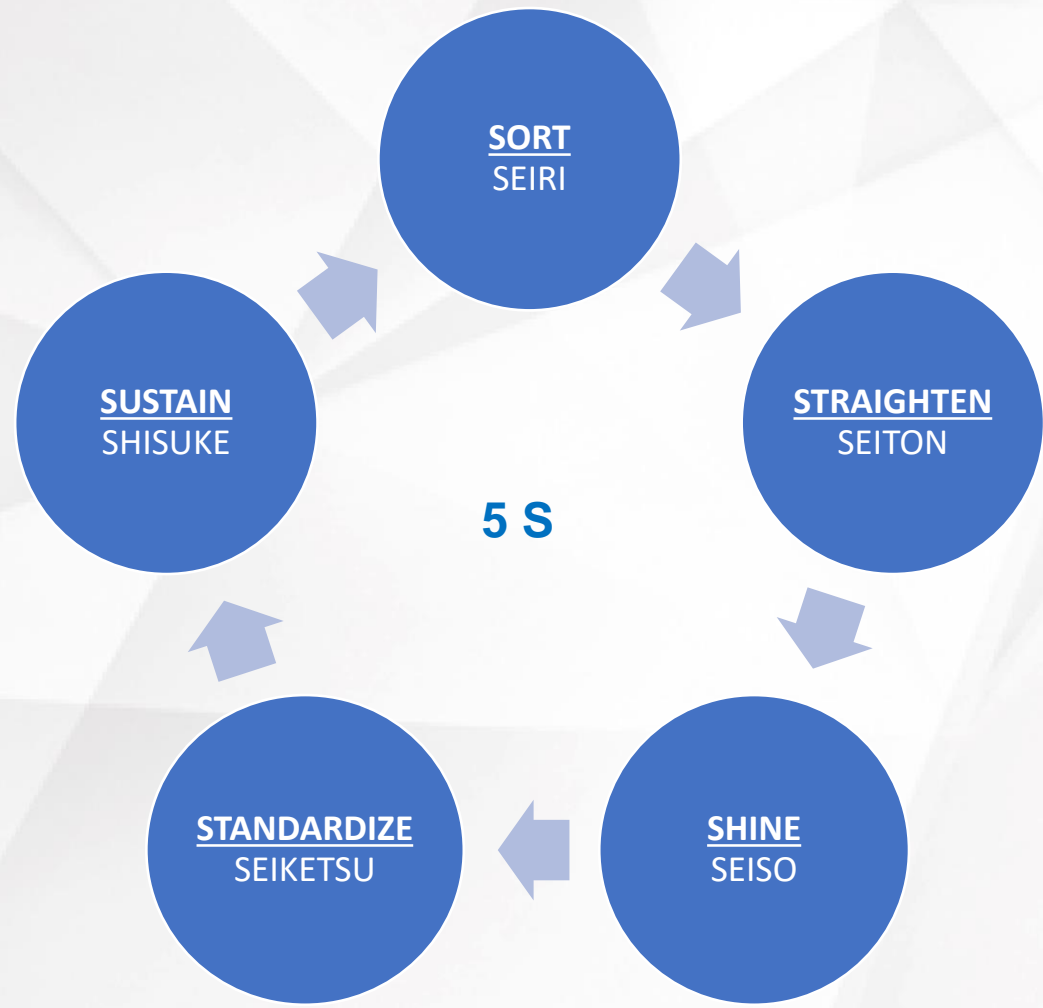
Bakery

Food to go

kp

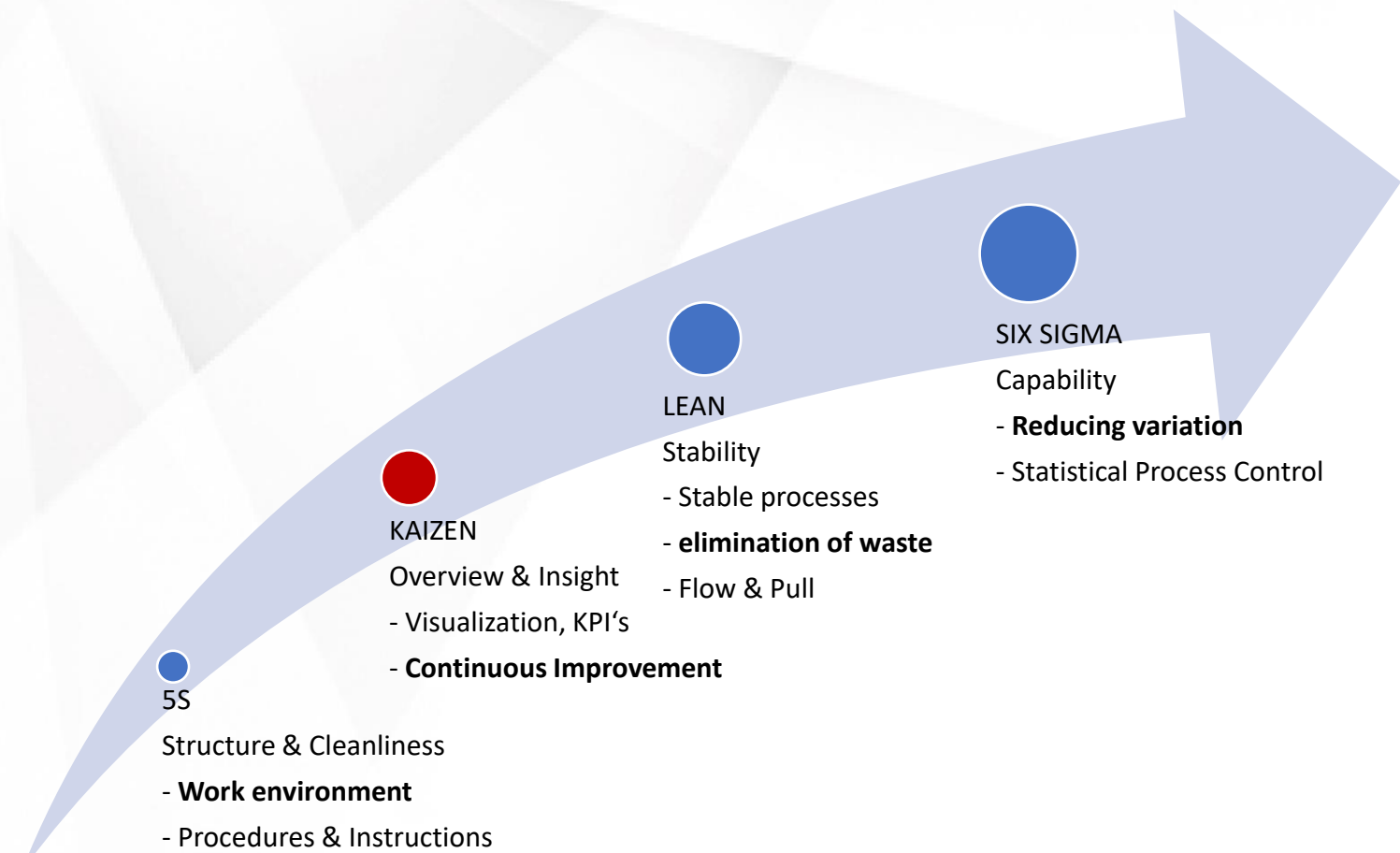# The typically way from 5S to LEAN SIX SIGMA

Tools make problems visible and support problem solving

The transformation in manufacturing is a long journey (based on automotive industry)

The typically way from 5S to LEAN SIX SIGMA

SORT
SEIRI

STRAIGHTEN
SEITON

5 S

SUSTAIN
SHISUKE

SHINE
SEISO

STANDARDIZE
SEIKETSU

SIX SIGMA
Capability
- **Reducing variation**
- Statistical Process Control

LEAN
Stability
- Stable processes
- **elimination of waste**
- Flow & Pull

KAIZEN
Overview & Insight
- Visualization, KPI's
- **Continuous Improvement**

5S
Structure & Cleanliness
- **Work environment**
- Procedures & Instructions

6 Sigma
LEAN

Kaizen

5S

PLAN

ACT

Continual Improvement

DO

CHECK

5S
Structure & Cleanliness
- **Work environment**
- Procedures & Instructions

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SIX SIGMA
Capability
- **Reducing variation**
- Statistical Process Control

The typically way from 5S to LEAN SIX SIGMA

Defect
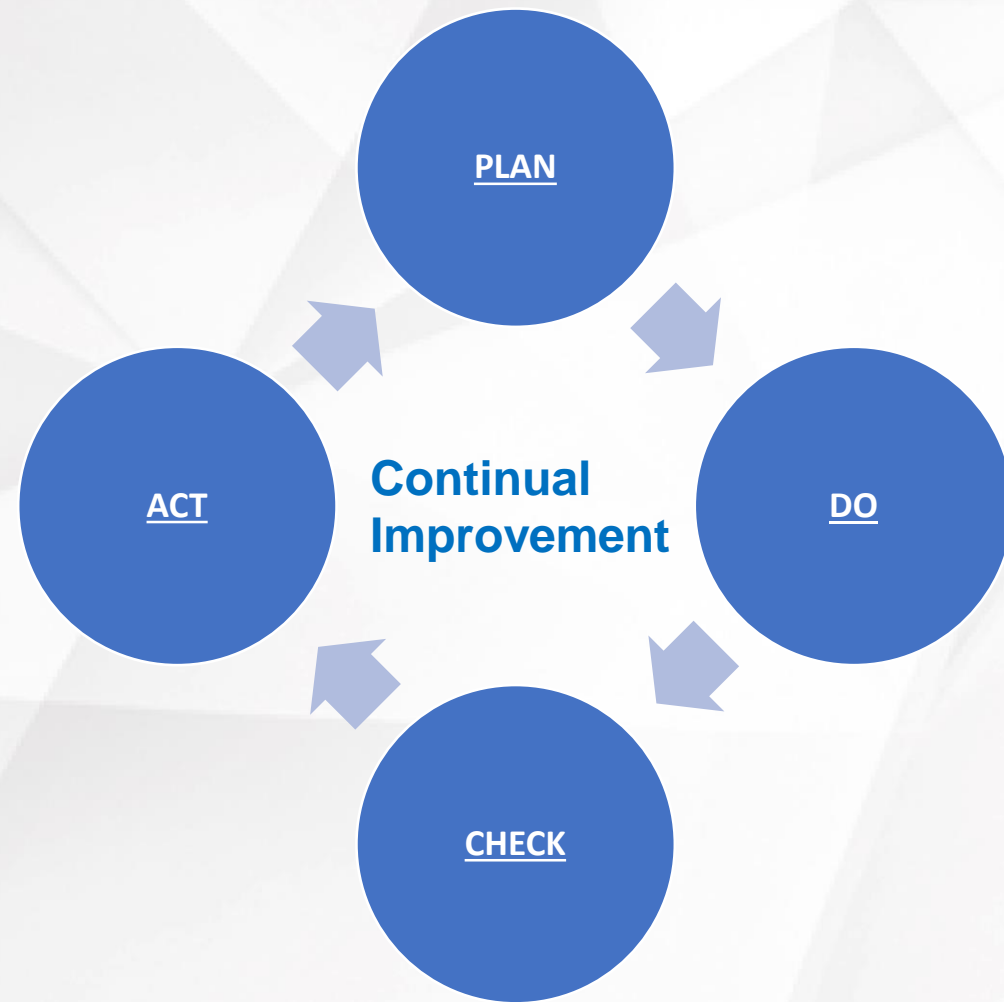
Transport

Overprocessing

Elimination of Waste

Inventory

Overproduction

Motion

Waiting

Six Sigma

Capability

- **Reducing variation**

- Statistical Process Control

LEAN

Stability

- Stable processes

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- Flow & Pull

KAIZEN

Overview & Insight

- Visualization, KPI's

- **Continues Improvement**

5S

Structure & Cleanliness

- **Work environment**

- Procedures & instructions

Six Sigma based on data and combine process management

DEFINE

MEASURE

CONTROL

ANALYZE

IMPROVE

SIX SIGMA
Capability
- **Reducing variation**
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Lower Limit | Process Average | Upper Limit

99.7%
95%
68%

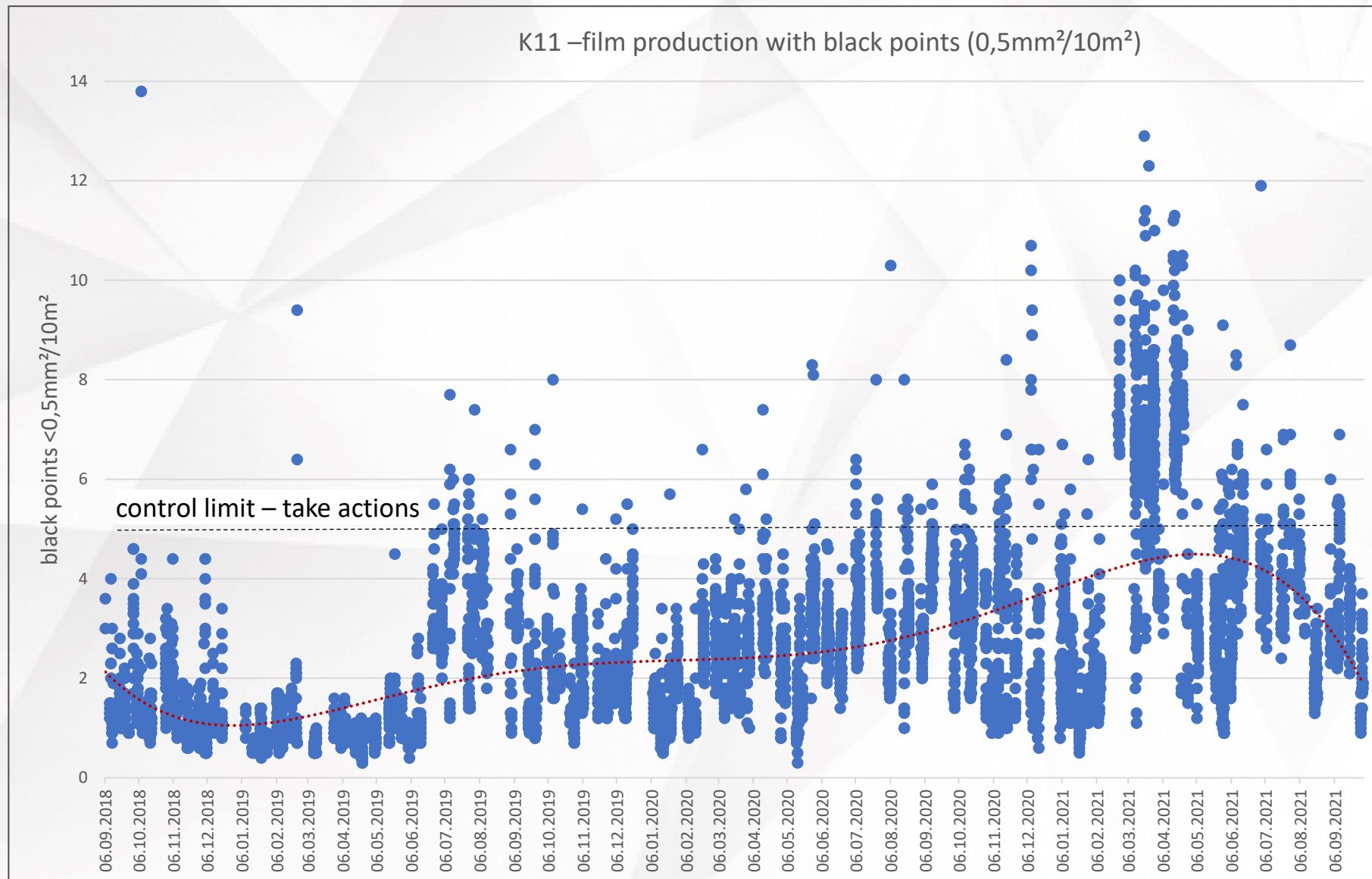-6σ -5σ -4σ -3σ -2σ -1σ Mean 1σ 2σ 3σ 4σ 5σ 6σ

Example: Increase of black point level in film (Oct 2021)

"What can be measured, can be managed."

LEAN SIX SIGMA and digital technology work in concert

Example: Increase of black point level in film (Oct 2021)

K11 –film production with black points (0,5mm²/10m²)

black points <0,5mm²/10m²

control limit – take actions

06.09.2018 06.10.2018 06.11.2018 06.12.2018 06.01.2019 06.02.2019 06.03.2019 06.04.2019 06.05.2019 06.06.2019 06.07.2019 06.08.2019 06.09.2019 06.10.2019 06.11.2019 06.12.2019 06.01.2020 06.02.2020 06.03.2020 06.04.2020 06.05.2020 06.06.2020 06.07.2020 06.08.2020 06.09.2020 06.10.2020 06.11.2020 06.12.2020 06.01.2021 06.02.2021 06.03.2021 06.04.2021 06.05.2021 06.06.2021 06.07.2021 06.08.2021 06.09.2021
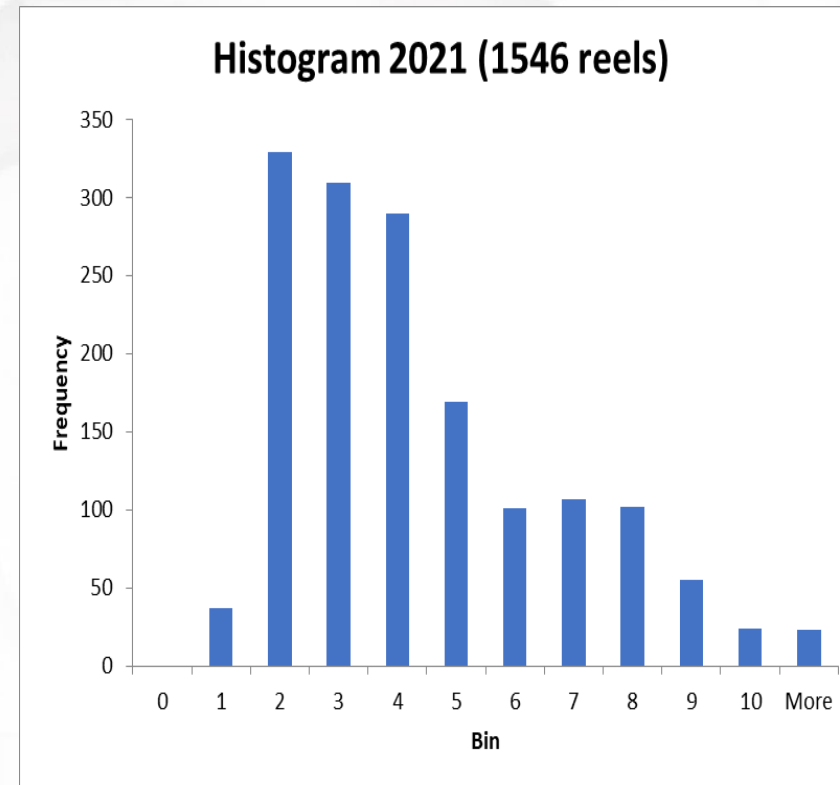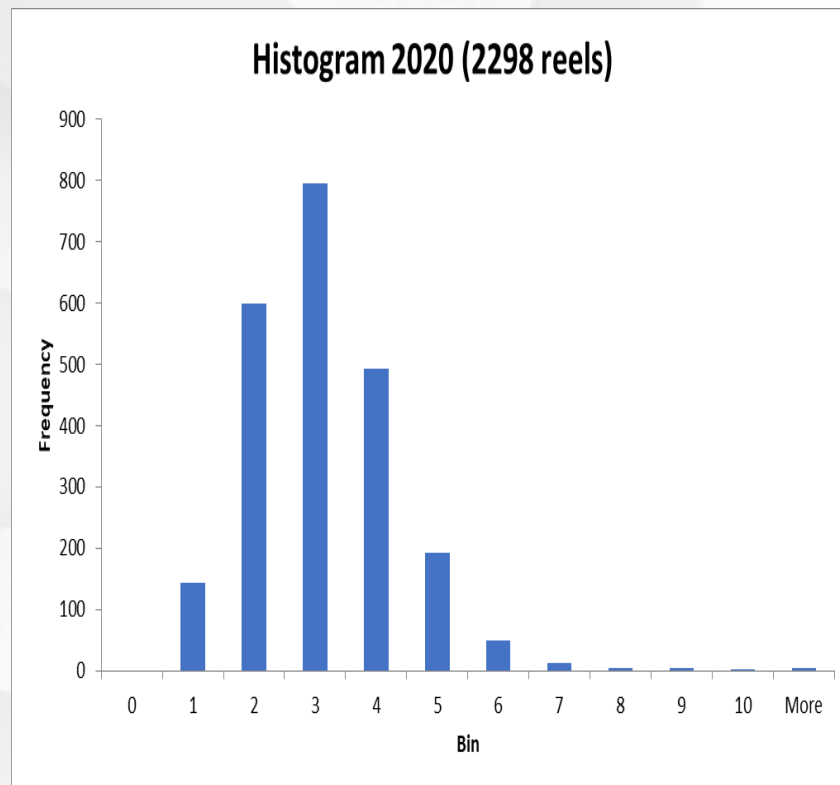
Analysis of ~ 6500 reels
- data from inline quality system/MES/SAP
- trend show increase of black points level
- ~90% of the orders in specification
- Peak in Feb/Mar/Apr 2021

Question:
What is the reason?
- Line
- Formulation
- Raw material
- …

Example: Increase of black point level in film (Oct 2021)

Histogram 2020 (2298 reels)

Histogram 2021 (1546 reels)

	2020
Mean	2,7
Median	2,6
Standard deviation	1,3

	2021
Mean	3,9
Median	3,4 (not straight)
Standard deviation	2,4 (wide)

Analysis 2020-2021
- 3844 reels 87% in specification

2021
- Mean/Average grows in 2021
- Median is not straight
- Wide distribution

Normal distribution changed in 2021
The trend go in a wrong direction

Question:
What is the reason?
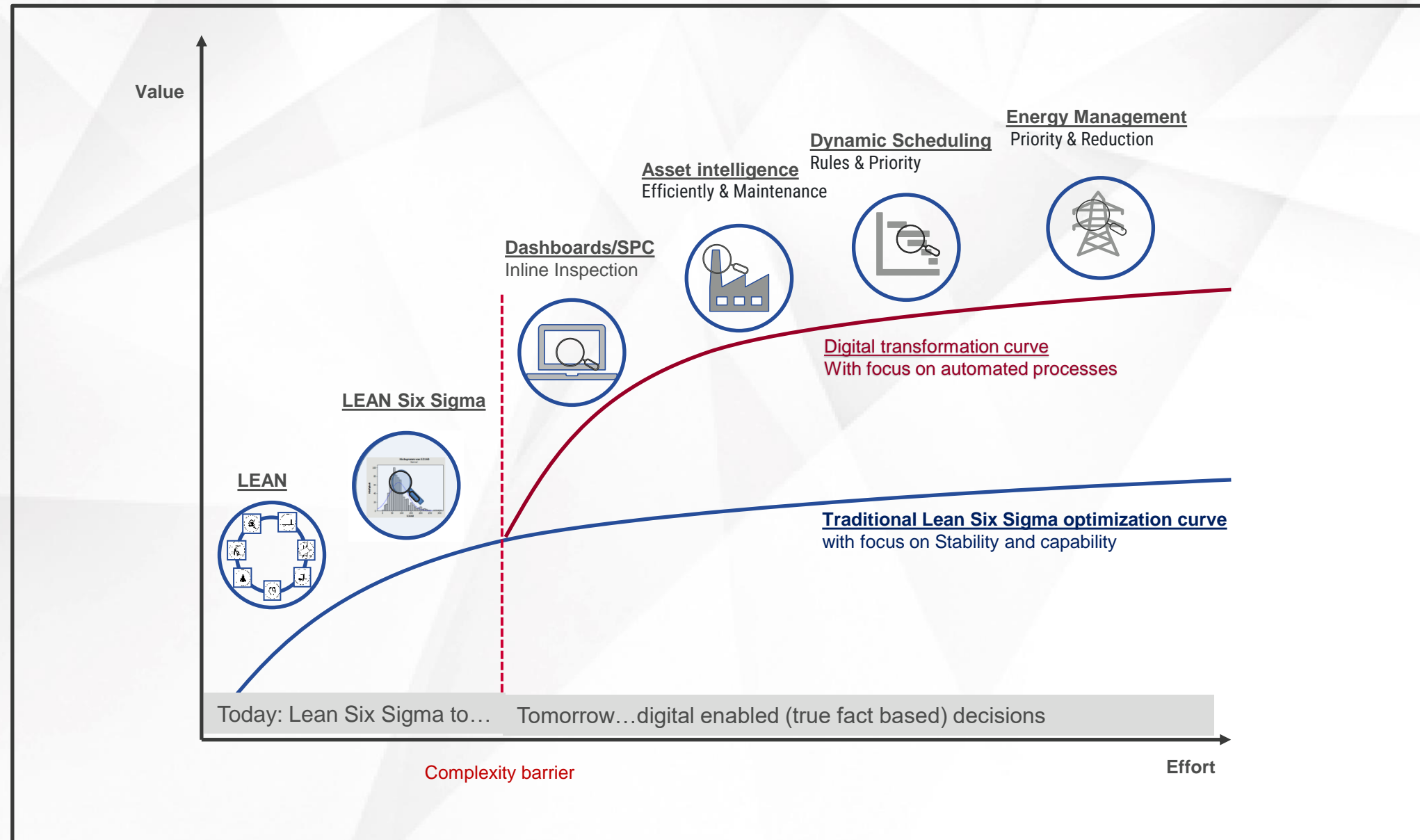- Line
- Formulation
- Raw material
- …

From Lean to Operational Intelligence

Digital transformation with databased communication

LEAN SIX SIGMA and digital technology work in concert

Operational Intelligence based on data

Value

Energy Management
Priority & Reduction

Dynamic Scheduling
Rules & Priority

Asset intelligence
Efficiently & Maintenance

Dashboards/SPC
Inline Inspection

LEAN Six Sigma

LEAN

Digital transformation curve
With focus on automated processes

Traditional Lean Six Sigma optimization curve
with focus on Stability and capability

Today: Lean Six Sigma to…   Tomorrow…digital enabled (true fact based) decisions

Complexity barrier

Effort

*based on Source: Deloitte analysis; Christopher Prinz: „Lean meets Industry 4.0: A practical approach to interlink the method world and the cyber-physical world", Procedia Manufacturing 23(2018)

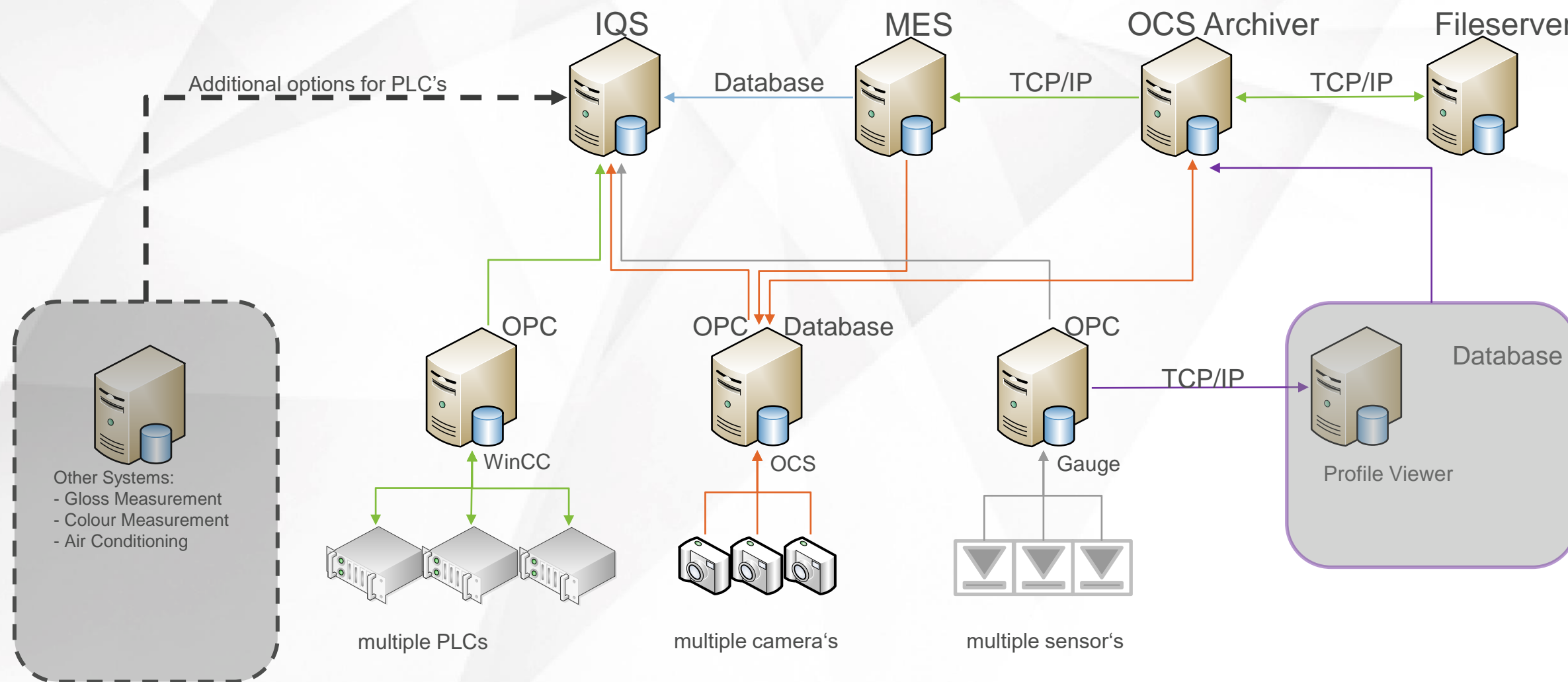# Different sources of input deliver different options
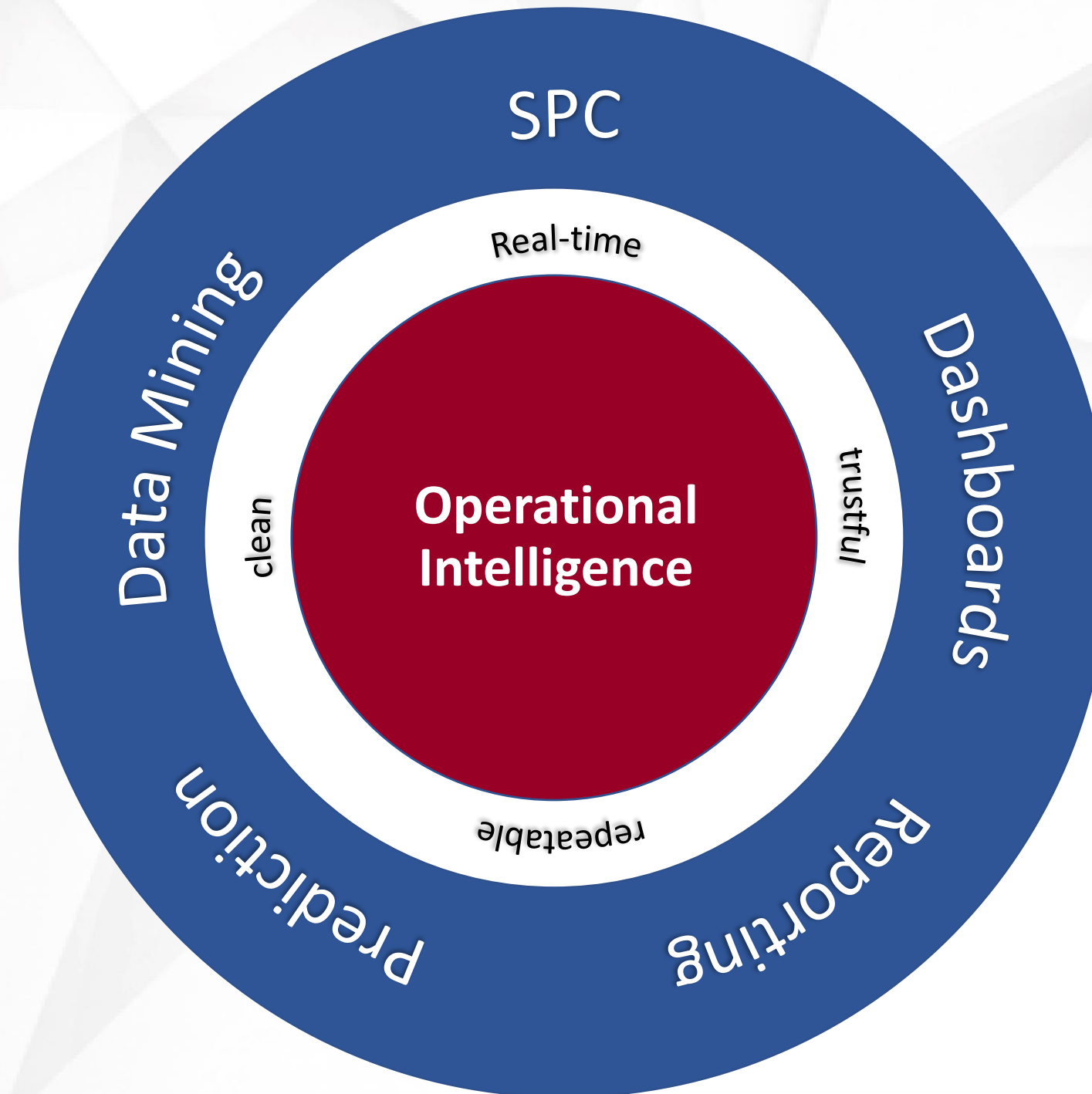
Challenge based on "historical" infrastructure in manufacturing

Local data in different silo's and competence in data analysis

Current complex landscape in "old" production sites

Other Systems:
- Gloss Measurement
- Colour Measurement
- Air Conditioning

Additional options for PLC's

IQS   MES   OCS Archiver   Fileserver

Database   TCP/IP   TCP/IP

OPC   OPC Database   OPC

WinCC   OCS   Gauge

multiple PLCs   multiple camera's   multiple sensor's

TCP/IP

Database

Profile Viewer

data in different silo's, missing data like process parameter, raw material, energy consumption, time scale, customer information, stock…

Example: Correlation of black point with machine data

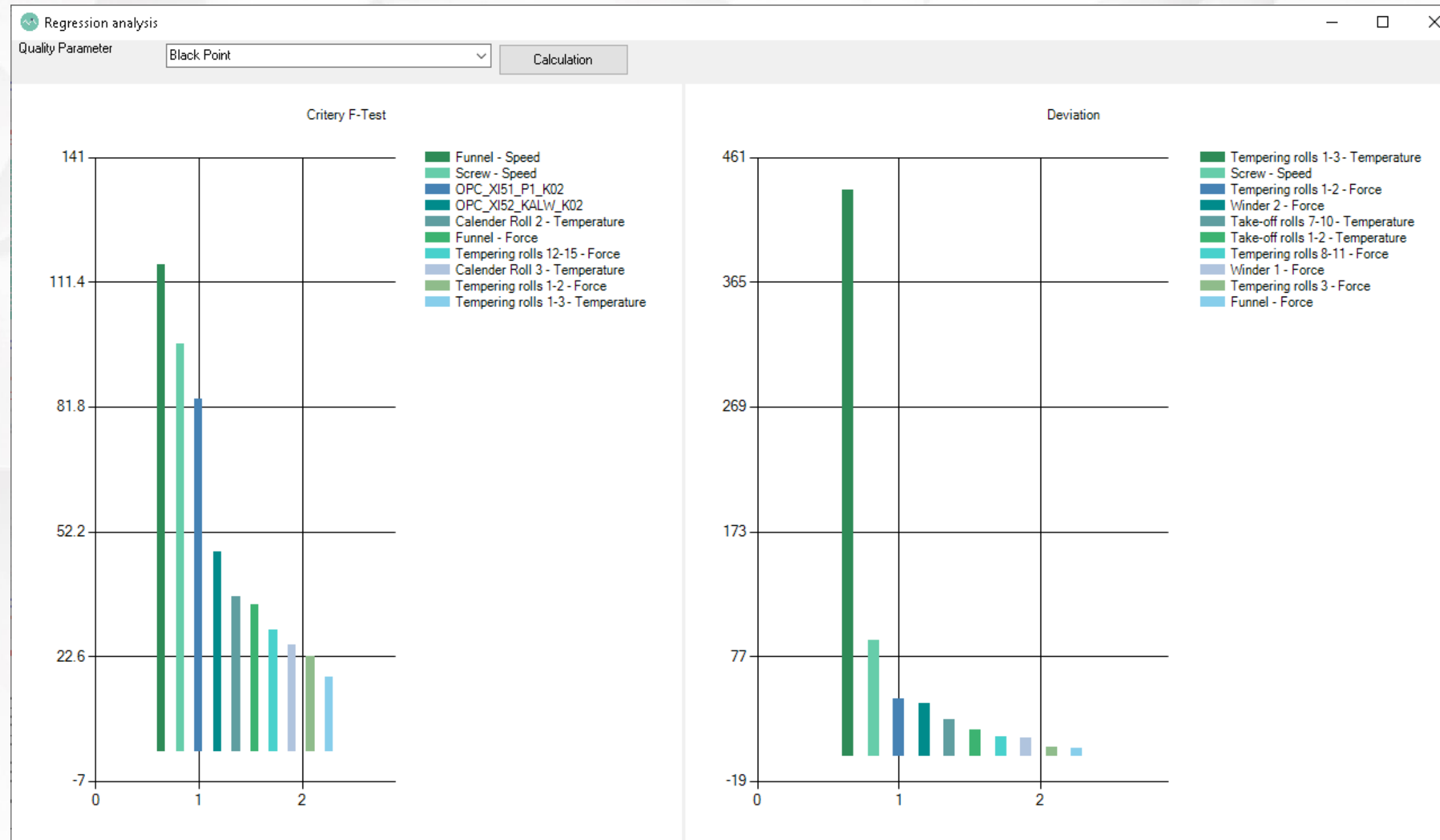"Machines talking to us and we have to learn to listen"

Project with KP in St.Petersburg with university

Visualization between machine data and quality

Correlation between machine data and quality

Challenges and limitations in manufacturing

Strategy for transformation

5 main challenges and limitations of existing local solution

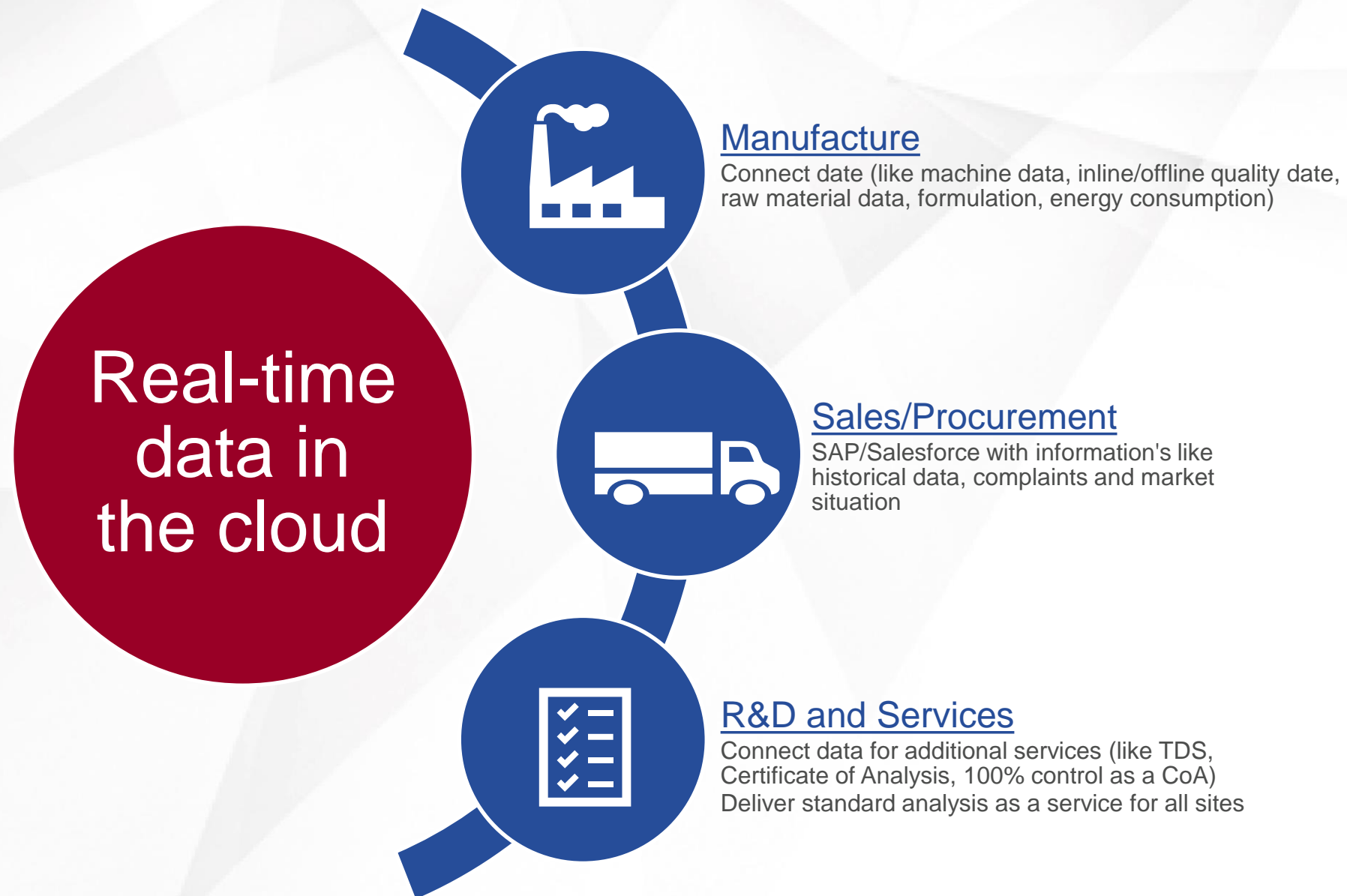| 1.	2.	3.	4.	5.
Systems can't **scale** fast enough to keep up with **data growth**	Data is not **fresh** or current enough, analysis need day's	Data's are in different **silo's** and not connected	**Access restrictions** on data prevent teams from working effectively	Systems don't support predictive maintenance and **machine learning**

Based on kp's local server situation:
- Actions based on data most time to late (days or weeks behind the event)
- Create monthly overviews needs more time as expected
- Comparability between sites/products/machines is a challenge
- Prediction/ML based on data not possible

Real time data impacts agility across manufacturing

Real-time
data in
the cloud

Manufacture
Connect date (like machine data, inline/offline quality date, raw material data, formulation, energy consumption)

Sales/Procurement
SAP/Salesforce with information's like historical data, complaints and market situation

R&D and Services
Connect data for additional services (like TDS, Certificate of Analysis, 100% control as a CoA)
Deliver standard analysis as a service for all sites
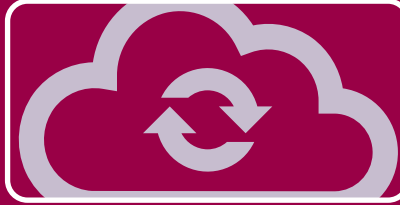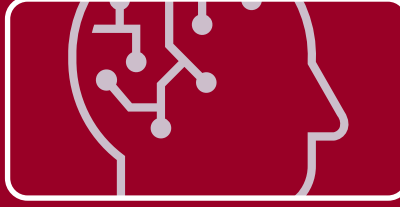
Summary and conclusion

Real-time data deliver big advantage for data driven manufacturing.

In-time visualization and dashboards are the first step

In summary: The benefit of cloud solution of all data

Real-time insight
- Analyse real-time data streams for instant insights
- Visualization of critical issues in time

Open and Flexible
- Global standardized data based on global rules
- Easy using of data in Excel/Minitab/Power BI..

Global Dashboards and Reporting
- Automated Dashboards and Reporting
- Using of manpower for problem solving

Break up existing silo's
- Connect data from different sources
- Deliver additional benefit for Lean, support data based decisions

Usable for innovation with ML
- Predictive maintenance
- Predictive quality

Thanks for your attention

большое спасибо за внимание

House of data

Customer Focus & Customer Satisfaction
Automate Visualization, SPC, alerts and artificial intelligence

OPS
Real-time Process Monitoring
- Define process data
- Introduction of escalation

Challenge:
- Alerts & control charts
- Standard for each level

Quality
Process Stability Analysis
- Define VOC
- define measured variable

Challenge:
- training & actions
- Define of statistical values

IT
Automation in PLC/MES/ERP/CRM
- Database migration
- Definition of interfaces

Challenge:
- OPC/data management

Define targets and limits
Process data (machine, recipe, quality, energy, disruptions) must be available in real time/quality
Commitment of Management, Education in Lean - Sigma & Leadership