Digital Analytics to reduce variability in production

J. Bachner, J. Strobel, G. Droschl

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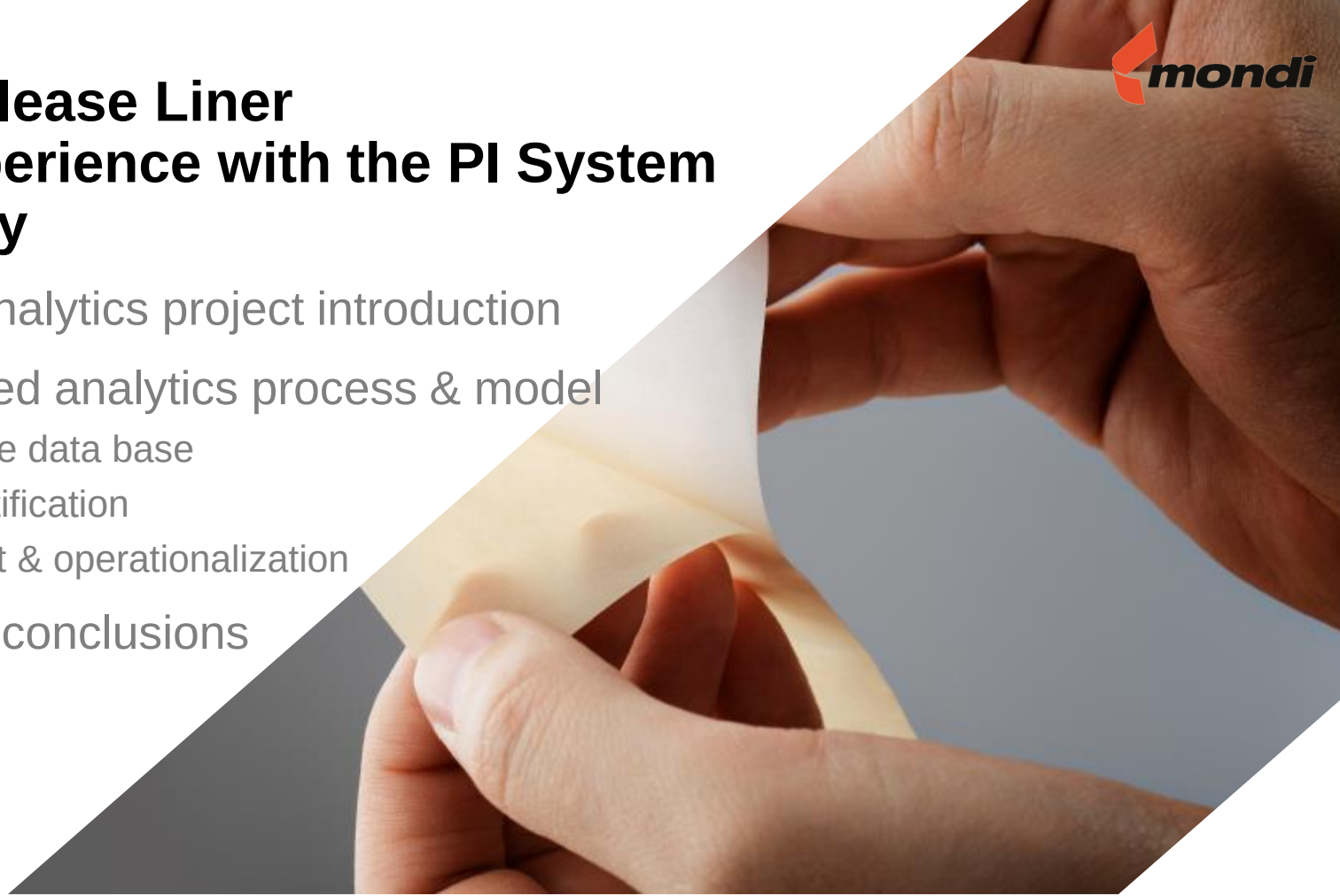
- **Mondi Release Liner & our experience with the PI System until today**
- Advanced analytics project introduction
- The advanced analytics process & model
  - Ensuring the data base
  - Model identification
  - Deployment & operationalization
- Summary & conclusions



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Mondi Group

Packaging Paper

10 operating sites

10 countries

Containerboard

Sack kraft paper

Speciality kraft paper

Fibre Packaging

60 operating sites

24 countries

Corrugated packaging

Industrial bags

Extrusion coatings

Consumer Packaging

30 operating sites

12 countries

Consumer goods packaging

Personal care components

Release liner

Technical films

Uncoated Fine Paper

6 operating sites

4 countries

Office paper

Professional printing paper

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Mondi Release Liner Applications

Graphic Arts

- Advertising films
- Traffic signs
- Car wrapping
- Structured liners

Tapes

- Single-sided tapes
- Double-sided tapes
- Transfer tapes

Fiber Composites

- Aerospace construction components
- Industrial composites
- Ballistics protection equipment
- Consumer recreational products

Labels

- Point-of-sale labelling
- VIP/business systems labelling
- Functional/security labels
- Primary labels for the food and cosmetic industry

Industrial

- Automotive
- Process Liners
- Food
- Textile

Hygiene

- Femcare (sanitary napkins, panty liners)
- Adult Care and diaper frontal systems

Envelopes

- Plastic envelopes and bags
- Document pouches and business forms

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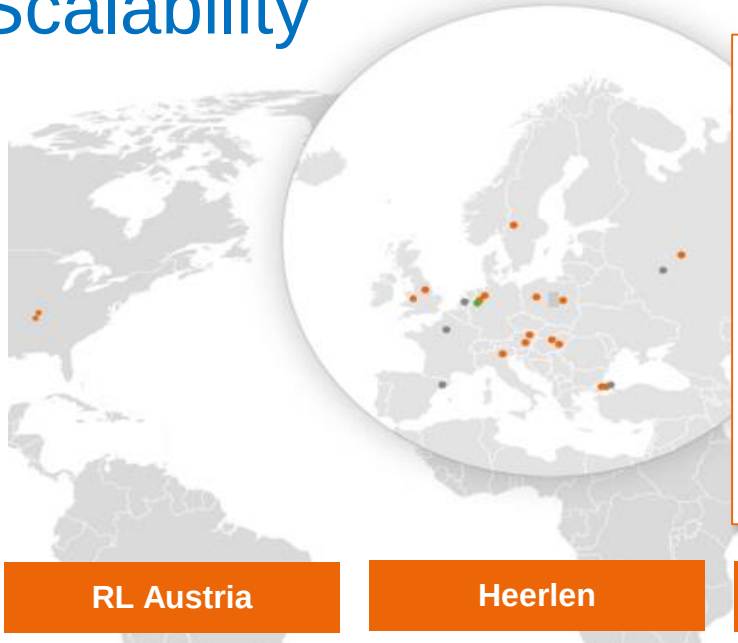
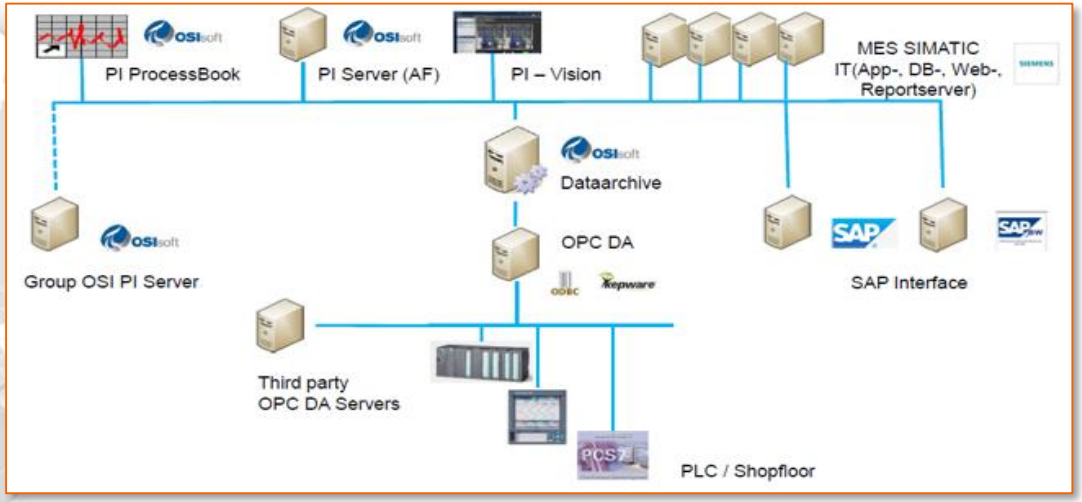
A Similar Infrastructure Across Sites Eases Scalability





RL Austria	Heerlen	Inncoat	Juelich	Pleasant Prairie

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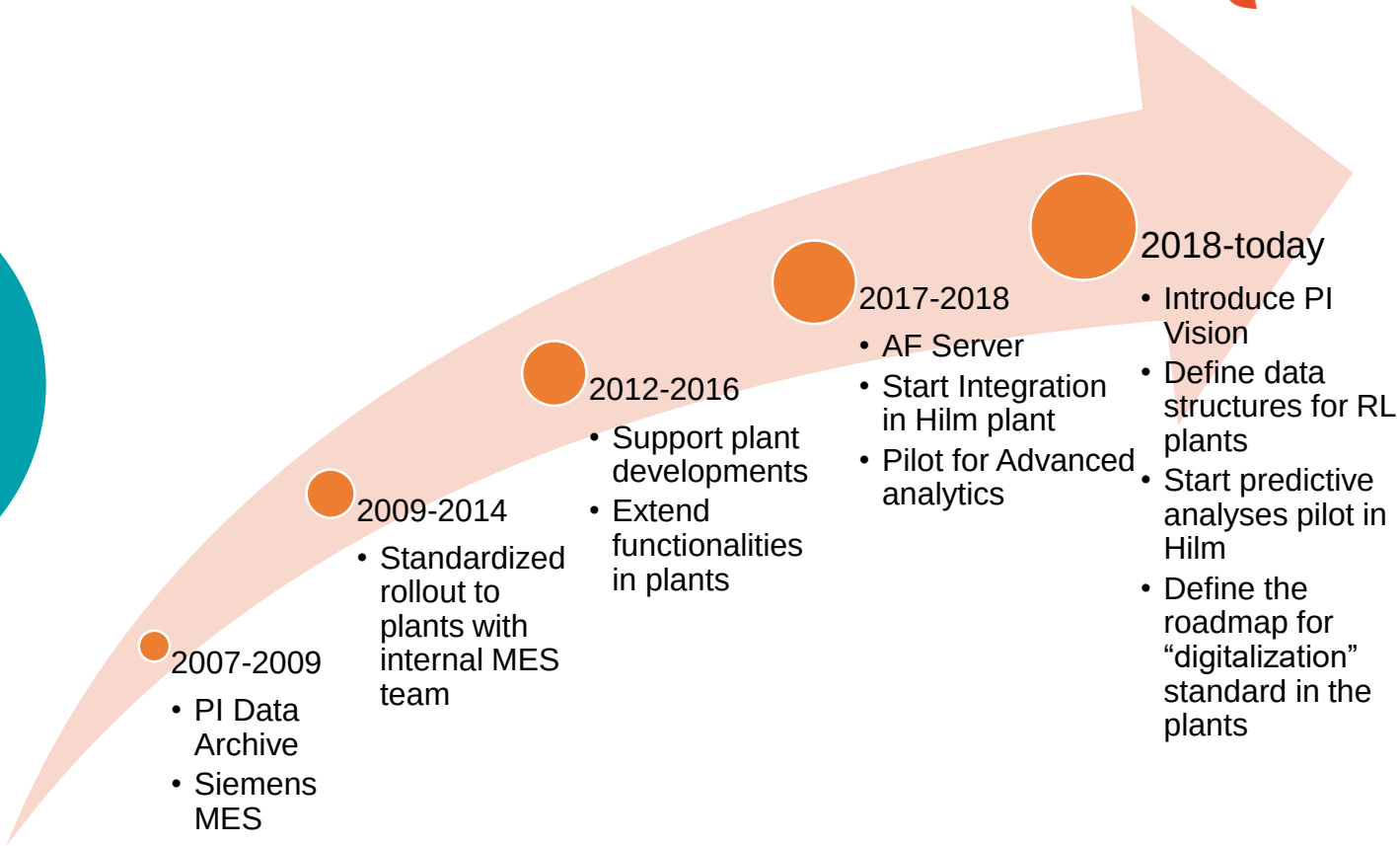
Our History with the PI System



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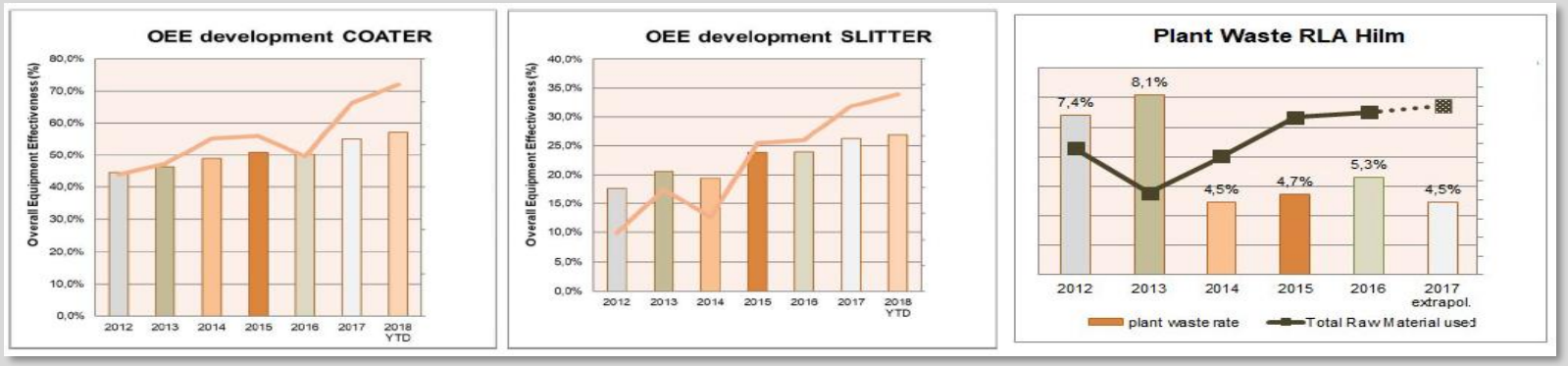
Continuously Improve Our Daily Routine



- High transparent operations layer: **See & understand what's going on**
- Supports lean projects / continuous improvement approaches
- Enables performance / waste reduction initiatives … **in daily business**
- Facilitates **data based** projects and **decision making**

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Why Did We Do This Project?

- How to ensure consistent application of **best operating practices** effectively?
- How to improve **operational expertise** across our broad range of products even further?
- How to **sustain and expand the competitive advantage** of our products?

Objective:

Build a **predictive model** as basis for a **prescriptive tool** for operators by using advance analytics

Better output

& Less rework

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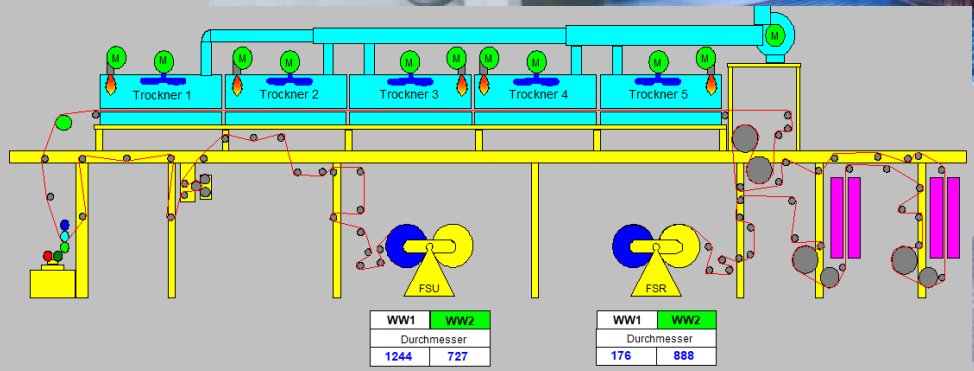
Introducing the Coating Machine



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A Pilot Project To Prove The Value

Machine learning

“Pro active” monitoring

Quality assistance

Objective

- Develop **a recommendation tool** with advanced analytics
- Focus on **quality-indicators** of products
- **Visualize** operating windows & automatic **notification**
- **Role model** for other coating plants

Expected sources of value

- Silicone cost reduction
- Reduction of rework
- Reduction of customer claims
- Improved process stability allowing for higher processing speed
- Further improved quality assurance

What is different to status quo?

- New approach in assuring product quality based on the combination of IT, AA and domain expertise
- New ways of working for the operators
- Continuous process control vs. project approach

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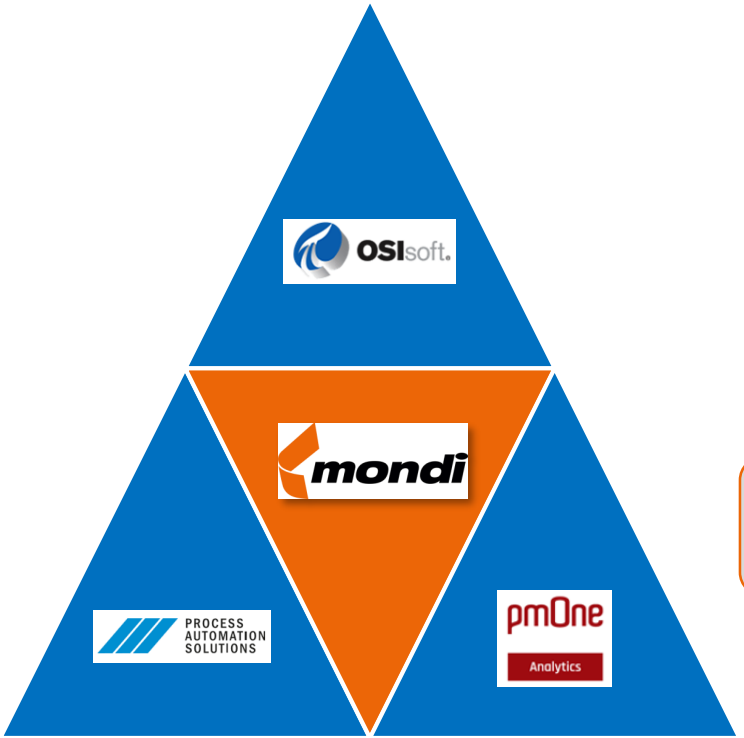
Form A Winning Team

A combination of qualified suppliers and the heads, hands, and hearts of key people in the plant

All involved parties **form one team** for pilot success



Every partner **contributes** very **actively** to achieve the pilot projects targets

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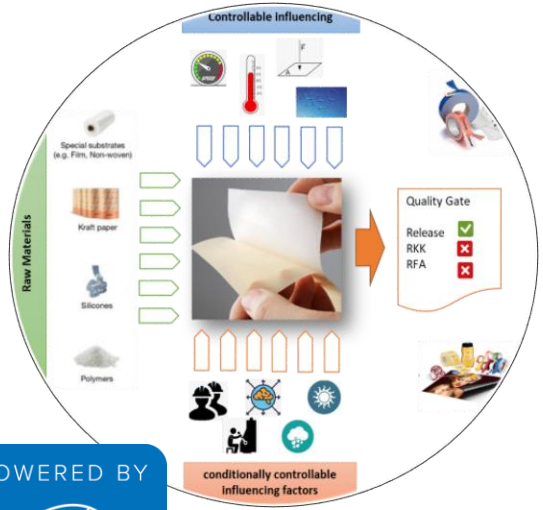
The Project Steps Leading To Our Objective

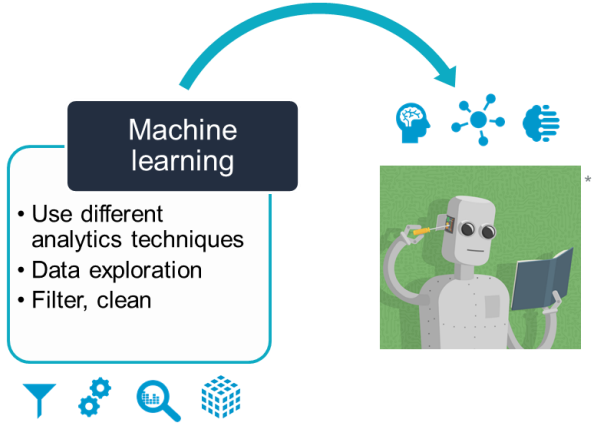
1 Ensuring the data base



POWERED BY OSIsoft.

Operational time-series data

2 Model identification



3 Deployment & operationalization

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Identify & Tap Into Relevant Data Sources

- MES, quality & process data
- Environmental data
- All data was contextualized to ease model building & scalability

Data household workshop:

- What data is available?
- How can we access
- How relevant is it fo

- Data from external systems not (yet) in PI System, e.g. weather forecast, supplier data, etc.

Collect & assign context	Transfer	Store	Analyze	Visualize

SAP

SIEMENS

PI System

PI Integrator

Data Lake

Machine Learning

PI Vision & Notifications
Dashboards and Actions

- Predicted quality KPIs

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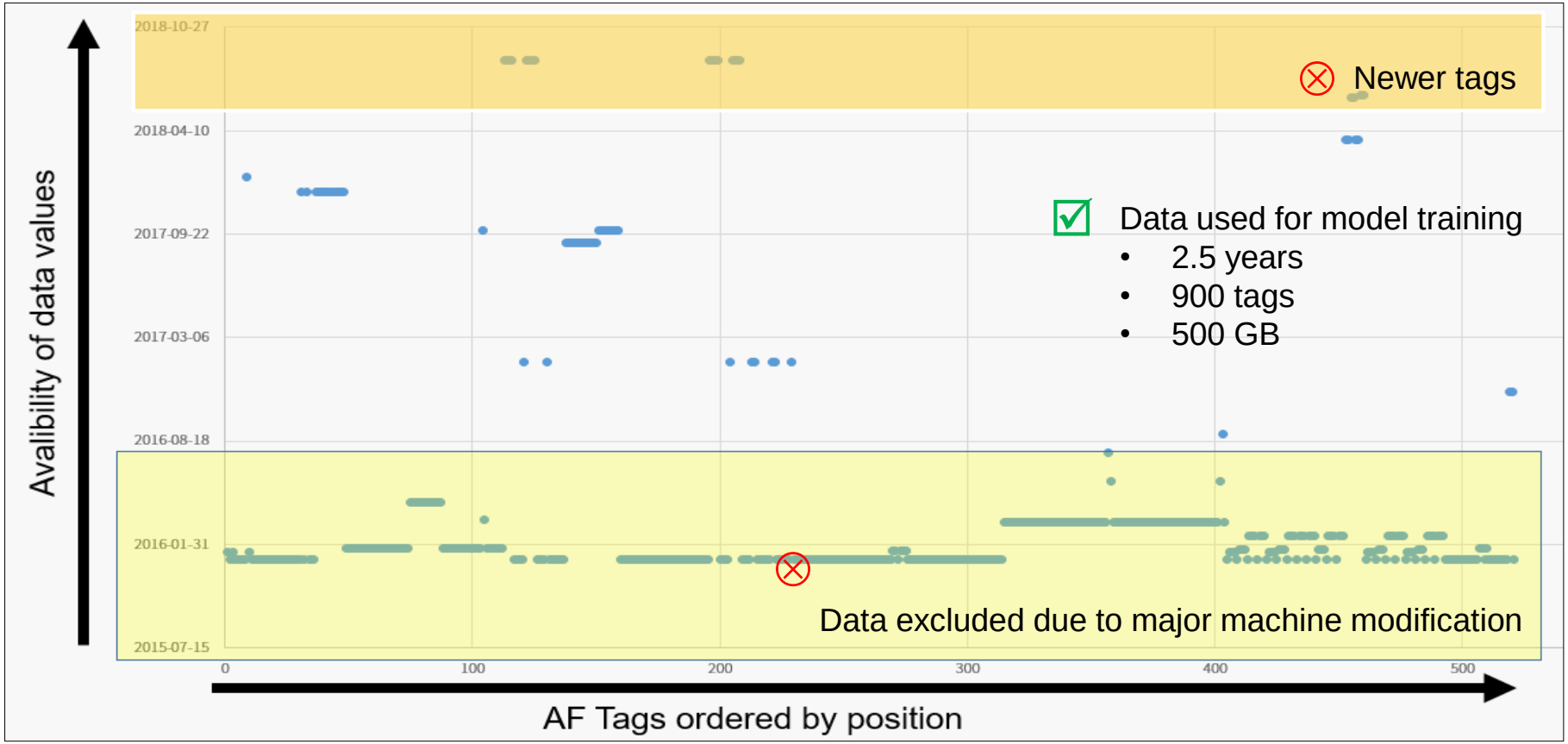
Review Data Range Used For Model Building



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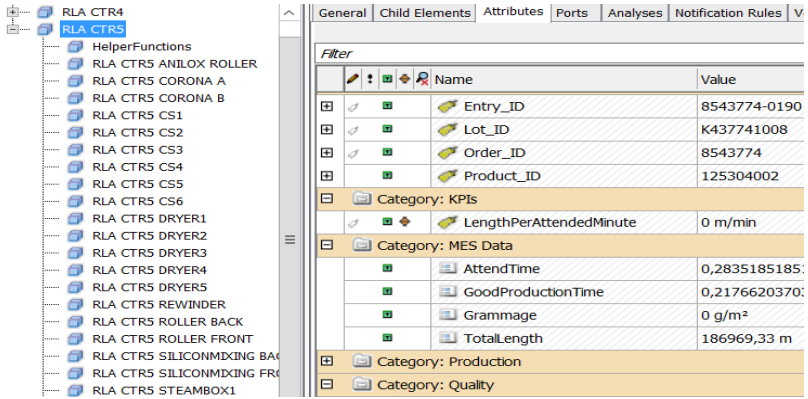
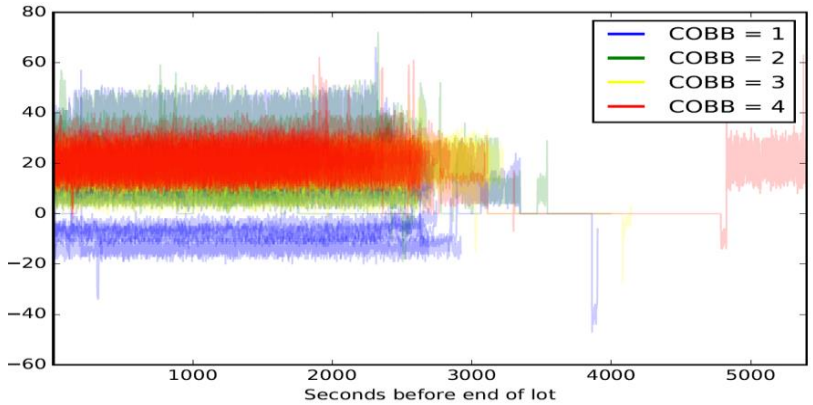
How To Identify Influencing Parameters?

Goal

- Find (process & environment) parameters with an influence on quality indicators





Methodology

- Started with ~500 AF attributes
- Domain know-how by Mondi
- Data Screening by pmOne
- Concluded with ~60 AF attributes

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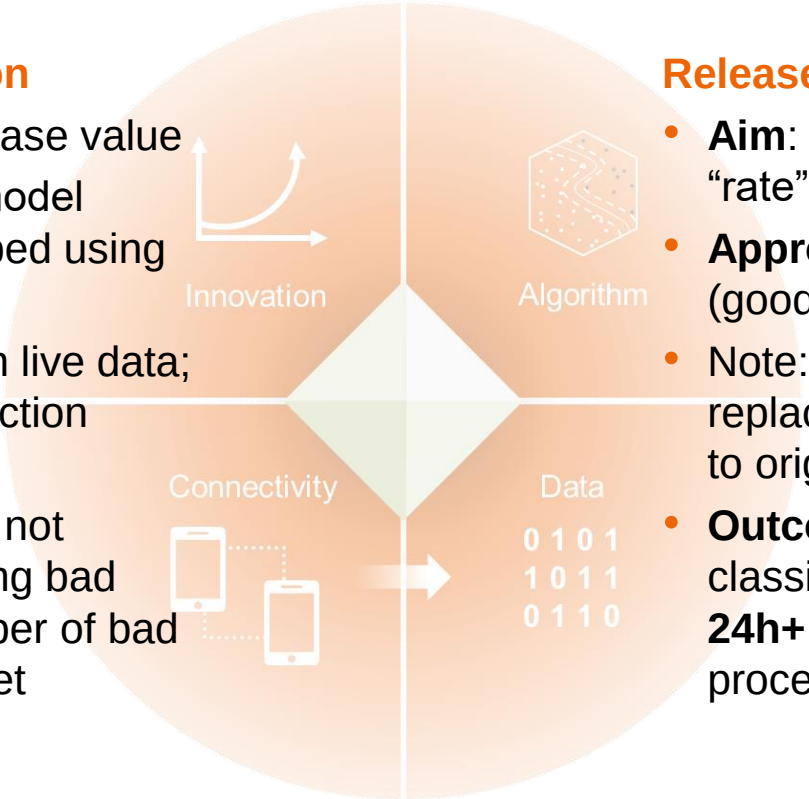
Evolution Of The Model

Release Value Prediction

- **Aim**: predict exact release value
- “Regression” type of model prediction was developed using historical data
- **Outcome**: validated on live data; on average good prediction accuracy
- Prediction model does not perform well in detecting bad lots, due to small number of bad lots available in data set



Release Value Classifier

- **Aim**: Improve bad lot detection “rate”
- **Approach:** binary classification (good / bad)
- Note: Classifier is not a replacement, but a supplement to original model
- **Outcome**: enables classification of product quality **24h+ earlier** than current process

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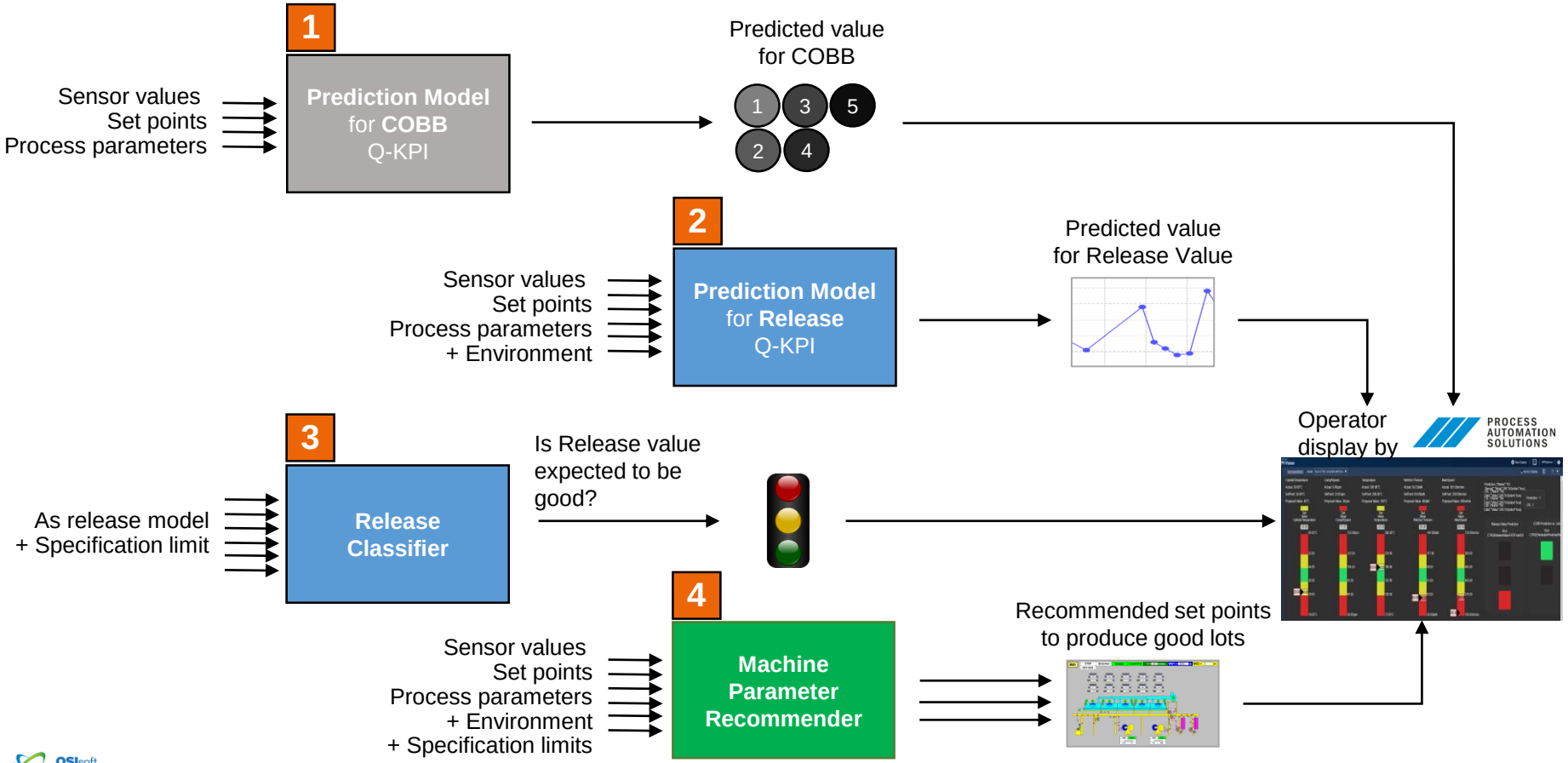
Combine Models To Support Operations



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Dedicated Environment For Model Building

Model building & re-training

DEV

python™ Spark

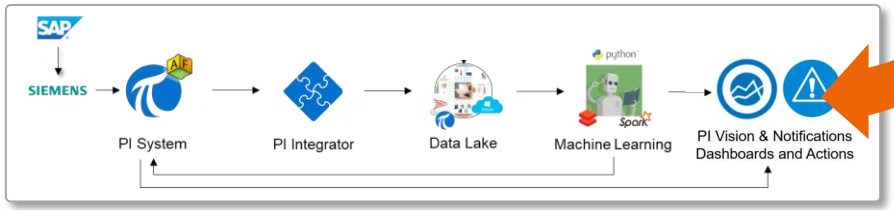
Data Science & Machine Learning

data ↑↓ predictions

Azure

Model operational application

PROD



python™

- Cater for **resource-intensive** identification of parameters, which have an impact
- **Flexibility** in terms of network security
- **Minimize risk** of model re-training on operational system

- Optimized for operational usage & balanced system load

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Model Performance In Practice

Deployed trained model in day-to-day production

Type of Model:	Release Prediction Model	
Type of Data:	**Historical Data**	**Live Data**
Target Value	Release Force	Release Force
Data Range	Aug. 2016 – Mar. 2019	Apr. – June 2019
Number of Products	13	16
Lots for Evaluation	846	577
Mean Abs. Error (MAE)	2.2	2.5
R^2	0.76	0.78
Accuracy vs. Specification Limits	95.8%	93.8%

- Keep increasing the number of products covered by prediction models.
- Scaling from 13 to 16 to over 100 products.

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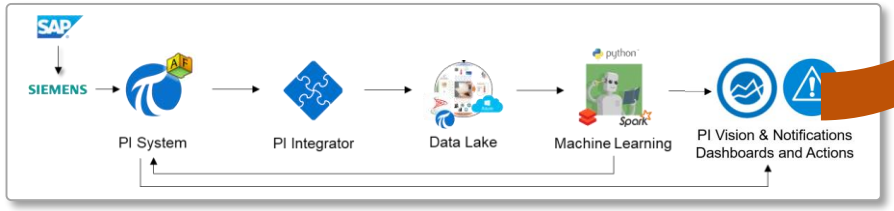
Gaining Trust with Line Operators

Model validation

VALIDATION

Model operational application

PROD



Objectives

- Evaluate prediction performance **in production**
- On-board **plant staff**

Validation

- 4 weeks per model over a wide range of products
- Creation of new input features based on input by plant staff

Result

- Confirmed model predictive performance
- Buy-in by future power users

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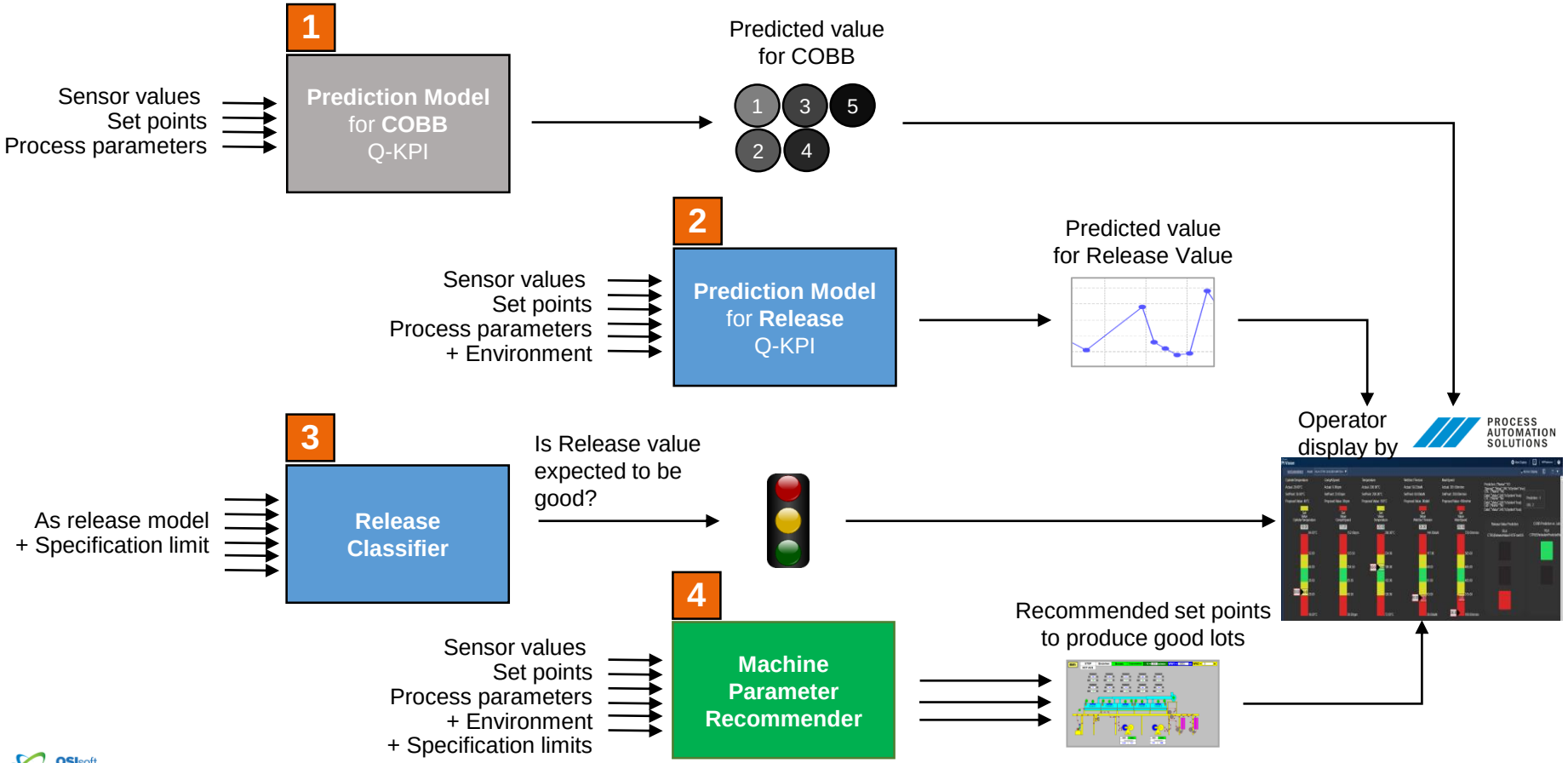
Combine Models to Support Operations



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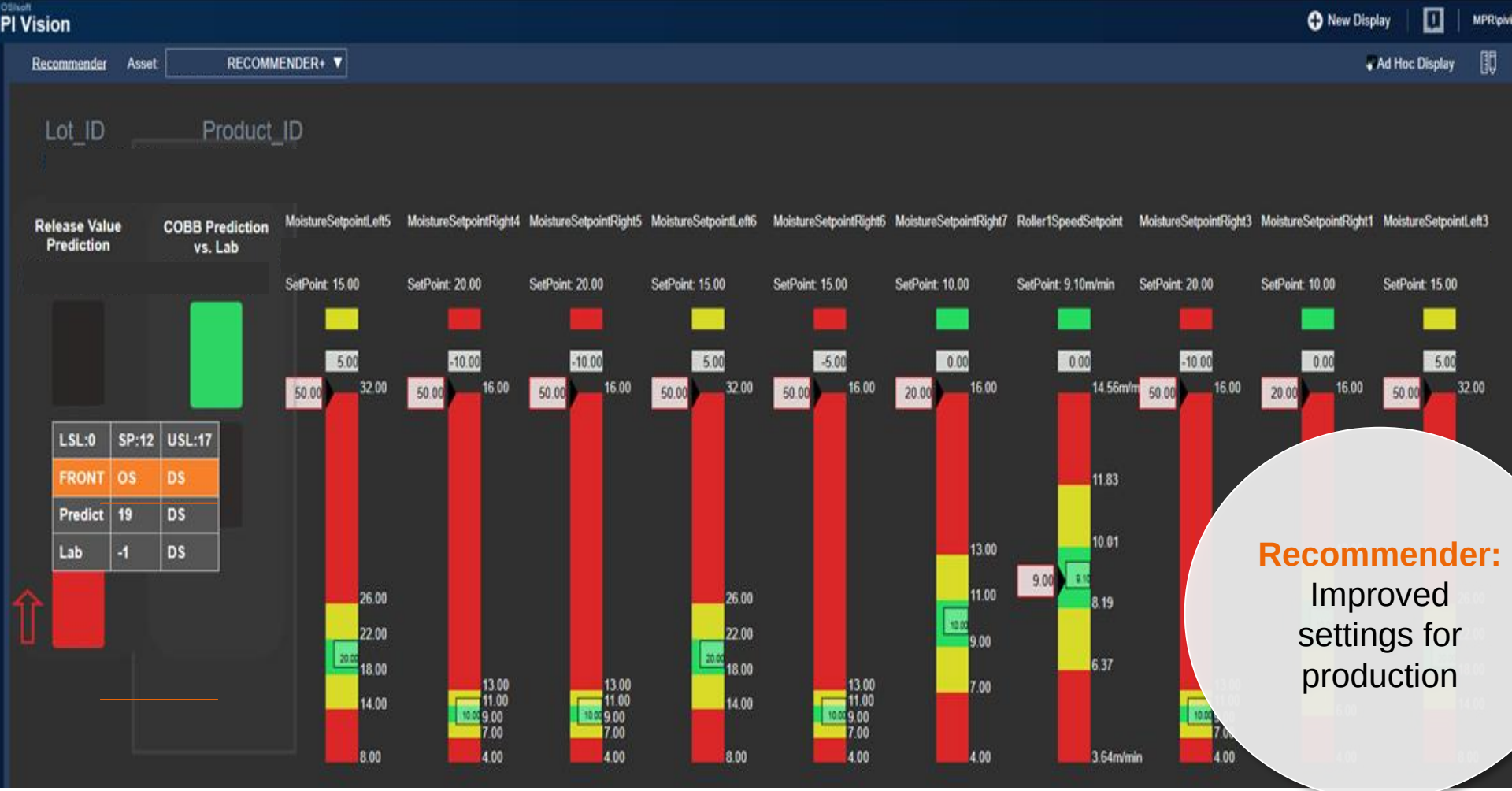

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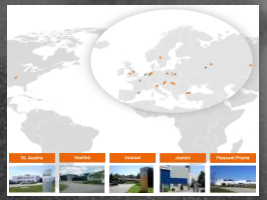
What's Next From Here?

- Refine model and operating procedures based on day-to-day operational experience



- Operative implementation across all Release Liner plants
- Consolidate learnings from diverse digital pilots
- Further leverage enterprise data infrastructure for Mondi's digital initiatives

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Advanced Analytics for Increased Production

CHALLENGES

- How to enable coating machine operators to classify quality of product lots faster and even further improve quality output with out huge CAPEX

SOLUTION

- PI System as foundation for data in context
- Advanced analytics focused on operational benefit
- Operator dashboard and notifications for actionable predictions

BENEFITS

- Moved from post-production to in-process quality assessment
- Which allows to reduce waste, rework, and transform the way of working for better output
- **8% additional rolls of good quality**

> A winning team is a combination of great suppliers and the heads, hands and hearts of key people in the plant.
> – Jürgen Bachner, Operations Director Mondi Release Liner

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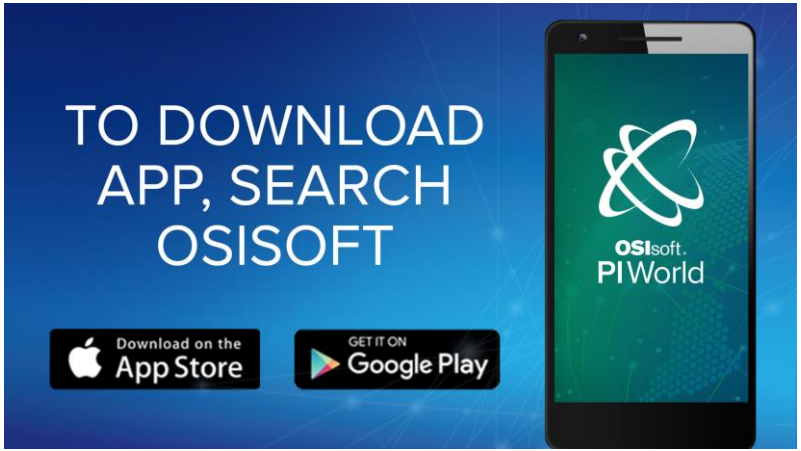

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