QUALITY LEVEL

MAX

QuinLogic

68th AMAP Colloquium

Dr. Michael Raus, QuinLogic GmbH

SMS group

How decision-making processes and production yield can be boosted

by connecting a Quality Execution System

to a Production Data Warehouse

MY AGENDA TODAY

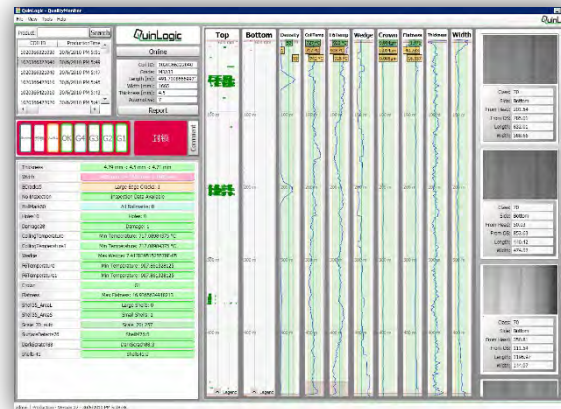# WHO IS QUINLOGIC?

Who are we?

1

**We are
a highly specialized
multicultural
software group
located in Aachen**

2

**The roots of our
employees go back
to the beginning
of the Parsytec
surface inspection
system in 1994**

3

**Since 2008,
we have only
one focus:
"Quality Assurance
Software
for Rolling Mills"**

4

**Since 2019,
we are a member
of the SMS group**

# What makes us the market leader in our field?

QuinLogic

Our customers.

Our roots

◆ Our roots go back to the automatic surface inspection in the rolling industries

◆ In 15 years of SIS customer projects we had learned some lessons:

   ■ Surface defects have a severe influence on product quality

   ■ Correct classification of defects is very important but always limited without context information

   ■ It's difficult to trace coils correctly to compare defects from different process steps

   ■ For product quality, surface quality is only a part of the picture

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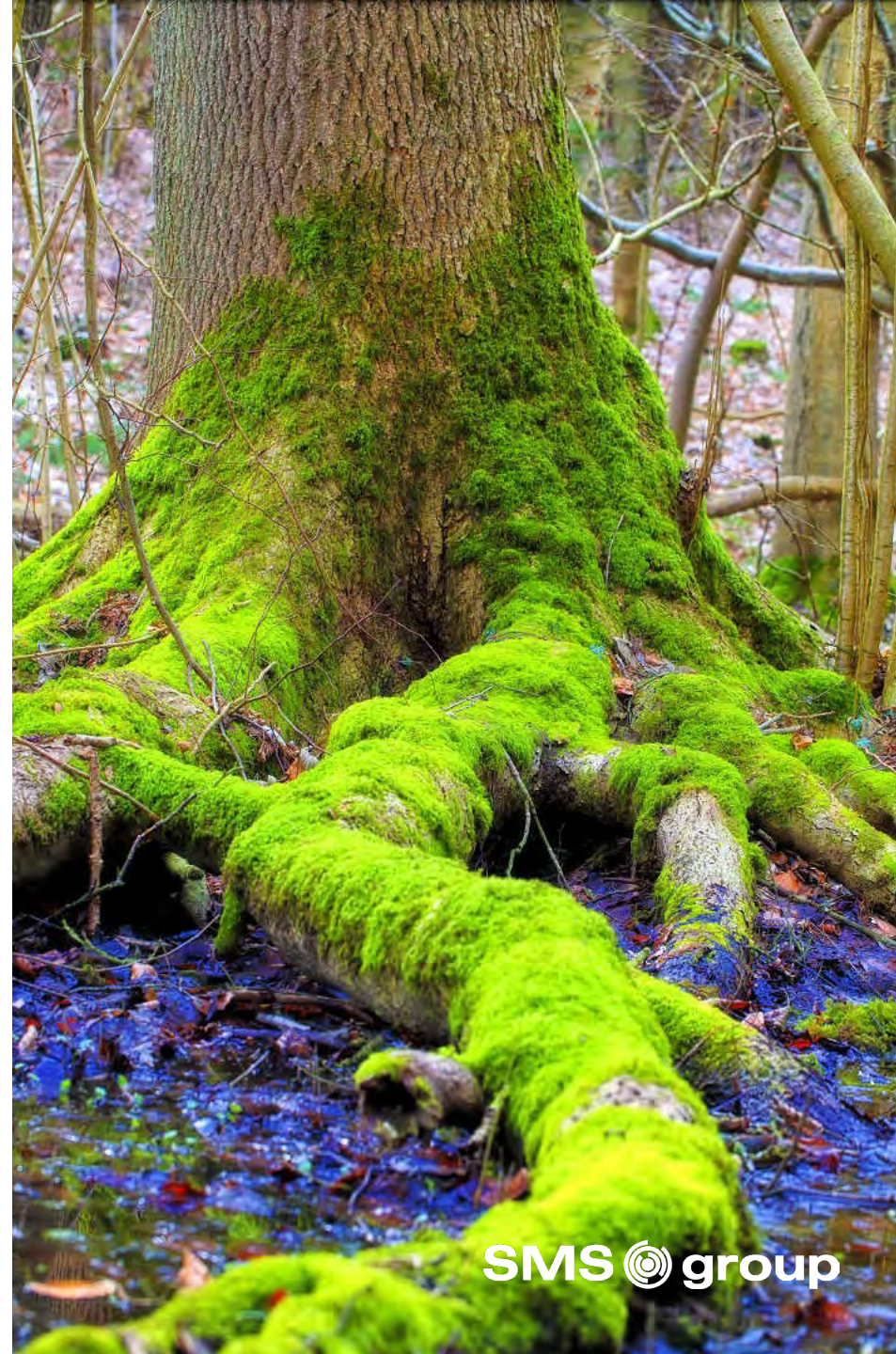
Our dream

◆ At that time, we dreamed of a world where

■ our customers could just access all defect data
of a coil throughout its process route

■ all other process data are just available
for an advanced analysis

■ our customers could just have the whole picture
of their coils' quality

▪ at their fingertips

▪ without deep IT & data analytics expertise

◆ So, we started developing a software
that could make our dream reality

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Living our dream

◆ We were sure that our clients would understand the amazing possibilities of our product

◆ So they would just make all this data and information available to us

◆ But we quickly realized that this was easier said than done

◆ In fact, our clients were thrilled by the opportunities, and we received the first orders

◆ But it turned out that this hurdle was very high for many of our customers

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Clearing obstacles out of the way

◆ Actually, this didn't come as a surprise to us,
so, we set about removing this obstacle for our
customers

◆ We rolled up our sleeves and took the task
of finding, connecting, converting data
from our customers

◆ So, we soon realized that we could do much more
for our customers

◆ Actually, this was the start of our

PRODUCTION DATA WAREHOUSE

SMS ◎ group

Living our dream

◆ Today we are realizing our dream and – even better – we are making the dreams of our clients come true

◆ It's incredibly satisfying to see how our project partners are stunned in front of their Quality Monitor when they see all process and quality data before them for the first time ever

◆ And the creative energy set free by this unlimited space of opportunities is astonishing

◆ Only after some years we recognized that, what we actually did, was opening our customers the door for what's nowadays called

INDUSTRY 4.0

WHAT IS QUALITY EXECUTION?

How does QuinLogic support developing into "Industry 4.0?

By horizontal integration:

◆ Networking between manufacturing sites

◆ Up-/downstream involved in the process

◆ Exchanging information throughout the value chain

◆ Intelligent system communication in demand, production and logistics

By vertical integration:

◆ Networking within the company from the manufacturing level to higher levels

◆ QES aggregates data from all levels

Manufacturing level

PRODUCTION PLANNING (ERP)

Operation control level

PRODUCTION CONTROL OPERATING DATA MANAGEMENT

MES

Process control level

OPERATING AND MONITORING SYSTEM (HMI/SCADA)

MACHINE AND SYSTEM CONTROL (PLC)

Field level

INPUT/OUTPUT SIGNALS (ACTUATORS/SENSORS)

MANUFACTURING/ PRODUCTION PROCESS

HORIZONTAL INTEGRATION

VERTICAL INTEGRATION
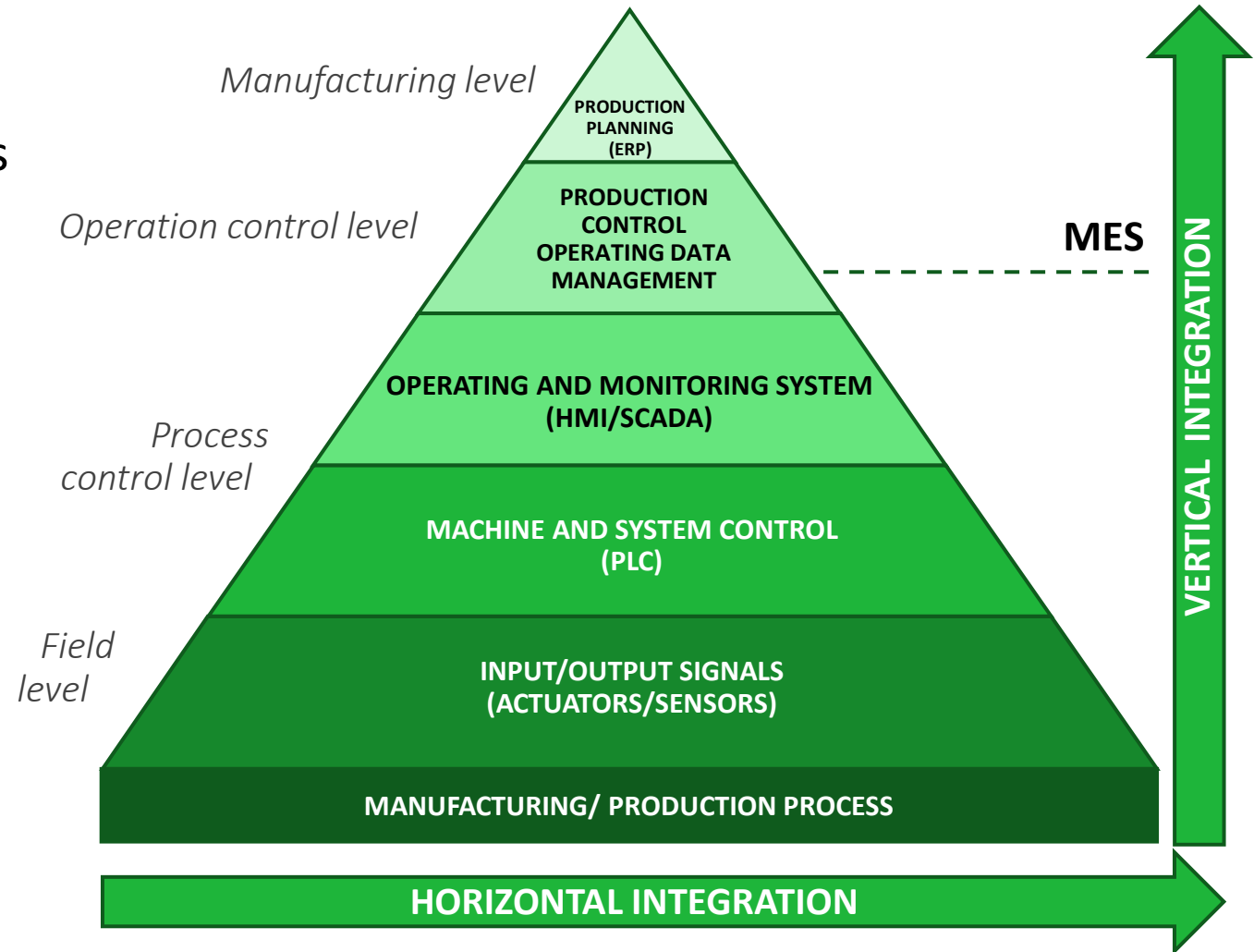
Does this look familiar to you?

ISLAND THINKING

- Multiple value-adding production steps in mostly isolated production lines

- Cumbersome to access up/downstream data

- Difficult to link finished product to production data

- Cross-facility value-adding production steps add complexity to data storage and provisioning solutions

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The QuinLogic **QES** is building bridges

- ◆ By using the QuinLogic **PDW**, bridges are built across the chasms between isolated processing lines

- ◆ Right starting point for cleaning up an <u>inhomogeneous data landscape</u>

Grown over years but never meant to be ready for digitalization

Multiple distributed data sources in the plant
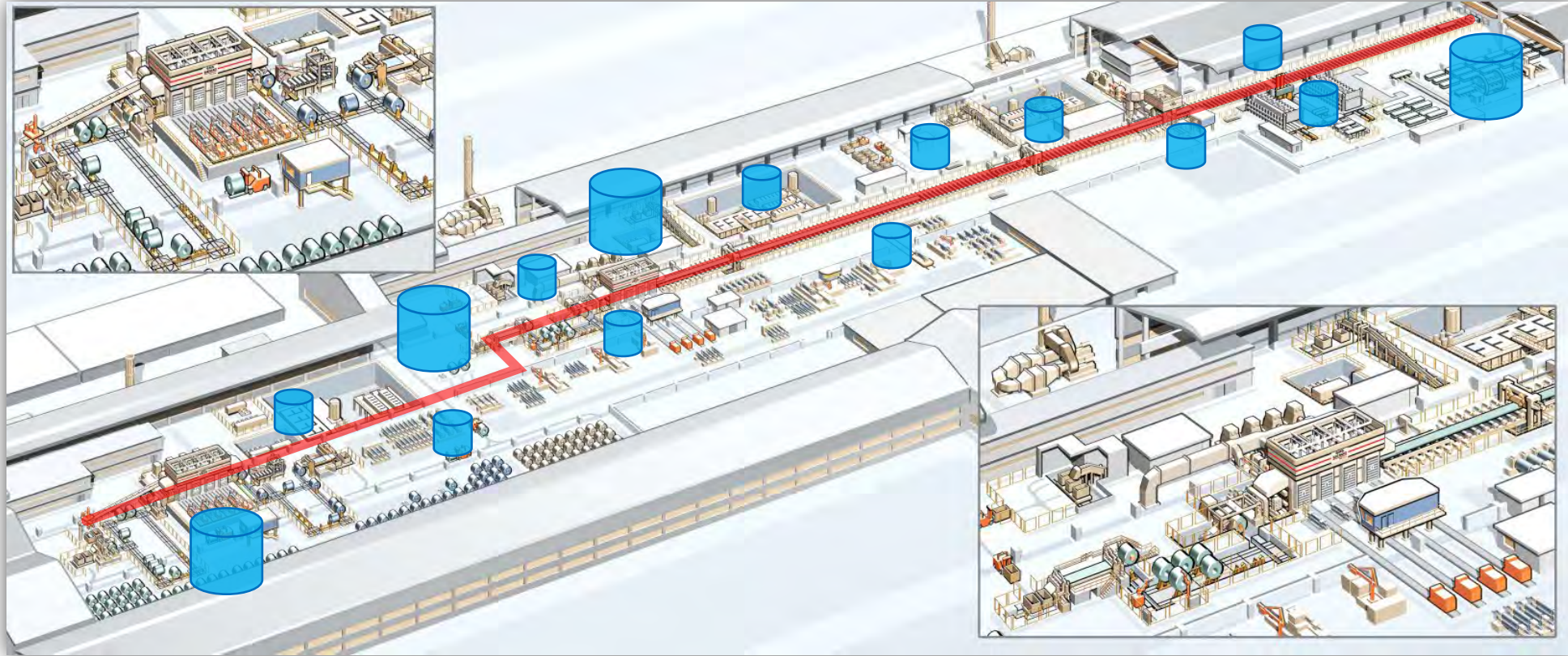
◆ On its way along the process route each coil produces numerous pieces of data

◆ The coil leaves these data behind on local servers and other devices

Multiple distributed data sources in the plant
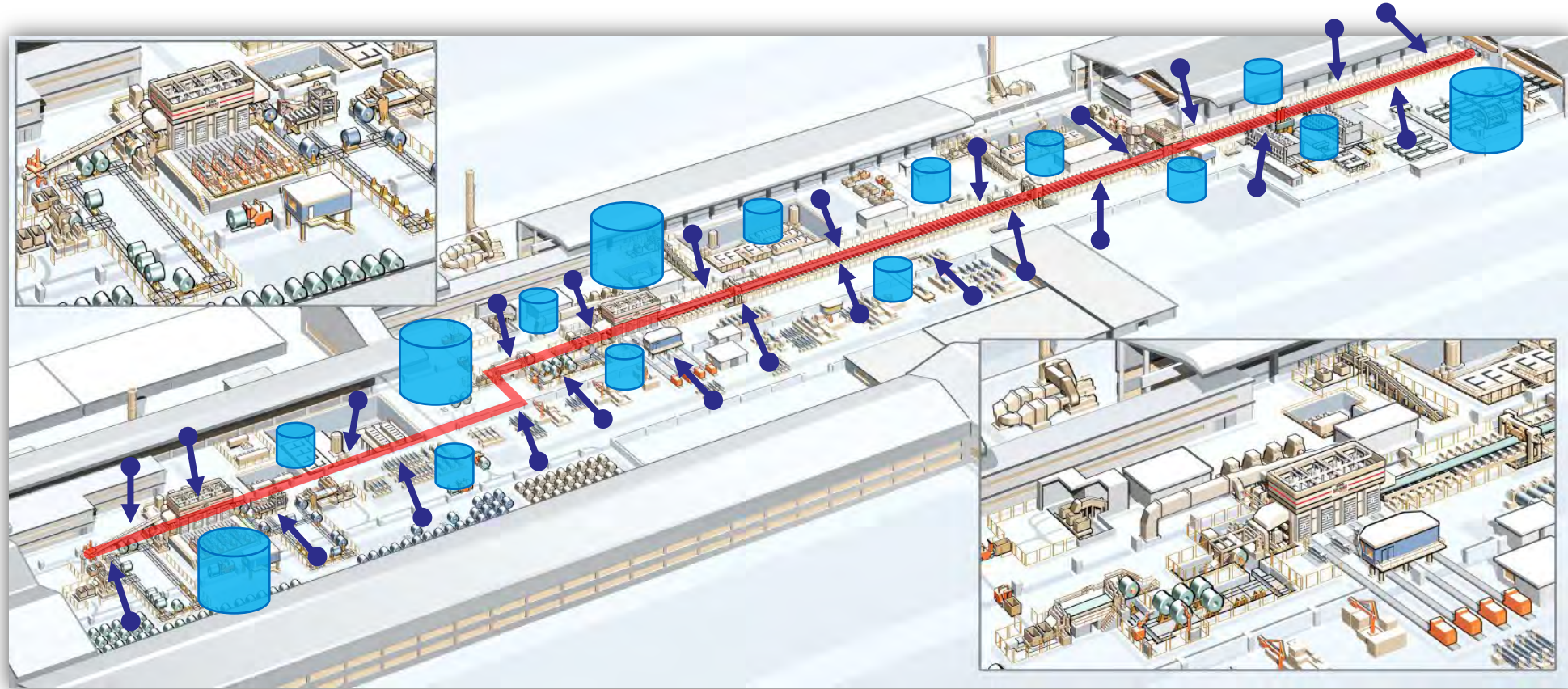
◆ In addition, the coil's quality is affected by many local process parameters

Which data determine the quality of a coil?

Each coil is represented by data from numerous data sources of the different automation levels

Order Data

Customer	BMW	
Target Width	1225	mm
Width Tolerance ±	5	mm
Target Thickness	1225	mm
Thickness Tolerance ±	5	mm
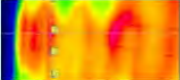
Ident Code

H-4711-0815

Grading Decision

SHIP

Coil Weight

w   13   t

Coil Dimensions

cl	1230	m
cw	1224	mm
ct	6	mm

length
width
thickness

Production Date

October   2020

Thickness Time Series

Temperature Distribution

Measured Speed

Lab Report

Example Mill Metallurgy Summary

MILL METALLURGICAL SUMMARY

Surface Defect Images

Surface Defect Map

Scrap Lengths

Tail   Head
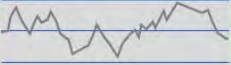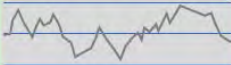
Scrap Length Head	2340	mm
Scrap Length Tail	785	mm

Representing a coil in the Internet of Things

Internet of Things

◆ For bridging the physical and the virtual (digital) worlds, data has to be transmitted seamlessly allowing the virtual coil to exist simultaneously with the physical coil

◆ As such, it holds a comprehensive digital replica of the physical coil:
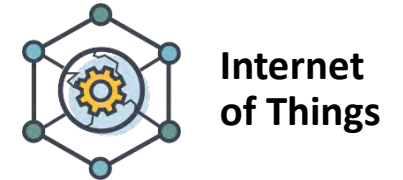
Physical Twin

Digital Twin

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Physical and digital twin

◆ The QuinLogic QES is able to collect, aggregate, and analyze all existing data related to a coil

Digital twin and its digital siblings

One and the same physical coil has not only one
but several digital siblings:
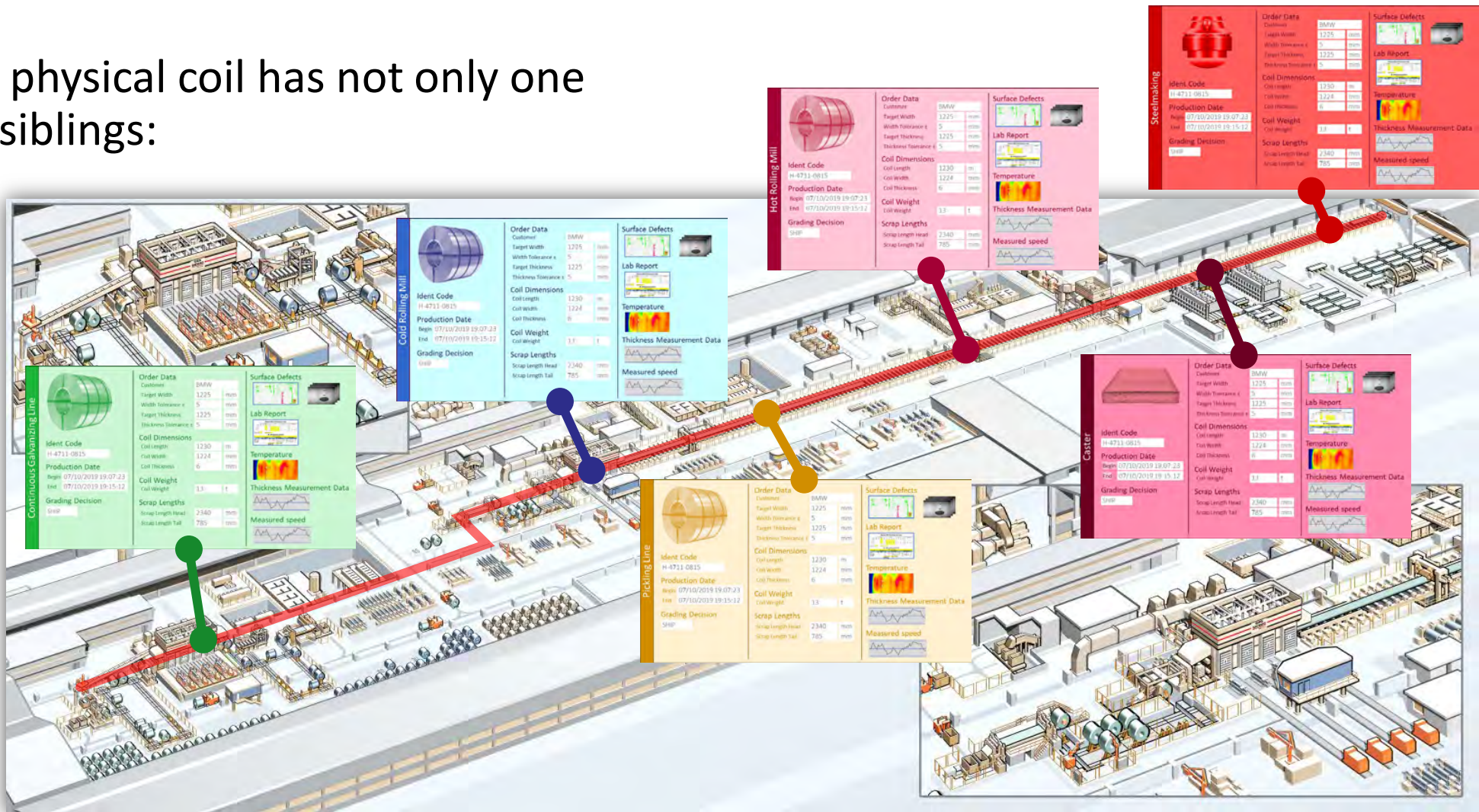
Digital family:
All data that
contain
information
about a coil's
evolution and
final status

QES – The Smart Assistant System

◆ Explore quality relevant data from all process steps

QES – The Smart Assistant System

- ◆ Explore quality relevant data from all process steps

- ◆ Analyze the evolution of quality degradation

QES – The Smart Assistant System

- ◆ Explore quality relevant data from all process steps

- ◆ Analyze the evolution of quality degradation

- ◆ Back and forward tracing for eliminating infected products
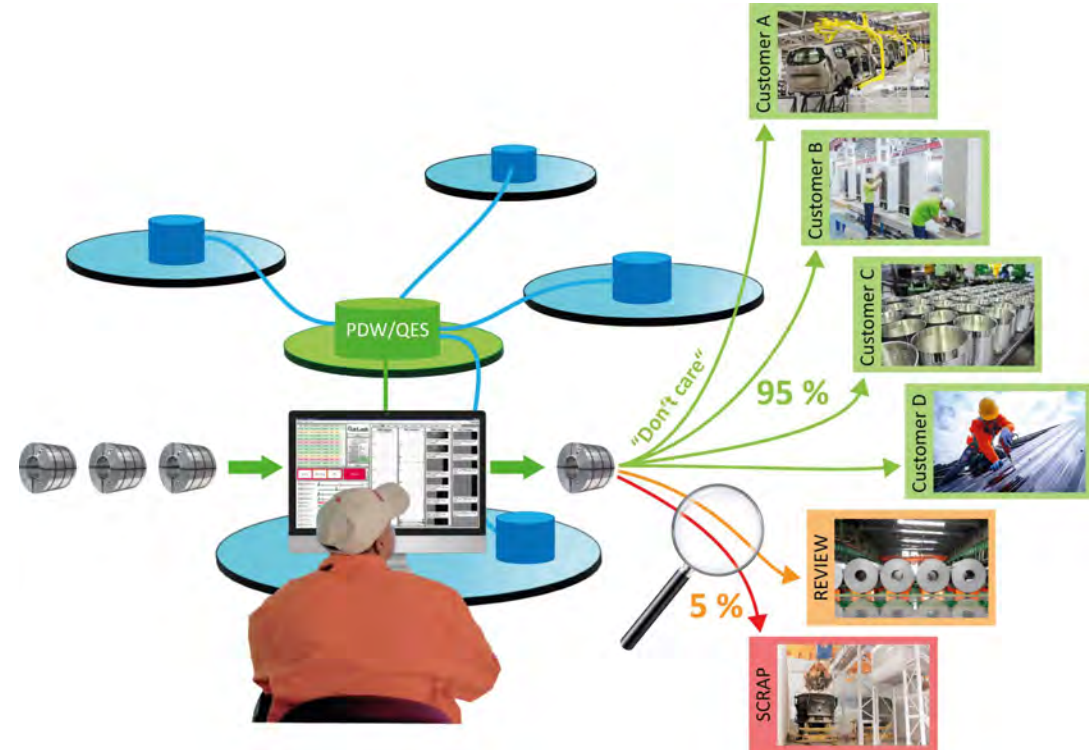
What is a Quality Execution System?

◆ **Quality execution** means not only **managing** quality, but:

 ■ actively **improving** quality

 ■ quickly identifying causes of quality fluctuations

 ■ getting the best out of quality deviations

◆ Quality and process experts are not replaced or ignored,
but actively involved

◆ Expert knowledge is mapped by an efficient, powerful control process

◆ Objectified approval decisions for products are generated automatically

Go the extra mile
It's never crowded

Why objectified automatic decisions?

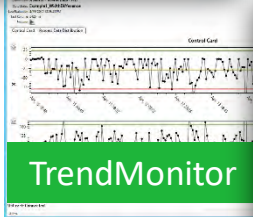**Making better decisions**

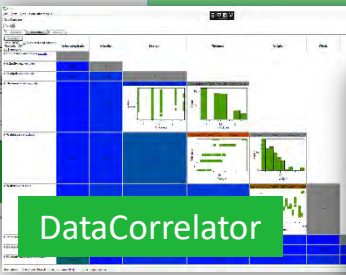# WHAT IS THE QUALITY EXECUTION SYSTEM?

Customizable standard product
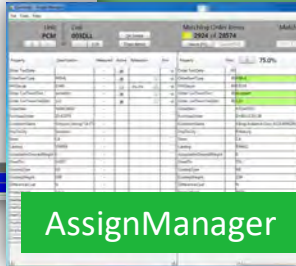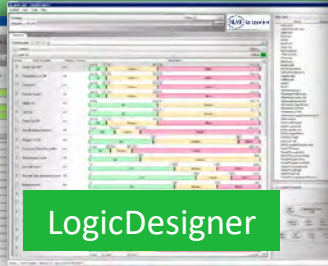
Quality Execution System (QES)

QualityMonitor

WebReports

TrendMonitor

DataCorrelator

AssignManager

LogicDesigner
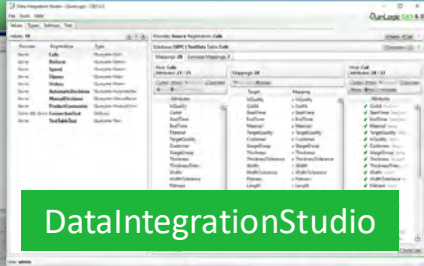
DataIntegrationStudio

Sustainable product development
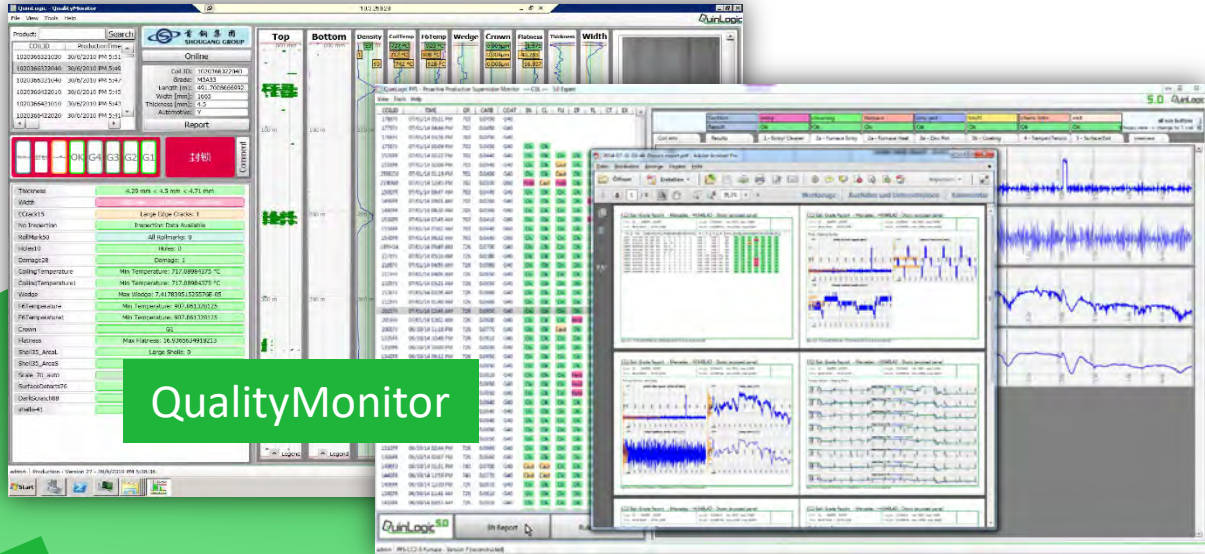
Regular software updates

- Quarterly updates
- One major release per year

11.3

Lively user community

- Annual user meeting
  - Presentation of new release
  - Feature request sessions
- Helpdesk

Learning & Development

- Monthly user webinars
- Online and classroom courses
- Certified trainer
- Online learning platform

What is our product about?

QuinLogic

The

**Quality Execution System**

monitors

documents

safeguards

- ◆ process and product quality
- ◆ from the start of the process chain
- ◆ down to the finished product

◆ All relevant production and process data are recorded and analyzed by rules

◆ The system provides quality decision support based on **Automatic Product Grading**

◆ It also monitors process data and – in case of deviations – issues instructions for action

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QualityMonitor Dashboard

- ◆ The **QES Dashboard** concept empowers the QES users to adapt the QualityMonitor and make it their own
  - ▪ According to their individual needs
  - ▪ At any time
  - ▪ Without QuinLogic support needed
- ◆ Data from various lines can be visualized and analyzed on the same screen
- ◆ Arbitrary number of **Dashboard** reports can be shown in parallel on split screens
- ◆ User, role and line specific **Dashboard** reports
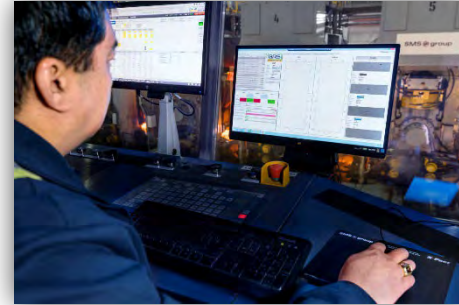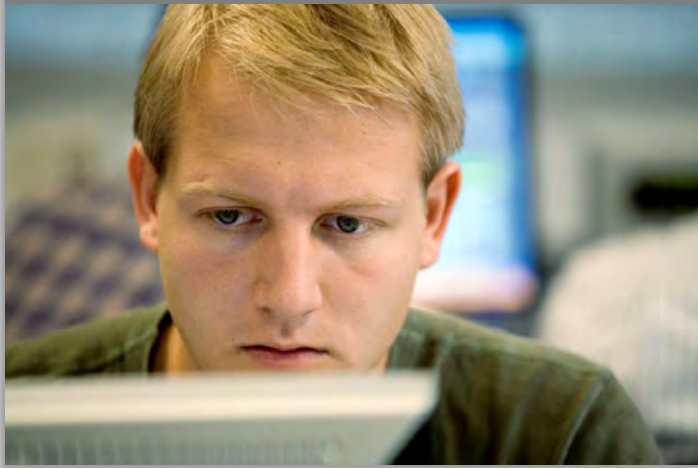
Does this remind you of something?

SCRAP

Customer A

Customer B

Customer C

Customer D

QuinLogic

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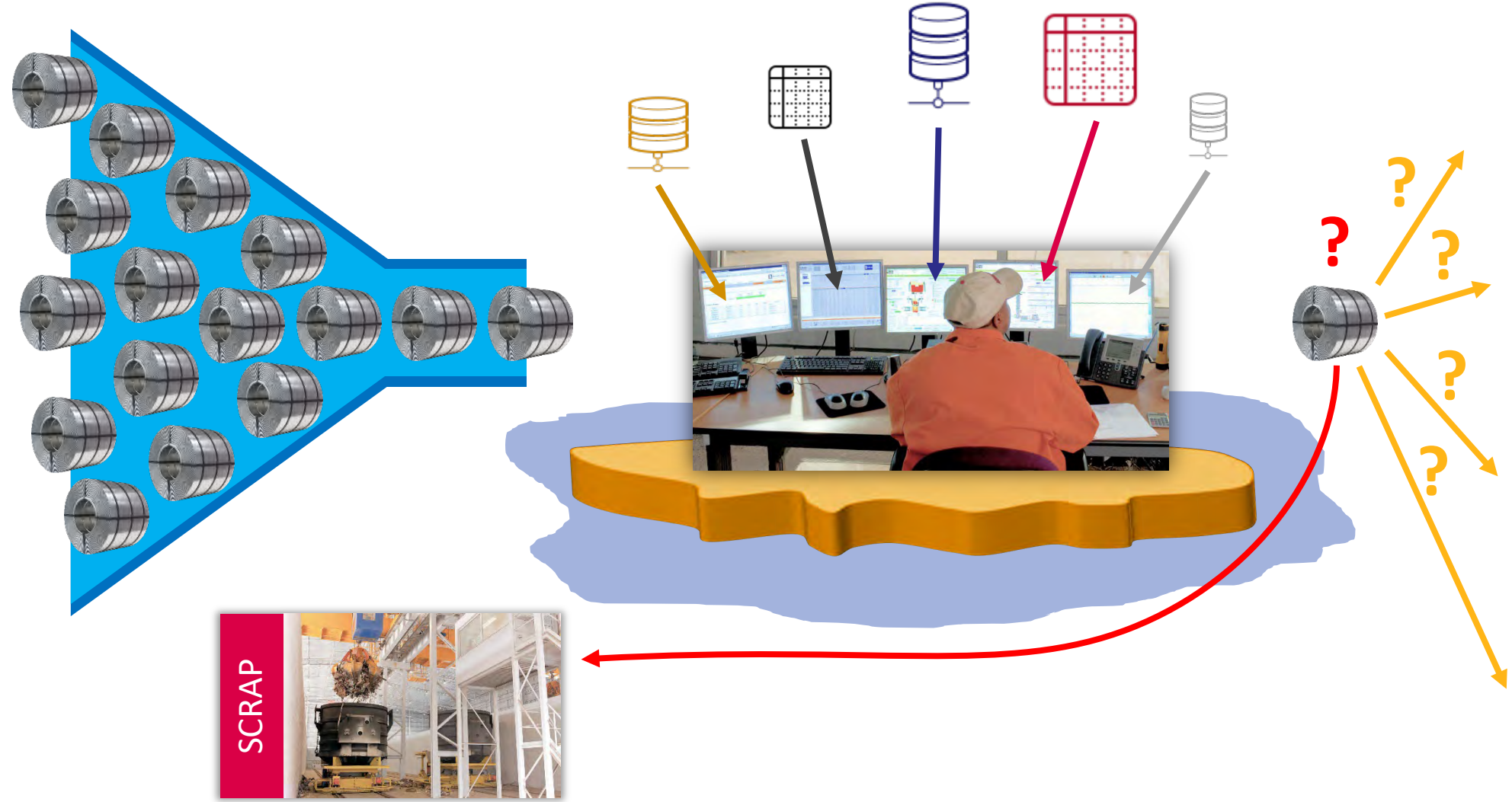
Manual product grading – key drawbacks

◆ What are the main drawbacks of this approach?

Your quality experts are fed up with routine work	**The grading decision is based on incomplete data**	**High number of products with unclear grading status**
➜ Less time for pro-active measures	➜ Limited reliability ➜ High claim rate	➜ Blocked warehouse capacity

The QES Automatic Product Grading application

- ◆ Full data access
- ◆ Smart assistance
- ◆ Focus on critical products only

Customer A

Customer B

Customer C

Customer D

SCRAP

REVIEW

QuinLogic

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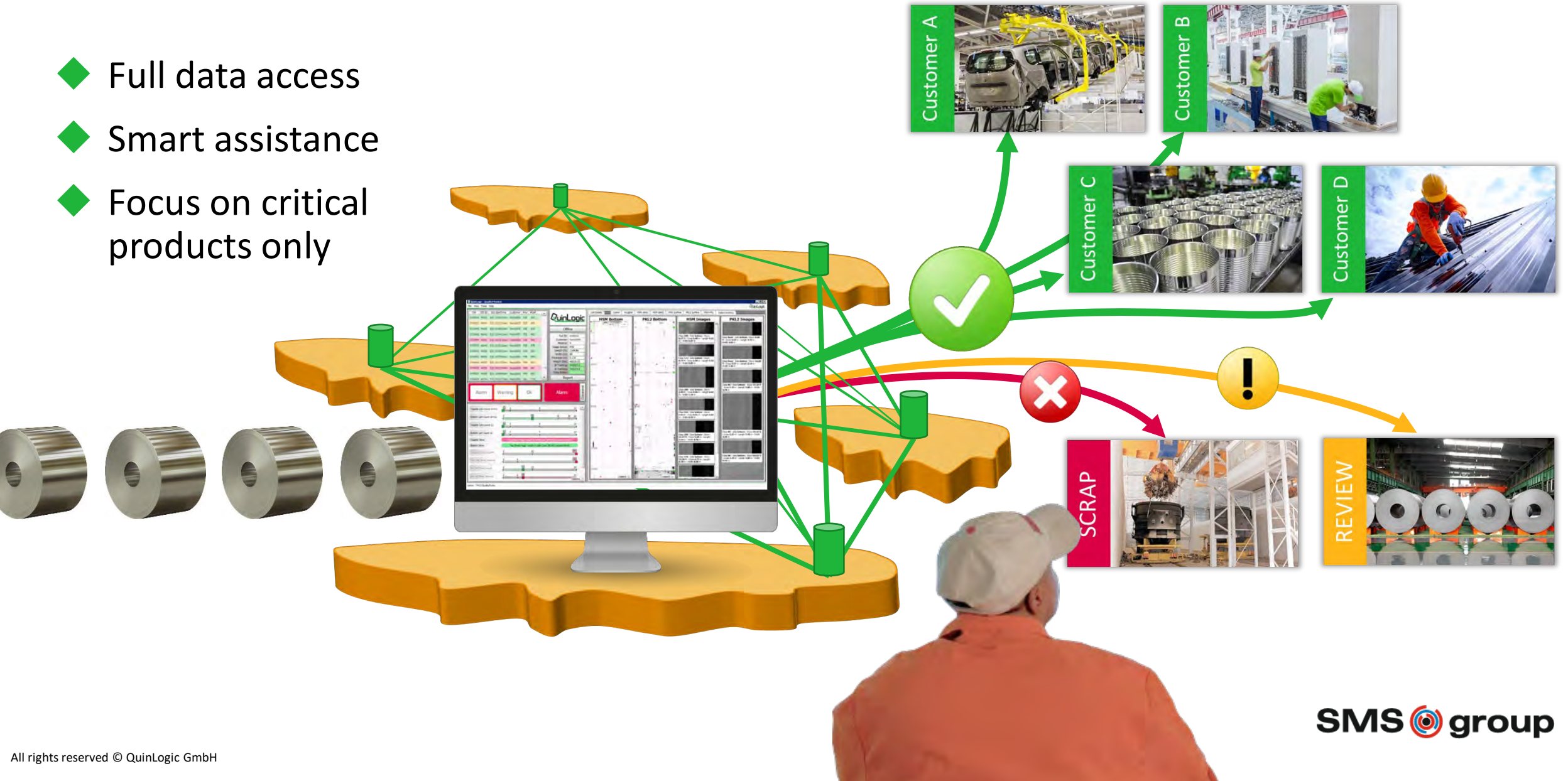
Automatic product grading – key benefits

◆ What are the main benefits of this solution?

Your quality experts are freed from routine work	All quality and process data available for grading	Less products with unclear grading status
➔ More time for pro-active measures	➔ High reliability ➔ Lower claim rate	➔ Free warehouse capacity

CLAIM RATE

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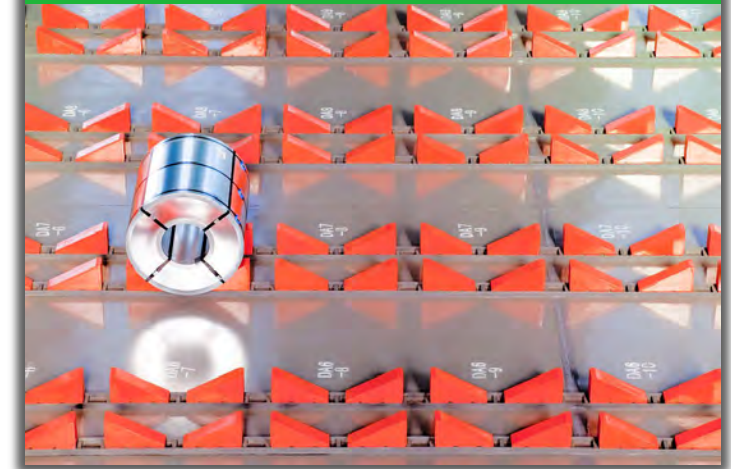
The QES is learning from you
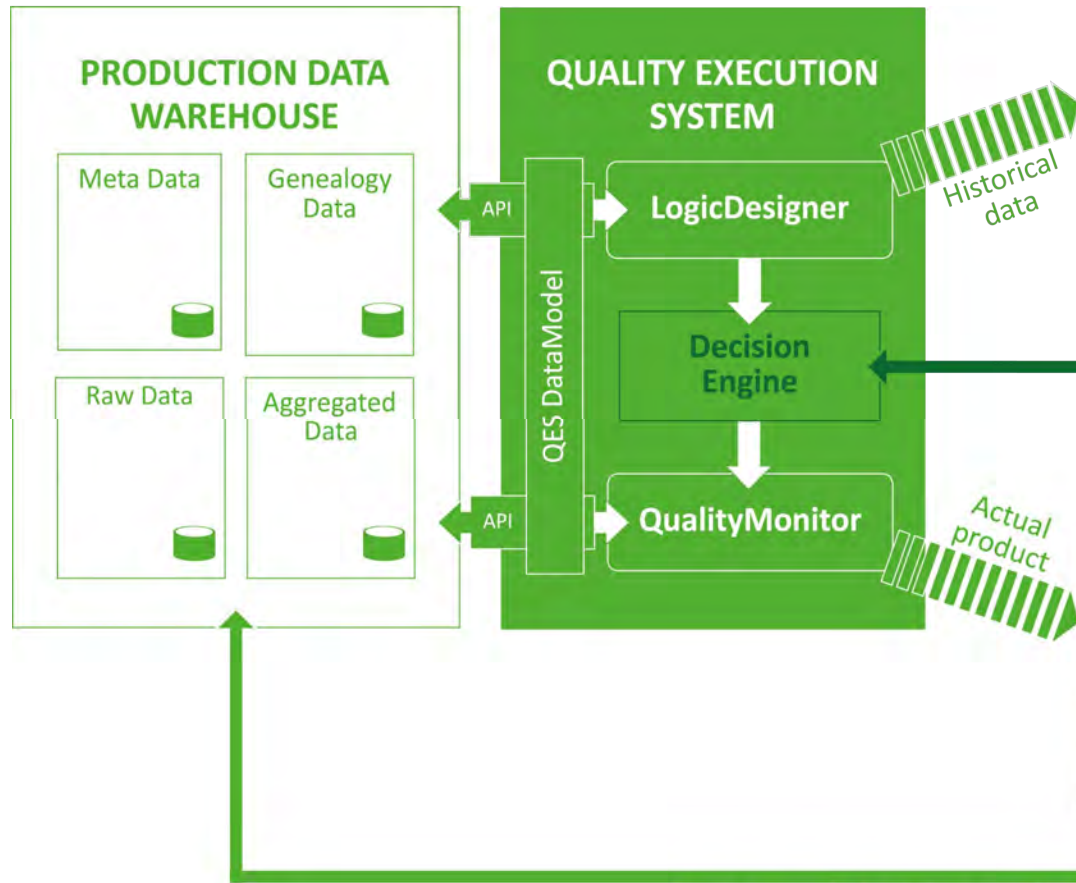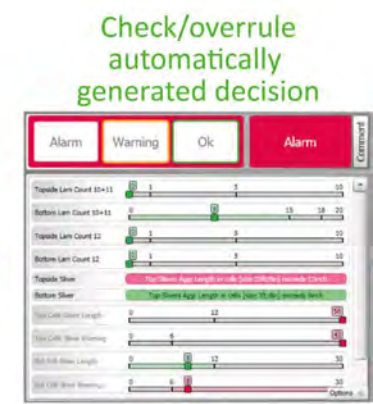
Optimizing the release rate

	true	false	
Released	60%	0%	= CLAIMS
Blocked	25%	15%	= TIME

OPTIMIZATION OF THE GRADING RULE SET
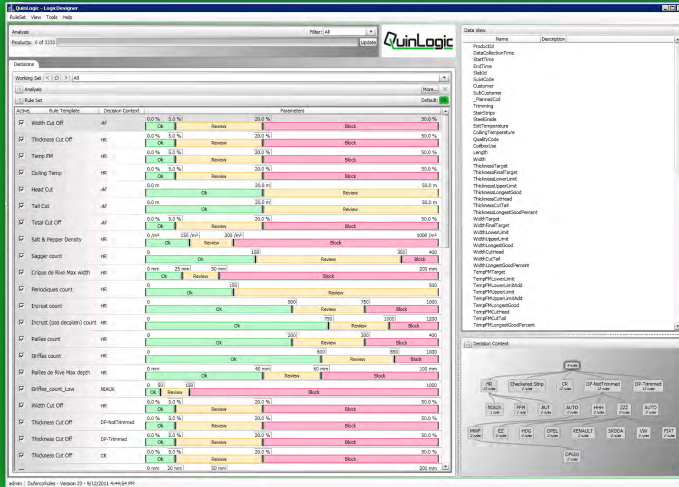
	true	false
Released	75%	0%
Blocked	20%	5%
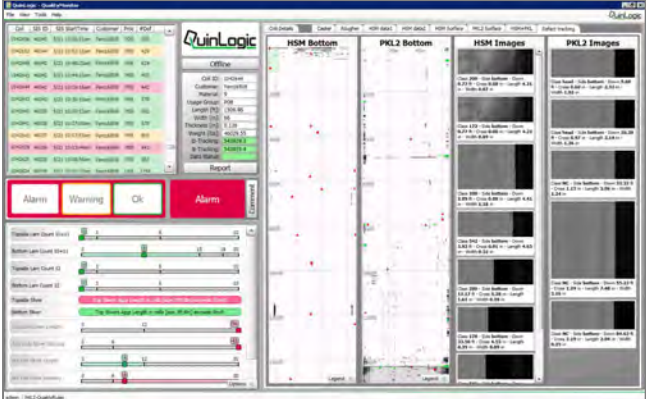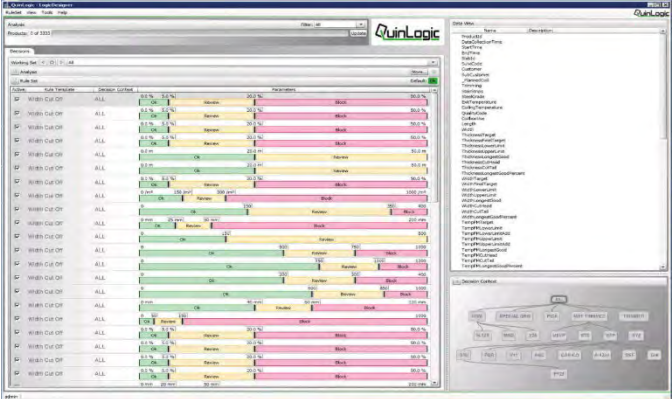
The QES Rule Management & Data Analytics tool set

LogicDesigner

- Rule definition
- Rule management
- Rule set evaluation

DataCorrelator
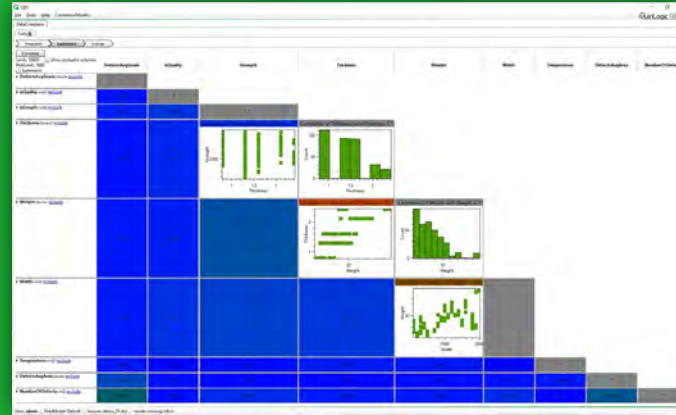
- Data selection & preparation
- Correlation analysis
- Exploration

TrendMonitor

- Statistical process control
- Control cards
- Monitoring and alarming

QuinLogic LogicDesigner

- User-friendly, intuitive tool for the creation of rule sets

- Direct access to PDW data

- Management of rule sets for various product contexts

- Analysis of new rules using archive data

Rule building – simple as drag & drop

◆ Rule templates for new rules

◆ All stored data items from the PDW available for rules

◆ Drag a data item and drop it on a new rule

Explorative data analysis – Turning data into insights

◆ What causes products to have more defects?

  ▶ Root Cause Analysis

◆ Did we really get less defects
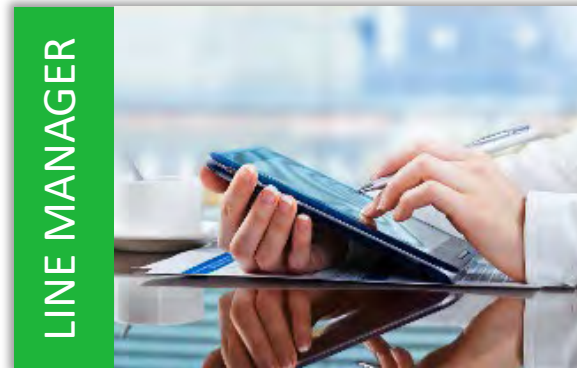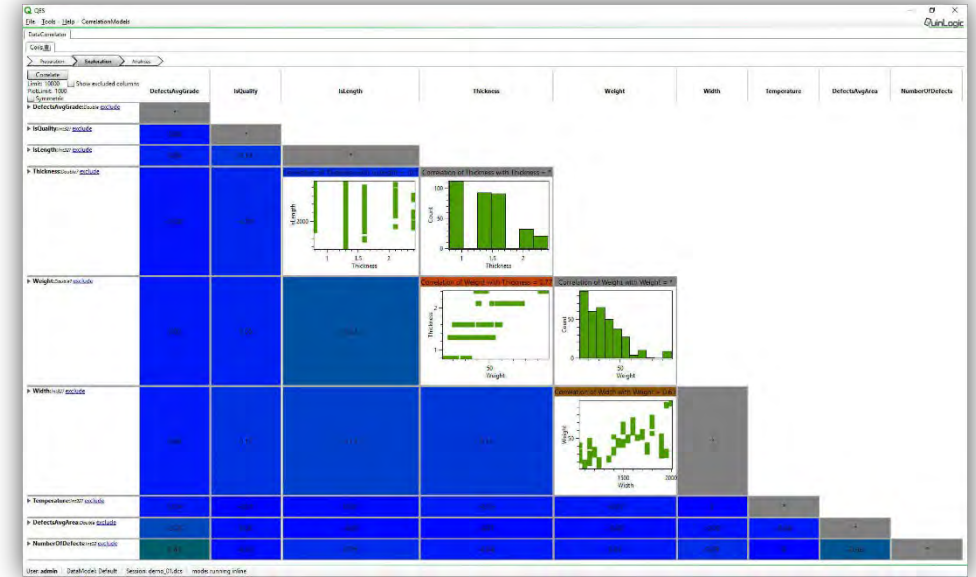with method A than with method B?

  ▶ Comparative Analysis

◆ If we have data about line X
can we know already something
about quality at line Y?

  ▶ Predictive Models

QES DataCorrelator
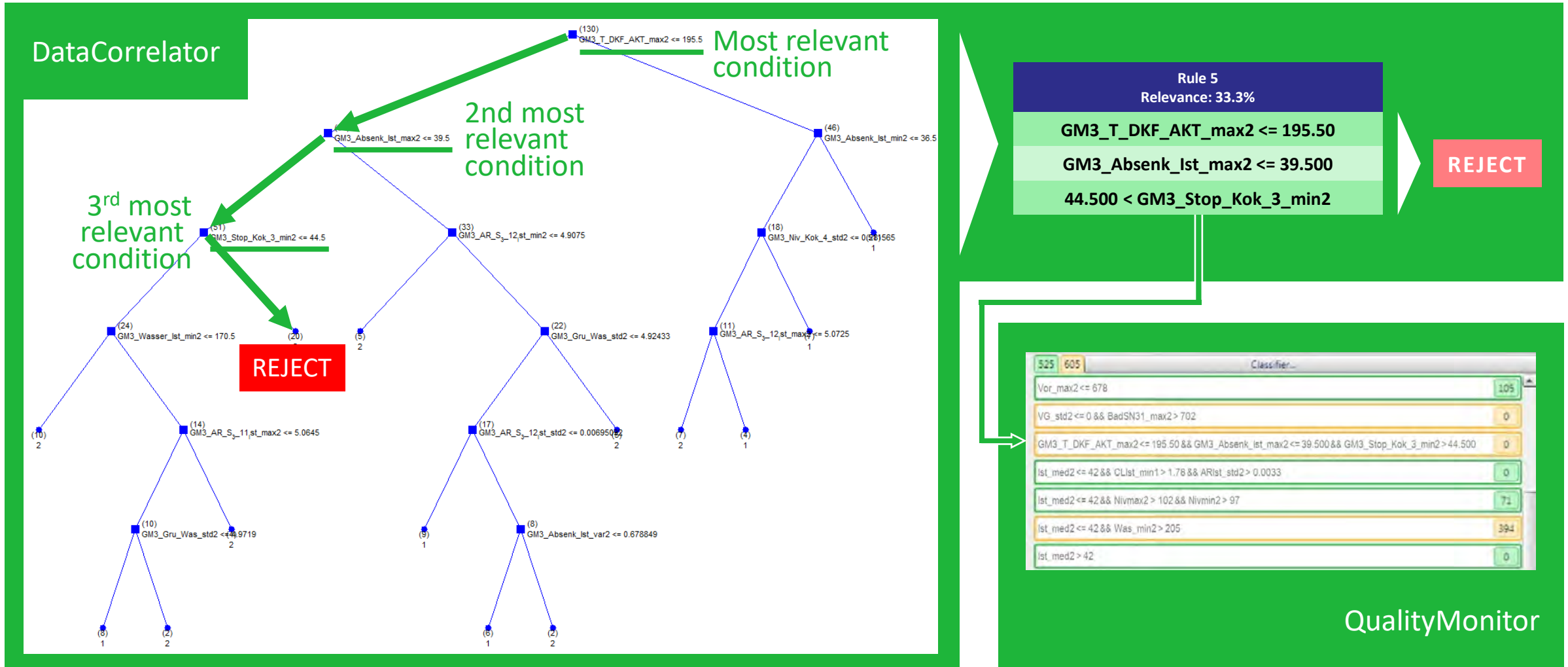
- ◆ The QES solution for explorative data analysis integrated in the QES environment offers
  - ▪ Easy data access and preparation
  - ▪ Easy export of results, e.g. in form of rules for the LogicDesigner
- ◆ Provides a set of well-designed functions that are useable without a data science background
- ◆ Targeted users are domain experts, e.g.

LINE MANAGER

QUALITY EXPERT

RESEARCHER

Typical DataCorrelator analysis outcome

DataCorrelator

(130)
GM3_T_DKF_AKT_max2 <= 195.5

Most relevant condition

2nd most relevant condition

3rd most relevant condition

GM3_Absenk_Ist_max2 <= 39.5

(51)
GM3_Stop_Kok_3_min2 <= 44.5

REJECT

Rule 5
Relevance: 33.3%

GM3_T_DKF_AKT_max2 <= 195.50

GM3_Absenk_Ist_max2 <= 39.500

44.500 < GM3_Stop_Kok_3_min2

REJECT

QualityMonitor

Increasing the rate of automatically released products

Quality and process data

Reject information

Logic Designer

RULES

Decision Service
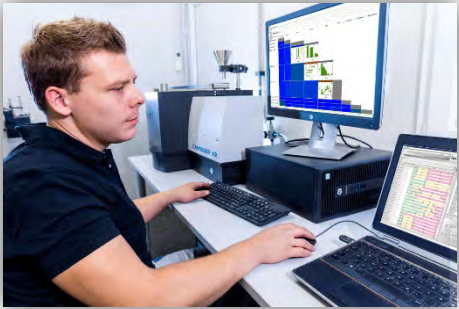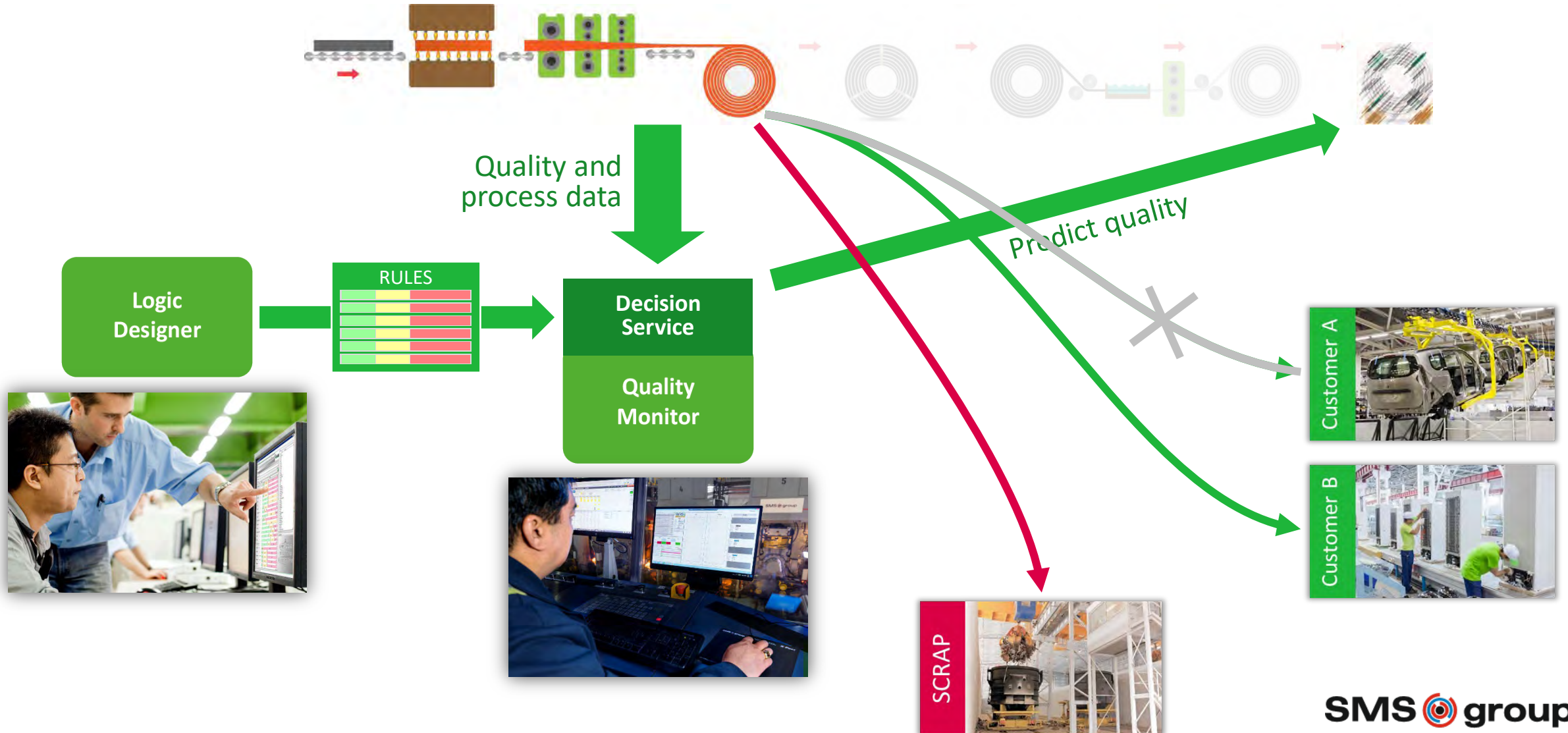
Quality Monitor

RULES

Derive rules from the analysis of data

Data Correlator

Avoiding putting more money on a "dead" product

Quality and process data

Logic Designer

RULES

Decision Service

Quality Monitor

Predict quality

Customer A

Customer B

SCRAP

TrendMonitor

◆ Process control cards with calculated limits

◆ Predefined, time-controlled notification triggers:

Activation ▶ Execution ▶ Action

◆ Any number of control cards in parallel

■ various control card types

■ different analyzers

Gartner Analytics Maturity Model

Analytics Circle
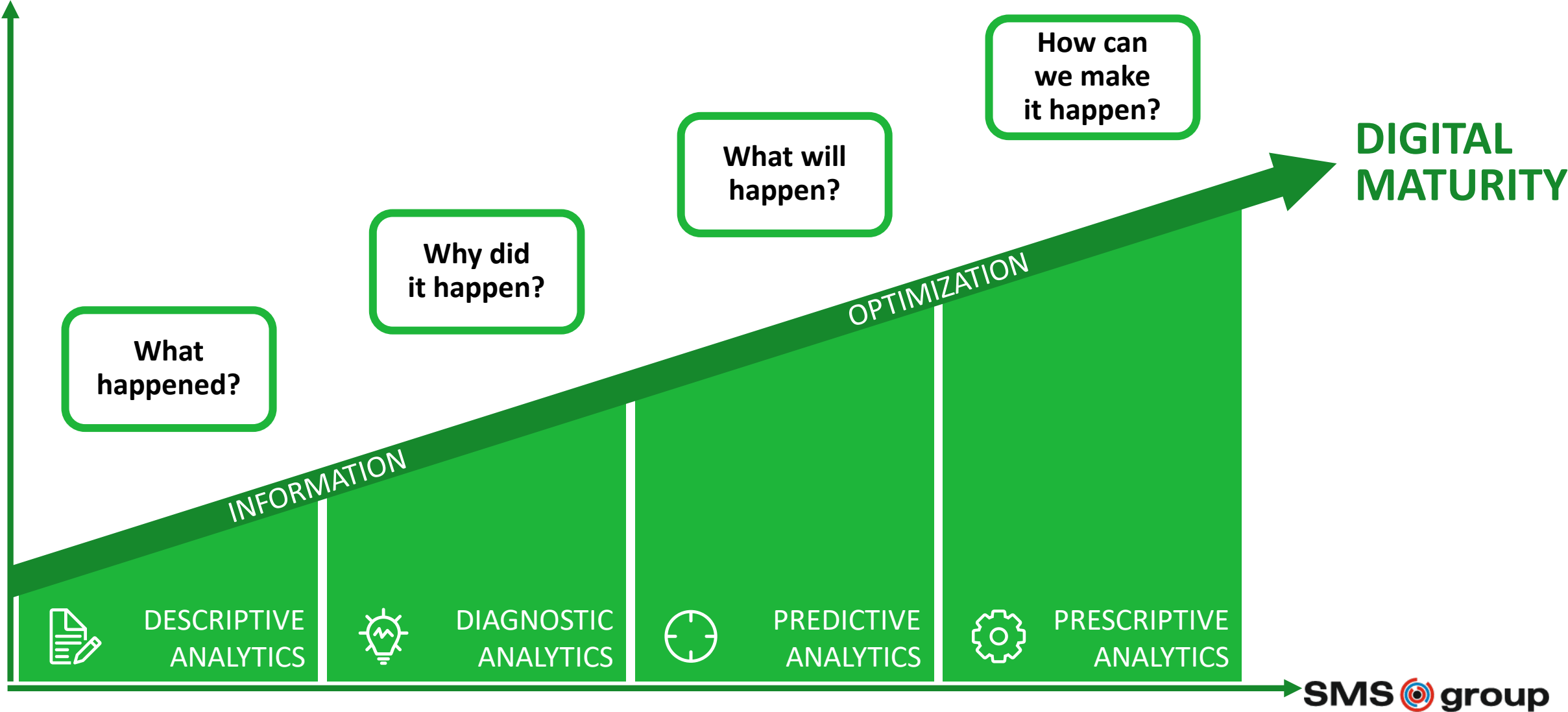
What happened?
Deviation? Trend?

Intelligent Monitoring of the Quality and the Process

Automated Product Release
rule based quality grading & release

TrendMonitor
long-term process trend monitoring

Learnings translated into rules

Why did it happen?

What will happen?

DataCorrelator -> find the root cause

TrendMonitor -> statistical process control
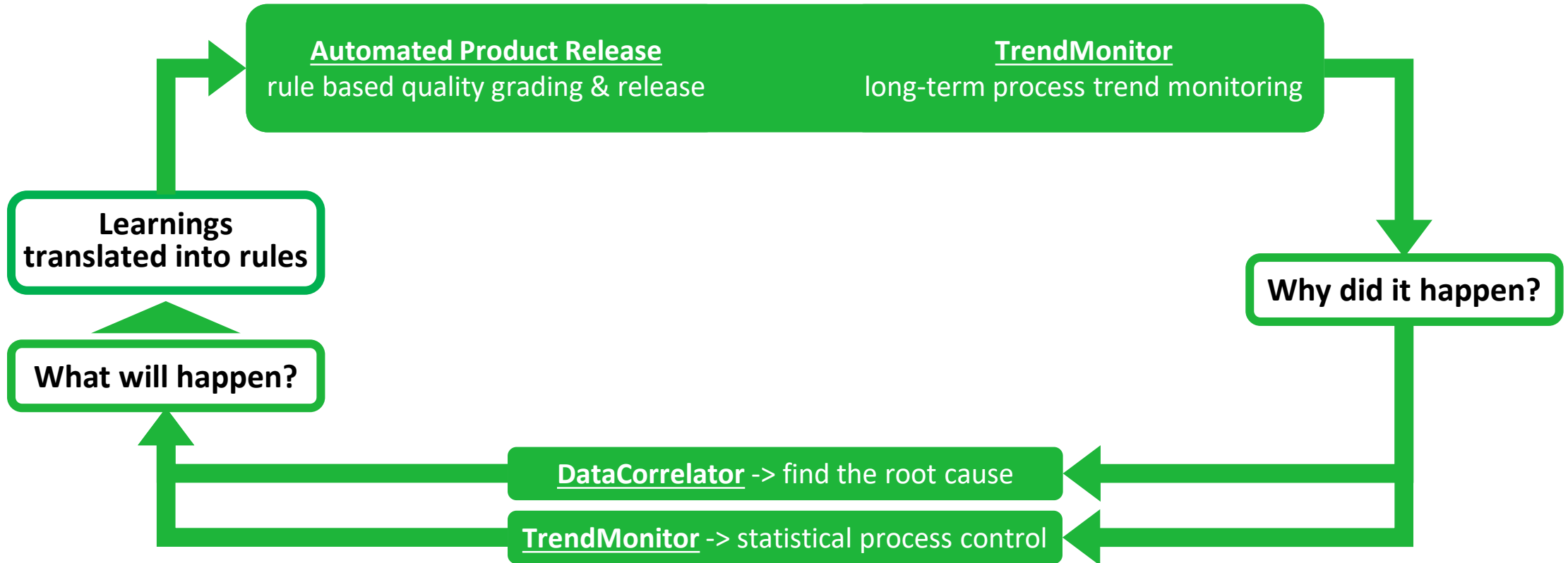
WHAT IS THE PRODUCTION DATA WAREHOUSE?

Access to the digital family in the QES

The QuinLogic **Production Data Warehouse** (PDW)

◆ collects all relevant mill data

◆ represents the robust foundation
for long term storage
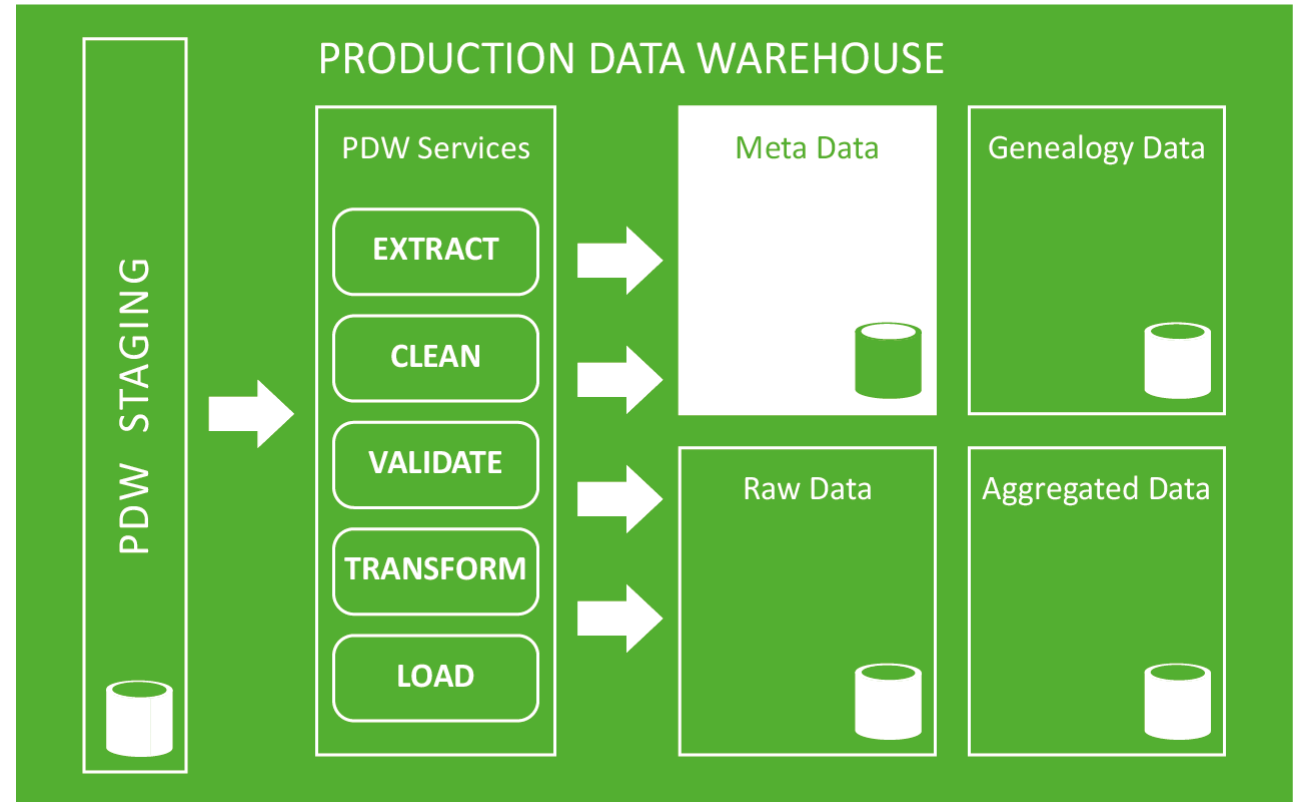
◆ provides the source for all data driven applications

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# PDW: All product, process, and quality data in one place
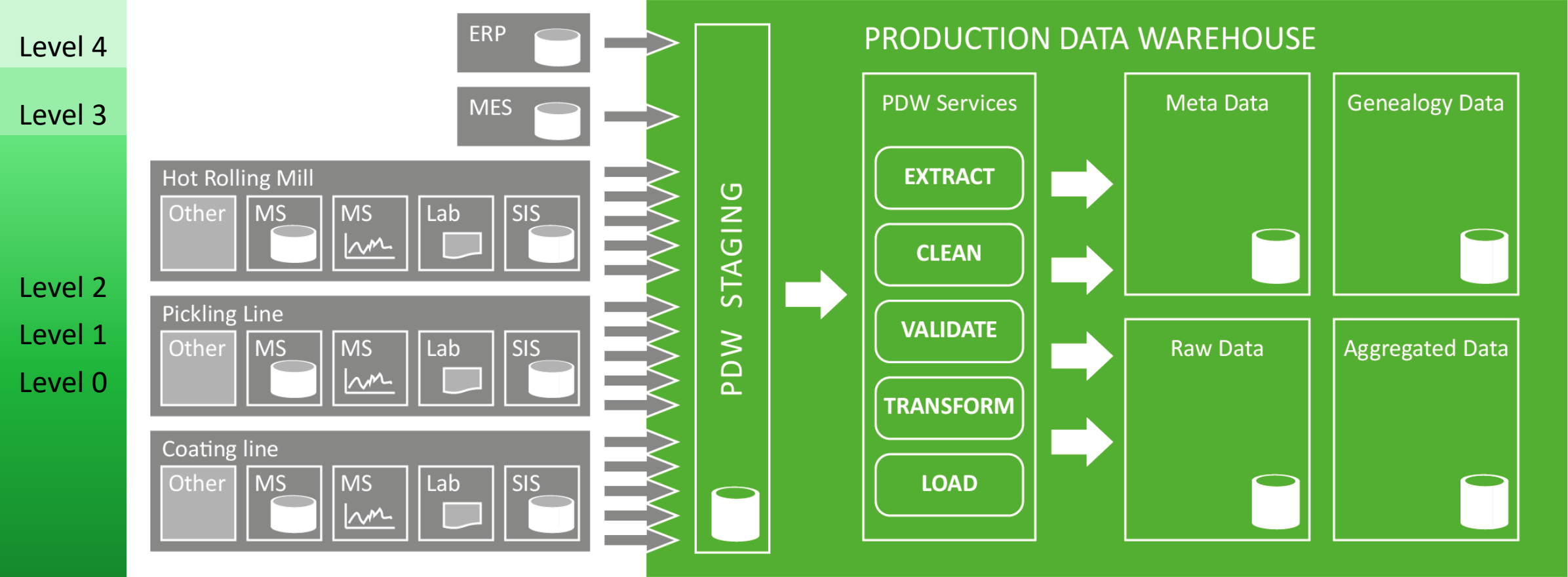
Meta data management

- ◆ Hierarchical alias naming scheme
  - → Absolutely essential to deal with 20k+ parameters
- ◆ Attribute descriptions
- ◆ Measurement units
- ◆ Limits
- ◆ Raw materials supplier
- ◆ Other semantic information

Pre-calculation / aggregation of data

- Unit conversion, e.g. [mm] ➜ [m]
- Pre-filtering of relevant defects
- Grouping of defect classes
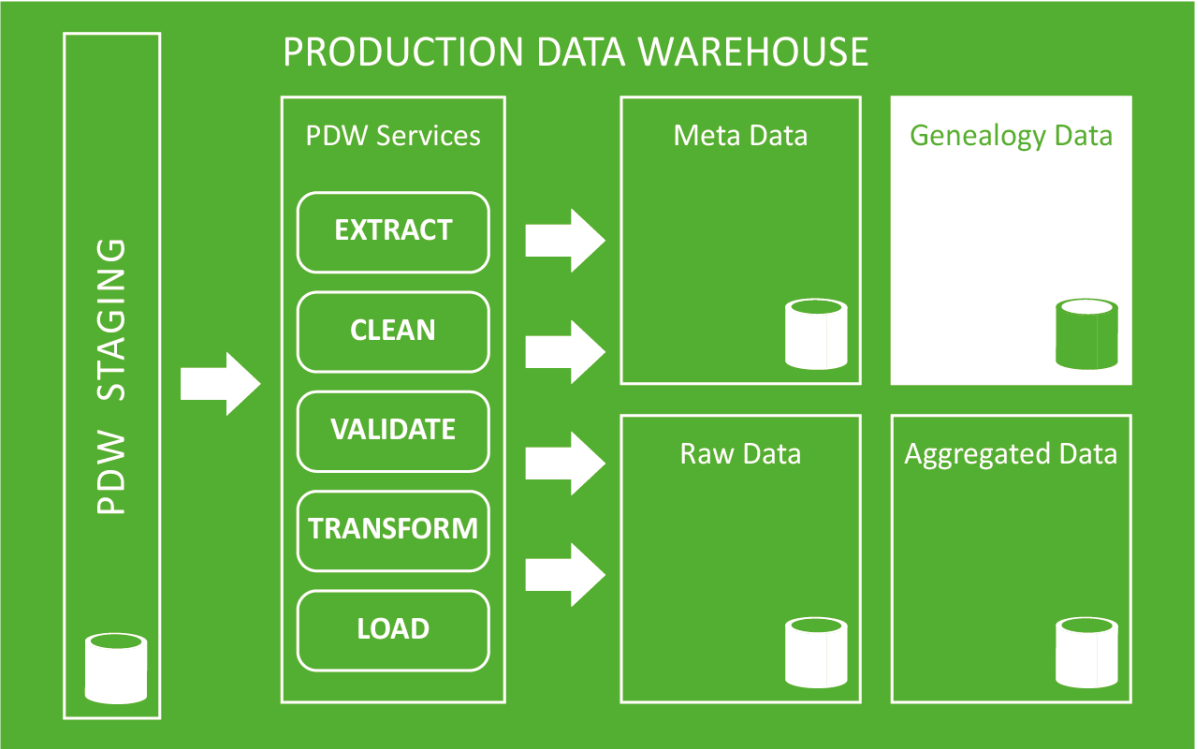- Calculating positions by speed profile integration
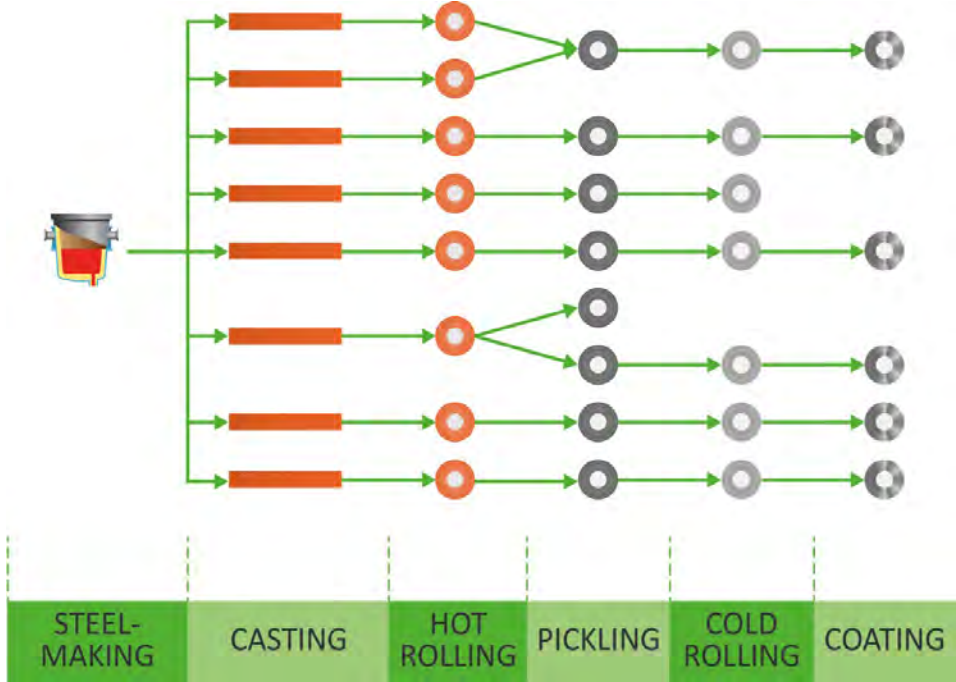- Time-to-length recalculation
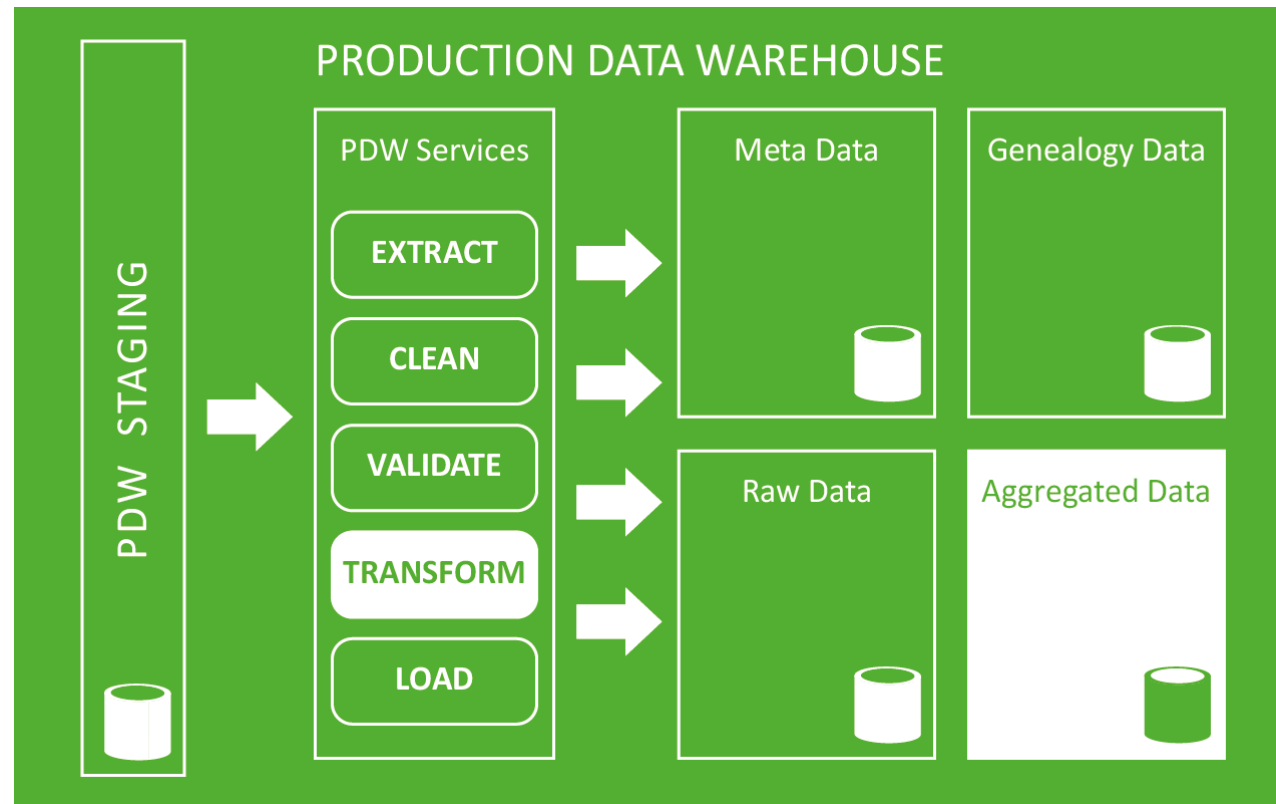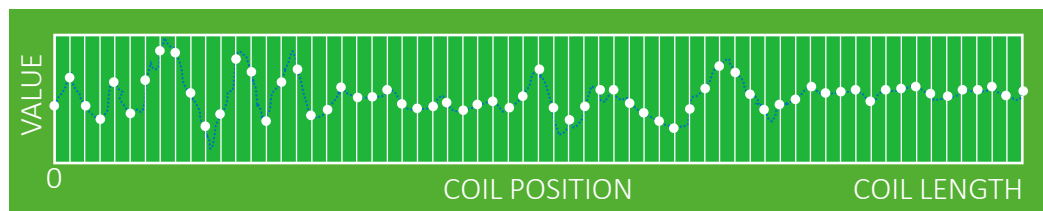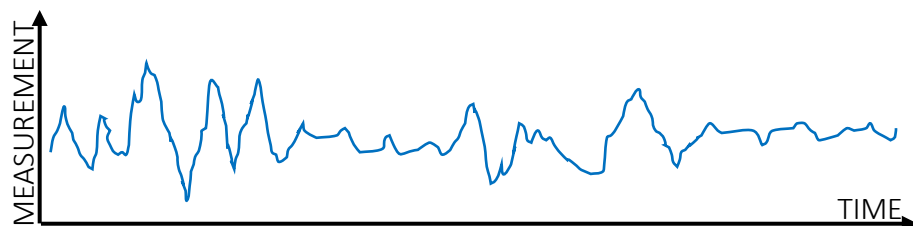
WHY IS PRODUCT GENEALOGY THE GAME CHANGER?

Fully support of product tracking and genealogy features

Modeling of the production plant in terms of material flow among plant's facilities:

STEEL-MAKING | CASTING | HOT ROLLING | PICKLING | COLD ROLLING | COATING

◆ Utilizes PDW global unique product identification

PRODUCTION DATA WAREHOUSE

PDW STAGING

PDW Services
- EXTRACT
- CLEAN
- VALIDATE
- TRANSFORM
- LOAD

Meta Data

Genealogy Data

Raw Data

Aggregated Data

Every product clearly identifiable in every process step

◆ Product path can be traced along entire production and processing chain

◆ Branches are known and resulting products are identifiable, e.g.

■ by producing several products from one basic product like several slabs from the same heat

■ through product divisions (transverse cutting or longitudinal slitting)
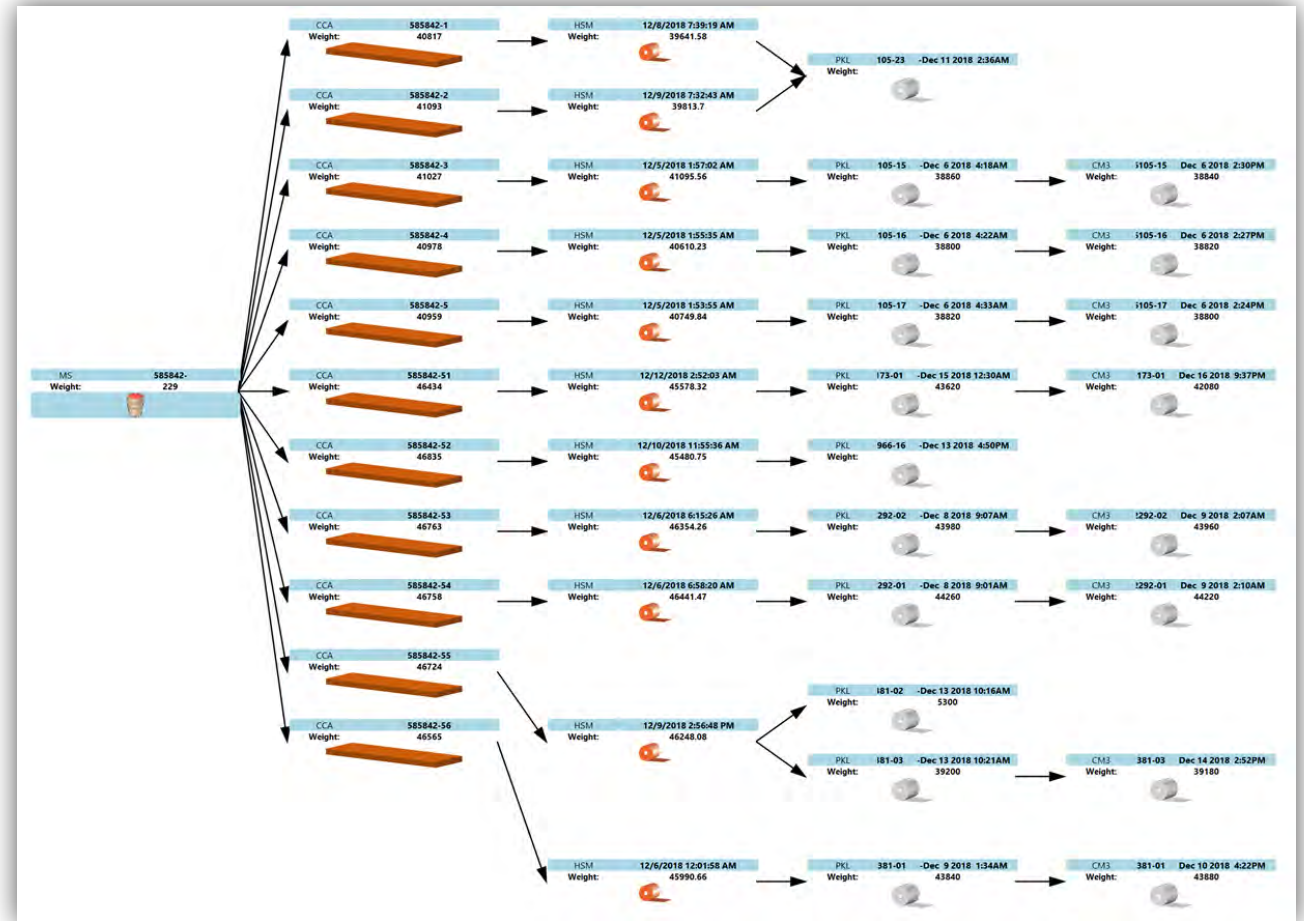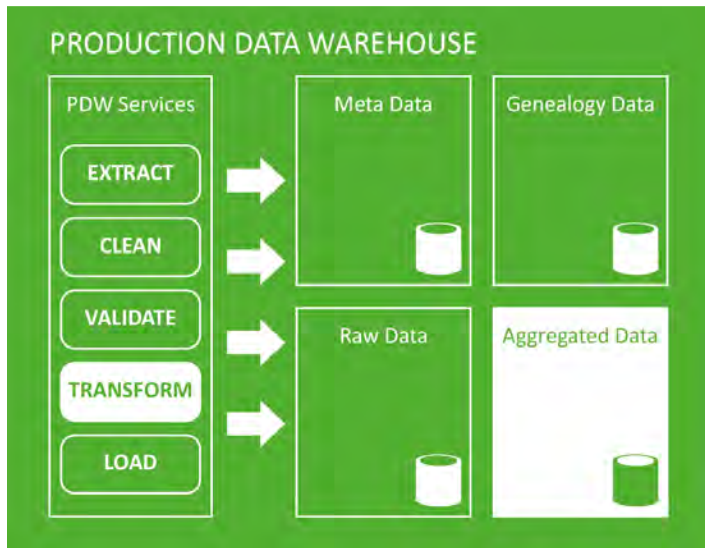
All manipulations of products are known:

- reversal of direction through repeated recoiling

- surface flipping by repeated recoiling

- elongation and change in width
  due to rolling processes

- side trimming

- cutting sections of scrap

- product division by transverse cutting

- product division by longitudinal slitting

- product connection by welding/tacking

- …
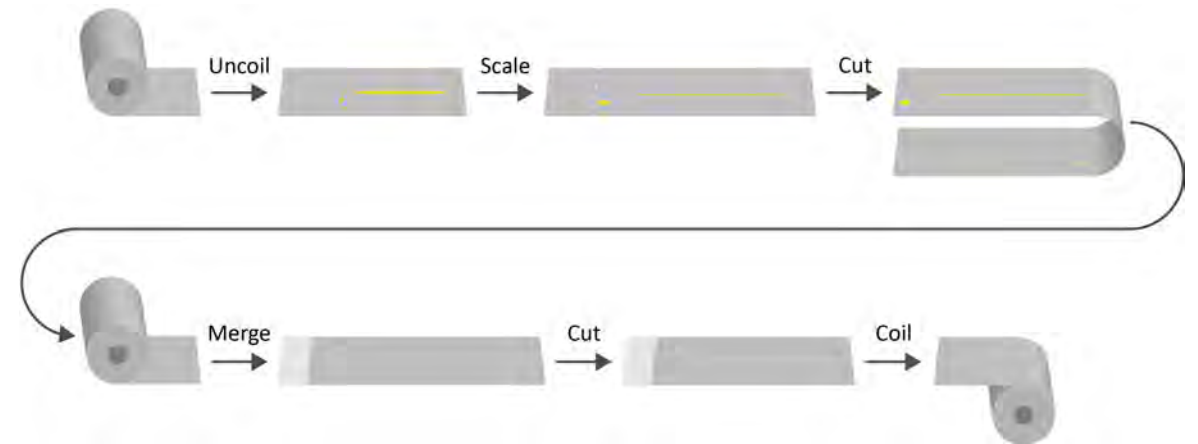
Automatic alignment of data from subsequent process steps

In the QES, these effects are "normalized" by the PDW TRANSFORM process:

Example: Product merging

◆ Describing a product completely, always includes looking at it's genealogy

◆ For a merged daughter product, the QES puts together the relevant sections of its two mothers
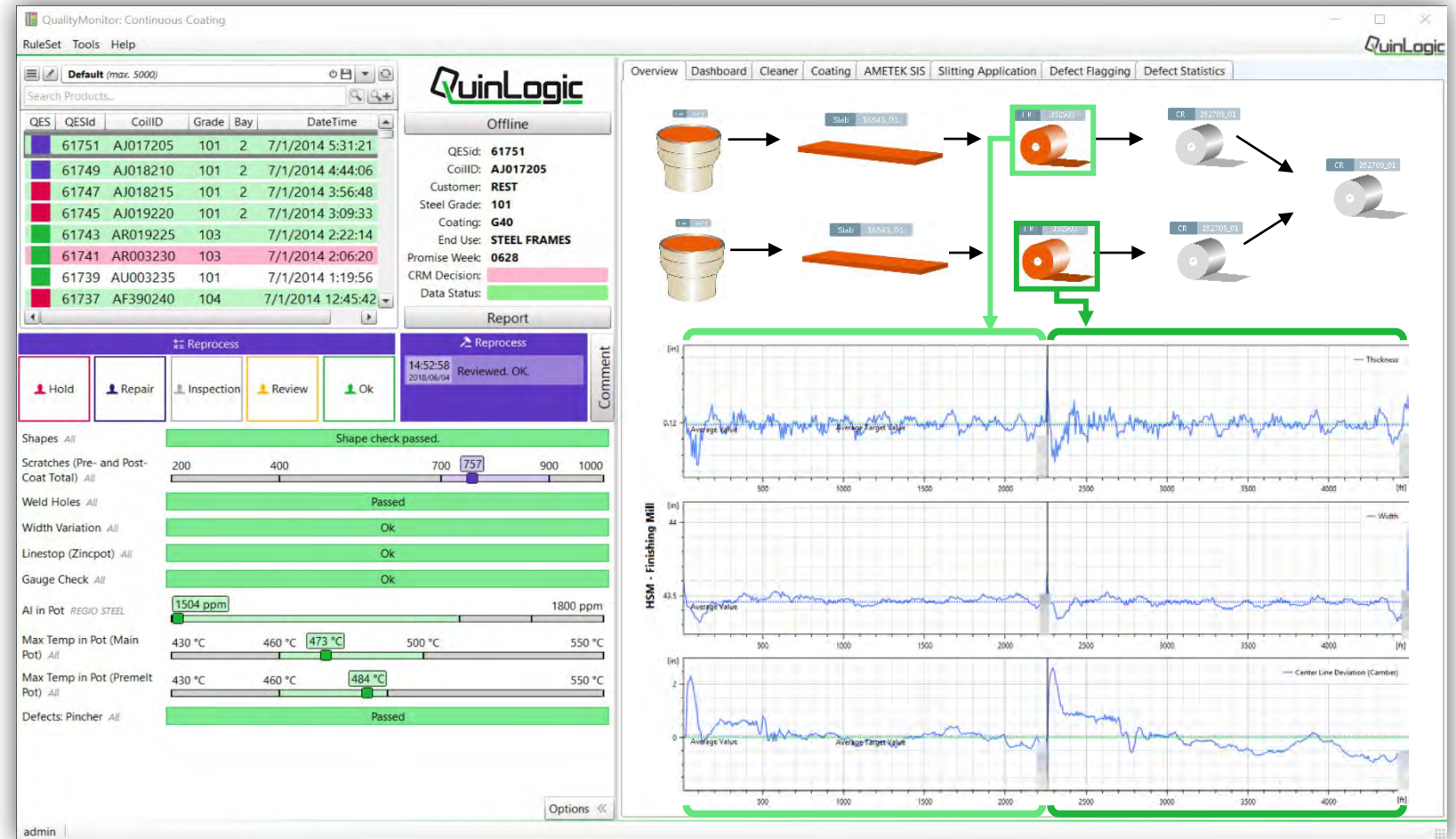
HOW DO CUSTOMERS ROLL OUT PDW|QES?

Avoiding scrap and increasing yield

◆ **Control products along the process chain**

◆ **Get data- and rule-based decision support**

◆ **Reroute or stop further processing if necessary**

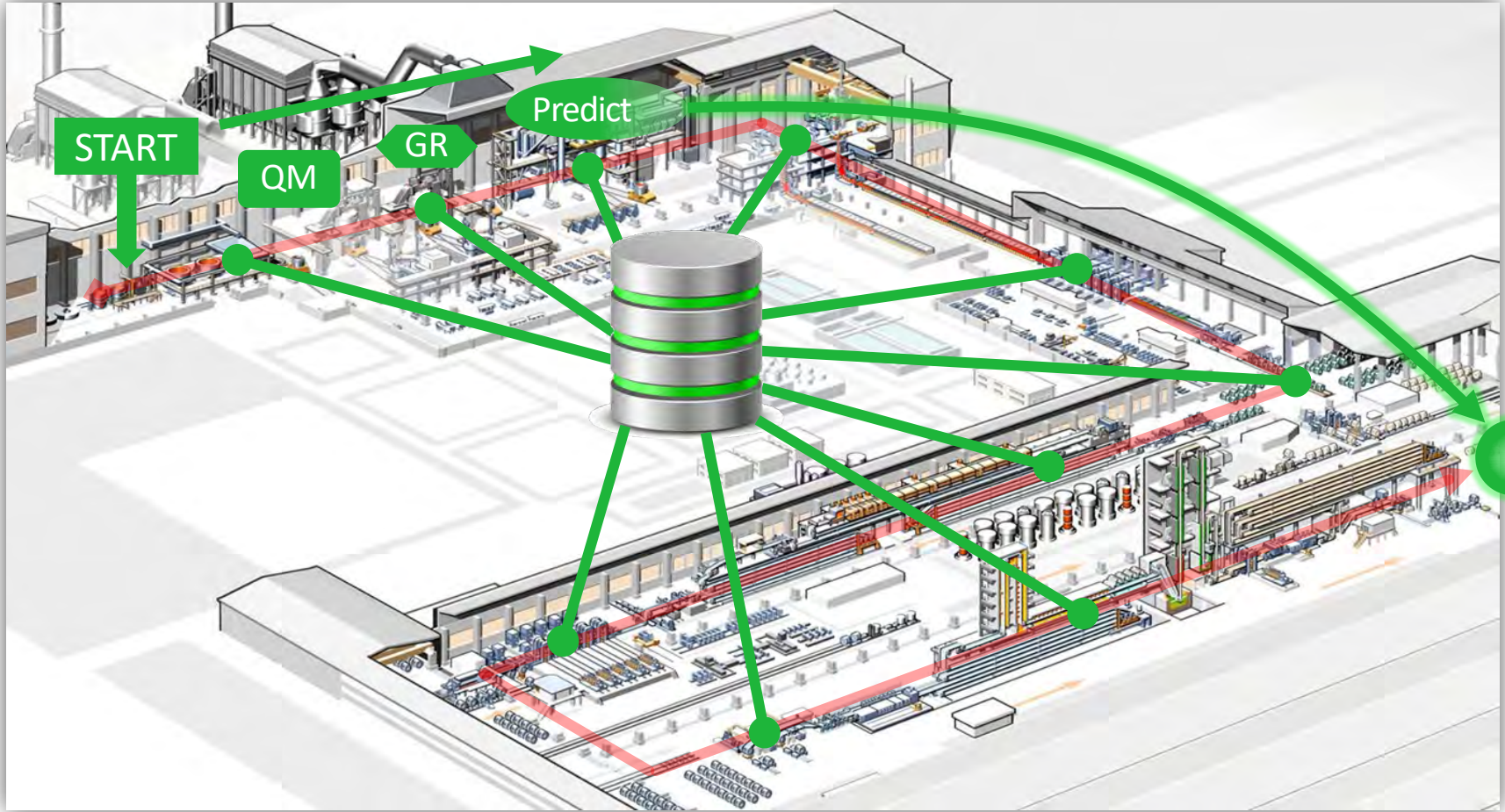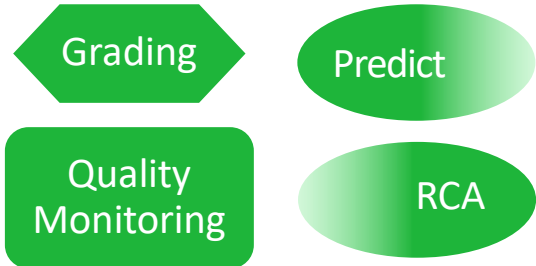Quality corridor

Product quality along the process chain
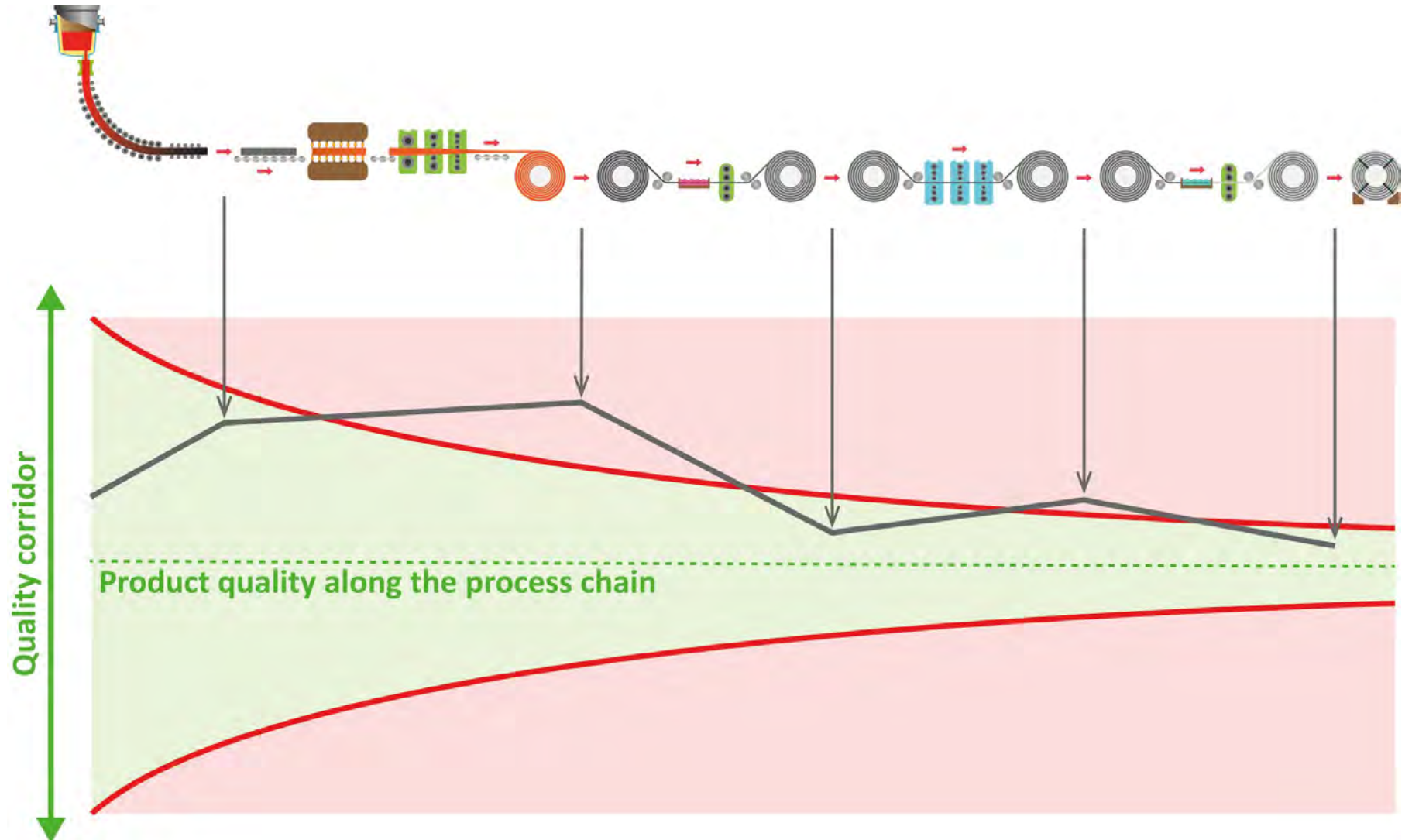
How can quality execution management be implemented?

DOWNSTREAM

- PDW
- Monitor start of process
- Automatic grading
- Predict final product quality

Grading

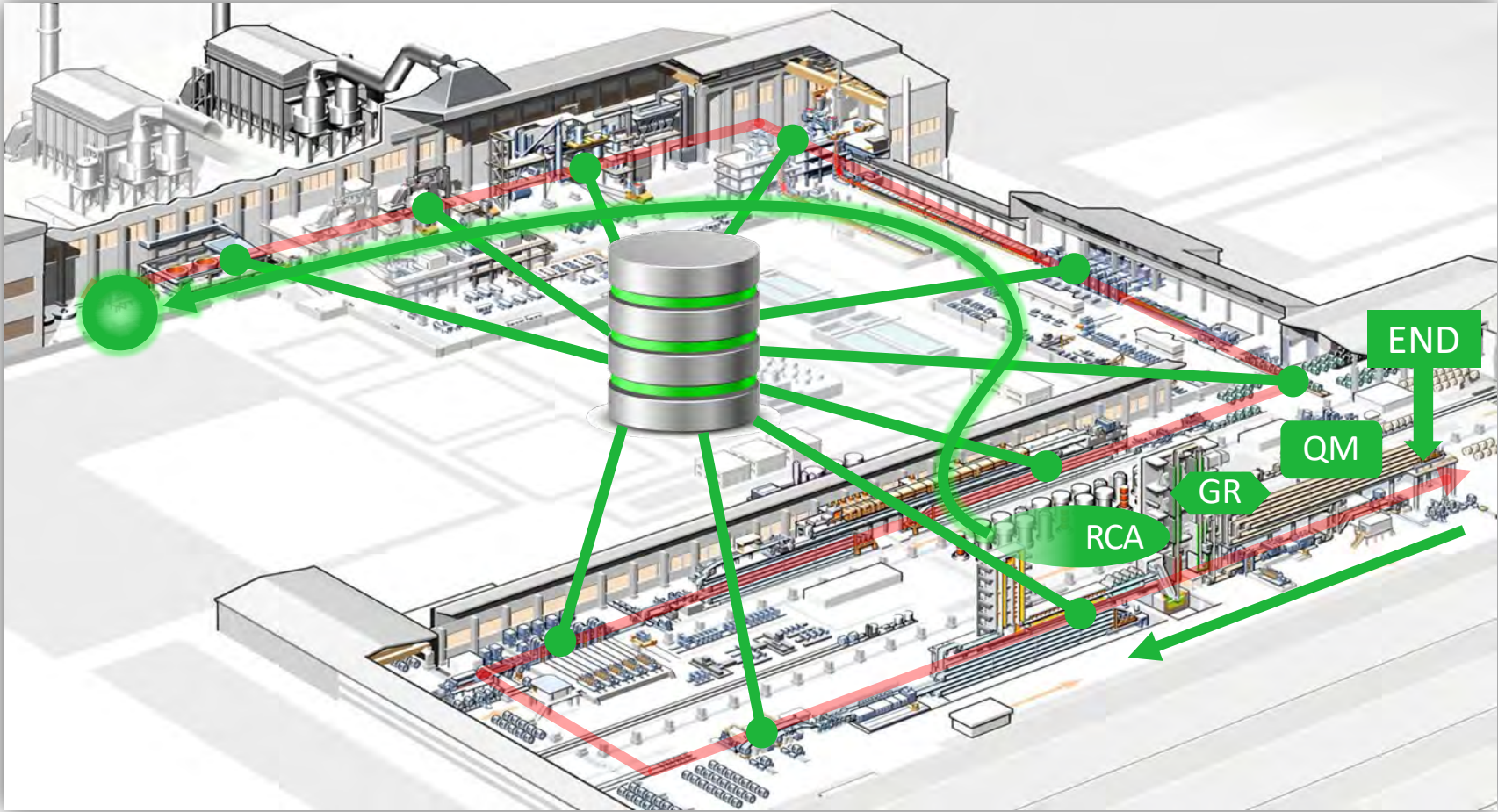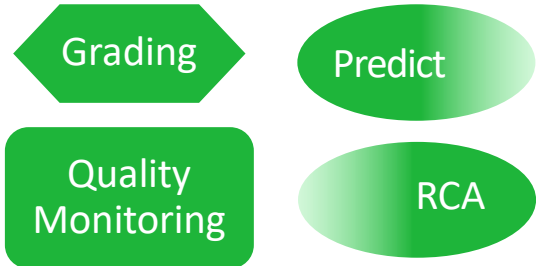Predict

Quality Monitoring

RCA

How can quality execution management be implemented?

UPSTREAM

- ◆ PDW
- ◆ Monitor final product quality
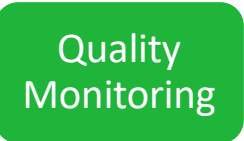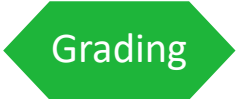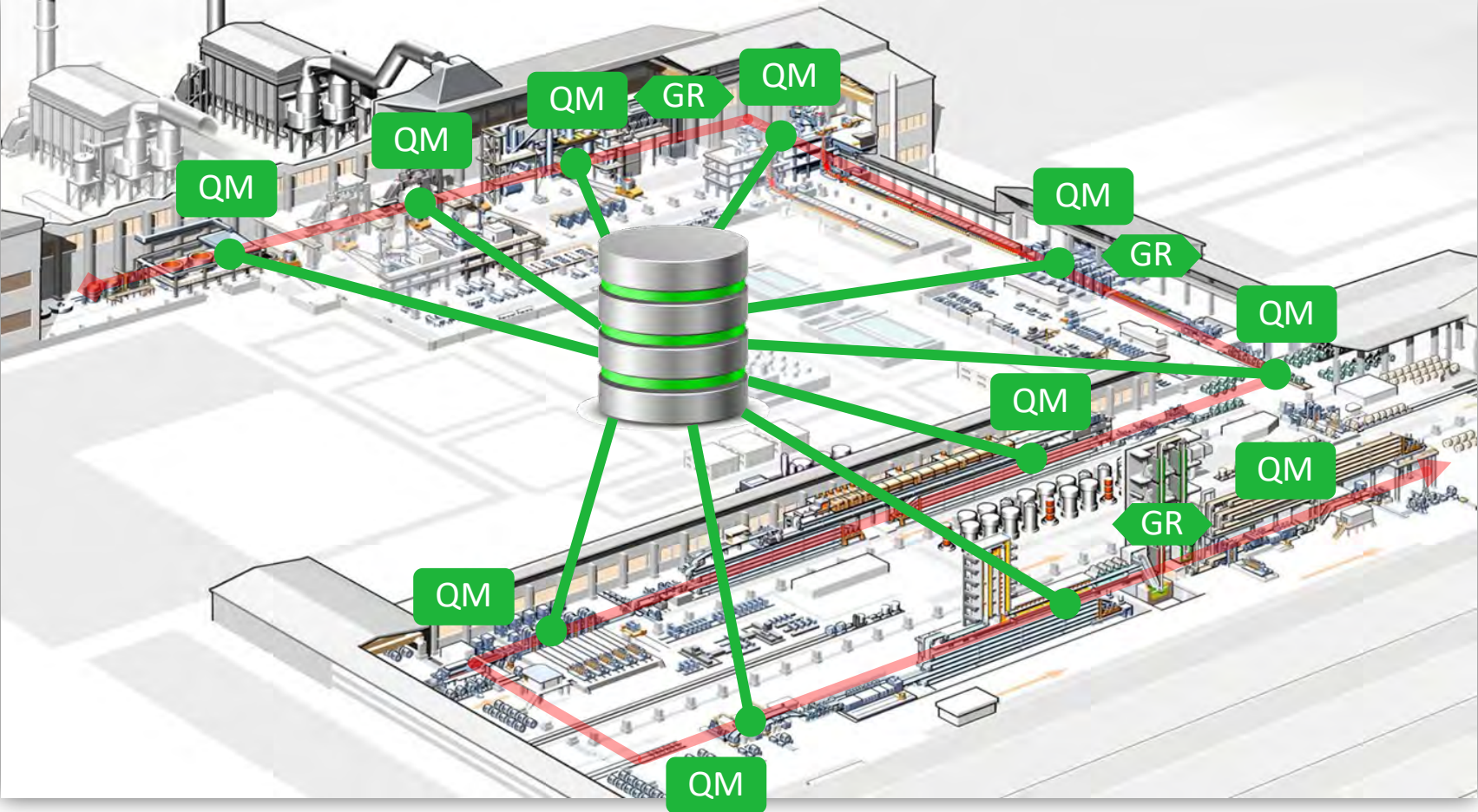- ◆ Automatic grading
- ◆ Root cause analysis

Grading

Predict

Quality Monitoring

RCA

How can quality execution management be implemented?

STEPWISE

◆ Extend PDW

◆ More grading decisions

# SUMMARY

Quality management in the aluminum industry

- There has always been the desire for a holistic view of the product quality along the processing path

- But there are many reasons why this is difficult to implement in practice:

  - inhomogeneous, historically grown data landscapes

  - "island thinking" mindset

 - no ready-made directions and no compass

  - a lack of software tools

  - …

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Solution: Quality execution with complete efficient data access

◆ **Data integration**

◆ **Genealogy**

◆ **Quality monitoring**

◆ **Automatic product grading**

◆ **Translation, modification and definition of quality rules**

◆ **Correlating data and feedback**
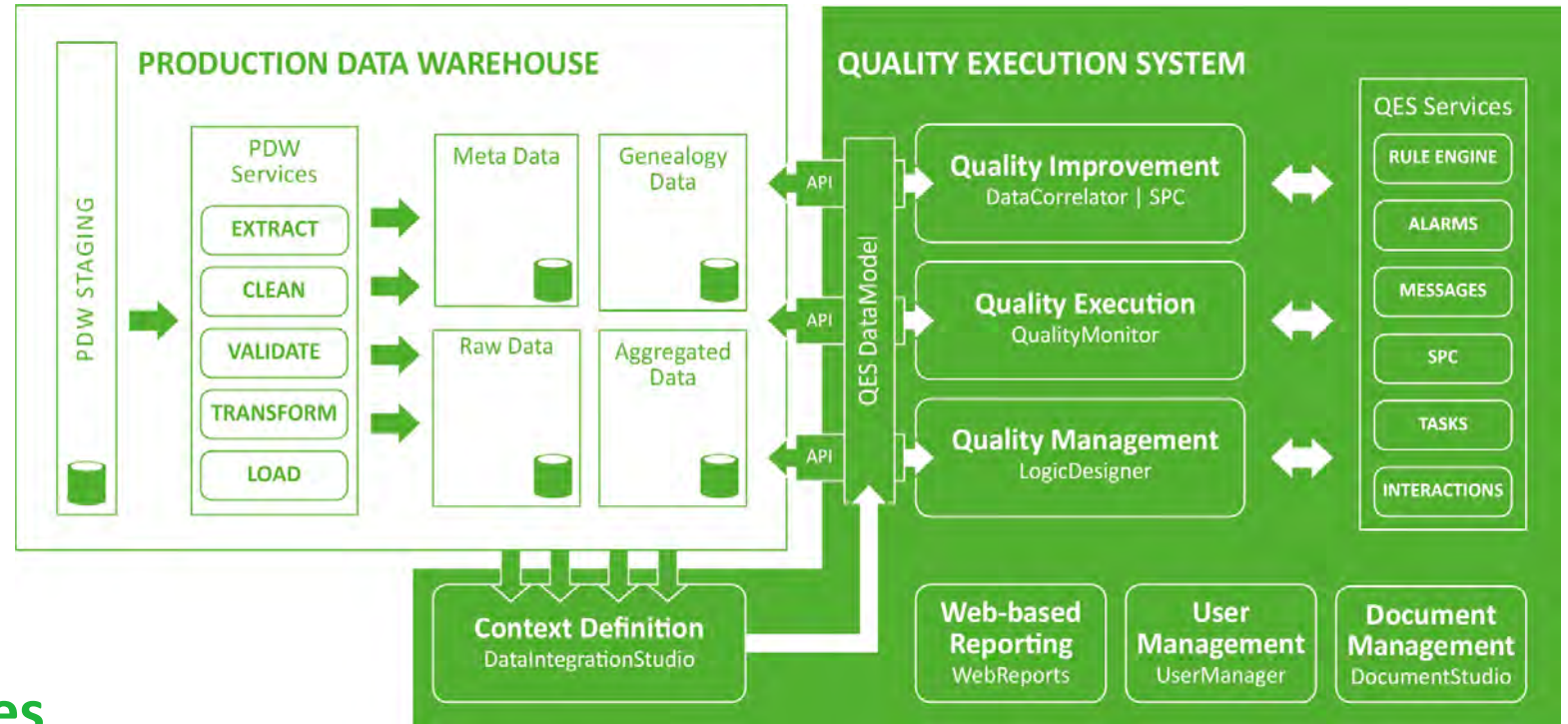
Solution: Quality execution with complete efficient data access
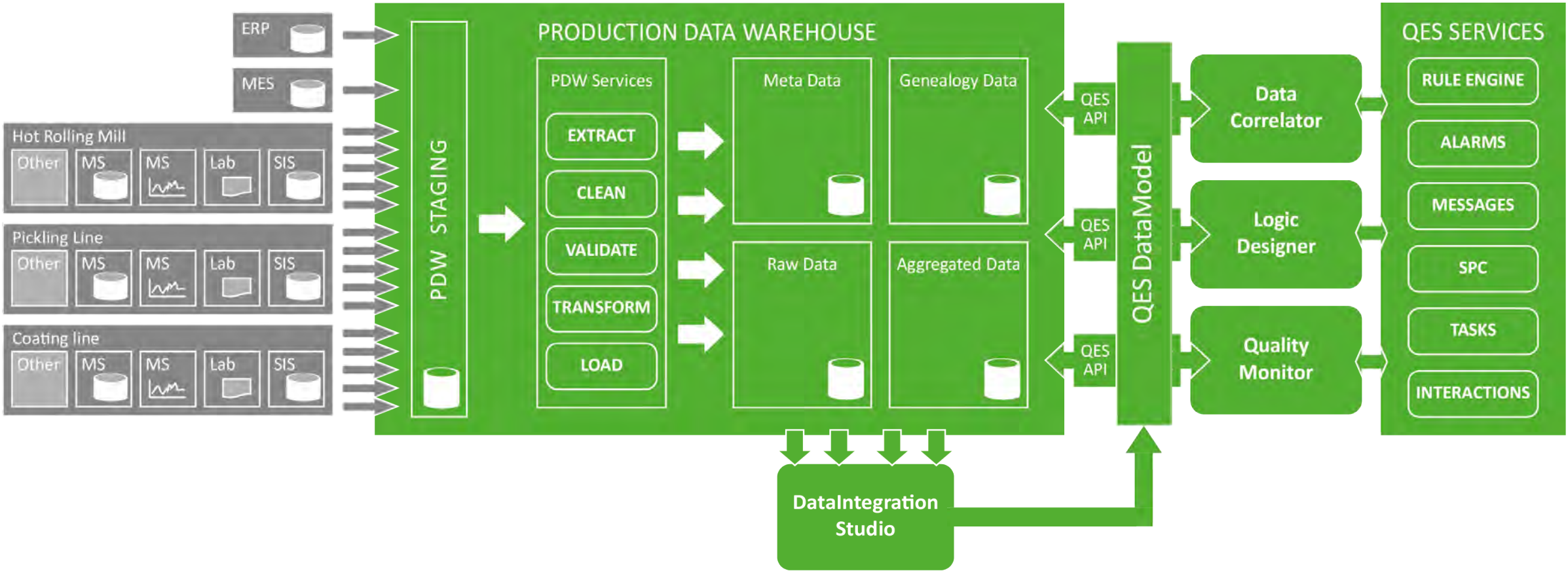
Thank you for your attention! Your questions please ...

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