Metals Production Management 4.0

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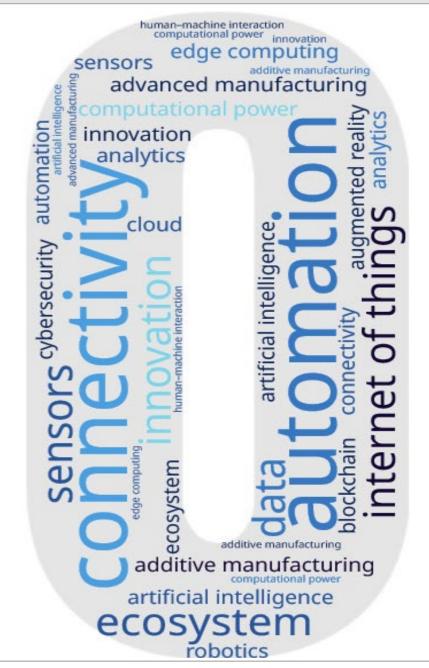METEC & 6TH ESTAD 2023
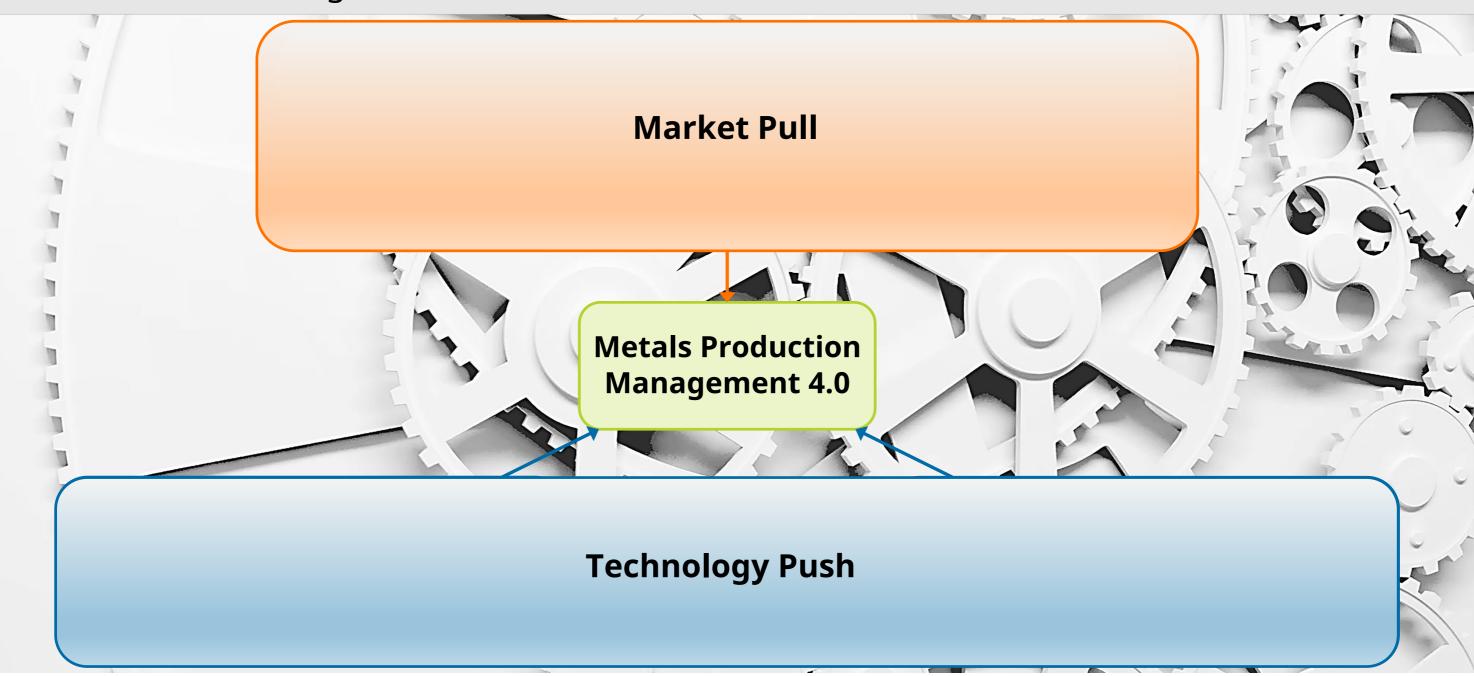
PSI

Market Pull

Metals Production Management 4.0

Technology Push

Market Pull

Fast reaction in production, executed with high precision and flexibility

Demanding factors in supply chain management: less predictable demand patterns, reduced lead times, minimization of inventories

Demanding factors in quality control: cost reduction (first time right), nonconformity management, production optimization
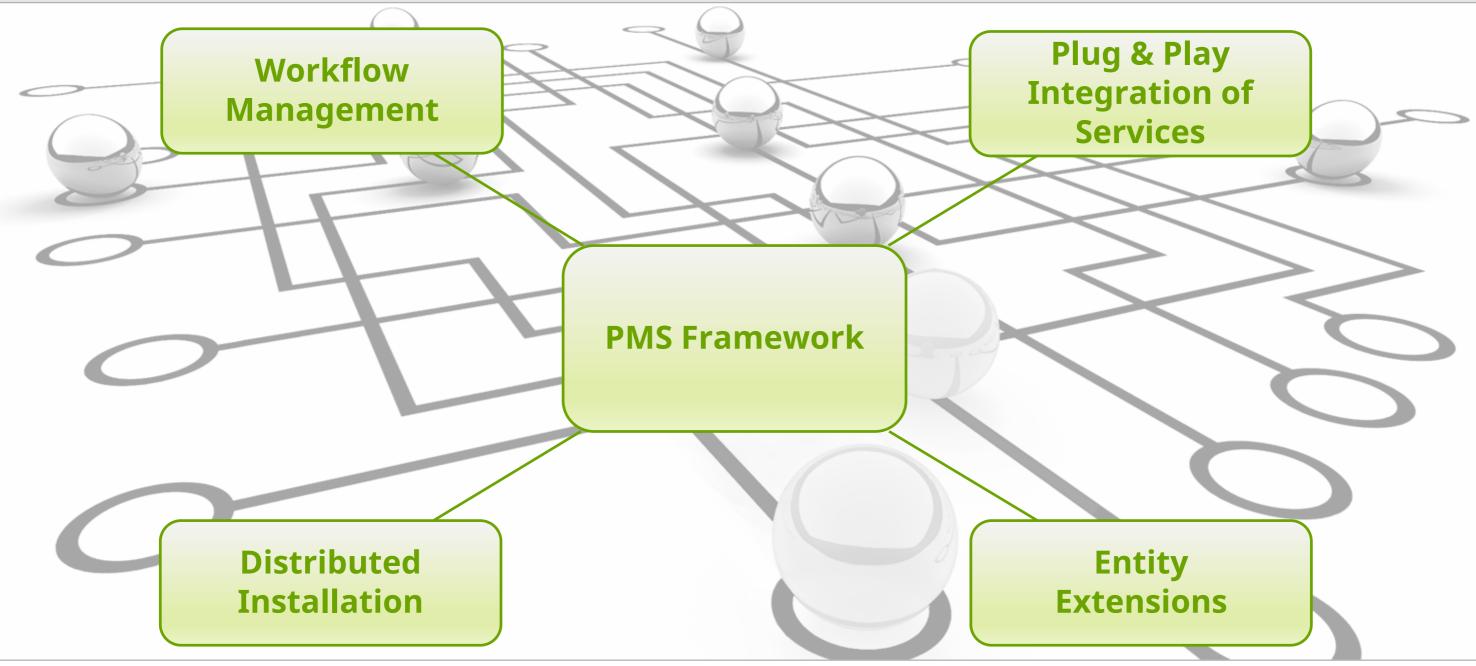
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Connectivity

Within the factory: Automation, Sensors, Internet of Things

With the outside world: Cross-site, Suppliers, Vendors, Customers, Logistics

Analytics

Data Science and (explainable) Artificial Intelligence / Machine Learning
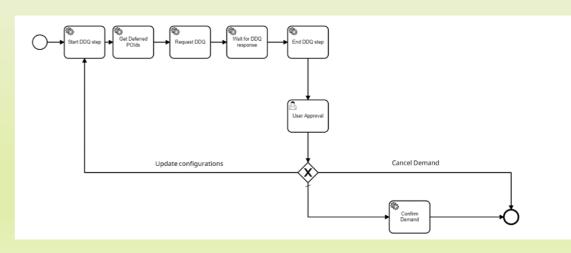
Simulation & scenario management

Framework for PMS 4.0

Workflow Management
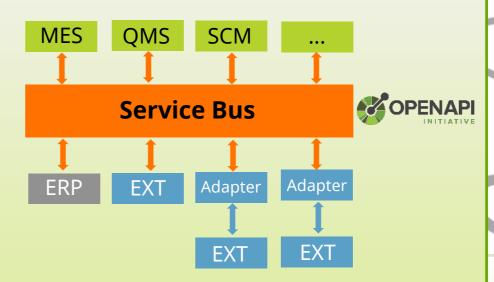
Plug & Play Integration of Services

- Flexible modelling of end-to-end business processes

- Orchestration of software service and human interactions

- BPMN interface for business users

- Use pre-defined best-practice workflows

- Easy customization

- Tracking of workflow status

Framework for PMS 4.0

Workflow Management

Plug & Play Integration of Services
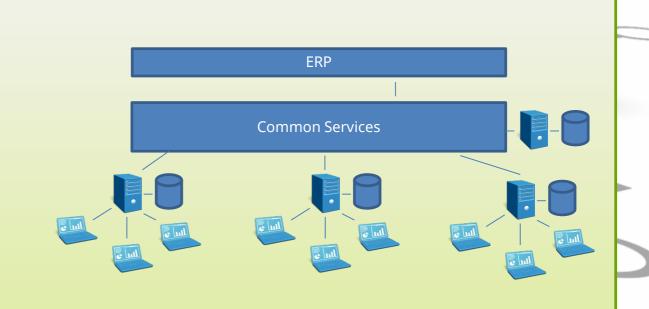
- Service Bus: Technical infrastructure for synchronous and asynchronous communication
  - Commands for direct service calls
  - Events for asynchronous information posted and consumed by registered services

- Integration of external services
  - Services in any programming language can register their APIs
  - Adapters available

MES	QMS	SCM	...

Service Bus

OPENAPI INITIATIVE

ERP	EXT	Adapter	Adapter

EXT	EXT

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- Non-disruptive update
  - (Almost) No downtime
  - Rolling / decopled updates of services

- Easy replacement of functionality

- Scaling: component instances in parallel

- More independent development of new features

Distributed Installation
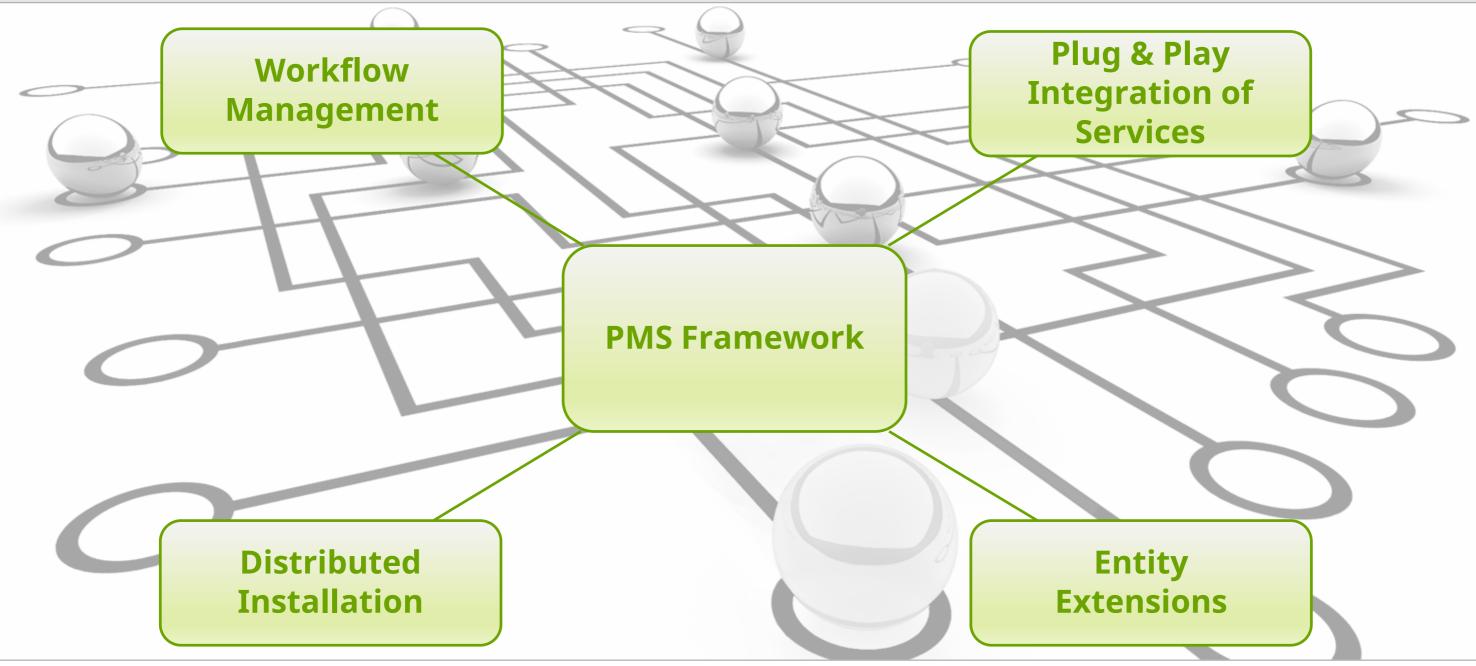
Entity Extensions

Framework for PMS 4.0

- Extension Mechanism of the data model allows
  - system integrators to enhance the scope of a solution as per their needs
  - customers to implement business specific use-cases

- Static extension: Add an entity by programming, requiring recompilation and re-deployment (product/project level)

- Dynamic extension: Add an entity at run-time as part of the system's configuration by an advanced end user

Distributed Installation
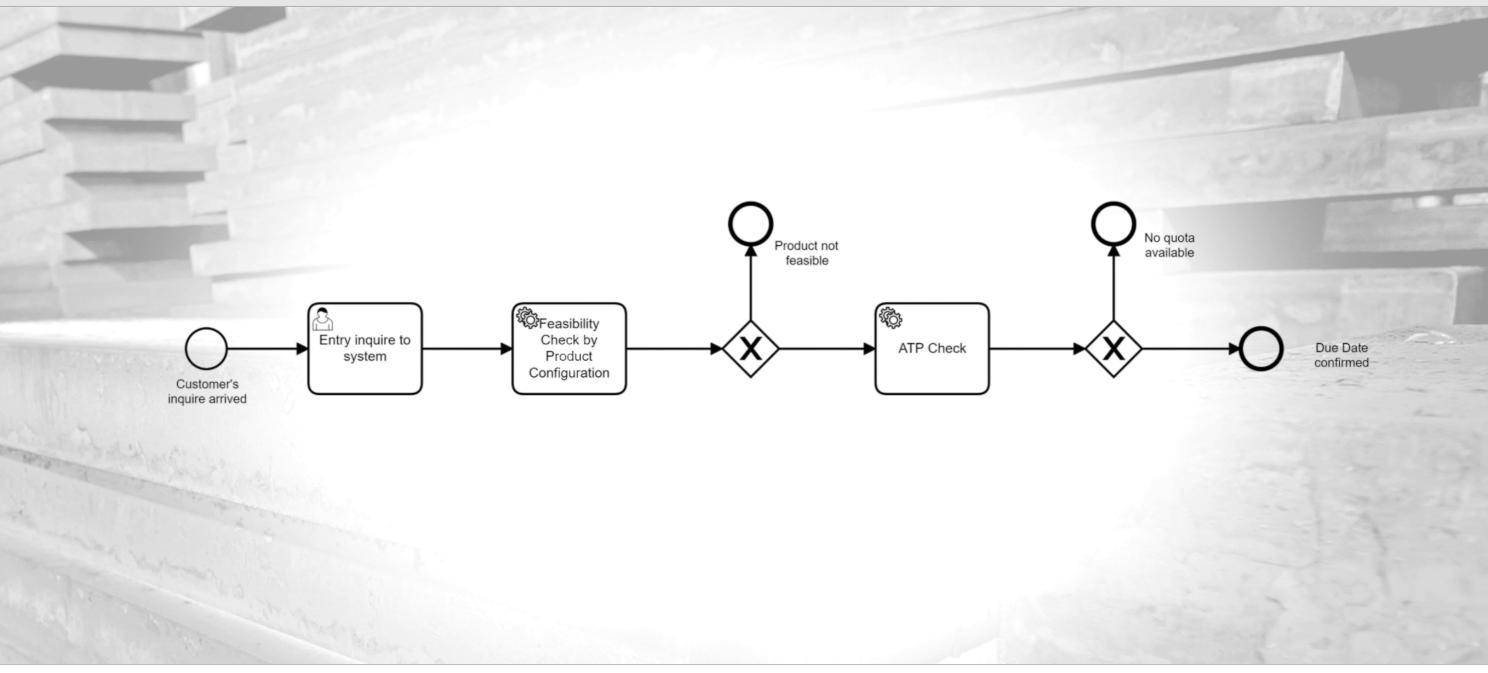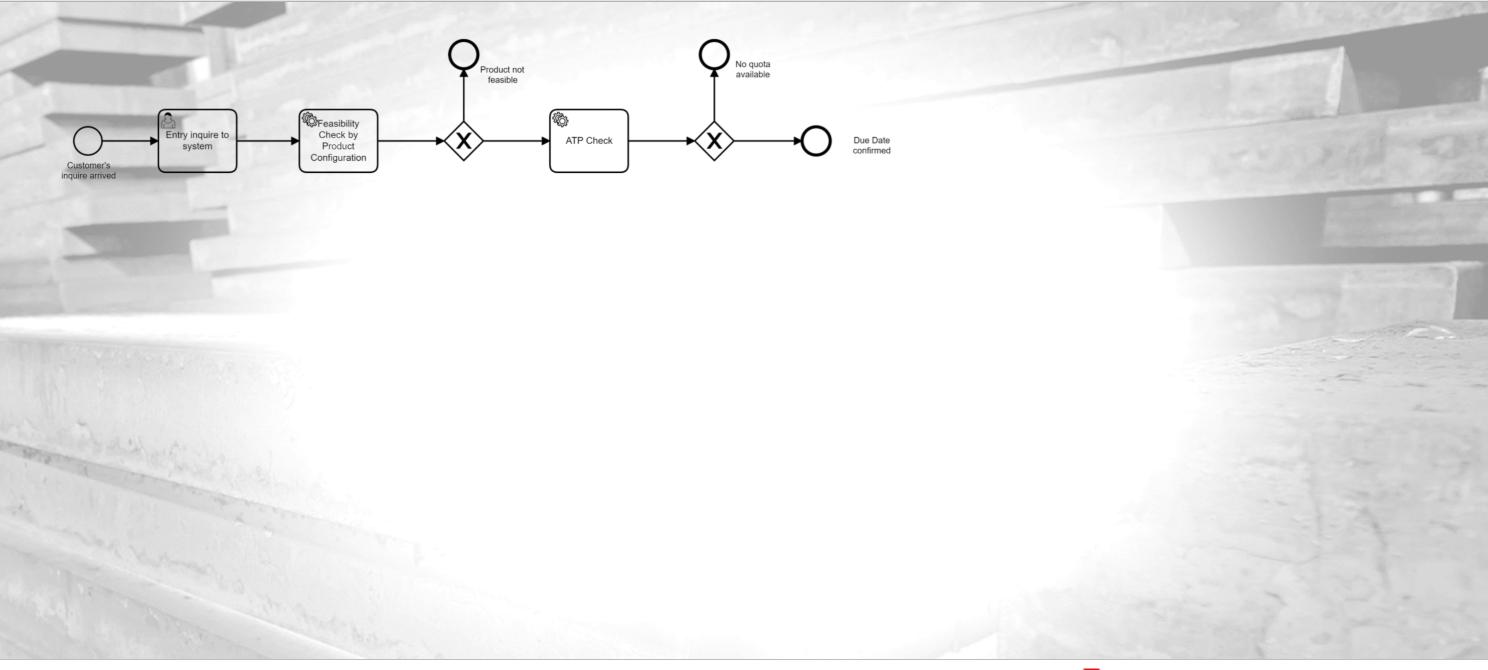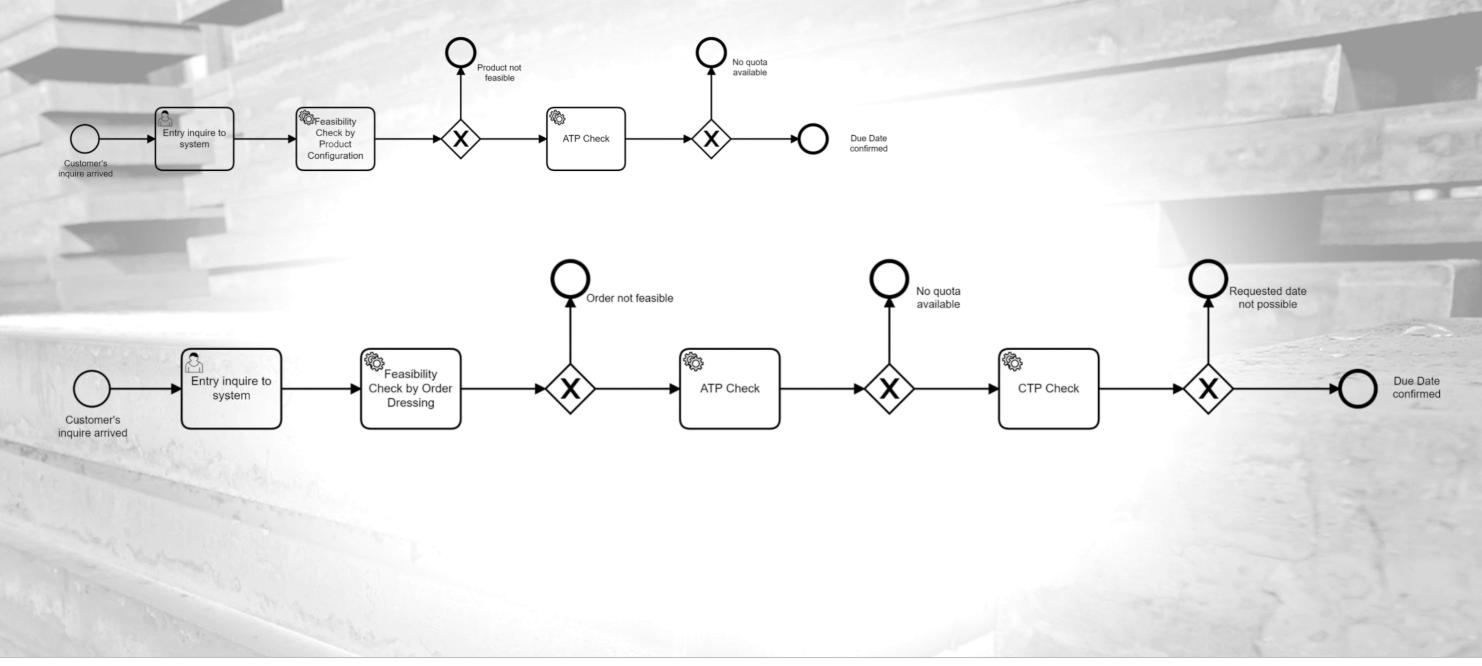
Entity Extensions

And in practice?
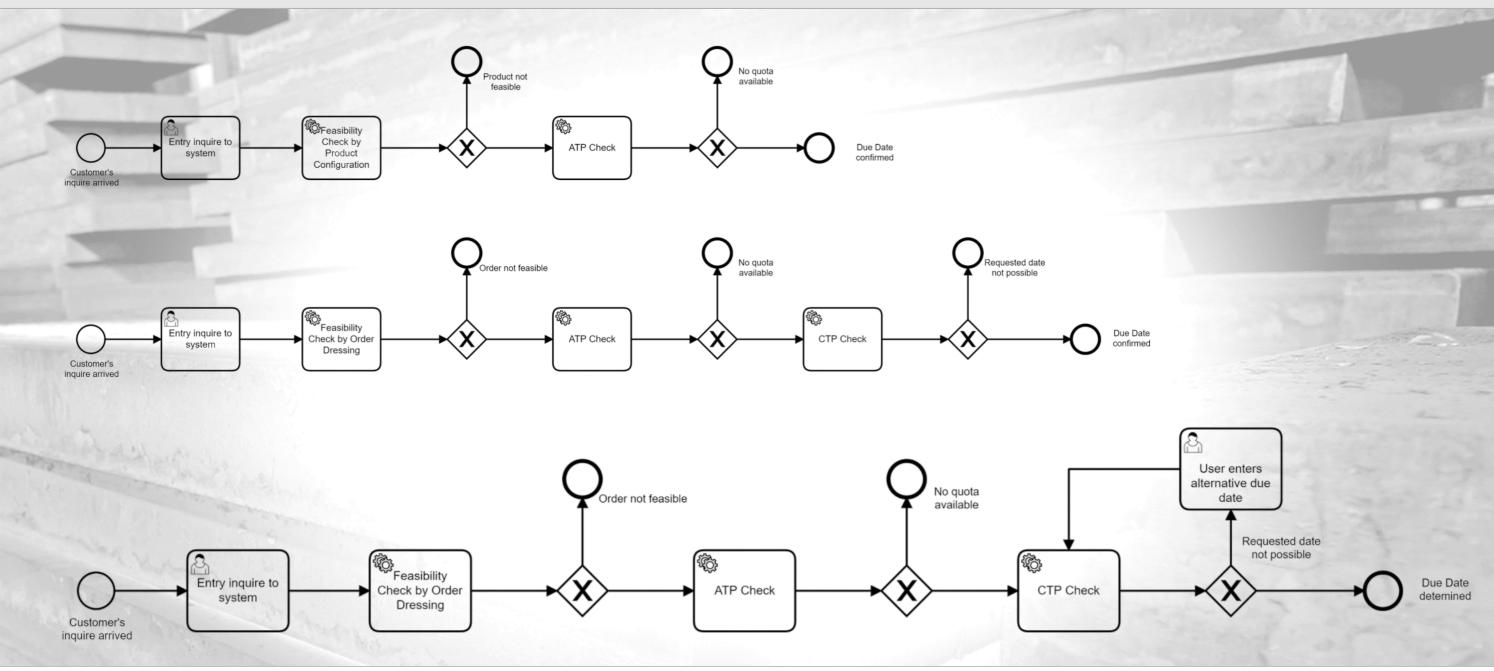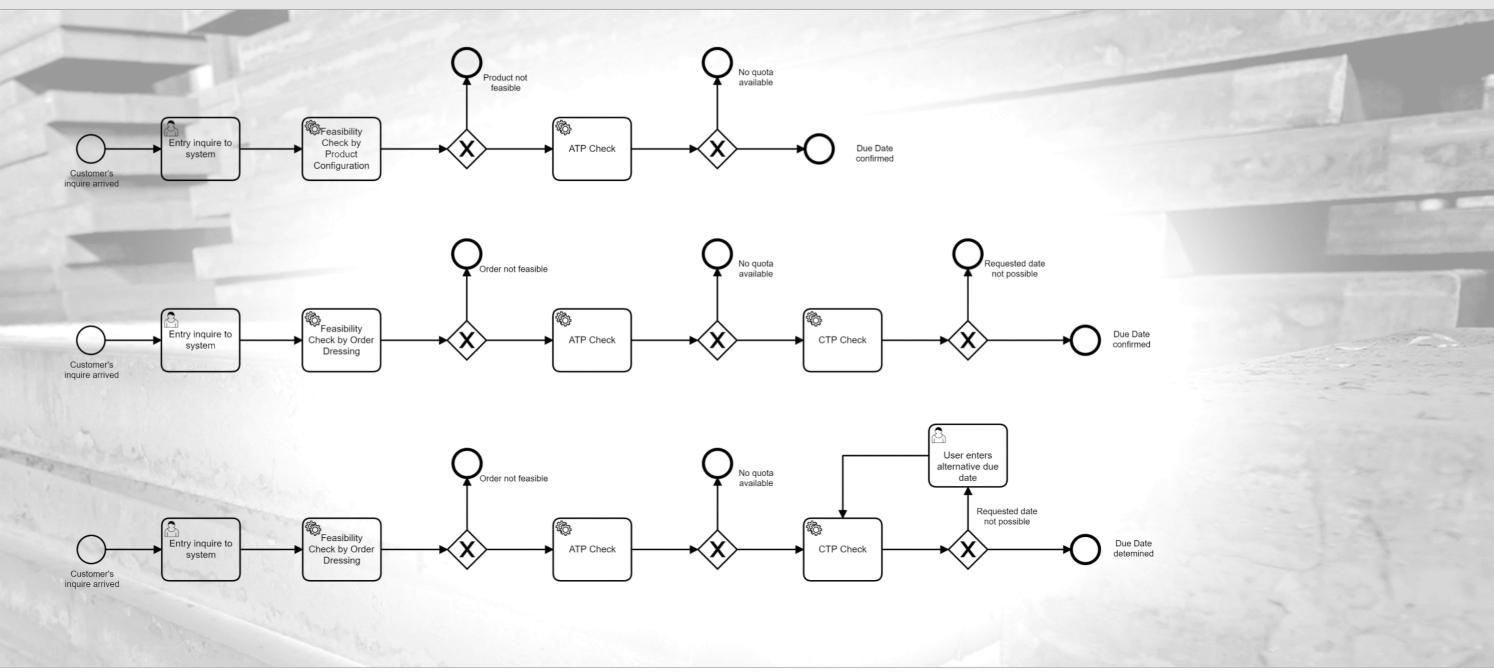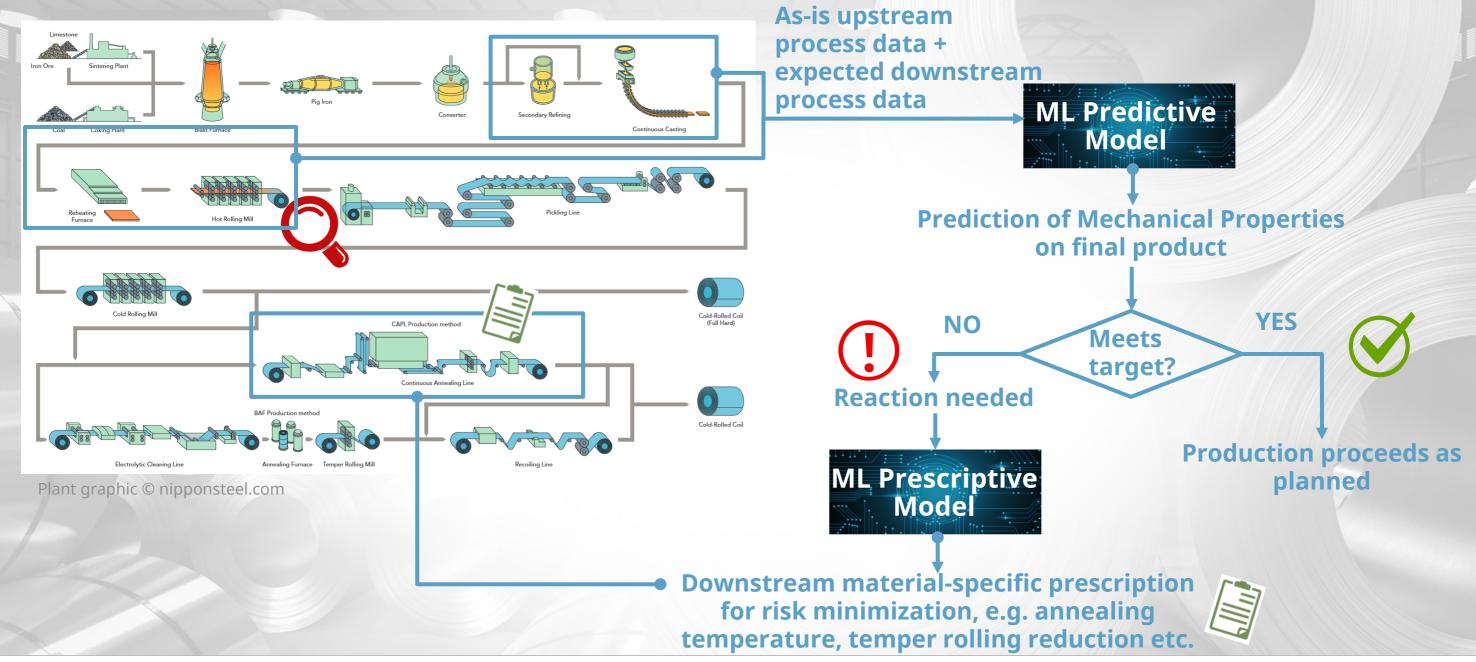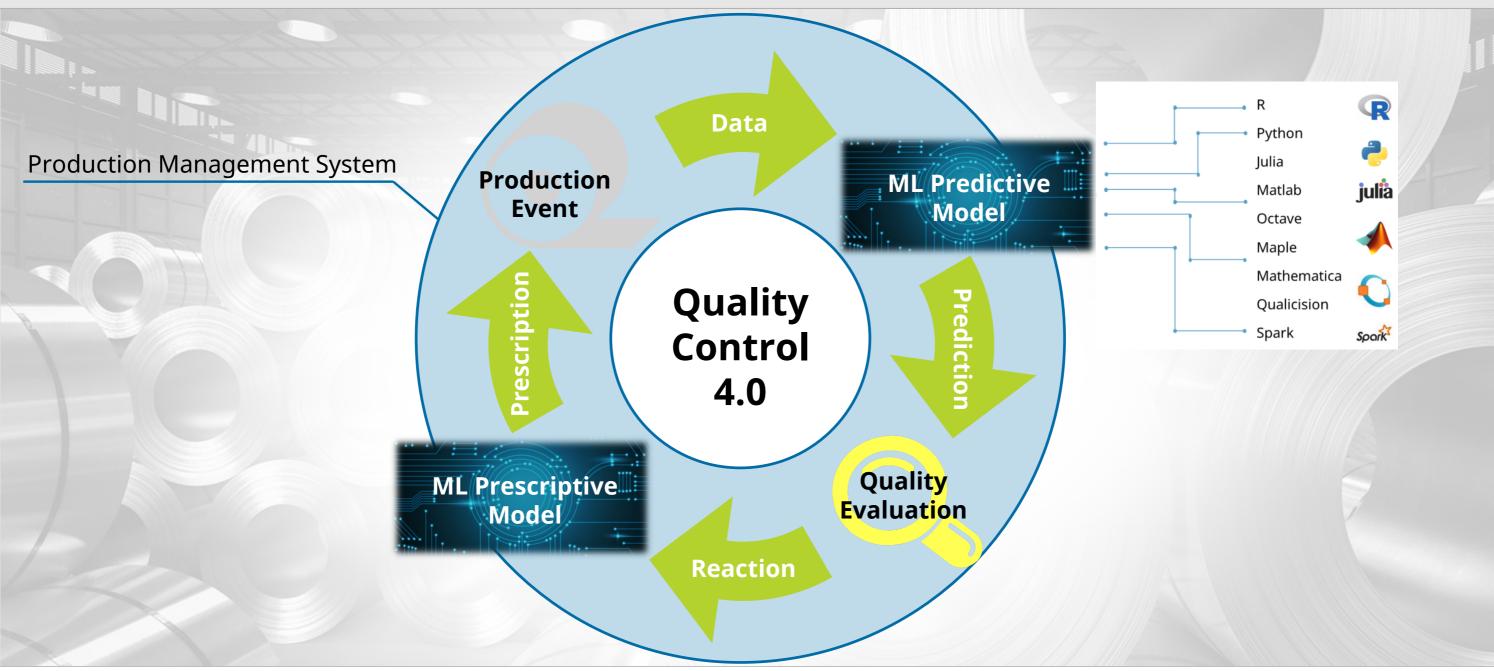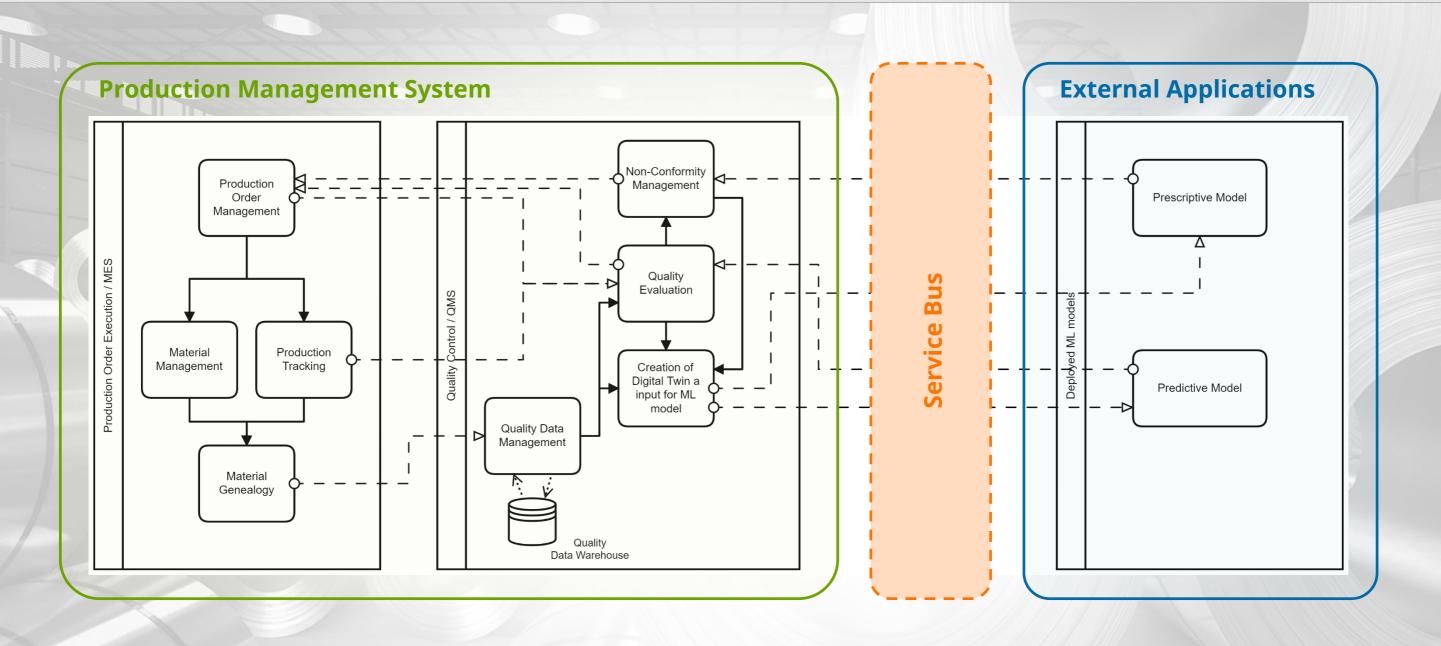
Predictive-Prescriptive Quality Control with ML: Example

Plant graphic © nipponsteel.com

As-is upstream process data + expected downstream process data

ML Predictive Model

Prediction of Mechanical Properties on final product

Meets target?

NO — **Reaction needed**

YES — **Production proceeds as planned**

ML Prescriptive Model

Downstream material-specific prescription for risk minimization, e.g. annealing temperature, temper rolling reduction etc.

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Predictive-Prescriptive Quality Control with ML: Generic Concept

Production Management System

Quality Control 4.0

- Data
- ML Predictive Model
- Prediction
- Quality Evaluation
- Reaction
- ML Prescriptive Model
- Prescription
- Production Event

R
Python
Julia
Matlab
Octave
Maple
Mathematica
Qualicision
Spark

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Thank You for Your Attention!

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