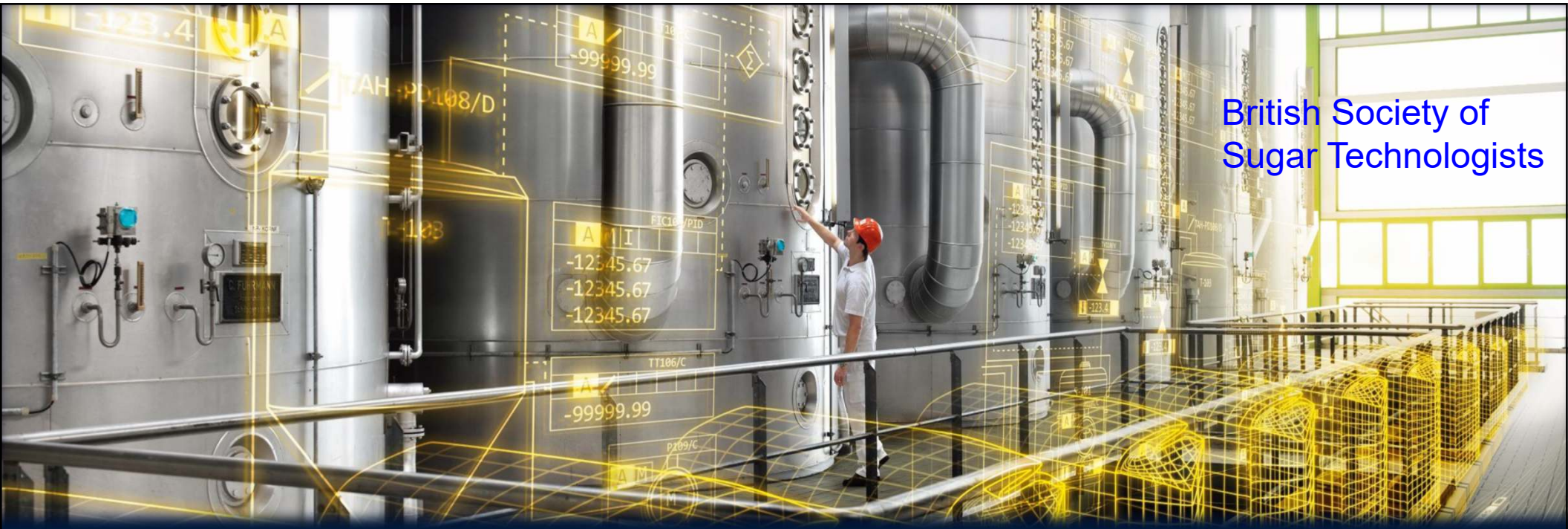


Digitalisation in sugar production – from vision to reality.

Chances of integrated thinking

ANNUAL GENERAL MEETING 2025 – Thursday April 10th 2025

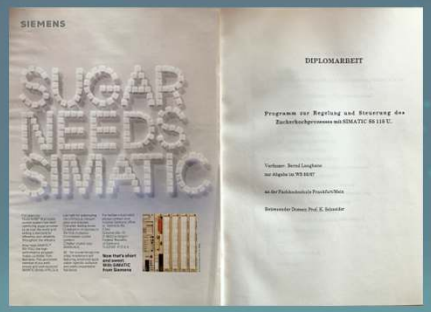
Bernd Langhans, Siemens AG Germany

SIEMENS

Bernd Langhans

* 27.02.1959 in Erlangen, Germany
Married, 3 kids, 1 granddaughter
Study at University Frankfurt
Diplom Ingenieur, Applied Computer Science

1986/87 Diploma on
„Automatic crystallization of sugar based on PLC S5-115U“
Implemented in Sugar Factory Rethen, Germany



1987
Software / Commissioning Sugar, Dairy, Starch
- Software development for DCS TELEPERM-M
- PLC based control
- Technological training

1989
R&D – sugar application
- Standardization of application software
- Strike sequence
- Extraction tower
- New packages for PLC
- MIS spec & definition

1992
Project Management & execution
- Sugar projects Germany after re-unification
- Könnern
- Delitzsch
- Klein Wanzleben
- Fuzzy Control for Dryer at Nordzucker

1997
Sales Support
- Contract Mgmt (CUMRA)
- Proposal Mgmt
- Organizations
- Intl. Sales support
- PCS7 project Zeil am Main, Version 3.2 Pilot project

2000
Sales & Marketing
- Sugar and F&B Projects
- VSS and SE&C
- Intl. Community build up
- Development of Global Engineering Center Thailand

2019…
Head of Sales F&B Sugar global
- Sugar Starch and Ethanol Project development
- F&B Solutions Sales
- Sugar Ind 4.0 Lead
- Head of Sales Sugar Projects global

SIEMENS

We create technology that the world needs – in

industry, infrastructure, mobility, and healthcare.

These industries are the backbone of our economies – and for all of them, digitalization offers tremendous opportunities to become more competitive, more resilient, and more sustainable.

With our technologies, we empower our customers to accelerate their digital and sustainability transformations.

Together we're transforming the everyday, for everyone.

Dr. Roland Busch
President and CEO of Siemens AG

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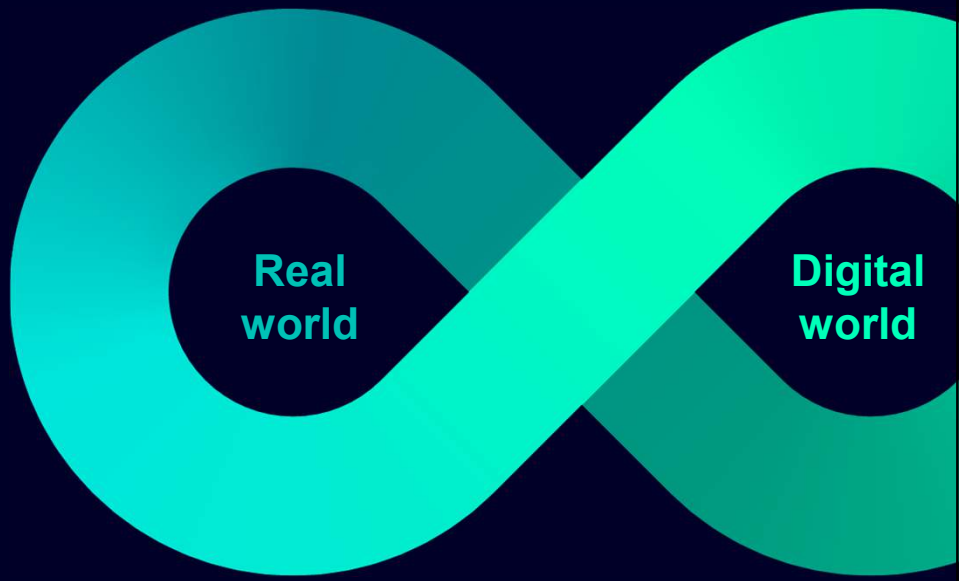
By combining the real and the digital worlds, Siemens empowers customers to accelerate their digital and sustainability transformation

- Glass Production
- Pharma-ceutical Industry
- Campus
- Tire Industry
- Mining Industry
- Cement
- Transpor-tation and Logistics
- Panel Building
- Wind Energy
- Pulp and Paper
- Life Science
- Healthcare
- Oil and Gas Industry
- Automotive Manu-facturing
- Airports
- Electronics Industry
- Semi-conductors
- Data Centers
- Machinery and Plant Production
- Food and Beverage
- Water and Wastewater Industry
- Chemical Industry
- Municipalities and DSOs
- Cranes
- Intralogistics
- Aerospace
- Battery Manu-facturing



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Digital transformation has the potential to drive progress and growth and reduce resource consumption in all countries

Industry

Up to **50% material savings** can be realized using digital twins and innovative production technologies such as additive manufacturing.

Infrastructure

Buildings are currently responsible for **39% of global energy related carbon emissions**. Data analytics and automated building management can unlock large saving potentials.

Mobility

Up to **30% higher network capacity** can be achieved through automatic train operation and by optimizing train flows and rail operations.

SIEMENS

We empower our customers to become more competitive, resilient, and sustainable

FY 2024

312,000 Employees[1,2]	**€75.9 bn** Revenue	**€84.1 bn** Orders
€9.0 bn Net income[3]	**15.5%** Profit margin Industrial Business	**€9.5 bn** Free Cash Flow[3]

1 As of September 30, 2024 | **2** Continuing operations | **3** Continuing and discontinued operations

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The dark sugar factory

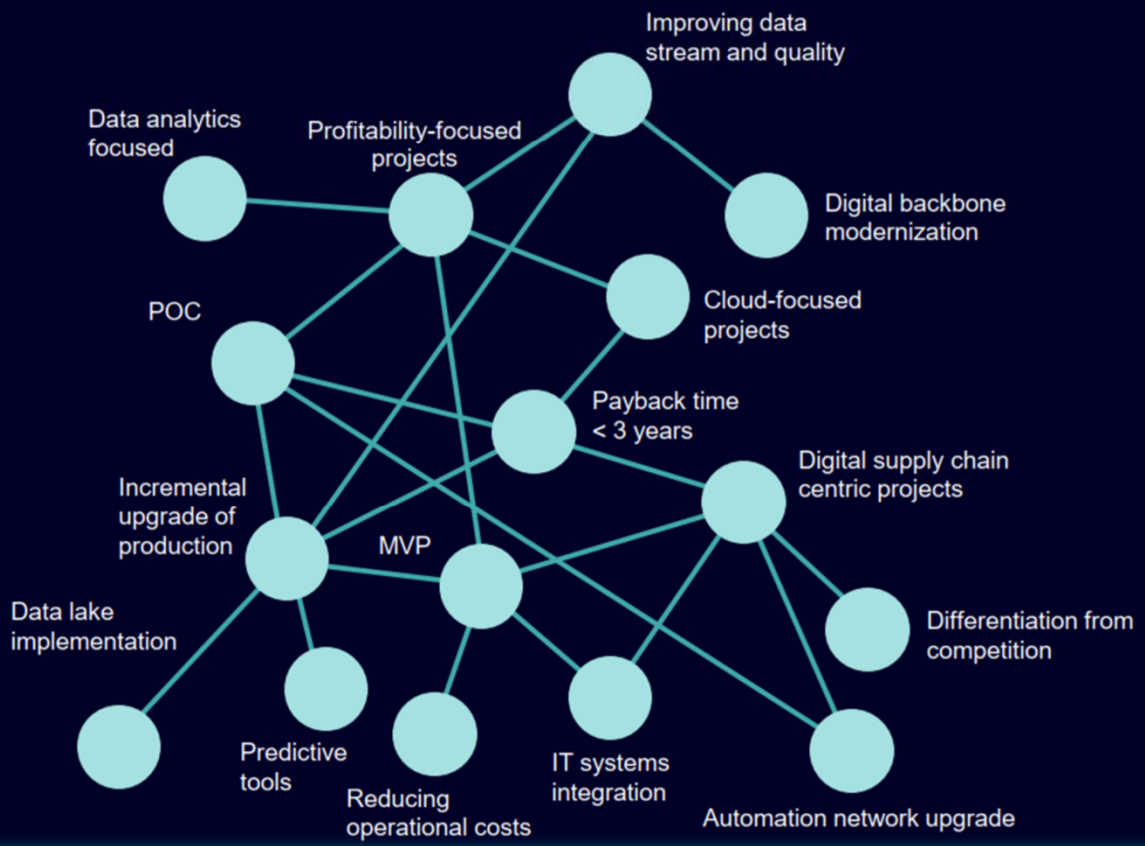
The SIEMENS vision for the future of sugar production

Digitalization concepts in the light of diversification and sustainability

Digitalization with purpose

EXTERNAL

Digital transformation
Complexity – many options available



45%

see the potential of Industrial IoT but don't know where to begin

60%

of all digital transformation initiatives / POC's do not reach their goals

$ 900 bn

wasted in wrong investments (over $1'300 bn in IoT)

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The goal is to turn data into information, and information into actionable insight.

Carly Fiorina
Former CEO – Hewlett-Packard

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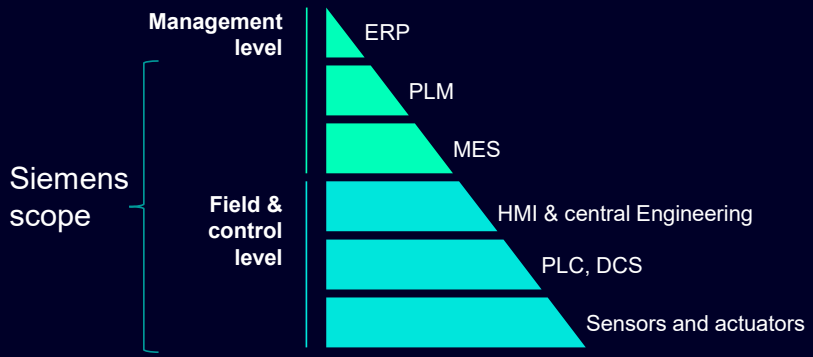
IT and OT Technologies and Discipline are converging

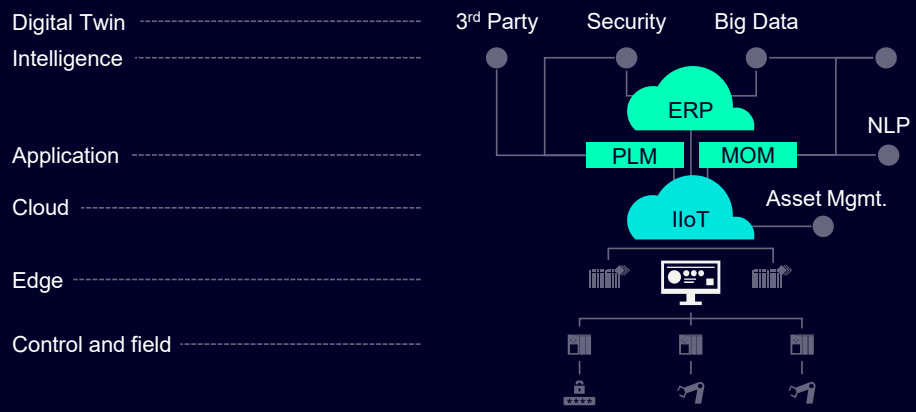
Yesterday/“often” today

Monolithic pyramid



Near future

The two worlds of IT & OT are converging



With the technology convergence data can now be leveraged where necessary

This means opportunities and challenges to our customers, and we – as Siemens – are ready help and solve.

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Integration of Data Driven and Knowledge Driven Approach is essential for sustainable investment into the digital operation, ensures smooth operation and provides the basis for future diversification options.

Data Driven Analytics

Knowledge Based Analytics

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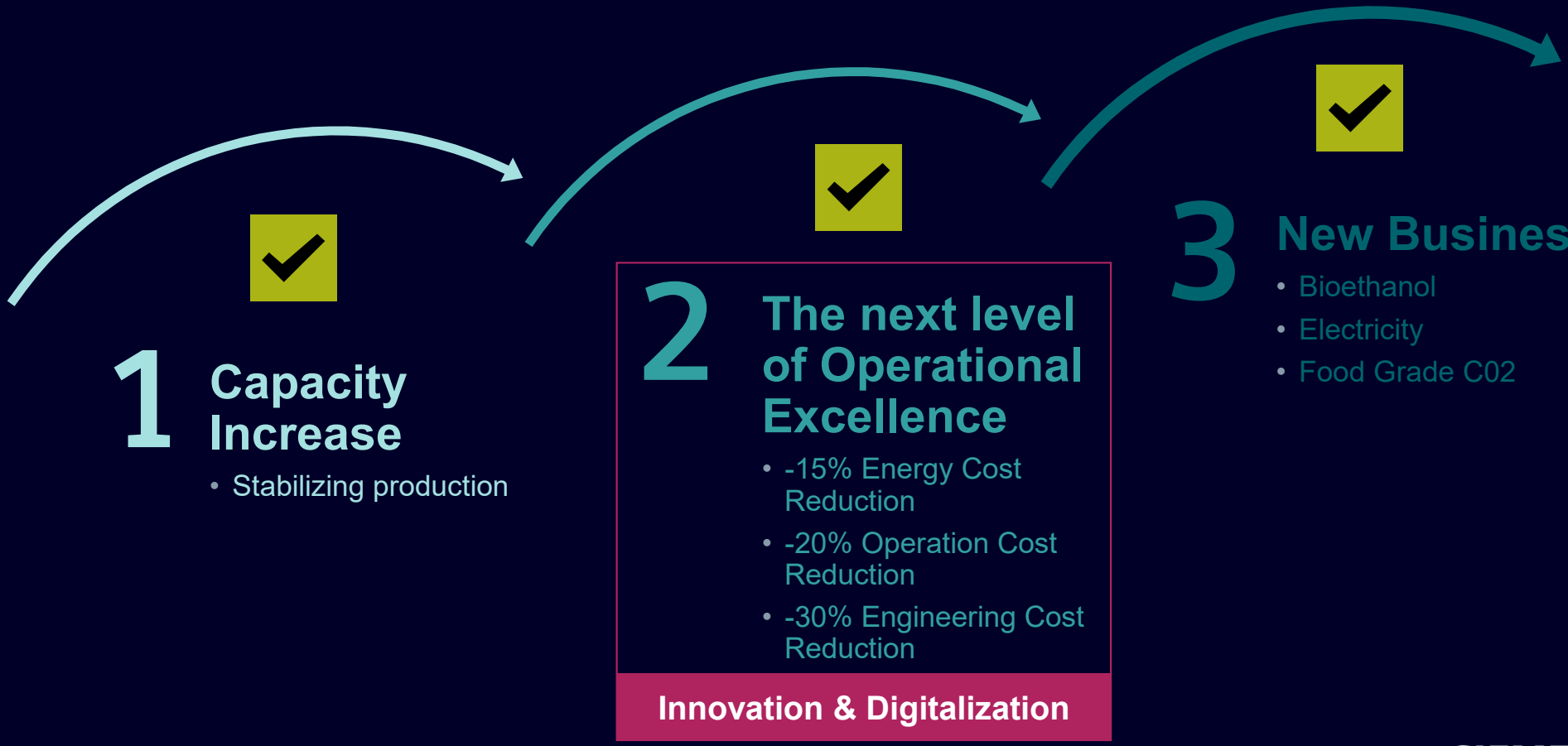
The Sugar Factory's Common Journey
Productivity – Efficiency – New Business



1 Capacity Increase

- Stabilizing production

2 The next level of Operational Excellence

- -15% Energy Cost Reduction
- -20% Operation Cost Reduction
- -30% Engineering Cost Reduction

Innovation & Digitalization

3 New Business

- Bioethanol
- Electricity
- Food Grade C02

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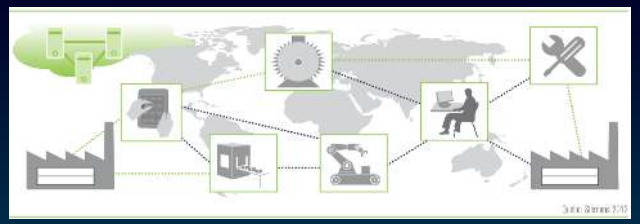
Digital Enterprise
A Definition?

The Definition of Digital Enterprise for process industry is following the logic of Industrie 4.0 with a specific interpretation

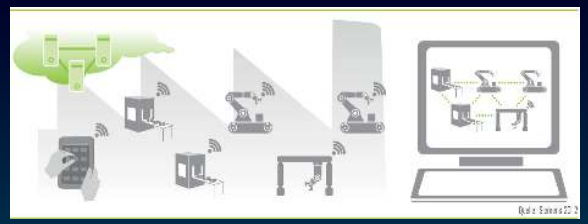
Horizontal integration through value-add networks *



Optimization of resources along value-add networks from raw materials to product

- Remote operations via Internet
- Cloud computing / Mindsphere
- Data driven services, e. g. predictive maintenance

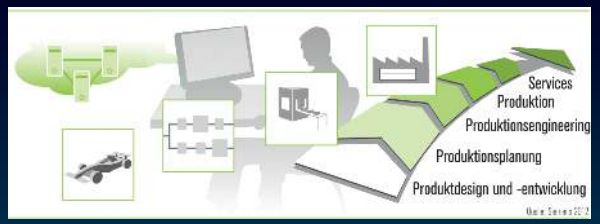
Vertical integration and networked production systems *



Increased flexibility and optimization of production in volatile and global markets

- Integrated Operations
- Plant Asset Management
- Seamless interoperability (Plug&Produce)
- Decision support / assistance systems

Seamless integration of the engineering along the entire life-cycle *



Time savings in engineering by consistent data storage along plant life-cycle

- Integrated Engineering
- Augmented reality
- Digital Twin of the “as-is”-plant status
- On-site training simulation

Modelling and Simulation

Seamless interoperability and communication based on standards

Cyber Security / Industrial Security

*) Source: acatech, April 2013 “Umsetzungsempfehlung für das Zukunftsprojekt Industrie 4.0”

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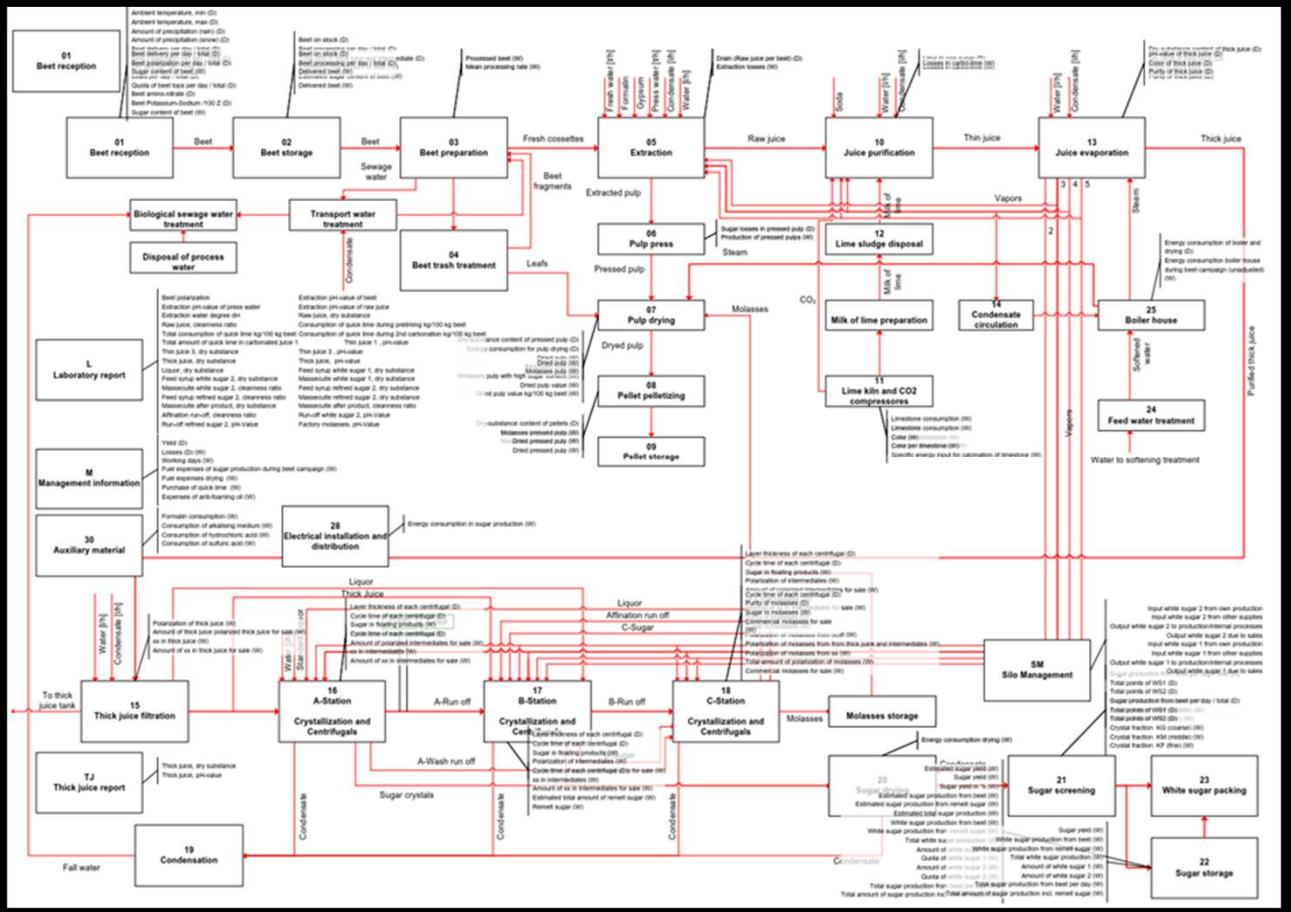
The „One-Setpoint-Factory“ Complexity is just another word for Reality



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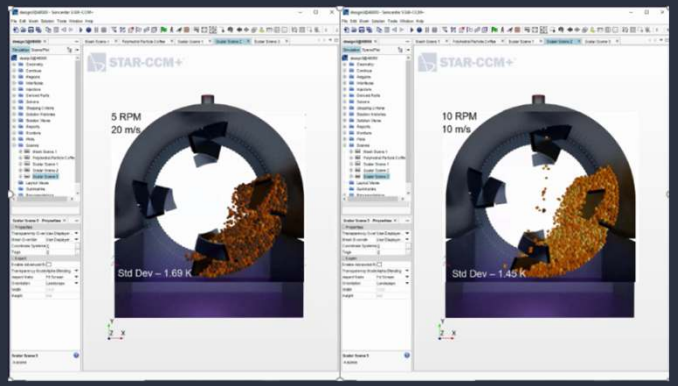
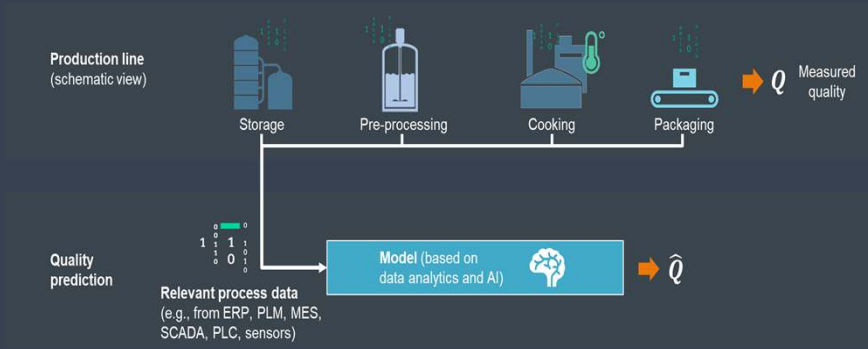
Two Types of digital twins

Model-driven Digital Twin



VS

Data-driven Digital Twin



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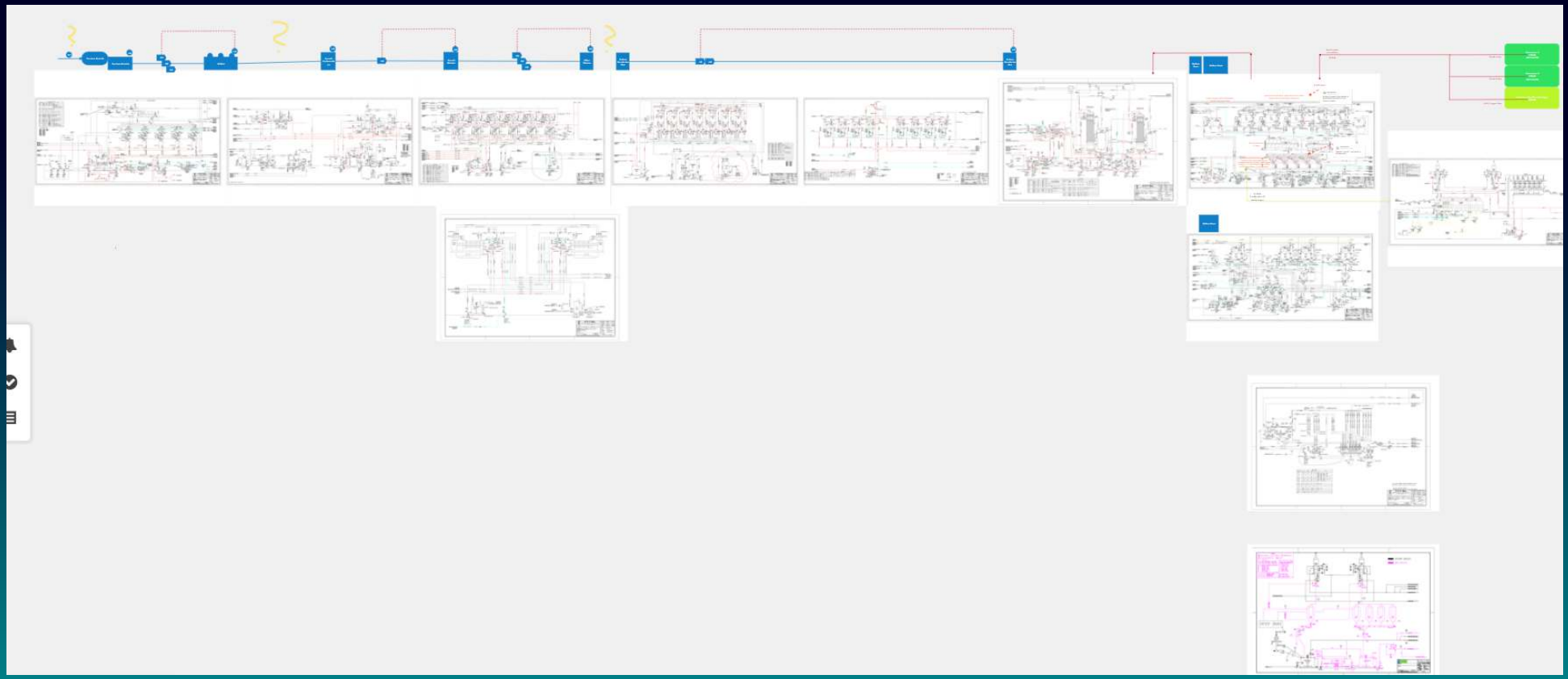
The real-life example, Sugar Refinery XYZ.



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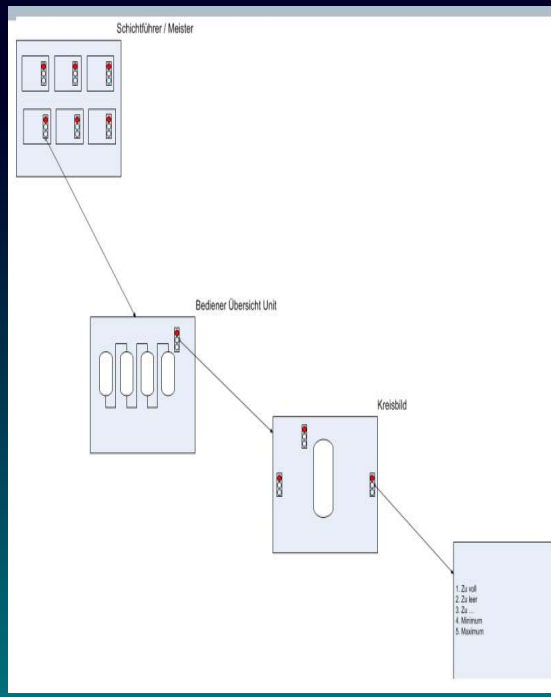
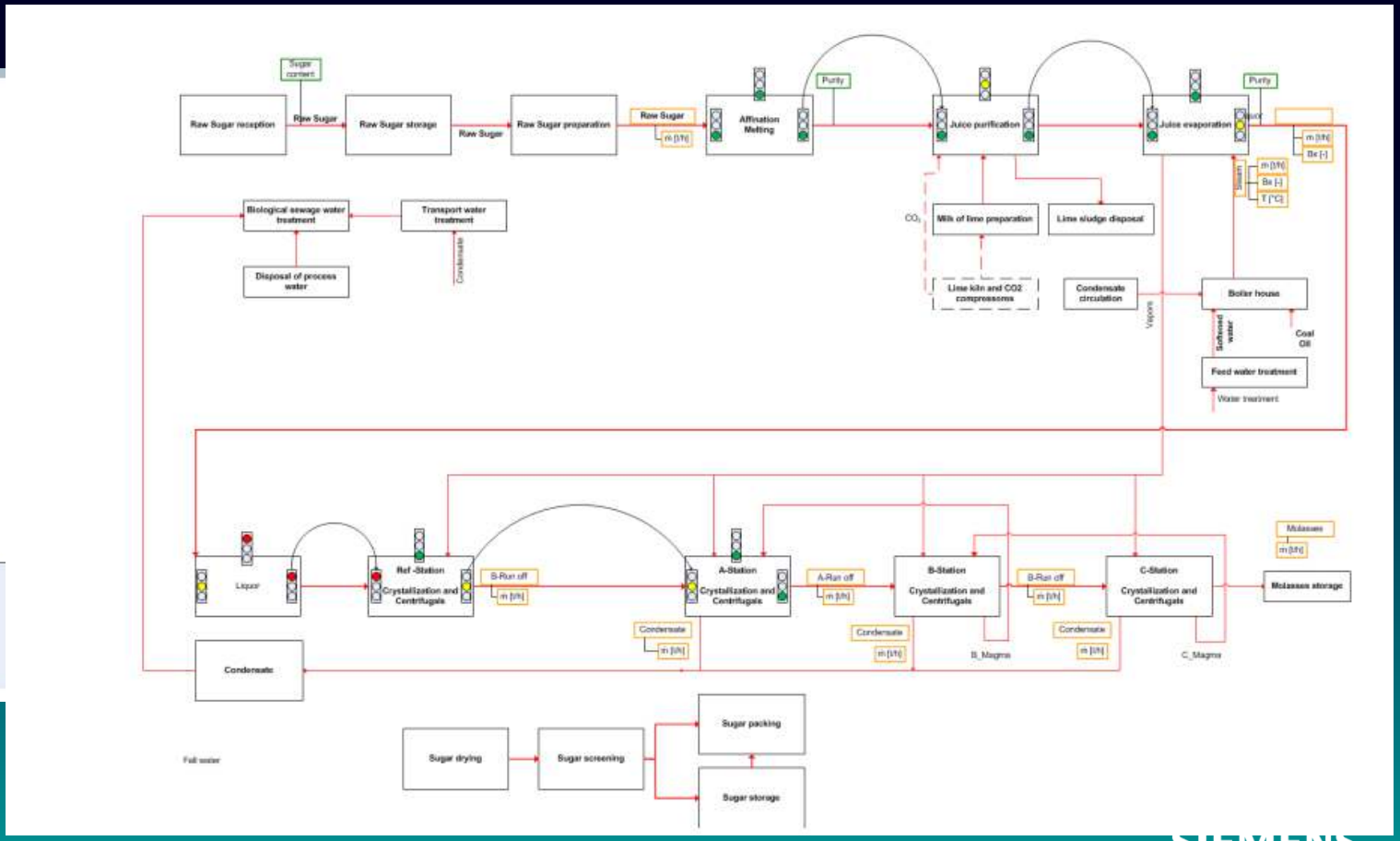
Using advanced plant control procedures in full automatic mode allows xxx to optimise production by reduced operations and fault avoiding algorithms





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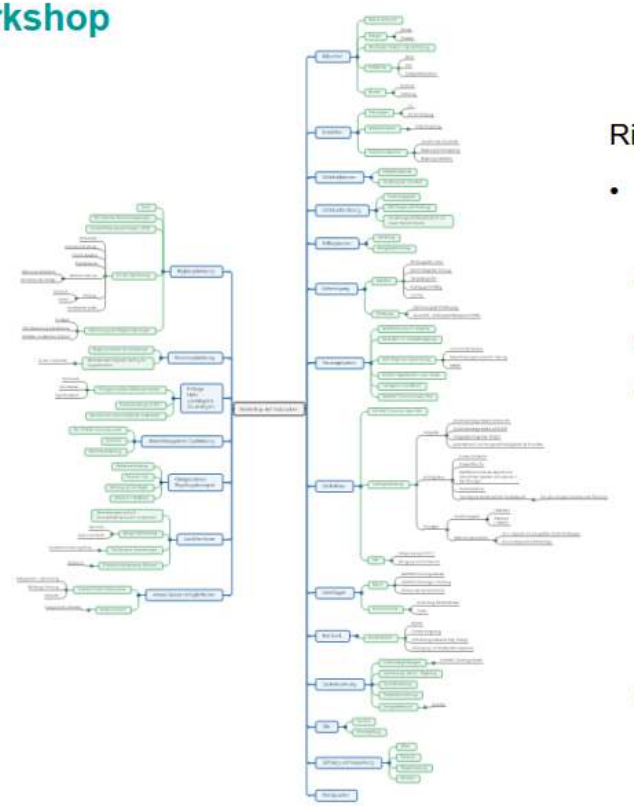
Mind-Map as Basis for the workshop

Left side:

- Measures, directly connected to
  DCS activities
  - Alarm Management
  - PID-Control optimization
  - HMI – Grphics Interface
    - Advanced process graphics
    - Operator Guidance
    - Reduction of process operations



Right side:

- Measures, with based on technological process areas
  - Functional optimization
  - Add-on interlocks
  - Section control
    - Extraction interlock
    - Sugar house:
    - Pan sequence
    - Vapor Rail control
    - Centrifuge Master
  - Data driven modelling

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Benchmarking Investment into I&C: Operator actions – classification

Monitoring related actions

- Open new operator windows or zoom into technological functions
- Online reporting of situations on the electronic shift book

Process related actions

- Initiate new products / recipies
- Select machines or production lines
- Start or stop of batches

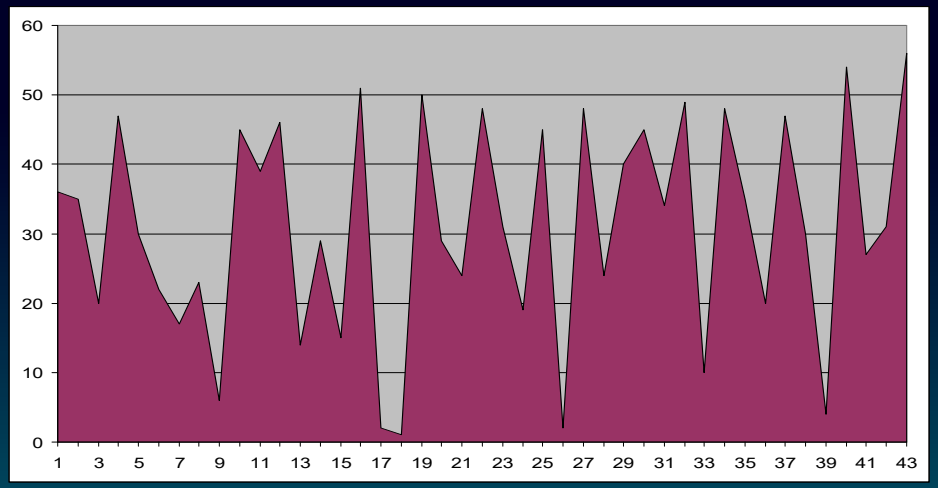
Fault related actions

- Take controllers to manual operations
- Take machinery to manual operation
- Acknowledgement of faults
- Manual operation of valves, pumps, motors etc.

Benchmarking Investment into I&C: Failure Analysis of a beet sugar plant

Alarms per day – Overview for 43 days
Average of 25 Alarms which need operator action per day
Approximately one per hour!

Additionally:
10-15 Process related action per hour



Overall Benchmark of 280-350 operation per day !

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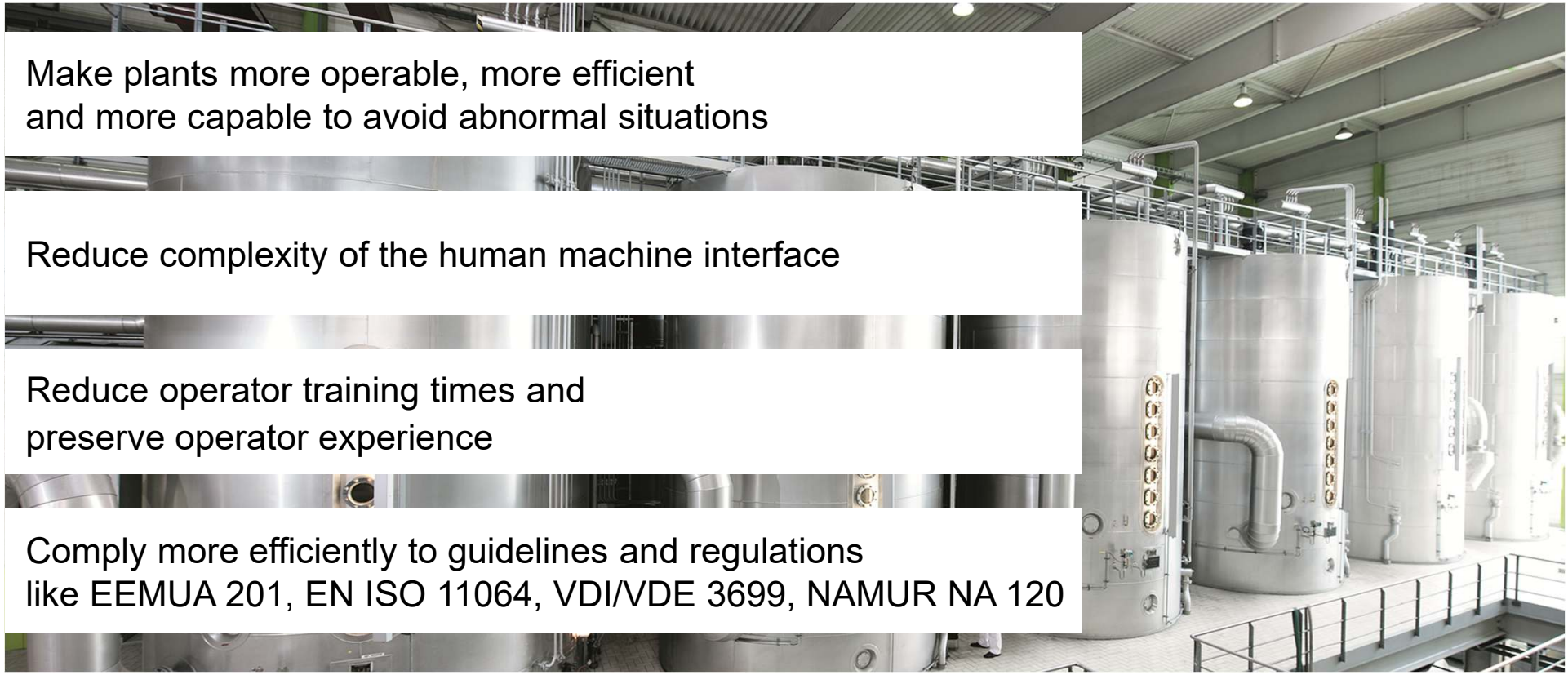
Benchmarking Investment into I&C: Comparison of use cases

	Monitoring	Process operations	Failure action	Total per day
Plant A Beet Sugar	?	240 – 320	3 – 40 per day	240 - 360
Plant B Beet Sugar	?	100 / hour	5 – 10/ Hour	> 3.000
Plant C Refinery	?	> 150-200 / hour	5 – 10 / Hr	> 4.000

Digital Enterprise creates opportunities to increase productivity
Siemens – Trusted partner for the sugar industry to achieve the next level



Make plants more operable, more efficient
and more capable to avoid abnormal situations

Reduce complexity of the human machine interface

Reduce operator training times and
preserve operator experience

Comply more efficiently to guidelines and regulations
like EEMUA 201, EN ISO 11064, VDI/VDE 3699, NAMUR NA 120

Digital Twin

A digital twin is a digital representation of a real-world entity or system. The implementation of a digital twin is an encapsulated software object or model that mirrors a unique physical object, process, organization, person or other system.

Data from multiple digital twins can be aggregated for a composite view across a number of real-world entities, such as a power plant or a city and their related processes. Integrating and connecting the digital and physical world.

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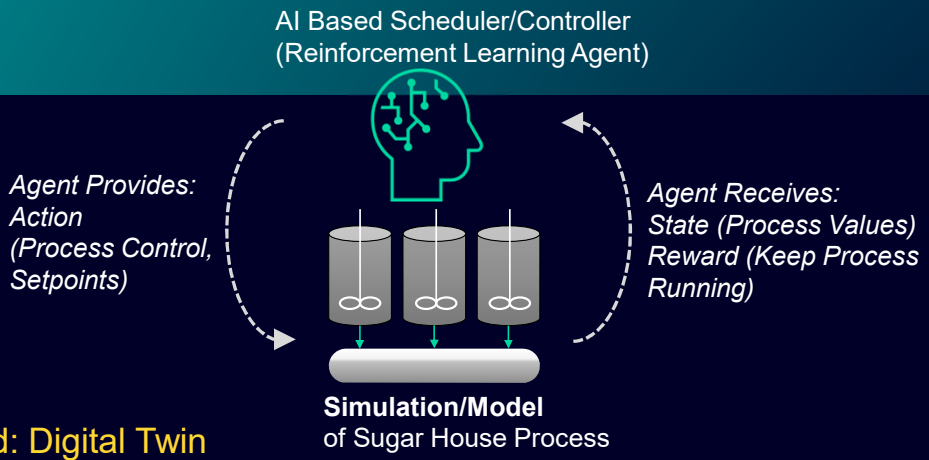
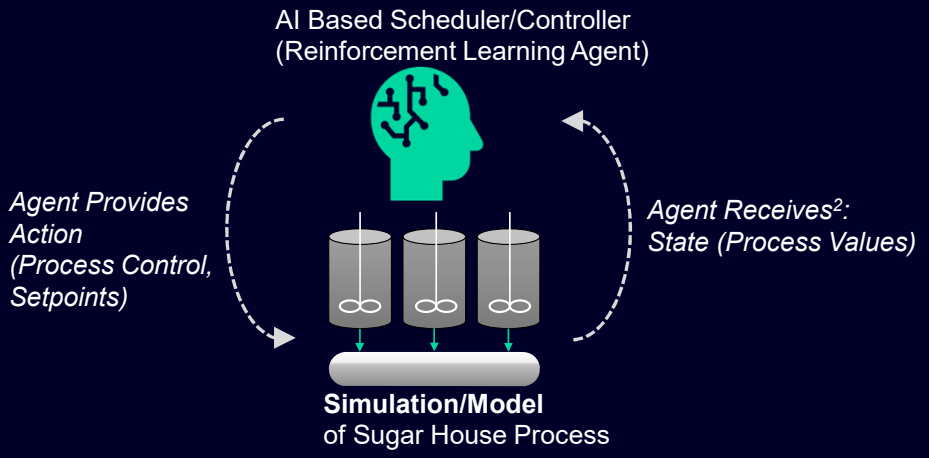
Use Case and Approach
AI Based Quality Sugar Crystallization Scheduling and Control



Virtual World: Digital Twin

Real World



Learning Phase
AI Agent interacts with Process Simulation.
Advantage:
- No harm to real world process during exploration.
- Large amount and variety of training data.

Inference Phase
AI Agent controls real word process.
Potential Benefits:
- Fast and computational lightweight inference.
- Reduction of idle times and energy consumption.

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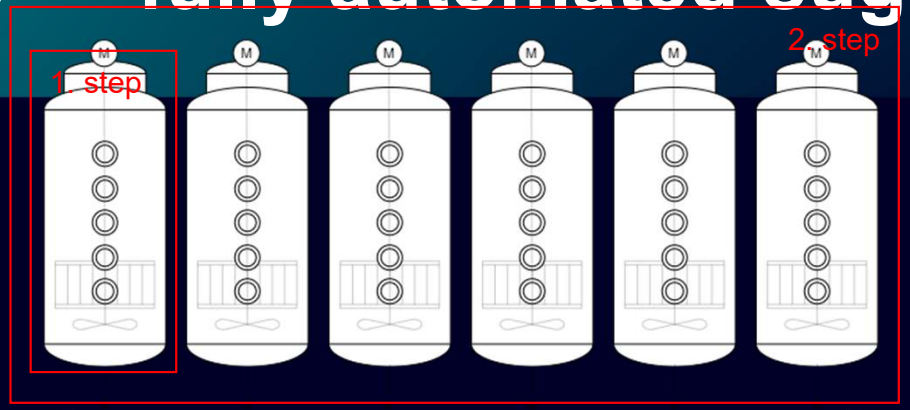
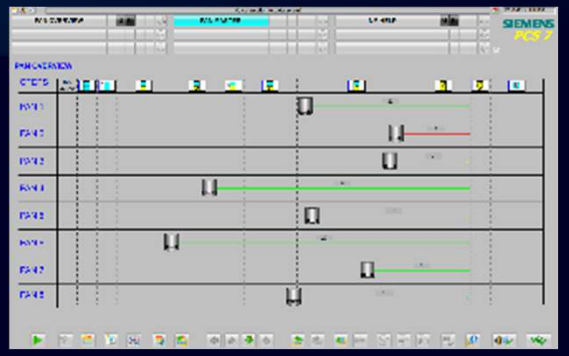
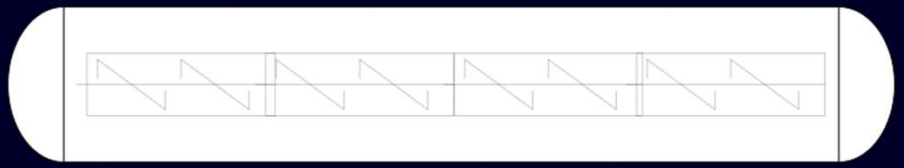
“Big picture” – fully automated sugar house

Vacuum Batch Pans
for Sugar Crystallization





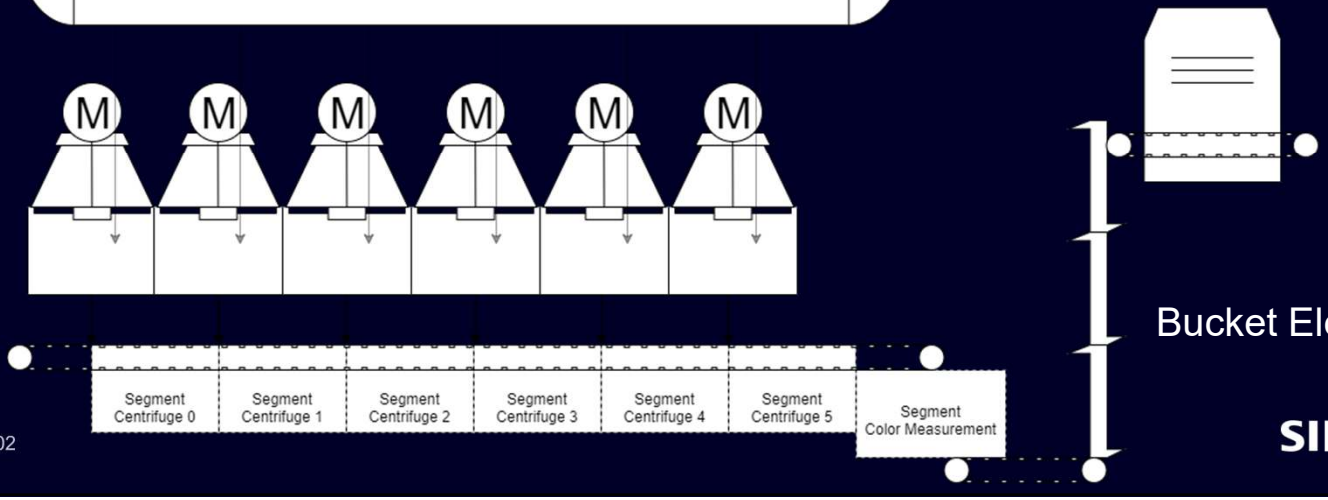
Strike Receiver



Sugar Drying

Centrifuge Station

Conveyor Belt



Bucket Elevator

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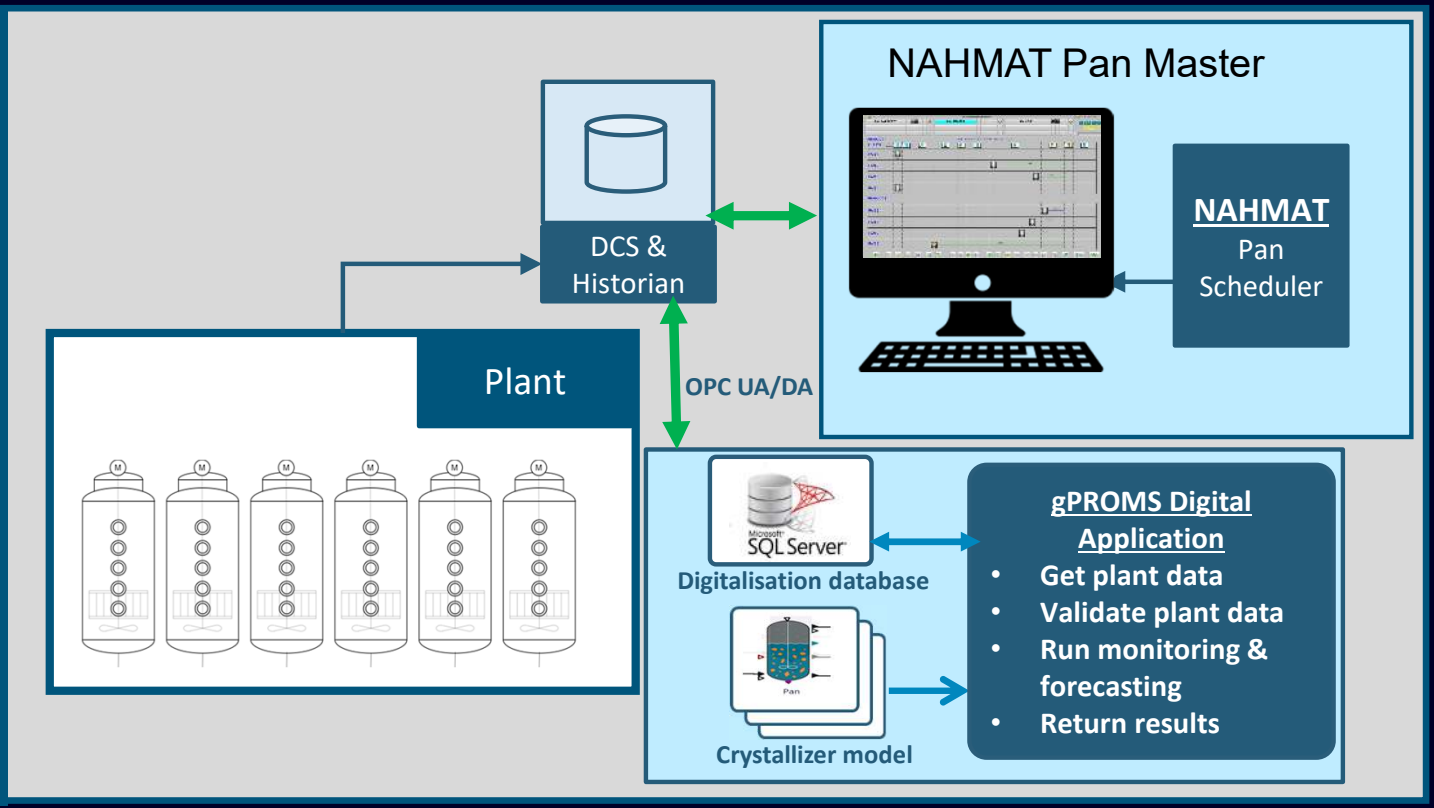
Crystallization batch pans performance monitoring, forecasting and scheduling
Technical architecture

Potential functionalities

- Monitoring of pan performance and quality metrics
- Forecasting of batch length
- Batch scheduling
- Optimization of batch operation*
- What if analysis*



** NOT INCLUDED in the current scope but can be added at a later stage with additional costs*

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SIEMENS Sugar Crystallization Digital Twin

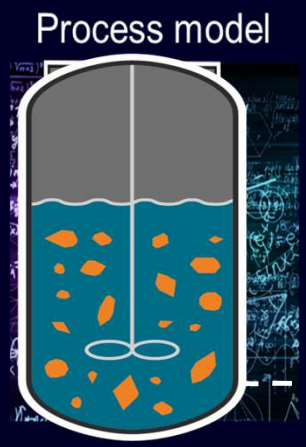
Modelling approach

Operating Conditions
Temperatures
Flow rates/pressure profiles
Compositions

Product specific information
Solution concentrations, Yield and PSD of seed/product

Crystallizer Geometry
Equipment volume and impeller specifications

Physical science-based model



Outputs
Batch time/run length
Particle Size Distribution (PSD)
Yield
Composition of liquid and solid phase

Result analysis
Sensitivity analysis

Operating process space mapping

Optimization

Key features of gPROMS crystallizer models:

1. Well mixed
2. Different model configurations
3. Dynamic model
4. Mass, energy and population balances
5. Crystallization mechanism and kinetic parameters
6. Support for complex physical properties/empirical expressions
7. Supports key phenomena: evaporation, PSD evolution, crystal purity tracking (if required), ...

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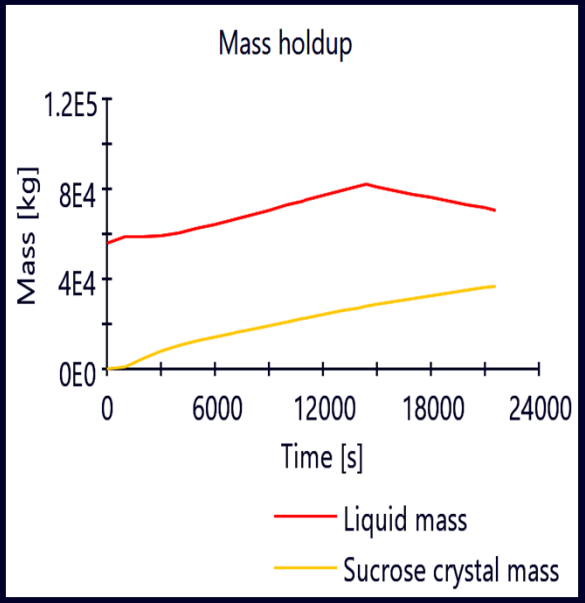
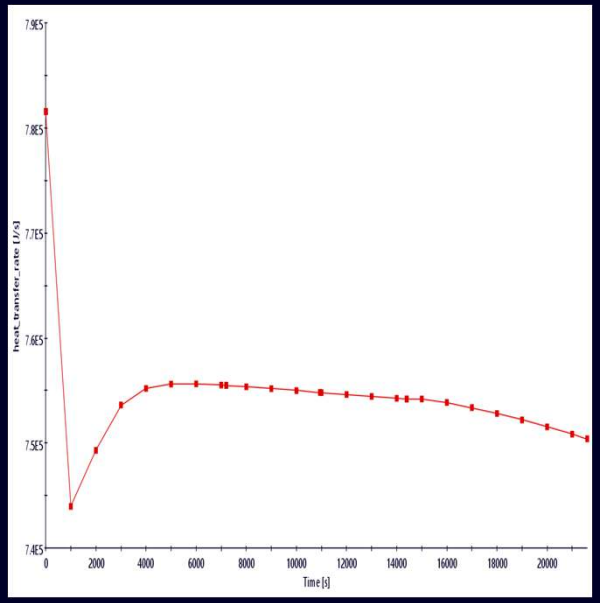
Model outcomes

AA(PSH2611

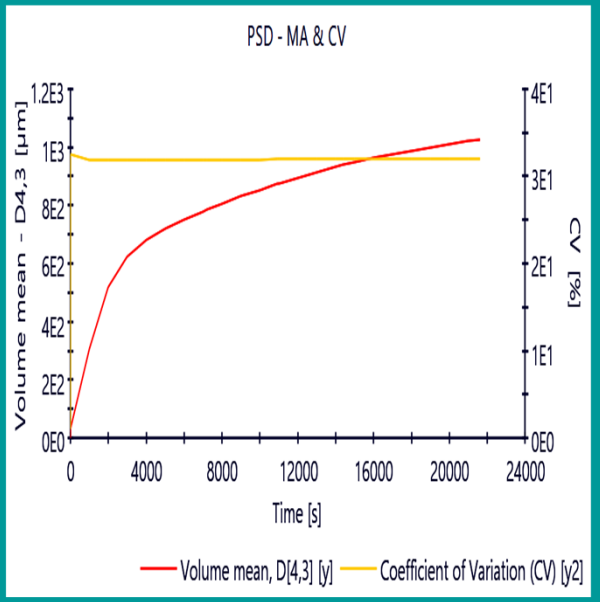
Key results 1 – expected boiling time



Key results 2- expected energy consumption



Key results 3 – crystal size



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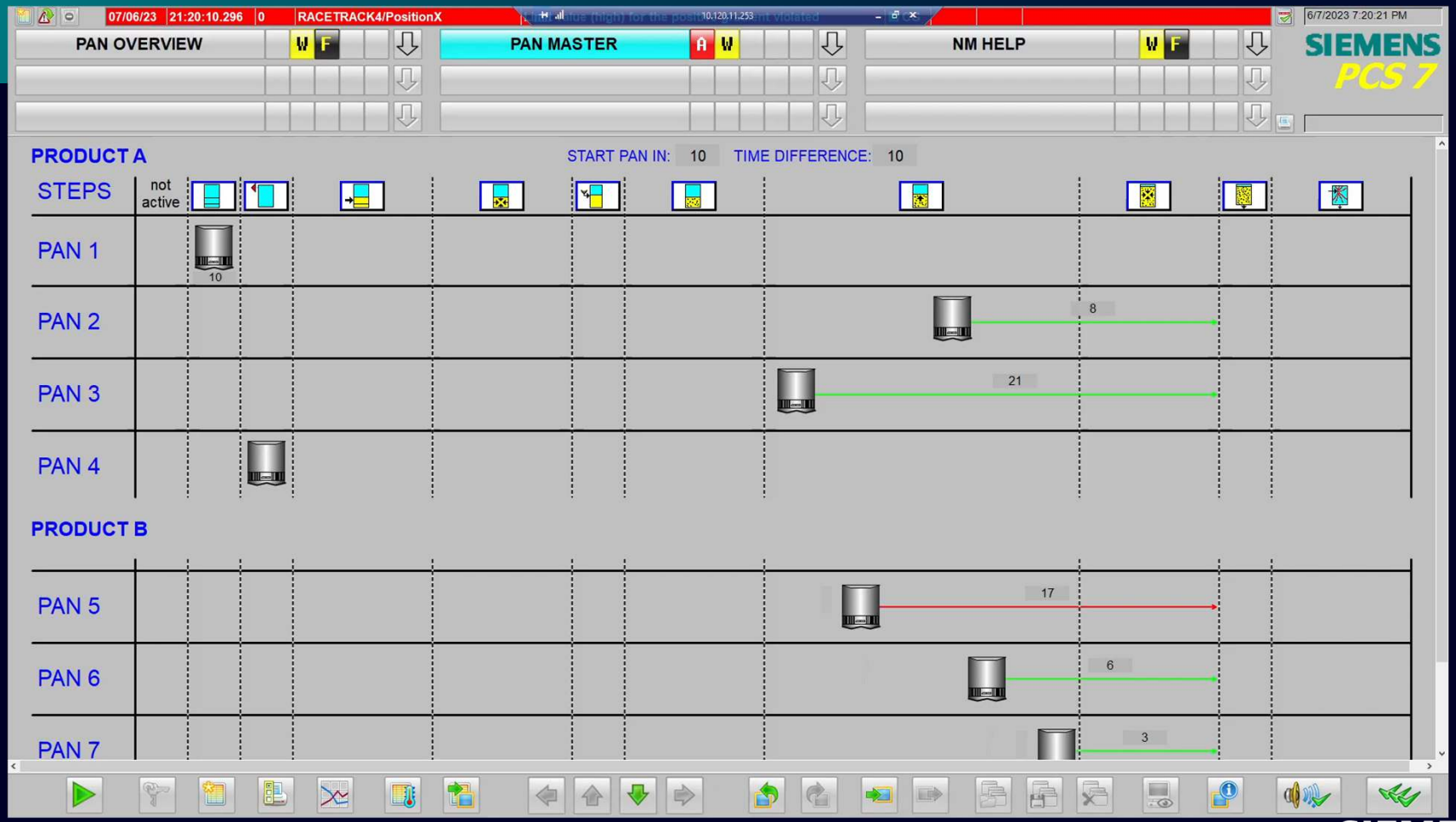
Slide 33

AA(PSH2611 [@Mitchell, Niall (DI PA SW IS CC PM SOL)] could we add the top 3 plots or KPIs that the model can predict here? Just to create some curiosity before we go into deep dive
Asokkumar, Amitha (DI PA SW HZ , 2025-02-14T11:59:25.702

NM1 0 Added trends from representative simulation. Let me know if you would like to modify. Thanks
Mitchell, Niall (DI PA SW IS CC, 2025-02-16T20:22:21.342

NAHMAT Pan Master – the brand new add-on



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Artificial Intelligence in process control

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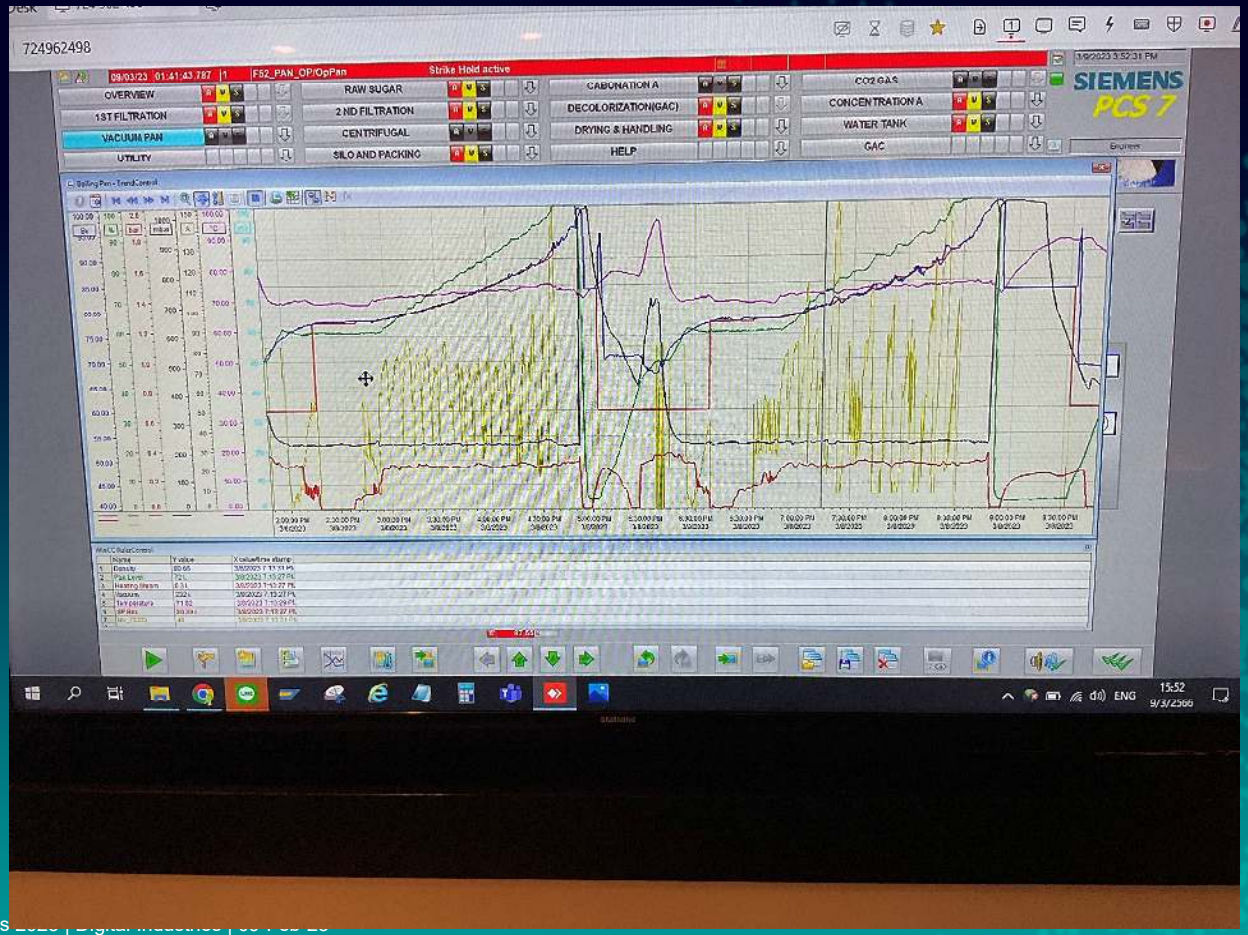
What is wrong here and why? Can AI solve that problem?



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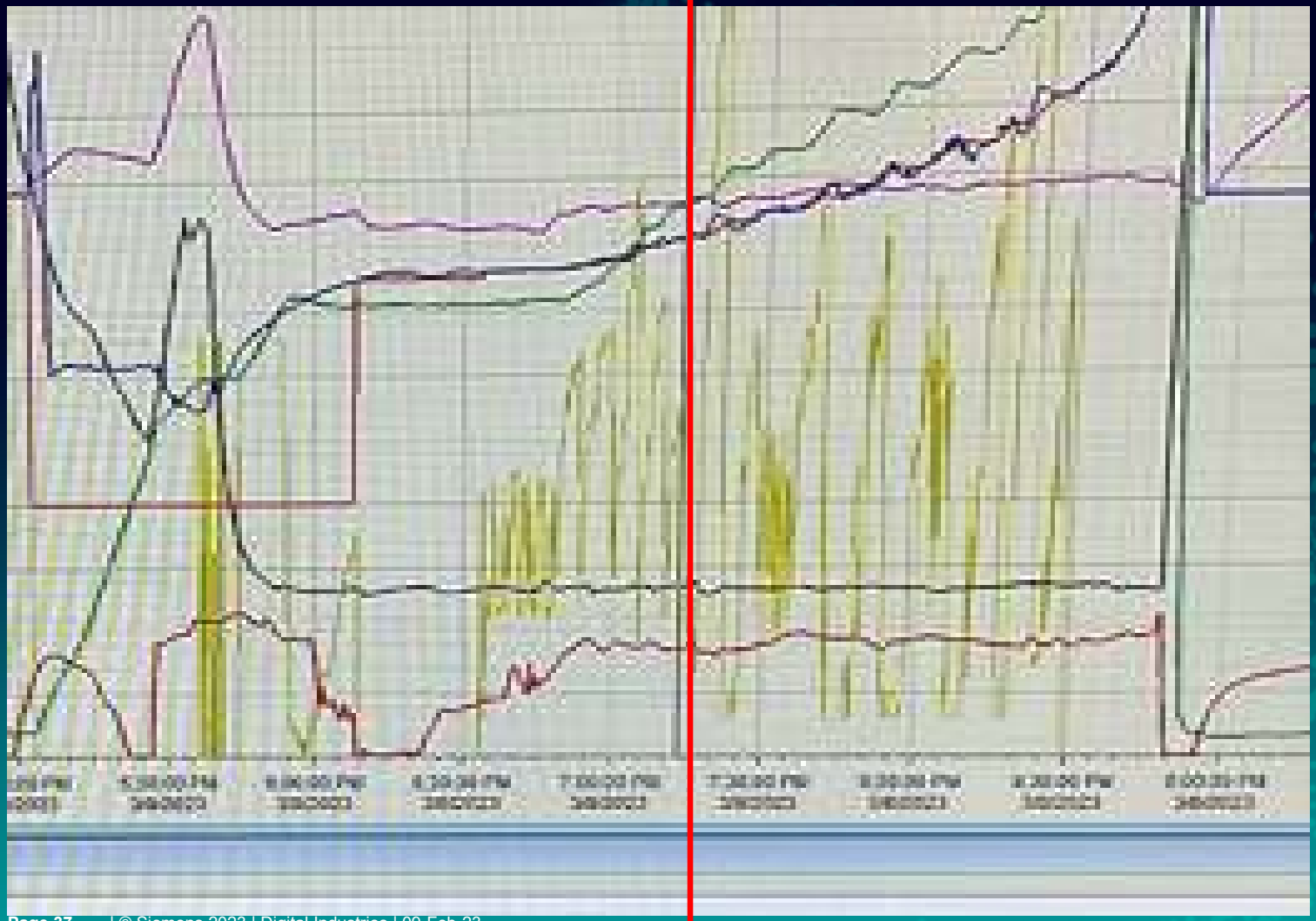

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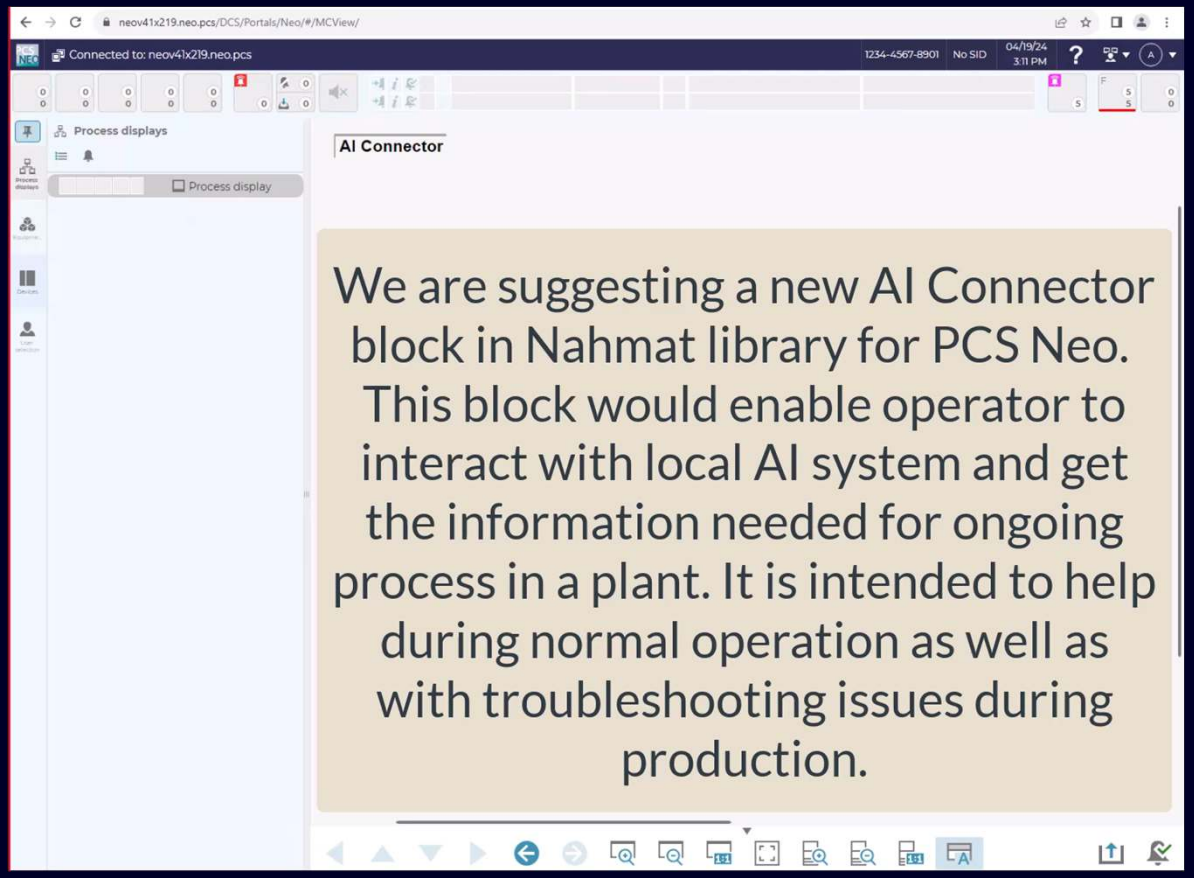
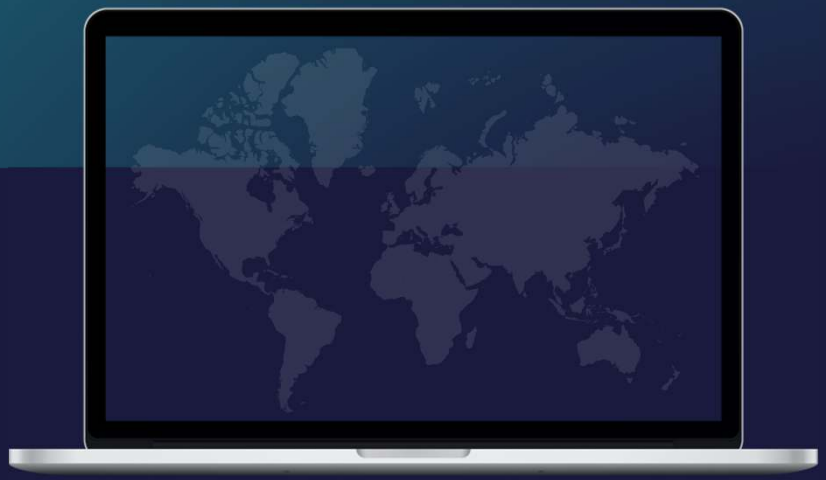
First Gen AI support solutions in NAHMAT



Remote Operations



What is that?

Central control of production sites

Global access via Remote-Terminals into local M&C (operator console)

Value

Higher Efficiency of operations

Higher productivity of resources

Global support and access

Technological support for local operations

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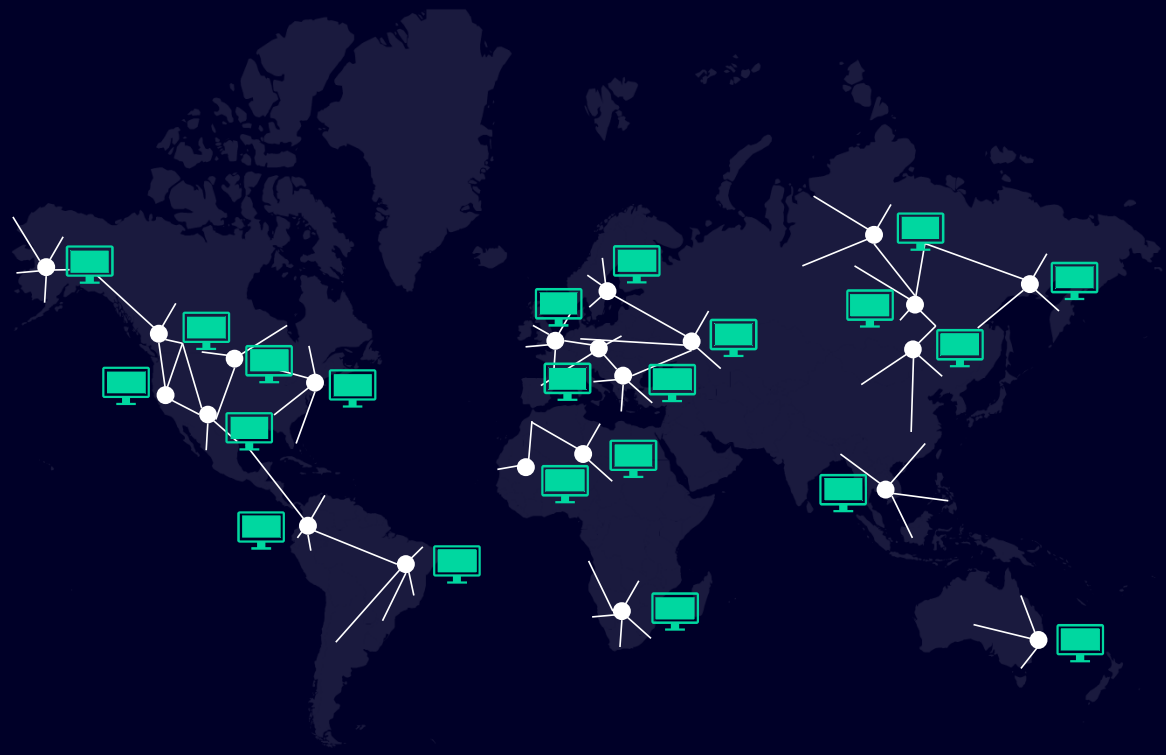
The next step:
Remote Operations

Marketdemand:

- Central access and control of distributed production plants
- Remote control of unmanned plants or plant areas i.e. during night shift.

Yesterday



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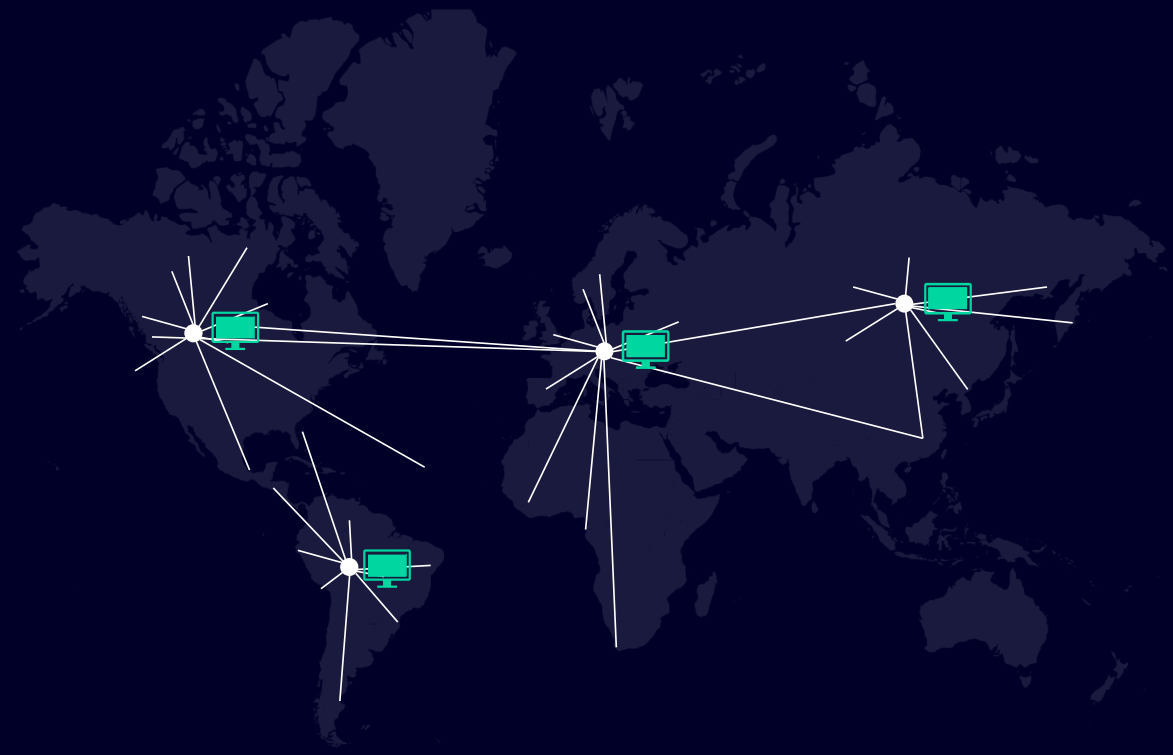
The next step
Remote Operations

Siemens Solution

- Remote Operations

Yesterday

Today



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SIMATIC PCS 7
Remote Operations

Reference

„Siemens provided a userfriendly, bandwitdth-optimised and secure solution for our remote operations demands. The project was delivered within time and budget.
And it was developed in close cooperation with our engineers“

Michael Schill, Head of Instrumentation Process Control and Technical Network,

Region Continental and Northern Europe

Linde Gases Division

Scope

- SIMATIC PCS 7 with remote terminals for open and high flexibility
- Networktechnology incl IT-Security
- Usability
- Operation of the plants within optimized plant condidtions in Automatic Load Control (ALC) and Linear MPC

Value

- Reduction of time and cost-intense site-service support
- Global control of down-time and maintenance activities.
- Preparing for continous production on global scale
- Savings in regard of assett information. Global access to storage/warehouse-management

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Thanks

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