The Digital (R)evolution
Integrating and digitalizing the entire value chain is key to staying competitive in the future.
Integrating and digitalizing the entire value chain is key to staying competitive in the future.
Digital Enterprise is our portfolio of solutions for the digital transformation.
Digitalization is THE driver for growth

Adapted for every Industry

Oil & Gas
Drive the digital oil-field through remote start-up/commissioning/operation and process simulation

Water/Wastewater
Smart Water – optimizing planning and operations. Digital solutions for leak detection and efficient pumping

Chemicals
Position as innovative partner for digitalization: Advanced process control and predictive maintenance

Pharma
Combining the virtual and real world along the entire materials chain – paperless and compliance conform

Minerals
Support OPEX reduction through integrated automation and asset performance management

Glass/Solar
Digitalization helps customers in the glass industry to boost productivity, flexibility, efficiency and quality

Fiber Industries
Self-organized, intelligent "eco-systems" that network all elements of the entire value chain

Marine/Shipbuilding
SISHIP EcoMAIN decision support system ensures optimization of the ship’s operation

There is no one-size-fits-all solution in Digitalization

Every industry, every company is different and requires solutions it can integrate into existing processes and the production structure step by step while not restricting operations due to downtime.

Klaus Helmrich, member managing board Siemens AG
Digital Enterprise Suite
Portfolio Elements
Digitalization

MindSphere
Preactor
Plant Simulate
PLCSIMAdvanced
CD Adapco
NX Motion
Process Simulate
S7-1500 MindLib / MQTT Publisher
SINUMERIK VNCK
AMP
COMOS
SIMPETION
XHQP
AR
MindApps
SIMATIC IT UA
Bentley
COMOS Walkinside
HEEDS
X-TOOLS
STAR-CCM+
SIMACSI
PCS 7
NX
MCD
Polarion

SiVarc
MAC
AMC
SIMIT
Teamcenter
SINEMA RC
SINUMERIK VNCK
TIA Portal
Cloud Engineering
SINEMA RC
S7-1500 MindLib / MQTT Publisher
TIA Openness
SCALANCE X/S/W
DE Modules Overview
Major application areas of first 10 DE Modules

End Customer (Discrete Manufacturer)

1. Product Design
   - DE-019 Vehicle Energy Management

2. Production Planning

3. Production Engineering
   - DE-006 Industrial Security Monitoring
   - DE-008 Virtual Machine for NC Program Validation

4. Production Execution

5. Services
   - DE-018 Increase In-Operation Performance of Machines

Machine/Line Builder

1. Machine/Line Concept
   - DE-016 Collaborative Automation Design for Production Machines
   - DE-005 Collaborative Automation Design for Production Lines

2. Machine/Line Engineering

3. Machine/Line Commissioning

4. Machine/Line Operation

5. Machine/Line Services
   - DE-007 PLM Integration of Automation Engineering

DE-001 Virtual Commissioning for Production Line
DE-002 Virtual Commissioning for Machine Tools
DE-003 Virtual Commissioning for Machine Builders
Digitalization Update
Digital Factory
Horizontal and vertical TIA value chain –
Use Cases to experience digitalization with TIA Portal

1. Automatic execution of engineering tasks
2. PLM integration to automation engineering
3. Efficient cloud based engineering
4. Virtual commissioning
5. Integrated Energy Management
6. Machine and plant security
7. Data acquisition for Cloud Services
8. Communication networks to handle IIoT data
Engineering
The engineer’s usage of time

- Actual engineering work: 29%
- Sharing and looking for information: 24%
- Meetings, mainly to share information: 14%
- Work that has been done before: 21%
- Vacation: 6%
- Breaks: 1%
- Other: 5%
Different data

- e.g. NX
- e.g. EPLAN/E3/
- TIA-Portal
Who takes part in the simulation race?
Simulation Scenarios
MiL – SiL - HiL

Virtual Commissioning = Importing, testing and modifying planning data in a virtual environment
Virtual Commissioning enables parallel work and thus a shorter time to market.

Time to Market

Engineering

- Concept
- Mechanical construction
- Electrical Design
- Automation
- Mechanical Design
- Virtual Commissioning (VC)

Manufacturing area

- Real Commissioning
- Production

Shorter Time to Market
System Engineering Approach

Production Plants

Production Cells

Machines

Machines components

Layout validation  Logistic verification  Throughput verification  Time validation

Geometry validation  Kinematic validation  Time validation  Cell Automation

Mechanical design  Electrical design  Machine Automation  Mechatronic Validation

Multiphysics validation  Component sizing  Design optimization  Energy loss tracking
From simulation to Virtual Commissioning

1. Preliminary Design
   - Mechatronic concept
   - Tool Selection & Reachability
   - Material Flow Concept

2. Detailed Design
   - Mechanic, Electric, Automation Design
   - Toolpath and offline Programming
   - Line Design & Validation

3. Commissioning
   - Training of shop floor-personnel
   - Upfront validation using virtual equipment
   - Shorter breakdown-times
   - Validation of the changes of the plant

4. Operator Training
   - Cycle time validation
   - Mixed validation with hardware
   - Mixed validation with other plant parts

5. Retrofit
   - Test of single plant parts and components
   - Preliminary tests and validation
   - Detailed design validation
   - Performance analysis
   - Training of shop floor-personnel
   - Upfront validation using virtual equipment
   - Shorter breakdown-times
   - Validation of the changes of the plant
Virtual commissioning

Switching HiL $\leftrightarrow$ SiL

TIA Portal

PLCSIM Advanced
WinCC

S7-1500
Simulation Unit

Virtual Commissioning

Automation Process
Simulation

Hardware in the loop

Software in the loop

Process & Mechanical simulation

NX MCD 12

Electrical & automation behavior simulation

SIMIT 9.1
MCD typical setup

**Hardware in the Loop (HiL) & Software in the Loop (SiL)**

**Hardware in the Loop**
- Siemens PLC
- SIMIT Unit
- OPC UA
- Profinet

**Software in the Loop**
- TIA Portal V.14SP1
- PLCSIM Adv. V.1.0 SP1
- OPC UA
- PLCSIM Adv. API
Simulation based Engineering from Virtual Commissioning to Operator Training

**Hardware-in-the-Loop Couplings**
- SIMATIC PCS 7/WinCC / WinCC OA ...
- SIMATIC S7 (300/400/1500)

**Software-in-the-Loop Couplings**
- PRODAVE (MPI/IE)
- PLCSIM
- PLCSIM Adv.
- SIMIT Virtual Controller
- OPC UA Client
- OPC
- SHM
- RCI

**Generic Data Couplings**
- Data exchange
- Synchronization and remote control

**Couplings**
- SIMIT Unit
- SIMIT Unit
- PROFIBUS DP
- PROFINET IO
- SIMIT

1 Shared Memory; 2 Remote Control Interface

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Page 23 01.03.2018

Digital Factory - Process Industries and Drives
## New CHEM BASIC Library Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Component</th>
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<td></td>
<td>ElectricalHeat Exchanger</td>
<td>Electrical Heat Exchanger</td>
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<td>Heat Exchanger Shell and Tube</td>
<td>Heat Exchanger Shall and Tube</td>
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<td></td>
<td>HeatPipe</td>
<td>Heat Pipe</td>
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<td></td>
<td>Indicator</td>
<td>Indicator for Pressure, Drive, Flow, Level, Temperature and Weight</td>
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<td></td>
<td>Storage Tank Liquid</td>
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</tr>
<tr>
<td></td>
<td>Valve</td>
<td>Valves: Angle Safety, Angl</td>
</tr>
<tr>
<td></td>
<td>RuptureDisc</td>
<td>Rupt</td>
</tr>
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</table>
Simulation based Engineering by SIMIT
from Virtual Commissioning to Operator Training

Device models
Siemens field device

- Specific field device models
- 11 models will be available in the first step
- Continuous update via SIOS
- Higher engineering quality by enabling early detection of errors and more comprehensive automation checks
- Faster commissioning including specific field device functions tested early w/o final hardware
Unfortunately, Siemens is not the only participant in the simulation race

Can I also use third-party simulation software?

(MiL) / SiL / (HiL)

PLCSIM Advanced

Co-Simulation Software

Technology-oriented applications

Matlab

Process simulation

Plant simulation

NX MCD

Amesim

SIMIT

Production simulation, esp. Automotive

WinMOD
Digitalization Update
Process Industries
# The life-cycle of a process plant and simulation use cases

## Supply chain – market demand and supply

<table>
<thead>
<tr>
<th>Product life-cycle</th>
<th>Plant life-cycle</th>
<th>Product planning and design</th>
<th>Plant life-cycle – detailed</th>
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<td>The feasible plant</td>
<td>The buildable plant</td>
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<td>The feasible plant</td>
<td>The approvable plant</td>
<td>The plant that can be contrac-ted out to tend.</td>
<td>The functioning plant</td>
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<tr>
<td>The approvable plant</td>
<td>The plant that can be contrac-ted out to tend.</td>
<td>The buildable plant</td>
<td>The plant that is capable of producing</td>
</tr>
<tr>
<td>The buildable plant</td>
<td>The plant that is capable of producing</td>
<td>The functioning plant</td>
<td>The assessed and settled plant</td>
</tr>
</tbody>
</table>

### Simulation use cases

1. **Design simulation**
2. **Simulation supported engineering and virtual commissioning**
3. **Operator training**
4. **Simulation supported plant optimization**

**Source:** (Urbas 2012; Gutermuth 2010); **Note:** NA35: NAMUR Worksheet
Integrated plant engineering and operations with COMOS

Time savings as a result of parallel working by the various disciplines

CAPEX savings

Your value: Integrated and consistent data management across the entire plant lifecycle!
Integrated Engineering and Integrated Operations for process plants

Simulation improves engineering and operational efficiency

COMOS or SIMATIC PCS 7 PA-Accelerator

SIMATIC PCS 7

Real Plant

SIMIT

Your benefits in Engineering and Commissioning

- Seamless transfer of engineering data
- Simulation and testing of the automation functions
- Training of operating personnel
- Efficient and smooth system start-up of the real plant
- Avoidance of errors and costly reworking
- Increased safety
Siemens with comprehensive and seamless Digital Enterprise portfolio for process plants

- COMOS
- COMOS Walkinside
- SIMATIC PCS 7
- XHQ Operations Intelligence
- SIMIT
- MindSphere
Strategic partnership between COMOS and Bentley Systems – Use case overview across the lifecycle …

2D – COMOS

3D – Bentley OpenPlant Modeler

Cable Mgmt.
Stress Analysis
Steel Design
Point Clouds
Context Capture

... more value in Process Industries
- Fast engineering and modernization
- Improved quality
- High transparency
- Seamless maintenance
- More flexibility
- Smart decisions

El&C  Walk-Inside
P&ID  FEED

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Page 32  01.03.2018

Digital Factory - Process Industries and Drives
High Level business process integrated engineering with COMOS and Bentley Systems

Conceptual
- Conceptual Modelling
- Cost Estimation
- Simulation
- Plant Wise

Basic
- Concept. Design
- PFD
- P&I
- Equipment Spec

Detail
- I&C
- Electrical Design
- Design Review
- Panel Design
- Cabling
- 3D Layout/Design
- Mechanical Design
- HVAC
- CSA

Constr. & Comm.
- Procurement
- Construction
- Commissioning
- Hand-Over

Operation
- Operations

COMOS
- COMOS

OpenPlant Tool Suite
- Pipe Class Mgmt.
- Pipe Design
- Piping ISO
- MTO

Plant Wise
- High Level business process
- Integrated engineering with COMOS and Bentley Systems

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Digital Factory - Process Industries and Drives
COMOS Process Engineering Adapter for OpenPlant

Benefits

- Fast and cost-effective Engineering
- Efficient process- and material planning
- Improved data quality and security through consistent data
- Time savings through less manual adjustments
MindTwin - Your Digital Asset Portal

Separation Column

Equipment List (pumps)

<table>
<thead>
<tr>
<th>Select!</th>
<th>Name</th>
<th>Type</th>
<th>Service</th>
<th>Status</th>
<th>Predict!</th>
<th>Power</th>
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</table>

Process Diagram
XHQ references: GSK = Glaxo Smith Kline
Production monitoring in Pharmaceutical batch plant

GSK IIM Digitisation Lab
The idea behind the IIM Digitisation Lab is to show the art of the possible in a working pharmaceutical manufacturing facility to help stakeholders experience the opportunities presented by automation, manufacturing execution systems, analytics, and informatics. The facility aims to demonstrate how state-of-the-art systems and technologies can be used and combined in a manufacturing environment to help the pharmaceutical industry exploit the potential of digitisation, ultimately contributing to GSK’s goal of improving access to medication for patients all over the world.
Digitalization Update
Robotics
Extending the Digital Twin to cover plant and process

Simulate & Program Robotics
Process Simulate

Siemens Industry Software Tecnomatix Plant Simulation
Extending the Digital Twin to cover plant and process

Simulate Material & Logistic Flow

Plant Simulate
Digitalization Update
Additive Manufacturing
Barriers to industrializing additive manufacturing

- Design software
- Simulation Software
- Print Preparation Software
- End-use part
- Finishing / Inspection
- Heat Treatment
- AM Process

**Conventional thinking**

1. 2. 3. 4. 5.

**Disconnected process chain**

**Multiple file conversions**

**Uncontrolled workflow**
Reimagining design, production and service for greater business value

Connecting a digital thread across the complete product lifecycle

- 15% reduction in weight (up to 30%)
- Equal or greater strength
- Less material waste
- On-demand availability

Original design

Final part

Generative design  Topology optimization  Light weighting  Adapt design

Convergent Modeling™

Validate Inc. process simulation

Post processing and inspection  Slicing, hatching printing™  Prepare for printing™

* Powered by Materialise

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Digital Factory - Process Industries and Drives
Seamless digital Additive Manufacturing chain and machine control components

Product manufacturer perspective

1. Product design
   - CAD
   - Component simulation

2. Production planning
   - Process simulation
   - Manufacturing planning

3. Production engineering
   - Manufacturing preparation

4. Machine operation
   - Operation and execution (MOM/MES)
   - Security and quality

5. Machine services
   - Machine control and automation
   - Machine data analytics

Machine builder perspective

1. Machine concept
   - Machine conceptual design & simulation

2. Machine engineering
   - Virtual commissioning

3. Machine commissioning
   - Machine control and automation

4. Production execution
   - Machine data analytics

5. Service
   - Automation engineering
Software defines the applications
Major 3D printing technologies supported in one system

Hybrid additive
Directed energy deposition

Multi-axis
Fused deposition modeling

Powder bed fusion
Laser material fusion

Multi jet fusion
Agent jetting/inkjet technology
Hybrid additive
Directed energy deposition
Generative design

- Set the conditions
- Run the simulation
- Iterate, iterate and iterate again
- Get your optimized design

Discover Better Designs, Faster!
Siemens and Stratasys collaboration

- **Speed**: Faster build time
- **Flexibility**: Better reachability, Print large parts
- **Efficiency**: No support structures
- **Quality**: Better surface

*Robotically Composite 3D Demonstrator*
Digitalization Update
CFD - Fluid Dynamics
Predictive Engineering Analytics

Simulate the product

Simcenter

Multiphysics
Coating & Drying & Screw Press & Expellers
Simulation-driven generative design

Computational fluid dynamics

Design space exploration
MindSphere – The cloud-based, open IoT operating system from Siemens

MindApps & other Apps
- Use apps from Siemens, partners or develop own apps
- Gain asset transparency & analytical insights
- Subscription based pricing model

MindSphere
- Open interface for development of customer specific apps
- Various cloud infrastructures: SAP, AtoS, Microsoft Azure offered as public, private or on-premise (planned)

MindConnect & other Connecting devices
- Open standards for connectivity, e.g., OPC UA
- Plug and play connection of Siemens and 3rd party products
- Secure and encrypted data communication
Apps for Process Industries

- Design & Engineering
- Automation & Operation
- Maintenance & Service
- Supply Chain & Logistics
- Industry (Verticals)

- Smart Water
- Valve Predictive Maintenance
- Control Performance Analytics
- Drive Train Analytics
- Smart Pumping
- SIPAPER Drive Performance Analytics

- Oil Production Monitoring
- Digital Lifecycle Services
- DCS Health
- Anomaly Detection For ESP
- Bentley
- COMOS in the cloud

- SISHIP EcoMAIN
- AX4 mobile
- AX4 Launch (Mobile)
- XHQ Launch (Mobile)
- Control in the Cloud (Workbench)
- Data & Security Gateway
- MindConnect
The three main advantages of digitalization
Software enables the full potential of Hardware

Data integration
Reusability

Validate through Simulation

Transform data into value
Realize innovation in the digital factory with Siemens

Transforming Manufacturing

Creating together
new business opportunities

Synergy

Digital Enterprise Suite

Totally Integrated Automation portfolio

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Page 58 01.03.2018

Digital Factory - Process Industries and Drives
The Digital (R)evolution
Creating together new business opportunities