Lean Digital Factory

Closed Loop Manufacturing Approach

Dr. G. Beitinger | November 2021
What have we reached so far ...?
The innovation power of LDF is honored by winning several industrial awards, supporting to position Siemens as digital thought leader in the market.

The development and scale-up of 4IR solutions is jointly driven according to aligned roadmaps.

<table>
<thead>
<tr>
<th>Number of joint projects</th>
<th>Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 20: 74</td>
<td>FY 20: 1,4'€</td>
</tr>
<tr>
<td>FY 21: 52</td>
<td>FY 21: 3,0'€</td>
</tr>
<tr>
<td>FY 22: 70</td>
<td>FY 22: 2,7'€</td>
</tr>
</tbody>
</table>

Up- & re-skilling program derived from LDF roadmaps, enabling DI employees to face digital change.

Learning channel on “My Learning World”, fostering life-long learning and increasing the digital mindset of Siemens employees.

<table>
<thead>
<tr>
<th># My LeWo views</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 20: 15,448</td>
</tr>
<tr>
<td>FY 21: 43,000</td>
</tr>
<tr>
<td>FY 22: 47,000</td>
</tr>
</tbody>
</table>

LDF is entering new territories …!

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1 PoCs, Pilots, Scale-ups; FY22 is forecast. | 2 Supported by “Future Fond” for 6.000 German DI employees. | 3 Statement during GWE visit with focus on automation of inbound logistics |
LDF proves benefits of own products to customers and collaborates with R&D to take them to the next level

The LDF plants are a driver for the Siemens portfolio

- Based on aligned target states & reference processes, gaps of existing portfolio are identified
- New feature development for DI products supported by PoCs
- Internal solution providers learn from experiences made by LDF network to enhance own solution
- LDF plants are showcasing portfolio to external customers

Examples for collaborative development of new features, interoperability and consistency of existing portfolio

- MindSphere
- Opcenter advanced (e.g. CAMSTAR, Valor PP)
- Modular MES
- Teamcenter manufacturing, Easy Plan
- ARTIMINDS
- Plant Simulate-Teamcenter Integration
- Process Simulate-Teamcenter-NX Integration
- IEC-NX-Line Designer-Toolbox
- Industrial Edge
- SIMOVE
- Solution Link
- …
Excellence in manufacturing
For our customers

Our Mission

"Be the Role Model for Excellence in Production and Logistics to provide proven Value Add for our Customers and Business Units, based on the methods of Digital Enterprise and Lean Industrial Engineering

Shape the Digital Future. Together.”

Dr. Gunter Beitinger, SVP Manufacturing; Head of Factory Digitalization & Product Carbon Footprint

Our Framework

Evaluate new Business models

- Shorten time to market
- Increase flexibility
- Improve quality
- Boost efficiency

Increase security

Sustainability

Our Footprint

[Map showing various locations with labels such as Concord, Breda, Guadalajara, etc.]

Page 5 Restricted | © Siemens 2021 | Dr. Gunter Beitinger | DI FA MF | November 2021
Siemens DI factories strengthen the focus on automation and digitalization hand in hand with lean productivity

“Classical” productivity measures: Lean production; lean administration

LDF guides the way to Digital Transformation
Lean Digital Factory

Digitalization Approach for over 30 plants

**Ideation**
- Organizational setup
- Technology workshops

**Reference processes**
- Reference process design
- Technology radar
- Mapping software platforms

**Digitalization roadmaps**
- Digital Twin
- Processes
- Big Data & Analytics
- Autonomous Manufacturing Systems
- New Ways of Working

**Reference IT architecture**
- IT Roadmap/Functions
- SolutionLink Analysis
- MDP Architecture

**Realization phase**
- **POC**
  - Concept evaluation in best-fit factory
  - Savings potential verification
  - Definition of scalable solution for all factories in the network
  - Start of ~40 PoCs in July 18
- **Pilot**
  - Implementation of dedicated standard concept within a specific environment to leverage first savings
- **Scale-up**
  - Parallel implementation of dedicated concept across all business units and their environments
- **Continuous roadmap update**

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Lean Digital Factory (LDF) set-up

- Project lead guides experts with support and buy-in from core team
- Strong PMO is crucial to coordinate, structure and enable project organization
- Key experts from each business unit are forming one team per workstream
- Workstream structure is mirrored in all plants to accelerate knowledge exchange and collaboration on all levels

“In addition to the financial and processual potentials, cross-BU collaboration within LDF formed a solid network – enabling sharing of ideas and innovation even beyond the project scope”
Meeting cascade established facilitating regular exchange across BUs and LDF levels

<table>
<thead>
<tr>
<th>Touch Points</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
</tr>
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<tbody>
<tr>
<td>Core Team</td>
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<tr>
<td>BU Leads &amp; PMO</td>
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<tr>
<td>BU specific LDF alignments: LDF@FA, LDF@GME, LDF@GMM, LDF@PA</td>
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<tr>
<td>Workstream Digital Twin</td>
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<tr>
<td>Workstream Process</td>
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<tr>
<td>Workstream Big Data &amp; Analytics</td>
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<td></td>
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<tr>
<td>Workstream Autonomous Manufacturing Systems</td>
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<td>Workstream New WoW</td>
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<tr>
<td>PoC &amp; Pilot Teams</td>
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</tbody>
</table>

Meeting cascade

The established cascade facilitates bi-directional communication throughout DI.
The five LDF workstreams serve the generally acknowledged Digital Factory vision

Lean Digital Factory (LDF) workstreams

- Digital Twin
- Big Data & Analytics
- Autonomous Manufacturing Systems
- New Ways of Working

Workstreams serve Digital Factory vision

- Digital Twin
- Big Data & Analytics
- Autonomous Manufacturing Systems
- New Ways of Working
- Processes

Reference architecture
Roadmaps to ensure holistic view on Digitalization per function and support stringent implementation

Idea and approach for Digitalization Roadmap

Idea
Sub-projects develop first draft of Digitalization Roadmap to …
… find new Digitalization measures beyond classical ideas
… understand interdependencies between defined measures
… enable mgmt. to trace progress of Digitalization

Approach
1 Identify relevant Digitalization trends
2 Concretize trend through target state for specific function
3 Define evolution states and detail way to target state
4 Elaborate and prioritize measures to realize target states

Due to high dynamic of Digitalization the Roadmap is a working document

Example/template

<table>
<thead>
<tr>
<th>FY17</th>
<th>FY19</th>
<th>FY21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple automated reporting dashboards with only independent data sources</td>
<td>Complex automated reporting dashboards with multiple interrelated data sources</td>
<td>Fully automated digital bidirectional data exchange with all suppliers</td>
</tr>
<tr>
<td>Example</td>
<td>Template</td>
<td>Example</td>
</tr>
<tr>
<td>Standardized format for data exchange defined</td>
<td>Internal system ready for data exchange via defined format (interfaces)</td>
<td>Data exchange established with main suppliers</td>
</tr>
<tr>
<td>Measure/s</td>
<td>Measure/s</td>
<td>Measure/s</td>
</tr>
<tr>
<td>Evolution state</td>
<td>Evolution state</td>
<td>Evolution state</td>
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<td>3</td>
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</tbody>
</table>

Trend
1 Target state described by a concrete use case
2 Fully automated reports incl. forecasts based on Data Analytics, pattern recognition and smart prediction
3 Complex automated reports complemented with predictions, e.g., extrapolations
4 Fully automated digital bi-directional data exchange with all suppliers

Data Analytics

Data integration in supply chain

Controlling
The workstreams “Digital Twin” and “Processes” are supported by defined enabler workstreams.

Lean Digital Factory (LDF) workstreams:

**Digital Twin**
Fast and reliable production introduction with simulation based on the digital twins of product and production.

**Processes**
Synchronized planning of all production resources and activities in the supply chain for short lead times and maximum utilization.

**Big Data & Analytics**
Availability of all relevant information about the supply chain in the cloud and creation of new insights with analytics and AI.

**Autonomous Manufacturing Systems**
Increased productivity through automation in production and logistics.

**New Ways of Working**
Create a digital mindset to foster new ways of efficient collaboration in a digital factory & enhance automation & digitalization understanding.
Automated production engineering increases speed and efficiency via holistic digital twins

Lean Digital Factory (LDF) workstreams
Automated production engineering increases speed and efficiency via holistic digital twins

Digital – Digital Twin

Comprehensive automated production engineering & optimization based on consistent usage of holistic digital twin to increase engineering efficiency and speed-up time-to-market

- Production engineering is automated, enabled by full-featured Digital Twins of Product, Production & Performance. These digital twins are aligned to the eCl@ss cross-industry standard and contain all levels of detail to automatize the process from product design to production on the shopfloor. The high degree of automation in the engineering process based on AI and supported by a knowledge database raises the efficiency and speeds up time-to-market to lay the foundation for shorter innovation cycles. This is supported by the automated programming of machines (in Mentor Valor PP or NX CAM). All tasks are coordinated by an overarching Mendix workflow system guiding through the whole process and ensuring fast execution. Seamless interoperability between all involved systems eliminates manual efforts for data preparation and raises output efficiency & quality of production engineering by providing comprehensive data.

- Integrated simulation of the production process in the virtual factory increases the reliability of production engineering. This ensures that the engineered production system will deliver the targeted performance with zero defects in the first place. Therefore all tasks from work cell design to optimization in the context of the whole factory infrastructure including logistic, workforce and maintenance are digitally assisted with Process Simulate, Line Designer and Plant Simulation. Automatic human work design calculation is carried out (TiCon4Teamcenter), while generating new work plans for process optimization.

- The digital twin of performance closes the loop to the real-world production by providing real-time data from the Manufacturing Data Ecosystem to initiate optimizations according to actual boundary conditions with AI.

Impact on category

EPEI: Every part every interval

Speed
- Time-to-market
- Data consistency

Flexibility
- Easy product relocation
- Product configuration

Quality
- Integrated FMEA
- Integrated Control Plan
- DfM

Efficiency
- Output efficiency of production
- Engineering effort

Scalability

Sustainability

Applied SAG Portfolio
- Teamcenter
- Mendix
- MindSphere
- NX Line Designer

Check-Mate
- Process Simulate
- Plant Simulation
- Mentor Valor PP
- NX CAM
The reference process shows a concept for automation and acceleration of production system planning by digitalization

Reference process production system planning – Target planning to rough planning (Section 1/3)
The reference process shows a concept for automation and acceleration of production system planning by digitalization

Reference process production system planning – Target planning to rough planning (Section 2/3)

Detailed Planning

Value stream simulation (detailed)
- Relations
- Material flow
- Com. Process evaluation
- Production control
- Information flow
- Material provision
- Process times
- Bottleneck work station
- Ramp-up simulation
- Detailed planning manufacturing structure

Rough layout
- Alternative designs of work stations
- Transfer ideal to real layout
- Target-layout
- Use of digital twins of equipment

Work station design
- Model and simulate human-machine-interaction
- Evaluation of ergonomics
- Time valuation
- Evaluation of safety

Logistics concept
- Milk run
- AGV
- Dimensioning of bin sizes
- Dimensioning of supermarkets

Information & automation concept
- Traceability
- Webservice communication
- Automated process sequence control
- IT measures for poka yoke and interlocking
- Concept for automation
- Interdependencies with other processes and equipment

Infrastructure concept
- Media supply
- Planning of IT-landscape

Detailed Layout
- Aggregation of rough layout with inputs from detailed planning (continuously)

Approval for implementation
- Technical
- Commerical
- Logistical
- Schedule
- If required (earlier) release of parts

Detailed planning finished?

Review detailed planning
- View

Scheduling (Backward)
- Scheduling and planning of critical path with milestones (continuously)

Project mgmt.

Data backbone

Justification manual process
Partly automated process
Manual process
Reference to Content Cluster Roadmap
The reference process shows a concept for automation and acceleration of production system planning by digitalization

Reference process production system planning – Target planning to rough planning (Section 3/3)

Implementation planning

- Resource planning
- Material planning
- Update schedule
- Relocation planning
- Feasibility and productivity study
- Simulation (continuous) of specific workstations and post-processing for program generation
- Query
  - Transfer of drawings and simulation data in addition to specification sheets
- Clarification with supplier
  - Construction review
  - Comparison with specifications and standards
  - Technical
  - Commercial
  - Logistical
  - Schedule
  - Review of completed specification
  - Simulation as input for machine program
- Evaluation and decision
  - Decision matrix
  - Alignment with QM, EHS...
  - Transfer of parameter provided by supplier in digital system (CAD, PMI, ...)
  - Update simulation of detailed planning
- Order
  - Automated provision of input data for order (as process output)
  - Target: Transfer of order from purchaser to supplier within 1 working day (overall release instead of partial releases)
- Execution planning
  - Automated tracking of budget (progress and partial payments)
  - Technical approval initiates commercial subsequent processes automatically
  - Specific simulation
    - Digital twin of equipment is integrated in digital model of the factory
- Pre-acceptance
  - Supplier staff handles machine
  - Virtual commissioning
  - Release for delivery (analysis)
- Final acceptance
  - Factory staff handles machine
  - Risk/safety assessments are available
  - Factory staff handles machine
  - Equipment handover to production
    - Machine readable available
    - Acceptance
    - Spare part overview
    - Maintenance schedule
    - Complete digital twin is available and integrated

Query

- Transfer of drawings and simulation data in addition to specification sheets

Clarification with supplier

- Construction review
- Comparison with specifications and standards
- Technical
- Commercial
- Logistical
- Schedule
- Review of completed specification
- Simulation as input for machine program

Evaluation and decision

- Decision matrix
- Alignment with QM, EHS...
- Transfer of parameter provided by supplier in digital system (CAD, PMI, ...)
- Update simulation of detailed planning

Order

- Automated provision of input data for order (as process output)
- Target: Transfer of order from purchaser to supplier within 1 working day (overall release instead of partial releases)

Execution planning

- Automated tracking of budget (progress and partial payments)
- Technical approval initiates commercial subsequent processes automatically

Specific simulation

- Digital twin of equipment is integrated in digital model of the factory

Pre-acceptance

- Supplier staff handles machine
- Virtual commissioning
- Release for delivery (analysis)

Final acceptance

- Factory staff handles machine
- Risk/safety assessments are available
- Factory staff handles machine
- Equipment handover to production
- Machine readable available
- Acceptance
- Spare part overview
- Maintenance schedule
- Complete digital twin is available and integrated

Training and incorporation

- Risk/safety assessments are available
- Factory staff handles machine
- Equipment handover to production
- Machine readable available
- Acceptance
- Spare part overview
- Maintenance schedule
- Complete digital twin is available and integrated

Project mgmt.

- Justification manual process
- Partly automated process
- Manual process
- Reference to Content Cluster Roadmap

Data backbone

- 7
- 11
A common resource library for DI factories is being established as a basis for plant and process simulations

**Trend: “Digital Twin”**

Setup a common library with standardized formats
- Simplification & standardization of CAD data from machine suppliers
- Derivation of reference models and assignment of attributes

Common basis for plant and process simulations

Feedback to Siemens Technical Machines Specification

<table>
<thead>
<tr>
<th>Native Data (NX-Import)</th>
<th>Case specific reference models (e.g. Resource “Siplace XYZ”)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Modell</strong> 3D-planning and kinematics simulation</td>
</tr>
<tr>
<td></td>
<td><strong>Simple</strong> High-performance 3D-Planing of large areas</td>
</tr>
<tr>
<td></td>
<td><strong>2D-Layout</strong> Layout planning of whole plants</td>
</tr>
<tr>
<td></td>
<td><strong>Build area:</strong> Simplified evaluation of space requirements</td>
</tr>
</tbody>
</table>

- Inconsistent between suppliers
- Poor performance due to e.g., duplicated objects
- No defined orientation

- Classifications, e.g., SMT machine
- Connections: Electrical, compressed air, etc.
- Invest: Vendor, normal/special costs
- Plant Sim attributes: Class, MTTR, availability
LDF Processes (E2E) - Autonomous coordination of supply chain resources based on artificial intelligence and real time transparency to maximize speed and efficiency

Lean Digital Factory (LDF) workstreams

Reference architecture

Digital Twin
Big Data & Analytics
Autonomous Manufacturing Systems
New Ways of Working

Target state

| Workstream | Digital twin | Complete supply chain is digitally connected with real-time data to provide valued solutions and optimization options. All resources are efficiently predistributed and utilized for a highly efficient supply chain. Decentralized and autonomous self-optimization of supply chain resources. Workstream autonomous manufacturing systems. |
|---|---|---|---|---|
| Trends | Digital twin | Complete supply chain is digitally connected with real-time data to provide valued solutions and optimization options. All resources are efficiently predistributed and utilized for a highly efficient supply chain. Decentralized and autonomous self-optimization of supply chain resources. Workstream autonomous manufacturing systems. |
| FY27 | Digital twin | Complete supply chain is digitally connected with real-time data to provide valued solutions and optimization options. All resources are efficiently predistributed and utilized for a highly efficient supply chain. Decentralized and autonomous self-optimization of supply chain resources. Workstream autonomous manufacturing systems. |
| FY28 | Digital twin | Complete supply chain is digitally connected with real-time data to provide valued solutions and optimization options. All resources are efficiently predistributed and utilized for a highly efficient supply chain. Decentralized and autonomous self-optimization of supply chain resources. Workstream autonomous manufacturing systems. |
| FY29 | Digital twin | Complete supply chain is digitally connected with real-time data to provide valued solutions and optimization options. All resources are efficiently predistributed and utilized for a highly efficient supply chain. Decentralized and autonomous self-optimization of supply chain resources. Workstream autonomous manufacturing systems. |
| FY30 | Digital twin | Complete supply chain is digitally connected with real-time data to provide valued solutions and optimization options. All resources are efficiently predistributed and utilized for a highly efficient supply chain. Decentralized and autonomous self-optimization of supply chain resources. Workstream autonomous manufacturing systems. |

Qualification and LEAN culture based on SPS @ PL
Cyber-physical systems for an autonomous coordination of the processes in the supply chain to improve efficiency and speed

Digital – Processes

Autonomous E2E-coordination of supply chain resources based on artificial intelligence and real time transparency to maximize speed and efficiency

• All resources (material, machines, workers, tools and fixtures) along the end-to-end supply chain are simultaneously considered in both capacity utilization and prediction (short & long-term) to maximize production efficiency of machinery and workers, using Opcenter APS
• Products and production have the ability to directly communicate with each other for decentralized, autonomous self-optimization of production execution under consideration of actual boundary conditions to reduce manual effort for production planning and control on shopfloor level. Therefore an agent-based architecture of cyber-physical production systems is the blueprint to raise the flexibility of our Manufacturing Execution Systems to the next level with adaptable microservices
• Real-time data from the supply chain are monitored continuously to detect deviations at the earliest point in time to increase the options for action. Therefore external data from the Supply Chain Suite & AX4 are considered simultaneously with internal material and resource position information from the Real-Time Location System (SIMATIC RTLS) with the accuracy of just centimeters. Based on this transparency the system automatically provides valued solutions in case of deviations with a self-learning system to increase the efficiency in deviation management

Impact on category

Speed
  • Lead time

Flexibility
  • Setup time  
  • Lot size

Quality
  • OTD

Efficiency
  • Productivity in planning and operations  
  • Utilization of resources  
  • Stock & WIP reduction

Scalability

Sustainability

Applied SAG Portfolio
  • Opcenter APS  
  • Opcenter family  
  • MindSphere  
  • SIMATIC RTLS  
  • Supply Chain Suite  
  • AX4
Cyber-physical systems for an autonomous coordination of the processes in the supply chain to improve efficiency and speed

Reference process Inbound- and Intralogistics

SCM Operations

1. New demand, change of demand
2. Check available stock
3. Check for receipt amount & date required
4. Contact manufacturer and supplier
5. Material release or stock reservation
6. Material availability

Production Operations

1. Material availability
2. Creation of plan
3. Order recognition
4. Material, buffer, quality
5. Resource reservation
6. Synchronization

Material Handling Operations

1. Data exchange of relevant process data (quality, trace, inline test-results); finish: (functional) final test data
2. Self-learning escalation management (external/Siemens internal)
3. Alternative suggestions not practicable/costumer deadline shift
4. Workforce reservation
5. Sufficient capacity and correct qualification
6. Material delivery and discharging

Goal MTS/BTO: fully automated
ETO: partly automated (cost/value) sorts of packaging material

Synchronizing point for resource reservation
Justification manual process
Partly automated process
Manual process
Reference to LDF Processes – Content Cluster
Digital value stream analysis (DVSA)
A real Lean Digital tool for factories
Manufacturing Data Ecosystem increasing quality, efficiency and scalability

Lean Digital Factory (LDF) workstreams

Reference architecture

- Digital Twin
- Big Data & Analytics
- Autonomous Manufacturing Systems
- New Ways of Working

Target state

<table>
<thead>
<tr>
<th>Cloud and Edge computing</th>
<th>Tracking and tracing</th>
<th>Analytics &amp; Artificial Intelligence (AI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citizen development</td>
<td>Overall supply chain traceability established</td>
<td>CI/CD pipeline established</td>
</tr>
<tr>
<td>Framework established</td>
<td>Processing in the edge/cloud</td>
<td>Pattern recognition and proposal available</td>
</tr>
<tr>
<td>ERP, PCM MOM platforms connected to cloud via integration layer</td>
<td>Data strategy finalized</td>
<td>Pattern visualization available</td>
</tr>
<tr>
<td>Production assets/equipment fully connected to edge/cloud</td>
<td>Traceability of supplier processes integrated</td>
<td>Prescriptive processes established</td>
</tr>
<tr>
<td>Traceability of factory processes integrated</td>
<td></td>
<td>Descriptive processes established</td>
</tr>
</tbody>
</table>

Trends

- FY17
- FY19
- FY21
- FY2X1

Evolution state Mainly enabler trend Content cluster
Manufacturing Data Ecosystem increasing quality, efficiency and scalability

Digital – Big Data & Analytics

A comprehensive Manufacturing Data Ecosystem, using artificial intelligence to increase quality and efficiency in production while laying the foundation for scalability

- As a complete Manufacturing Data Ecosystem (MDE) is in place we can get additional insights into machines behavior and processes and therefore can turn data into value. The MDE consists out of an “Industrial Edge” platform, a state-of-the-art manufacturing data platform concept by MindSphere (MDP) and data source connectivity to feed data into a raw data store and an open analytic platform

- The ecosystem enables data citizens and analysts to dashboard information or to get deep process insights to improve, predict or stabilize manufacturing processes, in an efficient way without manual data preparation. For this data and algorithms can be stored, provided, transformed and AI models are trained on cloud and/or edge environment, enabling closed loop manufacturing, machine learning and comprehensive cross-factory reporting and decision-making without compromising IT security

- A total and comprehensive traceability and tracking concept is enabled for quality, warranty, engineering and sustainability requirements, also due to the embedded data persistence in the Manufacturing Data Platform. All relevant information correlated in all dimensions is available to allow holistic tracing along the whole product lifecycle

- Via applications running on edge and cloud environment, value creation is done by prescriptive decisions and self-learning systems enabled by artificial intelligence (AI). Advanced analytics, machine learning and deep learning optimize product and production system efficiency and quality. Solutions can be scaled within the ecosystem to other factories

Speed
• Lead time

Flexibility
• Setup time
• Lot size

Quality
• Process Quality
• NCC

Efficiency
• Productivity
• Utilization of production

Scalability

Sustainability

Applied SAG Portfolio
• MindSphere
• MindSphere Connect
• Nanobox/IoT 2040
• Industrial Edge

• SIMATIC
• SINUMERIK
• Mendix
• Scalance

Impact on category
Aggressive milling dust causes drive bearing to get stuck.
AI predicts spindle maintenance for PCB cutting machine up to 2 days in advance. Reducing preliminary spindle failures of this type by 100%. Total calculated savings for 18 machines is 120 Tsd. p.a.
Scalable production systems raising flexibility and efficiency

Lean Digital Factory (LDF) workstreams

Reference architecture

Digital Twin
Big Data & Analytics
Autonomous Manufacturing Systems
New Ways of Working

Target state

Trends
FY25
FY23
FY22
FY17

Production equipment is modular, highly automated and without engineering efforts able to manufacture products with short lead times, cost-effective and in small lot sizes in a resource-friendly manner. Self-learning capabilities enable the increase of own efficiency, robustness and closed-loop engineering.

Advanced Material supply
Seamless integration AMR standard control architecture
AMR are connected to MES-Systems
AMR solutions widely distributed & copyleft

自主物製造
完全自動化
インフラと倉庫
マネージドフリート

安全自動化生産
移動可能なフレキシブルロボット
標準的なロボットプログラム

AI elements @ shopfloor
Robot program will be generated automatically
Decentral decision on shop floor level by AI
Reduce test efforts by AI

Smart Automation for fast scale-up
Flexible modularization
Flexible machinery equipment (e.g. gripper & easy to use)
Smart and flexible picking & feeding
Cost-effective Vision 2D/3D
Scalable production systems raising flexibility and efficiency

Digital – Autonomous Manufacturing Systems

Cooperation of digitally guided workers and interlinked autonomous production systems, enabling efficient, flexible and easy to scale-up manufacturing

- Also for low volume products and formally typical manual work the automation level is increased by modular autonomous production systems (e.g. robots). They are consisting of re-useable elements, are easy to scale-up and manufacture products with high efficiency, quality and speed. Respective machine programs are automatically generated (ARTIMINDS, Process Simulate), enabling a high flexibility and reducing manual programming efforts.
- Higher operator efficiency and flexibility are facilitated by augmented reality applications, which provide workers with customized product and process information, depending on their needs and competence profiles. At the same time process quality is raised.
- Managed fleets (SIMOVE) of material transport systems work seamlessly together, feeding materials directly into the production process to avoid manual material handling and raise OEE.
- Based on the Digital Twins of Product and Production (provided by Teamcenter), manufacturing resources and product components are 3D printed, decreasing time-to-market and increasing production flexibility.
- By permanent communication between production system agents, a flexible and efficient material & production flow is autonomously organized.
Challenge
Box handling with lightweight robot and autonomous guided vehicle

• Pendulum boxes (coming back from the customer) to be fed back into logistic system
• Process is manual and very irregular, making the planning for workers difficult
• Implementation of a low-cost automation, using an autonomous guided vehicle for pallet handling and a lightweight robot for box handling
Bin Picking: Handling of chaotically supplied parts serves as enabler for further unit assembly automation

Trend: “Robotics”

Before
Monotonous, time- and cost-intensive manual sorting of chaotically supplied parts for automatic handling by the robot

Now
Decentral integration of cost-efficient bin picking systems directly into the assembly station

The solution developed in the GWE is currently being transferred to the EWA (turntable HMI)
Connected workers applying new working methods in agile organizations to raise flexibility, efficiency and sustainability

Lean Digital Factory (LDF) workstreams

Reference architecture

- Digital Twin
- Big Data & Analytics
- Autonomous Manufacturing Systems
- New Ways of Working

Target state
- Co-working and agile collaboration supported by the required working infrastructure is leading to flexibility and efficiency.
- Awareness, systematrical data capturing and methodologies for carbon neutral factories.
- The digital factory is building on employees with a digital mindset and the right competencies, acquired by live-long learning.

Trends
- Flexible & agile collaboration
- Ambition for carbon neutrality
- Growth mindset

FY25
- Active cross functional collaboration
- Predictive energy management
- Skill transparency for all people and processes

FY23
- Common Toolbox with Agile methods and mindset
- Product-specific CO2 value stream to eliminate non value adding emission
- Process for continues competence development implemented

FY20
- Siemens Office at the plants
- Ensure data availability to capture specific carbon emissions
- Competences of the future defined and job profiles adjusted

FY17
- #NewWork
- #NextWork

1. Awareness for #futureofwork & sustainability

Evolution state
- Mainly enabler trend
- Content cluster
Connected workers applying new working methods in agile organizations to raise flexibility, efficiency and sustainability

Digital – New Ways of Working

Live-long learning employees with digital mindset apply new ways of working, increasing the flexibility and efficiency of digital and sustainable factories of the future

- The digital factory is building on employees with a digital mindset and the right competencies, acquired by live-long learning. Co-working and agile collaboration supported by the required working infrastructure (from office concept till payment system) is leading to flexibility and efficiency
- The cross-functional collaboration in a digital factory is based on trust, reliability and openly shared information in communities and networks. In addition they are facilitated by digital office and shopfloor management. Employees are encouraged to experiment by using agile methods to learn fast and increase speed
- Employees have a growth mindset for dynamic self-organized learning, to secure own employability. Transparent, future oriented competence overviews give orientation for live-long learning. Skill transparency is a conception of oneself, beneficial for all people, organizations and processes
- Having the courage to experiment and growing on the results, employees drive digitalization and eliminate waste in processes and energy consumption in own environment, using e.g. low-coding tools especially for process automation
#Next Work pilot@EWN conducted and rollout within DI MC already started
Holistic approach to strategic personnel planning & competence development

#NextWork

**Input Business Strategy**
- Vision/Mission
- Core/Non-Core
- Markets
- Business Model
- Footprint
- Portfolio
- …

**Output**
- Summary & opportunity-risk-matrix
  - Which job clusters require immediate need for action?
  - Transparency on gap of competences & supply/demand for current & target state
  - Opportunity-risk-matrix to identify risk clusters that require measures
- Development paths incl. concrete measures
  - What concrete measures are necessary?
  - Development paths incl. concrete measures to allow content-based strategic personnel planning

**Which job clusters require immediate need for action?**

**Strategic personnel planning**
- Proactive, forward-thinking planning of measures to address future job demand
- Based on business strategy

**Which measures are required per job profile?**

**NewWork – Accompanying measures DI MC**
Development of agile organizational forms and establishment of new ways of collaboration

- Trainings
- Qualifications
- Apprenticeships
- Recruiting (external/internal)
- Footprint measures (Outsourcing, near/offshoring, restructuring)
Holistic up- & re-skilling development journey
From skilled shopfloor employee to complex machine maintainer

Skilled Shopfloor Employee
- Machinery handling and controlling
- Tool setup
- Process parameter monitoring
- Product assembly
- Following defined order instructions

Complex Machine Maintainer
- Mechanical & electrical maintenance and servicing tasks
- Resolving of malfunctions
- Organization of machinery transitions
- Design & setup of workplaces

Future Competences
- Domain expertise:
  - Manufacturing technology
  - Automation & robotic
  - Hydraulic & pneumatic systems, drives
  - Manufacturer-specific machine know-how
  - Digital & programming basics
  - Analytics & problem-solving

Technological Trends
- Automation & robotic
- Substitution of physical and routine tasks
- Digitalization, Big Data and Analytics
- Predictive maintenance
- New ways of working

Development Path
- TIA: SERV1/2, S7 (lateral entry)
- KUKA: Robotic Operations PRO, Service & Electric, Malfunction & Maintenance
- Profibus Engineering
- NC controls & dives
- Pnoz-Multi programming & service
- MindSphere Basis
- Basis in Cyber Security

Source: Project #NexWork @ DI MC
Lean production and 4IR are established in the daily operation of our factories

What is the next challenge?
Carbon footprint?
Requirements on accountability for PCF are increasing but more than 90% are in the supply chain and not transparent

Reliable, comparable and verifiable information plays an important part in enabling buyers to make more sustainable decisions. Companies making “green claims” should substantiate these against a standard methodology to assess their impact on the environment.

1 Carbon Disclosure Project, Feb 2021

The European Green Deal
European Commission, Brussels, 2019
As a gateway to the independent ESTAINIUM Network, Siemens Provides SiGREEN web and SiGREEN connect

- Requesting, calculating and sharing trustworthy PCF data
- Uploading of BOM
- Convenient onboarding of suppliers via web frontend for standardized data input

SiGREEN web features plus:
- On-premise or private cloud with IT and OT integration, e.g., factory energy metering and ERP systems
- Automated footprint sharing and calculation

Leveraging Siemens’ industry expertise

1) Other companies are invited to develop their own gateways to the ESTAINIUM Network

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The ESTAINIUM Association

Education of stakeholders on use cases of inter- and intra-company execution of sustainability

Involvement in the development of international standards on sustainability

Alignment on common principles to allow for interoperability

Alliance of sustainability thought leaders across industries, NGOs and certifiers

Governs the ecosystem as an independent cross-company body

Initial tech-stack donated as open source by Siemens to kick-start activities

Alignment on common principles to allow for interoperability
Dr. Gunter Beitinger
SVP Manufacturing,
Head of Factory Digitalization &
Product Carbon Footprint