- Theory and Practice -

Ukraine, Dnipro city
NMETAU
01-02 October 2020
Industry 4.0: History

Industry 4.0 – The 4\textsuperscript{th} industrial (r)evolution

1. **Mechanization**  
   Mechanical production

2. **Industrialization**  
   Mass production based on division of labour

3. **Automation**  
   Electric automation

4. **Cyber-physical systems**  
   Integrated automation

<table>
<thead>
<tr>
<th></th>
<th>Water / steam power</th>
<th>Electrical energy</th>
<th>Electronics / IT</th>
<th>Cyber physical systems</th>
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<tbody>
<tr>
<td><strong>Industry 1.0</strong></td>
<td>End of the 18th century</td>
<td>Industry 2.0</td>
<td>Industry 3.0</td>
<td>Industry 4.0</td>
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<tr>
<td><strong>Industry 2.0</strong></td>
<td>Beginning of the 20th century</td>
<td></td>
<td>Early 1970s</td>
<td>Today</td>
</tr>
</tbody>
</table>
Industry 4.0: Design Principles

Realizing lot size one to the cost of mass production

From traditional to networked production
Industry 4.0: Core Elements

Cyber Physical Systems (CPS)
Radio-Frequency Identification (RFID)
Near Field Communication (NFC)
Smart Machine
Man-Machine Interaction
MRK - Man-Robot Collaboration
Assisted Operator
Mobile Robotics
Condition Monitoring
Energy Efficiency
Renewable Energy Integration
Smart/Mobile Maintenance

Digital Twin
Digital Shadow
Reconfigurable Factory
Plug & Produce
Shop Floor Management 4.0
Lean Assembly
Batch Size 1
Horizontal & Vertical Integration

Smart Devices
Open-Protocol-Communication Unified Architecture (OPC-UA)
IoT – Internet of Things (IIoT – Industrial Internet of Things)
Cloud
Big Data
Real-Time communication
Data Security
Manufacturing Execution System (MES)
Enterprise-Resource-Planning (ERP)

Augmented Reality
Virtual Reality
QR Code

Intelligent Logistics
Supplier Relationship

Customer Relationship

WWW

Smart Factory
Industry 4.0: Core Elements

Smart devices – Cyber Physical Systems CPS - Integration of local “intelligence” and communication capacities

The Internet of things
- + IP capacity

Cyber-physical systems
- + Internet communication
- + machine-to-machine communication
  - Wireless communication
  - Semantic description

Integrated systems
- + sensors, actuators
- + integrated intelligence

Physical objects, devices

Goal: Integration of Autonomous Subsystems & Components
Industry 4.0: Core Elements

**RFID**

- Radio frequency identification
- Uses radio transmission to read data from labels or write data to labels without contact

**NFC**

- Near Field Communication
- Communication between two elements located close to each other
- NFC = RFID in 1cm distance
Industry 4.0: Core Elements

Man-Robot Collaboration

Mobile robotics

Autonomous transport robots for logistics tasks in the smart factory
Industry 4.0: Core Elements

Energy Efficiency

Energy monitoring

Enables electrical output and flow rates to be recorded – for resource-efficient production
Industry 4.0: Core Elements

1. **Bottle-neck optimized work flow**
   (a chain is only as strong as its weakest part)
   - reduce machine performance according to bottle neck situation
   - Avoid buffer stocks, one-piece-flow
   - Reduce waste of energy

2. **Energy Peak management**
   - Avoid energy peaks
   - start critical machines at different times
   - reduces energy bill

3. **Utilise available energy sources better**
   - pre-heat galvanic baths are by “waste” energy of other machines/compressors
   - optimize these sequences in general, and daily depending on work-load
Industry 4.0: Core Elements

Predictive maintenance becomes possible by exchanging and analysing data

Benefits:
• Energy consumption reduction and management
• Networking with defined interfaces and standards

Pneumatic system
• Pressure measurement
• Air consumption

Hydraulic system
• Thermal characteristics
• Filter monitoring

Linear axis
• Vibration measurement
• Temperature measurement
Industry 4.0: Core Elements

Smart Maintenance – Example condition monitoring

Drilling module Self diagnostics

Condition Monitoring

Maintenance
Industry 4.0: Core Elements

Smart Machine
Assisted Operator
Condition Monitoring
Renewable Energy Integration
Virtual Reality
Digital Twin
Digital Shadow
Reconfigurable Factory
Plug & Produce

Shop Floor Management I4.0
Lean Assembly
Batch Size 1
Horizontal & Vertical Integration

Virtual reality
Virtual Reality places the user in another location entirely. It entirely occludes the user's natural surrounding.

Augmented reality
In Augmented Reality the visible natural world is overlaid with a layer of digital content, as an assistance system for maintenance.

QR Code
Link
Industry 4.0: Core Elements

Digitalization touches all areas of life
Industry 4.0: Core Elements

**Smart Devices**

**IT security**
In the world of Internet of things the IT-security is a very important topic.
IPsec

**Cloud Technology**
It's a model for enabling access to shared pools of configurable resources (such as computer networks, servers, storage, applications and services)

**Big Data**
It's term for big and complex data sets which includes capturing data, data storage, data analysis, search, sharing, transfer, visualization, querying, updating and information privacy.
Industry 4.0: Core Elements

Industrial Internet of Things (IIoT)

The explosion of the number of smart devices that are interconnected via the Internet. The IIoT is revolutionizing the way industry operates by sharing the information/data produced to improve existing business models and enable new ones.

Real-Time communication

**OPC-UA**: Interface standard for making data available amongst various systems
Industry 4.0: Core Elements

Smart Manufacturing – Example magazine status

Parts Magazine Monitoring

Magazine status

Supplier

Intelligent Logistics
Supplier Relationship
Industry 4.0: Core Elements

Manufacturing Execution System (MES)
Enterprise-Resource-Planning (ERP)
Industry 4.0: Networking

With OPC UA Information Models

Who are you?

My name is R2-D2

I can navigate, lift, drill and cut

What can you do for me?

Can you lift me up to the second floor?

What is your weight?

200 kg

OK, let’s start

Co-funded by the Erasmus+ Programme of the European Union

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OPC Day Europe 2014
Industry 4.0: Networking

- OLE (Object Linking and Embedding) Microsoft XLS ➔ PPT

- OPC (founded 1996)
  OLE for Process Control
  2001 Open Platform Communications
  2008: ~500 companies

- OPC-UA
  (IEC 62541 since 2010-2012)
  Industry 4.0 recommended standard April 2015 by „Platform Industrie 4.0“
  OPC-UA is an information model, not a fieldbus.
  It will be „tunneled“ through: Ethernet, Profinet, EtherCAT, CANopen, ...

Vendor Specific Extensions
- Collaboration Models
  - DA
  - AC
  - HA
  - Prg

Base Services
- Transport
- Meta Model

Schichtenmodell von OPC-UA

OPC UA Transport-Profile

- UA Binary
- UA Secure Conversation
- UA TCP
- UA XML
- WS Secure Conversation
- SOAP
- HTTPS
- HTTP
- TCP/IP
- 4840
- 443
- 80
Industry 4.0: Networking

Technology stack .. UA = **Unified architecture**

- Modern, **layered architecture**
- Only open **ISO/ IEC standards**
- User to define own **information models**
- "Companion standards" using
  - OPC-UA as language (ISA95, PLCopen)
- Specific **information models** for "kinds of data"
- Generic set of base services (SoA)
- Different transport channels
- One Data model for all kinds of data

SOAP – Service Oriented Architecture Protocol
Informations models for OPC UA

**OPC Data Access (DA)**
- Exchange of data, with some predefined structures and meanings

**OPC Alarms & Conditions (AC)**
- Event type information, as very important asynchronous data
  "what happened to the machine?"

**OPC Historical Data Access (HA)**
- Let data in user-defined time series be stored on the server and access it via a query interface
Industry 4.0: Data Security

**VPN packet**

**Secure connections between sections of a plant and operator workstations**

**Description**
- Secure communication between separated sections of a plant and/or operator network
- Interconnection to surrounding network infrastructure via firewalls
- Establishment of virtual private networks (VPN) using cryptographic standards (IPsec)
- Application of industrial devices (Siemens Scalance S615)

**This option includes**
- Additional security module S615 for each section of the plant/interconnected subnet
- Coordination of network interconnection
- Documented network and firewall concept
- Configuration of security devices
- Integration in plant
Industry 4.0: Data Security

VLAN extension

Structured networks in all sections of the plant

Description

- Network segmentation of the plant aligned with functionally independent parts
- Separation applying virtual local network segments (virtual local area networks, VLANs) according to IEEE-Standard 802.1q
- Communication relations between components of plant secured by firewalls

This option includes

- Upgrade of plant’s switches to managed Siemens Scalance XB208 switches
- Coordination of plant internal network structure
- Extension and documentation of network concept
- Configuration of switches and S615 routers with VLAN specific rules according to network concept
Industry 4.0: Data Security

Remote access extension  **Prerequisite: VPN packet**

Remote access for maintenance via Siemens Sinema RC server

**Description**
- Central server for setup of secure communication channels
- Interconnection of subnets
- Remote access from maintenance workstations via encrypted communication channels (OpenVPN)
- Central access control on the server

**This option includes**
- Sinema RC server appliance
- Extension/adaptation of the VPN network concept with a concept for remote access via Sinema RC server
- Dell-PC (with appliance installed)
- Two client licenses, additional licenses optional
- Configuration of Sinema RC server according to network concept
Industry 4.0: Data Security

Data security (encryption, authentication)

- X.509 certificates (asymmetric keys)
- Windows cert store

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**Authentication**
To whom am I connected? ✓

**Authorization**
What am I allowed for? ✓

**Confidentiality**
Can anybody read my data? ✓

**Integrity**
Is data consistently transferred? ✓

**Auditability**
Can the chain of trust be certified? ✓

**Availability**
Denial-of-service attacks? ✓
Industry 4.0: Data Security

Übertragung von Anlagendaten in die Cloud

Mechanismus
- Sammlung von Anlagendaten durch OPC-Client
- Weiterleitung der Daten in die Cloud
- Auswertung über Power BI

Informationsfluss
- Energiemessdaten
- Luftverbrauch
- Druck

Genutzte Technologien
- OPC UA
- AMQP/TLS
- Microsoft Azure

Analyze
Die Business Intelligence (BI) App stellt Werkzeuge zur Sammlung, Auswertung und Darstellung bereit.
Industry 4.0: Data Security

Erkennbares Muster
- Alternierender Energieverbrauch
- Aktive Phasen bei Werkstückbearbeitung
- Passive Phasen während Zuführung/Weiterleitung

Ableitbare Informationen
- Verarbeitete Stückzahl im Beobachtungszeitraum
- Schichtdauer
- Auslastung
- Stabilität des Fertigungsprozesses (über Ausfallzeiten)
Industry 4.0: Data Security

HMI 2017

![Diagram showing data flow and security measures in Industry 4.0 context]
Industry 4.0: Software
Industry 4.0: Software

New production and system control with MES 4 as flexible MES software
Industry 4.0: Software

MES4 - Features

- Order and material management over database (ACCESS over ODBC)
- Easy communication between PLC and MES over TCP/IP (PLC-Library) (roundtrip < 30ms) more functions addable
- No „main PLC“! Each PLC communicates directly with the MES (easy to understand) no redundant data management
- Each station can get each information at every time from the MES
- Create and manage buffers in MES (buffer zones are possible)
- Box -management and -configuration in MES (Templates for boxes)
- Traceability of each order position
- Easy OEE- end efficiency -report
- Easy customer management
- Overview of each station
- Calculate transport routes to a station dynamically during runtime
- Defined users with different rights
- Connection to SAP ME over OPC-UA
Industry 4.0: Software

- Communication
  - Industrial MES features
  - each module communicates directly with MES via TCP/IP
  - Service Oriented Architecture (SOA)

- Didactical Approach
  - RESET to a defined situation
  - Storage of different configurations
  - Quick creation of resources and workplans
  - Simulation mode
  - Different training scenarios

- Mobile MES 4
  - MES as web service
  - MES on smart devices

- Realtime Manufacturing Execution
- Optimized for Factory Automation and Hybrid Production
- Event based operation
- Identification based operation
- Ability based scheduling
- High performance
- Open Environment (ACCESS, VB.NET)
Industry 4.0: Software

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**Personalised MES**
The right information at the right time in the right place.
- Examples as websites
- Interfaces available for App Programming

**Detailed planning & control room**
- Detailed planning

**Data Collection**
- Data Collection
- OEE
- Traceability
- Quality data
- Job sequencing

**Machine data**
- Machine Data Collection
- Process data acquisition
- Machine connection

**BI & Big Data**
- Preparation of BI (Business Intelligence)
- Data Warehouse
- KPI (Key Performance Indicators)

**Energy Management**
- Energy data acquisition
- Energy consumption analysis
- Energy consumption planning

**ERP**
- „mini“ ERP
  - For order entry
  - And order
  - Generation
Industry 4.0: Software

- **Communication**
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Industry 4.0: Software

CP Factory plant simulation in 3D with CIROS® 6 and MES4

Virtual 3D Factory environment:
• 3D model library of CP Factory stations and application
  (full completion planned Q2 2017)
• Flexible factory layout designing
• Connectivity to full MES4 with specific interface CIROS <-> MES4
• MES4 connectivity to Cloud
• 6x licences of CIROS Studio and MES4
Industry 4.0: Software

Classroom scenario with 3D simulation plant, MES4 and Cloud

Note: 6 seats of MES4 and CIROS® 6 Studio are included in this step
Industry 4.0: Software

Exchange of knowledge relating to teaching about Industry 4.0

1. Moderated forum
2. www.cp.community.festo.com

CP Factory cloud
Industry 4.0: Software

Co-funded by the Erasmus+ Programme of the European Union

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Reliable WLAN
WLAN NFC

Supply chain
Logistics
Intralogistics

ERP
MES
Route

Cloud

Remote Services
24/7

Production LAN
Profinet
RFID

Internet

CP Factory partner school

CP Factory location

Life cycle

Delivery
Customers

Logistics
IT systems
IT security
Networking
CP Factory cloud
Industry 4.0: Products

Compact Trainer I 4.0

**Features**

- Product identification
- Webserver
- Product memory
- Energy monitoring
- Pick by light
- Raspberry Pi

Curriculum Compact Trainer I 4.0 (in progress)

**Info**

Video
Industry 4.0: Products
Industry 4.0: Products

Overview

- Single board computer „Data center“
- Insertion module „Automatic assembly“
- Operator guidance: Pick-By-Light
- Writing RFID process data
- Operator guidance: Touch panel HMI
- Energy monitoring DC-Wattmeter (back side)

RFID = Radio Frequency Identification
Industry 4.0: Products

Workpiece = mechanic + computer science

3 product variants with individual manufacturing-orientated fingerprint

Workpiece with digital product memory

Data:
- Status
- Error
- User login
- Order work plan
- Order number
- Customer
- Time of order input
- Start of production
- Finish of production
- Energy consumption

112 Byte
Industry 4.0: Products

Production scenario – designation of workpieces

- base roller
  POM with RFID, WH

- bearing hub steel

- bearing hub alloy

- bearing hub plastic
  POM, BK
Industry 4.0: Products

DC-Wattmeter App
Energy monitoring

DC-Wattmeter TCP-IP Server

RFID-Manager (Android)
order input

Operating Raspberry

Data Center
Raspberry Pi2

Application website

FluidLab energy (light)
Energy monitoring

USB-Reader
order input

TIA-Portal
SIMATIC STEP 7 V13 P

TIA-Portal
WinCC Advanced V13

remote control

LOGO! Soft Comfort V8

LOGO!8

LM1: Function and design – tools

FESTO
# Industry 4.0: Products

## MPS 203 I 4.0

### Features

- RFID modules
- Maintenance / monitoring
- Web services
- Mini MES on touch PC
- Product memory
- AR + QR info portal

### Covering advanced I 4.0 related topics
Industry 4.0: Products

AR App – Augmented reality assisted learning
Industry 4.0: Products

QR App / Info Portal – Relevant information anywhere, anytime
Industry 4.0: Products

Mini MES on MPS® 203 I 4.0
Industry 4.0: Products

CP-Lab

- Desktop version of a conveyor with a PLC, an HMI and an Application
- Modules are compatible with CP-Factory
- Limitation of big application modules (e.g.: Storage, Robot, CNC)
Industry 4.0: Products

Fundamentals of Control Technology

Learning content:
- Analyzing mechatronic systems
- Generating parts lists
- Generating I/O lists
- Generating function diagrams
- PLC project engineering
- Functional testing
- Commissioning

Step 1: Application module
Industry 4.0: Products

PLCs:
- CECC
- Arduino
- Rapsberry

Drilling
Drilling with CECC
Turn-Over
Industry 4.0: Products

Digital Press
Analog Press
Vision
Industry 4.0: Products

Heating

Magazine
The compact Industry 4.0-learning system

Learning content:

- CP Lab design and structure
- Collecting information using intelligent sensors
- PLC project engineering
- Communication using BUS technologies
- Binary pallet identification
- Identification with RFID
- Plug & Produce: quick integration of new application modules using Cyber-Physical Systems
- Material flow: Using RFID and NFC
Industry 4.0: Products

Integrated, modular, and scalable: the learning system for Industry 4.0

CP Lab – Single workstation

Scope of delivery:

- 1x CP Lab pallet transfer system
- 1x Application module
- 1x Touch panel
- 1x Mobile table with A4 frame
- 1x RFID read/write USB device
- 1x Power supply 24 VDC
- 1x Set of workpieces
Industry 4.0: Products

Complete lab for 12 students – 6 CP Lab single workstations with 6 different applications

Scope of delivery:
- 6x CP Lab pallet transfer system
- 6x Application module
- 6x Touch panel
- 6x Mobile table with A4 frame
- 6x RFID read/write USB device
- 6x Power supply 24 VDC
- 6x Set of workpieces
Industry 4.0: Products

The modular Industry 4.0-learning system

Learning content:
- CP Lab design and structure
- Collecting information using intelligent sensors
- PLC project engineering
- Communication using BUS technologies
- Binary pallet identification
- Identification with RFID
- Plug & Produce: quick integration of new application modules using Cyber-Physical Systems
- Material flow: Using RFID and NFC
- Manufacturing Execution System (MES): Creating, managing, controlling and visualizing customer orders

Step 2: CP Lab combinations
Complete lab for 12 students – 6 CP Lab workstations in sequence with 6 different applications

Scope of delivery:

- 6x CP Lab pallet transfer system
- 6x Application module
- 6x Touch panel
- 6x Mobile table with A4 frame
- 6x RFID read/write USB device
- 1x MES4 for order entry, PC incl.
- 6x Power supply 24 VDC
- 6x Set of workpieces
Industry 4.0: Products

Different learning situations
Advanced Industry 4.0 knowledge in an industrial environment

Additional learning content to CP Lab:
- Storage systems and storage strategy
- Autonomous mobile robotics
- Safety engineering
- Energy monitoring and energy management
- Robot cells with camera-supported assembly, use of gripper changing systems, palletizing, tracking and more
- Production, CNC machines with automatic loading, FMS (Flexible Manufacturing System)
- Additive production methods (rapid prototyping)
- Manual workstations, e.g. with pick-by-light, Andon (visual control system)
Industry 4.0: Products

- Rollers under the station
- One-cable connection (air, electricity, emergency, communication)
Industry 4.0: Products

- Conveyor [1]
- PLC [2]
- 2x Application modules [3]
- HMI [4]
Industry 4.0: Products

Robot Assembly

Storage
Industry 4.0: Products

1. CP Lab Module
   - Industry 4.0-skills in a tabletop device in a compact way

2. CP Lab Combination
   - Several CP Lab workstations in a realistic industrial pallet circulating system

3. CP Factory – Cyber-Physical Factory
   - The universal Industry 4.0-research and learning platform like a smart factory model

Start small, grow big: in 3 steps towards the Smart Factory

Qualification need

<table>
<thead>
<tr>
<th>Industry 4.0 Products</th>
<th>Low</th>
<th>Qualification need</th>
<th>High</th>
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</table>
Industry 4.0: Products

CP Lab circulating system combined with CP Factory – Variant 1

**Scope of delivery:**

- CP Lab circulating system consists of 7 CP Lab pallet transfer system, 6 application modules, 1 manual workplace, 7 Touch panel, 1 CP bridge and furniture, 4 active deflections
- 1x CP Factory robot assembly cell
- 1x MES4 for order entry, PC incl.
- 8x Power supply 24 VDC

Integrated, modular, and scalable: the learning system for Industry 4.0
Industry 4.0: Products

CP Lab circulating system combined with CP Factory – Variant 2

Additional to variant 1:
• 1x Mobile transport system (AGV)
• 1x CP Factory basic module branch
• 1x Fleet manager software for AGV
Industry 4.0: Products

CP Lab circulating system combined with CP Factory – Variant 3

Additional to variant 2:
- 1x CP Factory ASRS
- 1x CP Factory Basic Module
- 1x Application module Pick-by-Light
Industry 4.0: Products

CP Lab circulating system combined with CP Factory – Variant 4

Additional to variant 3:
- 1x CP Factory robot loading cell for CNC milling
- 1x CNC milling machine
- 1x CP Factory Basic Module
- 1x Application module analogue measuring
Industry 4.0: Products

CP Lab circulating system combined with CP Factory – Variant 5

Additional to variant 4:
- 1x CP Factory robot packing cell
- 1x CP Factory Basic Module Bypass
- 1x Mobile Transport System for boxes (AGV)
- 1x CP Factory ASRS for boxes
Industry 4.0: Products

CP Lab circulating system combined with CP Factory – Variant 6

Additional to variant 5:
- 1x Mobile Transport System for boxes (AGV)
- 1x CNC Turning machine
- 1x Robot loading cell for CNC Turning
Industry 4.0: Products

4 systems in 1

iCIM  MicroFMS  iFactory  MPS® Transfer Factory

4 systems  →  1 system

CP Factory
Industry 4.0: Products

The Mobile Robotics

Like this

or

Like this!
Industry 4.0: Products

Combining CP-Factory and CP-Lab

- Using CP-Bridge to combine CP-Factory and CP-Lab
Industry 4.0: Products

- Using CP-Bridge to combine CP-Factory and CP-Lab
Industry 4.0: Products

- Using CP-Bridge to combine CP-Factory and CP-Lab
Industry 4.0: Products

Combining CP-Factory and CP-Lab

- Using CP-Bridge and Robotino to combine CP-Factory and CP-Lab
Industry 4.0: Products

- Mobile Phone
  - Front Cover [1]
  - PCB [2]
  - Fuse [3]
  - Back Cover [4]
Industry 4.0: Products

- Carrier [1]
- Pallet [2]
Industry 4.0: Products

- Pallet
- Carrier
- Front cover
- Slot for the stopper
- Holes for simple Carrier ID recognition screws
- Screw for the „Carrier arrived” sensor
- RFID - tag
Industry 4.0: Products
# Industry 4.0: Products

## Product variations

<table>
<thead>
<tr>
<th>1. Front cover</th>
<th>1. PCB</th>
<th>1. Fuse</th>
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<tr>
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</table>
Industry 4.0: Products

Parts of the stopper

Simple Carrier ID recognition sensors
RFID sensor
"Carrier arrived" sensor
Stopper pin
Indicator lights
Stopper cylinder
Stopper sensor
Industry 4.0: Products

Parts of the stopper
Industry 4.0: Products

Parts of the stopper
7. Default Mode

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</tr>
<tr>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Process in default mode

1. The stopper is waiting for the carrier
Process in default mode

1. The first inductive sensor [BG1] will show if the carrier arrived
Process in default mode

1. Now the RFID sensor reads out the information from the RFID-tag

Carrier ID: 4
Code: 1
Process in default mode

1. 3. Check the Transition table for application run

<table>
<thead>
<tr>
<th>No.</th>
<th>Start condition</th>
<th>Application execute</th>
<th>Prog. No.</th>
<th>Parameter</th>
<th>End condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Init</td>
<td>none</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td></td>
<td>0</td>
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</tr>
<tr>
<td>4</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Program 3: Drill both

Carrier ID: 4
Code: 1
Process in default mode

1. 4. Run the application (e.g.: Drill both)
Process in default mode

1. 5. Check the Translation table for „End condition“

<table>
<thead>
<tr>
<th>No.</th>
<th>Start condition</th>
<th>Application execute</th>
<th>Prog. No.</th>
<th>Parameter</th>
<th>End condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Init</td>
<td>none</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>3</td>
<td>0</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Carrier ID: 4
Code: 1

Carrier ID: 4
Code: 2
Process in default mode

1. Write back the end condition to the RFID-tag
Process in default mode

1. Release the stopper to let the carrier go
Process in default mode

1. 1. Wait for Carrier
   - The BG1 inductive sensor will show it

2.2. Read out the RFID information
   - Read out Carrier ID and status Code for default mode

3.3. Check the Transition table
   - If there is a row with a start condition of the status Code
     - If the application is enabled

4. Run the correct application
   1. 5. Check the end condition of the actual row in the Transition table
   2. 6. Write the end condition back to the RFID as status Code

3.7. Release the stopper
   - When the carrier left the BG1 sensor, we can extend it
Default Mode -> RFID Production Mode with Smart Devices

Plug & Produce

- RFID
  - Enables individualization

- IN / OUT production
  - Transition codes for direct production
  - Access / modification with smart device possible

<table>
<thead>
<tr>
<th>Prod-ID IN</th>
<th>action</th>
<th>parameter</th>
<th>Prod-ID OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Press</td>
<td>1Sec</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Press</td>
<td>3 Sec</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>Press</td>
<td>60 Sec</td>
<td>205</td>
</tr>
</tbody>
</table>

RFID ID = 5

= 5

= 8
1. Features

**Industry 4.0 features:**

- MES4 (Service Oriented Software Structure SOA)
- RFID = digital Product Memory for Lotsize 1
- Cyber Physical Systems (CPS-Stopgate as an example for functional integration)
- Mobile / Augmented Reality / web-HMI
- NFC
- Plug and Produce
- Energy Management for the energy-flexible Factory
- **OPC-UA as a key for Industry 4.0:**
  - Communication up to the cloud
  - CP Factory Cloud: Data Analysis, Big Data, decentralized facilities
- Flexible Layouts and flexible logistics with autonomous robotics (Robotino)
Industry 4.0: Product comparison

- CP Factory
- CP Lab
- MPS 203 I 4.0

Features:
- Product Traceability
- MES System
- Online Services
- Simulation – AR
- HMI Interface
- Condition Monitoring
- Cyber-Security
- Predictive Maintenance
- Remote Control
- Remote Maintenance
- Energy Monitoring
- Individualisation
- One piece flow
- Data Exchange M2M
- Big Data – Cloud System
- Additive Manufacturing
- Robotic System - CNC