European Academy for Industrial Management (AIM)
Advances in Industrial cyber-physical systems

THE HUMAN ROLE IN CYBER-PHYSICAL SYSTEMS
Chair of Production Systems
Prof. Dr.-Ing. Horst Meier
THE HUMAN ROLE IN CYBER-PHYSICAL SYSTEMS

1. Industry 4.0
2. APPsist Project
3. Learning Factory
4. Conclusion
The 4th Industrial Revolution

1st Industrial Revolution
Implementation of mechanical production facilities with the aid of water and steam power

First mechanical weaving loom 1784

End of 18th cent.

2nd Industrial Revolution
Implementation of work-sharing mass production with the aid of electric power

First conveyor, Slaughterhouses of Cincinnati, 1870

Start of 20th cent.

3rd Industrial Revolution
Use of electronics and IT for further automation of production

First programmable logic controller (PLC), Modicon 084, 1969

Start of 70s of 20th cent.

4th Industrial Revolution
Based on cyber-physical systems

Today

End of 18th cent.

Kagermann et al. (2013), S.17

Level of complexity

Time

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Definitions

**Industry 4.0**
Crosslinking of cyber-physical systems (CPS) and integration into production and logistics (KAGERMANN et al. 2013).

**cyber-physical systems (CPS) – Industry 4.0**
Crosslinking of the physical world (actuators, sensors, etc.) and the cyber world (net-based services, that interpret data and trigger processes in physical world) (GEISBERGER & BROY 2012).

**cyber-physical production systems (CPPS)**
Decomposition of the automation pyramid to decentralized systems, where information is available everywhere and any time (VDI/VDE 2013).

**Smart Factory**
Crosslinking of machines and equipment as well as intelligent products, which can be clearly identified and located and which will “find their way through the production“ (KAGERMANN et al. 2013).
Smart Factory and intelligent infrastructure

Internet of Services

- Smart Mobility
- Smart Grids
- Smart Products
- Smart Logistics
- Smart Buildings

Internet of Things

Kagermann et al. (2013)
Industry 4.0 – „Internet of Everything“

Internet of People

Social Web

Internet of Services

Internet of Things

CPS-platforms

Smart Grid

Smart Factory

Smart Home

Smart Building

Business Web

Kagermann et al. (2013)
Automated Pyramid

Hierarchically built-up automation pyramid

Local nodes as CPS-network

Own representation based on (VDI/VDE, 2013) (Günther & Ten Hompel, 2010)
Physical and cyber level of CPPS

SMART FACTORY

CPPS

physical

cyber-digital

planning- & control level

shopfloor level

Integrated Machines

NETWORKED PRODUCT

ERP/ PPC

NETWORKED STAFF

NETWORKED CPS PLATFORM

SOPHIE

DIGITAL FACTORY

AGENTSYSTEM

SERVICES

Digital Planning & Control

SMT ART FACTORY

CPS PLATFORM

Integrated Machines

physical

cyber-digital

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Industry 4.0 = CIM 2.0?

Main idea:
- holistic consideration of a company’s value creation processes and support by integrated IT-systems
- continuous computer-aided information processing, based on an interdepartmental data base (CAD/CAM; flexible manufacturing systems).

Goal: unmanned factory

Human Role: planning and monitoring

“The perspective of a completely automated and unmanned factory cannot represent a realistic perspective because of technological and economical reasons.“
[Prof. Dr. Hirsch-Kreinsen]

New enablers: Internet technology, data collection storage and processing

Technical innovations shall not be considered isolated. A more integrated view of technical, organizational and personal aspects has to be considered as a socio technical system.

The human role within the production is still very important!
Industry 4.0 research projects at the LPS

DigiLernPro
Digital Media in Professional Education

- Development of semi-automated learning scenarios, that allow new forms of learning at the workplace.
- Situative Assistance for employees at shopfloor level concerning operations like commissioning, handling and machine maintenance.
- Use of virtual techniques for a specific presentation of information according to specific situations as well as personal competences and preferences.

Sophie
Virtual Techniques for the Factory of the Future

- Linking of the real world production with the digital factory in real-time.
- Semi-autonomous agent-based production planning.

DigiLernPro
Digital Media in Professional Education

- Development of semi-automated learning scenarios, that allow new forms of learning at the workplace.
- Sustainable competence development for staff by “Learning on the job“ and „Learning near the job“.

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Research Project

**APPSIST**

**INTELLIGENT KNOWLEDGE SERVICES FOR THE SMART PRODUCTION**
project consortium

provider

MBB
FERTIGUNGSTECHNIK

FESTO

operator

BRABANT
WERKSTOFFZENTRUM MEERENHOF

LEHNERT
Maschinenbau GmbH

application & validation

LPS
LEHRSTUHL
FÜR PRODUKTIONSSYSTEME

research & development

Deutsches Forschungszentrum für Künstliche Intelligenz GmbH

Fraunhofer IAO

FESTO Lernzentrum

imc

consulting

DIN
Deutsches Institut für Normung

Scheer Management
CONSULTING & SOLUTIONS

acatech
DEUTSCHE AKADEMIE DER TECHNISCHEN WISSENSCHAFTEN

* sub contracted partners
Motivation

Increasing complexity of plants, as a result of the use of flexible automation-systems within the production by using cyber-physical systems

The ability to manage these activities by staff does not increase simultaneously

Accrueument of competence deficits, which are to be balanced by an appropriate assistance-system!
Competence deficits

development /design engineering

production / assembly

documentation

commissioning

repair

maintenance

inspection

operation

plant provider

plant operator
Goals of the project

- Machine data
- Working data
- Staff data
- Operating data
- …

Shopfloor

- Commissioning
- Repair
- Maintenance
- Inspection
- Operation
- Activities

Competences
- Knowledge
- Qualification
- Employee profiles

Data
Information
Knowledge elements

APPsIST-System

Services
- eLearning
- eSupport

Devices for Visualization

*human-machine interaction
**human-computer interaction
Concept of Assistance

- Employee Profiles
- Processes/Activities
- Support
  - Context- and competence-specific support
- Crosslinking/Hardware
  - CPPS (Industry 4.0)
- Data (Formats)
  - Context specific data
- Ethernet
- APPsist System
- PLC
- DB
- PC
- Server
- 3D Models
- Compositions
- PDF
- Illustrations
- Failure ID
- Failure texts

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Technical dimensions

- Integration into existing systems
- Knowledge- and data management
- Input of data and information
- Output and visualization
- Software- & IT- architecture
- AI- based context sensitivity
- Transfer- ability
- Human- machine- interaction
- System crosslinking
Success dimensions

- Regulations in the company
- Guidelines of the company
- Guidelines of data protection
- Human resource development
- Trainings and education
- Business models
- Culture and history of the company
- Co-determination Work Council
How to bring Industry 4.0 into learning factories?

INDUSTRY 4.0

Smart
CPPS
CPS

Cloud

LEARNING FACTORY
How to bring Industry 4.0 into learning factories?

Questions:

- What is supposed to be the content?
  - general overview of Industry 4.0
  - benefit and challenges of Industry 4.0
  - Examples of Industry 4.0

- What are the benefit and challenges of the training?
  - participants develop a understanding of what Industry 4.0 stand for
  - participants learn how to implement Industry 4.0 in factories
  - participants know the advantages but also risks (co determination, personal rights) of Industry 4.0

- How to implement a training environment?
  - consideration of particular workplaces (local) and production system (global); how they operate without and with Industry 4.0 “standards”
  - presentation of a fully functional and implemented Industry 4.0 production (pilot factory)

- What kind of product is needed?
  - networked product
How to bring Industry 4.0 into learning factories?

Approach:

**target definition**
- **impact on target figures of the production:** time, cost, quality
- **impact on the production system:** technology, origination, personnel

**definition of requirements:**
- **technology:** machines (CPS), PPC, data, I&C, …
- **organization:** operational and organizational structure, flow of information, …
- **personnel:** duties/tasks, qualifications, development of competences, …
- **product:** networked components

**development of 2 scenarios:**
- **focus on technology implementation:** necessary installation of I&C-components
- **focus on human assistance:** possibilities, advantages, risks, changes for employees

**implementation:**
- **technical conversion of our pilot factory**
- **pilot phase**
Conclusion

- Industry 4.0 is a complex undertaking
- Challenges regarding technical and organizational aspects
- The human role is a key factor in the implementation
- Intelligent support systems are needed to plan, control and operate smart factories
- Learning factories have to adapt to Industry 4.0
5th conference on learning factories

TOPICS
• Lean production
• Industry 4.0 / Cyber-physical systems
• Resource efficiency
• Productivity management
• Digital learning environment
• Problem-based learning
• Consideration of the product lifecycle
• Industrial implementation

JULY 7TH 2014 (START: EARLY AFTERNOON)
• Greeting and introduction
• Workshops in the LPS Learning Factory
• Welcome reception

JULY 8TH 2014 (FULL DAY)
• Keynote
• Conference session

VENUE: Ruhr University Bochum
Important Dates

2014

November 3rd    Abstract submission
November 10th   Notification of abstract acceptance

2015

January 12th    Full paper submission
January 30th    Notification of paper acceptance
February 17th   Camera-ready paper submission
February 28th   Registration deadline authors
June 30th       Registration deadline participants
July 7th - 8th  5th Conference on Learning Factories sponsored by CIRP

www.rub.de/clf-2015
Thank you for your attention!