1. Introduction
2. Industry 4.0 / Smart Manufacturing
3. Research Projects
   • SOPHIE
   • S – CPS
   • AIS
   • FM Star
   • Application Centre Industry 4.0
Welcome to the Institute of Industrial Sciences and Factory Systems of the Chemnitz University of Technology
Project of the Future: Industry 4.0

Industry is on the threshold of the fourth industrial revolution. Driven by the Internet, the real and virtual worlds are growing closer and closer together to form the Internet of Things. Industrial production of the future will be characterized by the strong individualization of products under the conditions of highly flexible (large series) production, the extensive integration of customers and business partners in business and value-added processes, and the linking of production and high-quality services leading to so-called hybrid products. German industry now has the opportunity to actively shape the fourth industrial revolution. We want to support this process with the "Industry 4.0" forward-looking project.

### Development of Industry 4.0

#### Driving forces for Industry 4.0:
- High demands on flexibility and responsiveness
- Performance of modern IT systems

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- as from 1800
- as from 1900
- around 2000
- around 2050
INDUSTRIE 4.0

"Industry 4.0" was conceived as a forward-looking project under the Federal Government's High-Tech Strategy, focusing on information and communication technology (informatics). It has been developed further to include production research and user industries.


SMART MANUFACTURING

SM is an emerging manufacturing technology focused on the orchestration of wide spectrum of sensor-based and source data, information, models and simulation, along with approaches that make information accessible and actionable through workforce and control and automation systems.

Source: National Institute of Standards and Technology (NIST) June 2013
• Utilization of expected technical advances in the information and communication technologies for the production-related industry

• Increasing and consistent integration of ICT into production systems with progressively smaller subsystems and components

• Enhancement of mechatronic systems regarding additional communication ability (intelligent sensor systems, actuators, interaction with the environment) and (partly) autonomous performance

• Enabling of machinery and equipment regarding self optimization and reconfiguration (independent performance planning according to the environment; learning new performance modes and strategies)

• Customization of ICT in production applications, e.g. robustness, resilience, information security, real-time capability
Principles and Concepts

Industry 4.0
„Smart solutions - customized, flexible, fast“

**Principles**
Internet of things and services
- Service orientation
  - Standardization
  - Decentralization
  - Real-time capability
- Intelligent networking
- Blended reality (continuous connection between virtual and real world)

**Technologies**
- Cyber-physical systems on the basis of embedded systems
- Machine-to-machine communication
- Big Data

- **Smart Factory**
  - Adaptability
  - Continuous ergonomics
  - Interoperability
  - Resource efficiency
  - Customer orientation

- **Smart Logistics**
  - Tracking
  - Multi-agent systems

- **Smart Products**
  - Smart devices
  - Gentelligent components

- **Smart Grid**
  - Micro-grid
  - Virtual power plant
  - Energy management

- **Smart Mobility**
  - Augmented Reality
  - Traffic management
  - Car2X communication

- **Smart Health**
  - Telemetering
  - Medical network

- **Smart Home**
  - Smart meter
  - Ambient Assisted Living (AAL)

- **Smart Public-Social Level**
- **Smart Resource Level**
- **Smart Industry Level**
„physical and virtual, local and global, horizontally and vertically networked systems, dynamic system boundaries, partial or complete autonomy, active real-time control, cooperation and comprehensive cooperation between human and system“

“cyber-physical systems”, “internet of things”, “smart factory” and “industry 4.0” belong together

CPS involve **embedded systems**, production, logistics, engineering, coordination and management processes as well as Internet **services**, that collect physical data directly via **sensors** and influence physical processes via **actors**. They are interconnected via digital networks, use data and services that are available worldwide and have **multimodal man-machine-interfaces**. Cyber physical systems are open **socio-technical systems** and offer a set of new functions, services and characteristics.

**Vision: Internet of things, data and services**  
- e.g. Smart City

**Cyber-physical systems**  
- e.g. intelligently networked crossways

**Networked embedded systems**  
- e.g. autonomous flying

**Embedded systems**  
- e.g. airbag

Source: Agenda CPS

Source: Plattform Industrie 4.0
The concept of the smart factory is based on flexible and consistent networking of the data sources on the basis of a services model.

This enables (partly) autonomous and self-organized processes, which lead to increased efficiency and flexibility.

Source: Abschlussbericht des Arbeitskreises Industrie 4.0, Umsetzungsempfehlungen für das Zukunftsprojekt Industrie 4.0, (2012).
Public Cloud, Community Cloud, Private Cloud

**SaaS** – Software as a Service
Software Application (Google Docs)

**PaaS** – Platform as a Service
Operation System (Amazon Web Services)

**IaaS** – Infrastructure as a Service
Virtual Hardware (IBM)

Source: Moch
Framing Industry 4.0:
- Evolution instead of a revolution
- Great demand on people, technology and organization and not technology only!

Requirements:
- Support people making the transition towards Industry 4.0
- Make data as available as possible for internal and (selectively) external parties

Source: Jentsch
Goals:
- Establish a real-time link between physical production and the digital factory
- Utilization of virtual technologies to compare planned and actual process states
- Safeguard operational decisions based on valid and continuously updated simulation models
- Support users with preliminary analysis realized by virtual agents
analyzing the current processes and developing **reference processes** with S-CPS
Research Question

How can constantly evolving virtual technologies support production planning and control in an industrial environment?
Software agents can process simple information and ease the burden of information overload.
The complexities of production system behavior can be taken into account by detailed and synchronous simulation models.
Synchronous Production

**Physical Level**
- Real factory
- Employees
- Visualisation- & interaction-devices

**Cyber Level**
- Agent- & service-system
- Digital factory
- Simulation-applications

**Automation Level**
- SCM: Supply chain management
- ERP: Enterprise resource planning
- PPC: Production planning and control
- MES: Manufacturing execution system
- PDA: Production data acquisition
- MDA: Machine data acquisition
- CAM: Computer aided manufacturing
- SFDC: Shop floor data collection
Resource-Cockpit for Socio-Cyber-Physical Systems

Goals:
• Flexible integration of heterogeneous master and dynamic data
• Mobile support for internal and external maintenance personnel
• Prototypes (among others) in the Experimental und Digital Factory Chemnitz
• Improved efficiency and flexibility for in-site and off-site maintenance

Source: Jentschl

Partners:
ÉaÚoÚOý ÍÚoÝoÚOðÁj
çÚÜú ÚðÀáyÚôÚôP Ëí ÚaOðÚUoÚDá Òáú ÀÔáoÜáôáÚU døDÚUOÜO úÝÚ ôD Ò DÜúÚ úÝyÚoØûáP Ðú ÚáúDøpÁøÛâa ÕDÝøÚÔO úÝøÚaÜ oûÚ yÚüÚÚPÚyÚ Ðú Òá ÚáúYØøØóOý oÝUyÚaÚ

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áÚyÝyDdÁûáo Ðú Òá ÚáoÝúoÝúYú'
døDÚUOØ, ØøUáøÜû ÕDýÝøÚDá øOÖû á Ðá üÜÜyP oDdÚÚOý úØøØ Ûáâû ÕöûáDã Òáú yÚOÝOýÚpøøÚðá ÚDáUoóU Òá oûÚ ÙDáøÚdø Dû øüÜ ČÉauÝOðøP íë' ÝdøøDØü
Ontology: Bottom-Up Development Process
Prototype on a Tablet (Google Nexus 10 with Android 4.4 (KitKat))
FMSstar App - Features

- Screenshot Tablet

Prototype on a Tablet (Google Nexus 10 with Android 4.4 (KitKat))

Umwälzpumpe mit Darstellung der technischen Daten

Umwälzpumpe mit Darstellung der Wartungsaufgaben
Content:

• Reliable ambient energy supply for singular sensor knots
• Wireless energy transmission to moving objects
• Acoustic sensors for abrasion detection
• Integration of a sensor nets into the production environment
• Definition of optimal maintenance periods for logistic devices
• Application and network algorithms
• Energy efficient and reliable sensor communication

Partners:
Thank you for your attention!

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