Industrie 4.0 – Features, Potentials, and Challenges

Dr. Andreas Heindl, acatech

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Overview
Content of the presentation

- Fourth industrial revolution
- Elements of Industrie 4.0
- Challenges for the future
- Skills for Industrie 4.0
- Strategies for development
Fourth industrial revolution
Development, main drivers, and smart services
Industrial development
The fourth industrial revolution

Economic impact
- Production is highly flexible, highly productive
- Value creating processes are optimized on demand and in real-time
- Existing infrastructure can be upgraded gradually

Environmental impact
- Resource-efficiency
- Compatibility with urban life

Social impact
- Adaptive, intelligent assistance systems support the employee in his enlarged range of tasks
- Work-life-balance and human oriented work organization

Source: DFKI 2011
Megatrend Digitalization
Major drivers for Industrie 4.0 and Smart Service Welt

New aspects

Smart Objects
- Digitally enhances products

Internet of things
- Ubiquitous connectivity

Autonomous systems
- ‘Sense’: cheap sensors, big data
- ‘Plan’: AI, smart data
- ‘Act’: Robotics, 3D-Printing
- ‘Learn’: Deep Learning

Classics from the past

The user at the centre
- Personalized products and services

IT-driven ‘servitisation’
- ‘Everything as a service’

Internet-Economics
- Changed market dynamics
- Unlock underutilized assets (share economy)

► Disruptive, data-driven business models / business transformation
Elements of Industrie 4.0
Smart Factory, service platforms, and digital infrastructures
Revolution in industrial production
Smart Factory, Smart Products, and Smart Internet

Internet of things combines the idea of a smart factory with the idea of smart products within an autonomous system

- The Smart Factory introduces the internet of things and services into the world of production
- Human beings, machines and products communicate like in a social network
- With interfaces to Smart Logistics, Smart Grid etc. the Smart Factory is part of future smart infrastructures
- Smart Factories produce Smart Products
Digital ecosystems
Service platforms and platform economy

- Service platforms provide the business-oriented integration layer for collaboration of the actors
- Platforms serve as integration point for digital value-added networks

Data-driven business models

Open, digital platforms

Smart machines (different manufacturers)

Source: acatech / Siemens 2014
### Digital infrastructures

**Layers of Industrie 4.0 and Smart Service Welt**

<table>
<thead>
<tr>
<th>Digital society</th>
<th>Digital ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Service platform</td>
<td>Smart services</td>
</tr>
<tr>
<td><strong>2</strong> Software-defined platform</td>
<td>Smart data</td>
</tr>
<tr>
<td><strong>3</strong> Networked physical platform</td>
<td>Smart products</td>
</tr>
<tr>
<td><strong>4</strong> Technological infrastructure</td>
<td>Smart spaces</td>
</tr>
</tbody>
</table>

**Smart talent**

**(Digital) education and advanced training**
- Qualification in schools, universities and companies

**Developing new business models**
- Supporting startups and the creation of ecosystems

**Creating networks and (smart) data**
- Collaboration of companies and generating data

**Improving industrial productivity**
- Modernizing factories, manufacturing and products

**Building up broadband networks**
- Connecting rural and urban regions nationwide

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Challenges for the Future
Digital platforms, regulation, and labour markets
# Digital infrastructures

**Platforms, framework, labour, and acceptance**

## Establishing and operating digital platforms:
- Open, global standards
- Management of complex systems
- Reduce barriers for SMEs and Startups

## Organisation and work:
- New flexibility-compromise
- Changes in work contents and job profiles
- Qualification: personalized, on-the-job

## Framework:
- Efficient technical infrastructures
- Legal framework for data as an asset
- European digital single market

## Social acceptance:
- IT- and data security, data protection
- Human-machine interaction
- Leave room for experiments
Smart Factory of the future
Multimodal human-technology interaction

Navigation using a 3D-Modell and app stores for the Smart Factory

Collaboration with service robots
The Smart Factory is not empty
Greater scope for participation and decision-making

Fewer blue-collar production workers, more white-collar jobs:

- Systems planning, engineering, integration into existing landscapes
- Performing tasks that cannot be automated
- Coordination and orchestration

Networked, interdisciplinary working environment

Wider variety of tasks performed by individual employees

Shorter introduction and learning periods

→ Fewer „machine operators“, more experts and decision-makers
→ Less prescribed ways of working, more autonomy
→ Lifelong learning, flexible management of work content and working time
Future job perspectives
Polarization of labour markets and upgrading of skills

Change in occupation

Complexity of work

Polarization

Upgrading
Skills for Industrie 4.0
Scenarios, skill development, and training tools
Future of labour
Alternative scenarios

Alternative scenarios for future labour

- **Employment**: Substitution of functions versus preserving high-quality industrial work
- **Work organisation**: Technology-centred automation versus complementary automation
- **Working conditions**: Ultra-flexibility of workers versus creation of new social arrangements
- **Qualification**: Replacement of medium-level jobs versus (general) upgrading of job profiles

→ Preparing societies for digitalization
→ Proactive decision-making
→ Promoting innovation
Future capabilities
Requirements for companies

Priorities of large enterprises
- Technology and data-centred capabilities (like data analysis or IT security)

Priorities of small and medium enterprises
- Process and customer-centred capabilities (like customer relationship management or process management)
- Infrastructure and organization-centred capabilities (like handling of IT basic systems or social and communication competences)
Future skills
Qualification of employees

Priorities of enterprises
- Interdisciplinary, overview on processes, and more responsibility and independence
- Promoting change management (esp. leadership, innovation, and problem-solving)

Importance of IT skills
- Increasing relevance of IT skills in all sectors
- Highly specialized IT knowledge as well as broadly bases knowledge on application of IT

→ **New requirements for qualification in schools, universities, and companies**
Developing skills
Innovative approaches for qualification

Variety of tools and methods

- Higher training efforts in large enterprises than in small and medium sizes enterprises
- Predominance of "traditional" training tools and backlog demand for digital methods
- Event-oriented, context-related and dynamic approaches for Industrie 4.0 trainings

→ Potential for digital / online tools for future education and training (esp. for SMEs)
## Checklist for companies

### Possible starting points for transformation

<table>
<thead>
<tr>
<th>Terms and conditions</th>
<th>Business models and relationships</th>
<th>Qualification and training</th>
<th>Change management</th>
<th>Technology and machinery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creating awareness at all levels</td>
<td>Review of existing products and business models</td>
<td>Further training as a leadership task</td>
<td>Organisational development</td>
<td>Use of digital technologies</td>
</tr>
<tr>
<td>Strengthening strategic foresight</td>
<td>Networking with customers and suppliers</td>
<td>Strengthening self-responsibility</td>
<td>Strengthening of process knowhow</td>
<td>Transparency about production system</td>
</tr>
<tr>
<td>Systematic self assessment within the company</td>
<td>Open culture for innovation</td>
<td>Preparing the workforce</td>
<td>Adaption of the decision-making structures</td>
<td>Responsiveness of processes</td>
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<tr>
<td></td>
<td></td>
<td>Using digital learning methods</td>
<td>Openness for experiments</td>
<td>Shaping of human-technology-interaction</td>
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</tbody>
</table>
Strategies for development
International players and options for development
### International context

#### Different approaches towards Industrie 4.0

<table>
<thead>
<tr>
<th>Strong brand Industrie 4.0</th>
<th>High level of training &amp; qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengths in the production sector</td>
<td>Excellent international reputation</td>
</tr>
<tr>
<td>Strong focus on new business models</td>
<td>Large domestic market</td>
</tr>
<tr>
<td>IT-start-ups in Industrie 4.0</td>
<td>Driven by private organizations (e.g. IIC)</td>
</tr>
<tr>
<td>High-tech operating companies &amp; low-tech SME</td>
<td>Ambitious government programs (China 2025)</td>
</tr>
<tr>
<td>Dominance of “Chaebols”</td>
<td>Fragile legal framework</td>
</tr>
<tr>
<td>Know-how in consumer technologies</td>
<td>Focus on production efficiency</td>
</tr>
<tr>
<td>Strong production sector</td>
<td>Strengths in IT-infrastructure</td>
</tr>
<tr>
<td>Complex standardization landscape</td>
<td>Focus on new business models</td>
</tr>
<tr>
<td>Strong R&amp;D sector &amp; research transfer</td>
<td>Strengths in robotic &amp; work science</td>
</tr>
<tr>
<td>Focus on reindustrialization</td>
<td>Cooperation in “Catapult”-centers</td>
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Strategies for development
Evolution or jump towards Industrie 4.0

- **In general:** Consideration of disparities within a country / region (Industrie 2.0 versus Industrie 3.0 and infrastructure)

- **Option 1 – Evolution from Industrie 3.0 to 4.0:** Focus on (international) companies in key technology and highly competitive sectors in key regions

- **Option 2 – Jump from Industrie 2.0 to 4.0:** Focus on SME and startups beyond the high tech sectors and the highly competitive regions

- **Option 3 – Development of the socioeconomic framework:** Focus on education in schools, universities, and companies, focus on knowledge transfer and basic infrastructure / networks

Source: DFKI 2011
Possible starting points
Layer model as orientation for development

(Digital) education and advanced training
→ Qualification in schools, universities and companies

Developing new business models
→ Supporting startups and the creation of ecosystems

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