Betriebe und Beschäftigte gestalten die digitale Transformation – KMU 4.0

Companies and employees are shaping the digital transformation – SME 4.0

Aachen, 07. September 2018
Agenda

1. WZL of the RWTH Aachen University
2. Project presentation
Agenda

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2. Project presentation
RWTH Aachen University and the Fraunhofer Society

Fraunhofer Society
- 80 institutes and organizations at over 40 locations in Germany
- 12,500 employees
- research volume over 1.2 b. €, from which 1 b. € due to contract research
- 3 institutes in Aachen

RWTH Aachen
- founded in 1870
- 42,300 students

Faculty of Mechanical Engineering
- 12,000 students (2,900 of them first-year students)
- 62 professors
- 2,900 employees
- 200 doctorates/year
RWTH Aachen Campus: environment of research and industry

Production Engineering Cluster

Sustainable Energy Cluster

Biomedical Technology Cluster

Production Technology Cluster

Smart Logistics Cluster

Photonics Cluster

Cluster Heavy-Duty Gearbox

Smart Logistics Cluster

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Agenda

1  WZL of the RWTH Aachen University

2  Project presentation

   2.1  Company learning projects

   2.2  Qualifications
Objective of the project

Build-up of knowledge and competence for operational actors in the fields of innovation capability, digital production and work as well as organizational learning through company learning projects.

Background

- Digitalization (Industry 4.0) as a complex of sensors, virtualization and networking poses a major technical challenge.
- The digital working world is not determined by technology, it requires its own design approaches as a socio-technical system in form of work 4.0.
- This results in a "double" need for qualification for SMEs: to understand technical innovations and requirements for personnel management and to implement them operationally.
- The project aims to develop, test and disseminate a qualification concept for SMEs that integrates technical, organizational and human aspects and supports SMEs in the digital transformation.
The Fourth Industrial Revolution is supported by the collaboration in social networks.

Based on: H.-J. Warnecke (1992) Fraktale Fabrik
Changes in four core areas increase productivity and influence daily work

4. Industrial Revolution

Collaboration
Productivity
- Human/Human
- Human/Machine
- Machine/Machine

Physical systems: automation
Sensor Technology
Cognitive Systems

Physical systems: speed
Simulation
High Speed Computing
Save in der Cloud

Social behaviour: cooperation
Business Communities
Social Communities

IT-Hardware: speed

IT-Software: truth
PLM-Systems
ERP-Systems

Hardware
Software

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Future needs for competencies and abilities are changing

<table>
<thead>
<tr>
<th>Competence requirements of the companies (N=220)</th>
<th>Need for future employee skills (N=216)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data evaluation and analysis</td>
<td>Interdisciplinary thinking and action</td>
</tr>
<tr>
<td>Process management</td>
<td>Increasing process know-how</td>
</tr>
<tr>
<td>Customer relationship management</td>
<td>Leadership competence</td>
</tr>
<tr>
<td>Dealing with specific IT systems</td>
<td>Participation in innovation processes</td>
</tr>
<tr>
<td>IT business analysis</td>
<td>Problem solving and optimization competence</td>
</tr>
<tr>
<td>IT-security</td>
<td>Independent decisions</td>
</tr>
</tbody>
</table>

Data evaluation and analysis: 60.6%
Process management: 53.7%
Customer relationship management: 46.5%
Dealing with specific IT systems: 45.6%
IT business analysis: 44.1%
IT-security: 41.6%
Interdisciplinary thinking and action: 61.1%
Increasing process know-how: 56.2%
Leadership competence: 55.4%
Participation in innovation processes: 54.2%
Problem solving and optimization competence: 53.7%
Independent decisions: 50.0%

"The digital divide between the large and small enterprises must not become too wide. Small and medium-sized enterprises in particular should therefore continue to train their workforce for the step into industry 4.0 and use innovative learning solutions".

Citation: www.acatech.de, download 22.4.2016

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Fraunhofer IPT

RWTH Aachen University

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Framework concept for knowledge and competence development for operational and intercorporate actors: **WHAT** to qualify?

<table>
<thead>
<tr>
<th>Innovative capability (absorptive capacity)</th>
<th>Digital production und logistics</th>
<th>Digital work (digital literacy)</th>
<th>Organizational learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Knowledge of Industry 4.0</td>
<td>• Business models and processes</td>
<td>• Basic IT knowledge</td>
<td>• Systems und data</td>
</tr>
<tr>
<td>• Company learning projects</td>
<td>• Technical and software</td>
<td>• Media literacy and online</td>
<td>• Evaluation and</td>
</tr>
<tr>
<td>• Personnel planning and development</td>
<td>architectures</td>
<td>skills</td>
<td>comprehension of data</td>
</tr>
<tr>
<td></td>
<td>• Work organization 4.0</td>
<td>• Information literacy</td>
<td>• The company as learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Problem solving</td>
<td>organization</td>
</tr>
</tbody>
</table>

**Identifying and implementing innovations require knowledge and experience**

**Designing decentralized self-organizing units**

**Decentralized units require competencies**

**The learning organization needs data, systems and strategies**

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To successfully create participation, co-determination und operational agreements (workplace innovation)
Methodology for implementation of the comprehensive qualification: HOW to qualify?

- Operational Innovation and learning projects
- Company and inter-company workshops for the development of solutions and the exchange of experience
- Work-oriented and explorative learning groups for knowledge and competence development
- Research: Transdisciplinarity and Demonstration Factory

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2. Project presentation

   2.1 Company learning projects

   2.2 Qualifications
Overview of company learning projects SME 4.0

Source of Image Production: DFA Demonstrationsfabrik Aachen GmbH

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Example: recording current process

1. **Distribution**
   - creating an order in the ERP System
   - physical transfer of the project file

2. **Design**
   - packing design (production order)
   - Only delivery date, production start unknown

3. **Purchase**
   - material planning (Excel)

4. **Production**
   - production planning with group leaders - working papers
   - material withdrawal
   - material preparation (surface)
   - storage of material
   - order-specific production
   - assembly package
   - final inspection & notification of completion shipping

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Verbauchserfassung je Auftrag
Ein-/Ausbuchung Lager (Vorproduktion im System)
Production outside ERP/Navision
Verbauchserfassung je Auftrag

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Example: view of a functional excel-mock-up
**Example: design of mock-up**

As soon as **new orders** are added from the ERP and they have not yet been planned, the signal light changes to yellow (as soon as saved: changing to green).

Master data **dynamically adjustable** by double-clicking on the respective field; deviations during update lead to changed cell color.

<table>
<thead>
<tr>
<th>Geplante Aufträge</th>
<th>Start-termin</th>
<th>Soll-menge</th>
<th>End-termin</th>
<th>Verfügbarkeit (Beleg/Verfügbar)</th>
<th>Planung Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>00-99020-7090 (+1)</td>
<td>29.01.2018</td>
<td>624</td>
<td>30.01.2018</td>
<td>65% (30,9/48h)</td>
<td>✔</td>
</tr>
<tr>
<td>00-99020-7090 (+1)</td>
<td>29.01.2018</td>
<td>862</td>
<td>30.01.2018</td>
<td>65% (30,9/48h)</td>
<td>✔</td>
</tr>
</tbody>
</table>

**Saving the changes.**

**New orders** are additionally highlighted in white until they are saved.
Example: prototype of developed tools
Agenda

1. WZL of the RWTH Aachen University

2. Project presentation
   2.1 Company learning projects
   2.2 Qualifications
The qualification offers are part of the framework concept for the overall qualification of SME 4.0

**Workshop series „Fit for the Digitalization“**
Training for specialists and employees

<table>
<thead>
<tr>
<th>Digital work (digital literacy)</th>
<th>Organizational learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Basic IT knowledge</td>
<td>• Systems und Data</td>
</tr>
<tr>
<td>• Media literacy and online skills</td>
<td>• Evaluation and Comprehension of Data</td>
</tr>
<tr>
<td>• Information literacy</td>
<td>• The company as a learning organization</td>
</tr>
<tr>
<td>• Problem solving</td>
<td></td>
</tr>
</tbody>
</table>

Decentralized units require competencies

**Innovationen erkennen und umsetzen benötigt Wissen und Erfahrung**

- Wissen über Industrie 4.0
- Betriebliche Lernprojekte
- Personalplanung und -entwicklung

**Dezentrale selbstorganisierende Einheiten gestalten**

**Beteiligung, Mitbestimmung und Betriebsvereinbarungen erfolgreich gestalten** (workplace innovation)
Example: workshop series „Fit for the Digitalization“ I/II

Key data

Target group: specialists, employees

Duration: 0,5 Day preparation and post-processing with company management; 1,5 days workshops (module 1 and 2)

Number of participants: max. participants: 8

Description

- Digital transformation requires continuous learning.
- Due to the dynamics of development and the age structures in companies, this change can be mastered to a large extent with the existing workforce, whose average age is often around 45-50 years.
- Against this background, early information, motivation and participation of employees in the digitalization process are essential for successfully managing change in the company.
- This series of workshops enables employees to better understand digitalization and to play a reflected and active role in digitalization. It is embedded in the company's development as an operational approach.

Learning outcomes

- Penetrating the basics of digitalization
- Developing thinking in successive work steps (interdependencies)
- Identifying automation capabilities through digitalization in individual work processes and increasing process analysis capabilities
- Identifying media discontinuities, waste and possibilities for optimizing processes
- Removal of emotional barriers (concerns about new technologies)
- Enabling the participants to deal with technological developments on their own initiative ("attractiveness" of learning processes)
Workshop series „Fit for the Digitalization“ II/II

**Key data**

**Target group:** specialists, employees

**Duration:**
0.5 Day preparation and post-processing with company management; 1.5 days workshops (module 1 and 2)

**Number of participants:** max. participants: 8

---

**Workshop content**

<table>
<thead>
<tr>
<th>Duration</th>
<th>Module</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 day</td>
<td>Preparation</td>
<td>Multiple tasks related to workshop preparation</td>
</tr>
<tr>
<td>0.5 day</td>
<td>Module 1: “Basics of Digitalization”</td>
<td>Preparation of specific workshop concept, role and responsibilities of participants, presentation of workshop concept, elaboration of company-specific workshop concept, digitalization in experiential world, working out essential principles, Industry 4.0, networking within and between departments, company-wide networking, smart products and services, basic understanding of Digitalization, consciousness-raising of mindsets and expectations</td>
</tr>
<tr>
<td>1 day</td>
<td>Module 2: “Fit for the Digitalization”</td>
<td>Digitalization in company and in your own workspace, process improvement through digitalization, reflection and evaluation of the effects on activities, requirements, working conditions, presentation of group results in front of the executive board, understanding of company changes, ideas for process improvement through digitalization, sensitization for the impact of digitalization</td>
</tr>
<tr>
<td>0.25 day</td>
<td>Post-processing</td>
<td>Presentation and discussion of the results, further steps</td>
</tr>
</tbody>
</table>
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Production Engineering at the RWTH Aachen University

Laboratory for Machine Tools and Production Engineering (WZL)
- institute of the RWTH Aachen
- founded in 1906
- approx. 840 employees (approx. 220 research assistants)
- 10 000m² office space and laboratories

Fraunhofer Institute for Production Technology IPT
- institute of the Fraunhofer Society
- founded in 1980
- approx. 340 employees (approx. 60 research assistants)
- 3 000 m² office space and laboratories

Demonstration Factory Aachen
- Industry 4.0 reference factory
- founded in 2013
- 1 600 m² production area
- real production environment for empirical research and further training
Operating principles at WZL – science for practice

- Identifying the problems together with the need for action
- Researching on the challenges of industrial practice
- Developing innovative methods and tools
- Demonstrating the practical suitability of the methods and tools
- Applying methodologies and tools for structured problem solving
- Solutions for the practice
- Challenges of the industry

Problem solutions of application-oriented science for the practice
Production management at WZL
Design and organization of an agile production...

...FROM NETWORK...

Network strategy & Site roles
Network design
Location decision
Organization anchoring

GLOBAL PRODUCTION

PROCESS MANAGEMENT

PROCESS LOGISTICS

Lean Management
Location strategy
Production structure
Production planning and control

Business Process Management

Optimization of order processing

Production Systems

Industry 4.0 roadmapping

Production Analytics

Lean Management

Possibilities of collaboration

Consulting projects
Research cooperation
Seminars & Trainings
Studies & Benchmarks
Reference factory I 4.0

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The 4th industrial revolution forces companies to act

„… the effects of the fourth industrial revolution will be… as profound as in the case of the preceding industrial revolutions, which also unfolded their full effect only within decades…“¹

„Qualification for work in digitally networked processes and systems poses a major, perhaps the greatest social challenge in making our country fit for the future..“²

Source: ¹ Kagermann, 2014, S. 603
Chart: Google Trends, Abfrage April 2016 für Deutschland. Suchinteresse relativ zum Höchstwert im Chart.
Key trends and challenges for companies on the way to industry 4.0

"Digitalization": Development and implementation of technology

"Cyber-physical systems are socio-technical systems"

"Informisation": Knowledge and competence development

"Acceleration": Organizing company control loops
Sequence of company learning projects

For each company, company workshops are conducted, which are assigned to the 4 phases of the company learning project:

1. Definition and planning of the company learning project "Industry 4.0"
2. Development and adoption of the solution approach „Industry 4.0 in the learning project“
3. Development and adoption of the personnel development concept "Industry 4.0" and the necessary qualification measures
4. Evaluation of company learning projects
## Qualification offers for pilot companies

<table>
<thead>
<tr>
<th>Phase</th>
<th>Target group</th>
<th>Training module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Decision-maker</td>
<td>RWTH-certificate course</td>
</tr>
<tr>
<td>Phase 2</td>
<td>Process planner</td>
<td>Digital production and logistics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Architectures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Work organization</td>
</tr>
<tr>
<td></td>
<td>Staff association</td>
<td>Workplace innovation</td>
</tr>
<tr>
<td>Phase 3</td>
<td>Management</td>
<td>Leadership and communication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Industry and work organization 4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Executive as coach</td>
</tr>
<tr>
<td></td>
<td>Employees</td>
<td>Digital literacy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Basis knowledge IT/media</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Problem solving</td>
</tr>
<tr>
<td>Phase 4</td>
<td>Skilled employees</td>
<td>Organizational learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Systems and data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Evaluation and comprehension of data</td>
</tr>
</tbody>
</table>
The qualification offers are part of the framework concept for the overall qualification of SMEs 4.0

### Workshop series „Learning from Data“:

*Training of specialists, employees, managers*

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<thead>
<tr>
<th>Innovationen erkennen und umsetzen benötigt Wissen und Erfahrung</th>
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<td>• Media literacy and online skills</td>
</tr>
<tr>
<td>• Personalplanung und -entwicklung</td>
<td>• Information literacy</td>
</tr>
<tr>
<td>• Geschäftsmodelle und -prozesse</td>
<td>• Problem solving</td>
</tr>
<tr>
<td>• Technik- und Software-Architekturen</td>
<td></td>
</tr>
<tr>
<td>• Arbeitsorganisation 4.0</td>
<td></td>
</tr>
</tbody>
</table>

### Dezentrale selbstorganisierende Einheiten gestalten

- Decentralized units require competencies

### Organizational learning

- The learning organization needs data, systems and strategies

- Systems and data
- Evaluation and comprehension of data
- The company as a learning organization

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**Beteiligung, Mitbestimmung und Betriebsvereinbarungen erfolgreich gestalten**

(workplace innovation)
Example: workshop-series
“data analytics for SMEs - learning from digital data”

Key data

Target group: specialists, employees, managers

Duration: 1 day

Number of participants: max. participants: 12

Description

- The workshop is offered as an all-day inter-company measure. It is divided into two half days.
- The first half day (morning) is more input-oriented and teaches concepts and examples as well as methods and technologies for data analytics.
- The second half day (afternoon) has a stronger workshop character and serves to jointly point out starting points for data analytics in your own company and to describe them in a qualified manner with regard to essential characteristics.

Learning outcomes

- Deepening and updating knowledge about possibilities in the area of data analytics for SMEs as well as current IT-supported tools
- Qualified identification and description of starting points for data analytics in your own company

Workshop content

- Introduction into digitalization
- Data Analytics in Production Management
- Participants’ experiences with data analytics
- Explorative data analysis und visualization
- Data-based decision making
- Modelling and forecasting
- IT-Tools using the example of „R“
- Identification and evaluation of starting points in your own company