Industry 4.0: new challenges for work and qualification

Workshop „Technology and Work from a TA perspective”

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Georg Aichholzer
Overview

- Background
- Industry 4.0
- Impact on society: first assessments
- Focus on employment, work & qualifications
- Policy options
Industry 4.0

- Vision of a novel stage of industrial production
  - Digital integration throughout the value chain
  - Largely self-controlled, sensor-steered, self-optimising
  - Communication between humans, machines, parts, products (Cyber-physical systems)
  - Industrial Internet of things and services
- Far-reaching expectations
  - Increased productivity, flexibility, resource efficiency; competitiveness, reindustrialisation, reshoring
Technological drivers

- Performance increase in processors, memories and sensors
- Autonomous systems (adaptive industrial robots, software agents)
- Identification of objects, machines and people using (RFID) etc.
- Expansion of the Internet of Services, Internet of Things and Services
- Mobile communication between smart objects, machines and people
- Cloud computing and Big Data analytics
- New mobile interfaces and augmented reality applications
- Virtual design and digital modelling
- 3D printing and other decentralized production technologies
## The paradigm change in manufacturing

<table>
<thead>
<tr>
<th></th>
<th>Mechanisation</th>
<th>High volume prod.</th>
<th>Automation</th>
<th>Intelligence</th>
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</thead>
<tbody>
<tr>
<td>Production system</td>
<td>Manufactory</td>
<td>Taylorism</td>
<td>Toyota System</td>
<td>Learning Factory</td>
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<tr>
<td>Production structure</td>
<td>Factory system</td>
<td>Focussing</td>
<td>Modularisation</td>
<td>Virtualisation</td>
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<tr>
<td>Product structure</td>
<td>Individual parts</td>
<td>Standardisation</td>
<td>Complexity</td>
<td>Adaptive variability</td>
</tr>
<tr>
<td>Flexibility vs. Productivity</td>
<td>Ratio ≈ 1</td>
<td>Ratio ≪ 1</td>
<td>Ratio &lt; 1</td>
<td>Ratio ≈ 1 (adaptable)</td>
</tr>
<tr>
<td>Worker</td>
<td>All-rounder</td>
<td>Specialist</td>
<td>Flexible</td>
<td>Self organizing</td>
</tr>
<tr>
<td>Markets</td>
<td>Regional product</td>
<td>Globalization</td>
<td>Regionalization</td>
<td>Localization</td>
</tr>
<tr>
<td>Resource efficiency</td>
<td>Extensive use</td>
<td>Intensive use</td>
<td>Careful use of res.</td>
<td>Recycling</td>
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Key fields of impact

- Employment
- Work organisation
- Education and training
- Health and wellbeing
- Use of resources
- Economy and competition
- Safety and security
- Technical standards
- Regulation
Employment

• Impact on volume of employment: uncertain
  • Contradictory projections, many determinants
    (e.g. extent of automation, success in marketing I 4.0 components, external factors, e.g. at product level, materials, demography, global)

• Changing structure of employment
  • Increase of higher skilled jobs, new skill groups

• Challenges
  • Solutions for redundant workforce (if “jobless growth”)
  • Realising opportunities to improve job quality
Impacts on work organisation

• Various patterns of work organisation possible (design decisions)
  • Between „polarisation“ and „swarm organisation“ (skill upgrading)
• Flexible man-machine cooperation
  • Centrality or substitution of humans?
• Massive change with effects on skills, flexibility, working time, hierarchy,
• Challenges
  • Anticipatory, socially compatible design decisions
  • Balanced automation- and implementation concept
  • Attractive task profiles in man-machine cooperation
Trend towards “blended workforce”

- “Combines a variety of employees on different contracts, including permanent full-time staff, part-time, temporary workers, contractors and freelancers”
- Can encourage diversity but first of all provides leeway to employers
- Industry 4.0 adds robots and logic of global value chain (“crowd organisation”)
- Increased substitutability, further de-limitation of work
Impacts on vocational education and training

• New skill and training demands
  • IT skills; systemic thinking; interdisciplinary collaboration
  • Meta-cognitive key qualifications; readiness for lifelong learning;
  • New technical and social skills; new occupations (e.g. data-scientist; system security engineer)

• Challenges
  • Adequate skills for implementation and operation
  • Problem aggravation among low- and unskilled workers
  • Permanent further education (on-the-job/workplace-near)
  • Qualification pressure (especially for older employees)
Towards more concrete qualification demands

• General skill profiles dominate, differentiation missing
  • By sector, user vs. producer, system vs. component supplier, etc.

• Starting from major technical characteristics (Pfeiffer 2015)
  1. data@production (data-based networking of physical objects)
     • CPS, real-time parts-/service tracking, big data analytics,
       anticipatory maintenance, personalised products,
       self-controlled production
  2. nextGen.production (lightweight robots, drones, 3-D printer, etc.)
  3. body&mind (wearables, smart gloves, quantify-me apps)
  4. socialmedia@prod (shift doodle, KVP apps, etc.)
## Impacts of industry 4.0 on skill demands

<table>
<thead>
<tr>
<th>Change dimension</th>
<th>Magnitude of change</th>
<th>Nature of change / skill demands</th>
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</thead>
<tbody>
<tr>
<td>1. data@production</td>
<td>High</td>
<td>Disruptive; formal qualification in dealing with data; ability to relate offline and online; upgrading in industrial and logistic core</td>
</tr>
<tr>
<td>2. nextGen.production</td>
<td>Medium</td>
<td>For skilled workers: incremental learning of machine control possible; partially new procedures; increased complexity</td>
</tr>
<tr>
<td>3. body&amp;mind</td>
<td>Medium</td>
<td>Depending on design decisions; risk of downgrading in full automation scenario</td>
</tr>
<tr>
<td>4. socialmedia@prod</td>
<td>Low</td>
<td>Comparatively unproblematic; learning by doing</td>
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Qualification: policy options

1. **Framework conditions**
   Prioritisation, sensitisation, coordination, regulation to promote qualification for industry 4.0

2. **Education and training system**
   Institutional reforms for improved access and mobility, dualisation, focusing I 4.0 promotion on medium qualification segments

3. **Qualification contents**
   Basic digital skills for all, adaptation of technical and extra-technical qualifications (e.g. multi-disciplinary, social, communicative), new occ.

4. **Company level**
   Improving company level VET for Industry 4.0, promoting a culture of innovation, participation and skill transfer
Thank you for your attention!

Contact:
Georg Aichholzer
Institute of Technology Assessment
A-1030 Vienna, Strohgasse 45/5
Tel: +43 (1) 51581 6591
Fax: +43 (1) 7109883
Email: aich@oeaw.ac.at
WWW: www.oeaw.ac.at/ita