Robotics and Artificial Intelligence: Policy Implications for the Next Decade

- International Panel -

Dr. Robin Mishra
Structure

1. TV Thriller 4.0
2. Research 4.0
3. Industry 4.0
4. Work 4.0
1. TV Thriller 4.0

„Tatort“ – German Crime Series

→ TV Market Share (2015): 25,8 %

Tatort Stuttgart „HAL“ on August 28, 2016
Tatort Bremen „Echolot“ on October 30, 2016
2. Research 4.0

Center for Robotics & Mechatronics (RMC) at DLR (Oberpfaffenhofen)

- Core Competence RMC:
  - interdisciplinary (virtual) design
  - computer-aided optimization & simulation
  - implementation of complex mechatronic systems & human-machine interfaces

- Robotics community → one of the world leading institutions

- Research areas:
  - Flying Robots,
  - Medical Robotics,
  - Personal robot assistance
Fraunhofer Institute for Factory Operation and Automation IFF (Magdeburg)

- Research areas:
  - Digital Engineering & Industry 4.0
  - Convergent Supply Infrastructures
  - Smart Work Systems
  - Resource efficient production
    - make factories more energy efficient
    - reducing transportation
    - implementing smart energy cascades
    - closed energy & material cycles
Max Planck Institute for Intelligent Systems (Stuttgart, Tübingen)

- future-oriented research on intelligent systems
- 3 scientific departments:
  - Perceiving Systems
  - Autonomous Motion
  - Empirical Inference
German Research Center for Artificial Intelligence (Kaiserslautern, Saarbrücken, Bremen)

- Leading German research institute in field of innovative software technology
- Public-private partnership: among shareholders are BMW, Volkswagen, Deutsche Telekom, Bosch; but also Google, Intel, John Deere
- Variety of projects & applications:
  - Multilingual Technologies, Plan-based Robot Control, Educational Technology Lab, Robotics Innovation Center, Intelligent Analytics for Massive Data, etc.
3. Industry 4.0

- Mechanization: first mechanical weaving loom, 1784
- Electrification: first assembly line, 1870
- Automation: first storable-programmable control, 1969
- Networking: Industry 4.0

Timeline:
- 1800
- 1850
- 1900
- 1950
- 2000
- 2050
Economic potential of Industry 4.0 for Germany

Forecast until 2025:

- up to 430,000 new jobs
  → simultaneous elimination of 490,000 low-skilled jobs *
- GDP growth of about 30 billion EURO **
- Total investment of about 250 billion EURO **

Source:
* Study: IAB, BIBB, GWS (November 2015)
** BCG-Study: Industry 4.0 (April 2015) from Prof. Neugebauer SFU 2015
# Global economic potential of the Internet of Things

<table>
<thead>
<tr>
<th>Nine settings where added value is expected</th>
<th>Size in 2025, $ trillion¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factories</strong> – eg., operations management, predictive maintenance</td>
<td><a href="#">Low estimate</a></td>
</tr>
<tr>
<td><strong>Cities</strong> – eg., public safety and health, traffic control</td>
<td><a href="#">Low estimate</a></td>
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<tr>
<td><strong>Human</strong> – eg., monitoring and managing illness, improving wellness</td>
<td><a href="#">Low estimate</a></td>
</tr>
<tr>
<td><strong>Retail</strong> – eg., self-checkout, smart customer-relationship</td>
<td><a href="#">Low estimate</a></td>
</tr>
<tr>
<td><strong>Logistics</strong> – eg., logistics routing, autonomous vehicles, navigation</td>
<td><a href="#">Low estimate</a></td>
</tr>
<tr>
<td><strong>Work sites</strong> – eg., operations management, equipment maintenance</td>
<td><a href="#">Low estimate</a></td>
</tr>
<tr>
<td><strong>Vehicles</strong> – eg., condition-based maintenance, reduced insurance</td>
<td><a href="#">Low estimate</a></td>
</tr>
<tr>
<td><strong>Homes</strong> – eg., energy management, safety and security</td>
<td><a href="#">Low estimate</a></td>
</tr>
<tr>
<td><strong>Offices</strong> – eg., augmented reality for training</td>
<td><a href="#">Low estimate</a></td>
</tr>
</tbody>
</table>

¹Adjusted to 2015 dollars, for sized applications only; includes consumer surplus. Numbers do not sum to total, because of rounding.

**Total $4 trillion - $11 trillion**

*Source: McKinsey Global Institute analysis, June 2015*
Consequences for German economy

**Challenges:**
- Export-oriented economy
- Reliance on industries that are challenged by machine learning/AI (e.g. automotive, manufacturing, engineering)
- Data protection laws may slow down machine learning

**Opportunities:**
- Strong industrial base (GER Industry accounts for 30% of GDP compared to 20% in USA, GB, F)
- Strength in incremental (vs. disruptive) changes
- Structure of SME and family-owned „hidden champions“
- High quality universities and research organizations
- Vocational and educational training system
Consequences for individual companies

**Challenges:**
- Platforms and consulting companies may challenge existing B2B business models
- Risk aversion that may lead to slower adaptation of machine learning
- Data sharing beyond corporate boundaries
- Limited size and scalability

**Opportunities:**
- Minimize time for development and reduce downtimes
- Predictive maintenance
- Competitive advantage through real data about production processes
- Smart sensors / mixed reality interfaces
4. Work 4.0

Weißbuch (White Paper) Work 4.0

- published on November 29, 2016
- summarized conclusions of dialogue about „work 4.0“
- documents broader social debate
- stimulus for social design of the future of work
Labor Market is transforming

**Challenges:**

- Digital transformation → lead to unemployment (esp. for low skilled workers)

![Bar chart showing the probability of automation across different levels of education in Germany and USA.](chart.png)

- Primary Education
- Lower Secondary Education
- Upper Secondary Education
- Post-secondary (non-tertiary) Education
- Technical College Degree
- University/College Degree
- Ph.D.

**Legend:**

- Germany
- USA
Labor Market is transforming

**Challenges:**
- Digital transformation → lead to unemployment (esp. for low skilled workers)
- Quick devaluation of qualifications
- Demographic Change

**Opportunities:**
- New jobs in services, healthcare, education etc.
Labor Market is transforming

Predicted number of employees in selected industries, 2014 – 2030 (in 1000)

- Public Administration: -427
- Hospitality Industry: -259
- Metal Production & Processing: -216
- Retail: -168
- Engineering: -134
- Vehicle Construction: 106
- Electronic Engineering & Optics: 198
- Research & Development: 119
- Education & Teaching: 142
- Healthcare: 180
- Social Services: 306
- IT-Services: 239
- Business, Legal & Tax Advices: 317
- Other Business Services: 531
Labor Market is transforming

**Challenges:**
- Digital transformation → lead to unemployment (esp. for low skilled workers)
- Quick devaluation of qualifications
- Demographic Change

**Opportunities:**
- New jobs in services, healthcare, education etc.
- New quality of learning on the job
- Demographic dividend
Labor Market is transforming

**Tools:**

- Strengthen digital literacy
- Strategy for lifelong qualification & upskilling (turning unemployment insurance into a labor insurance?)
- Incentives & benefits for founders and start-ups
Working Conditions are changing

**Challenges:**
- Removal of boundaries between work and leisure
- Excessive demand on employees

![Bar chart showing working conditions over time](chart.png)

- Evening work
- Night work
- Saturday work
- Sunday work

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Working Conditions are changing

**Challenges:**
- Removal of boundaries between work and leisure
- Excessive demand on employees

**Opportunities:**
- Getting rid of physically and psychologically demanding work
- Sovereignty of working time and working place
- Self-determined life planning

**Tools:**
- Collective or company agreements with room for experimental spaces
- Working time accounts
Thank you for your attention!

“We’re looking for someone with your exact qualifications, but a mechanical version.”

For further information: www.germany.info
Follow @GermanyinUSA @MishraRob on Twitter