

# The Future of Higher Education in Times of Digitalization – The German Case

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Lifelong Learning and Higher Education Expert Meeting

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## Three quotes ...



*Till Reuter (CEO Kuka):*

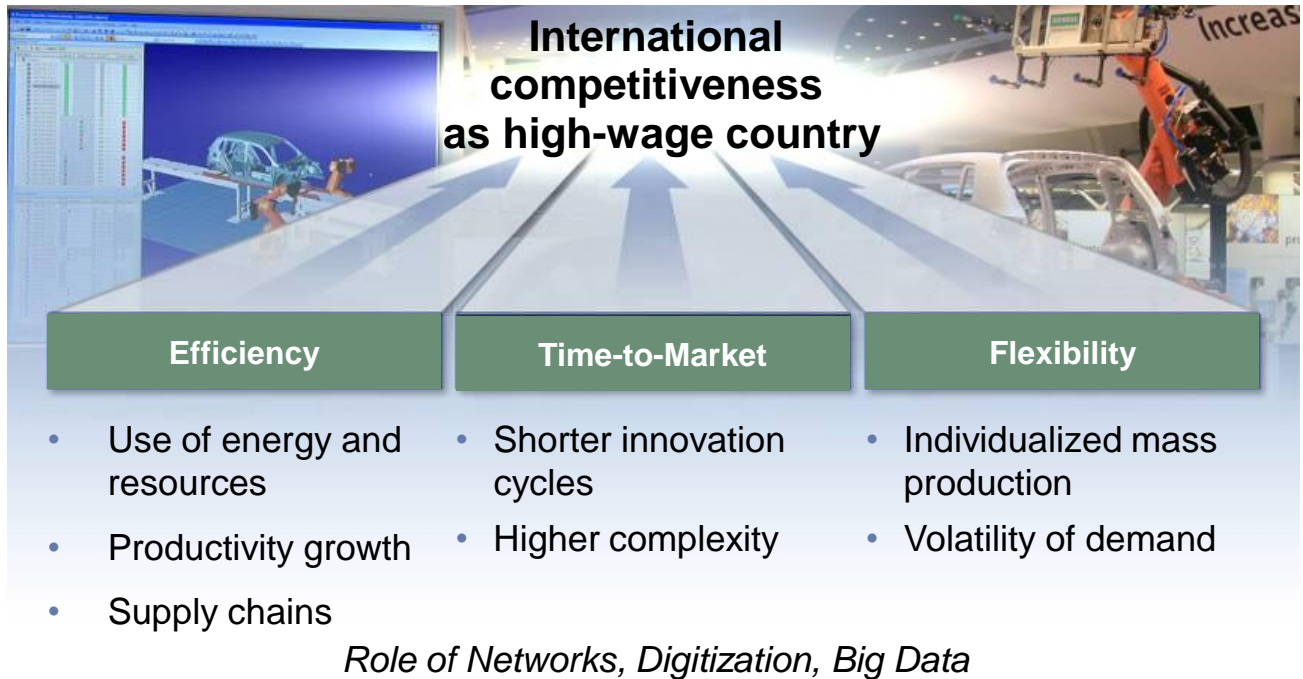
“For the current generation working with the computer is normal. For the next generation it will be working with robots “  
(Süddeutsche Zeitung, 11.06.2015, my translation)

*Carly Fiorina (vormalige CEO HP):*

„Everything that can be digitized will be digitized“

*Richard Freeman (Harvard) :*

“Robots, that is any sort of machinery from computers to artificial intelligence programs that provides a good substitute for work currently performed by humans, can increasingly replace workers, even highly skilled professionals, and thus reduce opportunities for good jobs and pay.”



**Possible acceleration of structural change**

## *Cyber-physical (production) systems*

- “... concepts of robotics and sensor networks with intelligence mechanisms proper of computational intelligence ...”\*

## *Soft robotics*

- robots are leaving their enclosures and are increasingly interacting with humans

## *Smart glasses*

- powerful device for enhancing workers’ abilities

## Ongoing technological development (2)



- *Big data*
  - Storage capacity of data doubles every 40 months, 90% of data generated within the last two years
- *3D printing*
  - Trends: more materials, lower costs ...
- *Remote maintenance systems*
- *Prosumers*
  - FabLabs, design by customer ...

# Success factors for an economy facing the new developments



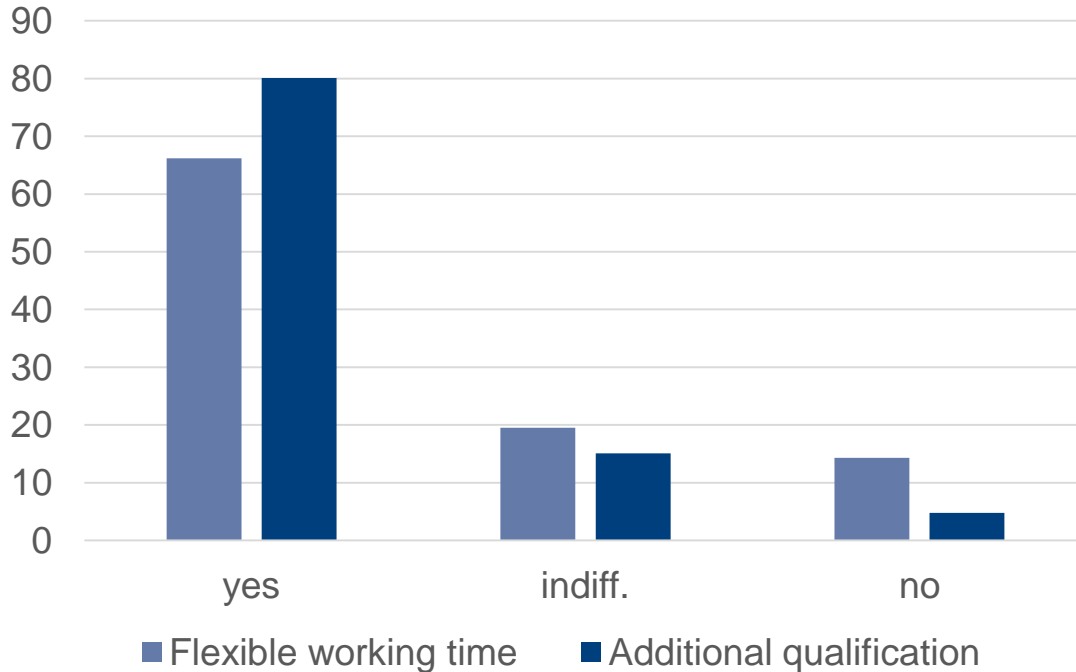
- A good “operating system”
  - Property rights, legal certainty, data security, effective administration, timely standardization
  - Effectiveness of educational system and continuing process of training (lifelong learning)
- Fostering innovativeness
  - Innovative milieus, entrepreneurship, risk capital
  - Attractiveness for innovative people
  - Diversity in solidarity

# Consequences ...



- Increasing knowledge intensity of production leads to faster and more complex work processes
- New possibilities in the man/machine interaction
  - High potential for more efficiency in manufacturing and services
- Extended substitutability of labour
  - Not only routine jobs at risk
- Increasing demand for flexibility

# Firms expectation of changes in requirement for labour characteristics





# Effects on the labour market

- Aggregate labour demand
  - Worker redundancies or shortages?
  - Interference with demographic change?
- Employment structure
  - Qualification structure?
  - Changes in tasks, professions?
- Dynamic adjustments
  - Matching problems
  - Internal and/or external flexibility

## ■ Qualifications

- Changes in employment shares of high, intermediate and low skilled
- Higher specificity of jobs
- More qualification within the firm, *training-on-the-job*

## ■ Tasks

- Increase in creative, planning, steering, communicative, socially interactive, decision making and problem solving tasks – decrease in routine tasks

## Chances ...

- Participation: higher self responsibility, self development of workers
- Humanisation of the workplace,  
Inclusion of disabled workers

## Challenges ...

- External determination, excessive control

## Requirements ...

- Institutionalisation of a continuing process of advanced training

# Qualifications

# Changes in the demand for skill over time



## 1<sup>st</sup> Industrial Revolution:

- Need of all kind of industry workers

## 2<sup>nd</sup> Industrial Revolution:

- High division of labour, assembly lines, Taylorism: relative productivity gains of low skilled workers

## 3<sup>rd</sup> Industrial Revolution:

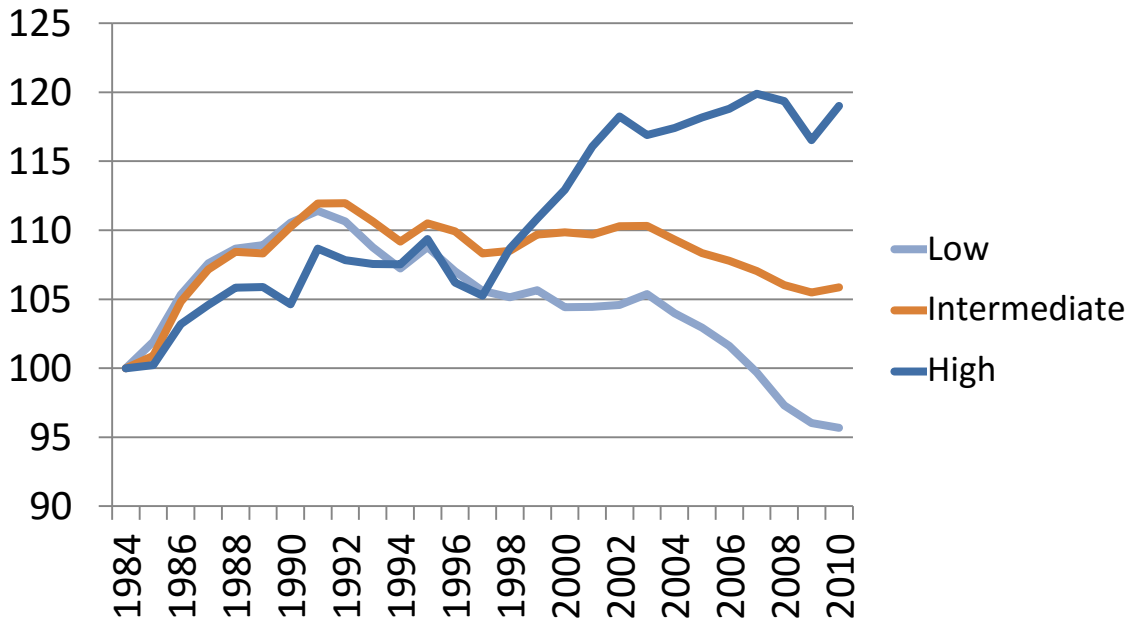
- Computerisation: increasing demand for high skilled workers, low skilled workers falling back

## 4<sup>th</sup> Industrial Revolution:

- CPS, digitalisation: Likely increase in the demand for high level engineering, IT knowledge, problem solving competences
- Possible increase of productivity of low skilled through knowledge-based assistance systems

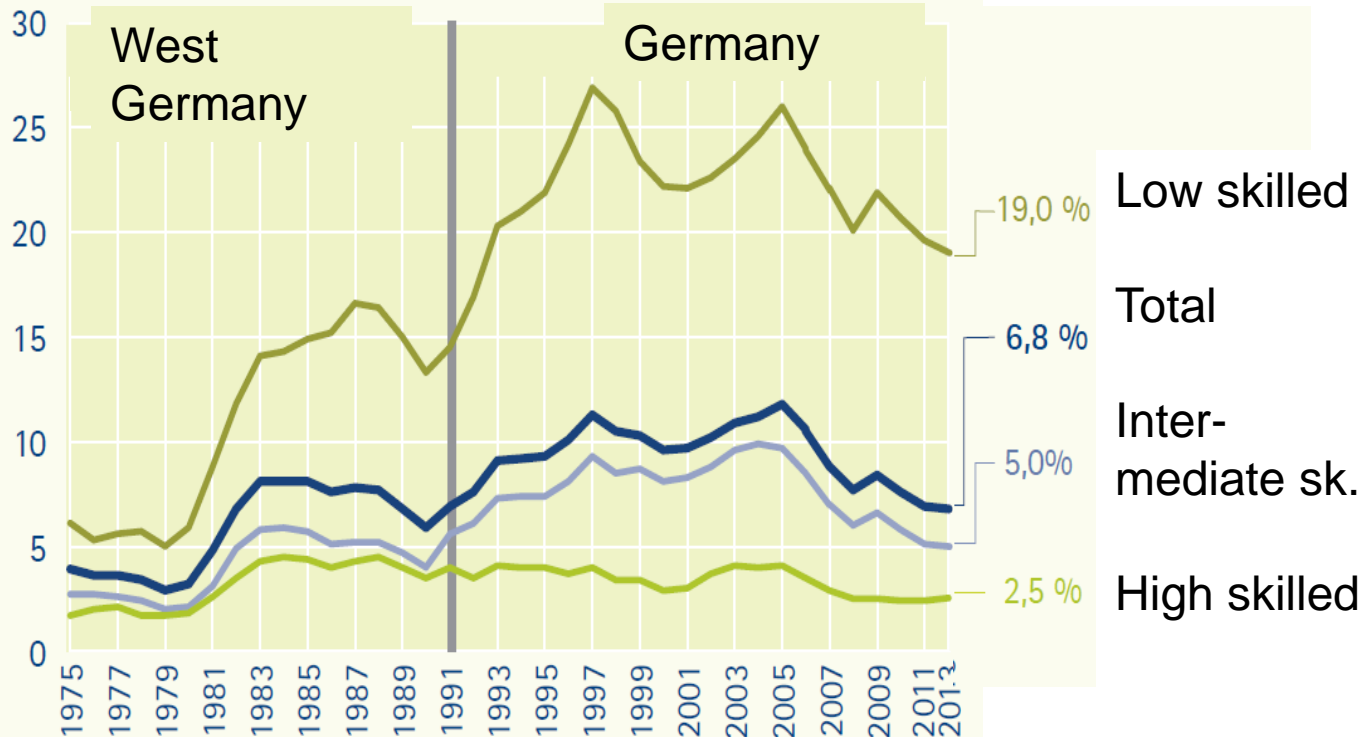
# Since the mid-1990s: increasing wage differentials in favour of the high skilled

*Real gross wages by skill level 1984-2010*



(Index 1984=100, male full-time workers, aged 40, West Germany)

# Unemployment falls with the skill level of the worker





# High-skilled workers clearly the winners in the last 25 years



- Higher employment shares of high skilled throughout the economy, low unemployment
  - Increasing skill differentials despite a higher supply of high skilled workers
- Unambiguous evidence for an increase in the relative demand for high skilled

Will this process continue?

- Acceleration of structural change (more qualified services)
- Winners: IT-professions and teaching occupations
- Losers: Manufacturing jobs, particularly steering of machines and maintenance of equipment
- Higher relative demand for high skilled
- Less jobs with high share of routine tasks

# Tasks

# Future demand for tasks and occupations

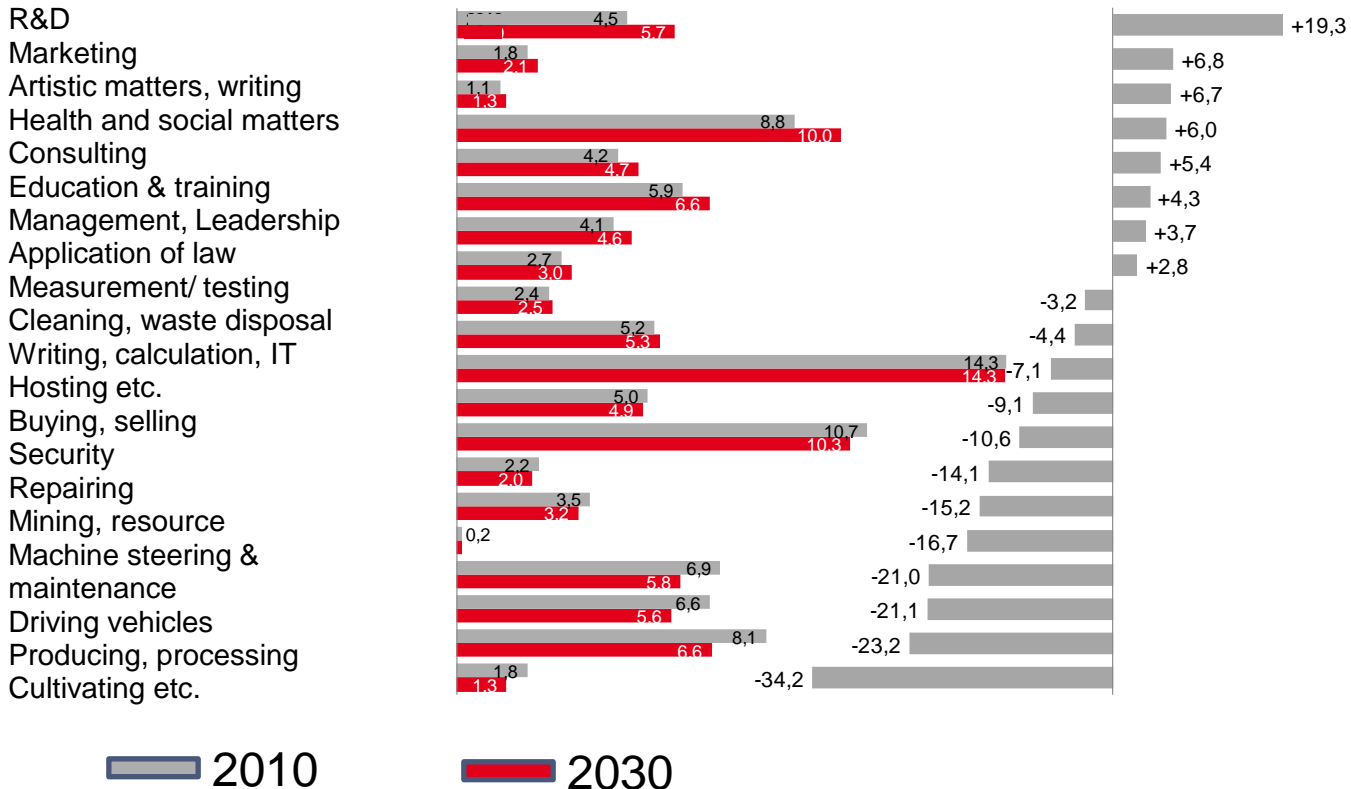


Is the demand for certain professions/ tasks/ occupations in 15, 20 or 30 years predictable?

Complex influences through ...

- ... technical progress (substitution of workers)
- ... global competition (*offshoring, re-shoring*)
- ... changes in consumer demand, tastes ...

# A conventional attempt: occupations 2030 vs 2010, winners and losers



# Factors determining the substitution of task through technology and computerisation



## Results of previous task-based approach:

- High substitutability in case of
  - manual and cognitive routine tasks
- Low substitutability in case of
  - Interactive tasks (simple or complex)
  - Knowledge intensive and creative tasks
- New developments ...

*Carl Frey and Michael Osborne*

*“Following recent technological advances, however, **computerisation is now spreading to domains commonly defined as non-routine.**”*

*“Nonetheless, the trend is clear: **computers increasingly challenge human labour in a wide range of cognitive tasks.**”*

*(Frey, Osborne 2013)*

# The Frey, Osborne (2013) approach



## Frey, Osborne (2013)

- Rapid technical development (mobile/soft robotics, machine learning) leads also to substitution of more complex (non routine) cognitive tasks
- More protected tasks are activities requiring
  - perception and manipulation
  - creative intelligence
  - social intelligence
- Calculation of the potential risk of replacement for different professions

# Results of different studies using the Frey and Osborne approach

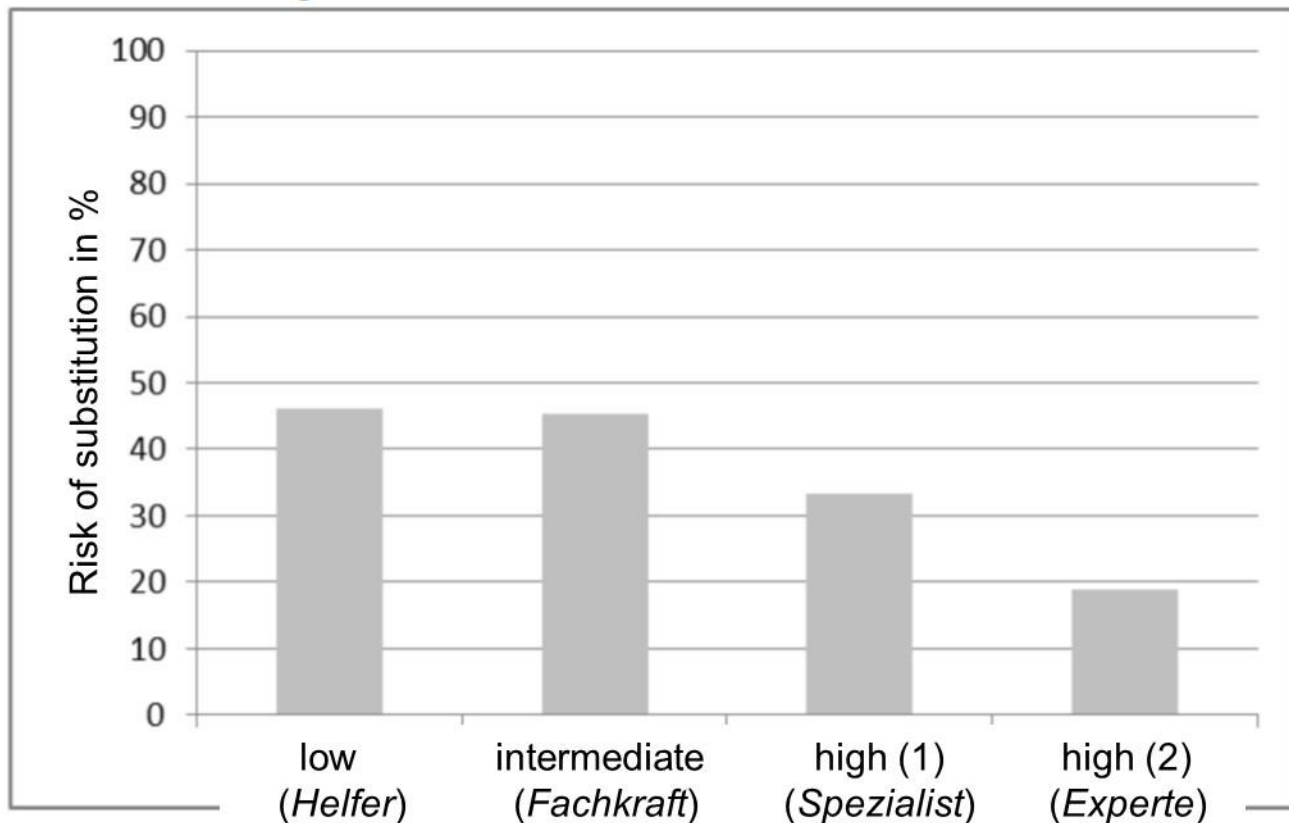


- US: 47% of jobs at risk (Frey, Osborne 2013)
- Finland: 1/3 of jobs at risk (Pajarinen, Rouvinen 2014)
- Germany:
  - 59% of jobs at risk (IngDiBA 2015)
  - 42% of jobs at risk (Bonin et al. 2015)

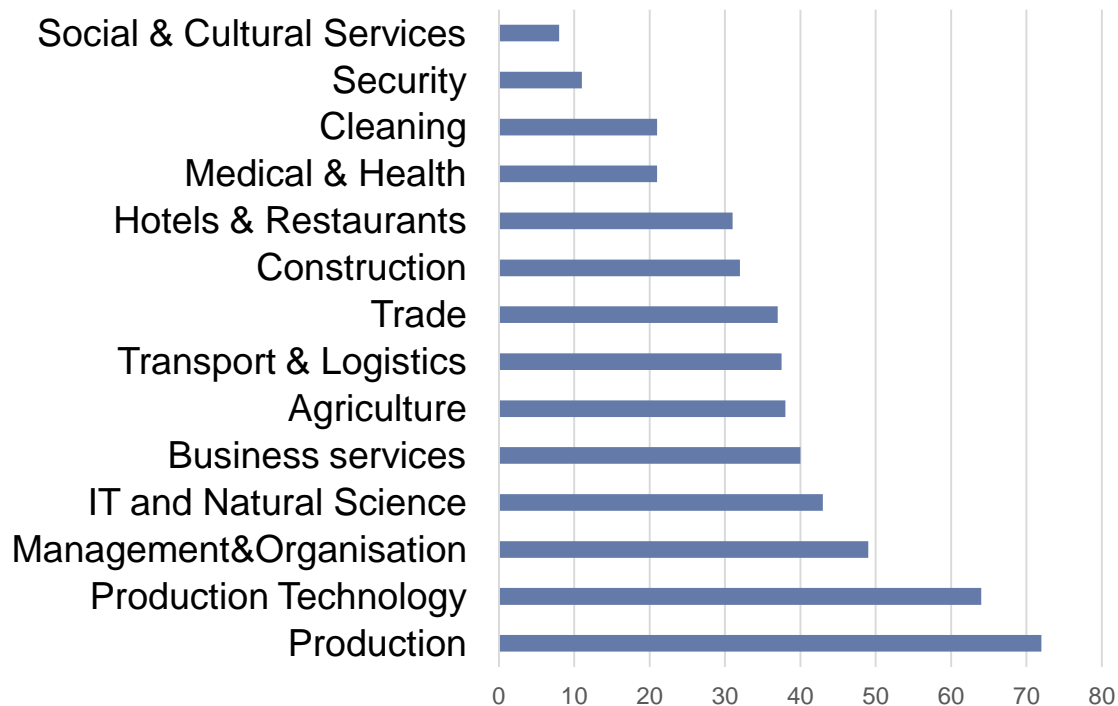
## An alternative approach

- Tasks substitutable, not professions!
- Significantly lower substitutionability
- Germany:
  - 12% of workplaces at risk (Bonin et al. 2015)
  - 15% of workplaces at risk (Matthes, Dengler 2015)

# Risk of substitution by skill level (Matthes, Dengler 2015)



# Risk of substitution by profession group (Matthes, Dengler 2015)



# Conclusions

- Transition to the knowledge economy and recent technological developments will lead to a rapid structural change
- Predictions on the requirement of professions in the future are not possible in detail, however, there are stable trends in the developments of tasks
- Skill formation is crucial, especially because qualification means flexibility

For further information see: [www.iab.de](http://www.iab.de)



## Two quotes



*Dave Brooks:*

*“In the 19th and 20th century we made stuff: corn and steel and trucks. Now, we make protocols: set of instructions.”*

*(New York Times, 11.01.2010)*

*Till Reuter (CEO Kuka):*

*„For the current generation working with the computer is normal. For the next generation it will be working with robots “*

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# Relatively protected tasks (1) („computerisation bottlenecks“)

Computerisation bottleneck	O*Net variable	Description
Perception & Manipulation	Finger Dexterity	Ability of making precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects
	Manual Dexterity	Ability to quickly moving your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects
	Cramped Work Space, Awkward Positions	How often does the job require working in cramped work spaces that requires getting into awkward positions?

# Relatively protected tasks (2)

(„computerisation bottlenecks“)



Creative Intelligence	Originality	The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem..
	Fine Arts	Knowledge of theory and techniques required to compose, produce, and perform works of music, dance, visual arts, drama, and sculpture
Social Intelligence	Social Perceptiveness	Being aware of others' reactions and understanding why they react as they do
	Negotiation	Bringing others together and trying to reconcile differences.
	Persuasion	Persuading others to change their minds or behavior.
	Assisting and Caring for Others	Providing personal assistance, medical attention, emotional support, or other personal care to others such as coworkers, customers, or patients

# The Frey, Osborne (2013) approach (1)



- Estimation of probability of substitution for every profession
- Data base: O\*Net 2010 → Information on 903 professions and their typical tasks
- Expert interviews to estimate the possibility of substitution at the current state of technology (for 70 professions)
- Estimation of a statistical model for determining the risk of substitution relying on typical task composition of the different professions
- Profession at high risk: substitution prob. >70%

- Chances of Economy 4.0 outweigh the risks
- A marked reduction in aggregate labour demand is unlikely
- It is important to ease the necessary adjustments  
(→ a role for active labour market policy)
- Social partnership is an important requirement to face the challenges of the future development successfully

# Limitations of the Frey, Osborne (2013) approach



- Share of tasks within professions taken as constant; however, there are significant changes of tasks within the professions over time
- Experts tend to overestimate the technical possibilities (→ e.g. Autor 2014).
- Technical substitutability not identical to actual substitution (e.g. legal restrictions, cultural obstacles, business calculations)

# Is the fear of technological unemployment justified?



*Keynes (1930)*

“We are being afflicted with a new disease ... **technological unemployment**. This means unemployment due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour.”

„Those countries are suffering relatively which are not in the vanguard of progress.“

# A reversal in the demand for high skilled in the US?



- At least some scepticism in the US for the future demand for skill
- Beaudry, Green, Sand 2013\*:  
  
”...about the year 2000, the demand for skill (or, more specifically, for cognitive tasks often associated with high educational skill) underwent a reversal.”