NEW INDUSTRY PROCESSES, NEW SAFETY ISSUES... BUT A NEW INTERACTION WITH MACHINES?

António B. Moniz

Observatory of Technology Assessment, CICS.NOVA

Universidade Nova de Lisboa, Portugal

Institute for Technology Assessment and Systems Analysis,

Karlsruhe Institute of Technology, Germany

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UNIVERSIDADE NOVA DE LISBOA

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TOPICS

- Robots all over the world
- Industry 4.0 and safety
- Robots replacing jobs?
- New challenges and new questions

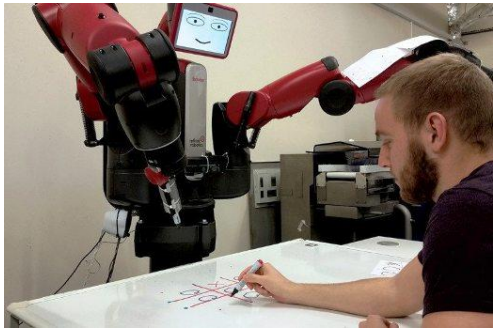
ROBOTS ALL OVER THE WORLD

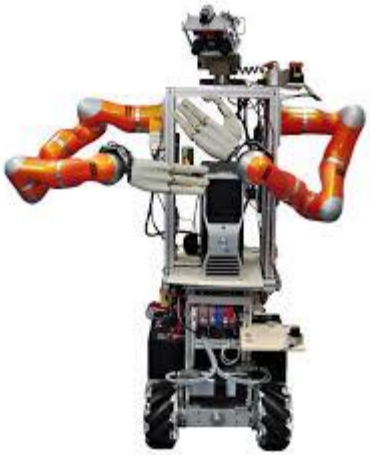
ADVANCED ROBOTS AS DRIVERS OF INDUSTRY 4.0

- Advanced robots are one of the main technological drivers of **Industry 4.0** and are equipped "with enhanced senses, dexterity, and intelligence", are not only acknowledged as "more practical than human labor in manufacturing" but also as appearing "in a growing number of service jobs"
  - (World Economic Forum 2016)

- "*Technological innovations occur on bionics, on micro- and nano-robotics, on haptic, grasping and manipulation, on tele-robotics, networking and swarm systems, on autonomous agents*" (Moniz 2014).

EXAMPLES OF INDUSTRY 4.0





SAFETY STANDARDS ON COLLABORATIVE ROBOTS

- ISO/TS 15066
  - Types of collaborative operation
  - Safety-rated monitored stop
  - Hand guiding
  - Speed and separation monitoring
    - Minimum separation distance
  - Power and force limiting
    - Biomechanical limits

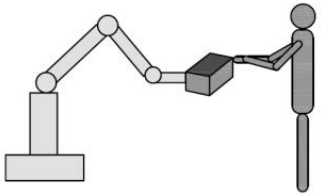
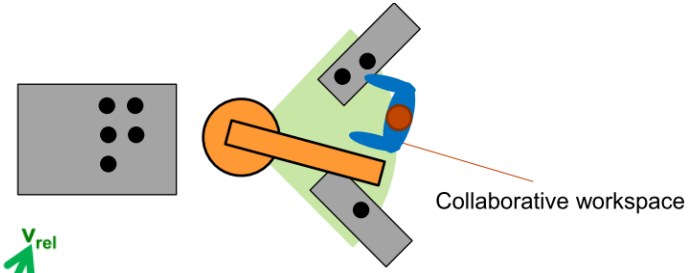
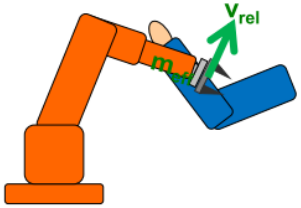
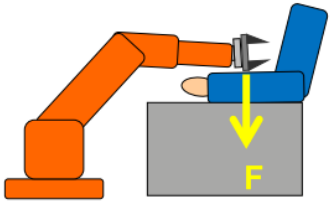


Figure 2 — Suggested labelling design (ISO 10218-2:2011



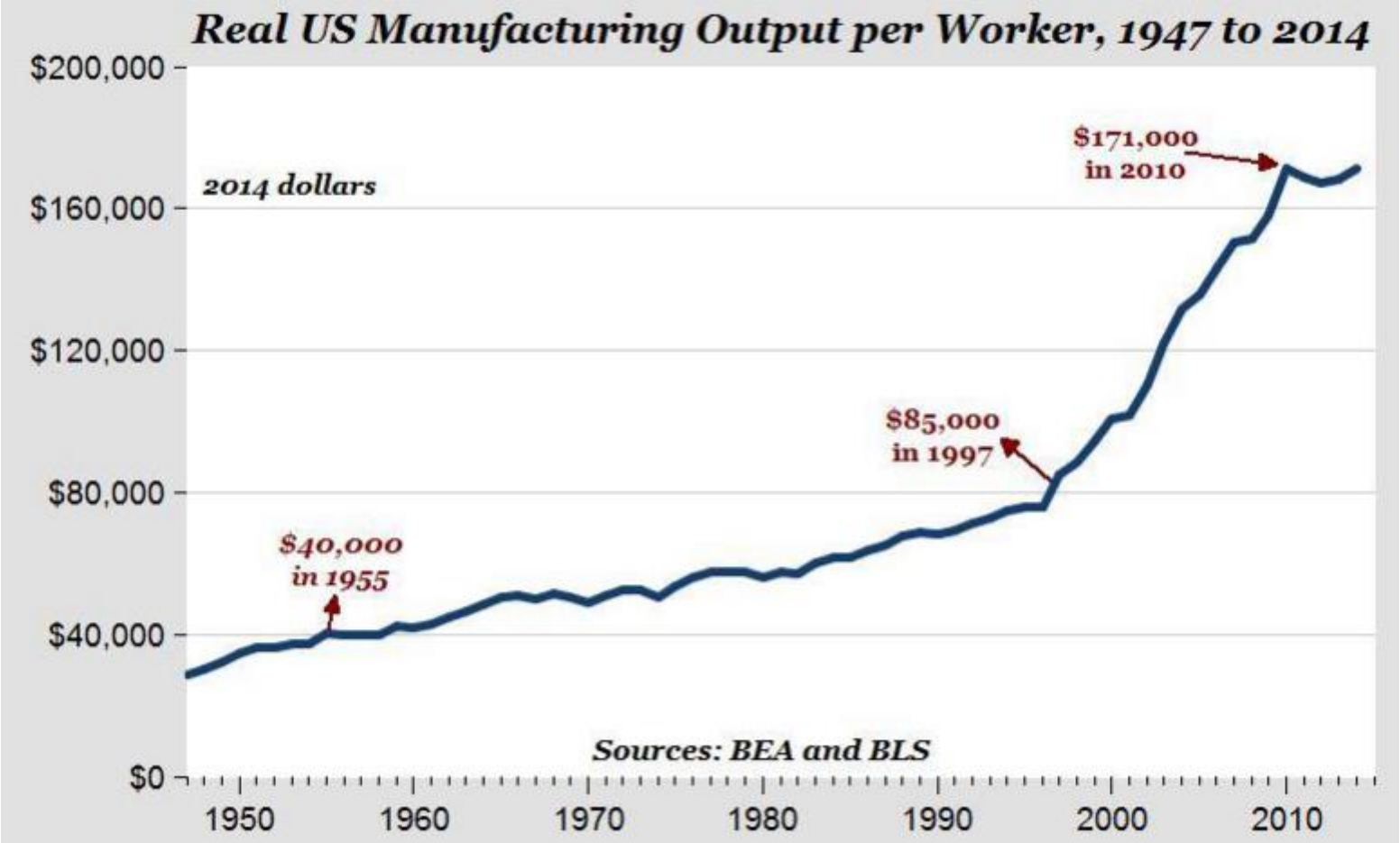


Free impact (transient)



Constrained impact (transient or quasi-static)

NEW INDUSTRY PROCESSES AND PRODUCTIVITY



ROBOTS AND INDUSTRY 4.0

- The technological innovations of Industry 4.0 may imply new principles of automation and Human-Robot Interaction (HRI)
  - Technical autonomy
  - Extended sensing
  - Augmented reality
  - Virtual work
  - Complex environments
  - Increased competences

ROBOTS AND INDUSTRY 4.0 (CONT.)

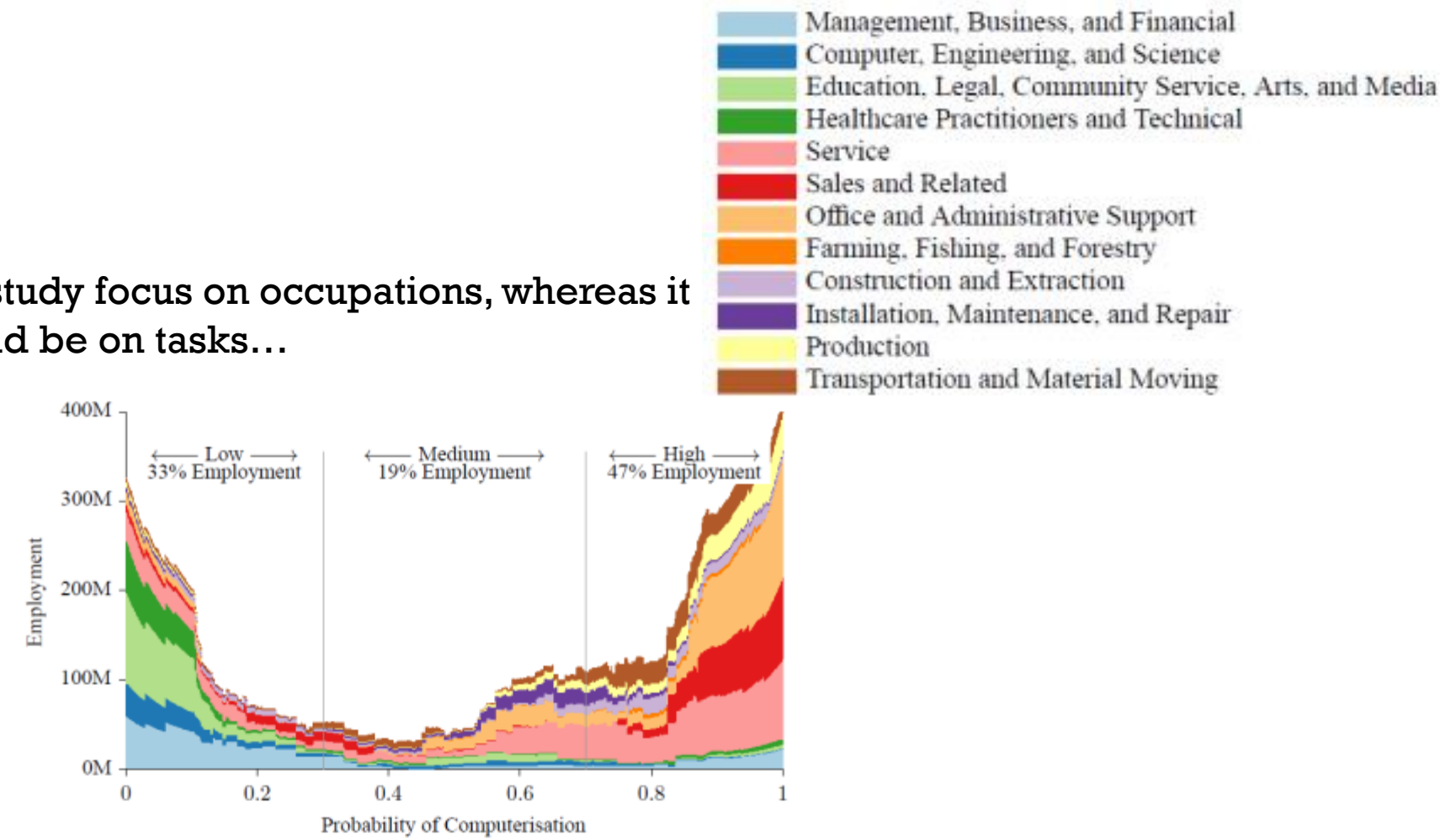
- The European Manufacturing Survey 2015 states that,
  - "**larger companies** have more experiences with the introduction of advanced production technologies and more possibilities and higher economies of scale to make efficient use of industrial robot systems
  - "automation systems and robots **enhance human workers** instead of replacing them, human-robot interaction has a severe impact on the outcome of the manufacturing industry
  - "The handling of limitations and **interdependence** of both, technology and human workers is a key issue"

NEW APPROACHES

- Frey and Osborne (2013) sees assembly on the top of susceptible tasks:
  - Assembly work is strongly **routinized** which is most easily replaced
  - Assembly in particular, with its still-high proportion of **manual tasks**, is regarded as a prime example of routine work

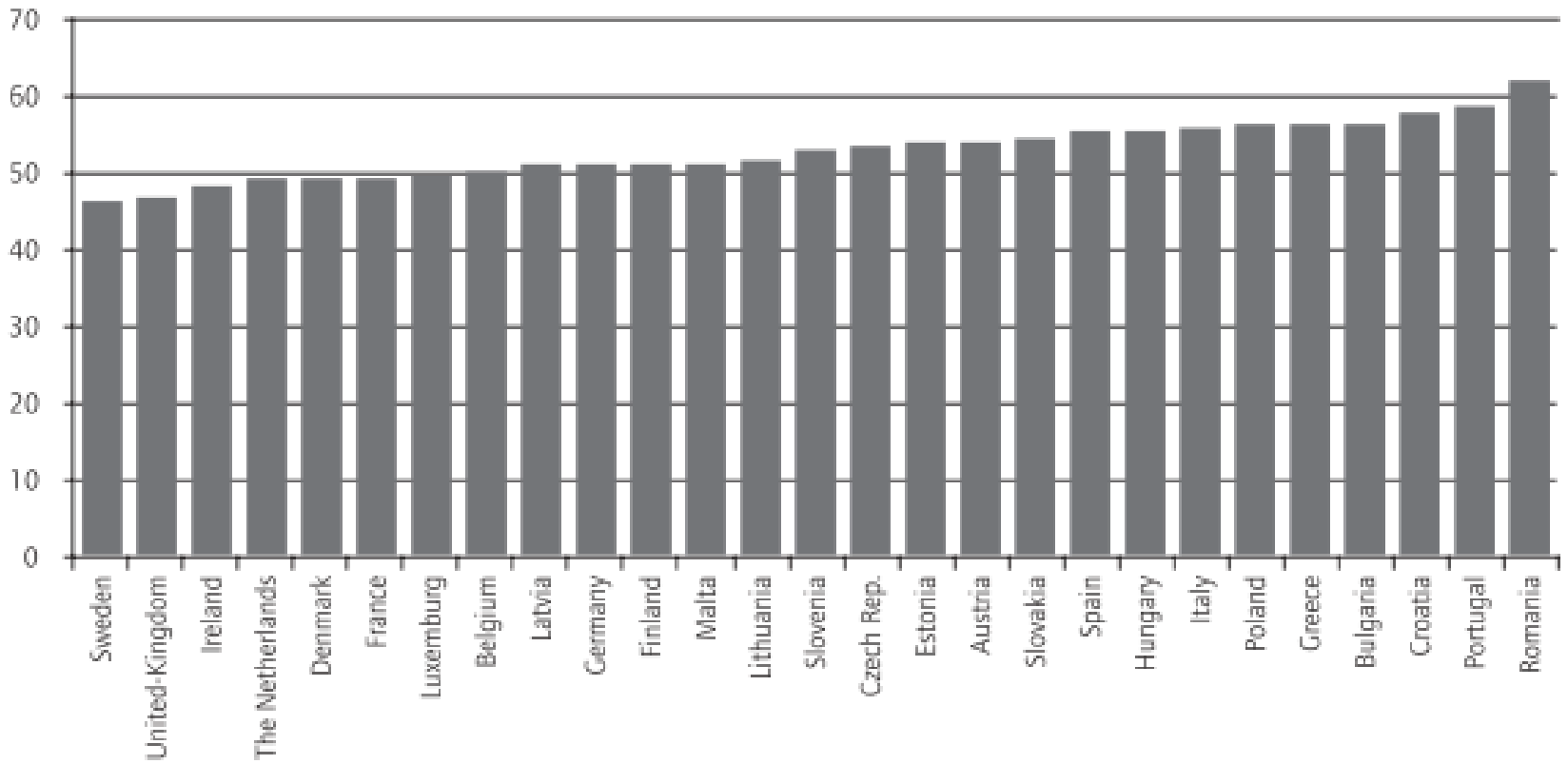
US EMPLOYMENT BY RISK CATEGORY, FREY AND OSBORNE

The study focus on occupations, whereas it should be on tasks…

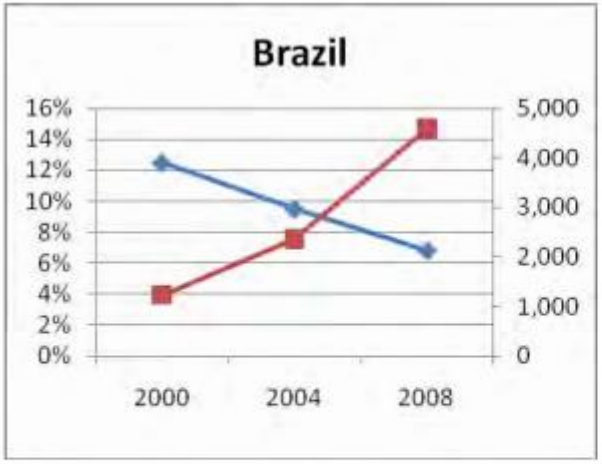


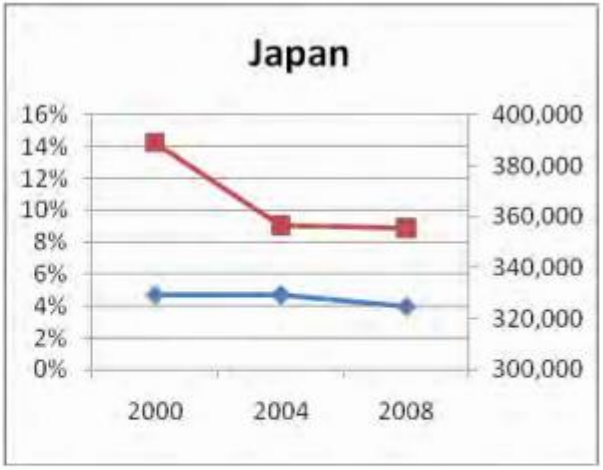
Source: Frey and Osborne (2013), The Future of Employment: How Susceptible are Jobs to Computerization? University of Oxford.

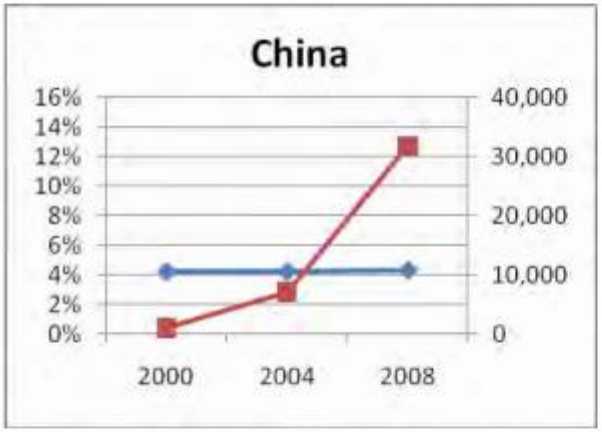
PERCENTAGE OF EU JOBS AT RISK OF COMPUTERIZATION BY COUNTRY

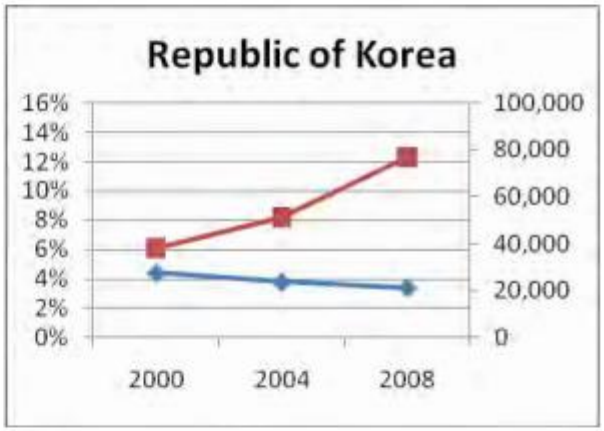


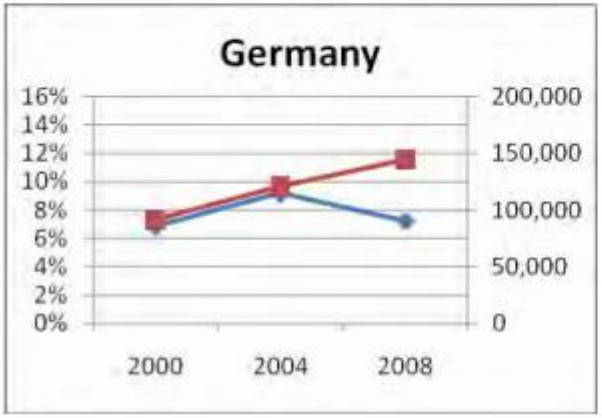
Source: Bruegel (2015), calculations based on Frey and Osborne, International Labor Office (ILO), EU Labour Force Survey

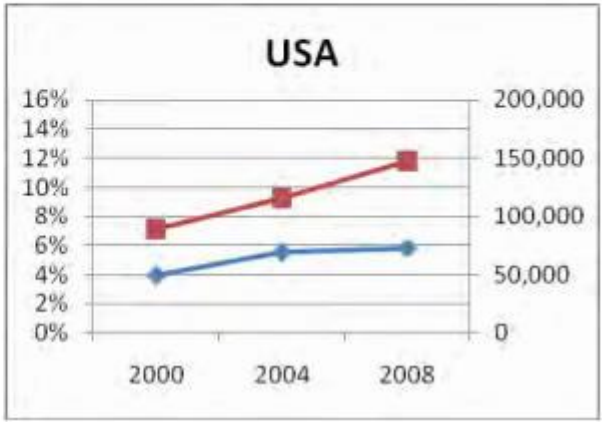










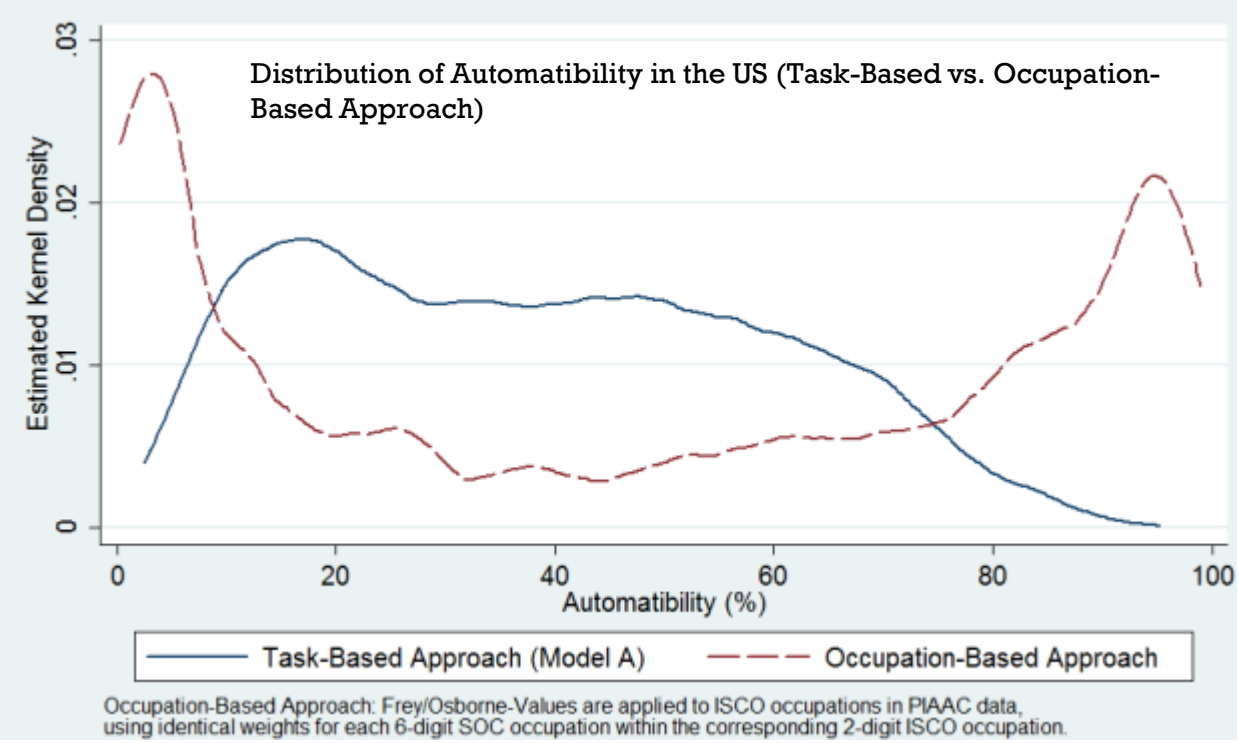


RATE OF UNEMPLOYMENT TREND VS NUMBERS OF ROBOTS IN USE

♦ = Unemployment %

■ = Number of robots

ARNTZ-GREGORY-ZIERAHN MODEL OF JOB AUTOMATIBILITY



Using information on task-usage at the individual level leads to significantly lower estimates of jobs "at risk", since workers in occupations with – according to Frey and Osborne – high automatibilities nevertheless often **perform tasks which are hard to automate**

Source: Authors' calculation based on the Survey of Adult Skills (PIAAC) (2012)

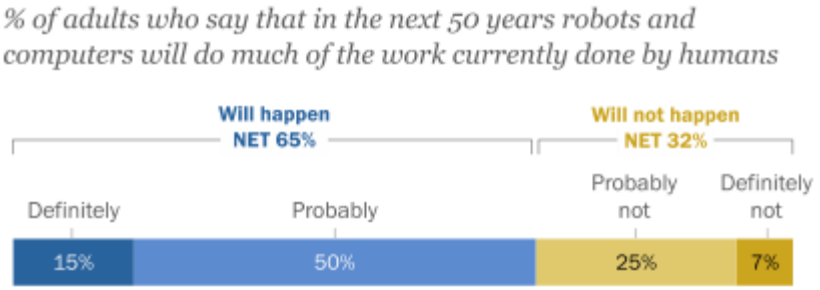
TASK DIGITALISATION

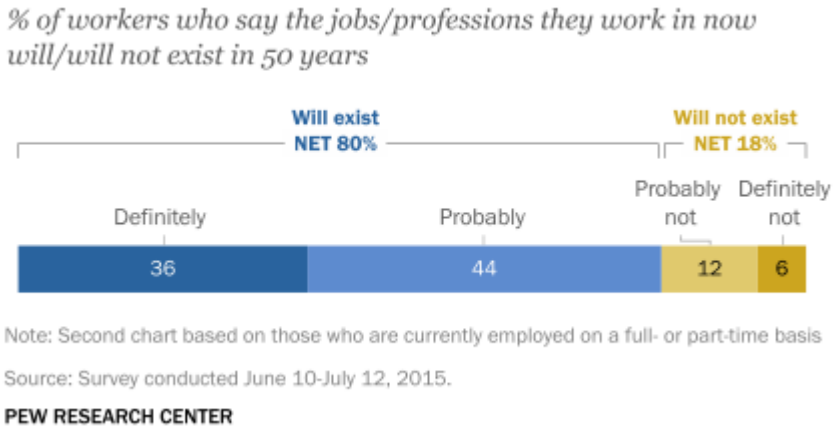
- Autor, Levy and Murnane (2003) classified work activity into non-routine tasks (analytical or interactive) and routine tasks (cognitive or manual), showing two effects of **digitalization**,
  - a **substitution effect** (routine work is substituted) and
  - a **complementarity effect** (support of creativity, flexibility and complex communication and thus of non-routine tasks).

- What is new is the massive growth in the **volume of digitised information** available and the vastly improved performance of **data processing and modelling software**" (Valenduc, Vendramin 2016:17). This enables also
  - The capacity to codify and quantify formal (and also) tacit knowledge, working processes: **standardisation of work processes**

ROBOTS REPLACING JOBS?

- Two-thirds of Americans expect that robots and computers will do much of the work currently done by humans within 50 years…



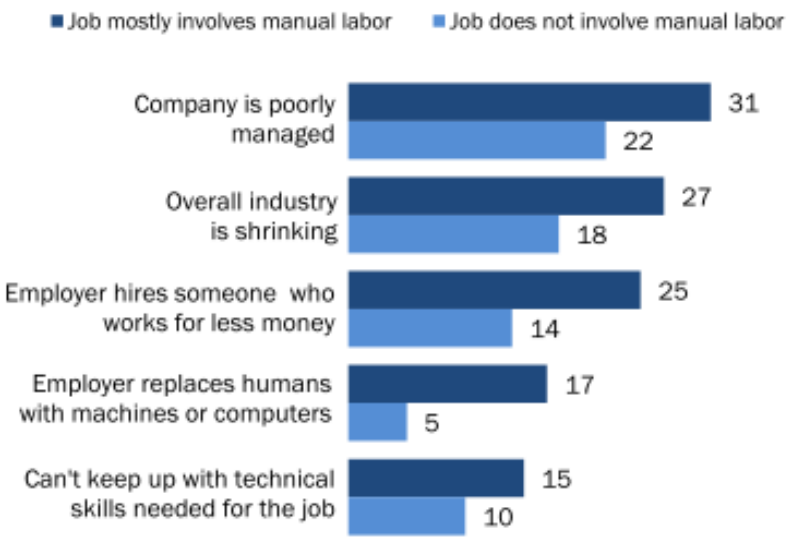


- …but most workers expect that their own jobs will exist in their current forms in five decades

ROBOTS REPLACING JOBS?
MANUAL LABOUR AND JOB REPLACEMENT

- Workers who perform physical or manual labour more concerned about a number of imminent jobs threats

% of workers in each group who are very/somewhat concerned about losing their current jobs because ...



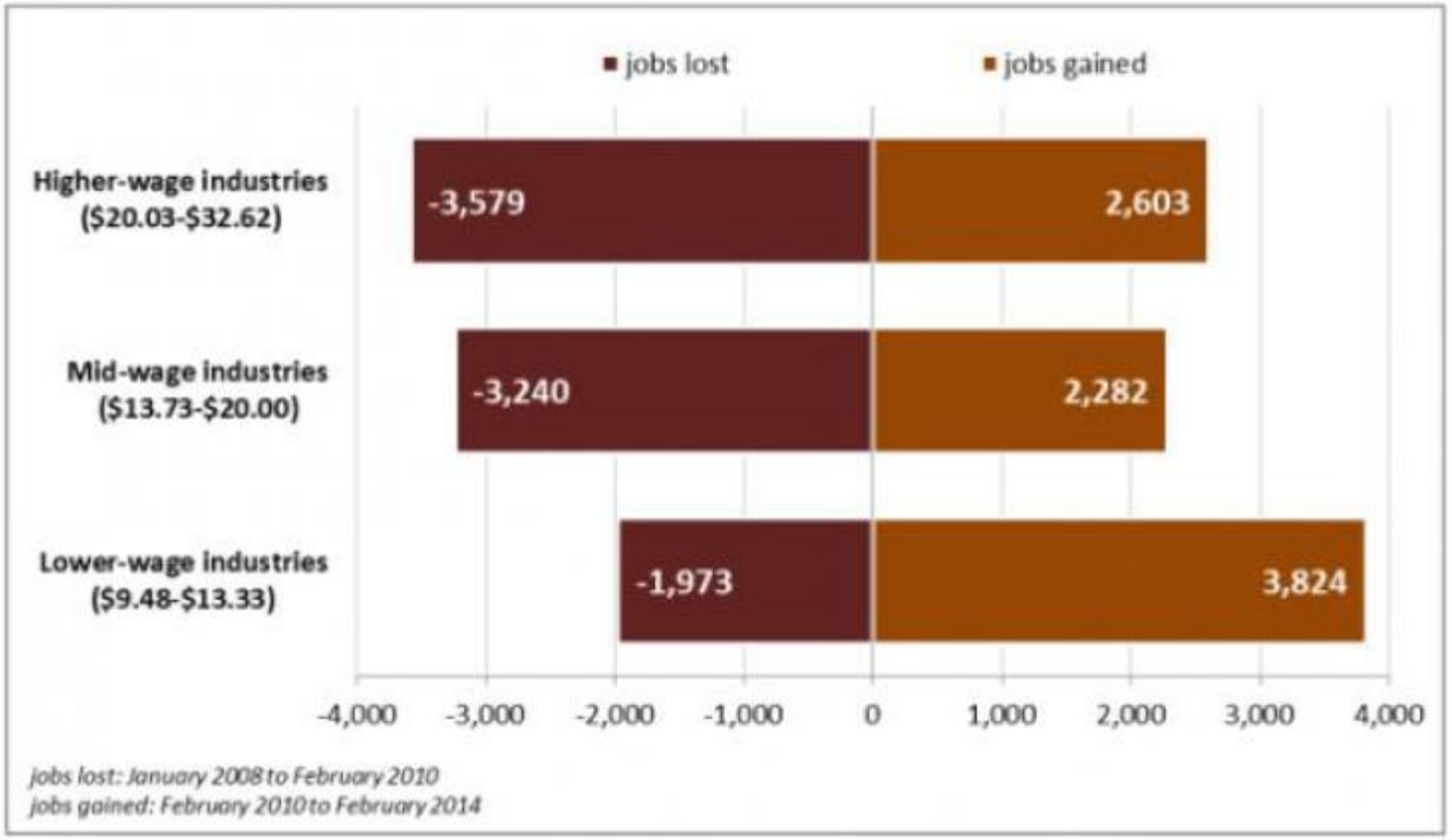
Note: Based on those who are currently employed on a full- or part-time basis

Source: Survey conducted June 10-July 12, 2015.

PEW RESEARCH CENTER

JOBS LOST AND GAINED (US, 2008-14)

Figure 1. Net Change in Private Sector Employment (in thousands)



Source: NELP analysis of Bureau of Labor Statistics data, see Appendix A for details.
Note: Wage ranges are updated from earlier reports to adjust for inflation and are in 2013 dollars. At the time of publication, employment data for disaggregated industries was only available through February 2014.

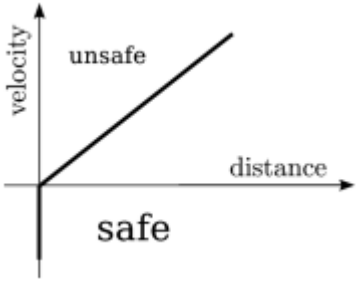
ACCIDENTS WITH ROBOTS

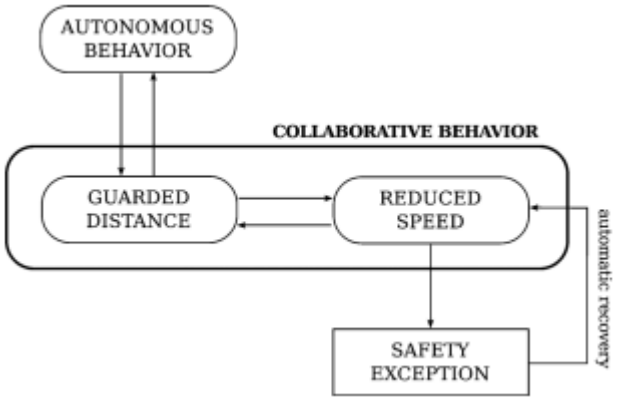
- Accidents increase
- More robots & less workers

Table 1 Robot-related severe accident from the Accident Report Database (TAPS) of the Safety Administration in Finland

Year	Quantity	Year	Quantity
1989	2	1998	0
1990	1	1999	1
1991	0	2000	2
1992	0	2001	2
1993	0	2002	4
1994	1	2003	1
1995	1	2004	2
1996	0	2005	5
1997	1	2006	2

- Safety is related with velocity and distance





- Other factors?

- Zanchettin, Ceriani, Rocco, Ding and Matthias (2016), Safety in Human-Robot Collaborative Manufacturing Environments: Metrics and Control, *IEEE Transactions on automation science and engineering*, vol. 13, No. 2, 882-893
- Malm, Viitaniemi, Latokartano, Lind, Venho-Ahonen, and Schabel (2010), Safety of Interactive Robotics—Learning from Accidents, *Int J Soc Robot* 2: 221–227

ROBOTS REPLACING JOBS?
FUTURE OF THE INTERNET CANVASSING, PEW RESEARCH CENTER 2014

- reasons to be hopeful
  - 1) Advances in technology may displace certain types of work, but historically they have been a **net creator of jobs**.
  - 2) We will adapt to these changes by inventing entirely new types of work, and by taking advantage of **uniquely human capabilities**.
  - 3) Technology will free us from day-to-day drudgery, and allow us to **define our relationship with "work"** in a more positive and socially beneficial way.
  - 4) Ultimately, we as a society **control our own destiny** through the choices we make.
- reasons to be concerned
  - 1) Impacts from automation have thus far impacted mostly blue-collar employment; the coming wave of innovation **threatens to upend white-collar work** as well.
  - 2) Certain **highly-skilled workers will succeed wildly** in this new environment—but far more may be displaced into lower paying service industry jobs at best, or permanent unemployment at worst.
  - 3) Our **educational system** is not adequately preparing us for work of the future, and our political and economic institutions are poorly equipped to handle these hard choices.

NEW QUESTIONS, NEW PROBLEMS

- Technical innovations create new modes of interaction of humans with technology in many working fields; increase of **systemic character of assessment** (productivity growth+ efficiency+ prosperity)

- Automation is rarely sketched empirically with respect to the **shifts of work** as well as to the mutual relationship between technical progress (production forces) and socio-economic relations (modes of production)

NEW QUESTIONS, NEW PROBLEMS (CONT.)

- Assessment of (technologies in) working fields imply "**big" questions** (welfare state building, distribution processes, demographic change, equality, social stability)

  - How does automation change work & safety & working conditions in **different fields**?
  - Which **expectations on technology** are strengthening the concepts of work?
  - Which **regulations and ethics principles** must be considered?
  - What are the **responsible innovation principles** applied to the automated work?
  - Which role (may) play **unions** within processes of implementations of technologies?

THE INDUSTRY 4.0 AND THE NEW CHALLENGES

„The debate shows, however, that the "side effects" of robotization are complex and that they should be strongly connected with future models of organizational, social, and political models of labor in current societies"

(Moniz and Krings, 2016)