Assessment of OSH challenges and opportunities associated with the state of knowledge on advanced robotics

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European Agency for Safety and Health at Work

Content

- Introduction & Methodology
- Types of applications
- OSH relevant HRI dimensions and identified OSH risks & opportunities

Introduction


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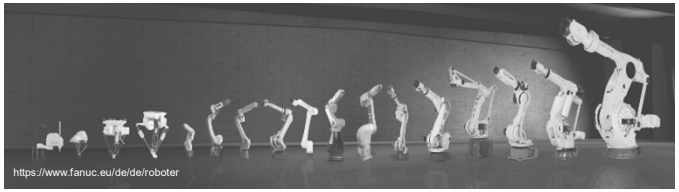
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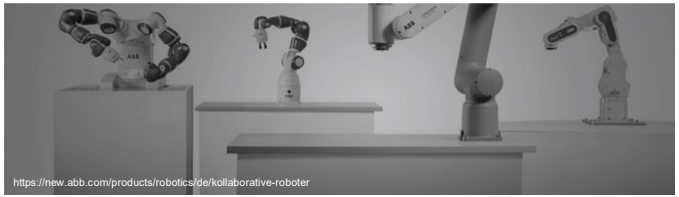
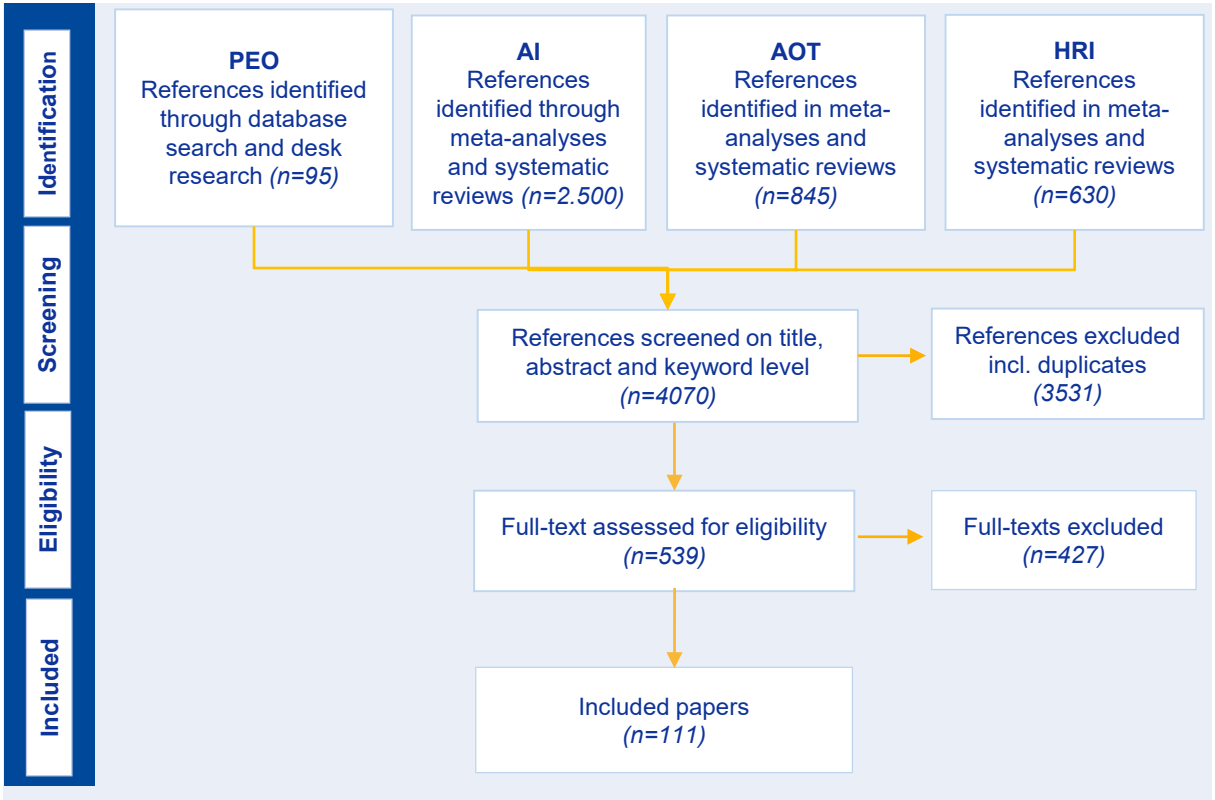

https://new.abb.com/products/robotics/de/kollaborative-roboter

https://www.softbankrobotics.com/emea/de/index

- **Number and variety of robotic applications has risen in the past years**
- **New generations of sensors and actuators allow closer interaction between humans and robots**
- **IFR members estimate: 50% of the production operators will be working collaboratively with a „robot assistant“ in 10 years time (IFR; 2020)**

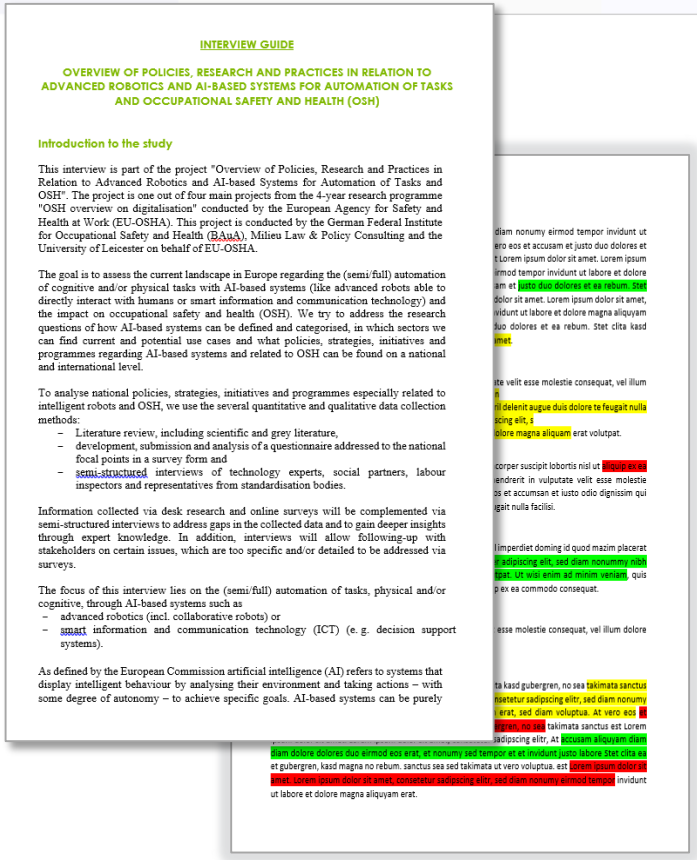
→ Which OSH risks & opportunities arise from the (semi-)automation of tasks with advanced robotics?

Methodology (literature review)



Methodology (interviews)

- **In-depth expert interviews**
  - International/ EU bodies and associations, academics and the private sector
  - Semi-structured interview (23 questions) addressed four focus areas
  - Seven interviews
  - Summarized and coded in three risk/opportunities categories
    - Physical
    - Organisational
    - Psychosocial
  - Summary of regulations and standards
    - Content
    - Implementation



INTERVIEW GUIDE

OVERVIEW OF POLICIES, RESEARCH AND PRACTICES IN RELATION TO ADVANCED ROBOTICS AND AI-BASED SYSTEMS FOR AUTOMATION OF TASKS AND OCCUPATIONAL SAFETY AND HEALTH (OSH)

Introduction to the study

This interview is part of the project "Overview of Policies, Research and Practices in Relation to Advanced Robotics and AI-based Systems for Automation of Tasks and OSH". The project is one out of four main projects from the 4-year research programme "OSH overview on digitalisation" conducted by the European Agency for Safety and Health at Work (EU-OSHA). This project is conducted by the German Federal Institute for Occupational Safety and Health (BAuA), Milieu Law & Policy Consulting and the University of Leicester on behalf of EU-OSHA.

The goal is to assess the current landscape in Europe regarding the (semi/full) automation of cognitive and/or physical tasks with AI-based systems (like advanced robots able to directly interact with humans or smart information and communication technology) and the impact on occupational safety and health (OSH). We try to address the research questions of how AI-based systems can be defined and categorised, in which sectors we can find current and potential use cases and what policies, strategies, initiatives and programmes regarding AI-based systems and related to OSH can be found on a national and international level.

To analyse national policies, strategies, initiatives and programmes especially related to intelligent robots and OSH, we use the several quantitative and qualitative data collection methods:

- Literature review, including scientific and grey literature,
- development, submission and analysis of a questionnaire addressed to the national focal points in a survey form and
- semi-structured interviews of technology experts, social partners, labour inspectors and representatives from standardisation bodies.

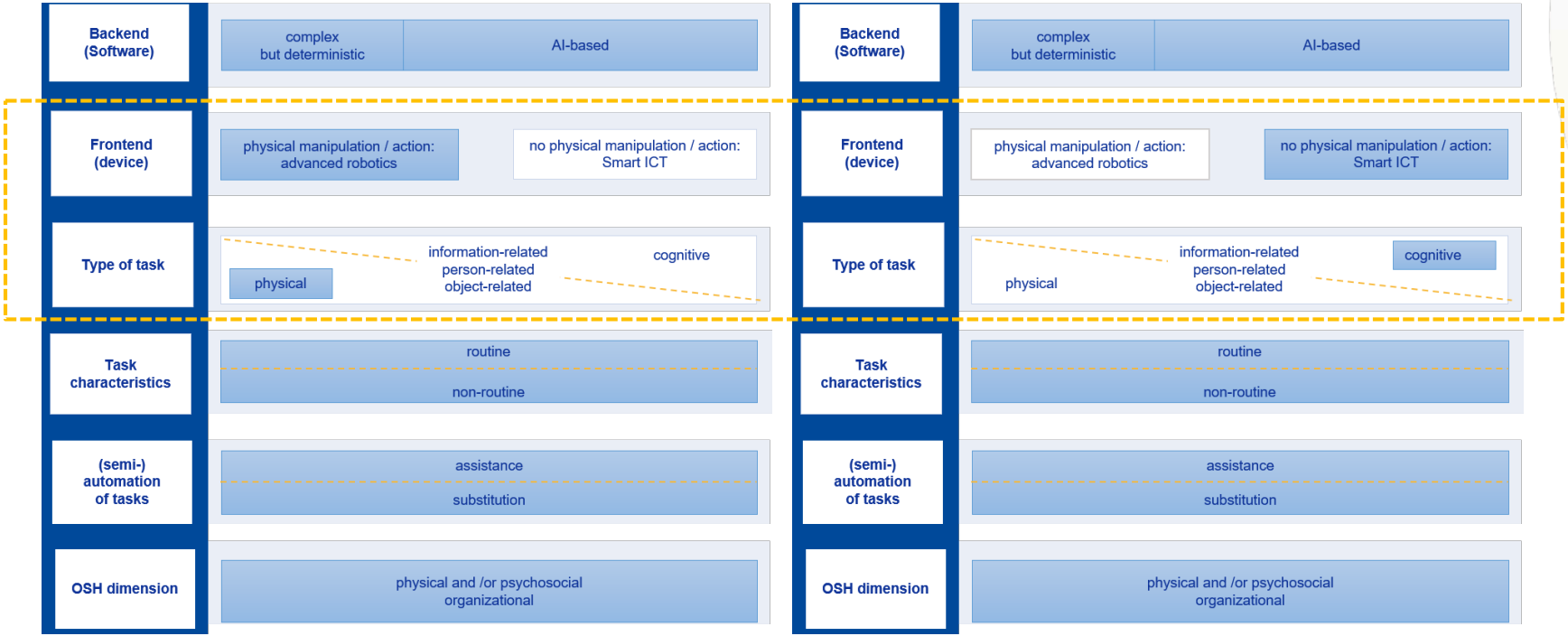
Information collected via desk research and online surveys will be complemented via semi-structured interviews to address gaps in the collected data and to gain deeper insights through expert knowledge. In addition, interviews will allow following-up with stakeholders on certain issues, which are too specific and/or detailed to be addressed via surveys.

The focus of this interview lies on the (semi/full) automation of tasks, physical and/or cognitive, through AI-based systems such as

- advanced robotics (incl. collaborative robots) or
- smart information and communication technology (ICT) (e. g. decision support systems).

As defined by the European Commission artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely

Advanced robotics for the automation of physical & cognitive tasks



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Physical tasks (semi-) automated by advanced robotics

- **Object-related tasks**
  - Wall construction
  - Pick & place
  - Object holding
  - Lifting parts
  - Transportation of objects (medicine, packages)
  - Welding

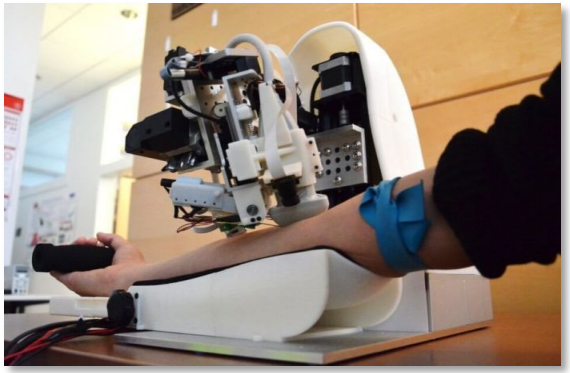
https://www.concreteconstruction.net/how-to/construction/how-robots-are-changing-the-construction-industry_c

https://www.rivistacmi.it/articolo/pinza-per-robot-collaborativi/

https://blog.robotiq.com/bid/70461/5-Factors-to-Consider-Before-Moving-to-a-Robotic-Welding-Process

Physical tasks (semi-) automated by advanced robotics

- **Person-related tasks**
  - Surgical tasks (e. g. suturing, biopsy, prostate surgery)
  - Medical procedures (intravenous catheterization, blood extraction)
  - Eating assistance
  - Patient lifting



https://www.theburnin.com/technology/rutgers-ai-powered-robot-autonomously-draws-blood-places-iv-2020-3/

https://www.davincisurgery.com/da-vinci-systems/about-da-vinci-systems

https://www.riken.jp/en/news

Cognitive tasks (semi-) automated by advanced robotics

- **Person-related**
  - Learning
  - Creation of motivation & creativity
  - Creation of positive emotions in elder care
  - Supporting therapy engagement
  - Nursing support (reminding functions, cognitive stimulation exercises)

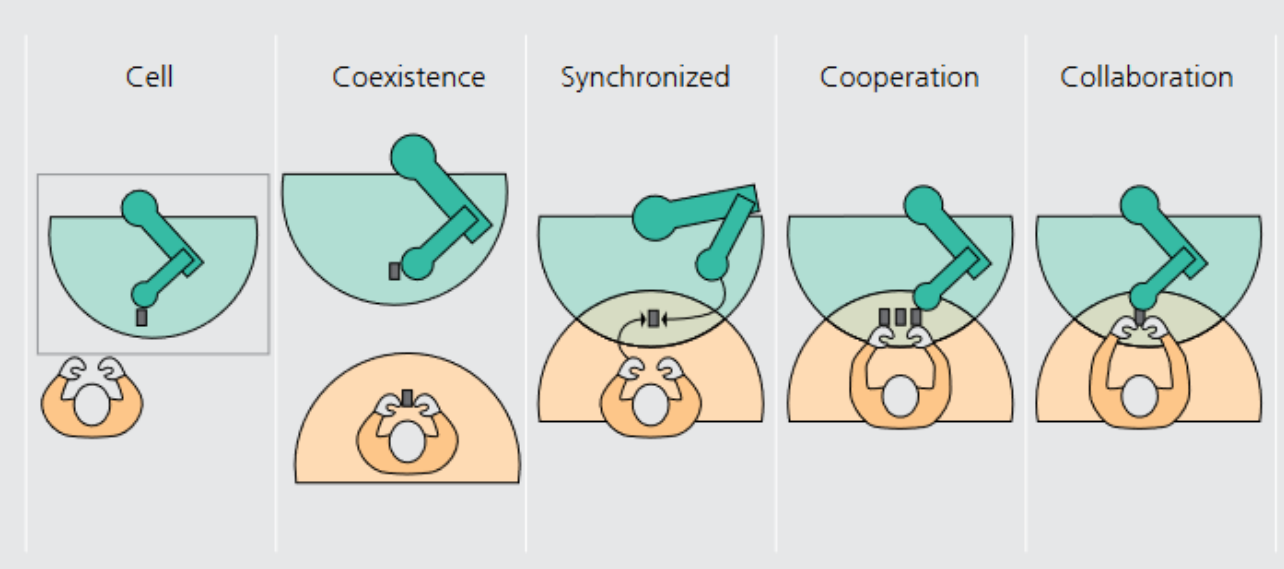
https://www.todayonline.com/singapore/robots-pre-schools-solar-powered-wi-fi-among-spores-infocomm-plans

https://innovationorigins.com/en/meet-sara-the-almost-autonomous-nursing-robot/

https://ietp-web-cdn-eandt-cache.azureedge.net/1/a/d/0/e/d/1ad0ed8e0b84e6de71dbca3ab222fefd94ca21db.jpg

Human-robot interaction forms

- Closer interaction forms are possible as new sensors and actuators emerge
- Closer interaction forms are not always profitable & currently creates high costs
- Rather coexistence and cooperation than collaboration



Bauer et al., 2016

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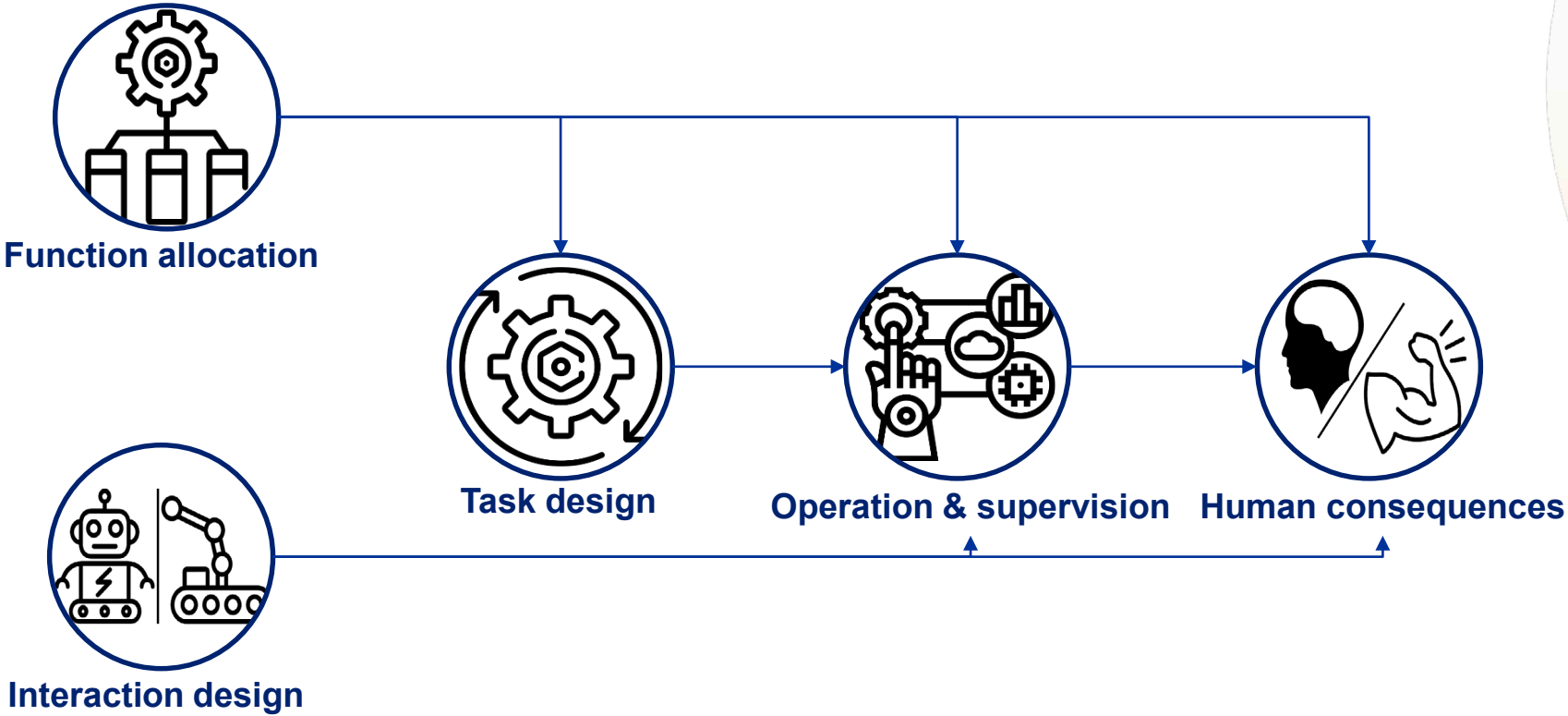
HRI aspects influencing OSH dimensions

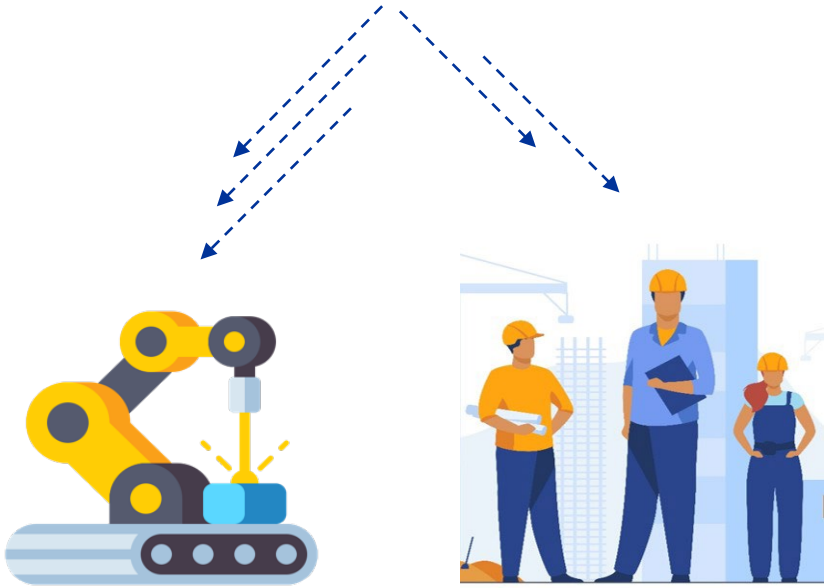


Images: Smahicons; Good Ware; freepik; Darius Dan via flaticon.com

Function allocation and psychosocial and physical OSH effects

- **Function allocation:**
  - Determination of functions or (sub-) tasks between human and robot
  - Different functions to varying degrees can be automated

- **Flexible and dynamic allocation of tasks**
  - The allocation process itself becomes a critical source for influencing OSH



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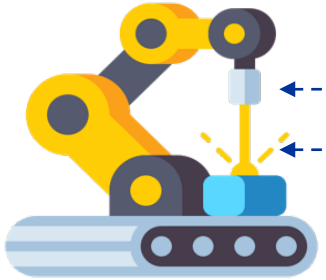
- **Opportunities/Challenges:**
  - Situation awareness
  - Mental workload
  - Trust
  - Perceived process control
  - Mental effort
  - Perceived fairness
  - Task identity
  - Acceptance
  - Flow
  - Self-efficiacy
  - Satisfaction

- **Challenges:**
  - Complacency (poor detection of system malfunction under automation)
    - Complacency is associated with accidents
  - Decision biases (errors in system use)

Task design and psychosocial and physical OSH effects

- **Design of human working task**
  - Directly results from function allocation process
  - Key aspect is human **job control**
- **Should enable human to take over enriched (qualitative higher) tasks**
- **Should allow sufficient flexibility regarding task excecution (e. g. regarding timely constraints)**



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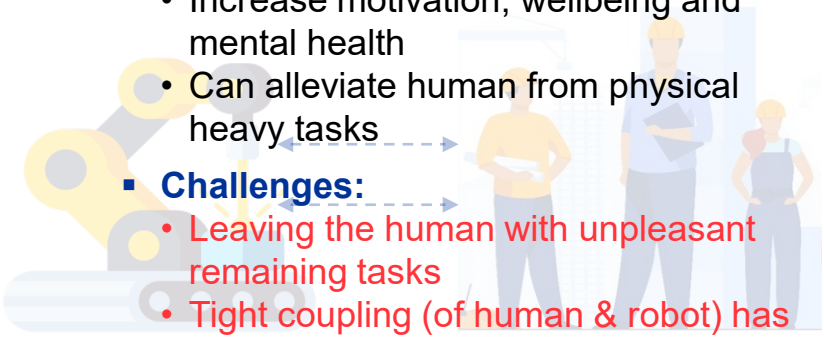
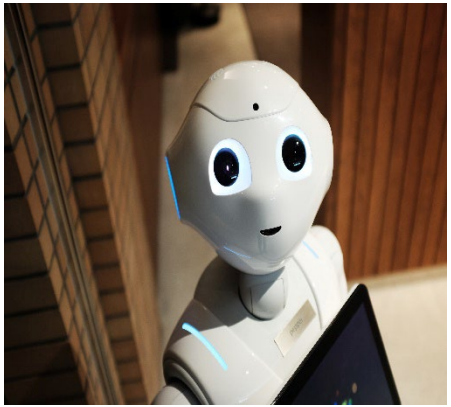
- **Opportunities:**
  - Increase feeling of control
  - Increase user satisfaction
  - Optimise cognitive load
  - Optimise strain and mental health
  - Increase motivation, wellbeing and mental health
  - Can alleviate human from physical heavy tasks
- **Challenges:**
  - Leaving the human with unpleasant remaining tasks
  - Tight coupling (of human & robot) has negative effects on mental health and motivation
  - Mental fatigue
  - Mental overload



Interaction design and psychosocial OSH effects

- **Anthropomorphic robot design**
  - Design features like eyes or facial expressions for a more natural interaction
  - Design features like movement or communication strategies

- **Anthropomorphic features will trigger expectations regarding robotic capabilities and behaviour**
  - Especially in industrial applications anthropomorphic cues should not be used, if not task-related



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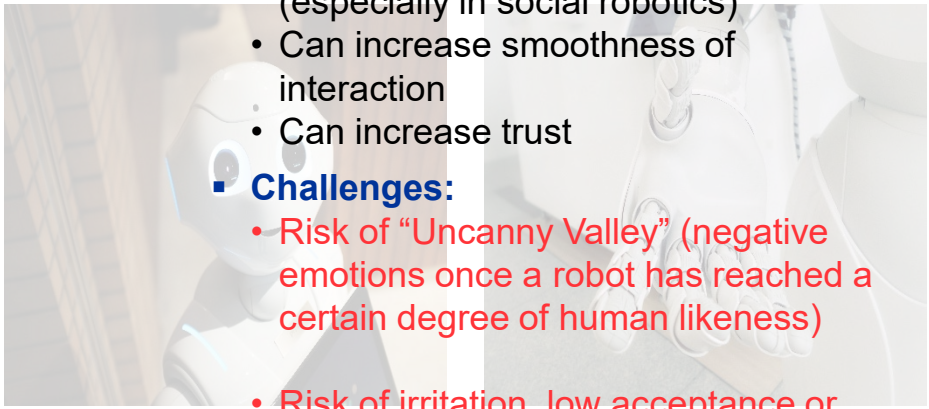
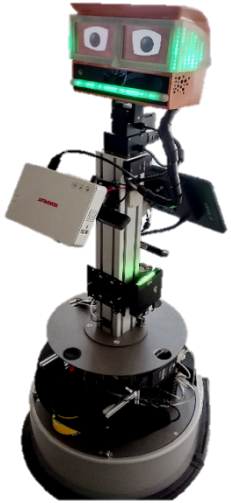


- **Opportunities:**
  - Can increase acceptance and likability (especially in social robotics)
  - Can increase smoothness of interaction
  - Can increase trust
- **Challenges:**
  - Risk of “Uncanny Valley” (negative emotions once a robot has reached a certain degree of human likeness)
  - Risk of irritation, low acceptance or neglect if not fulfilled

Interaction design and psychosocial OSH effects

- **Design principles and transparency**
  - Integrated functions and interaction modalities should follow known design principles **(Dialogue Principles, ISO 9241-210:2019)**

- **Importance and mode of expression of principles might shift:**
  - Some principles might gain more importance to create greater system transparency (e. g. Self-descriptiveness)



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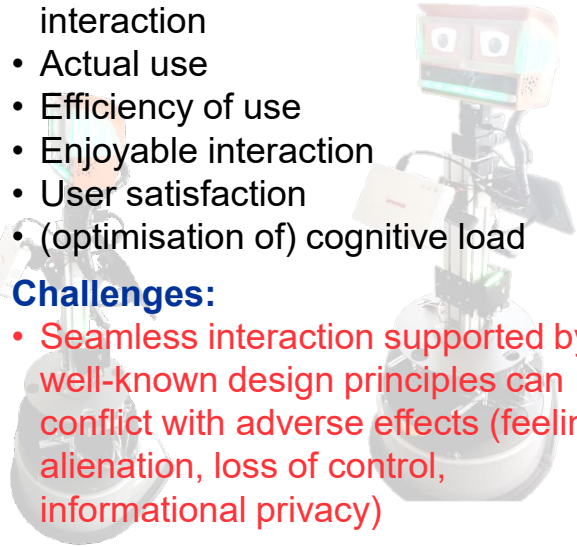
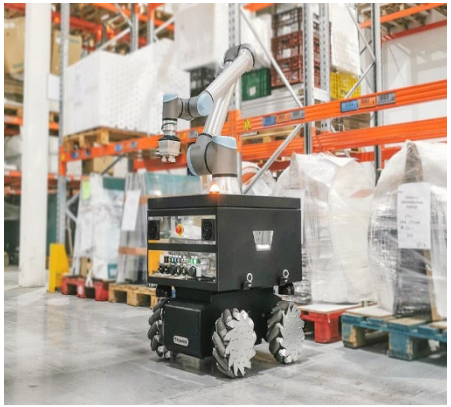
- **Opportunities:**
  - Acceptance and ease of interaction
  - Actual use
  - Efficiency of use
  - Enjoyable interaction
  - User satisfaction
  - (optimisation of) cognitive load
- **Challenges:**
  - Seamless interaction supported by well-known design principles can conflict with adverse effects (feeling of alienation, loss of control, informational privacy)



Operation & supervision and psychosocial and physical OSH effects

- **Operation & supervision:**
  - Direct result of function allocation & interaction design
  - Associated with safety

- **High levels of robotic autonomy influences human perception and attribution**
  - Humans tend to ascribe greater performance and authority to advanced robotics than to other humans or themselves



https://robotnik.eu/mobile-robotics-applications-more-safety-and-productivity-for-your-plant/

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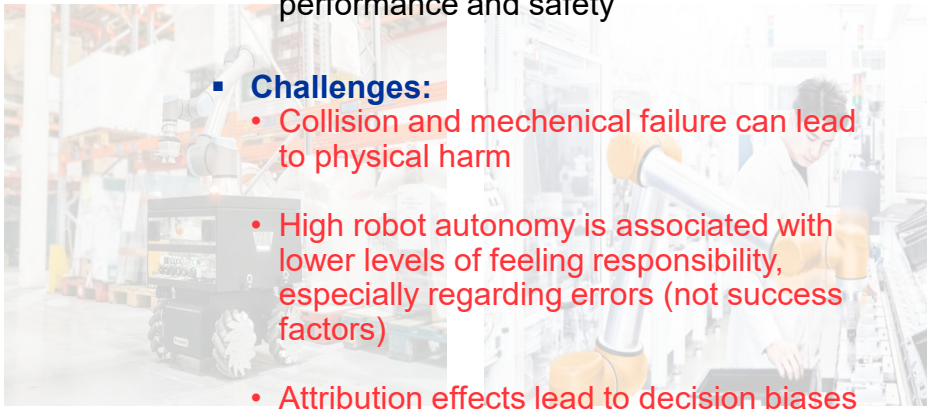
- **Opportunities:**
  - Overall: Wellbeing, performance, motivation
  - Reliability: Increases wellbeing, performance and safety

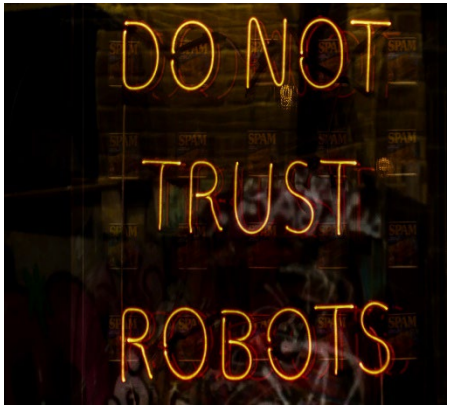


- **Challenges:**
  - Collision and mechenical failure can lead to physical harm
  - High robot autonomy is associated with lower levels of feeling responsibility, especially regarding errors (not success factors)
  - Attribution effects lead to decision biases (errors in system use)
  - Tight coupling (of human & system) has negative effects on mental health and motivation

Trust and psychosocial and physcial OSH effects

- **Trust in advanced robotics**
  - Attitude that an robot will help achieve ones goal [in situations of uncertainty and vulnerability]

- **Influential factors:**
  - **Robotic features:** Performance (reliability and failure rates), degree of anthropomorphism and physical appearance
  - **Proximity:** The closer the location of the robot, the higher the degree of trust (relevant for teleoperation)
  - **User expectations:** Trust is greater, if robot meets expectations (relevant for implementation process)



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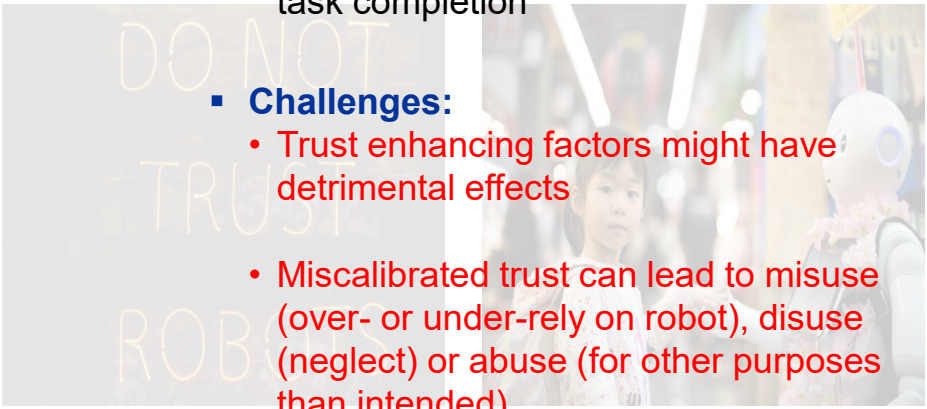
- **Opportunities:**
  - Adequate levels of trust promote appropriate system use, i. e. benefit task completion

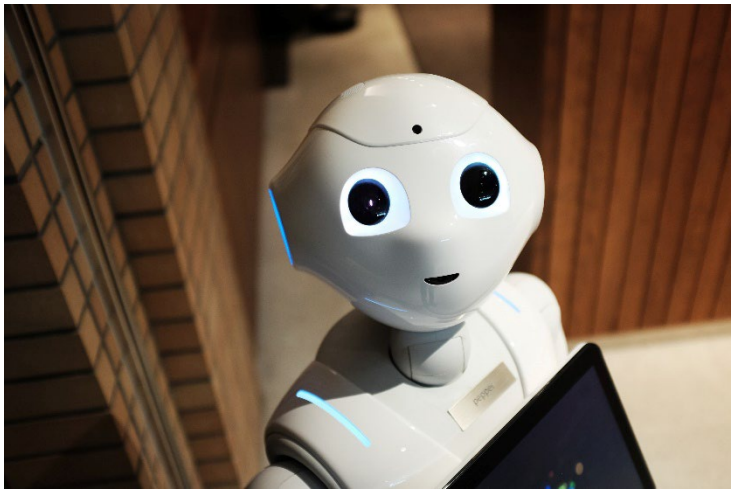


- **Challenges:**
  - Trust enhancing factors might have detrimental effects
  - Miscalibrated trust can lead to misuse (over- or under-rely on robot), disuse (neglect) or abuse (for other purposes than intended)
  - Miscalibrated trust lead to dangerous situations (like slow responses) and accidents

Summary & Conclusion

- **The variety of advanced robotics application for physical tasks (object- & person-related) is greater than for cognitive tasks (person-related)**
- **Social robots find more application in cognitive tasks**
- **Real collaborative scenarios are rare**
- **Most frequently influenced OSH aspects:**
  - Mental/cognitive workload
  - Wellbeing
  - Ease of use
  - User satisfaction
  - **Trust (key variable influencing psychosocial & physical OSH aspects)**
  - Physical workload
  - Accidents (mediated)
- **For advanced robotics special attention has to be paid to:**
  - Interaction design
    (anthropomorphic vs. functional design; dialogue principles & transparency)
  - Task design (human job control)

Thank you



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