

How Can Robots Enable Inclusive Workplaces?

Rethinking Safety and Design for Diversity in Manufacturing

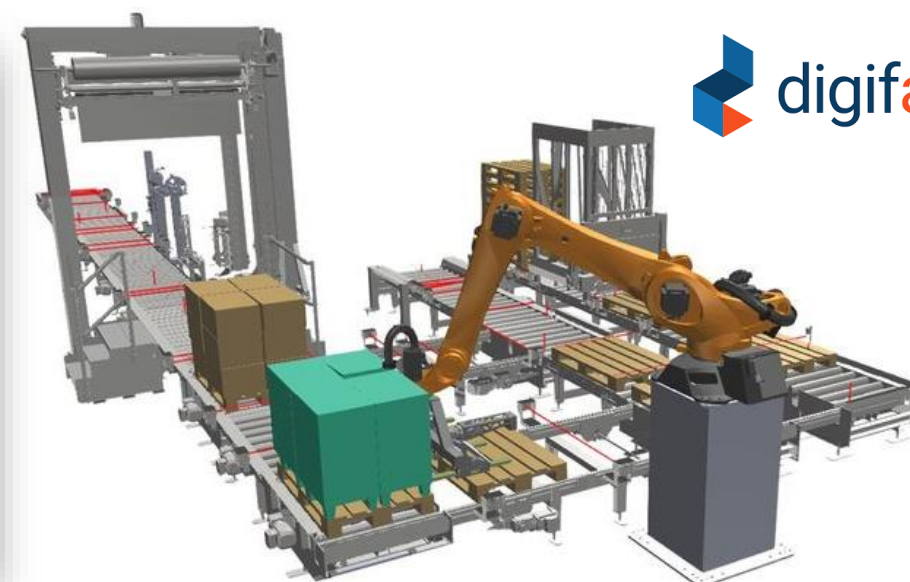
Series of lectures on Gender and Sciences
GENERA Network
25.09.2025
Clara Wiederschwinger-Fischer



JOANNEUM RESEARCH *2nd largest RTO in Austria* *Institute for Robotics and Flexible Production*



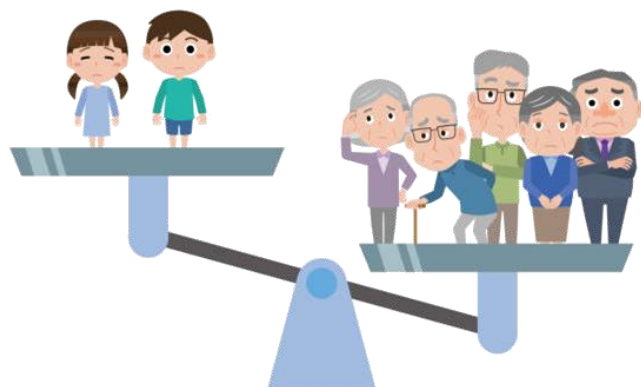
- 20 Researchers
- 500 m² ROBOTICS Solution Center
- Our Mission: R&D, TEST, TRANSFER



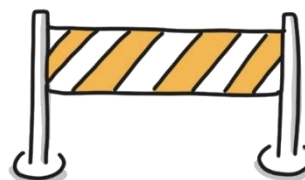
About the Lecture

- Inclusion in Manufacturing – Current Challenges
- Policy Framework
- Potentials of Robotics for Inclusion
- Insights of the SAFEIVESE Research Project
- Summary & Discussion

Inclusive Manufacturing Overcoming Challenges and Unlocking Potential



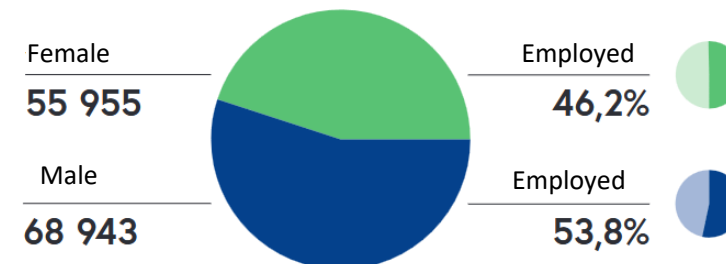
**Demographic change and skilled
labor shortage**



EU 2022:

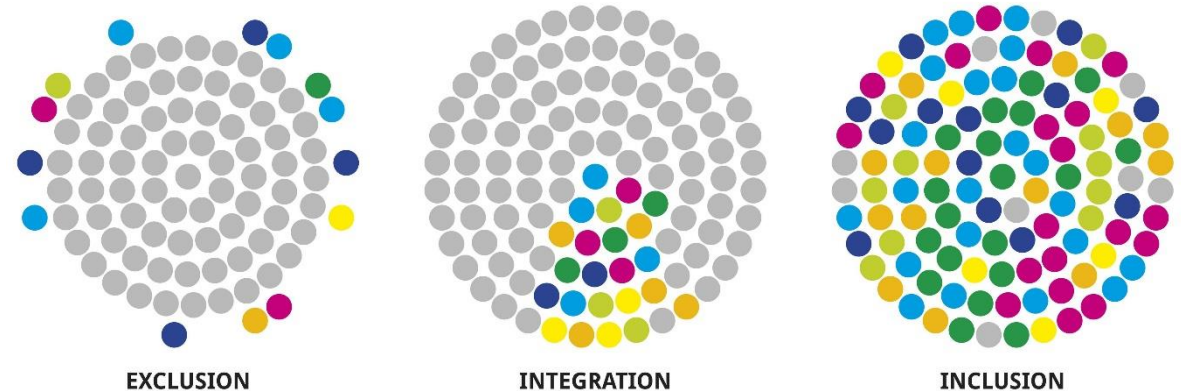
- Almost 20 % of working age population (16-64) are people with disabilities (PwDs)
- 54.3% of PwDs aged 20–64 employed

Registered PwDs Austria; 2022



Sheltered Workshops - Second Labor Marked

- Protected environment
- Social participation & skills training
- Not fully integrated into first labor marked
- Integration $\neq$ Inclusion
- Goal: From second $\rightarrow$ first labor marked



Trend of Industry 5.0 - Who Truly Benefits?



Image: EIT Digital

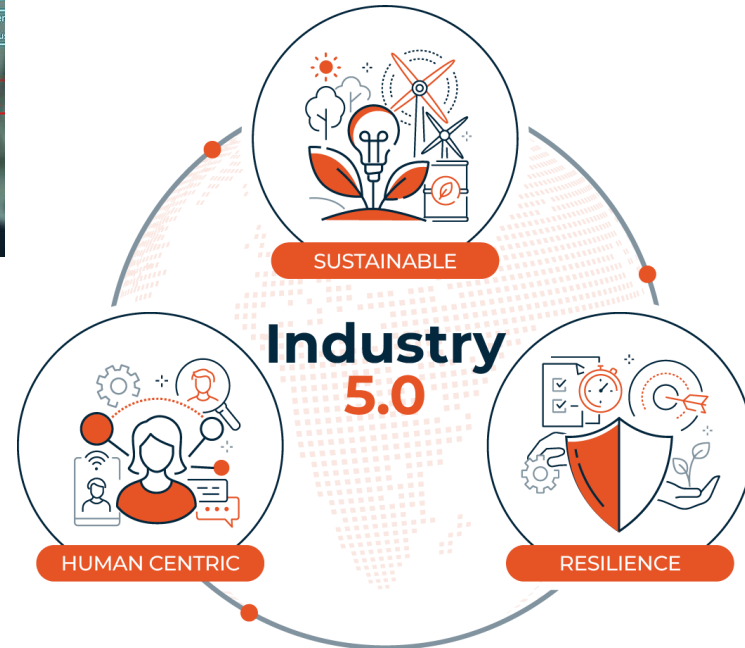


Image: <https://momenta.vc/industry5.0>

The screenshot displays a complex software interface for production planning. It includes a sidebar with navigation options like 'Live Monitoring', 'Simulation Planner', 'Scheduling', 'PTM/EA', 'Control', and 'Cost Estimation'. The main area is divided into several panels: 'Order Management' with a list of orders, 'Production Orders' with a detailed schedule, and 'Scheduled Orders' with a timeline view. The interface is filled with data tables, status indicators, and various filters, representing a professional-grade production planning tool.

Image: Productionplanner, advanced Scheduler – pro planner



Image: JOANNEUM RESEARCH ROBOTICS



Image: JOANNEUM RESEARCH ROBOTICS

Europeans Inclusion Strategy

- 2021–2030 Strategy for the rights of persons with disabilities
- Disability Employment Packages
 - **Goal:** Improve labor market integration of persons with disabilities

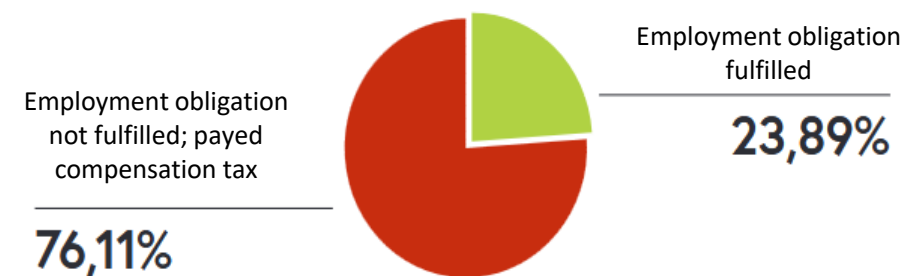


Image: ESF

Policy Activities in Austria



Employment obligation, Austria 2022



■ Disability Equality Act

- Protection of PwDs from discrimination
- Equal participation in society

■ Disability Employment Act

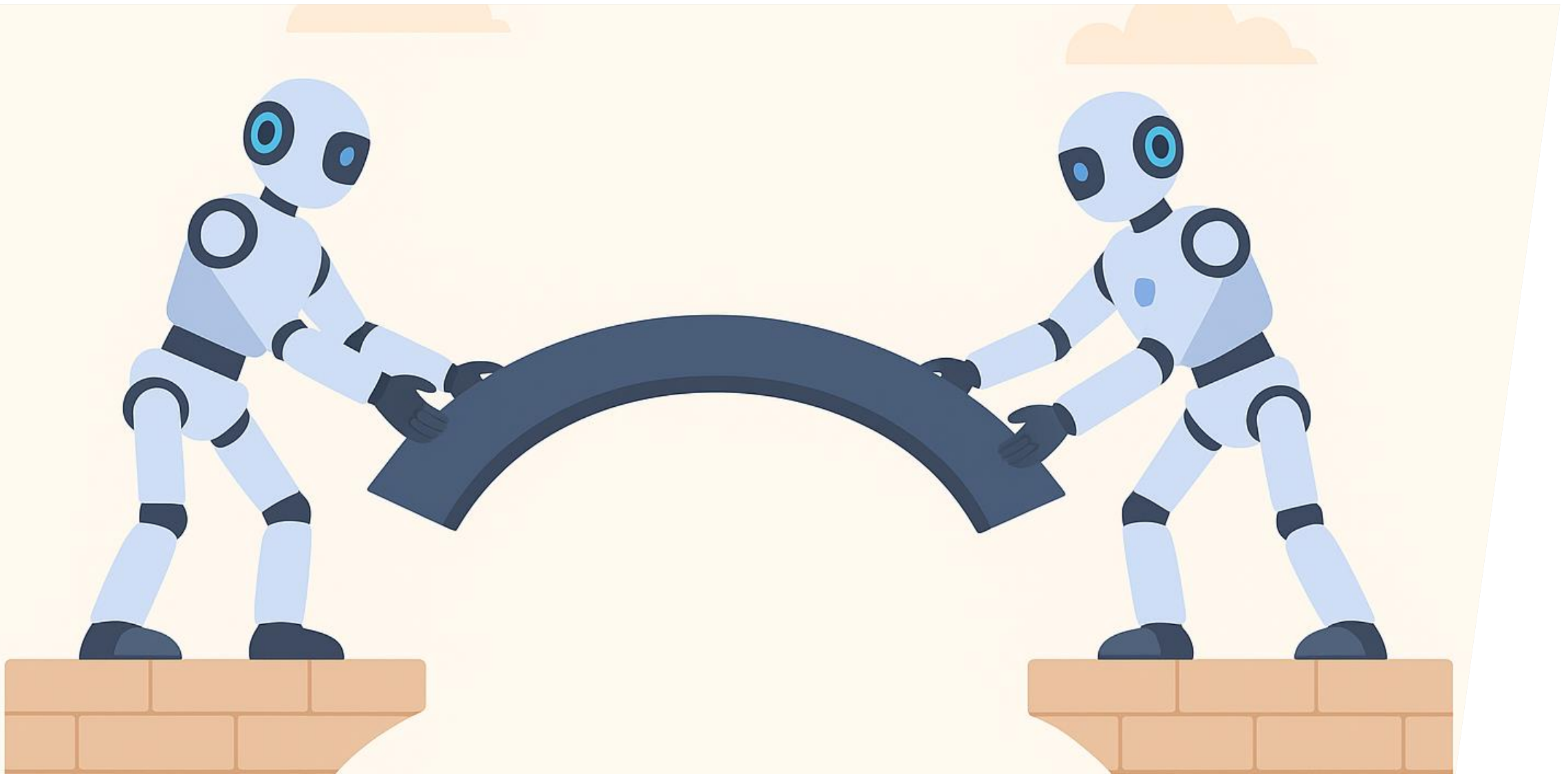
- Companies with 25+ employees required to hire at least 1 person with a disability
- Compensation tax if quota is not met

■ Dedicated Funding Programs

- Promote diversity in companies and advance research in inclusive technologies (e.g., FFG FemTech, DIVERSITEC)



From Second to First: Robotics as a Bridge



Assistive Robots for Inclusion

■ Home Care

- Assistive robotics in daily living
 - Understanding user actions in real time and adapting accordingly [1]
 - Robotic support for feeding [2]
 - Robot-based wheelchairs



<https://www.dlr-innospace.de/innospaceexpo/W&A/Home/content/industrie.html>

■ Healthcare & Medical

- Assistive robotics supporting caregivers
 - Improving ergonomics & taking over repetitive tasks
- Surgical robotics



<https://entrance-robotics.de/tag/robot-care/>

■ Social Inclusion

- Social robots fostering interaction and reducing isolation
- Telepresence robots for participation in work, school, and community life



Reha-Roboter ROBERT® mobilisiert Patienten: Roboterassistierte Therapie entlastet Pflegekräfte
<https://www.kuka.com/de-at/unternehmen/iimagazine/2023/02/robotik-in-der-pflege>

References:

- [1] Pinheiro, M., & Bicho, E. (2013, February). A socially assistive robot for people with motor impairments. In 2013 IEEE 3rd Portuguese Meeting in Bioengineering (ENBENG) (pp. 1-7). IEEE.
- [2] Ohara, E., Yano, K. I., Horiata, S., Aoki, T., & Nishimoto, Y. (2009, March). Development of tremor-suppression filter for meal-assist robot. In World Haptics 2009-Third Joint EuroHaptics conference and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (pp. 238-243). IEEE.

Potentials of Human-Robot-Collaboration (HRC)

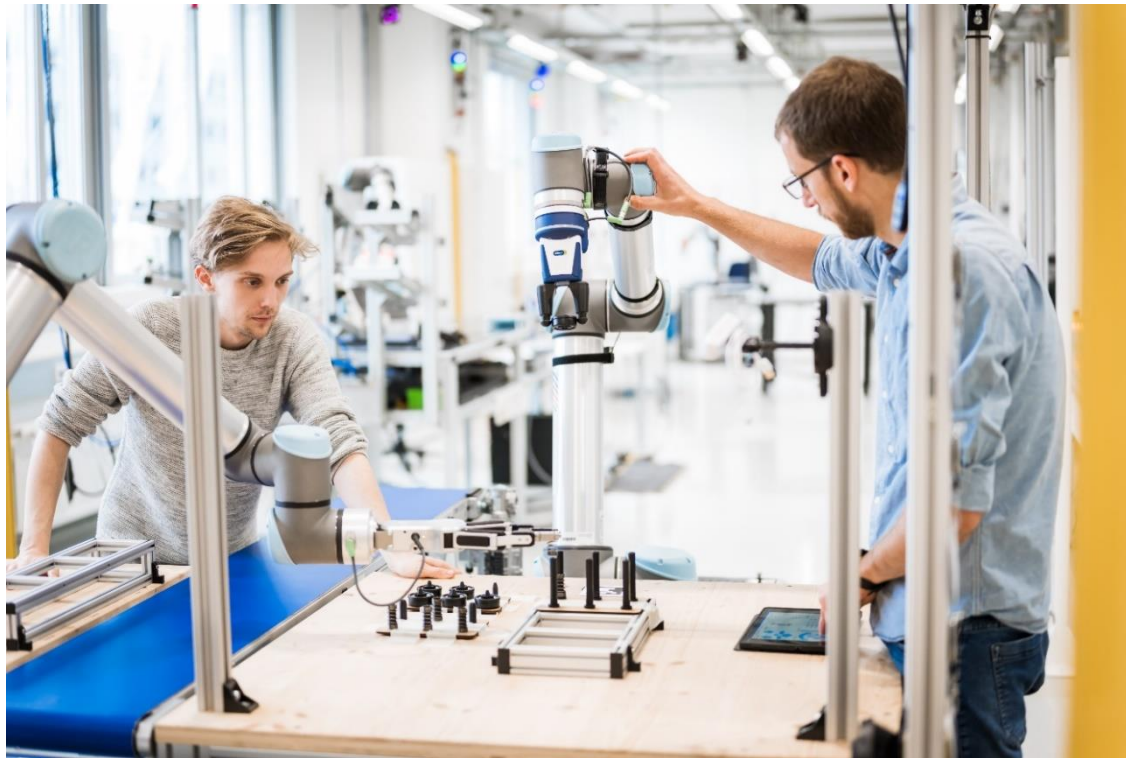
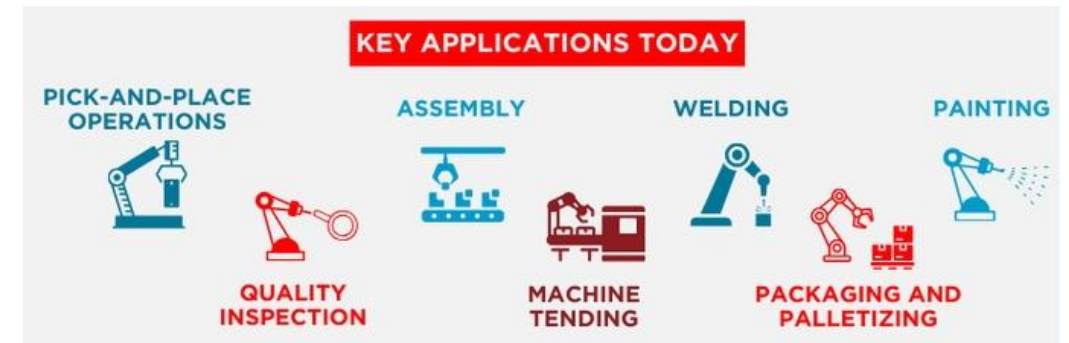
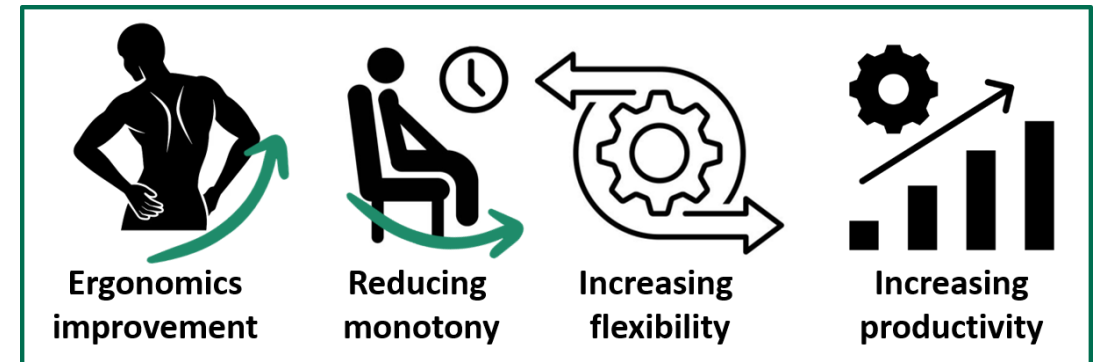
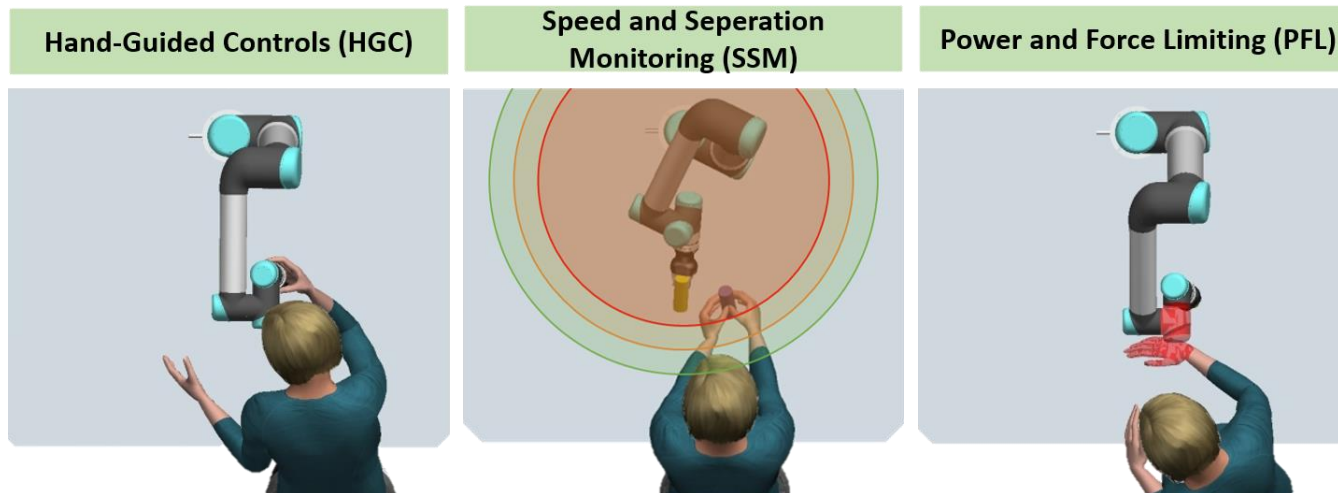


Image: JOANNEUM RESEARCH ROBOTICS



Safety in HRC

- **Potential of HRC vs. safety:** Manufacturer must meet safety requirements
- **Safety vs. flexibility:** Regulations can feel restrictive, reducing adaptability
- **Safety as an enabler:** Proper implementation enhances flexibility



*There is no safe robot,
only safe applications.*

It is important to emphasize that the term “collaborative robot” is not used in this document. Only the application can be developed, verified, and validated as a collaborative application. In addition, the term “collaborative operation” is not used in this document.

Limits of machines

According to regulation 2023/1230 of the European Parliament and of the Council, the manufacturer of a machine is required to conduct a risk assessment.



■ Risk assessment according to ISO 12100:2010

1. Determination of machinery limits
2. Identification of hazards
3. Risk estimation
4. Risk evaluation

5.3 Determination of limits of machinery

5.3.1 General

Risk assessment begins with the determination of the limits of the machinery, taking into account all the phases of the machinery life. This means that the characteristics and performances of the machine or a series of machines in an integrated process, and the related people, environment and products, should be identified in terms of the limits of machinery as given in 5.3.2 to 5.3.5.

5.3.2 Use limits

Use limits include the intended use and the reasonably foreseeable misuse. Aspects to be taken into account include the following:

- a) the different machine operating modes and different intervention procedures for the users, including interventions required by malfunctions of the machine;
- b) the use of the machinery (for example, industrial, non-industrial and domestic) by persons identified by sex, age, dominant hand usage, or limiting physical abilities (visual or hearing impairment, size, strength, etc.);

Limits of Diversity in Safety of HRC

- ISO 13857:2019 standardizes safety distances to prevent hazard zones from being reached by limbs
- Distances are based on anthropometric percentiles for upper and lower limbs
- Limit of diversity
 - Body sizes
 - Physical disabilities

Risk Assessment

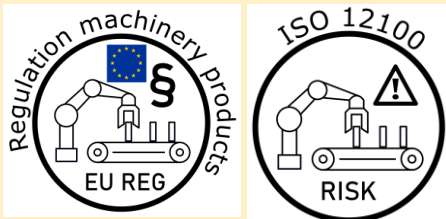
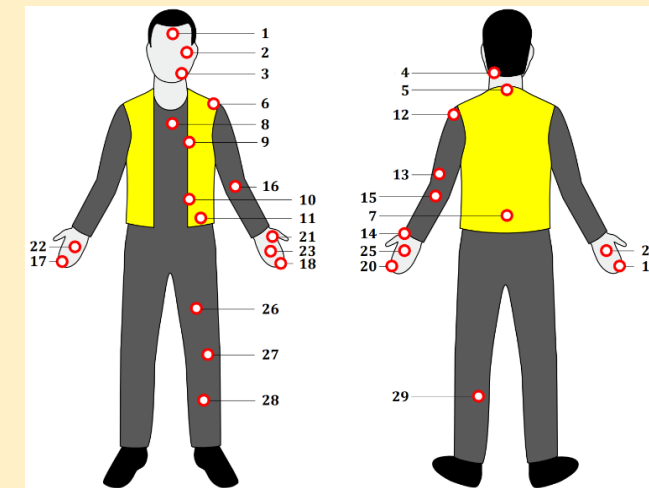
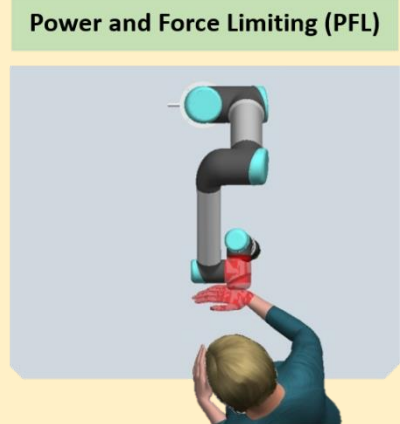


Table 3 — Reaching around with limitation of movement

Limitation of movement	Safety distance, s_r	Illustration
Limitation of movement only at shoulder and armpit	≥ 850	
Arm supported up to elbow	≥ 550	
Arm supported up to wrist	≥ 230	
Arm and hand supported up to knuckle joint	≥ 130	

A range of movement of arm
 s_r radial safety distance
 This is either the diameter of a round opening, or the side of a square opening, or the width of a slot opening.

- Person-neutral biomechanical limits
- Literature shows the need for gender- and age-specific limits [1,2]

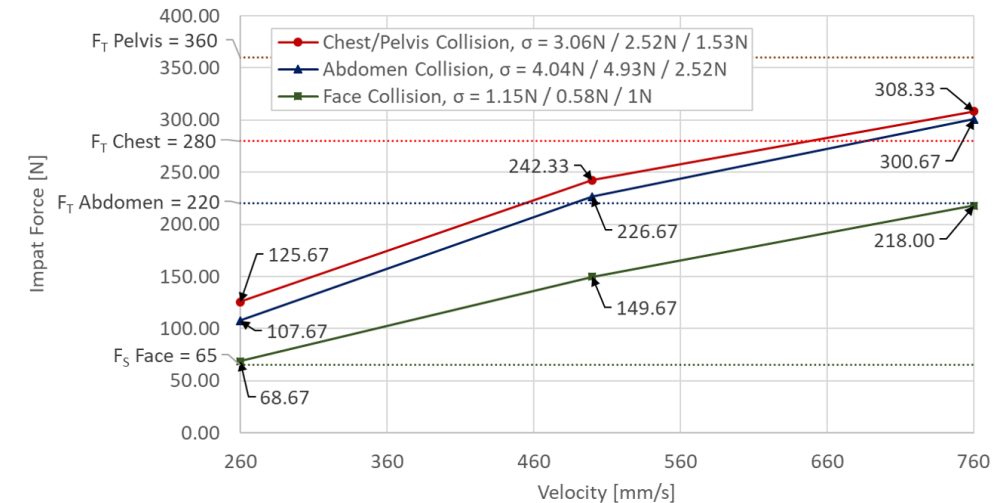
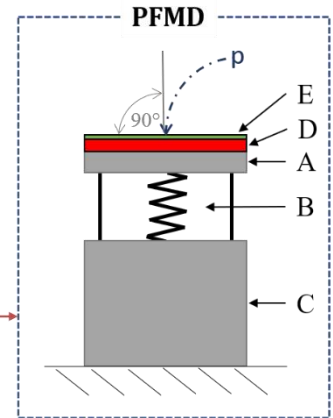
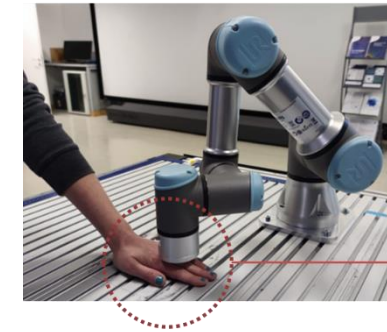
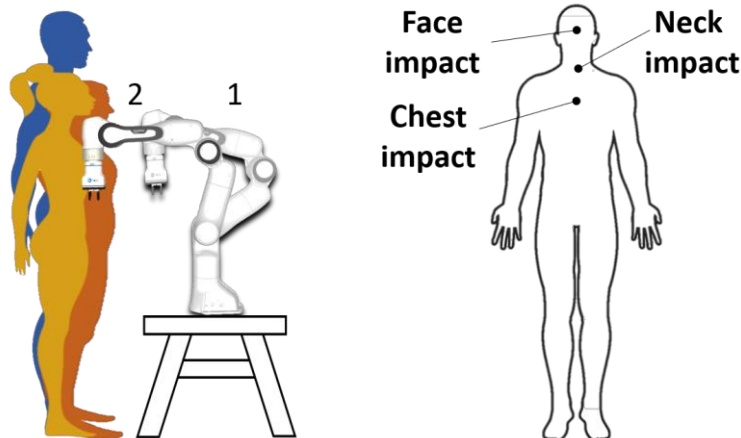


References:

- [1] Behrens, R., Pliske, G., Umbreit, M., Platek, S., Walcher, F., & Elkmann, N. (2022). A statistical model to determine biomechanical limits for physically safe interactions with collaborative robots. *Frontiers in Robotics and AI*, 8, 667818.
- [2] Behrens, R., Pliske, G., Platek, S., Walcher, F., & Elkmann, N. (2023). A statistical model to predict the occurrence of blunt impact injuries on the human hand-arm system. *Journal of biomechanics*, 151, 111517.

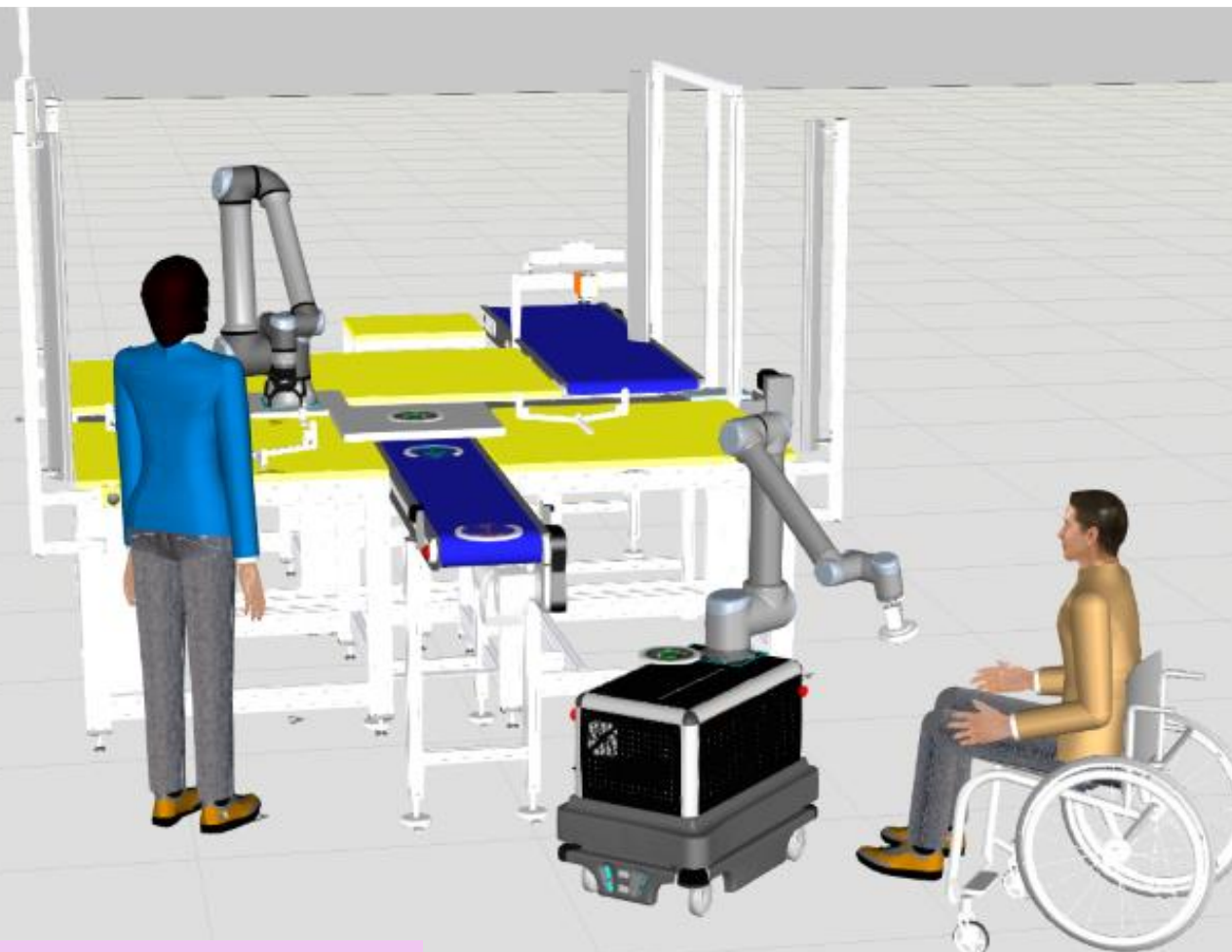
Influence of Personal Data & Body Postures

- **Anthropometric Data & Posture:** Determines affected body regions and biomechanical limits
- **Body-Specific Parameters:** Influence contact force and pressure in collisions
- **Limited Personal Data:** Worker-specific information usually unknown, affected regions are only estimated



Project SAFEIVERSE

Integrating diversity and inclusion into the design of safe human-robot collaboration



2 Years research Project (08/2024-07/2026)
JOANNEUM RESEARCH ROBOTICS & POLICIES

SAFEIVERSE - About the Project

- **Goal:** Development of a diversity-oriented design and safety concept for HRC in order to increase access to these technologies
- *Methods & Procedure*
 - Definition of requirements for inclusive HRC
 - Hands-on demonstrator in the Robotic Solution Lab
 - Stakeholder-oriented development (economic feasibility and acceptance)
 - Local organization as associate partners
 - Raising awareness and promoting understanding

Associate partners:

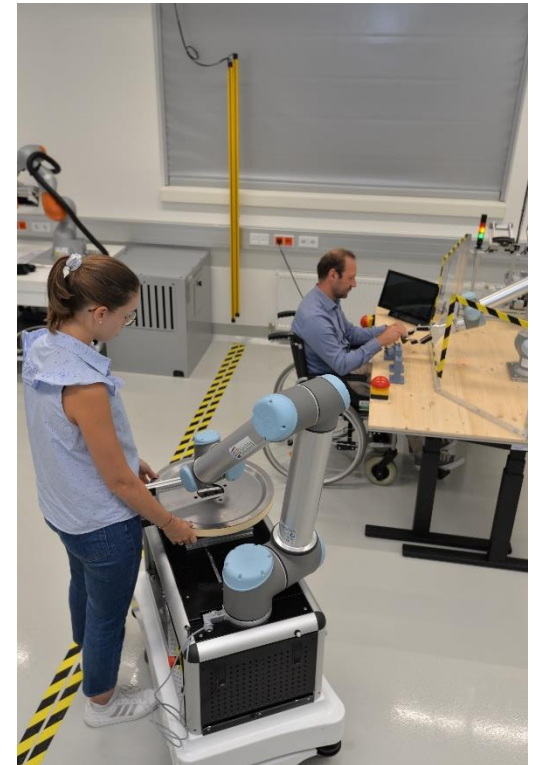


Image: JOANNEUM RESEARCH ROBOTICS

Vision for Future Workplaces

- Human-centered
 - safe, and technology-supported
- Adaptive & autonomous
 - Based on the skills of the operator
- Accessible and cost-efficient
 - Inclusion of affected individual
 - Economically feasible

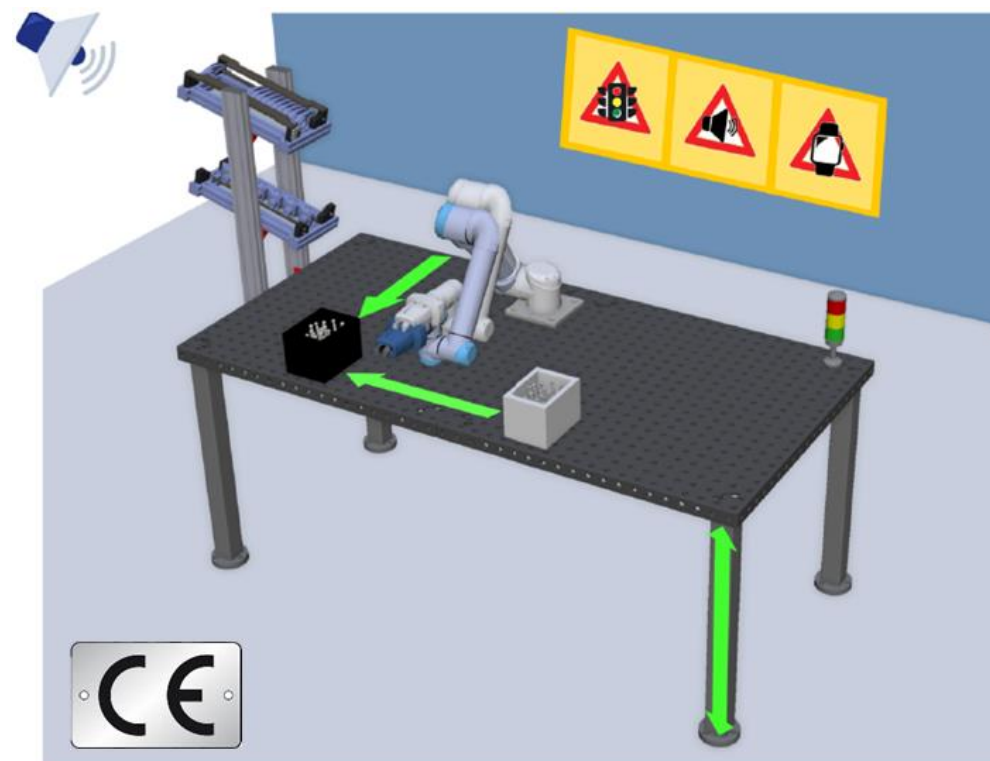
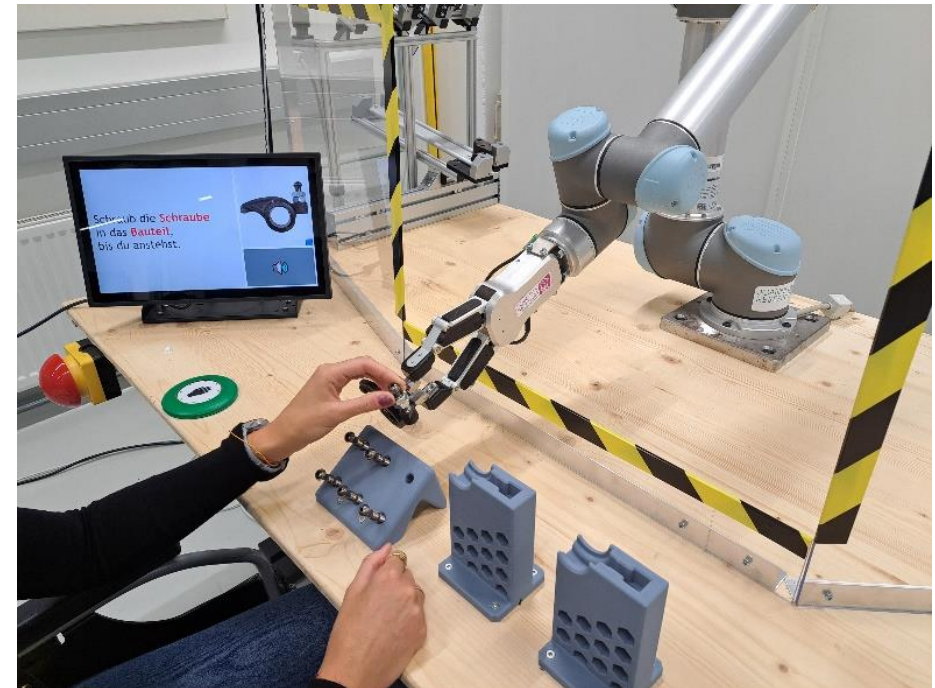


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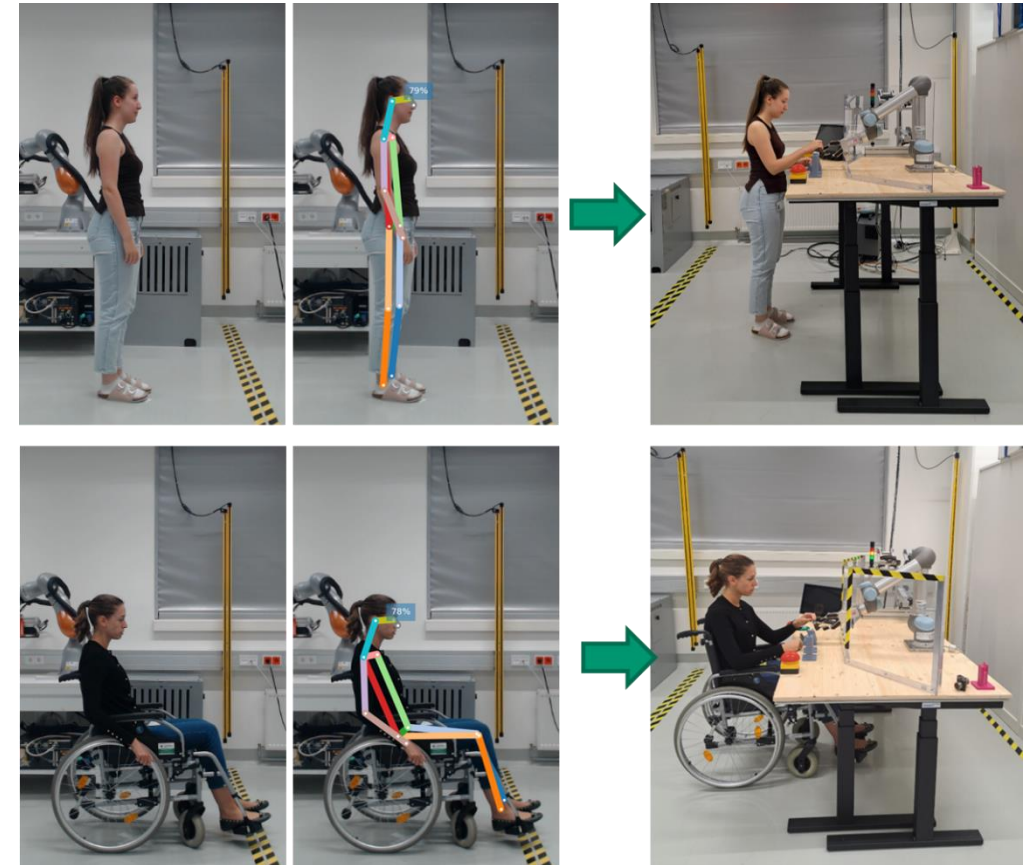
Inclusive HRC

- Examples of Suitable Production Processes
 - Assembly, quality control, carpentry work, sorting tasks
- Multi-Modal Guided User Interface (GUI)
 - Step-by-step instructions
 - multiple languages and proficiency levels
 - Text, sound, images, and videos
- Accessible and Ergonomic Components
 - Clearly visible and easily reachable controls
 - Accessible emergency stop buttons
 - Tactile sensors for effortless operation
- Adaptive, Autonomous Workstation
 - Table height and robot adapt according to the operator



Adaptive, Autonomous Workstation

- AI-based detection of body posture and height
- Calculation of ergonomic table height and robot posture
- Autonomous adaptation of the workstation based on camera detection
 - Real-time evaluation: images are not stored for data protection



User-Oriented Development

- User studies with associate partners
 - Conducted within the frame of „Robot-seminars“
 - Short task (Use Case) followed by an expert interview
 - Evaluation based on observation logs and interview results
- Evaluation parameters
 - Impressions and prior knowledge
 - Tasks comprehension
 - GUI usability
 - Interaction with the robot
 - Workstation setup



User-Oriented Evaluation

- Participants
 - n = 24 (8 female, 16 male), age 25 - 50
 - Mainly people with mental disabilities
- Iterative, formative research approach
 - Two separate studies (n = 12 each)
 - Slight adaptations of the use case after first study
 - GUI adjustments (volume, cycle time, ect.)
 - Ergonomic extension for wheelchair and walker users
- First findings
 - Participants felt comfortable and enjoyed working with the robot
 - Adaptive workplaces were well received
 - Multimodal instructions were appreciated, but information delivery should be adaptive and customizable
 - Task duration should be individually adjustable
- Ongoing work: scientific evaluation of the study



Image: JOANNEUM RESEARCH ROBOTICS

Design- and safety concept for inclusive HRC

Human-Centric Risk Assessment

- Operator who may be affected is considered during hazard identification
- Risk estimation according to the circumstances, needs, or limitations of different operators
- Operators diversity is taken into account during risk assessment

Adaptive Robot-Assisted Workstation

- Workstation and robot adapts to workers' posture and height
- Cycle time based on workers' preference and needs

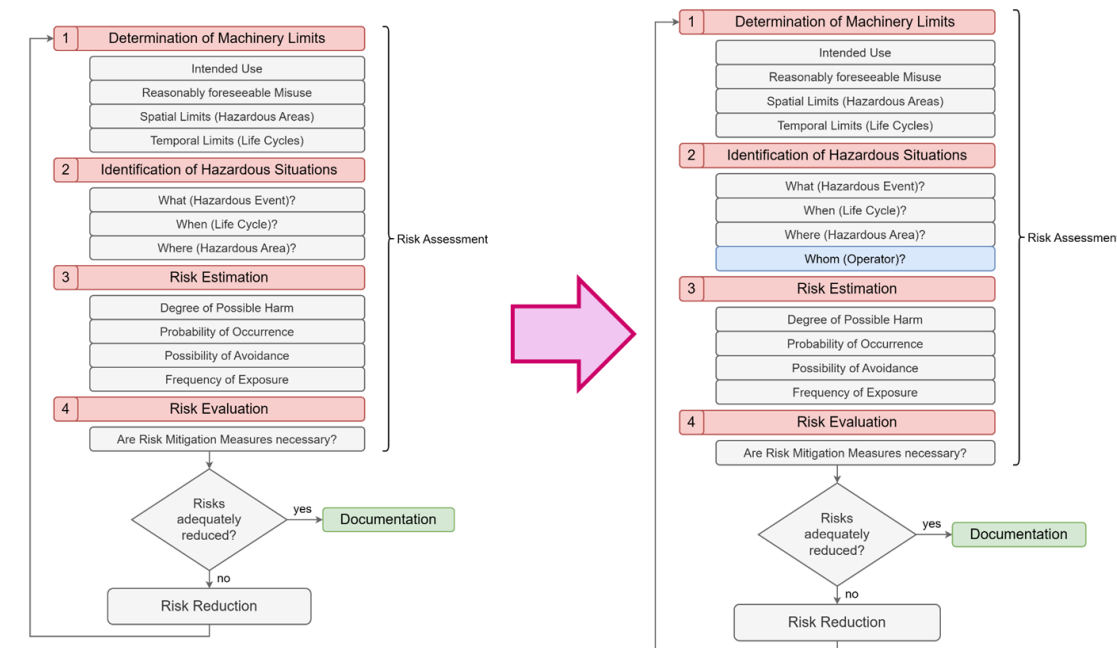
Multimodal Guided User Interface

- Step-by-step guidance
- Adapts according to workers' language and skills

Ergonomic and Inclusive Control Elements

- Clearly visible and easily accessible
- Intuitive interaction (tactile, visual)

Human-Centric Risk Assessment



Key Message to remember

- Production workplaces and modern technologies must be designed to meet the challenges of demographic change
- Opportunities exist, but what is needed now are safe, **adaptive, and diversity-oriented solutions**
- **Human–robot-collaboration** can enable participation for people with diverse abilities
- Design and safety of modern workplaces must **be adaptive and inclusive, with a user-centered approach** as a key principle
- While “**the ideal inclusive workstation**” does not exist, companies need **practical guidance and best-practice examples** to get started



Support Package 5: Inclusive Gendered Innovation (Policy) - Improving Quality and Equality in Research and Innovation

- **What it is:** A compact, **modular toolbox** for integrating gender and diversity dimensions into research content – to be used in research projects and in funding procedures.
- **For whom:** **Researchers** and applicants, RFOs: reviewers, policy actors, and institutions.
- **What it contains:** **Step-by-step guides** (research & innovation cycle), modules for funding organizations (along the funding cycle), curated tools/templates/examples, a glossary of key terms, lessons learned, and approaches for sustainable change.
- **How it is used:** Flexible and adaptable – select building blocks and integrate them into existing processes/templates.



<https://inspirequality.eu/support>

Open Training Unit 7: Inclusive Gendered Innovation Policy Toolkit (für RFOs)

26

- **What it is:** A module-based **training toolkit** for integrating gender and diversity dimensions into research content along the entire funding cycle.
- **For whom:** **RFOs**, program and policy officers, operational staff.
- **What you learn:** **Key concepts**, relevance for research quality; entry points in the funding cycle (design of calls, criteria, reviewer briefings; monitoring, sustainability) dealing with resistance, practical best practice examples;
- **How it works:** No prior knowledge required; modular structure with intro, content, reflection, and take-away. Slides including **checklists/decision guides** & speaker notes; flexible entry depending on needs.



<https://inspirequality.eu/training>

SHAPING THE FUTURE, TOGETHER



Let's stay
connected

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