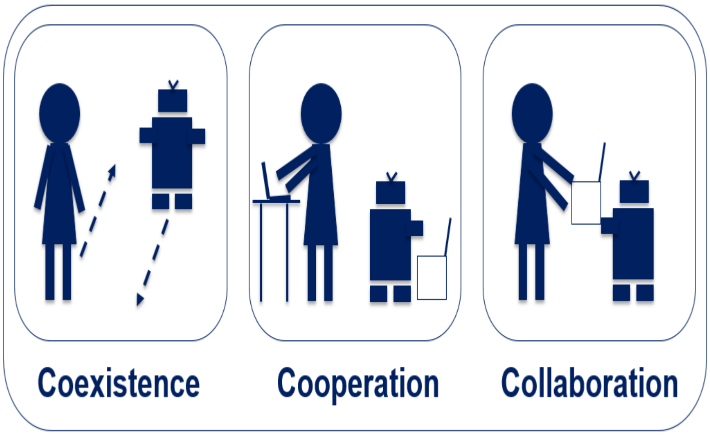
AUTOMATING PHYSICAL TASKS USING AI-BASED SYSTEMS IN THE WORKPLACE: CASES AND RECOMMENDATIONS

Advanced robotics in the workplace

Advanced robotics are becoming increasingly present in today's world of work. **Industrial robot sales increased by 31% in 2021, compared to 2020.**[1] **Worldwide sales of professional service robots grew by 37%.**[2] This growth is not limited to individual sectors. Sales for medical robots, including surgery robots, robots for rehabilitation and non-invasive therapy, and robots for diagnostics, increased by 23%. Eighty-five per cent more hospitality robots were sold in 2021 compared to 2020. Demand for robots in agriculture (6%), inspection and maintenance (21%), cleaning (31%) and logistics (45%) increased as well. While some of these robots are systems operating independently from humans, an increasing number is not only capable of some form of interaction but specifically designed for it (for example, healthcare robots). The International Federation of Robotics (IFR) defines collaborative industrial robots as 'a class of robots that perform tasks in collaboration with workers in industrial settings'.[3] The shorthand **'cobot', however, is often used on a wider variety of systems**. Some experts discuss **three types of human–robot interaction (HRI)**.[4] The first type of HRI is called 'coexistence', where a human and a robot share a workspace for a limited time, without sharing a common task goal. The occurrence of a nurse passing a mail delivery robot in the hallway would be described as coexistence. The second type is a 'cooperative' robotic system that works towards a shared goal with the human worker. However, their tasks can be independent from each other. Pick-and-Place robots at a workstation that prepare parts for human workers reflect this type of interaction. A collaborative HRI is represented by the human and robot working towards a common goal and additionally their tasks and subtasks are shared in time and place. Furthermore, human–robot collaboration is indicated by the creation and use of synergies.[5] An example is lifting a heavy object collaboratively. **All three scenarios include advanced robotics, which can be described as cobots, capable of perceiving and reacting to their surroundings.** Some of these systems rely on a complex but deterministic backend software to perform their tasks, while others use AI-based systems.

When looking at current case studies,human–robot collaborations in the ways described by Onnasch and Roesler[6] are rare to find at the workplace. Cooperative scenarios are the most common. However, as there is rapid growth in all sectors of robotics application, this distribution might change in the future. As the technology continues to expand into more and more workplaces and unstructured environments, companies might face difficulties and challenges during the implementation process. To reduce these barriers, one can consult case studies that have already successfully implemented advanced robotics in their workplaces.

Figure 1: Three types of human–robot interaction by Onnasch and Roesler



[1] International Federation of Robotics. (2022). *Executive Summary World Robotics 2022 - Industrial Robots*. https://ifr.org/free-downloads

[2] Ibid.

[3] International Federation of Robotics. (2019, January 24). *IFR Secretariat Blog*. https://ifr.org/post/international-federation-of-robotics-publishes-collaborative-industrial-rob

[4] Onnasch, L., & Roesler, E. (2019). Anthropomorphizing robots: The effect of framing in human-robot collaboration. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 63*(1), 1311-1315. https://doi.org/10.21934/baua:fokus20160630

[5] International Federation of Robotics. (2019, January 24). *IFR Secretariat Blog*. https://ifr.org/post/international-federation-of-robotics-publishes-collaborative-industrial-rob

[6] Onnasch, L., & Roesler, E. (2019). Anthropomorphizing robots: The effect of framing in human-robot collaboration. In *Proceedings of the human factors and ergonomics Society annual meeting*, 63(1), 1311-1315. Sage CA: Los Angeles, CA: SAGE Publications. https://doi.org/10.21934/baua:fokus20160630

As part of EU-OSHA's research on advanced robotic and AI-based systems for the automation of tasks and occupational safety and health (OSH), 11 case studies and 5 short case studies were developed that focus on workplaces that use these technologies. The following presents three summarised case studies from across Europe based on companies of varying sizes that use advanced robotics with varying degrees of automation. They each automated a different task with different systems.

Case studies

Case 1

The Slovenian-founded company for Case 1 operates on a global scale, in the field of automotive and industrial technologies. They currently have locations in **over 55 countries**. Within Slovenia, they employ **around 1,700 workers** in their production sites. They use a **six-axis, one-arm, medium-sized** collaborative robotic system from a **third-party supplier.**

The **cobot in this case study handles parts weighing between 2.5 kg and 3.5 kg** at an estimated pace of 600-700 times per day. Workers, as part of the production and quality control process, previously handled these parts. The cobot **lifts** a product part from the production line and moves it to a storage pallet. This process is interjected by a worker, who performs a **quality control check** on the presented part. The cobot performs an **object-related repetitive** task with **physical** manipulation of the aforementioned **2.5 kg and 3.5 kg** parts. For the task of lifting the parts, human labour is **substituted** and the workers' focus shifts towards the cognitive task of quality control.

The decision that a collaborative robotic system will be introduced to the worksite in this first case study was made by the company's management, in cooperation with the technology department. The first **testing phase** was initialised. This included a **risk assessment** and extensive **safety testing**. After the safety-related **certification** and approvals were acquired, and in consideration of safety regulations and requirements, **workers were included** to get to know the system before using it in everyday operations. Before starting the production with the cobot, there was also an **education period** for the operators.

Case 2

The company in this case is an **automotive supplier** operating on a global scale and specialising in the field of drive and chassis technology. They provide customised integrated solutions for automobile manufacturers, mobility providers, and other companies with a focus on transportation and mobility. This case study is located in one of their factories in **Portugal**. In total, the company has more than 100 locations in over 30 countries, with around 150,000 employees worldwide.

This factory deploys a **cobot** to automate the **sewing of bags**. The cobot performs the sewing task. It is a **one-armed multi-axis** robot from **a third-party supplier** that was customised to fit the factory's needs. The worker supplies the cobot with the necessary material to perform the sewing task. Once the sewing is completed, the cobot performs an initial quality control check to assess if all seams are of sufficient quality. The worker can then start a new sewing cycle for the cobot while they perform further quality control checks and assembly steps on the bag. The cobot performs **physical object-related tasks** with a **non-AI backend software** that is highly **repetitive**.

Before introducing the cobot, the company **assessed their production line for possible automated processes**. Worker involvement came after the decision had been made regarding which tasks to automate and which technology to use. Parties involved in these decisions were the system developers and an engineering team. The introduction took place in two phases. Prior to using the cobot, workers received specialised training. At first, both the cobot and a manual machine were available to perform the task. After a week, the manual machine was removed. Then, workers started using the cobot full time. The impact the cobot's performance had on production cycles has **allowed the company to restructure their workers' shifts**. Instead of working at one station for eight hours, they now rotate every two hours. The company reported initial hesitancy of workers to operate the cobot, due to subjective safety concerns. As their workers gained experience with the technology, the concerns resolved.

Case 3

The third company is active in a variety of sectors like automation and digitalisation in industry, infrastructure for buildings and decentralised energy systems. Today it can be classified as an **international company** with branches in 190 countries, however, it was founded in Germany.

Their cobot systems automate tasks through **six-axis articulated robots** or **four-axis scale robots**. Within their locations, there are both **self-designed robotic applications** as well as systems bought **from third parties**. **Cobots are used in slow-cycle assembly processes for a variety of product parts.** The cobot typically provides physical support by holding the workpiece. The cobot's function is to alleviate workers' physical strain, and assist them in their main task, by reducing physical load. At these cobot workspaces, **workers still generally perform their previous task, or take on additional skilled tasks** in the assembly process. The cobots perform an **object-related repetitive** task with **physical** manipulation of the workpiece. The company noted that automation through advanced robotics has, in some cases, led to **task consolidation for workers**. While in older factory set-ups the workers completed all relevant tasks concerning one workpiece, they now perform more and more 'side tasks'.

The company **explicitly encourages workers** to bring forward ideas and suggestions for further process automation. Workers can express the wish for a robotic system at their workstation to an automation specialist ('key user'), who then makes an initial feasibility assessment. Approved suggestions are forwarded and a project team is created, including a project planner, workers council and data protection officers on site, and advisory security staff. When the impulse does not come from a worker, their involvement typically starts after a concept phase. However, this does not end with the final roll-out of the robotic solution but continues into the ongoing production. Workers are **trained to optimise production**, hence, there is a **continuous open feedback system** to submit suggestions for changes, optimisation or innovation.

The **most influential factor** on trust was the **early involvement of workers** during the introduction process. In the company's experience, this increases acceptance towards the systems. Additionally, providing **information early on and communicating clearly** about both the **intention of the automation** and its practical functions is vital.

Recommendations

Advanced robotics are becoming more diverse, and more companies in Europe are using these technologies. Hence, they encounter different structural and technological hurdles along the way. The implementation process can be just as diverse, with different strategies being the most efficient for different companies. Which parties are involved and to what extent, not only depends on the company size, but also on their level(s) of experience with advanced technological systems. While some companies develop in-house solutions, others use third-party suppliers and customise those robots to their needs. It is therefore not goal-oriented to try and create a standard list of implementation steps to follow for every company. It can be more helpful to gather factors that helped companies along the implementation process that are not limited to their company size, sector or level of experience.

Questions regarding the **introduction process** and the assessment of **worker attitudes towards robotics systems need to be asked to facilitate a successful introduction and human-centred long-term working conditions**. All case studies acknowledged the workers' **fear of job loss** due to continuous automation. The case studies have developed ways to address these concerns with their workers and successfully reduce fear of job loss. It can be approached from two sides: **first by intervention, and second by prevention**. When a company becomes aware that their workers experience fear of job loss due to automation through advanced robotics or AI-based systems in their workplace, certain interventions can be made. **Most companies decide to improve their workers' understanding of the technology and the implications automation has for them and their work.** All companies in the case studies stressed that the intention of their automation is not to eliminate jobs but to improve working conditions. **Educating workers on how the technology impacts and benefits them**, their routine, and occupational safety and health is a separate intervention from training them on how to use the system. Workers have begun to recognise that being technologically literate is essential in an increasingly digital workplace.[7] Providing them with the skill sets needed in the long term could reduce their adjustment period to a new digital work environment and provide them with a subjective sense of job security.[8] Preventing subjective fear of job loss entirely is likely to be impossible. However, companies can take preventive measures independently from the introduction of a singular system. Firstly, in cases where workers were the initiator of the automation process, acceptance was higher. This falls under the larger umbrella of worker involvement in the implementation process. **Early worker involvement** provides them with

[7] Smith, C. L. (2015). *Technology literacy skills needed in further education and/or work: A Delphi study of high school graduates' perspectives* (Publication No. 5776) [Doctoral dissertation, University of South Florida]. USF Tampa Graduate Theses and Dissertations. http://scholarcommons.usf.edu/etd/5776

[8] Kozak, M., Kozak, S., Kozakova, A., & Martinak, D. (2020). Is fear of robots stealing jobs haunting European workers? A multilevel study of automation insecurity in the EU. *IFAC-PapersOnLine, 53*(2), 17493-17498. https://doi.org/10.1016/j.ifacol.2020.12.2160

the opportunity to exercise some form of influence and to communicate their wishes, needs and concerns early on. While not all companies may have the opportunity to involve workers in the design process of a new system, informing them about upcoming changes as early as possible, and creating a way for them to voice concerns, is good practice and might reduce fear of job loss along the way. Having managed the subjective fear of job loss for the introduction of one kind of robotic or AI-based system does not mean that a company should neglect this topic in any other/future automation projects.

Early worker involvement goes hand in hand with a **functional communication strategy**. Empirical research supports the companies' experience that having **a formal communication avenue** while introducing a change initiative reduced uncertainty and enhanced commitment.[9,10] Communicating future changes to workers can reduce feelings of uncertainty towards **the rationale behind the change**. Furthermore, clear and direct communication has been found to promote change-supportive behaviour from workers.[11] These findings in the literature were reconfirmed in the experiences outlined in the case studies. Having both personal (for example, team lead) and anonymous (for example, feedback box, or workers council representative) communication systems has been described as helpful to receive worker feedback and create conversation around relevant topics.

The relative novelty of advanced robotics in the workplace is accompanied by a workforce inexperienced in how to interact with them. A lack of familiarity can influence workers' attitudes towards robotic systems and colour the initial experience. Initial attitudes are perhaps even more so shaped by external sources like newspaper reports, which can be negatively biased regarding robotic systems at the workplace.[12] In one case study, the company specifically stressed how crucial it is to differentiate between fictional representation of robotic systems and the actual technology. Researchers found that **negative attitudes towards robots decreased as experiences of interacting with them increased.**[13] This is confirmed by companies, like in the second case study that faced initial hesitance towards the system but saw a significant reduction once workers gained experience with the system. Companies interested in reducing this initial hesitancy could start by offering early education on robotic systems before implementing them. Furthermore, to reduce unfamiliarity in the interaction, systems designers should orient themselves with established interaction design principles, one of them being the EN ISO 9241-110. This standard contains seven interaction principles for human–technology interaction called 'Suitability for the user's tasks', 'Self-descriptiveness', 'Conformity with user expectations', 'Learnability', 'Controllability', 'Use error robustness' and 'User engagement'. They can be used to evaluate HRI.

The fact that the world of work is rapidly changing, in part due to advancements in robotic systems, also increases the expectation that workers adapt and change with it. Working with advanced robotics often requires a new skill set and more detailed understanding of technology than most workers' previous tasks did. Some case studies have described difficulties of workers in keeping up with this demand for cognitive change. New work environments can challenge workers more cognitively, such as the requirement of increased decision-making, in contrast to the mostly physical tasks they were previously performing.[14] For this reason, **cognitive and sensorial aids should be provided to workers to prevent information overload and potential negative effects on the operators**.

Lastly, several companies within the project reported a change in task structure, in relation to the implementation of a robotic system. This is mostly described as a positive change, as workers now have more time to perform their main task or are described as using the additional time to help other co-workers or to perform secondary tasks. Task design needs to be considered during the implementation process. Other companies raised concerns that workers now possibly perform more disjointed tasks, decreasing **task completeness**. Others raised the concern that automation can lead **to task consolidation and work**

---

[9] Bordia, P., Hobman, E., Jones, E., Gallois, C., & Callan, V. J. (2004). Uncertainty during organizational change: Types, consequences, and management strategies. *Journal of Business and Psychology, 18*, 507-532. https://doi.org/10.1023/B:JOBU.0000028449.99127.f7

[10] Hobman, E. V., Bordia, P., & Gallois, C. (2004). Perceived dissimilarity and work group involvement: The moderating effects of group openness to diversity. *Group & Organization Management, 29*(5), 560-587. https://doi.org/10.1177/1059601103254269

[11] Kozak, M., Kozak, S., Kozakova, A., & Martinak, D. (2020). Is fear of robots stealing jobs haunting European workers? A multilevel study of automation insecurity in the EU. *IFAC-PapersOnLine, 53*(2), 17493-17498. https://doi.org/10.1016/j.ifacol.2020.12.2160

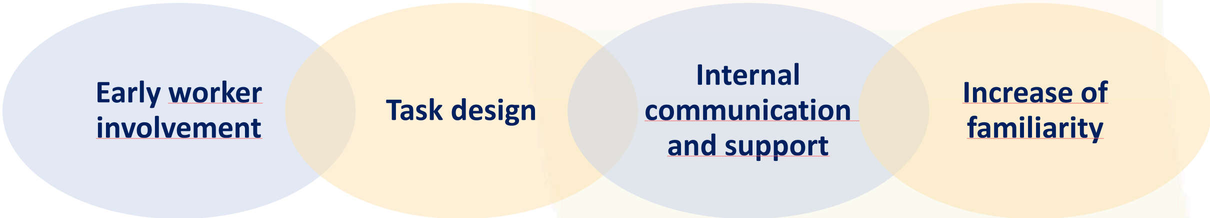
[12] Riemer, J., & Wischniewski, S. (2019). Robotics at work - News headline analysis 2016. In *2019 IEEE International Conference on Advanced Robotics and its Social Impacts (ARSO)* (pp. 202-207). IEEE. https://doi.org/10.1109/ARSO46408.2019.8948759

[13] Nomura, T., Suzuki, T., Kanda, T., Yamada, S., & Kato, K. (2011). Attitudes toward robots and factors influencing them. In K. Dautenhahn & J. Saunders (Eds), *New frontiers in human–robot interaction* (pp. 73-88). John Benjamins Publishing Company. https://benjamins.com/catalog/ais.2.06nom

[14] Gualtieri, L., Rauch, E., Vidoni, R., & Matt, D. T. (2020). Safety, ergonomics and efficiency in human-robot collaborative assembly: Design guidelines and requirements. *Procedia CIRP, 91*, 367-372. https://doi.org/10.1016/j.procir.2020.02.188

intensification. This risk is also described in the literature relating to task design.[15] So, before implementing an advanced robotics system, companies need to consider what job content and tasks are left for the human worker. Tight technological coupling should be avoided, and the human should still perform meaningful tasks, not only tasks that cannot be currently automated.

Figure 2: Recommendations for successful introduction



Technology-based factors, like choosing the best-suited robotic system for the task one wants to automate, are highly important for the successful implementation of advanced robotics. However, it is within their workforce and internal structures where companies report the most important steps to take to facilitate a successful, long-term implementation. Figure 2 presents the four most often named antecedents, from the companies' perspective, for the long-term successful implementation of advanced robotics. In their collective experience, human-centred design and communication reduce or prevent hurdles along the way.

Authors: Eva Heinold, Federal Institute for Occupational Safety and Health (BAuA), Patricia Helen Rosen, Federal Institute for Occupational Safety and Health (BAuA), Linus Sioland, Milieu Law & Policy Consulting Brussels, Dr Sascha Wischniewski, Federal Institute for Occupational Safety and Health (BAuA).

Project management: Ioannis Anyfantis, Annick Starren (EU-OSHA).

This policy brief was commissioned by the European Agency for Safety and Health at Work (EU-OSHA). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect the views of EU-OSHA.

European Agency for Safety and Health at Work, EU-OSHA, 2023

[15] Karasek, R. (1979). Job demands, job decision latitude, and mental strain: Implications for job redesign. *Administrative Science Quarterly, 24*(2), 285-308. https://doi.org/10.2307/2392498