ADVANCED ROBOTICS IN INJECTION-MOULDED AND EXTRUDED PLASTIC PRODUCTS MANUFACTURER REDUCING PHYSICAL DEMANDING TASKS (ID13)

Introduction

An increasing number of companies employ artificial intelligence (AI) or advanced robotics in their workplaces. 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 objective of a case study is to investigate the practical implementation of advanced robotic and AI-based systems for the automation of physical and cognitive tasks in the workplace. This includes researching their impact on workers and related OSH dimensions, specifically, how OSH is managed in relation to such systems. This will help companies, policymakers and researchers gain a better understanding of the drivers, barriers and success factors for safe and healthy implementation of these systems.

To identify such case studies, several key informants at the EU and international levels, including workers' representatives and industry associations, were consulted. The participating companies then filled out a questionnaire, providing information about their company, describing the technology they use and addressing OSH-relevant topics regarding task automation. These results were then categorised within a taxonomy published in EU-OSHA's report 'Advanced robotics, artificial intelligence and the automation of tasks: definitions, uses, policies and strategies and Occupational Safety and Health'. Finally, each case study presents key takeaways, based on the experience of each company.

General company description

The researched company for this short case study is a manufacturer of plastic products in Sweden. It has four associated brands active in non-invasive breath-sampling devices and ironing beads. One of their core products is breath-sampling devices for professional use in workplace drug testing, the monitoring of therapeutic drugs and clinical studies, among other applications. The ironing beads are for recreational use. The company has been active since the 1950s and currently has a workforce of fewer than 50 people.

The company is committed to constant improvement, regarding both their products and their workers. Professional and personal development, out-of-the-box thinking, high-quality products and close cooperation with their partners form the basis of their operation. Both their production process and production site have to uphold high engineering, ethical and scientific standards. They emphasise that they **are committed to producing their products in Sweden, especially regarding the high standard of worker safety**. They are also committed to adopting new innovative technologies and changes in the world of work. One way to do so is to turn to robotic automation as part of their production.

The company has been integrating different automation systems since the late 1990s. This short case study describes one of their non-invasive sampling devices. The company developed their first automated production cell in the early 2010s, and by the end of the decade **they had finished their first cobot laboratory sample preparation unit**. Now, they have integrated cobots into the process of sample preparation for liquid chromatography (LC) with a Compact Mass Spectrometer (CMS), short LC/CMS-analysis units (road-side drug test). The applied technology is a dual-arm robotic system, which is described in detail in the following section.

Description of the system

The company uses a **dual-armed lightweight** cobot, which is manufactured by a third-party multinational company. It is an **advanced cobot** that can be used for different manual tasks depending on the user's needs. In this short case study, the company uses it for laboratory sample preparation before analysis with 'high sensitivity LC/CMS'. LC/CMS is an analytical technique to accurately measure microgram and sub-microgram quantities of targets or elements in an analytical test sample. It physically separates the compounds in a target sample (for example, a soil sample), which then is followed by a mass analysis of the compounds in the sample. The sample is then heated, vaporised and ionised, as the mass spectrometer can only detect and measure gas-phase ions. These ions are then phased through a number of preparation steps, which result in an analysis of their individual mass in the prior samples. The cobot assists a worker in preparing the LC/CMS test samples. In this specific short case study, the samples collected are breath samples. This involves a number of **small, repetitive precision tasks, executed by the cobot**. Each sample needs to be transferred from its collection container into a medical test tube, diluted with a special solvent by mixing the samples, and then the test tube is sealed, gets a barcode attached to it for traceability and is finally placed into a holding rack for further analysis. These tasks are all automated by the cobot. It also prepares the sample collectors for freezer storage, so that the samples do not deteriorate. The worker provides the cobot with the needed material, ensures that there are enough empty test tubes, and removes racks of prepared samples to either perform the needed test or put them into appropriate storage. This results in a cooperative form of human–robot interaction.

The operator is **controlling the cobot through an interface** equipped with a touch screen. All command tasks can be performed from this screen, as well as starting and stopping the cobot. It will also show statistics about the processed samples as well as any **errors**.

The system provides solutions for three main issues in laboratory sample production. Firstly, it automates a monotonous and repetitive task, otherwise performed by a skilled worker, to ensure sufficient consistency and quality in the results. The cobot can prepare a rack of samples in under 60 seconds, which is highly time-efficient. Secondly, as the samples are later used for high-precision analysis, the cobot naturally has a lower risk of contaminating a sample than a human. Thirdly, the small, repetitive and precise hand motions can be straining on the wrists and arms of workers.

This system was developed as part of a roadside drug testing facility. Hence, it is intentionally easy to set up and use. The company states that the lab could be operated by a person without any laboratory training experience.

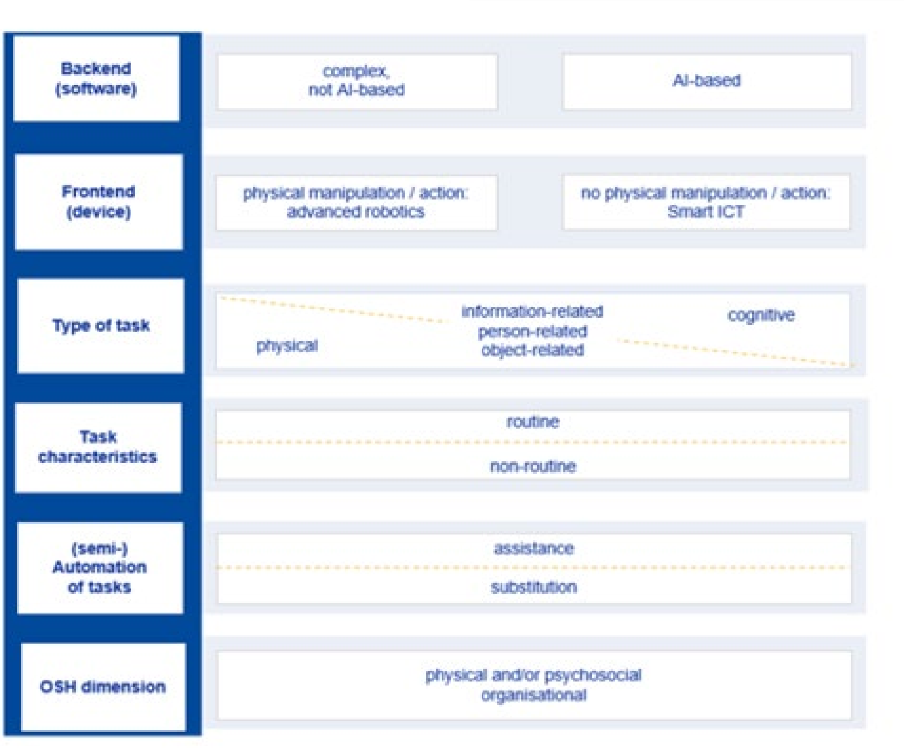
The companies that integrate the cobot into their operations receive **training** from the production company on how to operate it safely. In addition, they receive a user manual in their preferred language. **During the installation of the cobot, a health and safety check is performed by an external specialist.** The user manual and declaration of conformity is translated into the official language of the customer according to the requirements of the **Machinery Directive**.

Taxonomy-based categorisation

To categorise different types of technology, a taxonomy specific for different important criteria of advanced robotics and AI-based systems was developed and published in the EU-OSHA report 'Advanced robotics, artificial intelligence and the automation of tasks: definitions, uses, policies and strategies and Occupational Safety and Health'.[1] This taxonomy includes the type of backend and frontend used and the type of task performed, as well as which category it falls under (information-related, person-related or object-related). It distinguishes between routine and non-routine task characteristics as well as the degree of automation in the forms of assistance or substitution. Finally, the taxonomy takes into account different OSH dimensions (physical, psychosocial and/or organisational) that are impacted by the technology.

[1] EU-OSHA – European Agency for Safety and Health at Work, *Advanced robotics, artificial intelligence and the automation of tasks: definitions, uses, policies and strategies and Occupational Safety and Health*, 2022. Available at: https://osha.europa.eu/en/publications/advanced-robotics-artificial-intelligence-and-automation-tasks-definitions-uses-policies-and-strategies-and-occupational-safety-and-health

Figure 1: Taxonomy for advanced robotics and AI-based systems for the automation of tasks



According to that taxonomy, the dual-armed cobot in this case study performs high-precision **manual tasks** with a **non-AI backend software**. It performs an **object-related**, **repetitive** task with **physical manipulation** of the test tubes. The cobot is described as a 'dual-arm small parts assembly robot' that includes flexible hands, parts feeding systems, camera-based part location and state-of-the-art robot control. In this part of the assembly process, human labour is **substituted**. The latter-described OSH dimensions, which are impacted by the robotic system, are primarily **physical**, however, the company also describes some **organisational** effects.

OSH implications

The technology replaces human labour in the laboratory for a variety of **monotonous and repetitive manual tasks** in preparing the breath samples. Workers supervise the cobots' performance and carry the responsibility of quality control during the process. The use of the cobot improves efficiency; it can prepare the samples in under 60 seconds. Its high precision and accuracy improves the reliability of tests. According to the company, 'the sample preparation by the collaborative robot attains a level of precision and replicability which is unattainable through manual preparation, but nevertheless is a prerequisite for reaching the level of sensitivity needed in the analysis.'

A fundamental factor in OSH implications is always the task, which is automated by the cobot. This company utilises the technology to replace a physical task. According to the company, **the use of the lightweight cobot improves the ergonomics of the workplace by replacing repetitive and monotonous human labour** that can be strenuous on the wrists and arms. Furthermore, its use was the key to the possibility of creating a mobile lab unit for drug testing that could be operated by a person without any laboratory training (for example, a police officer). Thus, the cobot is considered to provide two main advantages, first by positively impacting the long-term health of laboratory workers, and second, by increasing the reliability of the test and protection against the contamination of samples. The second factor decreases overall workload in the long run, as fewer retests would have to be performed.

While the task itself is physical, this automation can possibly impact workers' **cognitive states positively**, as they no longer have to perform monotonous tasks.

Risk assessment prior to the introduction, as well as ongoing monitoring for possible emerging risks, are important steps when it comes to OSH. The company states that there are **no physical risks identified** with the use of this cobot for humans. The cobot has been advertised by others (and the manufacturer) as 'inherently safe' to **work side by side with humans, without requiring fencing or cages**. The operator controls the product through an interface equipped with a touch screen, where they are in control of the cobot and can start or stop it as needed. The cobot has a **low noise level**, so it does not prove a risk to one's hearing ability. Hot surfaces and high voltage surfaces inside the cobot are **not accessible** to the operator. In addition, there are **several safety mechanisms** such as **safety covers** for sharp parts that could cause injury in place. This way, the cobot can interact safely with the laboratory workers.

Key takeaways and transferability

The use and functionality of advanced robotics or AI-based systems can differ greatly from use case to use case. However, gathering information on similar use cases and transferring applicable insights about opportunities, risks and challenges, or other lessons learned, can help companies navigate the implementation process more efficiently and successfully, especially concerning OSH.

The presented company and its use of the dual-armed robotic system allows for some OSH-related takeaways, which have transferability to comparable cases. Firstly, the application of advanced robotics to automate repetitive and monotonous tasks can have a number of positive effects. **Musculoskeletal disorders** caused by repetitive strain is a well-documented health risk for workers.[2] Secondly, these kinds of tasks are **highly automatable**. Through the introduction of a robotic system, workers' risks of musculoskeletal disorders caused by these repetitive motions can decrease, simultaneously freeing the workers' **time to perform other more stimulating and less physically challenging tasks**.

Another key takeaway is the **hiring of specialists** to perform **health and safety checks**. This creates another layer of safety for workers, as the installation process of a system, in particular, needs to be performed correctly for the system to run safely. Workers' safety, when working with complex technology like advanced robotics, can be increased when experts are consulted in the process.

Authors: Eva Heinold, Federal Institute for Occupational Safety and Health (BAuA), Patricia Helen Rosen, Federal Institute for Occupational Safety and Health (BAuA), Linus Siöland, Milieu Consulting SRL, Dr Sascha Wischniewski, Federal Institute for Occupational Safety and Health (BAuA).

Acknowledgement: The authors thank Prof. Dr Phoebe Moore, University of Essex, for her constructive comments and feedback.

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

This case study 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.

[2] Colombini, D. (2002). *Risk assessment and management of repetitive movements and exertions of upper limbs: Job analysis, Ocra risk indicies, prevention strategies and design principles*. Elsevier.