Deploying Collaborative Robots into Hazardous Environments

Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

By Frazer Graham,

Dstl, Porton Down, Salisbury SP4 0JQ

Contact: fgraham@dstl.gov.uk

1. Aim

Defence Science and Technology Laboratory (Dstl) works with hazardous materials (Chemical, Biological, Radioactive) to deliver world-class expertise and technology for the benefit of the nation and its allies. Historically (Figure No.1), there have been incidents involving personnel working with hazardous materials.

To improve safety and maintain capability, Dstl is investigating the implementation of collaborative robots (cobots) to automate activities (Figure No.3) involving hazardous materials.

Past → Present

1 — 2 — 3

6th May 1999

An emplyee was exposed to a hazard group three pathogen. [1]

18th Feb 2011

An emplyee died during the preparation of explosive charges. [2]

March 2018

Employees were exposed to irritant products. [1]

Figure No.1 - Dstl's Historic Incidents

What is a Collaborative Robot (Cobot)?

Unlike traditional industry robots (Figure No.2), which require programming knowledge, engineered control measures (guards) to prevent collisions, and are fixed to achieve a single task, cobots are designed to work with humans. Cobots require minimal programming knowledge and can quickly be redeployed for different tasks. Their flexibility and safe human interaction allow them to be rapidly deployed into hazardous environments.

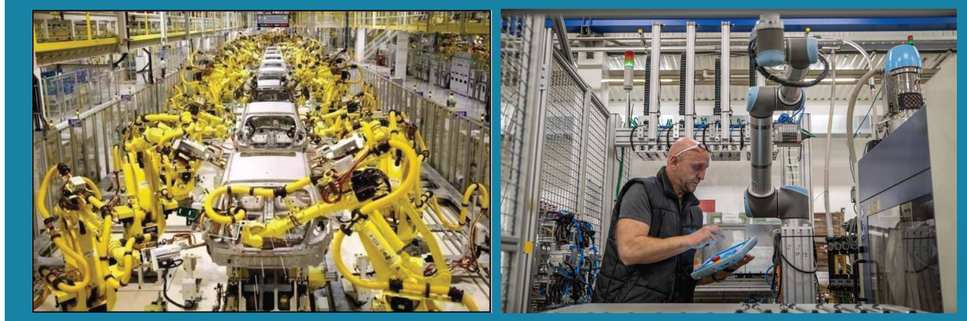

Figure No.2 - An example of industrial robots (left) and collaborative robots (right). Notice the size, and level of protection for each. [3,4]

4 (Dis)Assembly of components

3 Quality Control and inspection

2 Lab Analysis Work

1 Energetic Handling

Cobot Applications

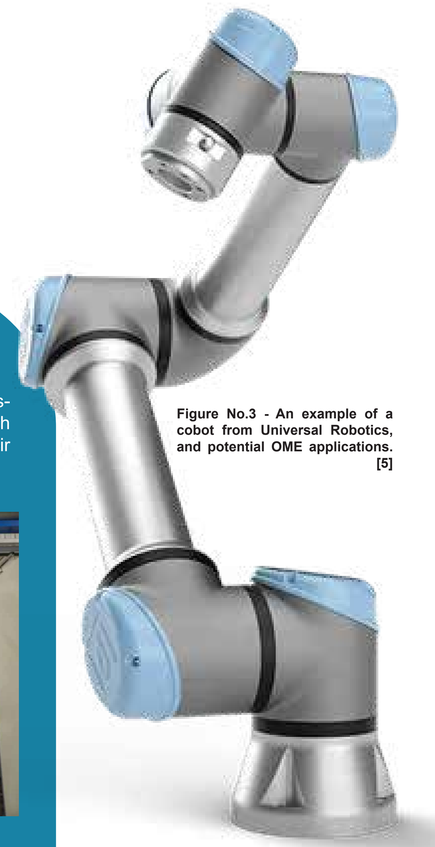

Figure No.3 - An example of a cobot from Universal Robotics, and potential OME applications. [5]

2. Challenges

To deploy a cobot into an energetic environment, the following challenges need to be overcome:

- Explosive Safety: A device is required to meet Defence Safety Authority 03 Ordnance Munitions Explosives (OME) Part 2 Joint Servic Publication 482 standards, which results in conformity testing and approval from the Defence Ordnance Safety Regulator (DOSR).
- Assurance Data: Information is required to determine how the cobot will interact with explosives. Otherwise, there is the risk of an energetic event from crushing, friction, electrical, or heat.

3. Assurance Testing Method

The cobot will be programmed to execute a simple pick-and-place routine (Figure No.4) on a calibrated component that can detect the forces exerted onto it. Using the forces exerted on the component, the data can be compared against small-scale hazard data. This will determine which primary explosives the cobot will be able to interact with safely.

Unfortunately, due to funding challenges, assurance testing could not be achieved this financial year (2023 / 24). However, it will continue in FY 2024 / 25 to ensure the cobot gripper does not cause an energetic event through impact and/or friction.

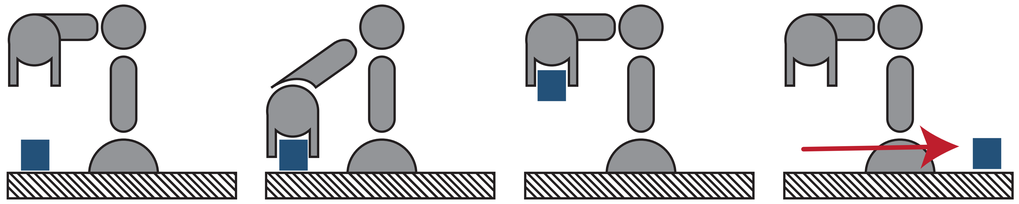

Figure No.4 - Assurance Testing Method. Forces will be recorded from picking up the component. Moving the component, and placing the component.

4. Conclusion

Assurance testing is required to determine which primary explosives the cobot can safely handle energetic materials.

If proven successful, cobots could be a method to automate hazardous activities. Improving worker safety and company productivity through the use of automation.

5. References

[1] Dstl Secretariat , "Accidents and or security breaches involving biological agents, nerve agents, gases or any other lethal chemicals at Porton Down," 11 April 2018. [Online]. Avilable: https://assets.publishing.service.gov.uk/media/5b1fd2c3ed915d2cc380166d/2018-04111.pdf [Accessed 14 March 2024]

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[3] M. Wolinski, "Industry 4.0 and Explosion Prevention," Fire and Environmental Safety Engineering, vol. 247, p. 6, 2018.

[4] E. Demaitre, "UR Injection Moulding Machine Interface to help plastic manufactureres integrate cobots," 23 April 2020. [Online]. Available: https://www.cobottrends.com/injection-molding-machine-interface-helps-integrate-ur-cobots. [Accessed 16 March 2023].

[5] Universal Robots, "UR5e," Universal Robots, 4 April 2024. [Online]. Available: https://www.universal-robots.com/products/ur5-robot/. [Accessed 4 April 2024].