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END USERS MUST BE AT FOREFRONT IN NEW TECHNOLOGY DEVELOPMENT

The introduction of automation and new technology on mine sites has potential to make them safer and more productive. However, for this potential to be realised, the design, implementation, and integration of new technology into mines needs to take human abilities and limitations into account.

The study - Human Aspects of Automation and New Technology in Mining: Integrating People and Technology Through Human-Centred Design – explores the human aspects of new automation and new technology in coal mining.

The research examined ways to reduce safety and health risks using human-centred design techniques, which place end-users at the forefront of the design process by understanding the needs, experiences, and behaviours of those who will interact with the new equipment.

The work was carried out by Robin Burgess-Limerick, Tim Horberry, Danellie Lynas, Andrew Hill from the Minerals Industry Safety and Health Centre, The University of Queensland, and Joel Haight from the Swanson School of Engineering, University of Pittsburgh, USA. This project report, C34026, is available from the ACARP website

"This study builds on work undertaken in defence, rail, and aviation, said Robin.

"While automation that takes people out of harm's way overwhelmingly has safety and productivity benefits, we have to be careful not to introduce new hazards," he said.

"Involving end-users at the start of the automation procurement process and during deployment on mine sites is vital. Issues to consider include training, operator workload, equipment design and human systems integration processes."

One of the project's ACARP industry monitors, Tony Egan said automation had the potential to change human behaviour with both positive and negative consequences, and this had to be considered when introducing new technologies on site.

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“For example, people will become over trusting of technology, expecting machinery to stop if they cross its path. However, the laws of physics still apply, and the equipment might not be able to stop in time to avoid a collision, so operating within the equipment’s functional environment use-case parameters is vital.”

“People on site have to understand not just the capabilities of the new equipment, but also its limitations,” he said.

Other credible failure modes include:

- Inadequate software logic programming.
- Communication technology disruption.
- Cyber security breach.
- Unauthorised access to autonomous zones.
- Loss of manual skill.
- Input errors.
- Inadvertent mode changes such as between autonomous and manual modes.
- Complex/emerging interactions.
- Inadequate system awareness of environment.
- Loss of situational awareness by operators.
- Distributed situational awareness challenges where there is no individual who has all the information needed.
- Ineffective communication between team members.
- Operator workload cognitive overload.
- Musculoskeletal injury risk factors.

As of 2022 there were 183 installations of autonomous (and semiautonomous) mining equipment fleets globally, with 44% in Australian mines and 16% in Canada.

The most common fleet types are autonomous surface haul trucks and semi-autonomous underground load-haul-dump vehicles, followed by autonomous surface drill rigs.

Most Australian installations were at surface mines (64%) while most Canadian installations were at underground mines (62%). The total number of autonomous haul trucks in operation globally in 2022 was 1070 (an annual increase of 39%), of which 706 were operated in Australia.

OVER 1800

The number of autonomous trucks in operation globally is forecast to exceed 1800 by the end of 2025.

Other mining equipment automation relevant to Australian coal mines are autonomous drilling, autonomous haulage, semi-autonomous dozers, and autonomous longwalls.

Robin said the automation experiences in aviation, rail, road transport, healthcare, oil and gas and defence demonstrated that unless the technology was developed from human-centred design perspective, and is well-integrated with the overall work system, then it is likely to fail, or at least not work optimally.

“Achieving the productivity and safety improvements promised by automation requires careful consideration of the capabilities and limitations of humans, as well as the characteristics of the technology,” said Robin.

“This is the basis of a new human readiness level **(HRL)** standard developed by The Human Factors & Ergonomics Society **(HFES)/**American National Standards Institute **(ANSI),** which provides a way to evaluate, track, and show the readiness of a system for human use. It mirrors the technology readiness level **(TRL)** standards developed by NASA and adapted by mining equipment designers for new equipment development.

“The goal of the HRL scale is to provide a metric that indicates the readiness of a system to integration successfully with humans.”

“The HRL is an approach successfully used in other industries and is an example of a method that could be applied successfully in the mining industry,” said Tony.

“Another advantage is that HRLs have the potential to minimise the cost of design changes, through early identification of human issues, and reduce human error in automated systems deployed at site,” he said.

Robin said that similarly, Human-Systems Integration **(HSI)**, or Human Factors Integration, was developed by the defence industry in the US and UK to ensure that human-related issues were adequately considered during system planning, design, development, and evaluation. “The USA Department of Defence requires managers to undertake risk management, engineering, analysis, and human-centred design activities to ensure that human considerations are integrated into the system acquisition process,” said Robin.

“Current standards and guidance materials pay insufficient attention to the integration of humans and technology during the implementation of automation in mining.

“A guideline that has come out of this study will help companies procure and integrate equipment while avoiding the pitfalls outlined in the research.

“It includes 12 key lessons from the research, which focus on the need for structured procurement and deployment processes, the role of regulations and Human Readiness Level assessment, ongoing end-user engagement, better feedback loops and the importance of considering operator workload, interface design, training, and mine site cultural changes.

“Human systems integration processes adapted from other industries should be implemented during acquisition of automated mining equipment, and technology vendors should be required to provide a human systems integration plan.”

Robin will continue research on the topic during a two-year secondment to Think and Act Differently, powered by BHP, with support from the Resources Technology and Critical Minerals Trailblazer and the Commonwealth Government through the Trailblazer Universities Program.

Tony and Robin are both confident the industry will take on board the recommendations of the research.

MORE INFORMATION
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