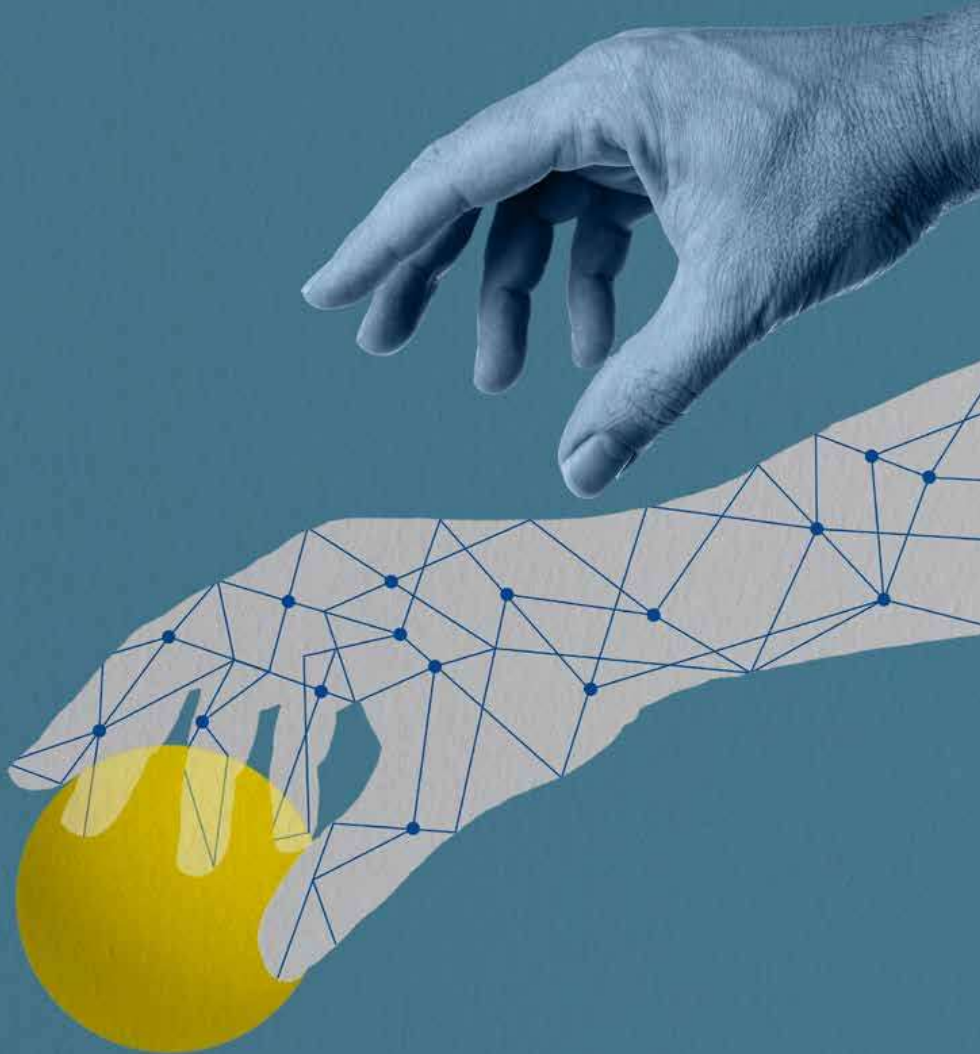


# 02 | Innovation

Using Artificial Intelligence to deliver **ground-breaking science.**



At present, applications of Artificial Intelligence (AI) in the nuclear sector include robotics elements used in nuclear decommissioning as well as in day-to-day operations on nuclear sites. However, as a sector, we have only scratched the surface of its potential use and there remain many avenues where AI could have a transformative impact.

**As we continue to innovate, we also need to make sure we consider how we can implement emerging AI advancements both efficiently and safely.**

To support this, NNL is working closely with the Office for Nuclear Regulation (ONR) to foster conversations around how the sector can and should regulate the use of AI, both now and for the future. Representing NNL, Brendan Perry and Senior Technology Manager Gary Bolton sit on the ONR's expert panel for Artificial Intelligence. NNL is also represented in UKRI's artificial intelligence for nuclear (AI4N) group, established in 2022 to support the adoption of AI across the nuclear sector.

*“Over the coming decades, AI is going to completely reshape the nuclear industry – as it will many other industries. At NNL, we are working with partners both in the UK and globally to explore how we can develop the use of AI and employ it to best effect, complementing the knowledge and work of human operators that are critical to the sector's success.”*

**Brendan Perry**  
Technology Manager at NNL

## Quality

**Employing AI from Silicon Valley to Sellafield**

Fully functioning ventilation systems are critical to the secure and effective operation of facilities across many industries, including nuclear, manufacturing, pharma and shipping. In the UK, it is a legal requirement for ventilation systems to be regularly inspected to make sure any defects, such as perforations or loose flanges, are quickly identified. Typically, this is done via visual inspection or by using ultrasonic thickness detection. However these both involve significant cost and time and, if carried out manually, exposure to ventilation hazards.

In 2022, NNL launched an open innovation challenge to find a digital solution that would be able to conduct remote and continuous inspections. Co-funded by Safetytech Accelerator and NNL, the resulting pilot was a collaboration between NNL, Sellafield and Reality AI, a US-based SME.

At NNL's Workington Laboratory, the team constructed a test rig made of square steel ducts and a powered air filter. This in turn was connected to a series of microphones, exciters (sound creators) and a data collection device. From this, 96 acoustic samples of the ventilation in a variety of normal and defective states were

collected and put through the Reality AI platform. This pilot solution was able to successfully detect a defect in the test rig within one second at almost 98% accuracy.

*“Tapping into NNL expertise in designing, building and operating experimental rigs at their facilities in Cumbria once again demonstrates the strength of the collaborative relationship between Sellafield Ltd and NNL. NNL is a conduit for innovation into the UK nuclear sector, enabling innovative technologies from SMEs such as Reality AI to be developed into impactful solutions for Sellafield and beyond. We look forward to building on the excellent work undertaken in this pilot and in supporting the project towards a real-world deployment of this novel application of AI.”*



**Andy Cooney**  
Innovation lead  
at Sellafield

## Partnerships

### Sharing our pioneering robotics facilities

The National Nuclear User Facility for Hot Robotics (NNUF-HR) supports UK academia and industry to deliver ground-breaking research in robotics and AI. NNL's Workington Laboratory is home to one of four NNUF-HR facilities across the country.

With a range of full-scale industrial equipment and flexible floorspace it allows academics, SMEs and industry to develop, test, and demonstrate new and innovative robotic solutions for the nuclear industry. Importantly, having access to this shared facility means that researchers can hire the equipment they need for the length of their project, rather than invest significant sums of their own capital to purchase what is needed, and at the same time benefit from the knowledge and insights of our experts at NNL.



The research team from the University of Manchester at NNL's NNUF-HR.

## Talent

### Collaborating with academia to enable first-of-its-kind robot-human interaction

In 2022, a team of researchers from the University of Manchester were given access to Kinova Gen3 collaborative robots at Workington Laboratory. Supported by the team at NNL, the researchers used AI in several novel ways.

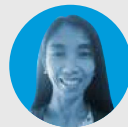
Firstly, they developed a Natural Language Processing (NLP) system to convert verbal instructions into commands that the robot can understand, enabling a level of human-robot interaction which did not previously exist in the nuclear sector. Alongside this, they developed a Computer Vision system which allows the robot to identify different objects in a variety of colours and shapes and their position relative to one another. The resulting system can take a verbal command, understand how this relates to the objects in front of it and implement the required action.

This project has opened up several new research paths, including further work into how we can use NLP to

deploy robots in more challenging nuclear environments – helping to improve both efficiency and safety.

Building on this collaboration, NNL and the University of Manchester will continue to work closely throughout 2023 to deliver LISTENER – a collaborative project which seeks to use AI technology to better analyse health and safety data for Sellafield Ltd.

“We are grateful for having been given access to the NNUF Hot Robotics facility at Workington Laboratory. It was a really unique opportunity for us to test our research. Likewise, the support the team at NNL gave us – from guidance on system configuration and troubleshooting to other expert advice – was invaluable and enabled us to complete our experiment successfully.”



**Dr Riza Batista-Navarro**  
Lecturer in Text Mining at the University of Manchester

## Impact

### Cutting-edge digital solutions to keep UK industry ahead of the curve

#### Through our work in this area, we are:

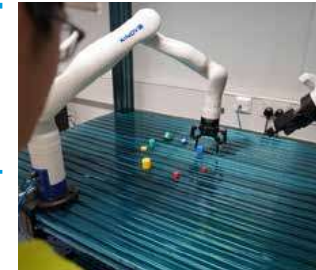
Delivering an AI-based solution to transform a critical industrial process for the benefit of UK industry as a whole;

Engaging in open innovation to share our learnings from decades of work in the sector and, at the same time, benefit from the knowledge of AI experts from outside the sector;

Building successful working relationships with partners in the UK and around the globe;

Helping to ensure there are robust and effective processes in place to regulate the use of AI in the sector, particularly as we look to innovate for the future;

Ensuring UK nuclear will benefit from pioneering developments enabled by AI, specifically the streamlining and safeguarding of day-to-day processes.👁️



“Across the nuclear industry, experts are consistently looking at ways to integrate new and emerging digital technologies in nuclear operations – whether it’s to improve the efficiency of certain processes or to enhance safeguards for human operators even further. As part of this work, at NNL we have set up a Digital Community of Practice to connect digitally-minded individuals across the organisation.

This community is a way for us to collectively discuss developments taking place across the digital landscape and for our teams to share best practice. Whether through our capabilities in robotics, AI or modelling and simulation, NNL has a proud history of delivering impactful digital solutions for the nuclear industry. It is an exciting strand of work we are looking forward to building on for the future.”



**Naomi Rutledge**  
Junior Mechanical Engineer at NNL and Chair of the Digital Community of Practice