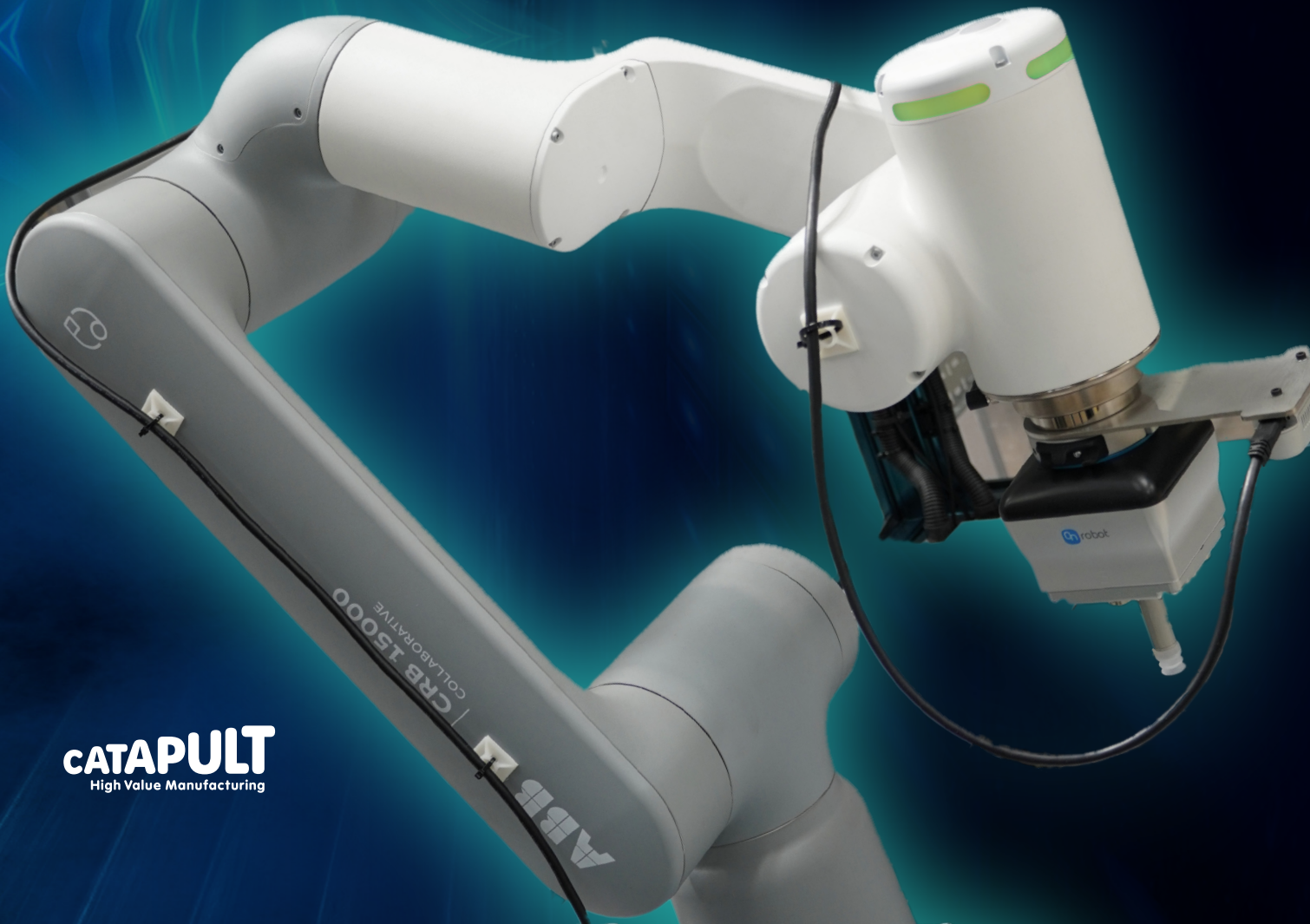


mtc

Manufacturing
Technology Centre

ELERA

AUTONOMOUS ROBOTIC
MANUFACTURING PROCESSES



CATAPULT
High Value Manufacturing

INCREASING **MANUFACTURERS**
RESILIENCE BY REDUCING THE
RELIANCE ON MANUAL LABOUR
AND **MINIMISING** THE IMPACT
OF **WORKFORCE DISRUPTIONS.**

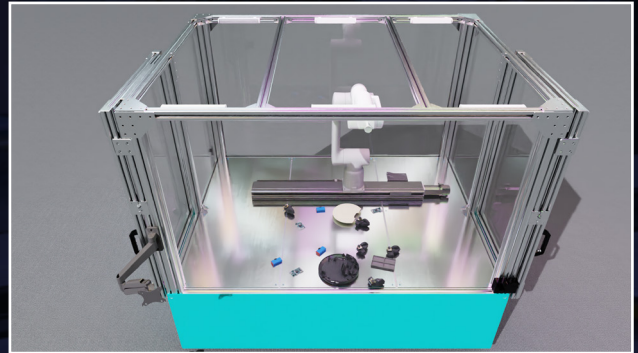
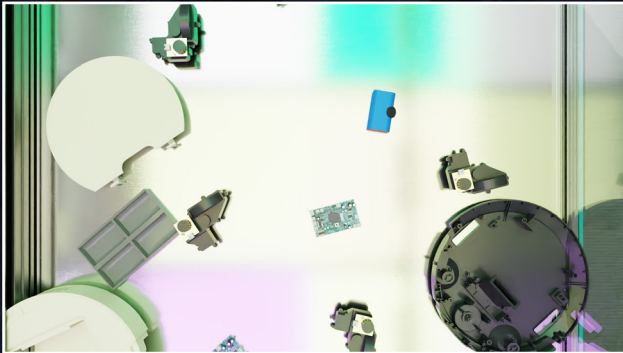
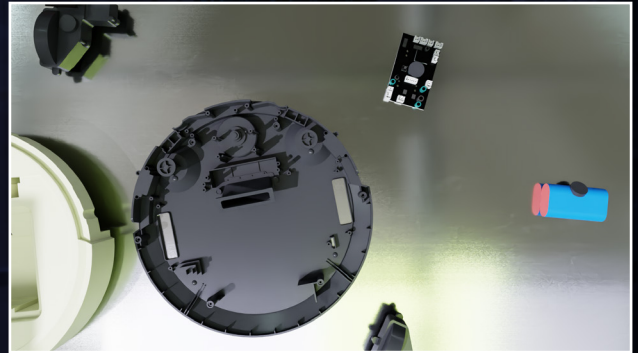
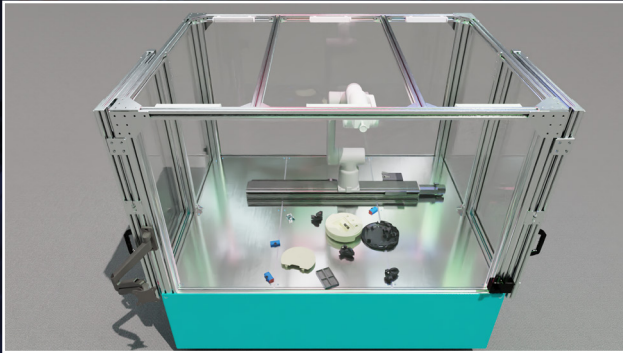
THE CHALLENGE

Traditional automation systems require significant investment in redesign or modification to accommodate product variability or change. This might include specialist expertise to reprogram and recommission the system as well as new fixtures, sensing and peripheral tools. Unstructured and short-duration environments are typically considered too costly to automate but the alternative, manual labour is increasingly costly and scarce. Examples include seasonal tasks in food production, low-to-medium volume product assembly and packaging, and glovebox tasks in pharmaceutical processing.

The inability of UK companies to quickly scale up manufacturing lines to cost effectively meet demand remains a key driver for offshoring of manufacturing activity. Offshore production of goods destined for the UK market has a negative impact on the environment, due to increased transport emissions, as well as a negative impact on UK productivity and prosperity. Money invested in offshore production is diverted away from the local economy where such investment could be supporting industry, infrastructure, and UK jobs. Offshoring has accompanying risks of loss of IP control and legal protections for both the company and workers when operating outside the jurisdiction of UK law.

The development of agile and reconfigurable manufacturing systems with high levels of automation but also maintaining relatively low costs is essential to the economic health of the UK. By enabling faster changeover and ramp up of production there will be more incentive to invest in UK based capability.





Intelligence

Computer
Vision

Digital Twins

Autonomous
• AI-based approach
• Enables the quick
• Increases production



THIS PROJECT IS A **SIGNIFICANT STEP FORWARD** IN PROVIDING COST EFFECTIVE AGILE ROBOT AUTOMATION THAT **MEETS THE NEEDS OF SMES**. THIS WILL OPEN UP MANY **MORE OPPORTUNITIES** FOR UK MANUFACTURERS AND THE ECONOMY TO GAIN **FROM THE BENEFITS OF AUTOMATION ADOPTION.**

MIKE WILSON,
CHIEF AUTOMATION OFFICER





THE SOLUTION

SYNTHETIC DATA GENERATION

Using state of the art simulation tools a virtual environment can be created to digitally mirror the production cell and product with a high degree of photorealism. This environment can be used to generate large quantities of synthetic physics simulation and image data. Domain randomisation allows for a large range of conditions to be simulated such as variation in materials, lighting, physical properties, and geometries to reflect manufacturing and environmental realities. This synthetic data can then be used to train learning-based AI algorithms for manufacturing system control and to complete virtual commissioning of a new product production process before the physical production must begin.

VISION BASED ROBOT CONTROL

Vision-based control gives the robot the ability to see and react to visual stimulus, for example to align parts together before insertion. Once contact is made force-based control can take over to ensure a satisfactory action execution. This model of behaviour more accurately reflects human operators when compared to traditional automation systems where no sensing is enabled. The next generation of collaborative robots are both fast and sensitive providing safe and efficient means of moving tools and objects around the working envelope and force sensing suitable for assembly tasks.

TASK PLANNING FOR ASSEMBLY

Task planning is an important component for achieving longer horizon goals in highly flexible environments. Some planning tasks might only need to happen once such as assembly sequence definition for a new design whilst other planning tasks might need to happen regularly in process such as reacting to the observed success or failure of an assembly action.

SIM 2 REAL

Bridging the gap between simulation and reality through increasingly robust SIM-2-Real methodologies makes the real implementation more robust at launch and shortens the “live” training/data collection time needed to ramp up a production system.

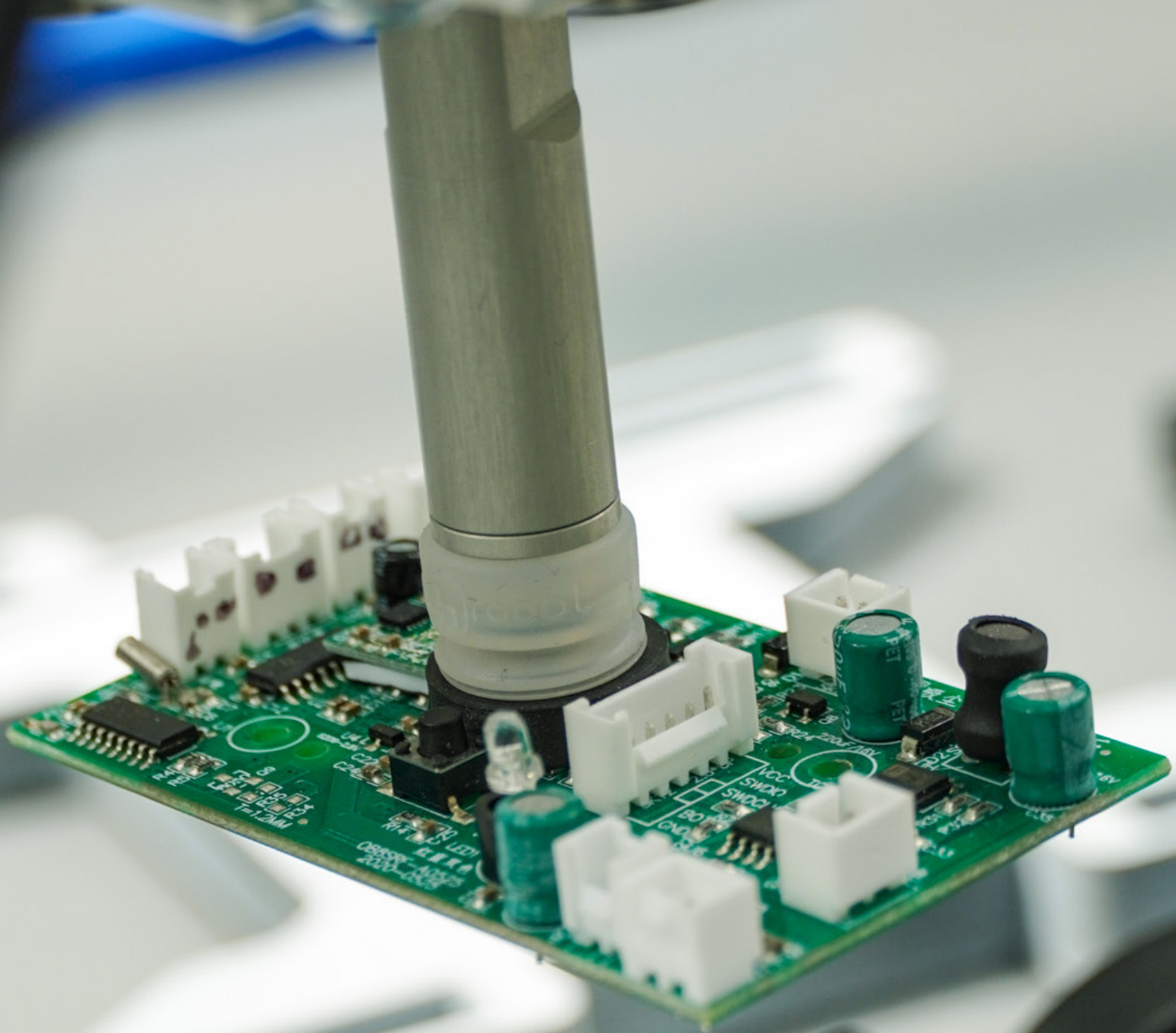
THE OUTCOME

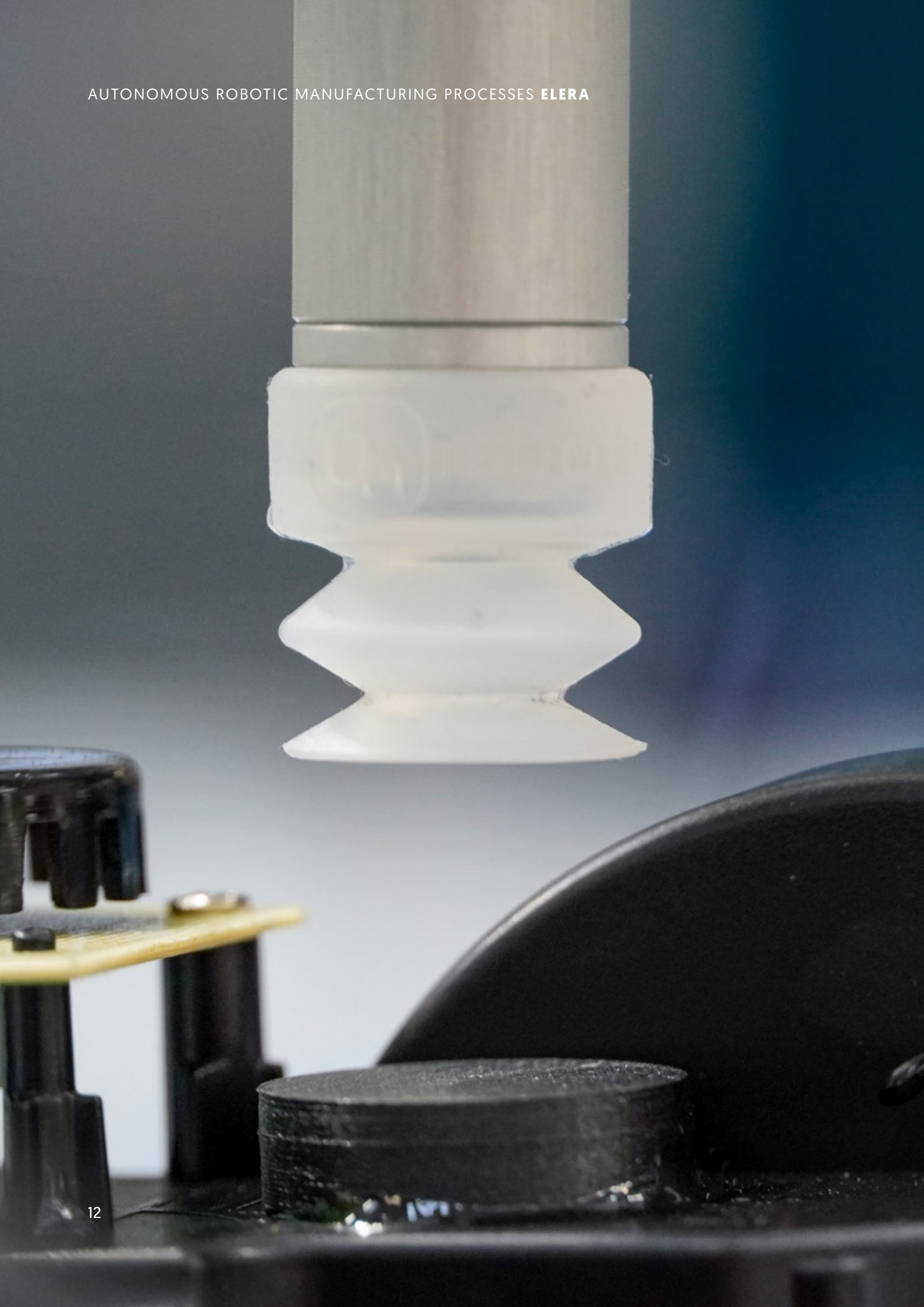
MTC have developed a hardware platform alongside ABB Robotics with a digital twin powered by the latest NVIDIA's Isaac simulation software. The system houses ABB's latest collaborative robot, a CRB15000, in a world first installation on a linear slide providing an extended working volume.

The hardware system is fully enclosed and has a large touchscreen control panel. An accompanying visual interactive experience has been designed in Unity to guide viewers through the functionality of the demonstration task whilst being scalable to add new tasks in the future.

A software pipeline for generation of synthetic data for visual robot control has been created using robust SIM-2-Real methodologies. A consumer product assembly task has been used as an illustrative example to validate the technology.

The digital twin virtual environment accurately replicates a physical testbed, enabling engineering teams to perform simulation-based development of new application deployments with high-fidelity physics and visual realism. This platform will be available for upcoming industrial and research projects, serving as a means of demonstrating technology transfer while also continuing to develop novel learning-based robot control methodologies.





BENEFITS

Enabling quick and cost-effective automation deployment that can increase adoption of agile automation in high mix, low volume, and rapid changeover manufacturing scenarios. Thus addressing the challenges posed by inflexible and time-consuming traditional automation process, resulting in greater efficiency and competitiveness.

Creating the ability to automate tasks that were previously too complex or difficult to automate, such as manipulation of complex or deformable objects, that can lead to significant benefits, including improved production efficiency, reduced costs, increased safety, improved quality control, and the ability to perform tasks that were previously impossible with human labour alone.

Increasing manufacturers resilience by reducing the reliance on manual labour and minimising the impact of workforce disruptions. Also enhancing competitiveness by improving production efficiency, reducing costs, and increasing product quality. The demonstrated solution can help adapt to changing market demands and optimise production processes.

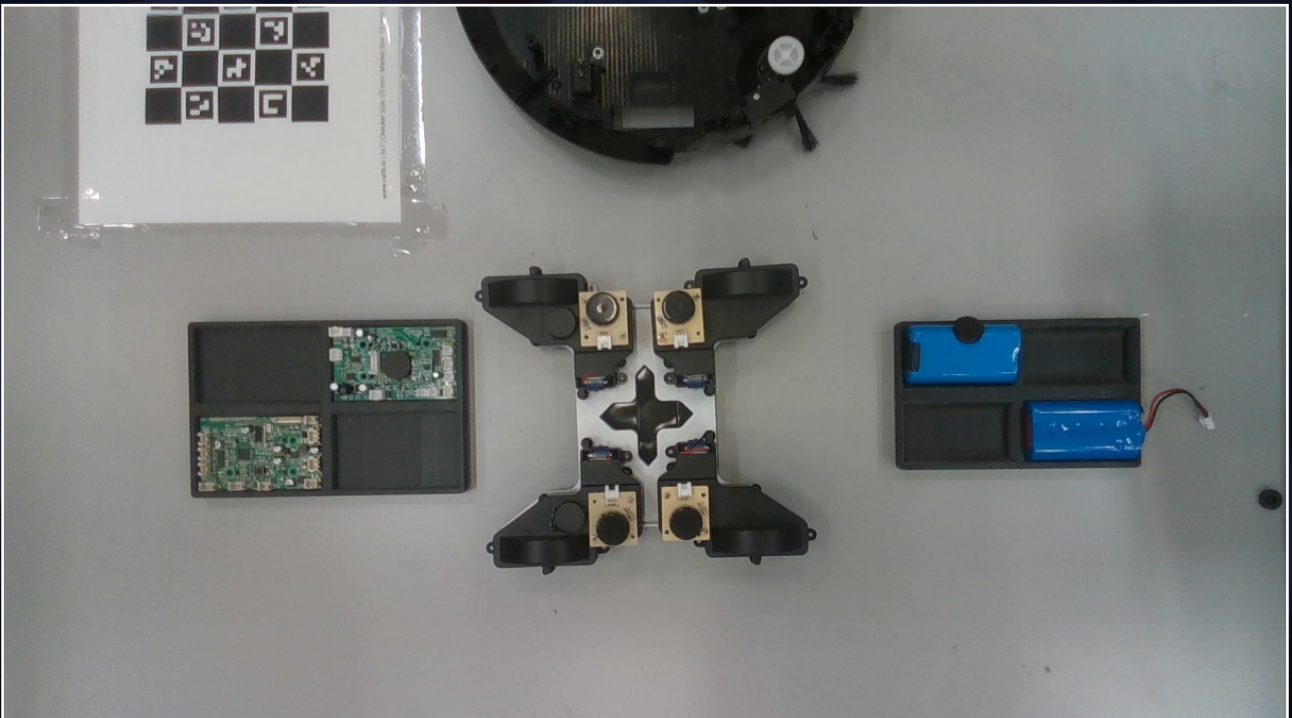
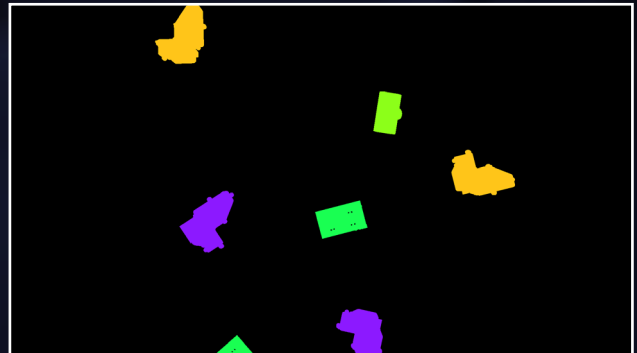
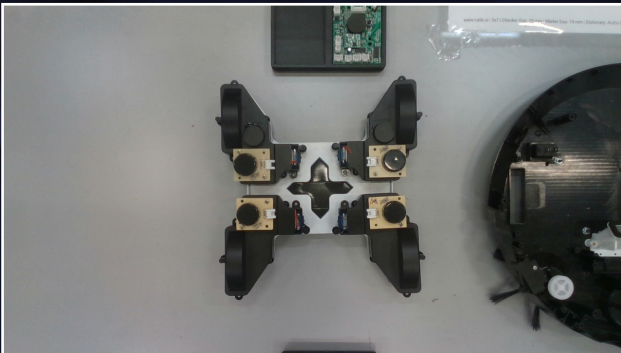
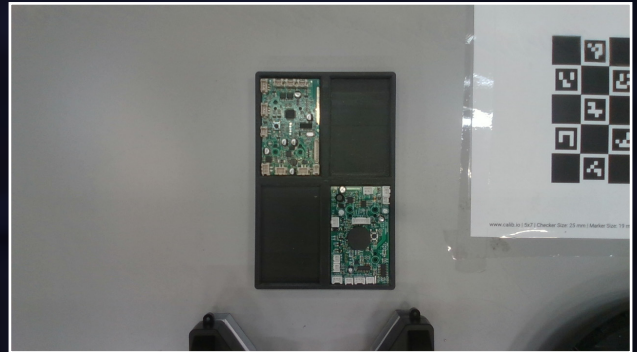
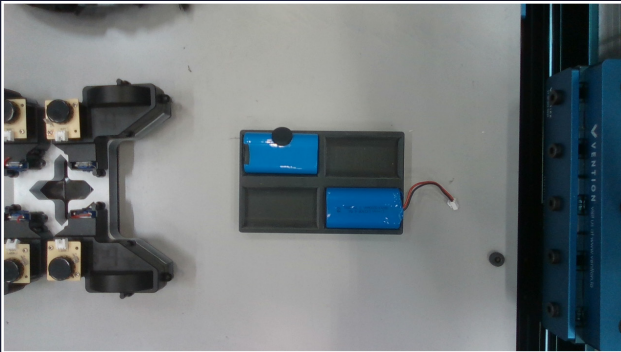
By accelerating the adoption of AI-based approaches for robotics development and teaching, the solution can lead to more efficient and effective development of robotic applications. This can ultimately result in benefits such as improved productivity, increased safety, and the creation of new opportunities for innovation and growth.



THIS DEMONSTRATION SHOWS
A SIGNIFICANT ADVANCEMENT
IN USING SYNTHETIC DATA
GENERATION FOR DEPLOYING
RELIABLE AND COST-EFFECTIVE
VISION-BASED ROBOTIC
SOLUTIONS, PAVING THE WAY
FOR **WIDER ADOPTION** OF
AGILE AUTOMATION AMONG
THE UK MANUFACTURERS.

KAROL JANIK,
AUTOMATION & ROBOTICS TECHNOLOGY MANAGER





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