



Box Encapsulation Robotics Project

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Sellafield – One of The World's Most Challenging Nuclear Sites

THE CHALLENGE

- 1200 buildings in 6 sq km:
 - 200 hold nuclear inventory
 - 100 equivalent or greater than a nuclear reactor in terms of hazards and security
- Ageing infrastructure, 60+ years
- Poor historical record keeping

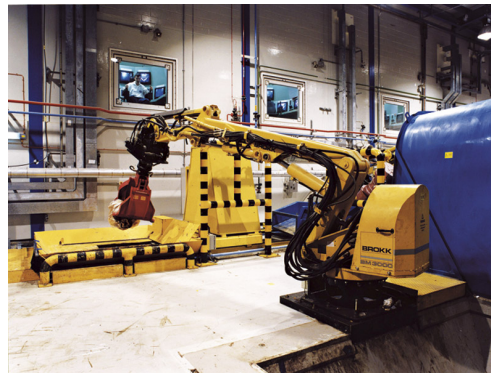
LARGEST UK CONSTRUCTION SITE

- Multi-billion facilities being built for clean-up
- 450 engineering and construction projects
- 17 valued over £100 million



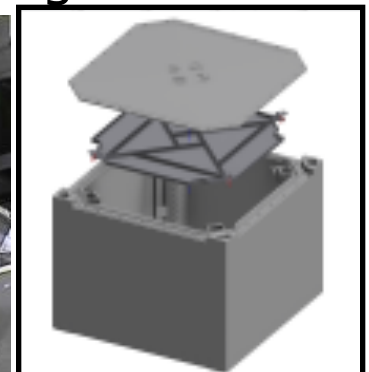
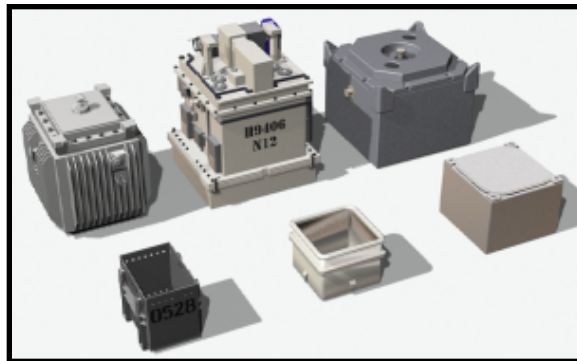
Why Remote Intervention?

- Decommissioning the UK's current nuclear facilities including waste storage will cost £115 billion over the next 100 years.
- The cost of a UK geological disposal facility is circa £12 billion
- UK investment in new nuclear build before 2030 is circa £60 billion
- Clearly a step change is required to make improvements in risk reduction, safety, reliability, efficiency and cost across the entire UK nuclear cycle.
- Robotics has the potential to make that step change for deployment in harsh environments.



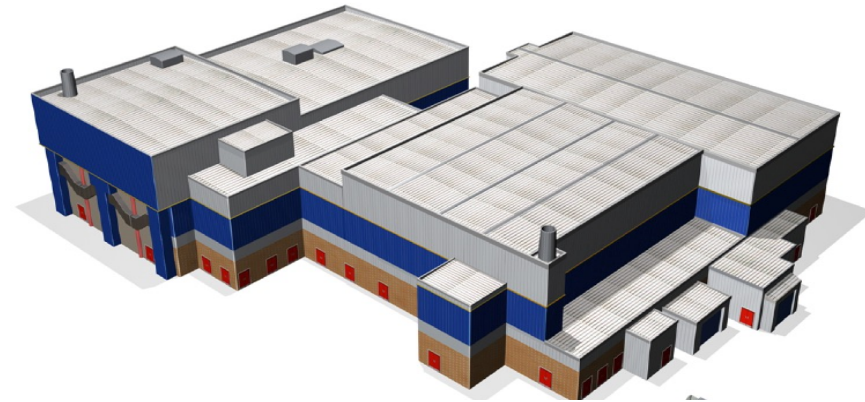
Box Encapsulation Plant Project

- Box Encapsulation Plant is being constructed to accelerate the Sellafield High Hazard and Risk Reduction legacy Beta/Gamma waste programme.
- BEP expectations:
 - Accelerate delivery: BEP commissioned 2018 and operate for 50 years.
 - Receive waste from numerous donor plants in differing import skips.
 - Recover, identify and flood grout the processed waste.
 - Transfer the encapsulated waste for interim storage before GDF disposal.

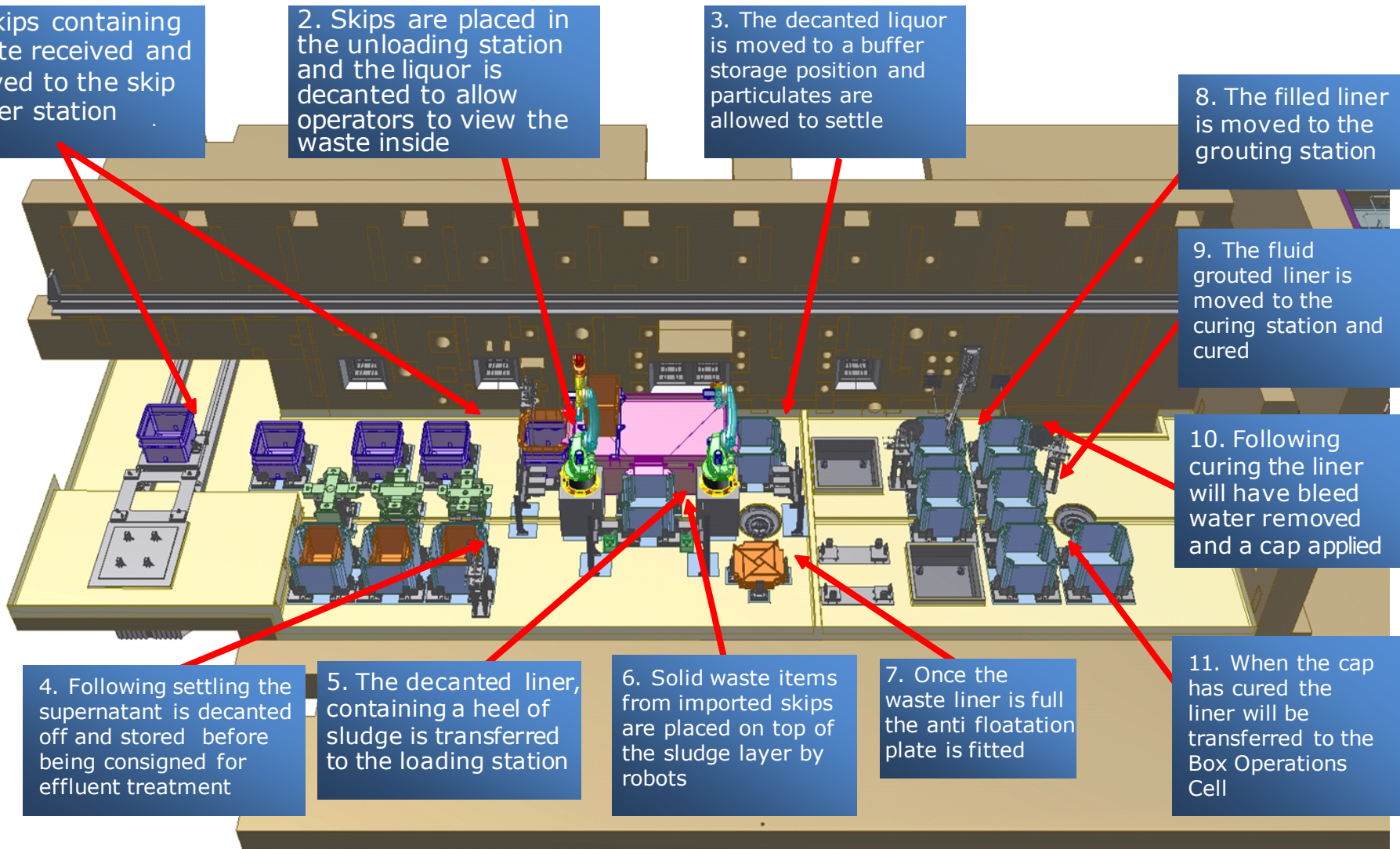


Step Change: Box Encapsulation Robot Project

- BEP Robotic project involves the development of a robotic system that operates in both the tele-operation and automated modes
- Capable of handling legacy nuclear waste in a new plant at Sellafield to be commissioned by 2018.
- The project will run for 5 years and is being delivered in a collaborative approach between Sellafield Limited, NNL & KUKA on behalf of the NDA



Box Encapsulation Plant: Waste Treatment Cell (WTC)



Project Significant Features and Robot Operations

- Develop BEP robots designed for structured environments, to operate in unstructured environments.
- Minimise development and trials, and utilise LFE from elsewhere.
- Adopted systematic approach to technical development separate to project delivery.
- Utilise and nuclearise proven commercial 'off the shelf' technology.
- Very high reliability of robots and ancillary equipment required.
- No man access is possible:
- Use CCTV cameras to identify the waste items
- Process the waste by disruption of items to release trapped liquors and ensure full grout infiltration to minimise voidage



Robots had to demonstrate operability in a high radiation and contaminated environment. They must meet the following criteria:

- Demonstrable history of proven, technology, high reliability, service provision and prior nuclear applications.
- High payload (0.5 tonne), but robot weighs less than 3 tonnes.
- Use of resolvers rather than encoders.
- Operate in both tele-operation and programme mode with Force feedback, zoning and collision avoidance features.
- High accuracy and repeatability e.g. 0.08mm.
- IP67/65 rating for wet and sludgy environment.
- 3D live simulation of robots and environment.
- Good supplier support.
- Supplier of choice KUKA.



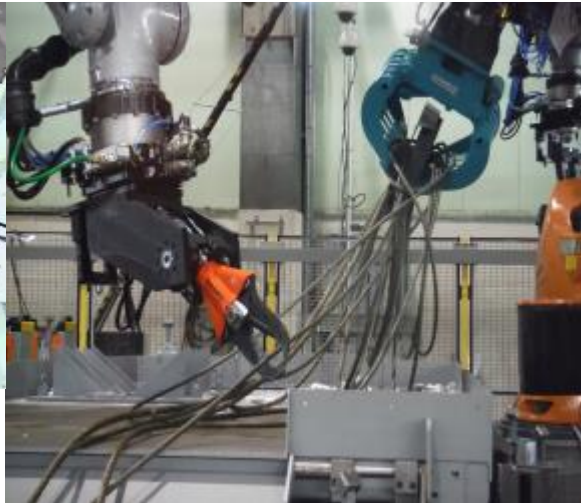
BEP Robot: Waste Recovery Trials

- All of the test materials trialled have been successfully recovered, handled, disrupted and deposited in export liner, remotely using cameras, and at acceptable throughput rates, using 2 robots.
- Graphite blocks, Magnox swarf, Aluminium doughnuts
- Sludge carryover
- Zeolite skips, Ionsiv cartridges, swarf bins, Filters
- Drums, cans, boxes and containers (tins and fuel bottles)
- Plant equipment valves, motors, gearboxes, pumps etc.)
- Generic scrap: Pipes, hoses, tubing, plastic bags and sheeting, wire rope, reels, cables, slings, chains etc.



BEP Robot: Disruption Trials

- A very high degree of dexterity & control, both in manual tele-operation & automated modes.
- A high waste consolidation & packing efficiency and enables packing of light weight waste into new cans.

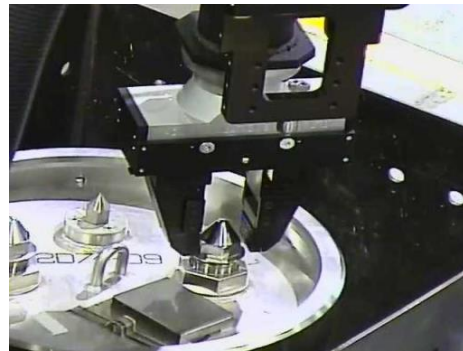
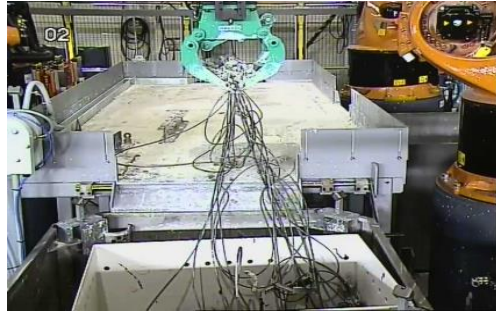


BEP Robot: Control and Tooling

- Automated programmed sequences have reduced operator workload and stress especially for routine operations, housekeeping, waste/liquor management and tool change



BEP Robot: Tooling



BEP Robot Future Project Work

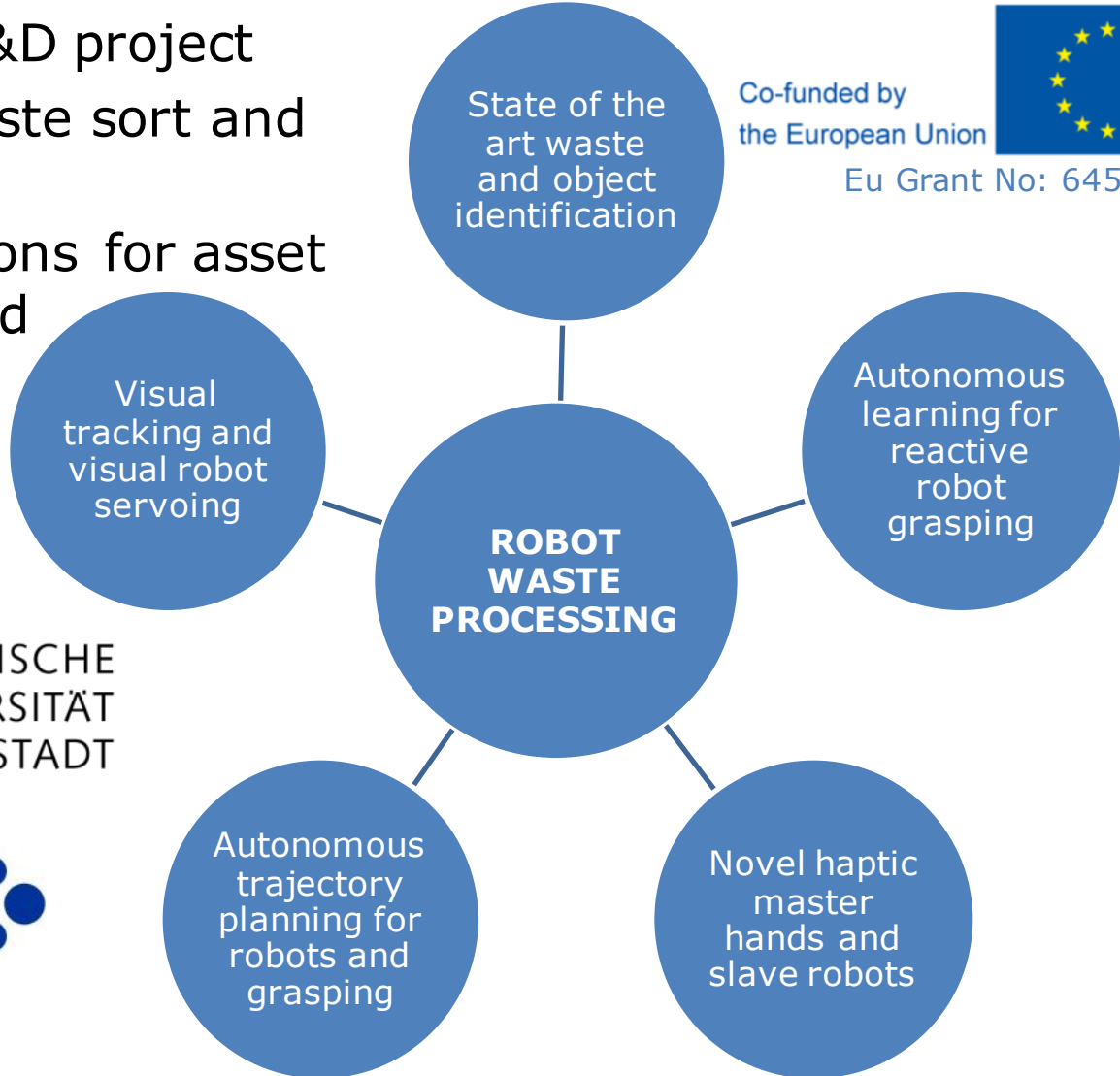
- Current test rig will be modified to be a complete inactive demonstrator of the BEP cell.
- Trials to investigate remote installation/removal and failure recovery equipment.
- Completion of radiation and environmental tolerance assessments.
- Nuclearisation modifications on the robot implemented
- Continued trials to investigate robot reliability, redundancy, human factors, waste identification and inventory etc.



EU Horizon 2020 RoMaNS: Robotic Manipulation for Nuclear Sort and Segregation

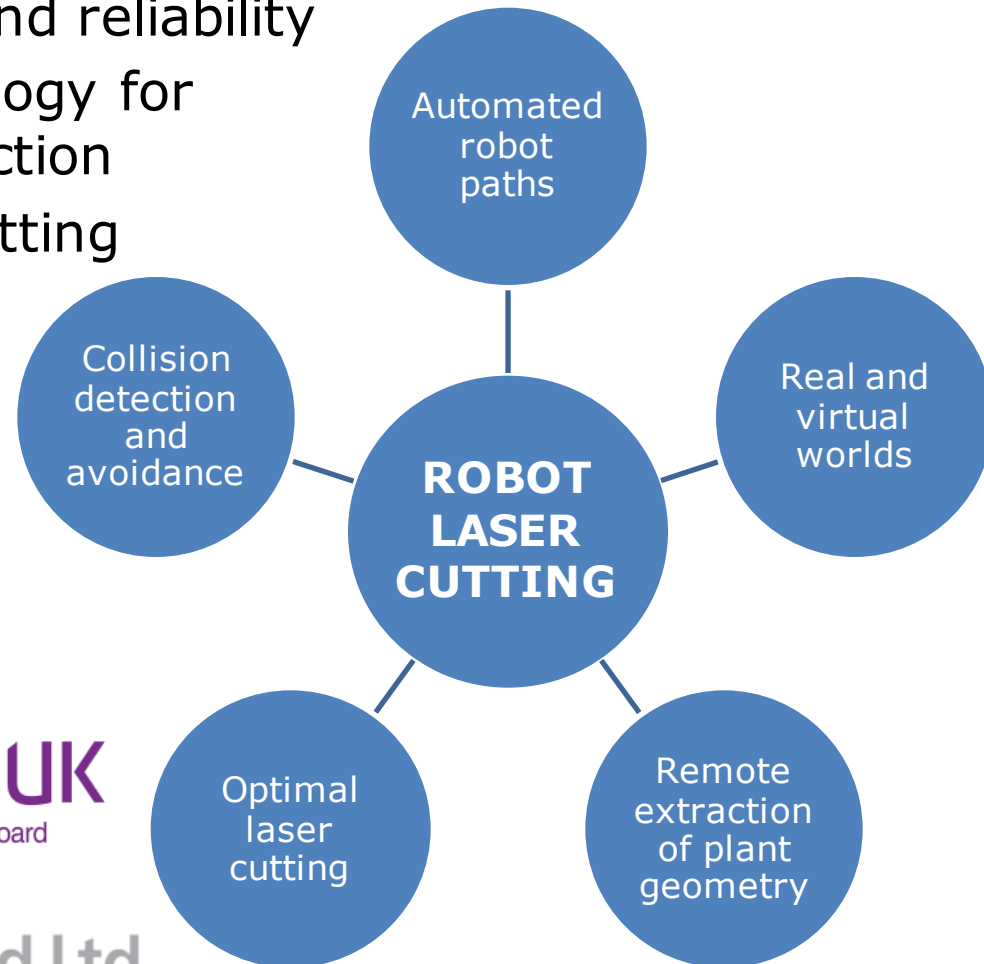
- €6.4 million 3 year R&D project
- Applied to nuclear waste sort and segregate processes
- Cross-sector applications for asset care, maintenance and decommissioning

Co-funded by
the European Union 
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Robot Laser Cutting

- Deploy industrial robot and laser at Sellafield
- Increase throughput, safety and reliability
- Proven and innovative technology for robot paths and collision detection
- Applied to welding, plasma cutting
- Easy operator interfaces



Laser Optical
Engineering Ltd



Department
of Energy &
Climate Change



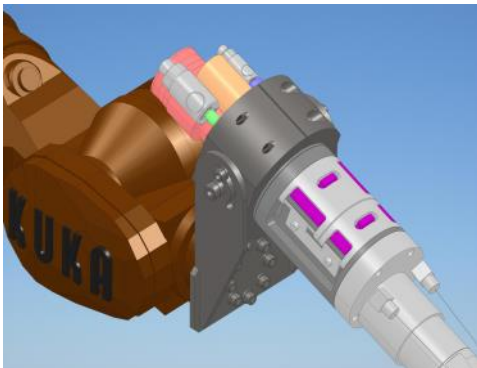
ULO Optics



Innovate UK
Technology Strategy Board



Sellafield Ltd



- Robots have been chosen as the technology to deliver the SL risk reduction programme for the next 50 year.
- Box Encapsulation Plant will be commissioned in 2018 with installed robots.
- Robot trials will continue for the next 5 years supporting:
 - Nuclearisation of the robots
 - Continuous Training and education platform for employees
 - Hot spares for operational robots
 - Inactive test rig supporting active operations
 - Testing for future robot and tooling development.
- Research is undertaken in parallel to delivery of the BEP Robot project thereby minimising schedule and scope creep

BEP Robot Project: Any questions?

Thanks to:



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NUCLEAR
TECHNOLOGIES



NSG

legacy management

KUKA

