



Advanced Robotic Welding

using the IONA Photogrammetry System as part of a multi-sensor approach

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3D METROLOGY
CONFERENCE

Overview

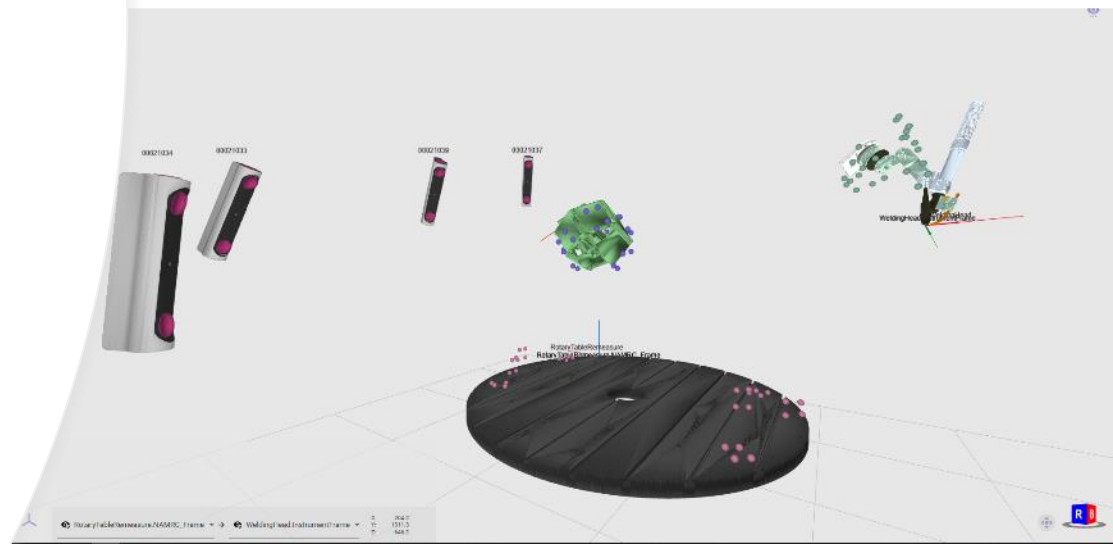
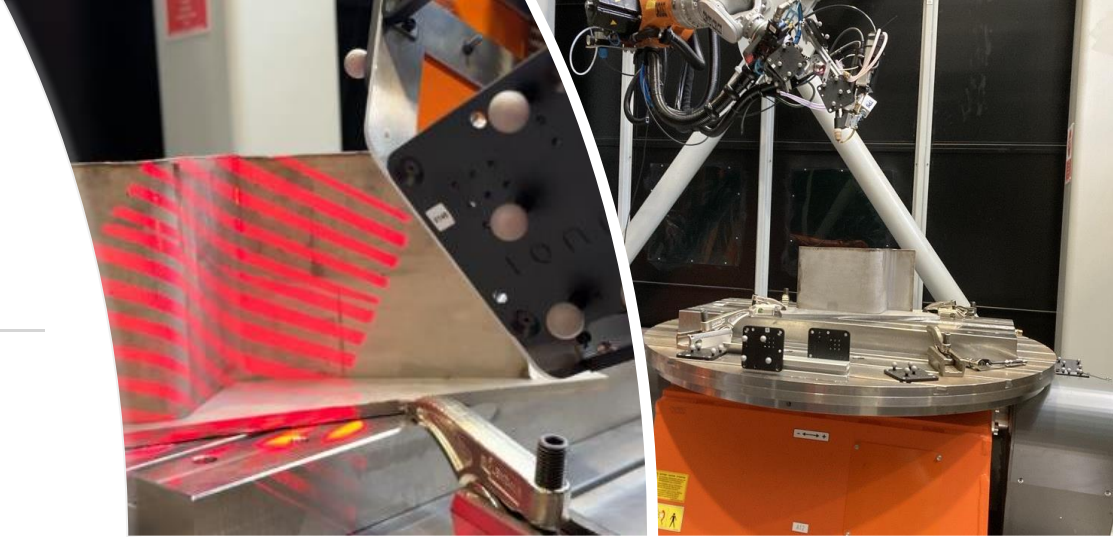
1. Why Automate?

2. The AFFIRM Project

3. Outcomes

4. Challenges

5. Next Steps



- Developing an **automated welding solution**
- Using **Nuclear Waste Container** boxes as the industrial use case
- Integrating advanced **sensing** technologies



Quality

Build quality affects performance and longevity in nearly all fields of manufacturing

Nuclear waste container boxes must be built to last!

- Tight tolerances
- Stringent regulations
- Extensive inspection requirements – metrology and NDT

Automation has the potential to increase quality far beyond the natural limits of manual processes



Demographics

There are too few skilled welders, and they are getting older

*“Around half of welders are expected to retire by 2027”
(Construction Skills Network, 2024)*

Nuclear waste container demand will rapidly exceed manufacturing capacity (similar challenges exist across multiple industries)



Why Automate?



Capacity

UK needs 1,000 boxes by 2026 and 10,000 by 2040 (Sellafield data)

The need waste containers is growing, and predictable for decades (in-fact centuries!) to come, in UK and globally



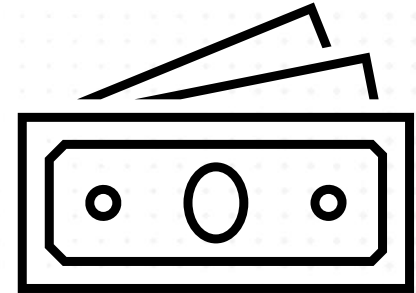
Why Automate?



Cost

Automated manufacturing can:

- Reduce labour costs
- Reduce factory footprints
- Reduce energy demands
- Reduce scrap and rework
- Flex with demand



Increased automation in nuclear industry welding is projected to reduce manufacturing costs by 20% (Sellafield Review)

Why Automate?

Productivity

The IFR World Robotics 2022 report notes that the UK is slow to adopt automation with 111 robots per 10,000 employees (c.f. S.Korea 1,012 Germany 415)

"very low for a Western European country"

It concludes,

"we cannot expect to continue competing on the international stage unless we automate."



So Why Don't We Automate?

Robots lack contextual awareness and struggle to adapt.

Inadequate ability to compensate for variation in fixtures, set-up, raw materials, in-process deformation



Revolutionising robotic welding through advanced 3D scanning and metrology technologies

Increasing:

- Automation
- Precision
- Quality
- Productivity
- Capacity



createc



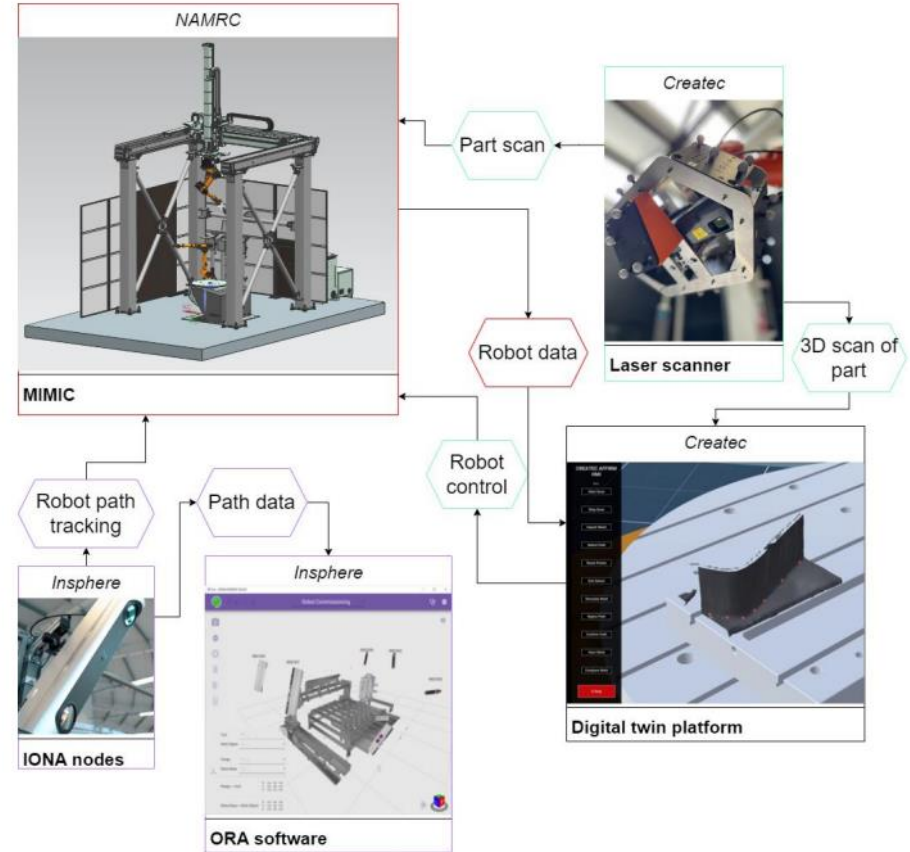
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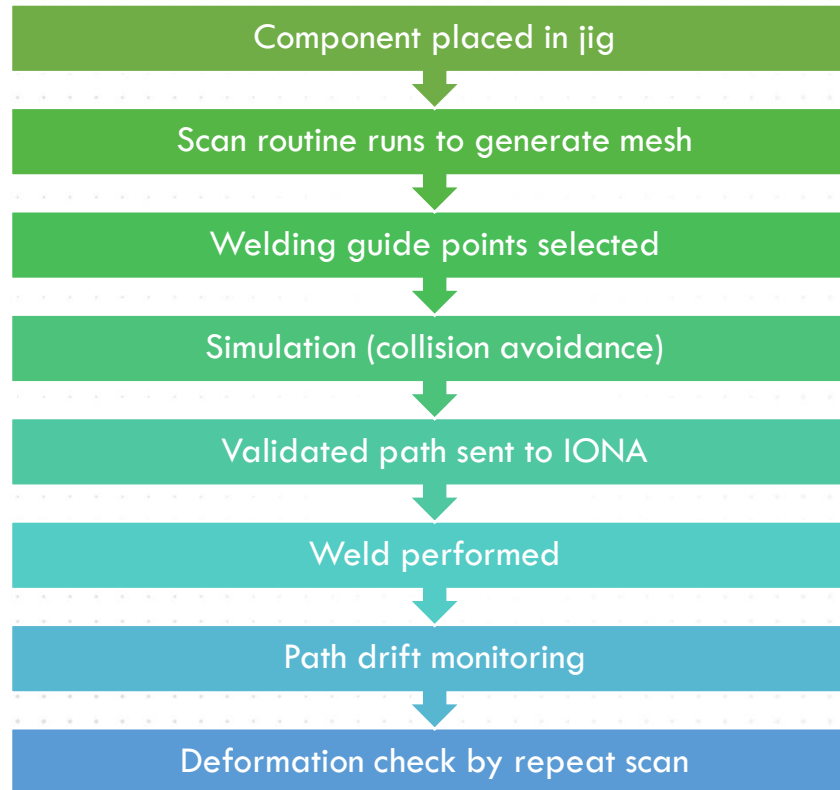
 **INSPIHERE**

MIMIC – Modular Intelligent Manufacturing and Inspection Cell

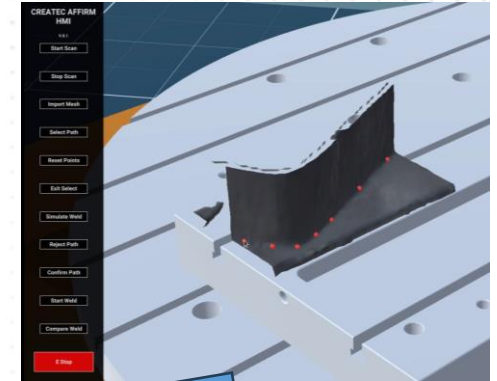
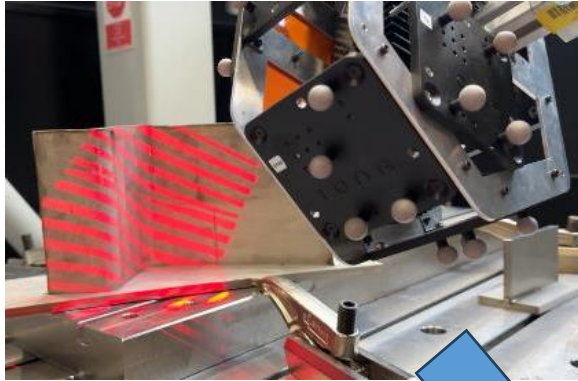
- Gantry-mounted welding robot
- Floor-mounted scanning robot
- Workpiece mounted on 2-axis trunnion
- Full cell safety system and interlocks

NAMRC has integrated IONA with Createc's scanning technology to enable autonomous manufacturing that adapts to different parts.

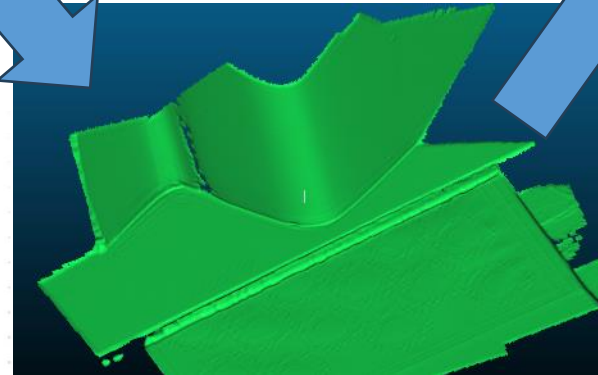




3D Imaging to plan the weld path



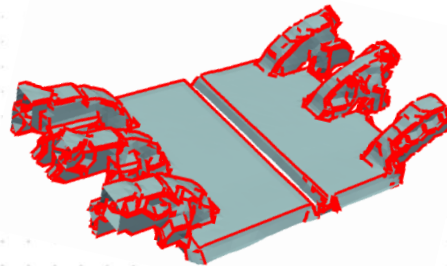
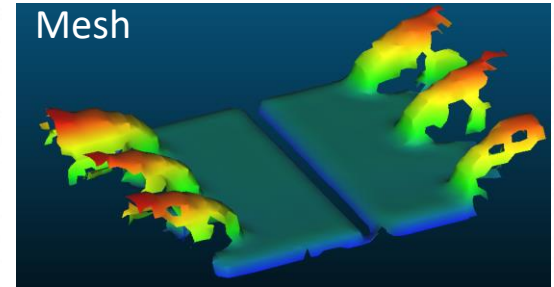
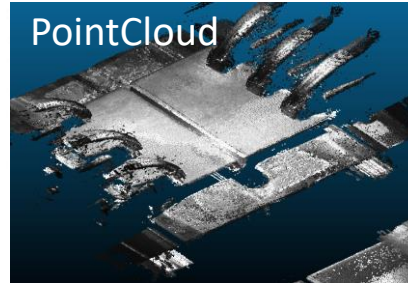
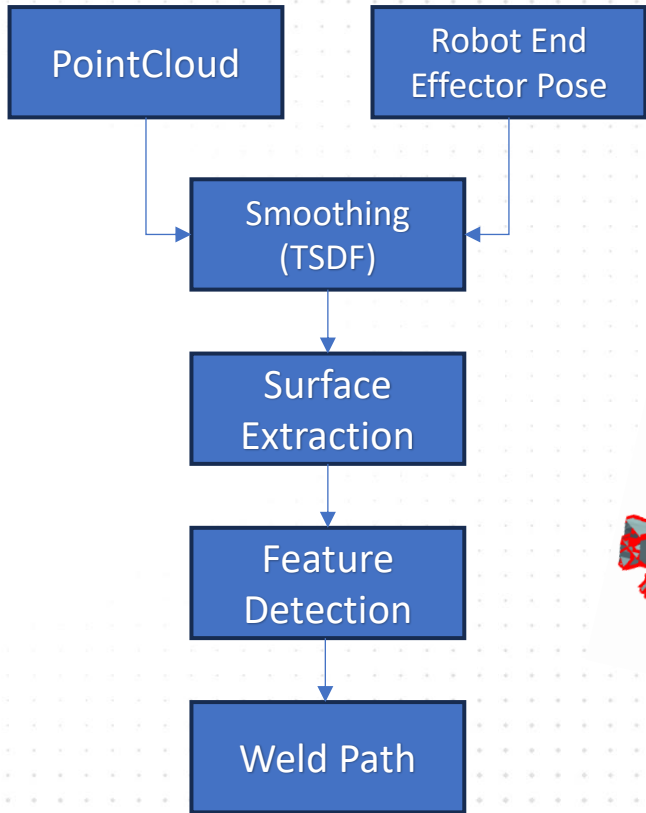
- Createc integrated a robot-mounted Photoneo 3D camera into the cell
- Robot routine collects multiple structured light images to capture component geometry
- Resultant 3D model enables flexible weld path selection on mesh



- Custom HMI developed to control robot scanning and welding
- 3D geometry of the weld plate is imported to the Digital Twin.
- Weld path points can be selected
- Weld simulation validates robot movement
- Welding robot controller is initiated from HMI
- Pre- and Post-weld scans facilitate planning and verification



Feature Detection to automate weld path planning

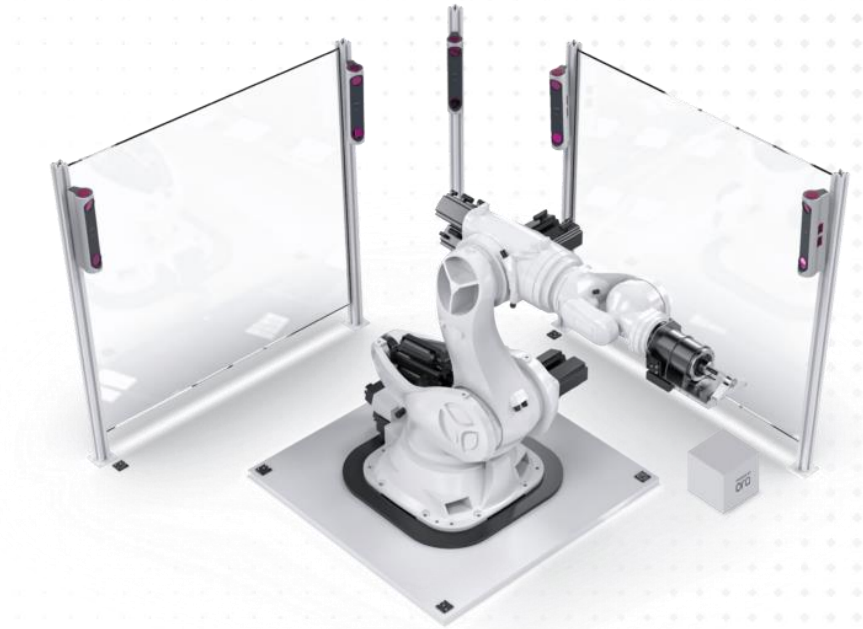


Monitoring the cell with precision metrology

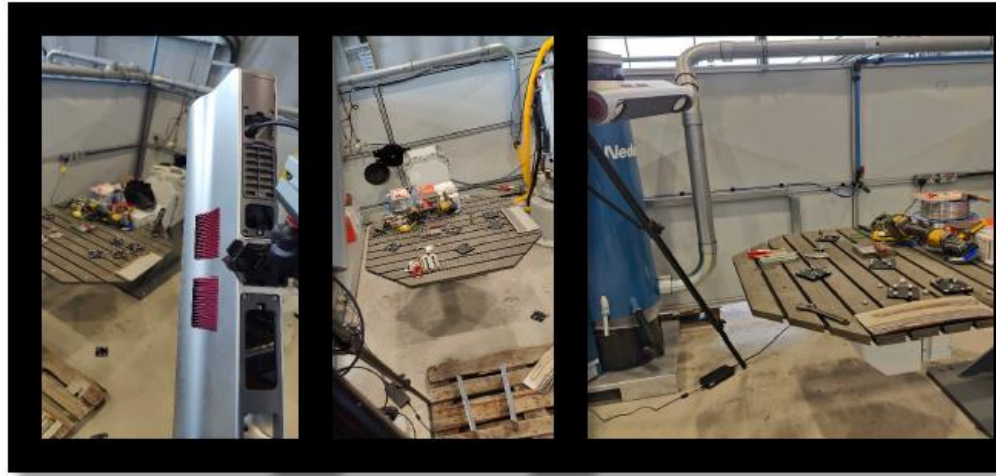


IONA: A network of stereo camera pairs for real-time monitoring and control of robots in manufacturing environments, providing highly accurate 3D positioning.

ORA: Proprietary software to interact with IONA and robot cells



- We reviewed and tested robustness and sensitivity of the IONA nodes and targeting
- Cell setup – we used IONA to establish robot tool centre and base positions within the cell
- IONA tracked the welding tip for traceability and to verify adherence to pre-planned path



Targets

Monthly review over a 6-month test period in welding cell

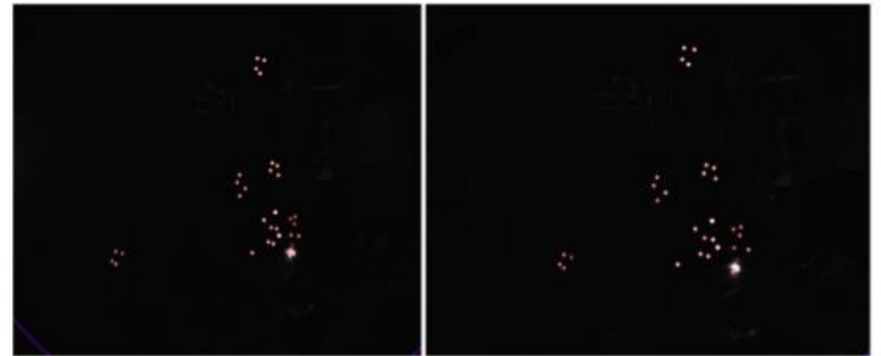
- No visible defects to targets
- Target sphericity unchanged



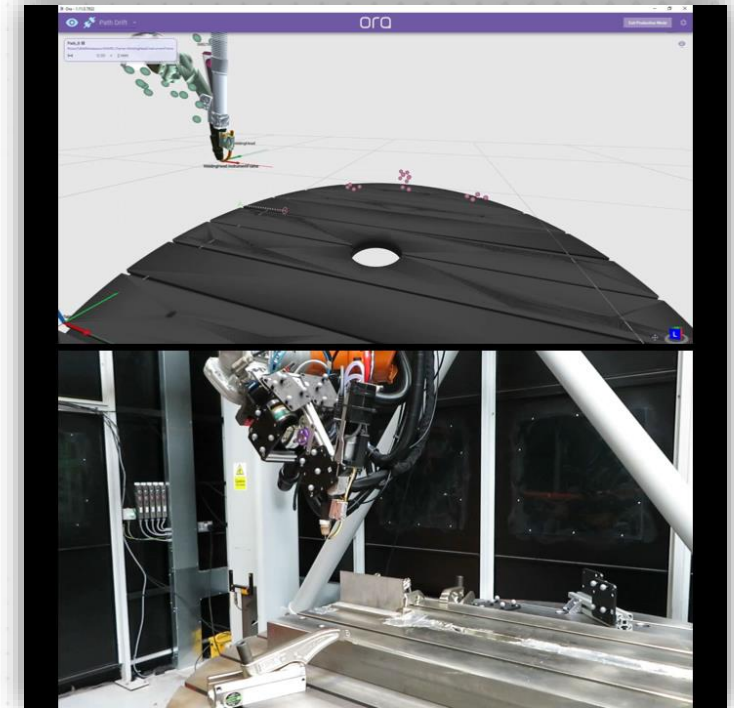
Cameras / Filters

Testing of measurement resilience in welding environment

- Multiple IR filter options tested
- Weld flash had no adverse effect on measurement performance (target decoding and sphere centring).

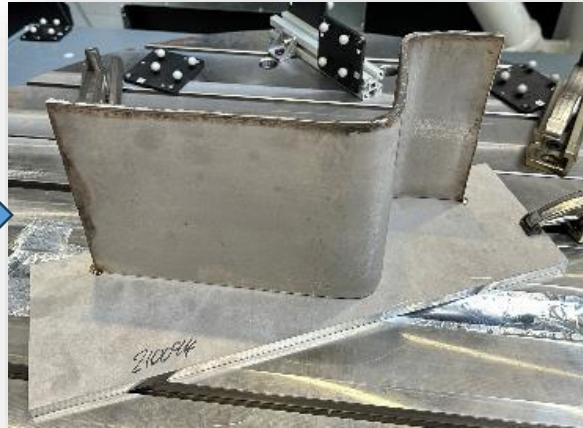


- Planned weld path is automatically imported to ORA
- As weld path is executed, ORA generates in-process comparison of measured path to planned path
- Deviation indicators on weld path
- Data can be output to digital twin and factory networks



More complex paths

- Test samples with representative geometry for waste container box corners were included in welding trials
- Complex geometry (curved edge paths) welds were successfully performed



- We developed a robotic welding and inspection cell, integrating IONA with Createc's scanning technology to enable autonomous manufacturing that adapts to parts variation
- A custom HMI was developed to control robot scanning and welding
- The welding path was tracked in process with IONA for traceability and potential correction
- Automated Welding was carried out for complex geometries (curved corners) used in nuclear waste container box manufacture



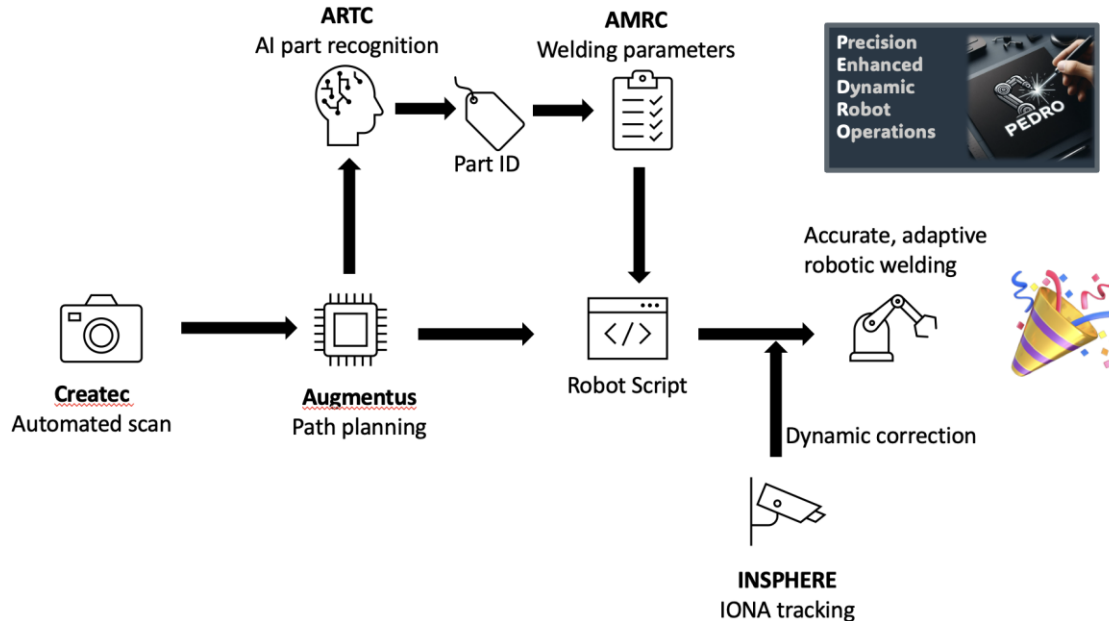
1. IONA and other system elements operate reliably and robustly in a welding environment
2. Full integration of system components was achieved



1. Robotic welding is very challenging!
2. User requirements vary – there is no one-size-fits-all solution
3. Further work is being done to increase automation in path planning
4. Further work is planned to use IONA for path tracking *and correction*
 - *Dry-run correction*
 - *Trained correction (ML)*
 - *Direct in-process correction*



A collaborative international project application has been submitted to develop a readily-deployable solution for the nuclear industry





Data for Intelligent Automation Solutions

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