

Optimisation of Ultrasonically Welded joints through Autonomous Experimentation

Pat Mongan

PhD Researcher

CONFIRM is the Science Foundation Ireland Research Centre for Smart Manufacturing

HOST INSTITUTION:



UNIVERSITY of LIMERICK
Ollscoil Luimnigh

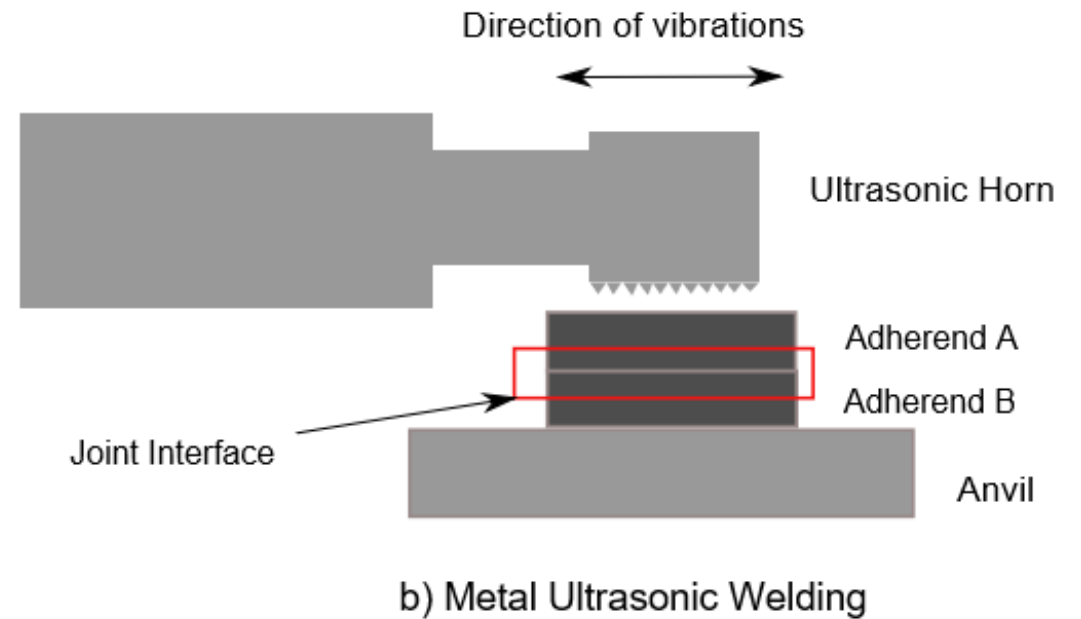
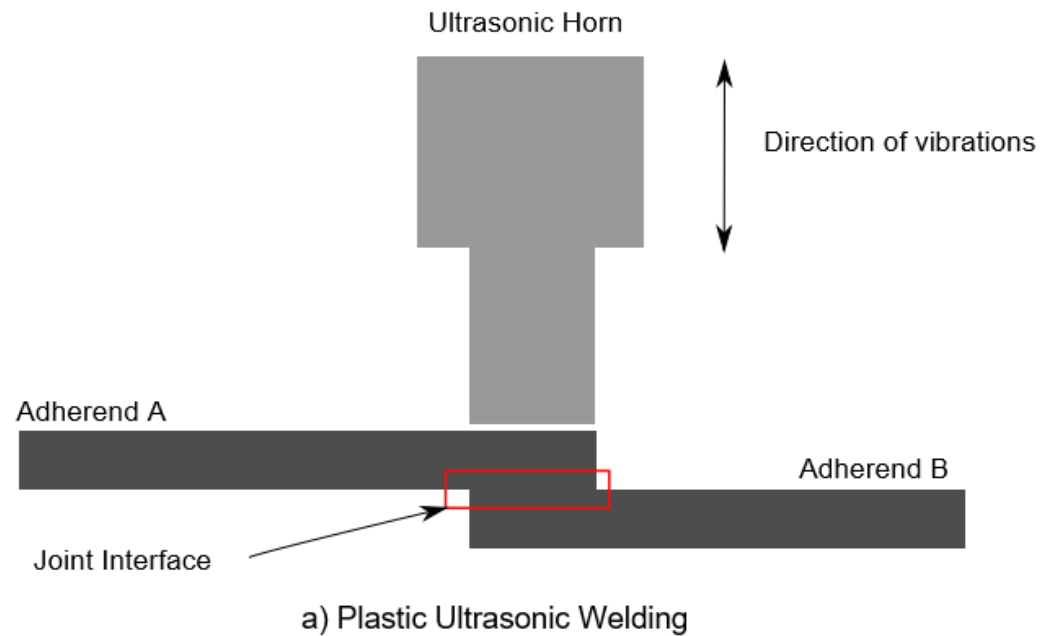
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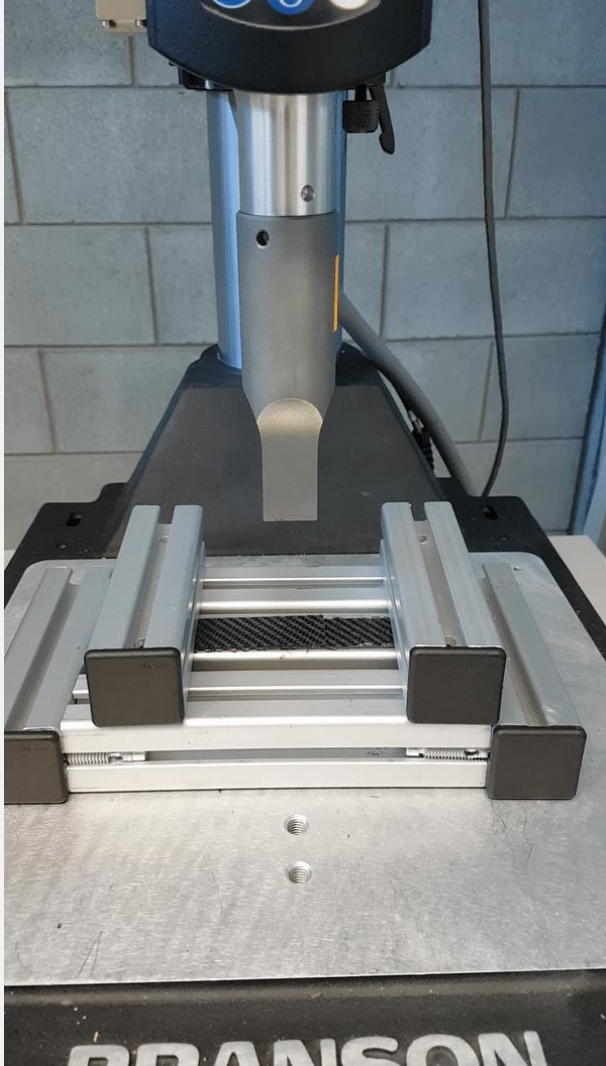
Ultrasonic Welder



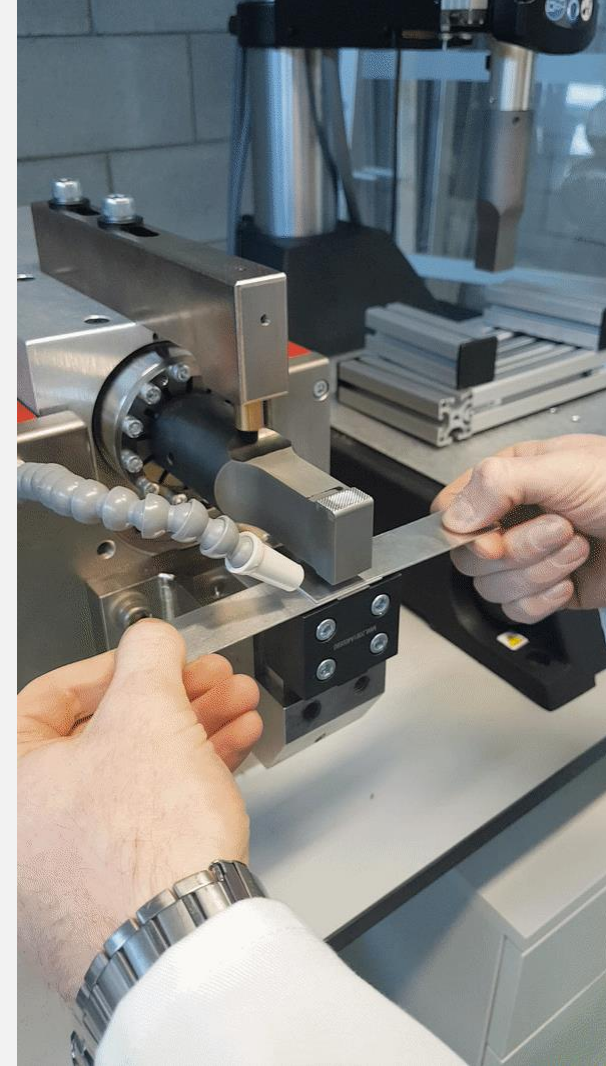
Ultrasonic Welding



Ultrasonic Welding



Plastic Ultrasonic Welding



Metal Ultrasonic Welding

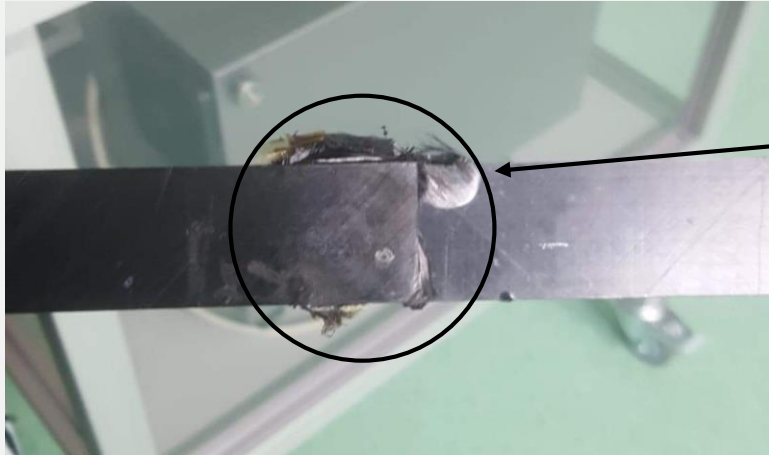
Ultrasonic Welding Applications



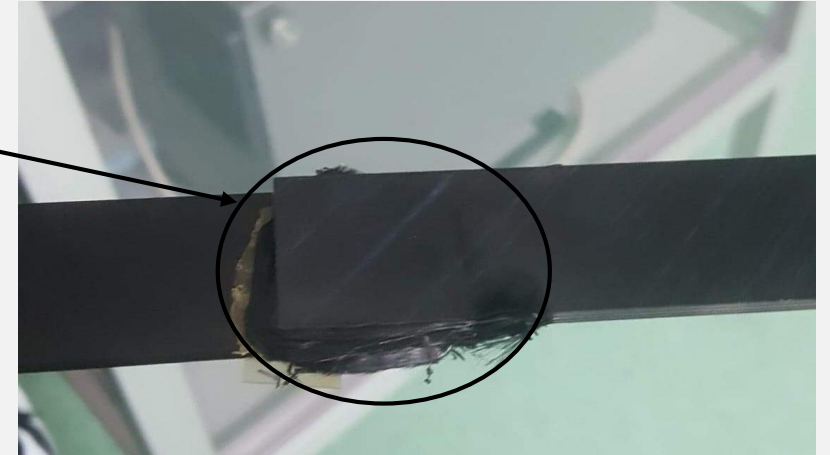
Advantages

- Low cost
- Low energy
- Rapid process
- Single process
- Uses the constituent materials
- Lightweight
- Easily automated

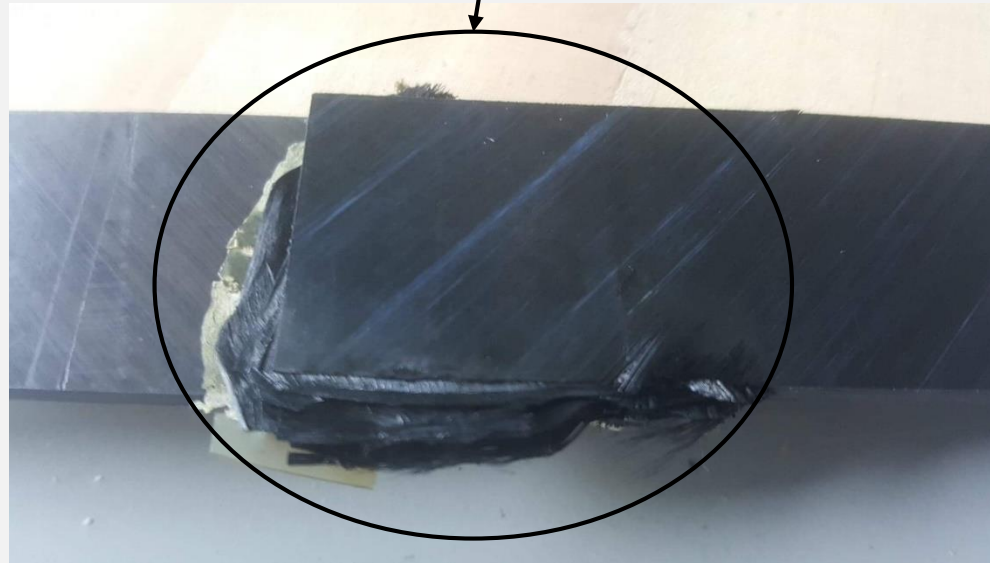
Ultrasonic Welding Challenges



- Matrix degradation
- Fiber push-out
- Delamination
- Unwelded zones



Parameter Relationships



Predictive Models

Industry 4.0 Motivation – Digital Twin

Physical

Machine



Product

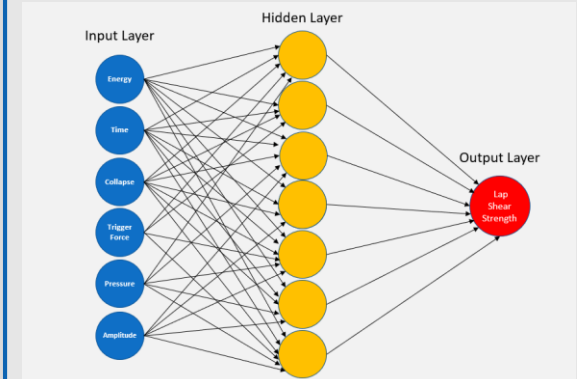
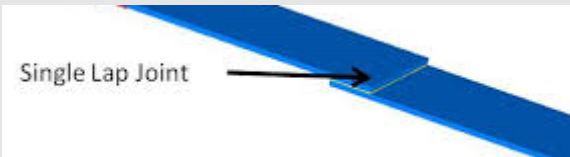


Process

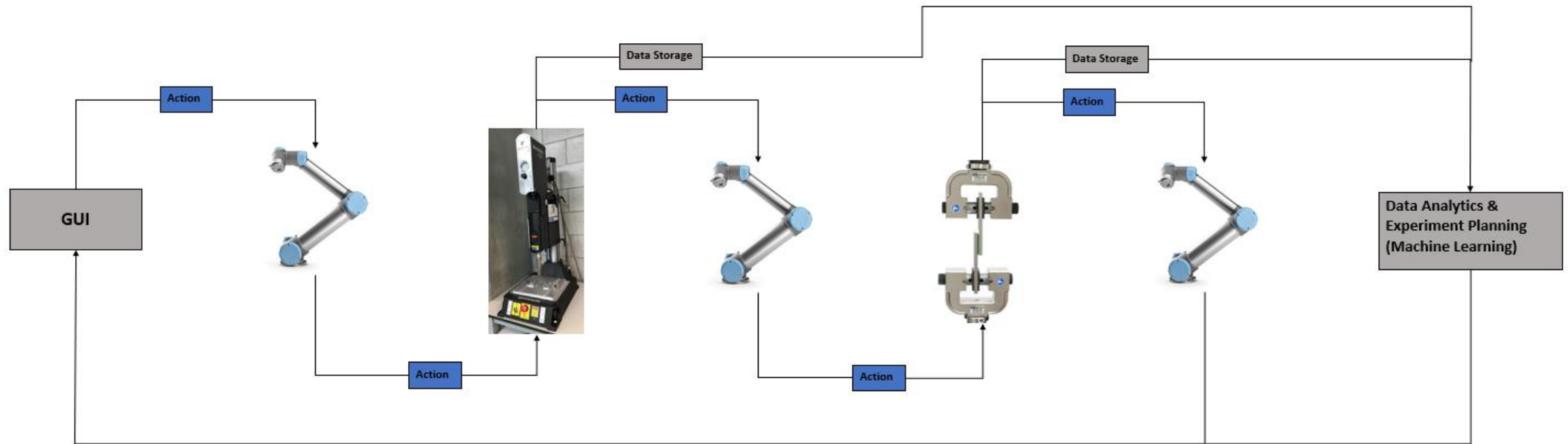


Digital Thread

Digital



Autonomous Experimentation Procedure

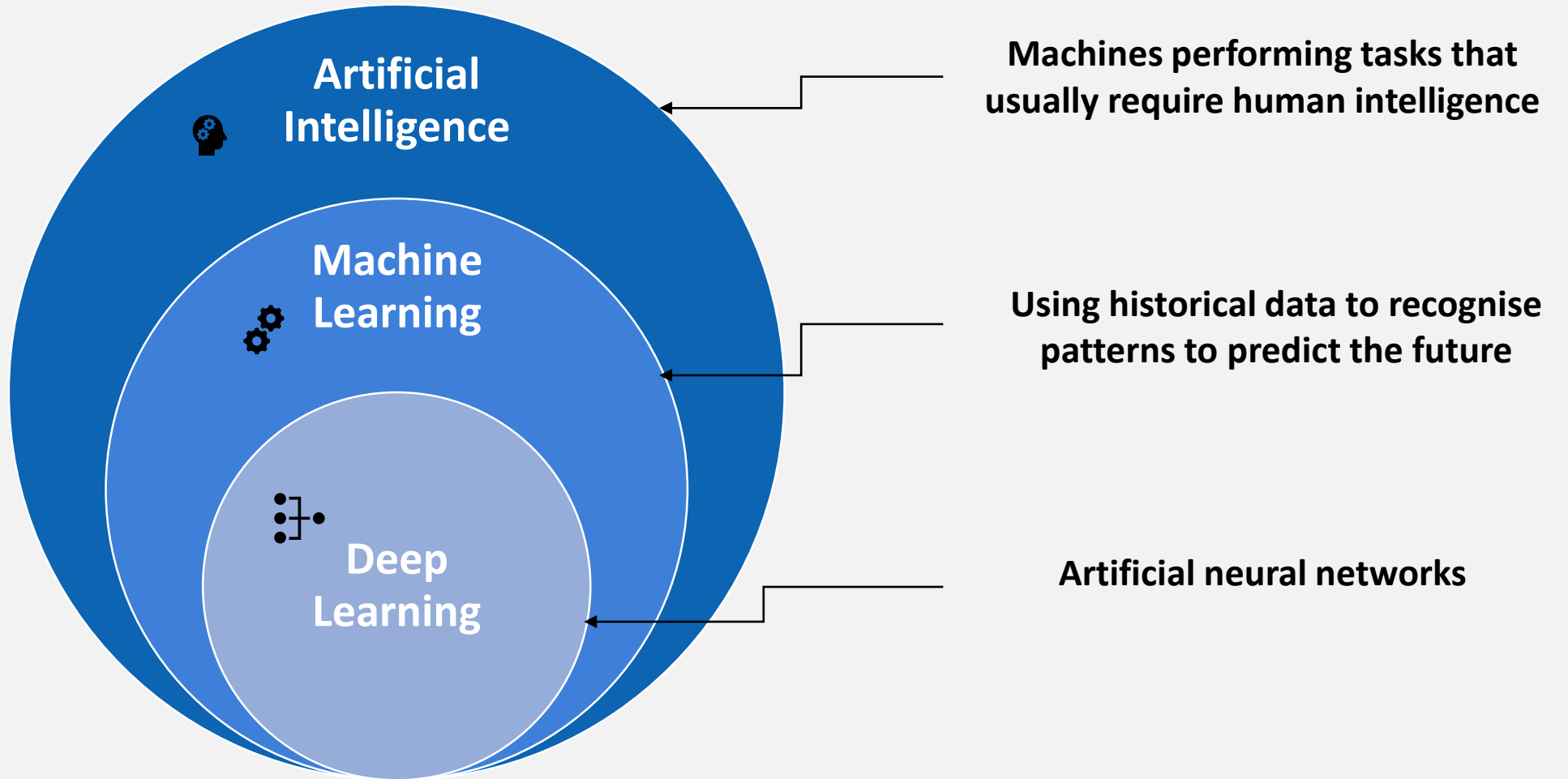


Collaborative Robotics

- **Humans and robots working in harmony**
 - **High repeatability**
- **Liberation from repetitive tasks**
- **Integrated force sensors**
- **Easy programming**
- **Flexible automation**

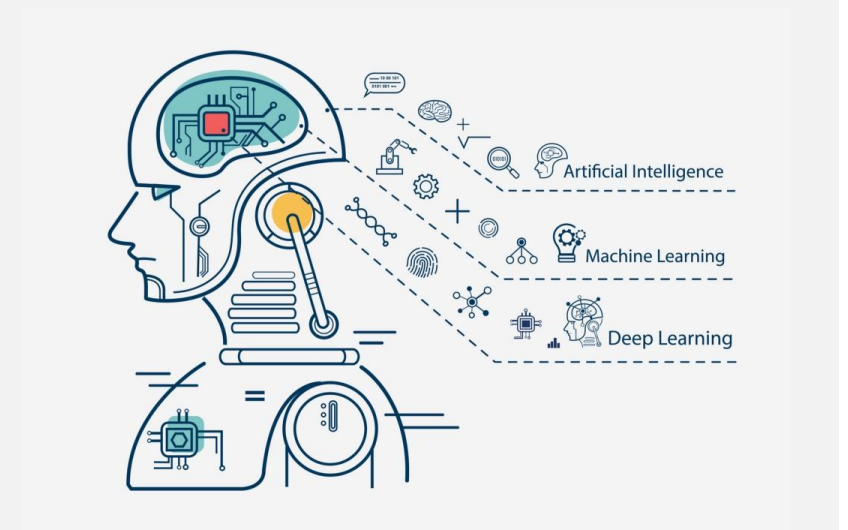
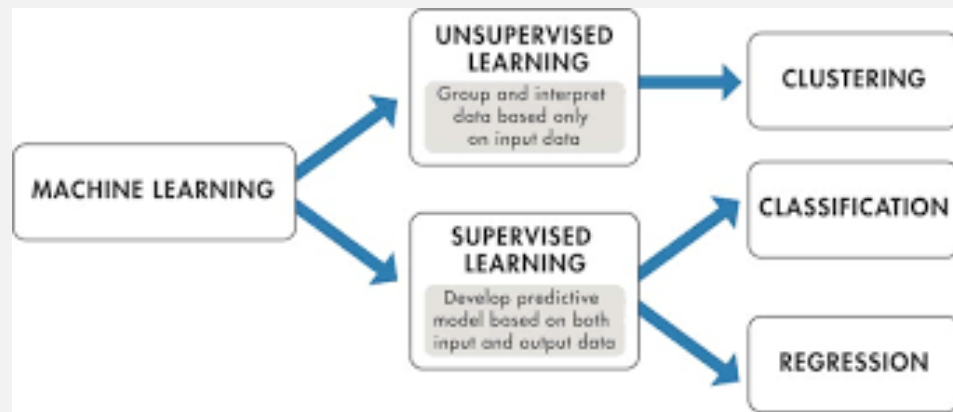


Artificial Intelligence

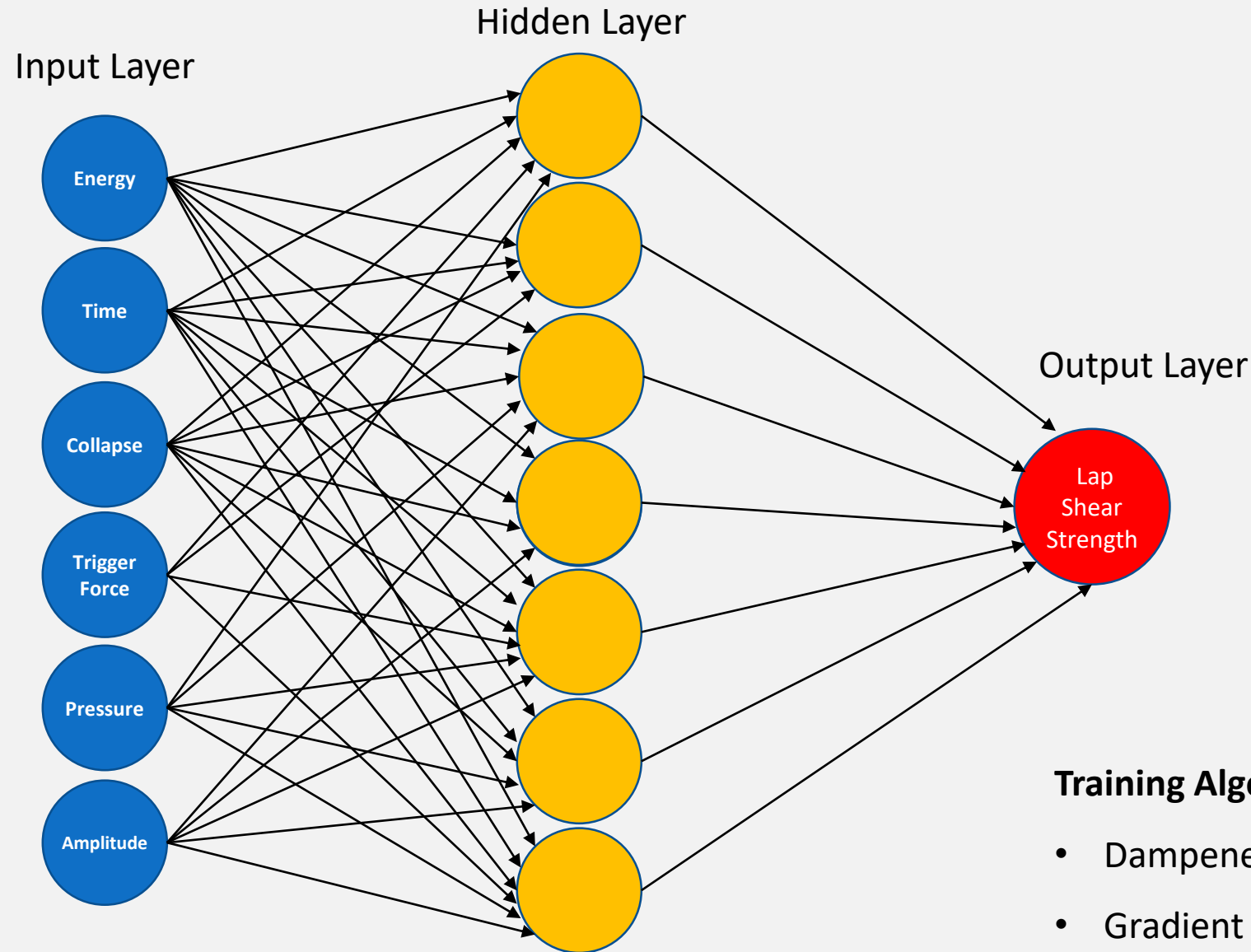


Machine Learning

Machine learning is computer systems that learns from data and automatically improves with experience



Artificial Neural Network (ANN) & Levenberg-Marquardt

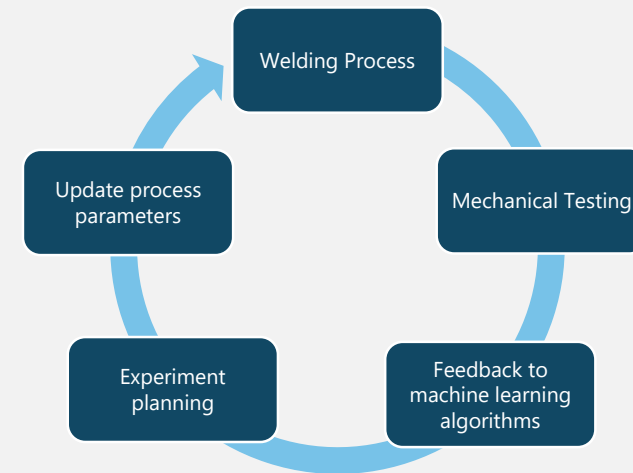
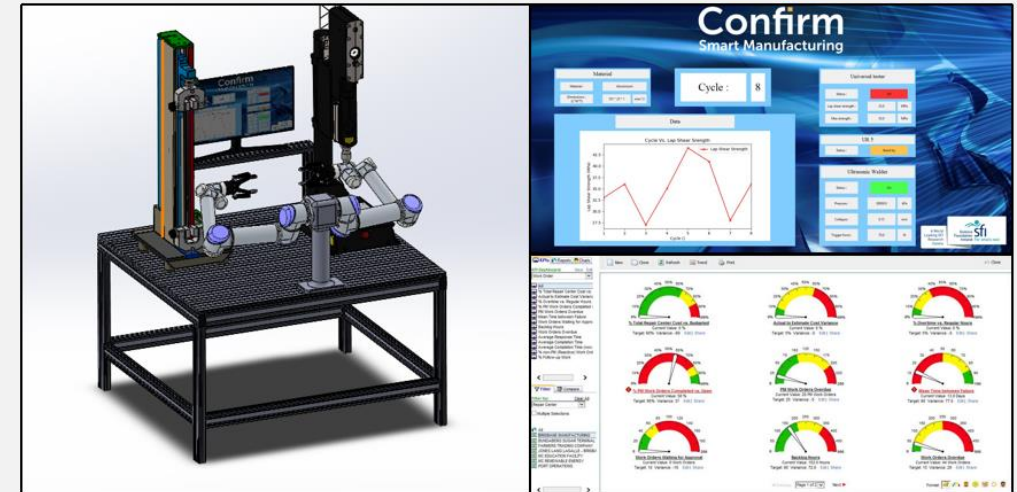


- *Underfitting*
- *Overfitting*

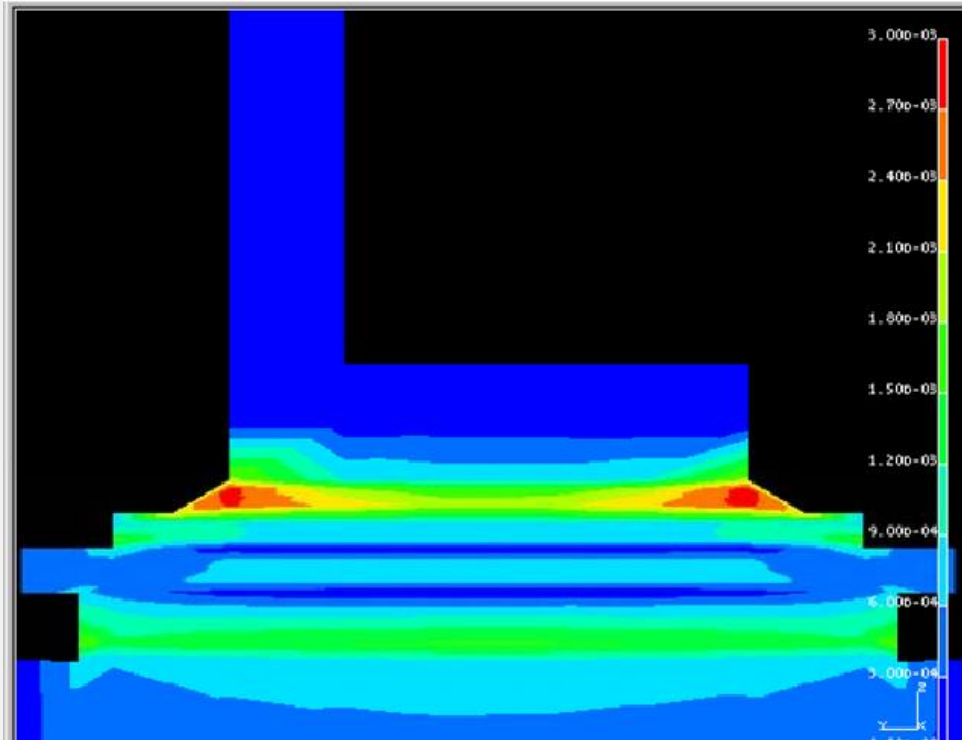
Training Algorithm 'Levenberg-Marquardt'

- Dampened least square method
- Gradient descent and Gauss-Newton

Autonomous System

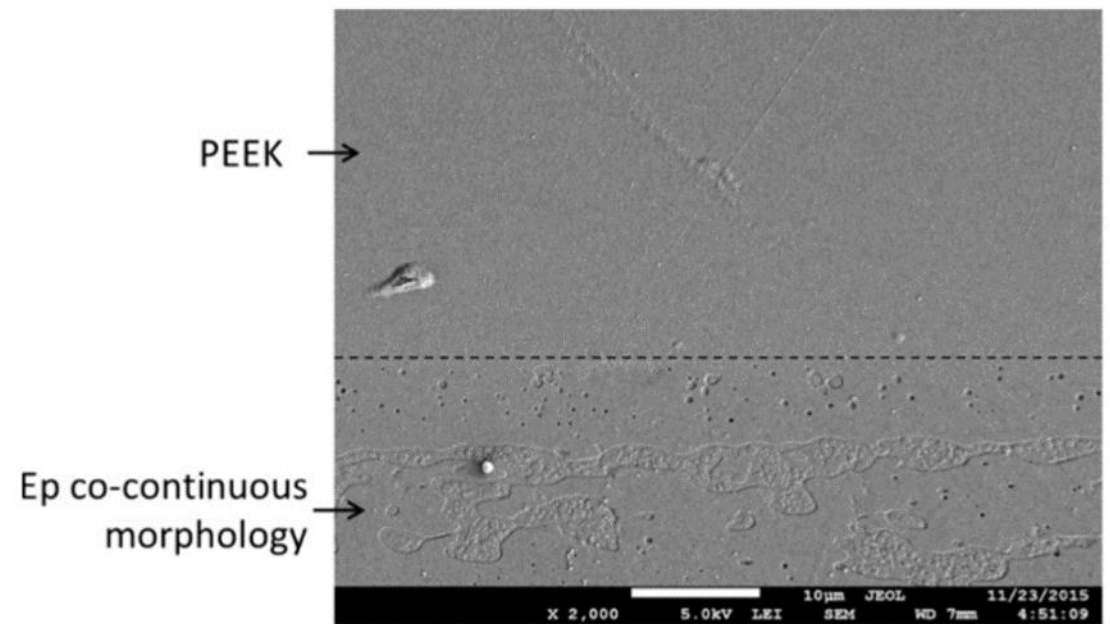


Advantages – Research



Liberation from repetitive tasks

Efficient allocation of resources



I. F. Villegas and R. van Moorlegheem, "Ultrasonic welding of carbon/epoxy and carbon/PEEK composites through a PEI thermoplastic coupling layer," Composites Part A: Applied Science and Manufacturing, vol. 109, no. February, 2018.

Advantages – Industry

Accelerated process development

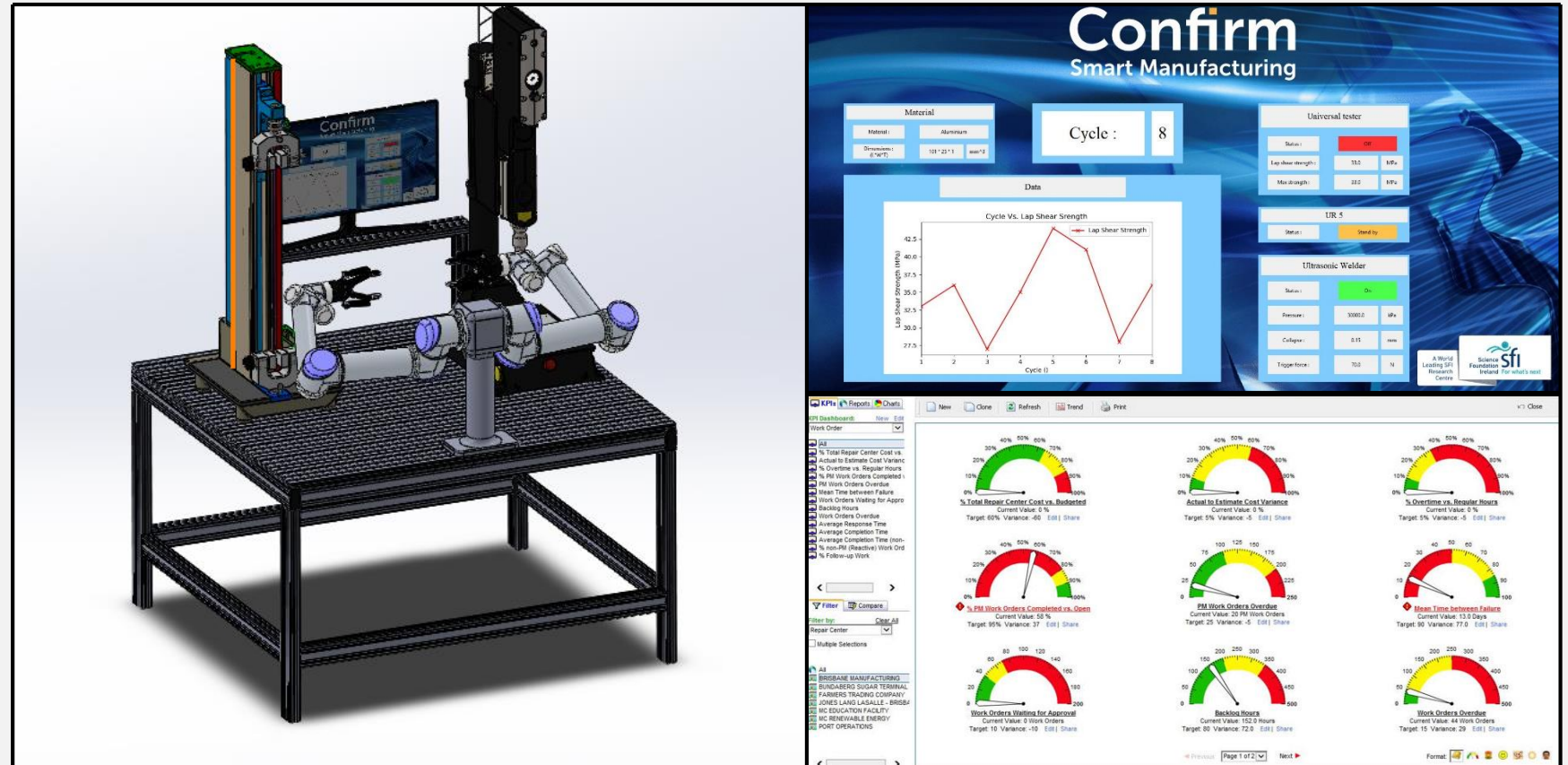
Low experimentation cost

Efficient transition for design iterations

Data storage

Minimal waste

Minimises destructive testing



Equipment - JAMIR



JAMIR

Joining Advanced Materials using Industry Four



Transforming Irish industry to become
world-leaders in smart manufacturing



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For what's next

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Phone +353 61 204395
Email confirm@ul.ie