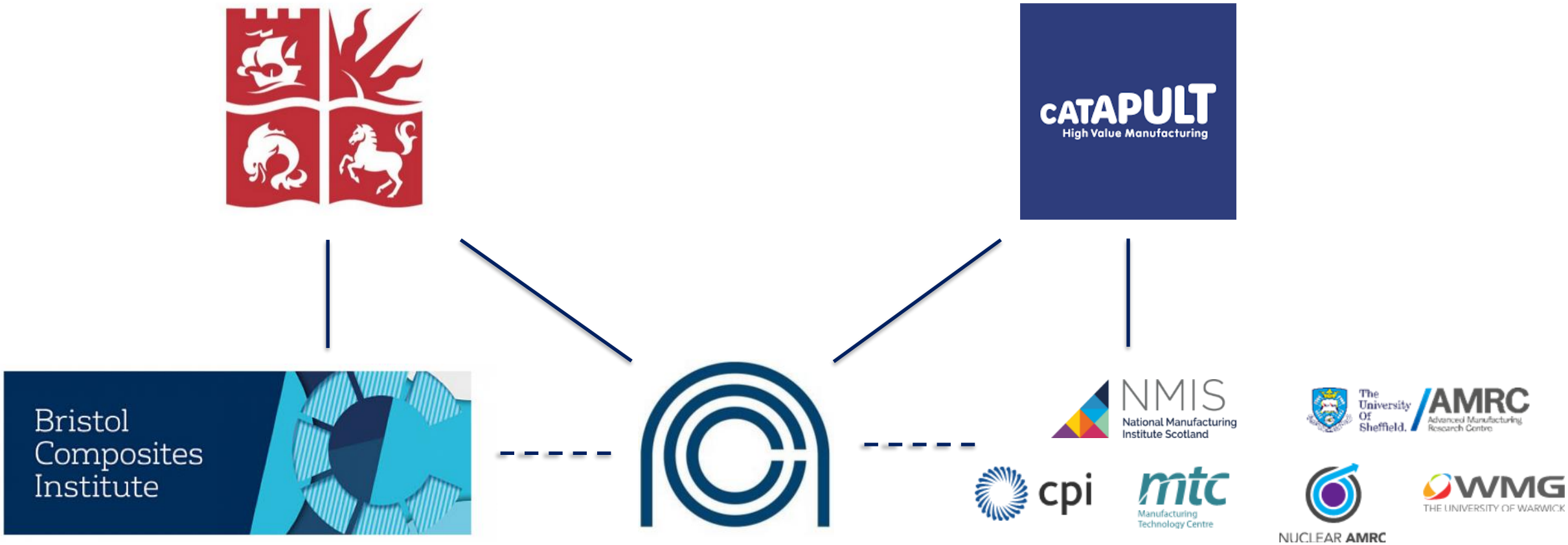
NATIONAL COMPOSITES CENTRE

Powering the full exploitation of composites opportunities: Automated Composites Manufacturing

Enrique J Garcia, CTO

NCC - Part of University of Bristol & HVMC



Plus other UoB Institutes

HVMC - Who We Are

Established by **Innovate UK** in 2011

Seven centres of industrial innovation across 18 sites working together on the future of manufacturing in the UK.

CATAPULT High Value Manufacturing

NMIS National Manufacturing Institute Scotland

The University of Sheffield AMRC

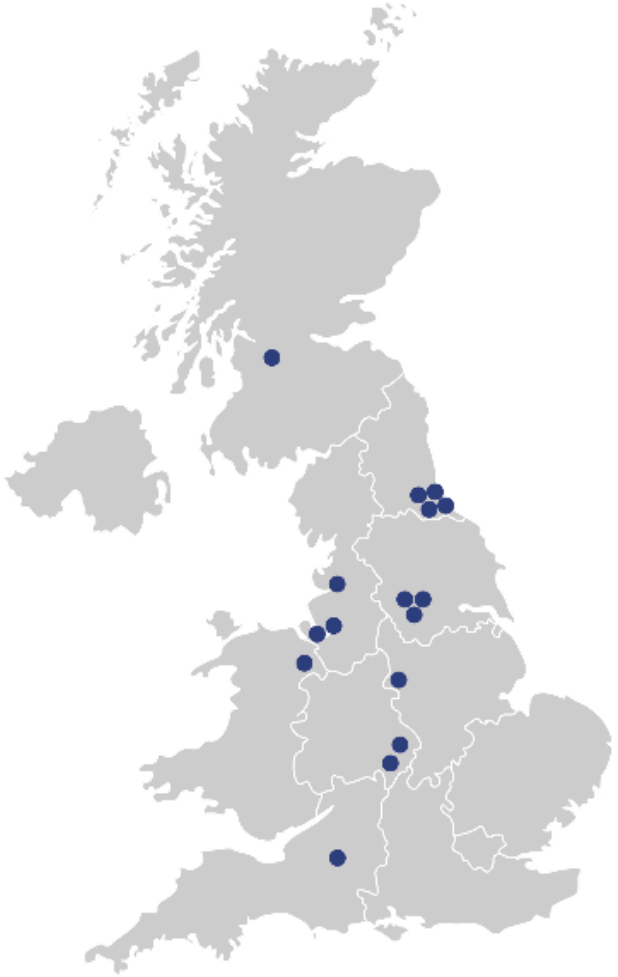
cpi

mtc Manufacturing Technology Centre

National Composites Centre

Nuclear AMRC

WMG The University of Warwick



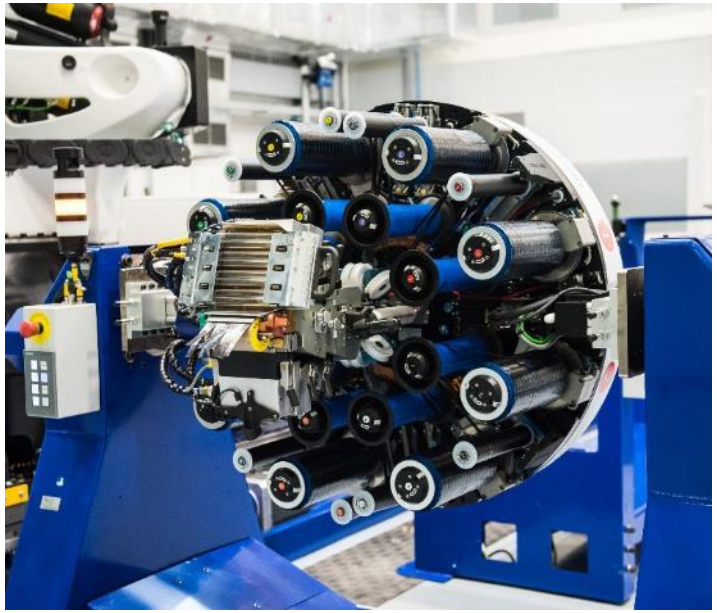
Largest advanced manufacturing capability in Europe

We've worked with more than **22,000** companies

54% were SMEs

4,000+ staff

NCC - Europe's leading composite innovation capability

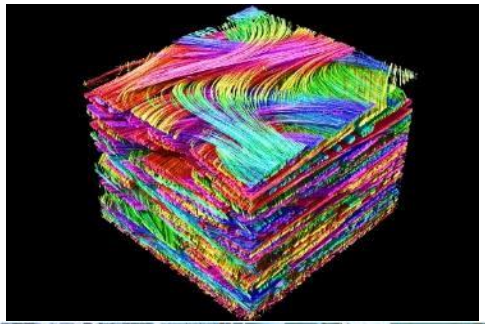


NATIONAL COMPOSITES CENTRE

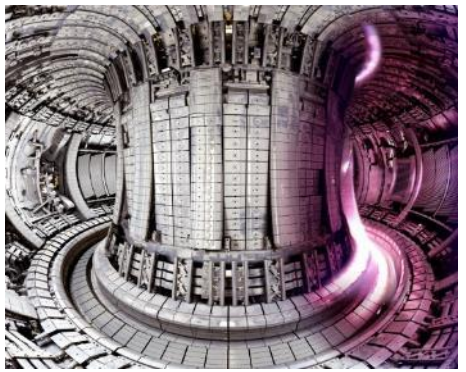
Catapult mission:
Bridging the Valley of Death

Trends in Automated Composites Manufacturing

- **“Horses for courses”:**
  - Highly specialised solutions
  - Wider portfolio of manufacturing processes for automated deposition and beyond
- From manufactured part inspection to **in-process monitoring**:
  - Rapid identification of quality issues, increased reliability
- From iterative (trial/error) to “Right First Time” to **“Right Every Time”**
  - Advances in Simulation Tools, Machine Learning and other AI, etc allow for “close-loop” manufacturing process



Composites enabling the Net Zero Transformation: More variety



‘Net Zero requires transformational technology to deliver a step change in product and system level performance – composites can enable this transformation’

- **Light-weighting** to **accelerate zero emissions mobility (electric, H2)**
- **Storage and distribution** technology to **enable hydrogen**
- **Performance step-change** to **scale wind energy**
- **Zero emission aircraft** to achieve **‘jet zero’**
- **Energy efficient infrastructure** and **buildings**
- **High temperature, lightweight** materials to **unlock nuclear**

Source: https://compositesuk.co.uk/leadership-forum/uk-composites-strategy

Automated Deposition

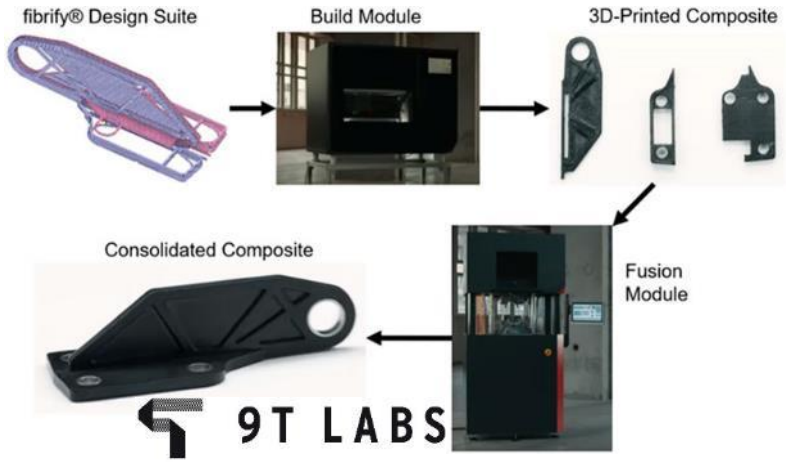
Automated Deposition

Ultra High-rate Deposition

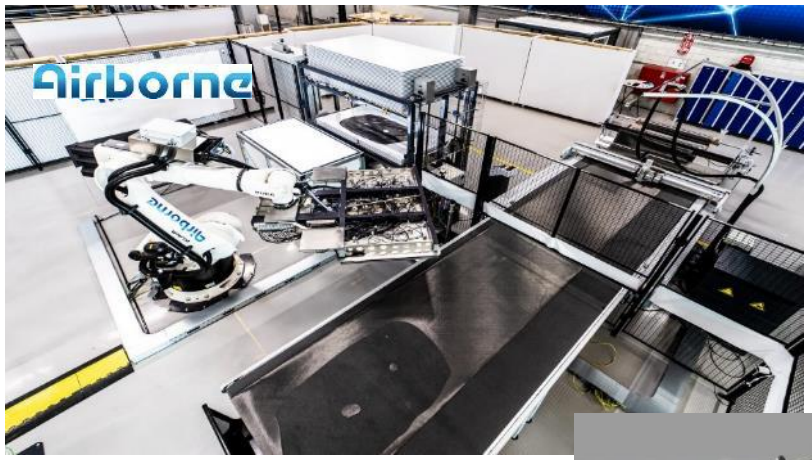
Additive Manufacturing

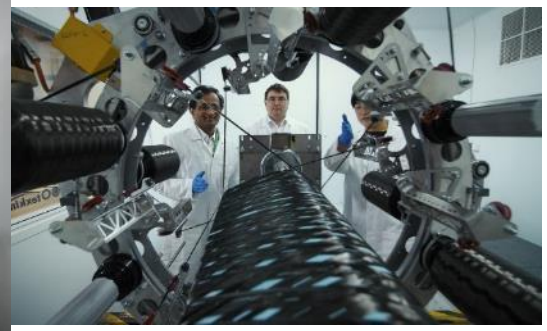
Continuous Fibre Additive Manufacturing

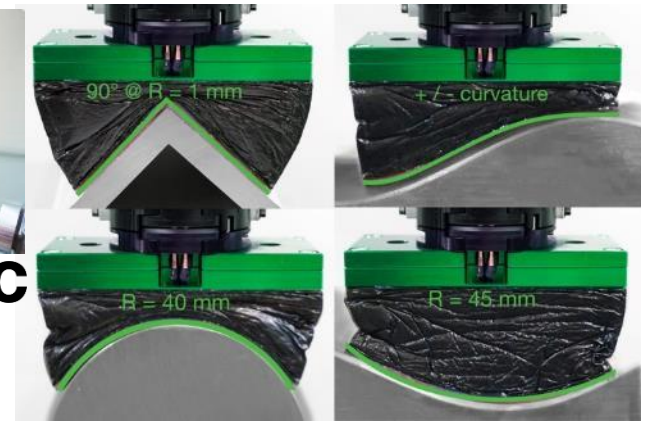
Markforged

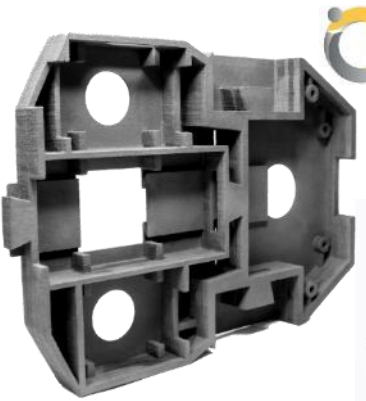


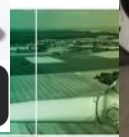
More automated processes

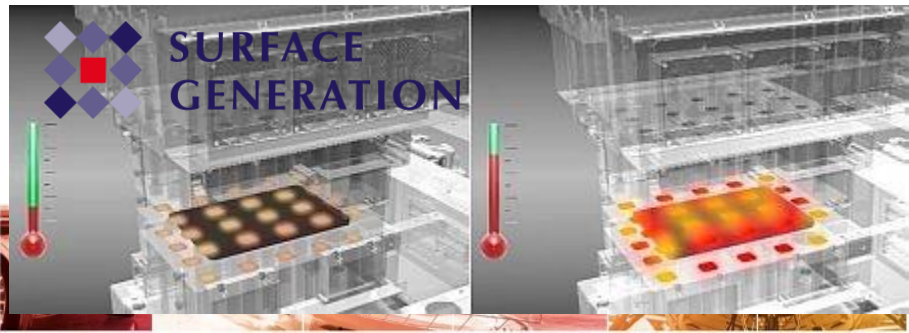




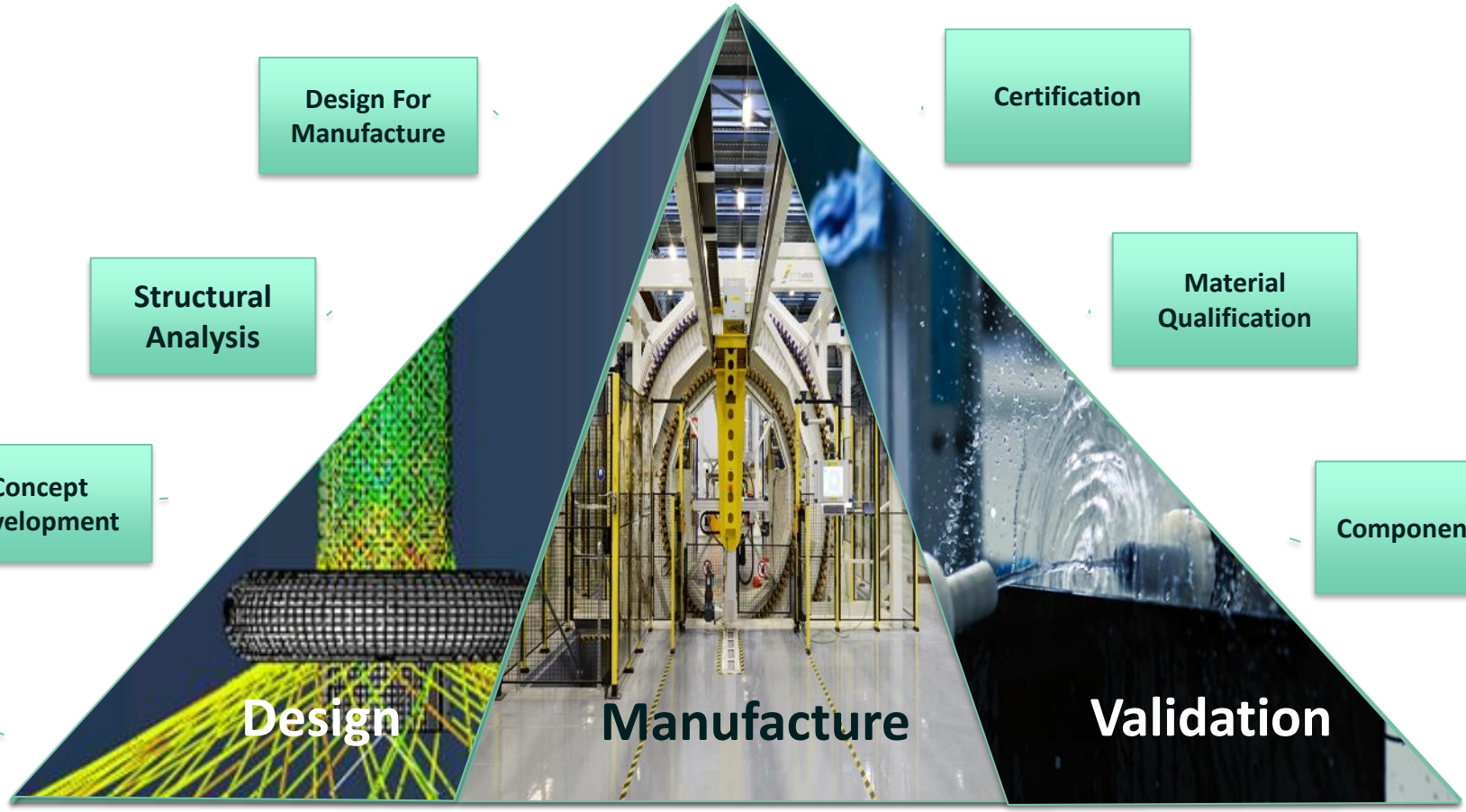






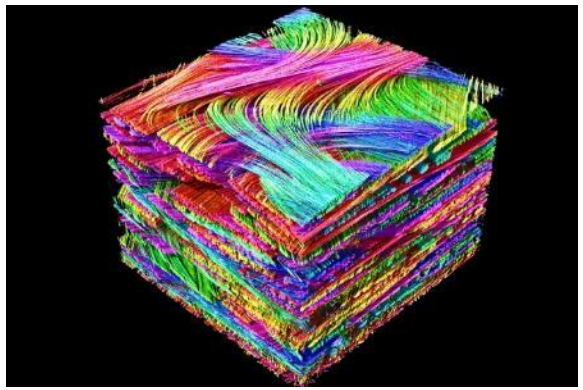


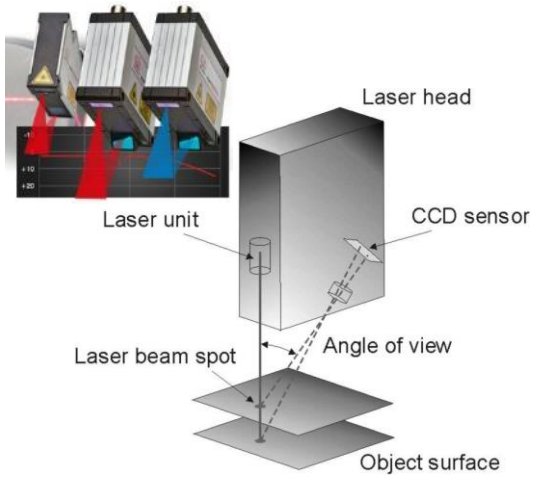
Automated Manufacturing does NOT work in isolation



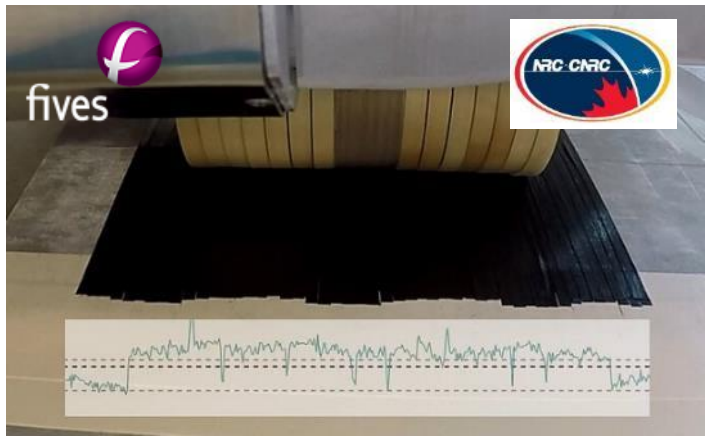
- Design For Manufacture
- Structural Analysis
- Concept Development
- Requirement & Spec Development
- Certification
- Material Qualification
- Component Testing
- Non Destructive Testing
- In-process monitoring

From part inspection to in-process monitoring to maximize AS-MANUFACTURED performance





Line Laser Triangulation (LLT)

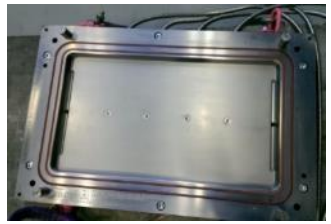


Optical Coherence Tomography (LLT)

In-tool sensors (flow front, curing,…)

Digitally enabled closed-loop cycle: Right Every Time

CLAMPS - Example with RTM component



Tool with **embedded sensors**

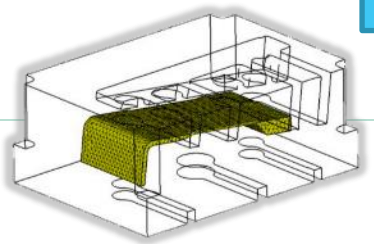
Output focussed (quality control)

Statistical process control

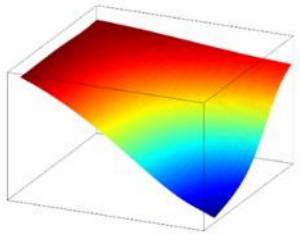
In-process inspection

Offline predictive (manufacturing process simulation)

Correlation of the simulation



15,000 Simulations to construct a **Surrogate Model**

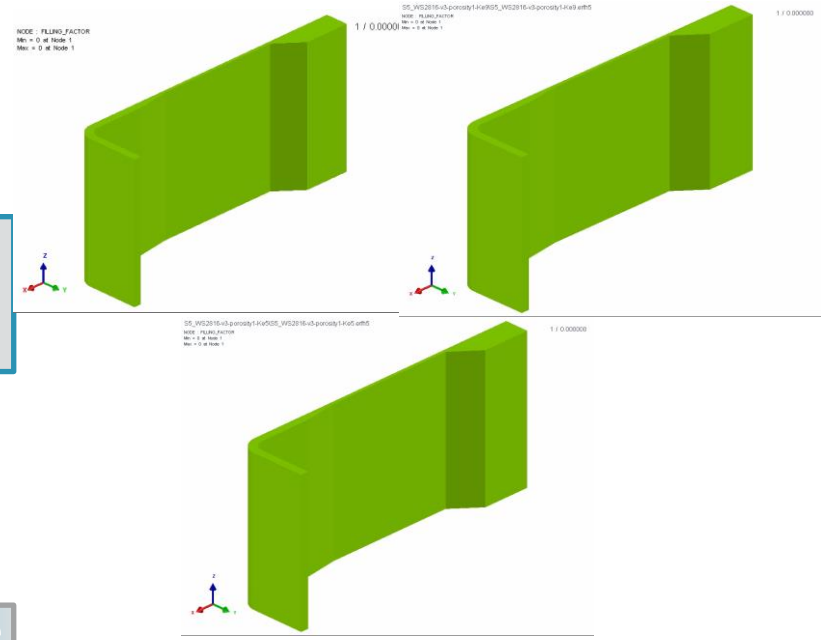


In-process predictive

Updating predictive simulation

In-process control

High Fidelity Simulation of the manufacturing process



Machine Learning used to build an **adaptive model** with complete understanding of process variables and control requirements

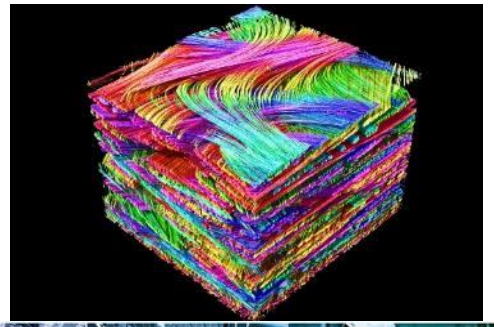
Process becomes ***adaptive*** and able to intelligently overcome process variation → **Right-every-time**

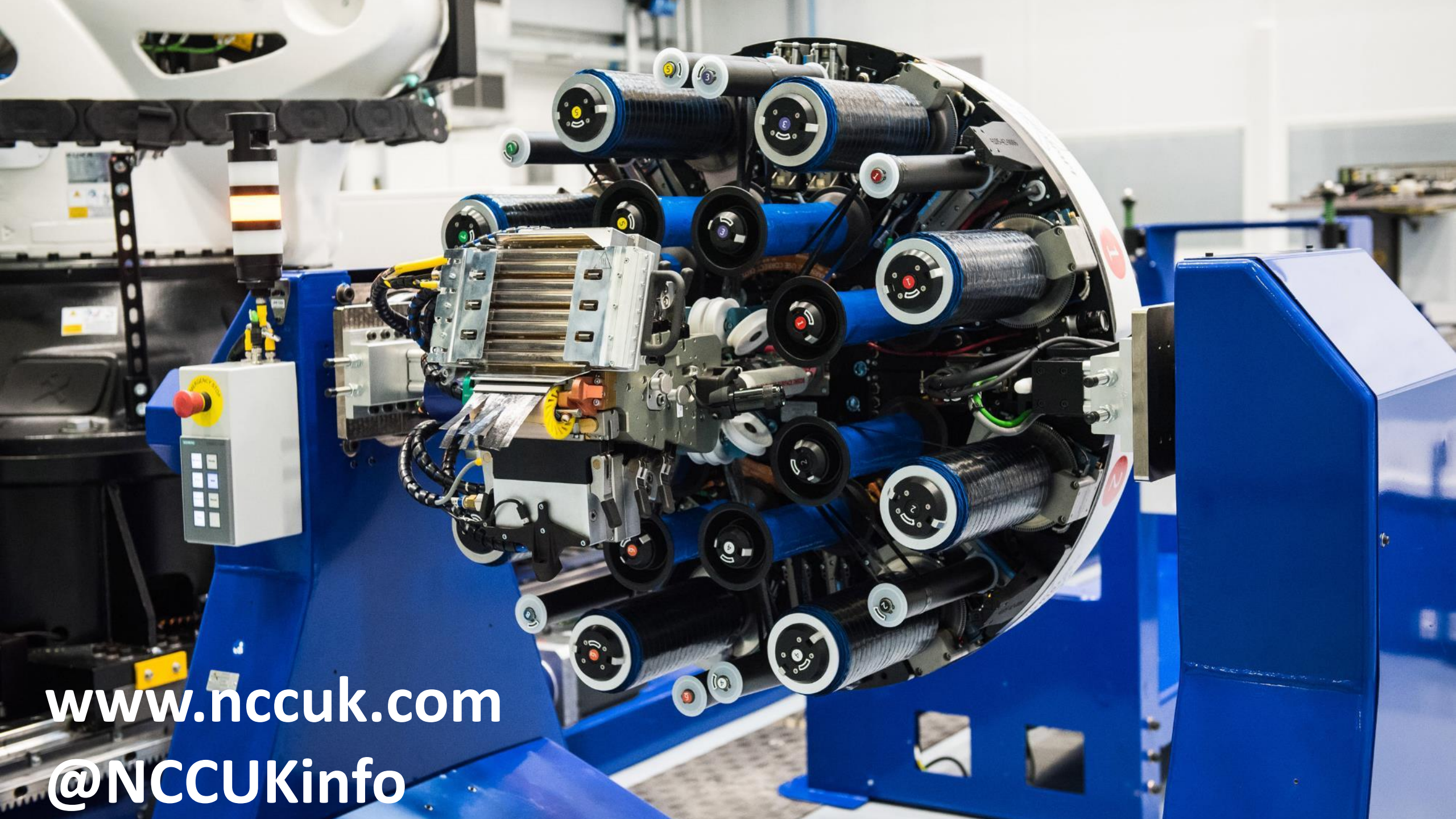
cfms

University of BRISTOL
Bristol Composites Institute (ACCIS)

Automated Composites Manufacturing

- **“Horses for courses”:**
  - Highly specialised solutions
  - Wider portfolio of manufacturing processes for automated deposition and beyond
- From manufactured part inspection to **in-process monitoring**:
  - Rapid identification of quality issues, increased reliability
- From iterative (trial/error) to “Right First Time” to **“Right Every Time”**
  - Advances in Simulation Tools, Machine Learning and other AI, etc allow for “close-loop” manufacturing process




www.nccuk.com
@NCCUKinfo