
# Blade Integrity Inspection – How the NCC can help…

## BINDT – Requirements Workshop for NDT of Wind Turbines – OREC Blyth

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Feb 13th 2019

University of BRISTOL
Department for Business, Energy & Industrial Strategy
CATAPULT High Value Manufacturing
Homes & Communities Agency
European Union European Regional Development Fund Investing in your future

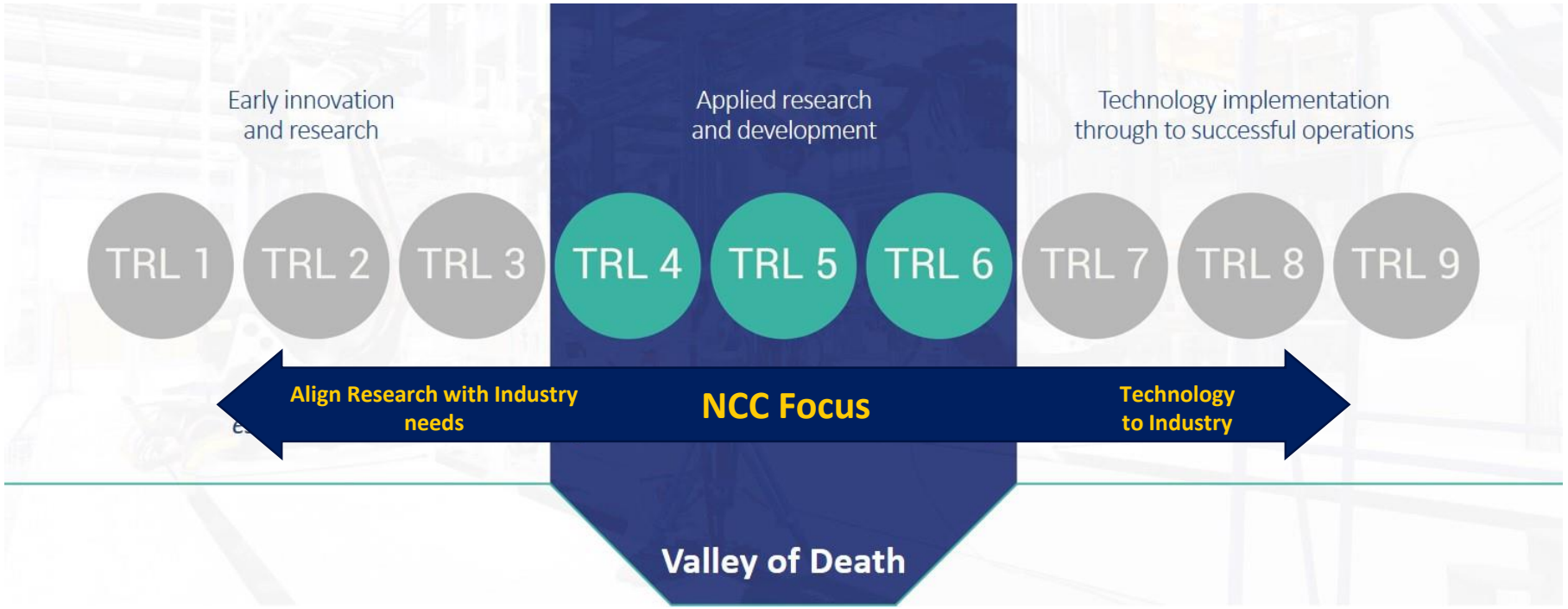
# Overview

## The National Composites Centre (NCC):

- Created as a result of the UK Composites Strategy, Nov 2009 & opened in Aug 2011
- Extended to include high volume manufacturing area, large assembly workshops and teaching & training facilities; the extension opened in Oct 2014.
- Open access, industrial scale, state-of-the-art, not-for-profit development facility
- Led by industry, used by industry, and hosted by University of Bristol
- Accessed through Tiered Membership models or general pay-per-use
- Part of the High Value Manufacturing Catapult Centre

# About NCC

# About NCC. Market Failure: Bridging the Valley of Death



# About NCC – Facilities & Equipment


Industrial scale equipment to allow development of full-scale manufacturing and associated processes

# NDT Capabilities

Manual Portable A-Scan

Automated Phased-Array, Through Transmission, Pulse-Echo

Bondtesting

Manual/Semi Auto Phased-Array

Thermography: Pulse, Transient, Lock-in

Laser Shearography with thermal excitation

## NCC NDT Team

Currently 6, drawing experience from manufacturing, aerospace, NDT service industry, NDT training business, research and academia, Technicians to Principal Research Engineer

Experience in developing techniques, applying technology to a wide range of inspection requirements from Aerospace, Marine, Wind, Automotive sectors – mostly Carbon fibre, but that is starting to change, as we pick up more work in non-aerospace sectors.

# The Future – Summer 2019:

NCC has recently secured funding from the Aerospace Technology Institute, Catapult, and Local Enterprise Partnership, for a significant increase in our Capability.

This includes the Composites Integrity Verification Cell (CIVC) which will be installed and commissioned in Q3 2019.

Key Features:

- Automation – Robotic Inspections
- Automatic scan path calculation and adaptation from CAD models
- Multi-method inspections integrated on the same platform
  - Ultrasonic - PAUT, TT, FMC/TFM
  - Thermography - Pulse, Lock-In and Transient
  - Non-Contact Metrology
  - Shearography – Infra-Red Excitation initially – to be developed
- Results displayed on common models
- Virtual/Mixed/Augmented Reality for visualisation of results in complex structure/geometry

Image supplied by Ultrasonic Sciences Ltd

# CIVC – Composite Inspection and Verification Cell

- Twin Robots
- 4m dia Turntable
- Immersion tank
- 10m x 4m x 4m scanning volume

Phase 1:

- Ultrasonic:
  - Single Element
  - Phased-Array
  - FMC/TFM

Phase 2:

- Thermography integrated
  - Pulse
  - Transient
  - Lock-in
- Shearography integrated
  - Thermal excitation
- Metrology integrated

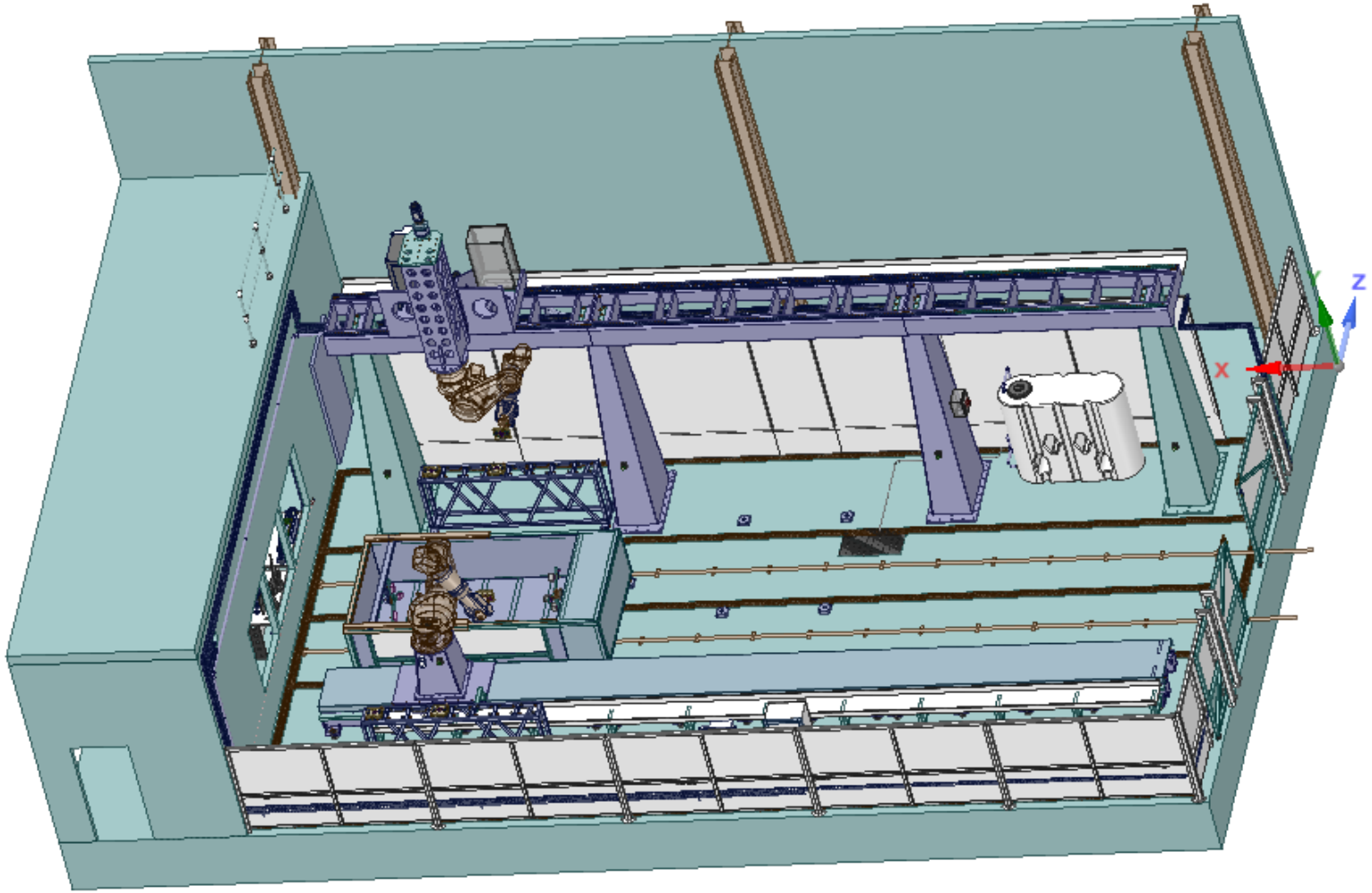
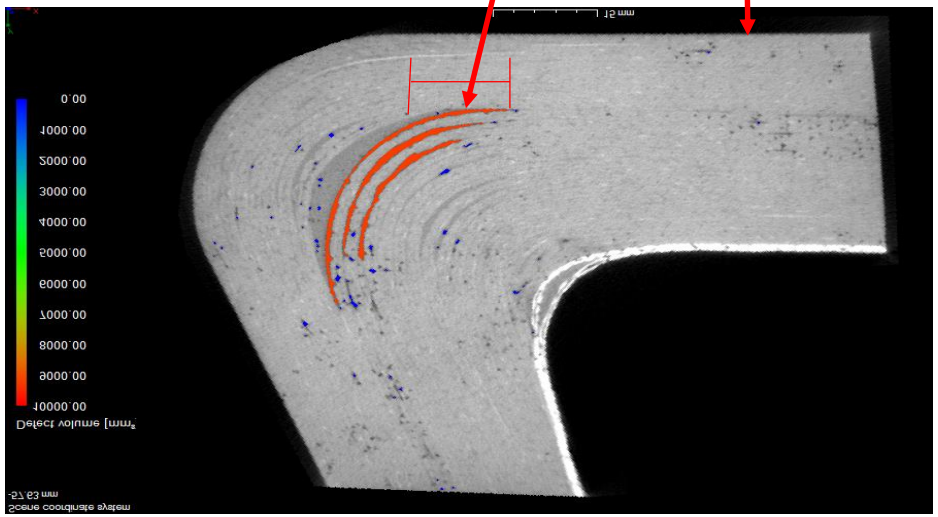


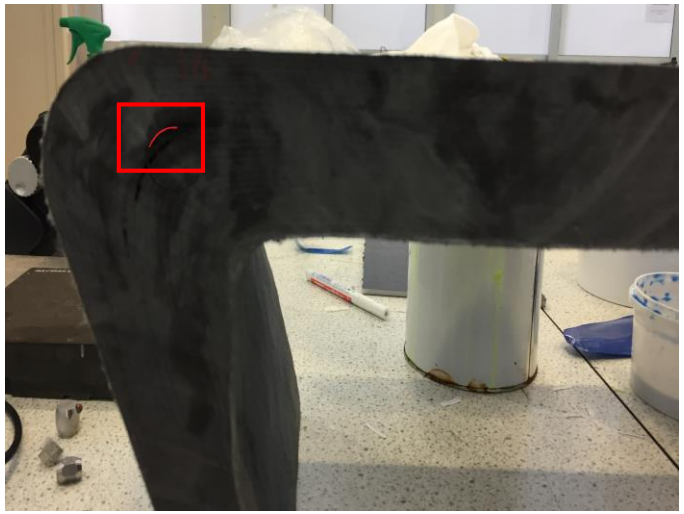

Image supplied by Ultrasonic Sciences Ltd

# How can NCC Help – with Blade integrity assurance?

- **NDT Inspections of composite materials, structures and assemblies**
  - During manufacture,
  - In-service
  - During structural testing
- **Develop, adapt NDT methods and techniques to suit particular inspection application or challenge**
  - Feasibility studies to determine the most suitable method to inspect a particular material/geometry, and validation of trial results
  - Development of inspections for components with complex geometry and novel manufacturing techniques in glass, carbon and hybrid materials
  - Automation of inspection techniques/methods
  - Correlation and validation of data obtained from different inspection methods

# Case Study – Ultrasonic inspection of thick carbon fibre structures

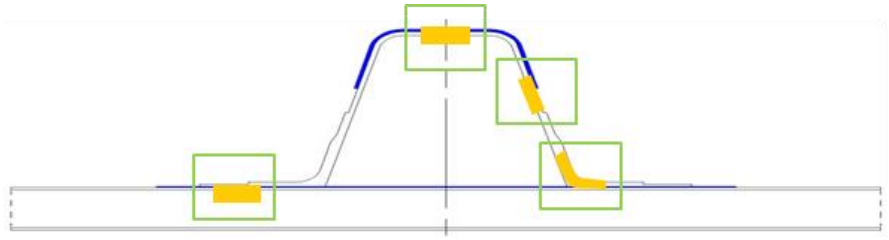



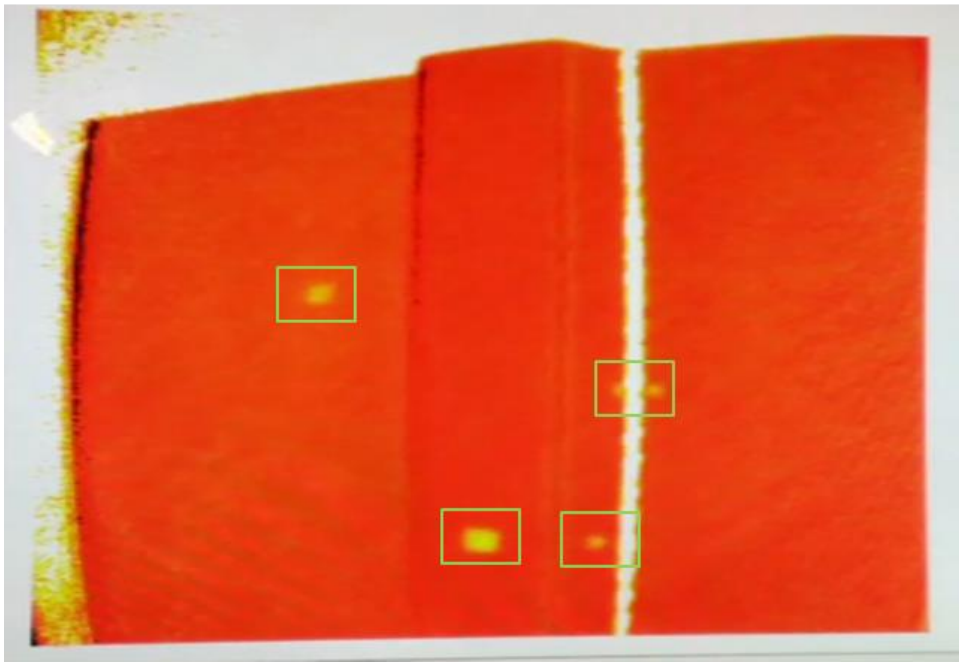



Thick sections with complex geometries and high levels of porosity offer significant challenges for inspection.
A range of Ultrasonic techniques were employed, with Phased-Array linear scanning giving the most promising detection of porosity, delamination and voids.
X-ray CT was used to validate ultrasonic results

Further development:
Optimisation of PAUT inspection with special probes, and future automation of process

# Case Study – Tailored use of Thermography for fast and cost effective defect detection





1-shot, 5 seconds. 4 defects detected, inspection area 500mm x 500mm approx.

The increase in use of composites for large primary structures with complex geometries and varying thicknesses requires the use of tailored NDT techniques.
Whilst ultrasonic inspection may provide detailed information, the automotive industry required faster and more cost effective defect detection.
This work optimized the thermography inspection for the detection of surface and sub-surface flaws, fibre bridging and voids for large irregular components with complex geometries and thin sections.

The impact of this is a tailored thermography inspection technique for fast and cost effective defect detection suitable for implementation in an automotive environment for example – and can be read across to other sectors with similar inspection requirements

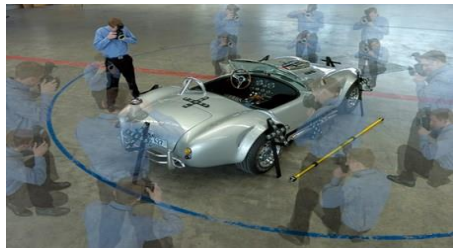
# Moving away from NDT – Metrology for blade integrity assurance

## Photogrammetry

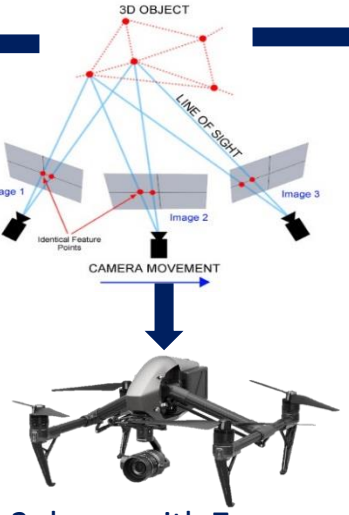
The science of making measurements from photographs.

### Close range photogrammetry

Typical accuracy 0.03 mm



NCC's Tritop photogrammetry system



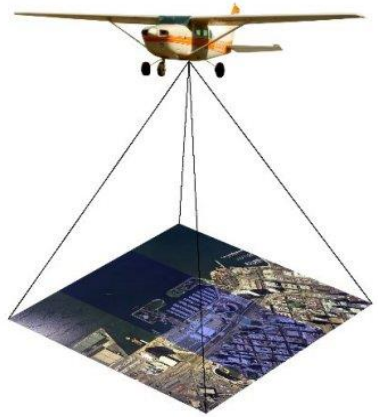

NCC's Inspire 2 drone with Zenmuse X7 camera

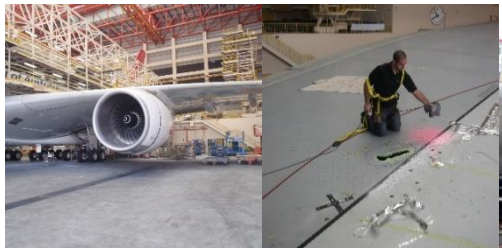
**NCC drone photogrammetry**

High accuracy for large scale inspection

### Aerial photogrammetry

Typical accuracy 30 mm



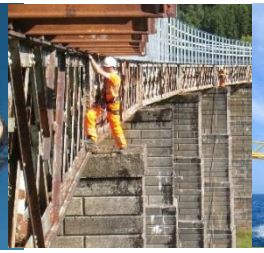


Aircraft Wing Inspection

Shipbuilding

Wind Turbine Inspection & Testing

Satellite Inspection



Structural Health Monitoring

Oil & Gas Industry

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# Drone-based Metrology

- Drone based Metrology and Remote Visual Inspection incorporating AI for defect recognition, in partnership with third party for automatic feature recognition and logging

## Future work to develop NCC Drone capability

- Indoor autonomous drone flight inspection.
- Image analysis for damage and defects.
- Live image quality feedback.
- Aerial photogrammetry – making low accuracy measurements without need for photogrammetry targets.
- Combination with other techniques (e.g. thermal imaging).

# Training

- **NDT**
  - Appreciation of NDT of Composites – aimed at composite engineers with limited knowledge or understanding of NDT methods and techniques
- **Composite Manufacture**
  - Introduction to Composites
  - Introduction to Manual Prepreg Techniques
  - Introduction to Resin Infusion Techniques
  - Resin Transfer Moulding
- **Courses under development**
  - Sustainability
  - Concept design
  - Modelling
  - Design for manufacture
  - Design for Automated Layup
  - In-Process Testing
  - Process Control
  - Material Characterisation

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