BINDT/RCNDE Workshop on NDT & SHM Requirements for Wind Turbines
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Requirements for Wind Turbines

Welcome and Introduction

Prof. Robert Smith, University of Bristol
Director of RCNDE and BINDT Past President
Health and Safety etc

• Tony Fong, ORE Catapult
Welcome and introduction

- BINDT Workshops on NDT Requirements
  - Regulators, insurers, operators, manufacturers and NDT community.
  - Follows four previous NDT requirements workshops:
Session 1 – Understanding the industry Part 1
11.15 Coffee/tea
Session 1 – Understanding the industry Part 2
12:45 LUNCH
Session 2 – Design, failure modes and effect of defects
15:10 Tea/coffee
Session 3 – NDT/SHM/CM experiences from the field Part 1
16:30 CLOSE
Session 3 – NDT/SHM/CM experiences from the field Part 2

10.30 Coffee/tea

Tour of Blyth Wind Turbine Demonstrator

12:30 LUNCH

Session 4 – Potential future NDT and SHM improvements

Session 5 – Breakout session (4 groups of ~10, 15-minute rotation)

15:15 Tea/coffee

Session 6 – Panel session

16:30 END of WORKSHOP
UK Composites Strategy 2016

UK Composites – Market Opportunities

2015 Baseline
- AEROSPACE: £273m
- DEFENCE: £383m
- AUTOMOTIVE: £380m
- RAIL: £55m
- CONSTRUCTION: £362m
- MARINE: £220m
- OIL & GAS: £15m
- RENEWABLES: £601m
- UK Total: £2.29bn

2020 Forecast
- AEROSPACE: £1,155m (33%)
- DEFENCE: £952m (16%)
- AUTOMOTIVE: £530m (4%)
- RAIL: £98m (10%)
- CONSTRUCTION: £640m (14%)
- MARINE: £270m (3%)
- OIL & GAS: £337m (68%)
- RENEWABLES: £685m (3%)
- UK Total: £4.67bn (15.32%)

2030 Opportunity
- AEROSPACE: £3,590m (17%)
- DEFENCE: £1,146m (7%)
- AUTOMOTIVE: £4,900m (15%)
- RAIL: £155m (7%)
- CONSTRUCTION: £1,520m (8%)
- MARINE: £370m (3%)
- OIL & GAS: £1,100m (31%)
- RENEWABLES: £1,100m (4%)
- UK Total: £12.48bn (11.97%)

2015 Baseline
- AUTOMOTIVE: £380m
- CONSTRUCTION: £362m
- MARINE: £220m
- OIL & GAS: £15m
- RENEWABLES: £601m
- UK Total: £2.29bn
CLF Strategy Delivery

UK Composites Strategy 2016

Cluster Groups

<table>
<thead>
<tr>
<th>Cluster Groups</th>
<th>Working Groups</th>
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<tr>
<td>Affordable Composites</td>
<td>Develop: Technologies and supply chains to capture immediate market opportunities.</td>
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<tr>
<td>Large Structures</td>
<td>Diversify: Enable UK industry to take advantage of increased use of composites in other sectors.</td>
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UK Supply Chain Manufacturing Clusters and Products

- Low volume, high performance
  - Nacelles, Single Aisle Wings, Wide Body Wings
  - Land Systems, Military Aircraft, UAVs
  - Motorsport

- High volume, high performance
  - Engine Blades, Brackets, Propellers, Rotors
  - Weapons
  - Spoolable Pipes

- High volume, low cost, semi structural
  - Interiors
  - Components, High Volume
  - Interiors
  - Fittings, Pipes / Systems

- Mid volume, Structural
  - Medium Volume, Luxury Vehicles, Bus
  - Leisure Furniture, Garden, Vehicles / Modules
  - Cabin Modules, Leisure Craft
  - Equipment, Pressure Vessels
  - Wind Blowers, Nacelles, Marine Turbines
  - Naval Vessels
  - Platforms Systems, Trackbed

Current Sales
Potential £2,290m
Growth to 2030 of £10,200m

Ultrasonics and NDT Group
<table>
<thead>
<tr>
<th>Breakout stations: 15 minutes at each</th>
<th>Leader</th>
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<tbody>
<tr>
<td>1. Requirements for manufacturers</td>
<td>Peter Thayer, RCNDE</td>
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<td>2. In-service requirements for composite blades</td>
<td>Tony Fong, ORE Catapult</td>
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<tr>
<td>3. In-service requirements for non-blade structures</td>
<td>Colin Brett, Uniper</td>
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<td>4. Potential for new NDT, CM and SHM.</td>
<td>Richard Freemantle, Wavelength NDT</td>
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• NDT to life prediction transfer function
  • Operational data too

• Design/cert – unknown unknowns affect design
  – could benefit from better information
  • Benefit taken in reduced weigh
  • Assumptions being made about NDT capability

• Wrinkles –
  • if know curvature can predict strength using FE model
  • Need to characterise wrinkles
• Insufficient to look at surface effect.
• Automated screening. – time crucial.
• Remove delay on as many blades as possible.
• Short delay is costly. Worth having better NDT.
• Needing operator input causes delays
• Sensors during manufacture eg Bragg gratings has been tried but could be developed
• Data, machine learning, processing, AI.
  • Filtering data to present relevant info – what is relevant to end user?
• Practicalities of NDT equipment, deployment, logistics.
  • Automated/robotic deployment
  • CM/SHM offers benefits over NDT in-service.
  • Targeted
  • GW.

• Data
  • Identify important specific data
  • Failure modes – need to understand these to know what to monitor
• Identify inspection locations and rank them, defect types.
  • Designers to take on board and specify this.
  • Design to feed through to in-service requirements.

• How to measure – what parameters?
  • Establish correlation between parameters and knock-down.
  • May be material dependent, as is the NDT!

• Damage tolerant design.
  • Monitoring and analysis of flawed state – inspection intervals
  • Design – what tolerance is built in?
• Blade repairs
  • Return to service
  • Best practice guidance