NATIONAL COMPOSITES CENTRE

Welcome to the Technology Pull-Through Launch Webinar

We will start shortly after 09.30

9 October 2024

Agenda

09.30	Welcome and introduction to the NCC	Giuseppe Dell'Anno
09.35	Introduction to TPT and the TPT process	Roger Walker
09.45	Our **Materials & Sustainability** Strategy	Tim Young
09.50	Our **Hydrogen** Strategy	Matt Scott (rep. Marcus Wall-Bruck)
09.55	Our **Digital & AI** Strategy	Stephen McCartney / Amit Visrolia
10.00	Our **Defence** Strategy	Konstantina Kanari
10.05	Conclusions, questions and thanks	Giuseppe Dell'Anno
10.30	Finish	-

NATIONAL COMPOSITES CENTRE

Brief introduction to the National Composites Centre

Giuseppe Dell'Anno NCC Academic Liaison

9 October 2024

High Value Manufacturing Catapult

CATAPULT
High Value Manufacturing

7
centres

17
locations

27
technologies

3500+
people

£800m
assets

Over 2000
projects per year

1/3
government funded

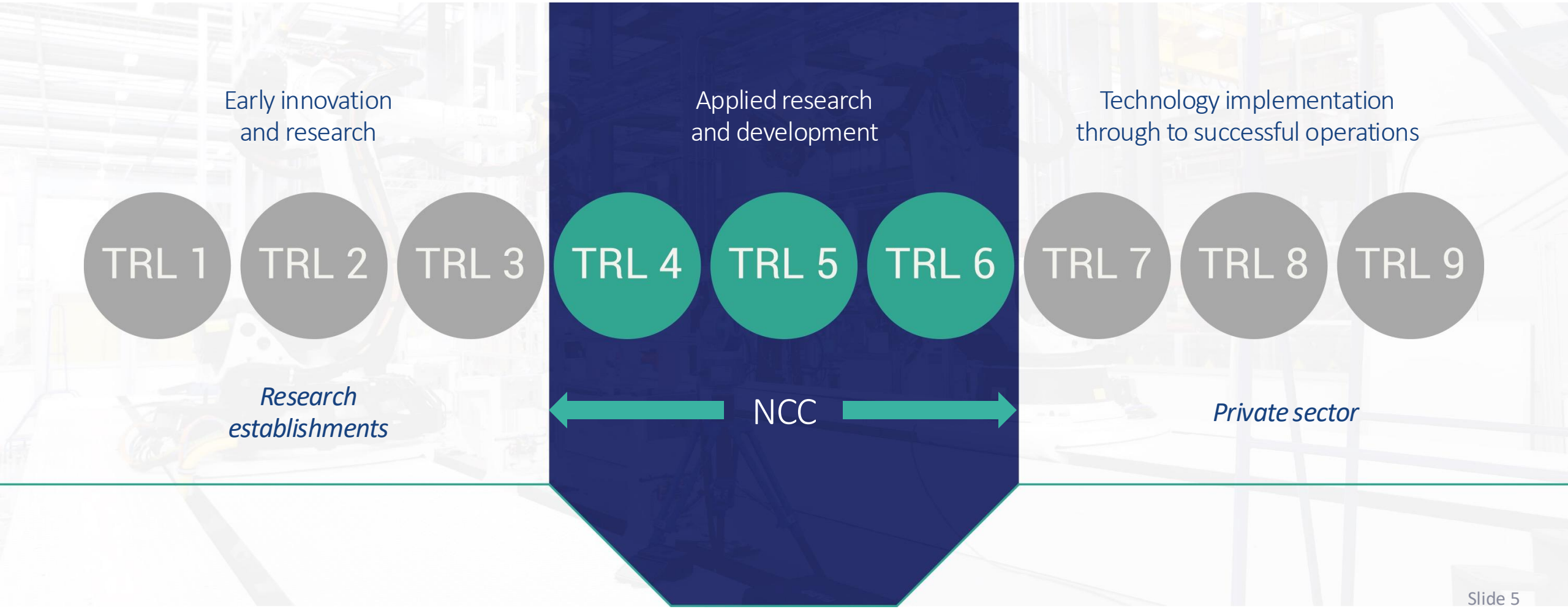
2/3
industry funded

£500m
industry R&D linked to HVMC per year

1. AFRC – Advanced Forming Research Centre, University of Strathclyde
2. cpi
3. Nuclear AMRC
4. AMRC – Advanced Manufacturing Research Centre
5. mtc – Manufacturing Technology Centre
6. WMG – The University of Warwick
7. National Composites Centre

Image courtesy of the Earth Science and Remote Sensing Unit, NASA Johnson Space Center

Catapult Mission: Bridging the Valley of Death



The National Composites Centre

Vision

A pioneer of industrial transformation, delivering innovations to create a sustainable, productive, and resilient future

Mission

Transforming industry through collaborative innovation and accelerating its adoption

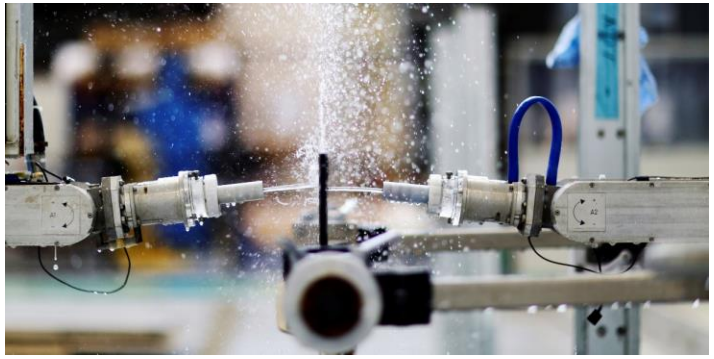
£200m
invested in capabilities

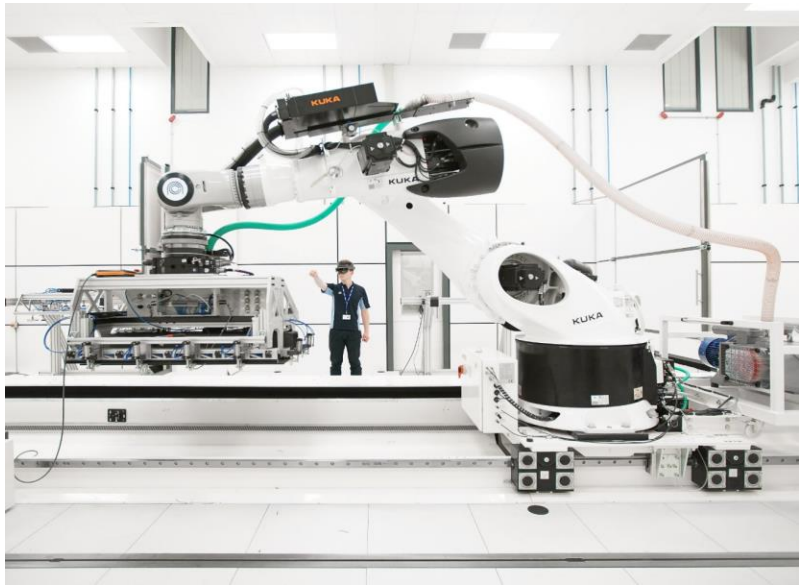
700+
organisations supported

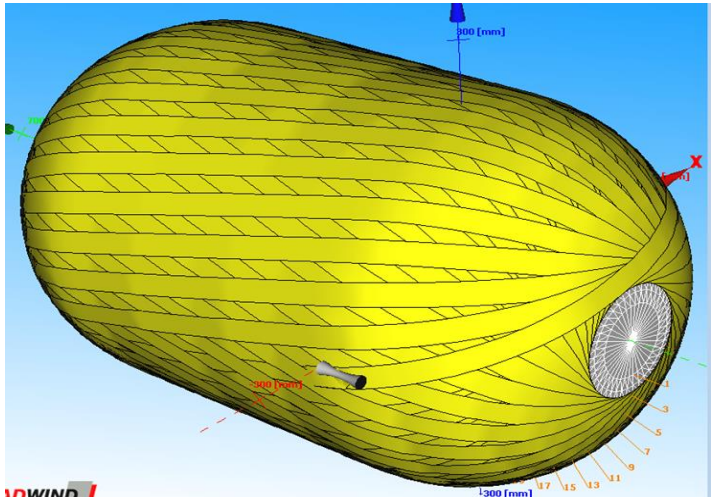
600+
composites specialists

60+
university partners

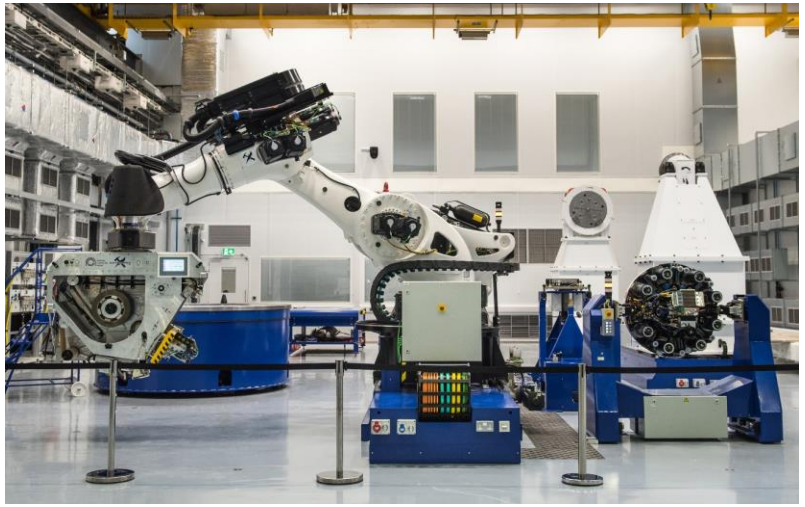
Capabilities

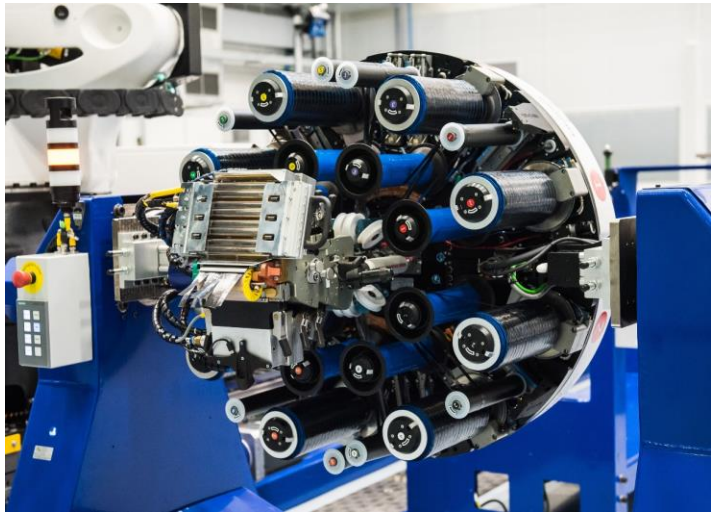






Europe’s leading composite innovation centre





NATIONAL COMPOSITES CENTRE

NCC Technology Pull-Through Programme: Transitional Research in Action

Roger Walker Technology Programme Manager

9 October 2024

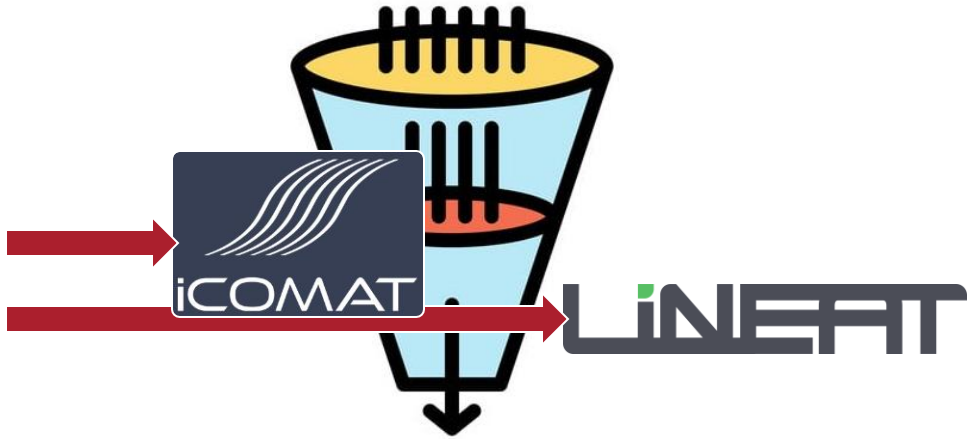
Technology Pull-Through: What is it?

- A technology development programme to stimulate the transition of suitably mature technologies to industry
- Scope is technologies and methods ready to leave the lab environment (TRL3-4)
- Projects are 12 months long, are funded and managed by the NCC, and conducted primarily by NCC
- Background IP stays with the source universities, foreground IP is shared*

*Foreground IP is owned by the NCC, with a perpetual and irrevocable license to the academic partner for teaching and research purposes. Commercial exploitation of the foreground IP is agreed on a case-by-case basis to reach a fair share of benefits between the parties.

Technology Pull-Through: History

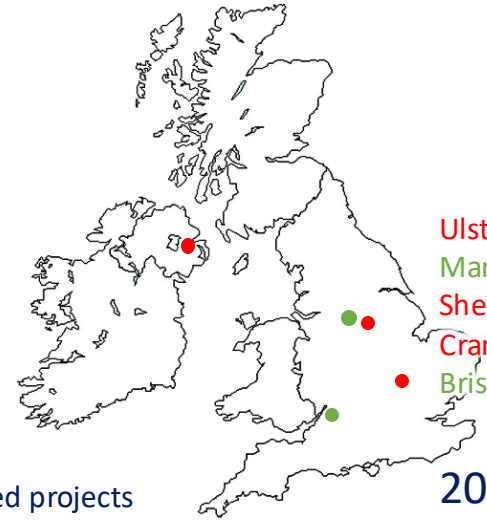
- First programme launched in 2017
- 23+ technologies matured – including:
  - Continuous Tow Shearing
  - HiPerDif
  - SimpleCure
  - Dielectric sensors
  - Dismantlable joints
  - Bio-derived thermoplastics



Down-selection process includes CIMCOMP KEC

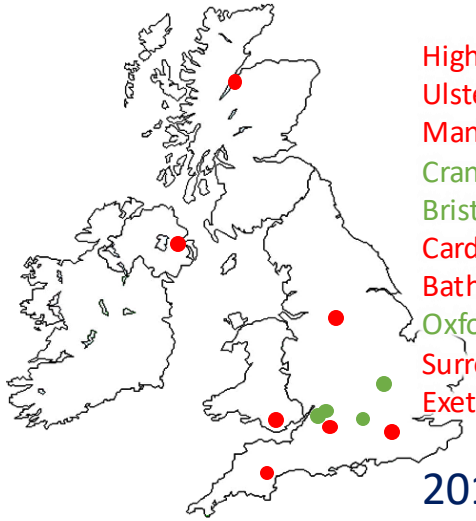
~£2.2m total invested in upcoming technologies over last 5 years

Geographic Spread



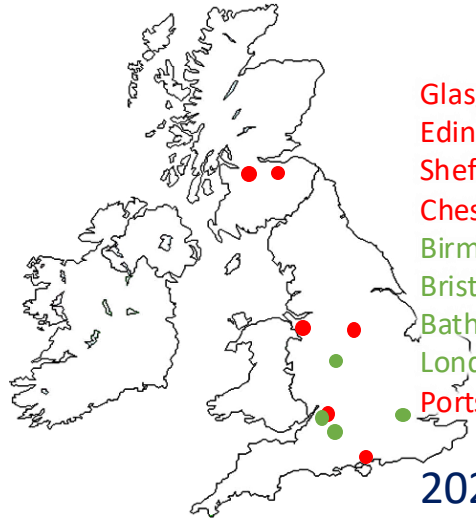
Ulster
Manchester
Sheffield
Cranfield
Bristol (UoB)

2018-19



Highlands
Ulster
Manchester
Cranfield
Bristol (UoB, UWE)
Cardiff
Bath
Oxford
Surrey
Exeter

2019-20



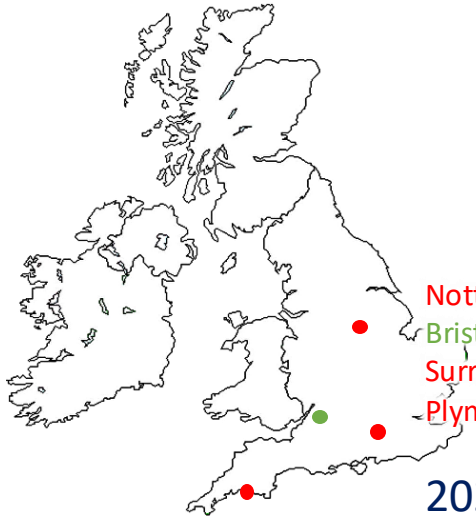
Glasgow
Edinburgh
Sheffield
Chester
Birmingham
Bristol (UoB, UWE)
Bath
London (UCL)
Portsmouth

2021-22

- Launched projects
- Applications received

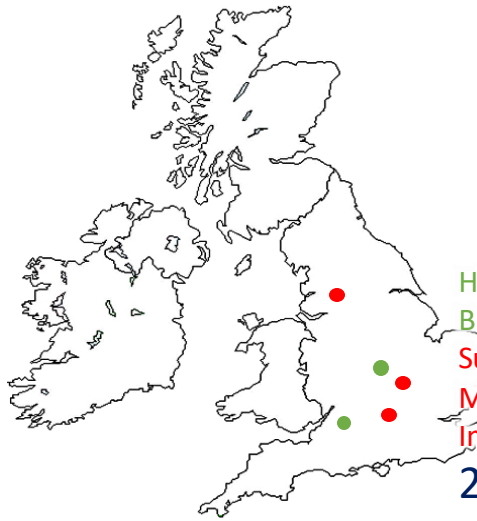
Liverpool
Nottingham
Birmingham
Bristol (UoB, UWE)
London (UCL)
Portsmouth
Exeter

2022-23



Nottingham
Bristol (UoB)
Surrey
Plymouth

2023-24



Hertfordshire
Bristol (UoB)
Surrey
Manchester
Imperial

2024-25

This year: Technology Pull-Through **2024-25**

- Two TPT projects kicked off for 2024-25
- Both directly aligned with NCC composites strategy

MARKET PULL

TECHNOLOGY PUSH

Market drivers

Sector trends

Sector platforms

Enabling products

Technology challenges

Technology themes

Technologies

NCC's current
Technology Challenge THEMES

Materials & Sustainability

Composites for Net Zero

Digital & AI

Defence

InVIsion Carbon - Inductive sensing for Value-added Inspection of Carbon-Fibre Manufacturing

- ✓ Dr Robert Hughes @ University of Bristol working alongside Dr Per Saunders @ NCC/(UoBris)
- ✓ Deploy in-line Eddy Current testing (ECT) in two realistic carbon-fibre manufacturing environments at the NCC
- ✓ Tackles the problem of handling variety and complexity associated with different carbon-fibre components and manufacturing processes
- ✓ Enables in-process non-destructive inspection for sub-surface defects and manufacturing flaws

University of BRISTOL

Compression moulded ceramic BMC

Sustainability

- ✓ Dr Guogang Ren @ University of Hertfordshire and Prof Paul Hogg @ Avalon Consultancy Services
- ✓ Ceramic mouldable composite solution for a temperature between 350-1100 degrees Celsius
- ✓ Reduced cost of manufacturing
- ✓ Fast production with complicated shapes or curvatures
- ✓ Solve essential issues such as mould/tooling release, release agent/film, and post curing

University of Hertfordshire

Technology Pull-Through **2025-26**

- Next year's programme will CONTINUE with new academic proposals

- Selection criteria will include:
  - ✓ Technology Readiness Level (3-4)
  - ✓ Alignment with Technology Challenge Themes
  - ✓ Viability and impact for future industrial application
  - ✓ Intellectual Property and freedom to operate

* Materials & Sustainability
- Digitalisation & AI
- Defence
- Composites for Net-Zero

Technology Pull-Through **2025-26**

- Application process starts today – Wednesday, 9th October 2025
- Expression of Interest form will be circulated from today
- Key dates
  - **08 November** – Expression of Interest submission deadline
  - **29 November** – Full application opens
  - **31 January** – Full application submission deadline
  - **28 February** – Projects selection completed
  - **Aril 2025** – Projects start

NATIONAL COMPOSITES CENTRE

NCC Materials & Sustainability Outlook

Tim Young NCC Chief Technologist: Materials

Materials & Sustainability

9 October 2024

Advanced Materials and Sustainability focus areas at NCC

Challenge: Imported, insecure and high GWP material supply for UK Manufactured products

Vision: Domestic sovereign advanced materials and technology capabilities supplying a global market

Ceramic Matrix Composites

Carbon Fibre

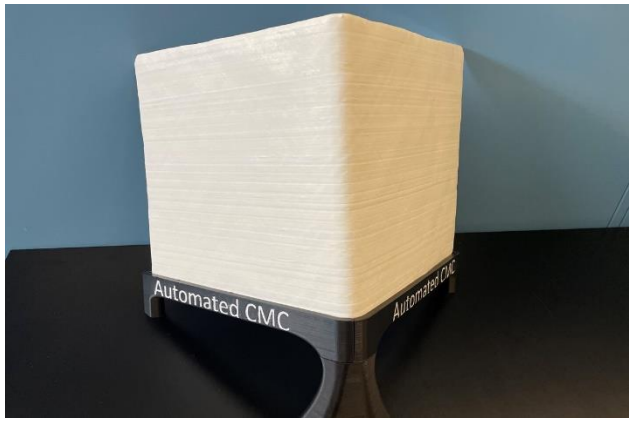
Circular Supply Chains

System Level LCA and Carbon Accounting

CMCs: Oxide *facilitating mass adoption*

Current Status

- ✓ Developed TRL 6 manual process, tested at ground-based test demonstrator to 1100°C
- ✓ Materials have been qualified in aero sector
- ✓ Automation at TRL 3-4
- × No Supply Chain in the UK



Technology Challenge

- × Cost reduction (3x too expensive)
- × Development and incorporation of novel oxide materials (including test, characterisation, modelling)
- × Joining technologies CMC-CMC & CMC-Other

Targets

2021: 1m sq aero demonstrator

2023: Oxide part exceeds Ground Based Test aero requirements

2026: Cost reduction to allow commercialisation in aerospace

2030: Cost effective prototypes for defence sector

2033: Cost effective, mass adoption across defence & energy sector

CMCs: Non-Oxide *developing sovereign next gen materials*

Current Status

- ✓ Novel materials able to withstand 2500°C – polymer injection based manufacture
- ✓ Sharp edge and thick demos

Some ideas from this work:

- Transpiration cooling
- Melt infiltration manufacture
- High temperature testing (+1200C)
- Joining

Current Capability Gap

What haven't we done this year that leaves a capability gap?

- × Improve mechanical properties
- × Component scale manufacture
- × Joining
- × Aerothermal modelling
- × Alternative manufacturing routes to those based on polymer injection

Targets

2016: CMC capability created

2023: HASTE process established

2024: CapDev Small demos

2025: In-house non-oxide furnace

2027: Secure facility

2028: Large scale demonstrators

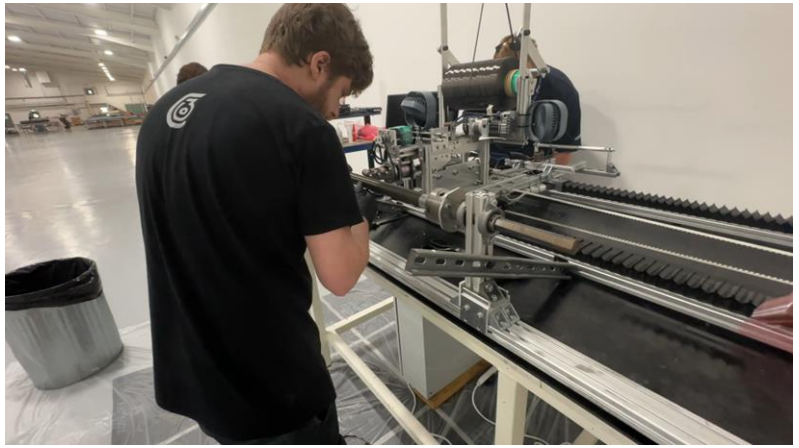
2030: Hypersonic and fusion prototypes

2040: Adoption by defence sector

Carbon Fibre: Net Zero, Defossilised, performance fibre

Current Status

- ✓ NCC pilot line in progress
- ✓ UK related Academic Research & nano-lines in operation
- × No Supply Chain in the UK



Technology Challenge

- × PAN & precursor production
- × Verification/validation e.g. Filament to Tow representative test & scalable models
- × Digital Twin & LCA of processes
- × Novel process improvements (e.g. safer, chemicals, decreased temperatures, efficiencies)

Targets

2024: Process Mapping & Partnership development

2026: Pilot Line operational

2027: CF produced @ 5kg/week competitive Performance & representative cost

2030: TRL 5 defossilised, net zero fibre meeting performance target for wind/aero @ cost

Circular Supply Chains

Current Status

- ✓ X-Sector Circularity: Build the evidence case & demand
- ✓ Technology Incubation & development
  - ✓ Continuous fibre: testing at coupon scale “like-for-like”
  - ✓ Tow inspection capability for rapid defect detection
  - ✓ Matrix valorisation mapping for production of r-chemicals
  - ✓ Consumable waste programme showing promise

Technology Challenge

- × Tools/methods for analysing EOL
- × Enablers that support product concepts from recyclate
  - × Consumable/plastics
- × Reducing energy consumption/GWP or cost of reclamation processes
- × Testing methods
- × Splicing & Joining tow’s

Targets

2020: Sustainable Composites, SusWIND, Core & Catapult programmes launched

2025: Continuous Carbon Fibre process developed & QA determined

2026: X-sector circularity & supply chain case

2030: “Low GWP” circularity pilot plants established delivering routes for new materials/chemicals from complex waste

System Level LCA and Carbon Accounting

Current Status

- ✓ LCA is still manual / very user dependant
- ✓ Frameworks/national networks in (HVMC, LCARSIN)
- ✓ Skills still not embedded across training platforms
- ✓ Continually increasing demand & complexity for LCA

Technology Challenge

- × Training platforms, tools
- × Data & consistency
- × Tools to reduce complexity / cost for scenario planning & early design
- × Predictive / digital tools

Key Milestones

2020: Training, Tools and Data

2027: CBAM launch

2034: CBAM is fully rolled out

Irrespective of EU or UK CBAM… need to make LCA cost effective & trusted to fully embed from predictive design to certification

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Composites for Net Zero

Composites for Net Zero

Matt Scott NCC Chief Technologist: Strategy *Rep. Marcus Walls-Bruck*

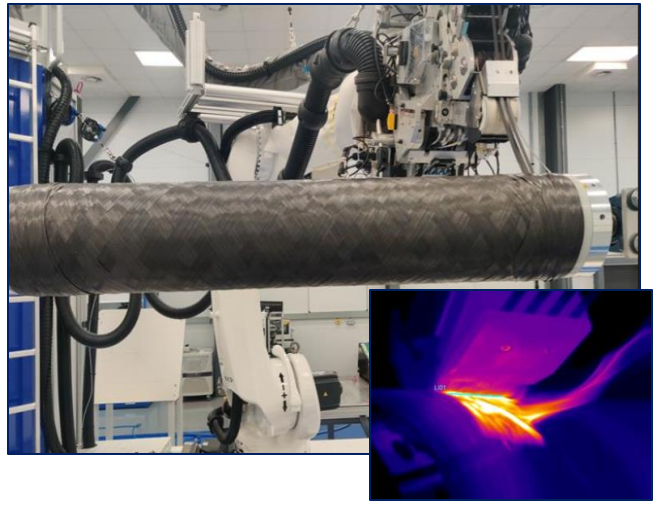
9 October 2024

Hydrogen focus areas at NCC

Pressure vessels

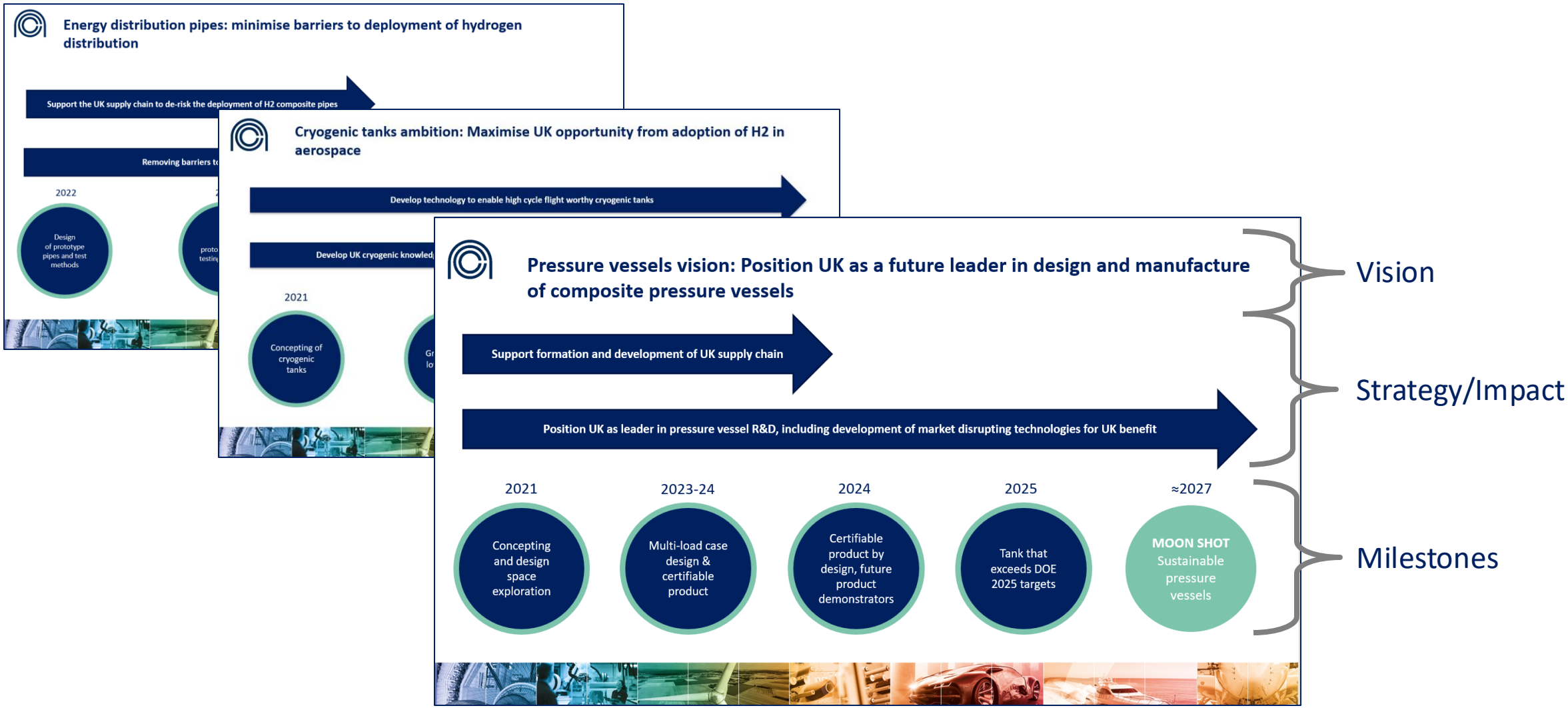
Cryogenic tanks

Distribution pipes

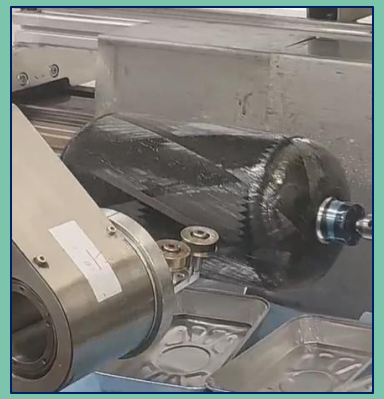


Today's focus

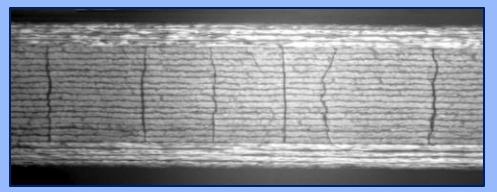
Multi-year strategy for each of the three priority products



Developing capability to deliver strategy




Pressure vessels: TECHNOLOGY GAPS

2021	2024-25	2027	2027	≈2030
Concepting and design space exploration	Multi-load case design & certifiable product	Certifiable product by design, ~~future product demonstrators~~	Tank that exceeds DOE targets	**MOON SHOT** Sustainable pressure vessels

Challenge 1: Polymeric liners – process modelling

During pressure vessel manufacture the liner undergoes a series of processing steps. It is moulded, then acts as the mandrel for the filament winding process before being place in an oven for composite cure, and then plays a vital role in tank performance. ***Understanding the impact of processing conditions on in-service performance is key and currently not fully understood.***

Challenge 2: Modelling damage growth and fatigue life

Efficient design of pressure vessels must capture the as manufactured state and be able to accurately represent damage initiation and accumulation, currently not considered in commercially available tools. ***Accurately predicting the geometry / build-up of the as manufactured tank and prediction of damage growth is key to optimise tank design.***

Cryogenic tanks: TECHNOLOGY GAPS

2021	2023	2025	≈2030
Concepting of cryogenic tanks	Ground tested low cycle tank	Flight worthy low cycle tank	Flight worthy high cycle tank

Challenge 3: Micro-crack tolerant / resistant materials

Current materials suffer from micro-cracking when mechanically cycled or thermally cycled to cryogenic temperatures. Growth or accumulation of these microcracks into networks can result in leakages. ***Materials that can either prevent crack initiation or growth are required.***

Challenge 4: Materials with reduced permeability

Loss of hydrogen through tanks walls can have numerous impacts on storage tank performance (i.e. loss of insulation properties when using vacuum insulation). ***Materials or suitable coatings to reduce permeability properties across ambient and cryogenic temperatures are required.***

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NCC Digital Outlook

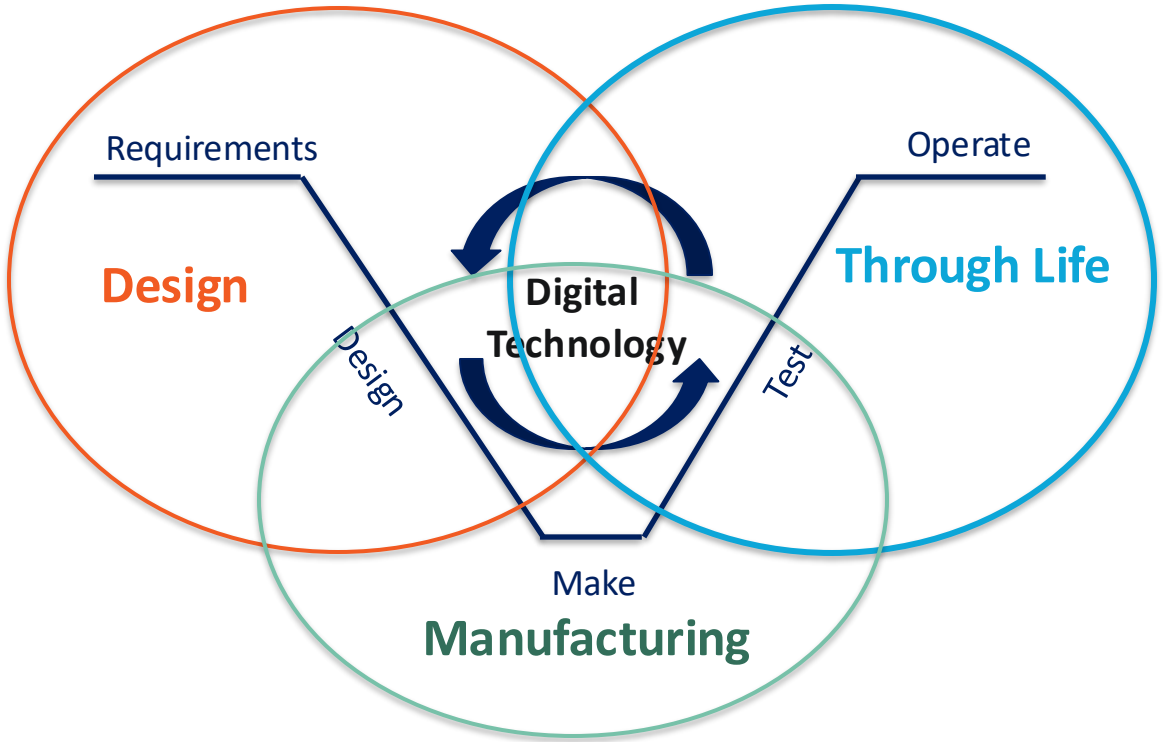
Marc Funnell NCC Head of Digital

Digital & AI

9 October 2024

Digital Engineering @ NCC

Exploiting digital Technology to transform the Product Life Cycle



Developing Digital People
Establishing Digitally enabled Ways of Working
Pulling through and Integrating Digital Technology

DIGITAL ENGINEERING TECHNOLOGY & INNOVATION

Phase 1 Completed

https://www.nccuk.com/what-we-do/digital/deti/

5G-encode

Testbed and Trails Completed

https://www.5g-encode.com/

MADE SMARTER WEST OF ENGLAND

https://www.westofengland-ca.gov.uk/growth-hub/technology-innovation/made-smarter/

Digitalisation of Design

Amit Visrolia

Accelerating Design and Certification cycles of product development across distributed supply chain

Model Based Enterprise

Techniques enabling system agnostic CAD-CAM-Shopfloor Automation and x Supplier Traceability

Concurrent Design Systems

Enabling collaborative Multi Disciplinary simulations and design decisions across supply chains

Certification by Analysis

Building trust in CAE, mathematics and data science to reduce physical testing requirements (Material – System)

Generative AI

What can Chat GPT and other generative tools do for knowledge management and rapid concepting

Digitalisation of Manufacturing

Jonathan Butt and Stephen McCartney

Reducing waste and cost of operation (striving for right every time manufacture)

Self-Adaptive Manufacturing

Exploiting AI for real time process control with defect detection Automation where appropriate

IIOT and Connectivity

IT Solutions to make your shopfloor smarter
Sensors and Dashboards enabling LEAN processes

Augmented Operations

Guided Instructions and In-Process Inspection techniques enhancing workforce capability

Waste Management

Asset Tracking and energy monitoring for Scope 1,2
Product Carbon Accounting and waste recycling

Digitalisation Through Life

Marc Funnell and Stephen McCartney

Extending operation lifespans, safety of critical assets and cost of through life operation

Structural Heath and Usage Monitoring

Twinning and Data insights to enable predictive maintenance and relifing of critical assets in service

Augmented In-Field Servicing

Remote Expert Helper, Guided Instructions and automated inspection enhancing maintenance

Through Life Passports

Standards, pedigree and traceability circulatory, end of life and scope 3 assessments

Specific Areas of Interest

- Human augmentation, visual (in- and post-process verification), audial (voice control) and physical — there are good examples of exo-skeletons that increase the strength of human operators, but not that significantly increase speed or dexterity
- Machine learning for manufacturing — general AI models for language, image generation etc. are becoming commonplace, but there hasn't been much progress on general AI for manufacturing. What should this look like, what kind of QHSE and ethical controls should be built in. Especially critical too for limited data sets.
- AI LLMs for Engineering Knowledge Management
- OT cyber-security of IoT devices in factory Come and use our factory testbed to test new concepts and devices in the IoT and OT security space
- Manual dexterous task tracking and machine vision verification – hand tracking learning using AR headsets as opposed to laser line scanners, specific HD cameras and other in-process verification capabilities.
- Structural Health Monitoring or condition-based monitoring solutions of in-service products using embedded or other sensor solutions e.g. fibre optics as support for H2 — detection of cracking etc. in service and other safety considerations
- Bringing in attributes from supply chain and manufacture (e.g. manufacturing capability, energy usage and resilience) into the early design phases as part of the MDO solutions
- Model-based Systems Engineering, Integration platforms and digital thread techniques — keeping traceability from material development — Design Make, Test and following through life (via digital twin in operations) and through recycling reuse phases.

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NCC Defence & Space Outlook

Konstantina Kanari Advanced Research Engineer

Defence

9 October 2024

Defence – Roadmap and Strategy

- Technology Strategy for Composites in Defence for 2024/2025
  - Survavibility
  - High Temperature Applications
  - Extreme Environments

- Industry priorities
  1. Composites for extreme temperatures
  2. Fatigue and Ageing
  3. Fire, Smoke and Toxicity
  4. Marine environment
  5. Electromagnetic protection

‼ Any sovereign capabilities with a supply chain based in the UK

Defence – Capabilities and Needs

- Topics that we would like to see
  - Sovereign supply chain developments
  - Smart composites with multifunctional capabilities, adding features and conductivity to laminates and surfaces
  - High volume manufacture for airframe on fixed wing UAS
  - Engineering Biology solutions for smart composites or composites with increased fatigue/ageing
  - Composite materials for use in the marine environment
  - Materials and manufacturing technologies associated with reducing the effects of RF and Laser directed energy
  - Materials and manufacturing technologies associated with repeatable and low-cost manufacturing of ceramic matrix composites

NATIONAL COMPOSITES CENTRE

TPT: Summary and Conclusions

Giuseppe Dell'Anno NCC Academic Liaison

9 October 2024

So what?

- TPT stimulates the transition of suitably mature technologies from academia to industry
- This gives researchers the opportunity to show the IMPACT of their research (…REF)
- Prior work has shown that TPT gives promising technology the opportunity to progress
- Expressions of Interest opens today – 9th October 2024

Thank you – questions?

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