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UoS & Boeing - AMRC

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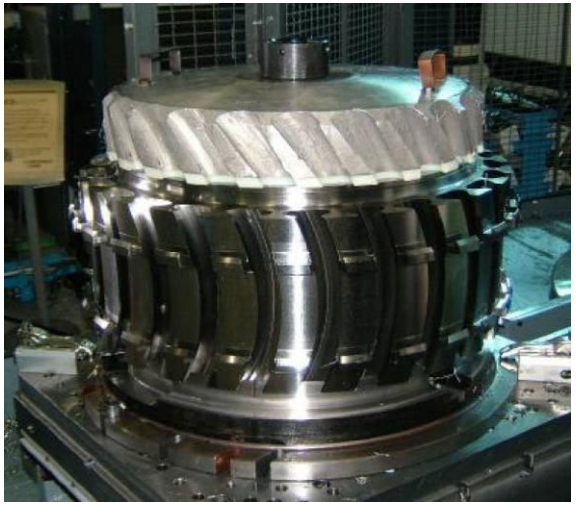
- The Advanced Manufacturing Research Centre was established in 2001
- Research and Development of new means, methodologies, tools and techniques to advance manufacturing technology



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AMRC – How we Operate

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Programme phase	MCRL	State of development
Phase 3 Production implementation	9	Fully production capable process qualified on full range of parts over extended period (all Business Case metrics achieved)
	8	Fully production capable (FAIR Stage 2) process qualified on full range of parts over significant run lengths
	7	Capability and rate confirmed (FAIR Stage 1 without concessions) via economic run lengths on production parts
Phase 2 Pre-production	6	Process optimised for capability and rate using production equipment
	5	Basic capability demonstrated using production equipment
Phase 1 Technology assessment and proving	4	Process validated in laboratory using representative development equipment
	3	Experimental proof of concept completed
	2	Applicability and validity of concept described and vetted, or demonstrated
	1	Process concept proposed with scientific foundation

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Figure 1: Technology Readiness Level

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AMRC Structure

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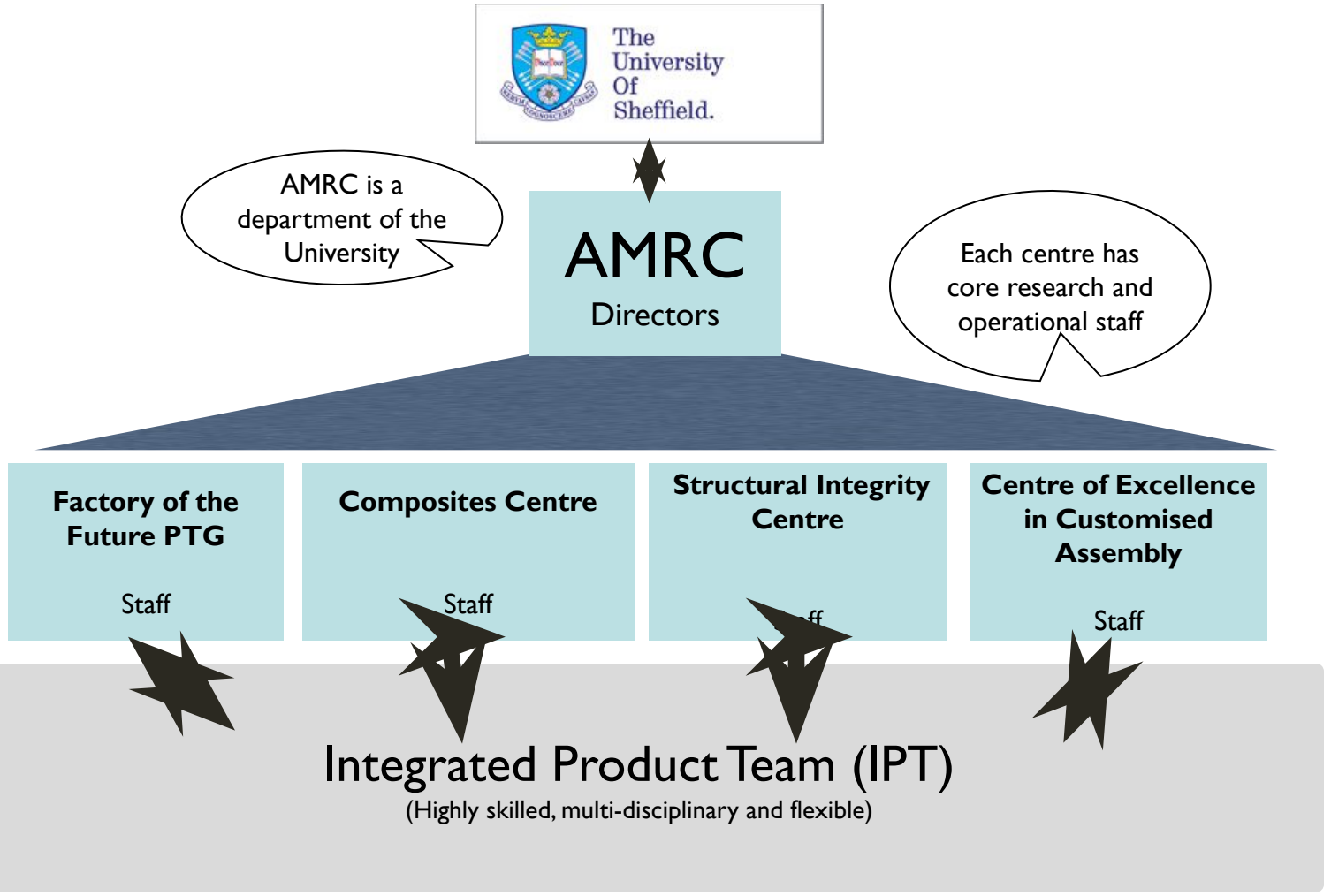

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BAE SYSTEMS
Messier-Dowty
SAFRAN Group
MORI SEIKI
THE MACHINE TOOL COMPANY
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the milling experts
ATS
CARPENTER
Weston EU
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ALCOA
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Accessing The AMRC

- Membership
  - Tier 1
  - Tier 2
    - IP Owned by AMRC for benefit of Members
- Collaboration
  - FP7, TSB, Other grant body
    - IP shared according to Collaboration agreement
- Commercial
  - Project based work
    - IP owned by the funder

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Funding

- **Source of Funds**
  - **Tier 1 Members £200,000 per Year**
  - **Tier 2 Members £30,000 per Year**
  - **Collaboration Programmes**
  - **Commercial Work**

- **Application Of Member Funds**
  - **1/3 Allocated to Generic Pool Projects**
  - **2/3 Available for Company Directed Generic Projects**

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Factory of the Future PTG

Rolls-Royce

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Materials Challenges

- Increasing use of difficult to cut materials
  - Composites
  - Titanium alloys
  - Heat resistant super alloys

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Case study: Titanium Fan Disk

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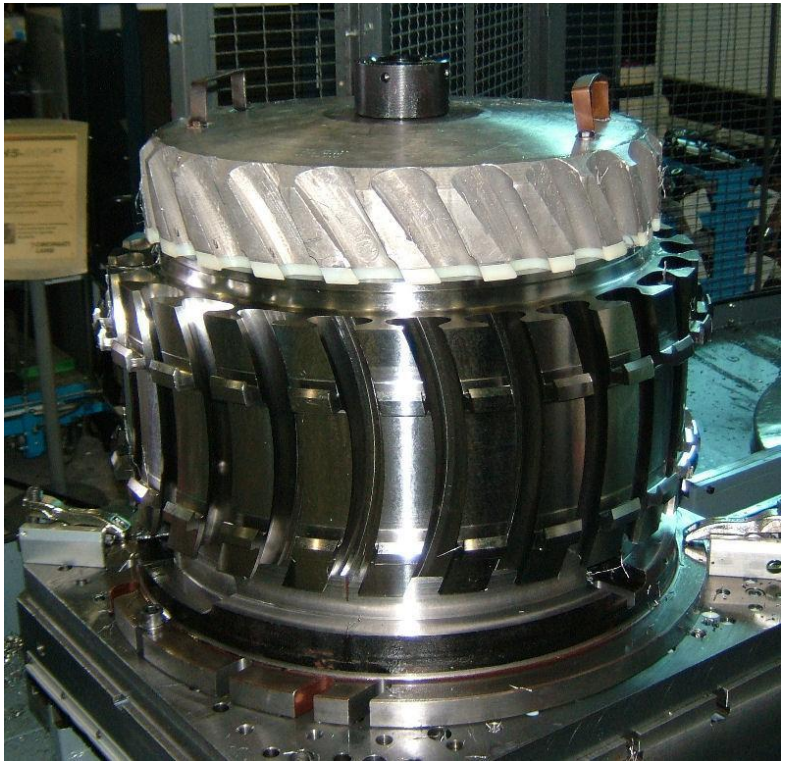
- Original
  - Time per slot = 54 mins
  - Time per disk = 26 hrs
- Target = 18 mins/slot
- Achieved
  - Time per slot = 1.5 mins
  - Time per disk <2 hrs



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Case study: Titanium Pintle

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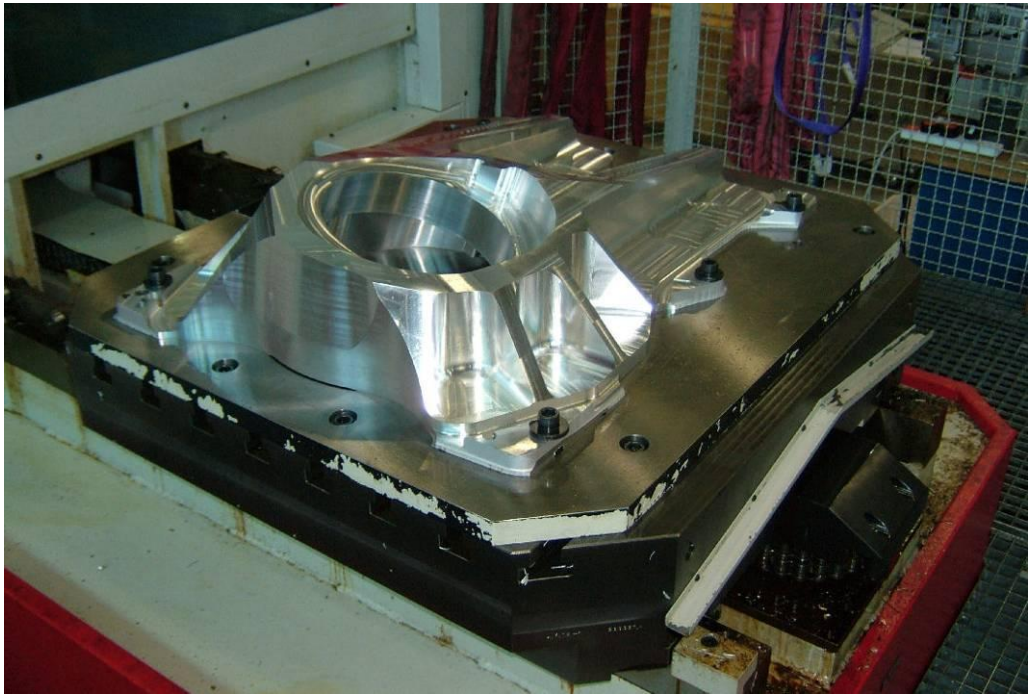
- Original
  - Time = 145 hrs
  - Target = 50 hrs
- Achieved
  - Time = 19 hrs



Titanium pintles manufactured for Airbus 380 Freighter

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Machine dynamics

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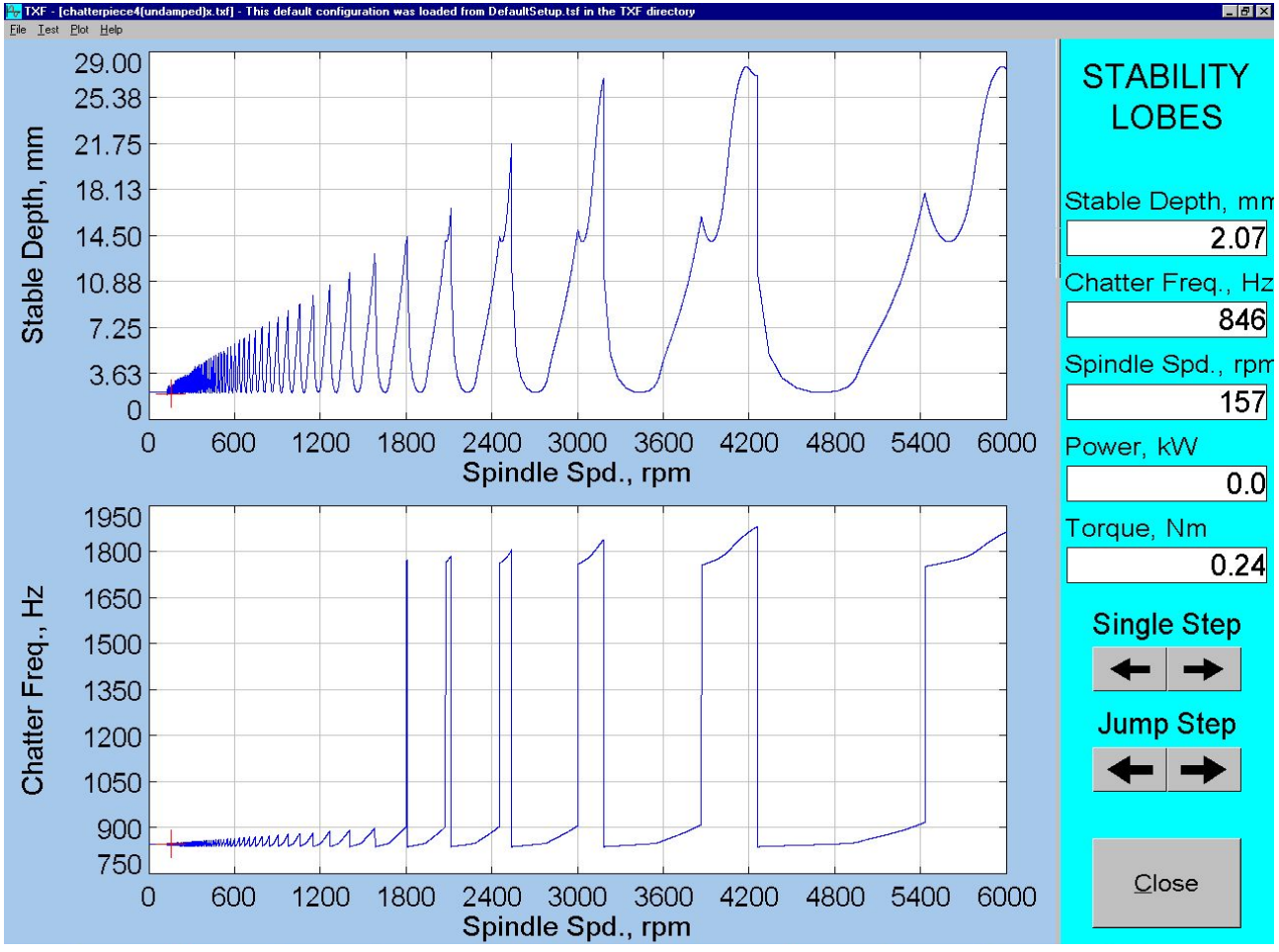

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Process Technology Projects

- Machining aluminum, titanium and nickel alloy components reducing time by a factor of 5. Typical products are engine casings, ribs, pintels, etc.
- Characterisation of coolants
- Design of cutting tools
- Design of new tool paths to improve metal removal
- Stability analysis
- High performance grinding
- Ceramic milling and turning

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University of Sheffield Structural Integrity Centre SIC

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Status

- UKAS accreditation for tension, compression and fatigue testing.
- Work Package 4 on Airbus Integrated Wing Project is ongoing. Static and Fatigue testing of components and assemblies manufactured by the AMRC and three other collaborating organisations.

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Capacity

- 2000 KN Tensile / Compression
- 1000 KN Tensile / Compression / Fatigue
- 250 KN Tensile / Compression / Fatigue
- 50 KN Tensile / Compression / Fatigue
- Custom build Capability
- UKAS Accreditation

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Centre of Excellence in Customised Assembly (CECA)

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Purpose

To develop a centre of Excellence in High value assembly

- High value manufacturing needs to remain in the UK
- Focus on low volume, high value products
- Complements The Composite Centre

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Developing expertise in high accuracy metrology, …

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… Large volume metrology, …

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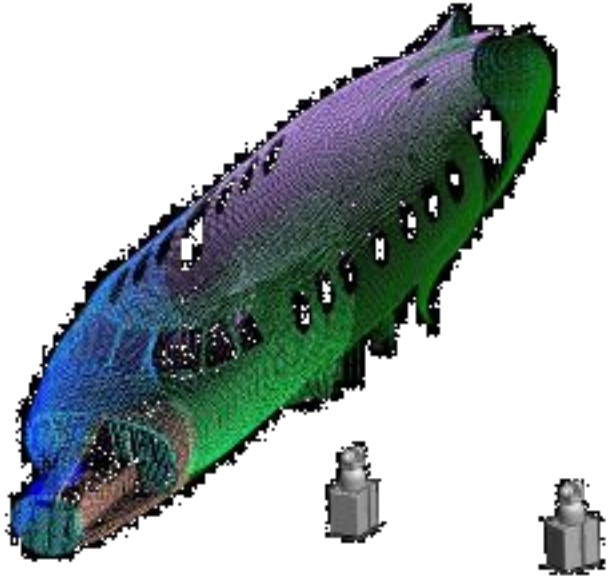

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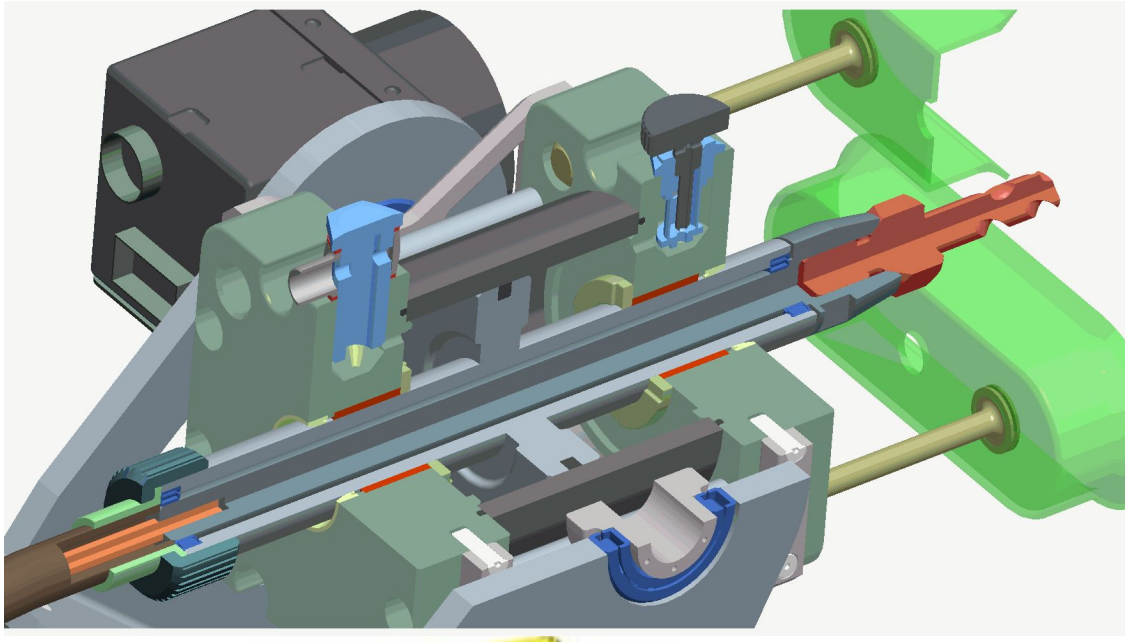
… Robotics and automation, …



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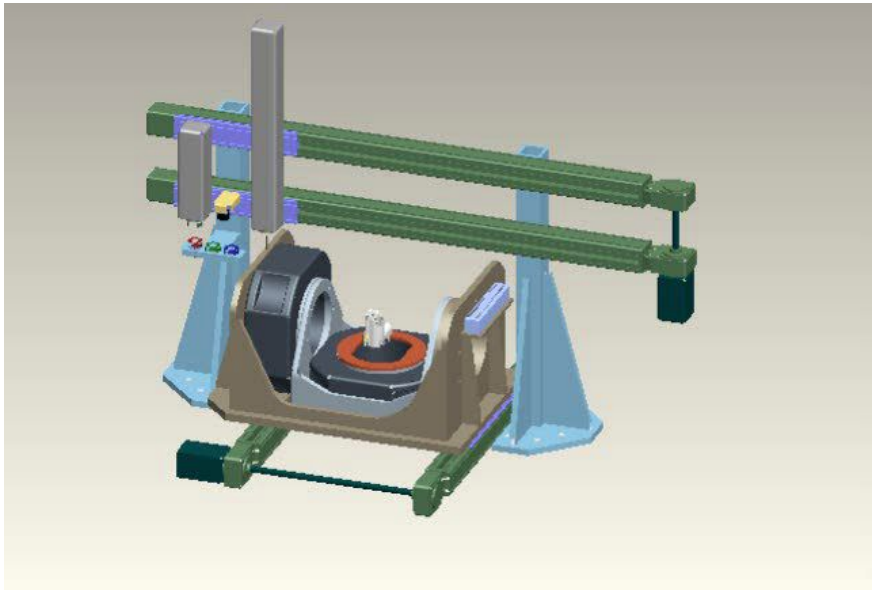
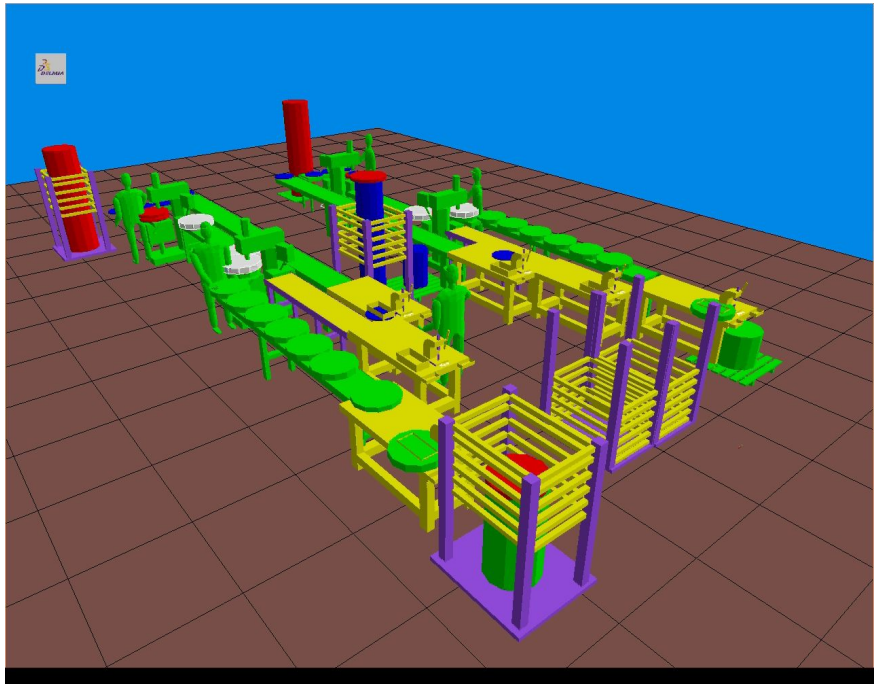
… and simulation.





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Assembly Projects

- Design for assembly
- Assembly of aero-engine components
- Assembly of aero structures
- Assembly of composite structures
- Large volume metrology
- Flexible tooling and adaptive fixturing
- Specialist Machine Design Projects

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Virtual Reality Projects

- **Virtual modeling of landing gear, engines and aero structures**

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The Composite Centre

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Available Technologies

- Hand Layup In / Out of Autoclave
- Automated Fibre Placement In / Out of Autoclave
- Automated Tape Laying In / Out of Autoclave
- In Situ Thermoplastic Automated Fibre Placement
- Resin Transfer Moulding
- Resin Infusion
- Thermoset and Thermoplastic processing
- Composite Machining
- MMC Process Development

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Core Technologies

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- Fibre placement
  - Thermoset
  - Insitu Thermoplastic
- Microwave
  - Thermoset
  - Thermoplastic
  - Co cure
  - Joining
- Automated Layup
  - Filament Winding
  - Pick and place
- Machining
  - Drilling, trimming, surface machining, stack machining

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Supporting Technology Areas

- Out Of Autoclave Materials
- Filament Winding
- Tooling development
- Application of multi axial fibre
  - 3D Weaving
  - Braiding
- RTM
- Modelling and Simulation
  - Process
  - Flow
  - Life Cycle

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Equipment

- ADC automated fiber placement machine 2.75 x 1.4m. Heads: ¼" / ½ " thermoplastic, 3" thermoset tape and 1/8" tow placement
- LLBC 3 x 5m autoclave 210ºC 10 Bar
- LLBC 1 x 2m high temperature autoclave 400ºC 20 Bar
- Caltherm 3 x 3 x 3m oven 230ºC
- ISOJET RTM injection system
- ISO Class 7 Clean room 15 x 7m
- CMS 5 axis machining center 4.8 x 1.8 x 1.2 m
- Eastman N/C ply cutter 3.6 x 1.8m
- CAD: CATIA V5, ProE, UGS, Solid Works
- FEA: Nastran/Patran, StressCheck, Mechanica

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ATP/AFP Equipment

- **ADC Automated Tape / Fibre Placement Machine complete with:**
  - **¼" & ½" Thermo Plastic Head**
  - **3" Thermoset Tape Head**
  - **12 x 1/8 " Thermoset Tow Placement Head**

    (4 x ¼" Thermoset Tow placement head in negotiation)

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Equipment

ISO Class 7
Clean Room Facility

Eastman Ply Cutter

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Equipment

3m x 5m Autoclave
Thermoset Materials

1m x 2m Autoclave
Thermoplastic Capability

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Equipment

CMS 5 Axis Machining Centre

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Equipment

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Caltherm 3m x 3m x 3m Oven

ISOJET Resin Transfer Moulding

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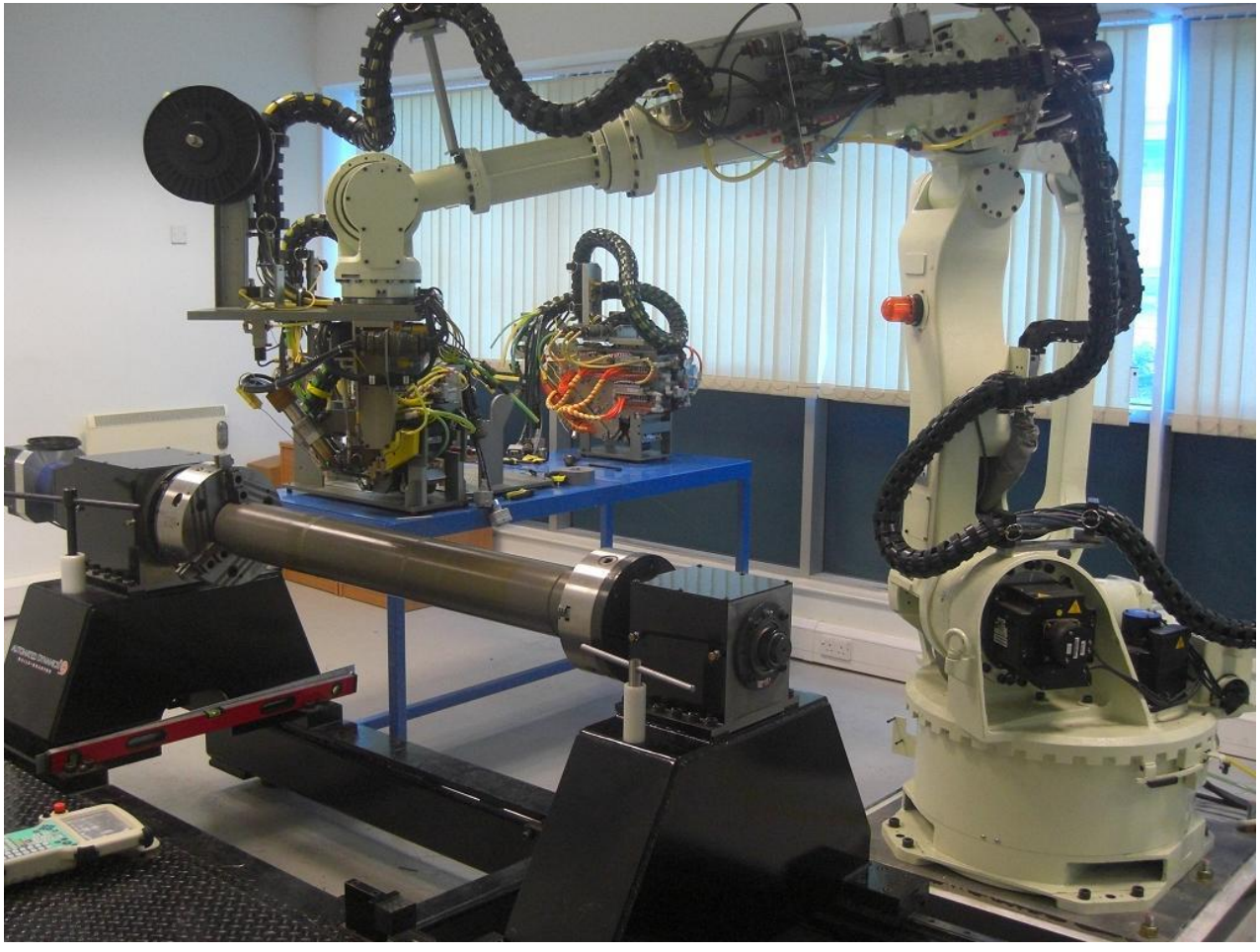
ATP / AFP Facility



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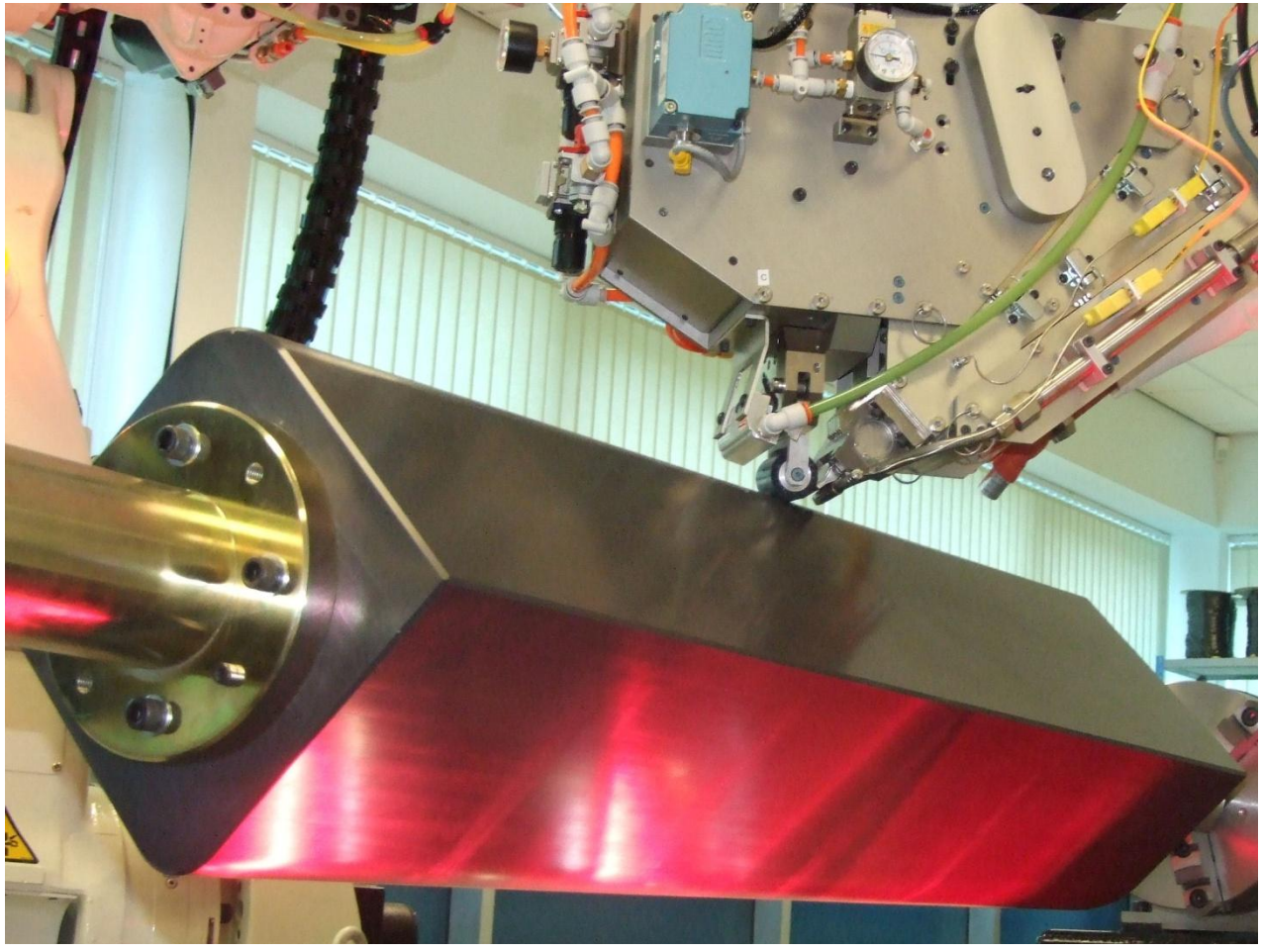
12 Tow Thermoset Head



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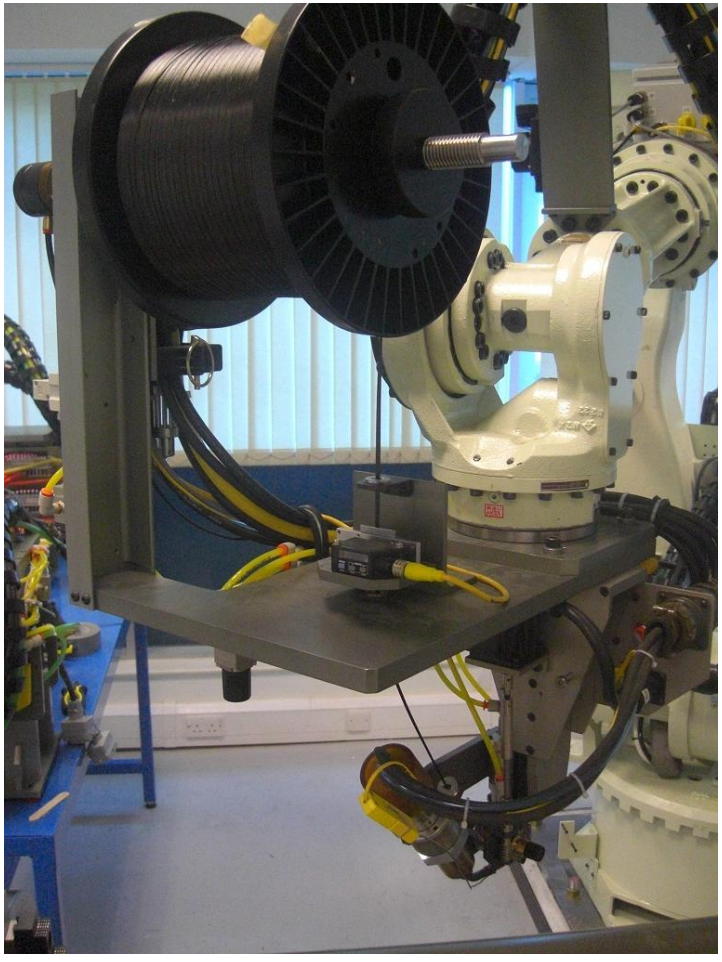
Thermoplastic Head



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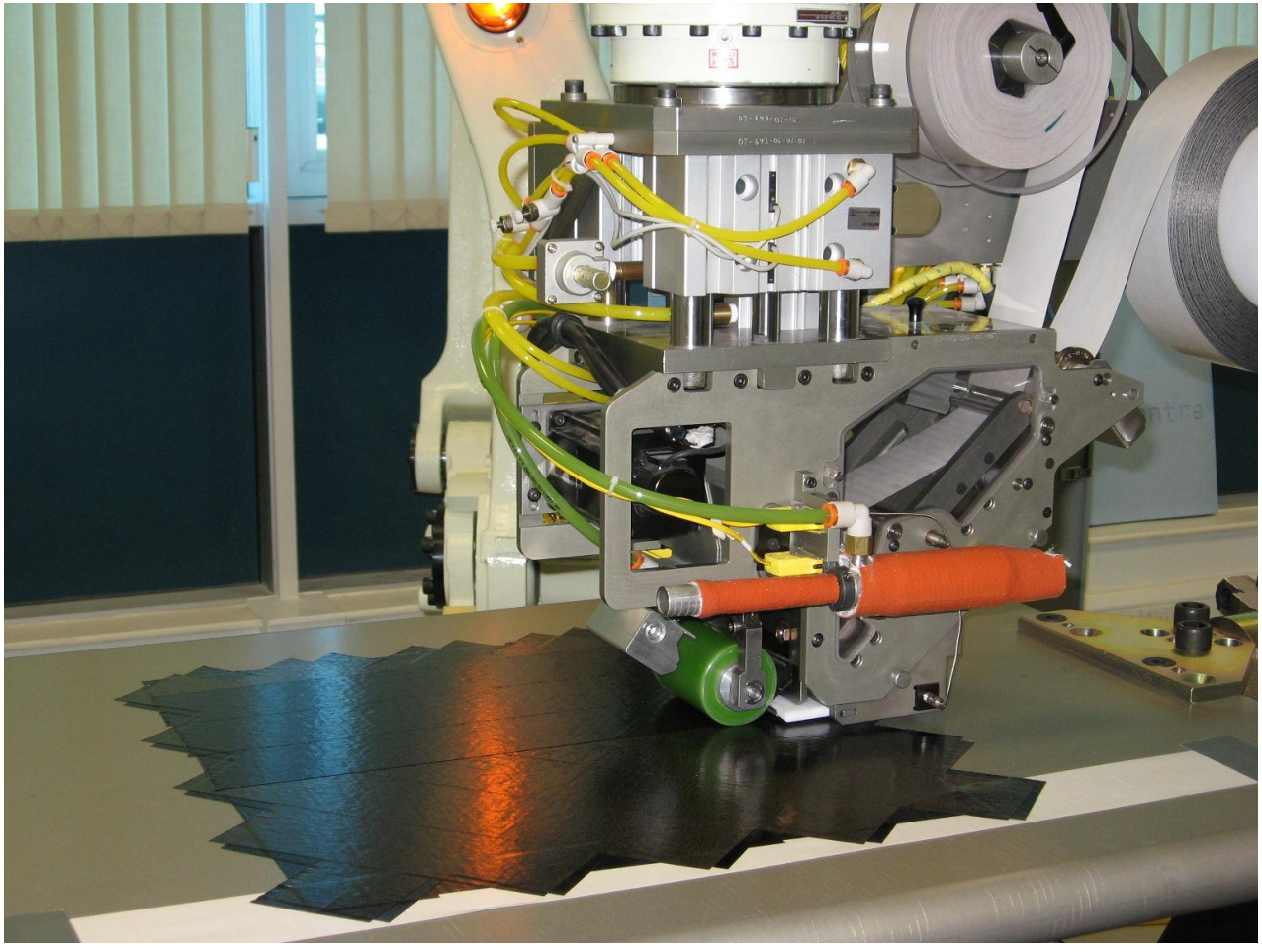
3” Thermoset Tape Head



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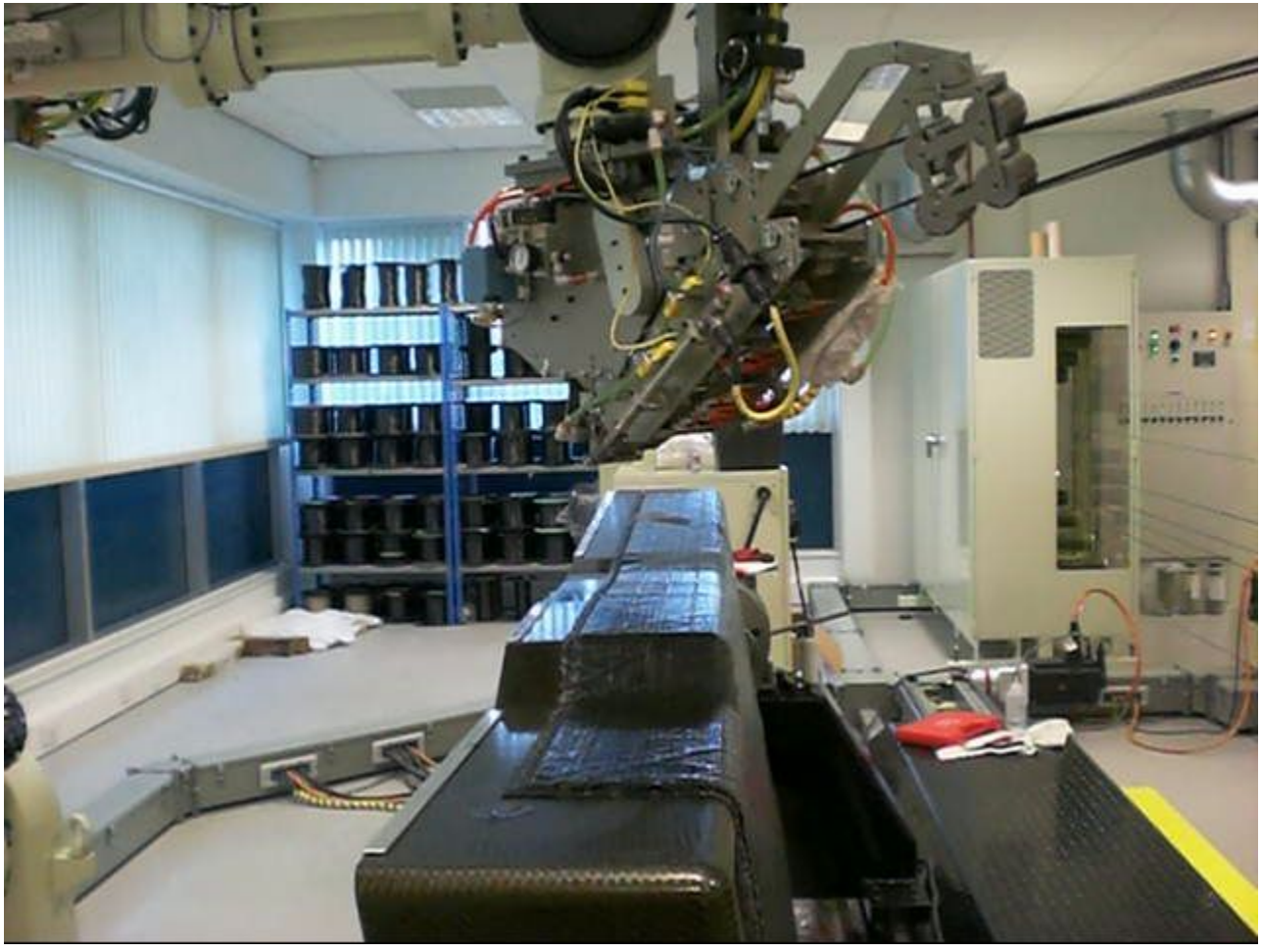

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Generic Projects

- Generic Flap (Technology Development)
- Machining of Composites Phase 1 Drilling
- Machining of Composites Phase 2 Trimming
- Hybrid Structures (CF / Ti)
- Out of Autoclave Material Development
- Microwave Curing of Thermoset materials

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Directed Generic

- **Multi Axial Woven Structures for the Construction of Composite Fittings (Boeing) Phase 1 and 2**
- **Mechanical fixings for composite materials**

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Current Industrial Projects
Product Design and Manufacture

- Kingkraft Disabled living aids - Sports wheelchairs
- Hybrid pressure cylinders - Sports goods, oil rigs & aerospace
- Bromley Technologies – Winter Sports goods
- Dormer - Cutting tools
- Manor Motorsport - Motorsport
- Antiquity GRP - Building products
- Horizon Ceramics – Aerospace and Tooling
- Eastman -Composite Cutting machines
- Ultra GRP - Children's play equipment
- International Products – Rail
- Stage One – Theatre products

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Airbus Integrated Wing Project

- TSB funded Technology Validation Programme
- Working on a Messier Dowty package
- 3 year programme ending in September 2010
- Developing Hybrid structure (Metallic / Carbon Fibre)
- Landing Gear Applications
- To develop to TRL 5
- In final manufacturing and testing Phase

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Current Industrial Projects
Process Development

- TSB Funded Grand Challenge- AFP development of aircraft fuel tanks
- TSB funded ULCV programme. Development of long fibre reinforced aluminium castings for automotive applications
- TSB funded Lenoweave Project- Technical textile for ballistic applications

Composite Centre & The NCN

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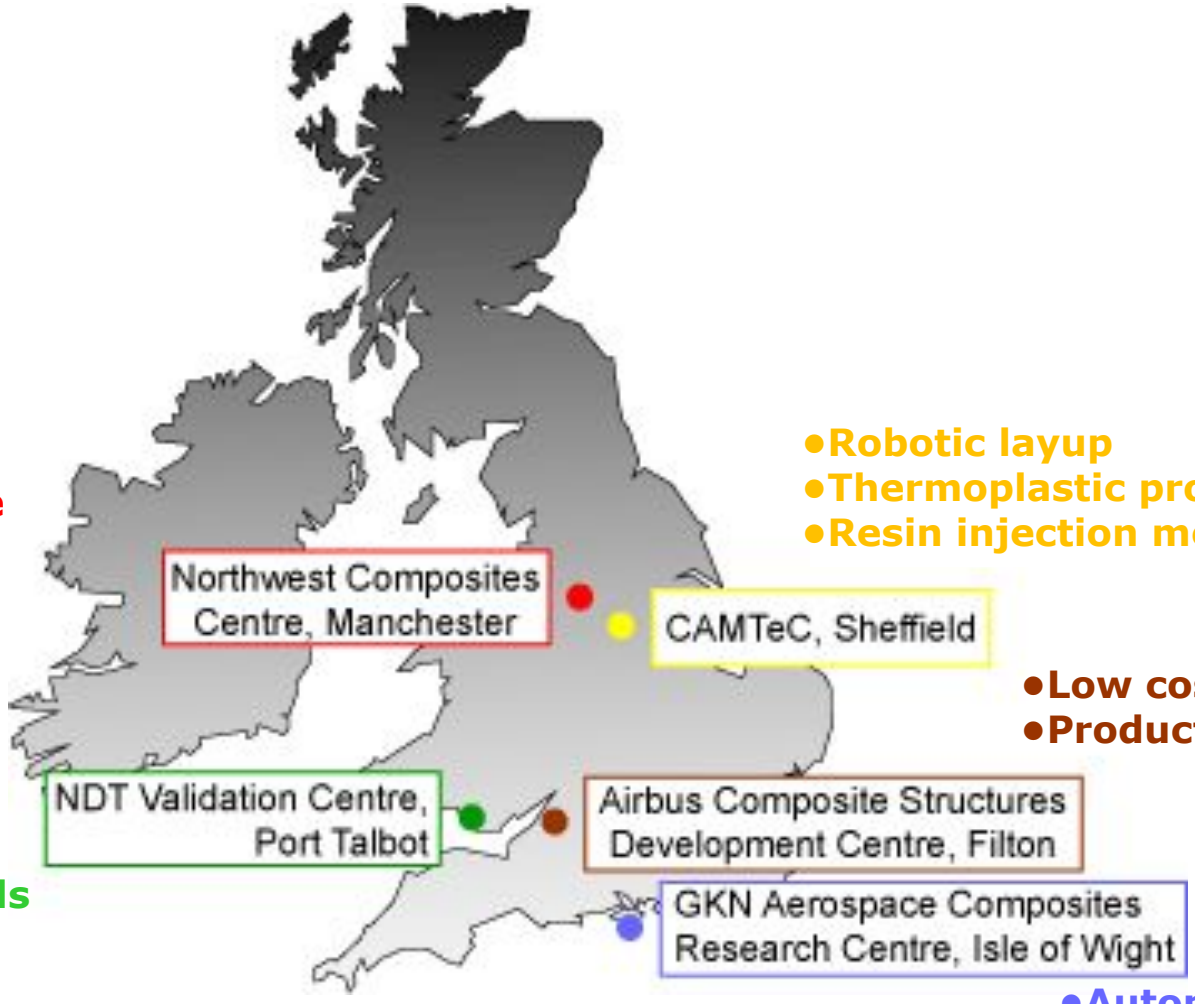

- Low energy
- Low cycle time
- Textiles

- Robotic layup
- Thermoplastic processing
- Resin injection methods

- Low cost technologies
- Product development

- Accuracy
- Consistency of NDT methods

- Automated layup
- Hot forming

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AMRC Composite Centre Regional Impact So Far

- 180 Jobs Created or Safeguarded
- 83 knowledge collaborations with the University
- £ 3.5 M of Private sector investment as a result of involvement
- 15 Instances of company's Levering R and D finance through collaboration

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The Future / NAMRC

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SITE LOCATION

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Advanced Manufacturing Research Centre with Boeing

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Advanced Manufacturing Research Centre,
Factory of the Future with Rolls Royce

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