Technology and Innovation for the Future of Composites Manufacturing

Ben Davies | Sophie Wendes | 15th July 2014
Overview of Presentation

- Introduction to Sophie Wendes and Ben Davies
- GKN Overview
- GKN Aerospace Overview
- Composites Overview
- CRC – Composite Research Centre
- Key Technologies at CRC
- CTC – Composite Technology Centre
- Key Technologies at CTC
- STeM Case Study
- Summary
- Questions
Introduction to Presenters

Ben Davies – Composites Research Engineer

Based in the Composites Technology Centre, Bristol

➢ BEng (Hons) Mechanical Engineering
➢ IEng MRAeS
➢ Manufacturing Engineer for Airbus UK and GKN Aerospace
➢ Apprentice Aircraft Fitter for Airbus UK

Current Projects:
➢ Automated deposition of winglet skins
➢ Reinforcement techniques of fan blades for CTAL

Other Activities:
➢ NCC core projects
➢ Engineering Education Scheme
Introduction to Presenters

Sophie Wendes – Composites Research Engineer

➢ Studied: BSc (Hons) & MDes in Industrial Product Design
➢ Before GKN: Junior Design Engineer for an engineering design consultancy & Product Designer for military surveillance equipment.
➢ At GKN: Design Engineer/Composite Research Engineer

Design and manufacturing experience at GKN Aerospace:

➢ Impact slat testing - bird strike
➢ Slat flight demonstrator
➢ Winglet
➢ Inlet acoustic barrels
➢ Lip liner ¼ scale models
➢ Through thickness re-enforcement
➢ Stringers
➢ Tooling design/test rig design
➢ Noodle development
➢ Strain gauging – design and manufacture
We have four operating divisions: GKN Driveline and GKN Powder Metallurgy that focus on the automotive market; GKN Aerospace, and GKN Land Systems. Every division is a market leader, each outperforming its markets, giving unrivalled expertise and experience in delivering cutting-edge technology and engineering to our global customers:

### 2013 - Sales by division

- **GKN Driveline**: £3,416m (45%)
- **GKN Powder Metallurgy**: £2,243m (30%)
- **GKN Aerospace**: £932m (12%)
- **GKN Land Systems**: £899m (12%)
- **Other**: £104m (1%)

**2013 Sales by Division**

- **GKN Driveline**: A world leading supplier of automotive driveline systems and solutions, including all-wheel drive.
- **GKN Powder Metallurgy**: The world’s largest manufacturer of sintered components, predominantly to the automotive sector.
- **GKN Aerospace**: A leading first tier supplier to the global aviation industry focussing on aerostructures, engine systems and products and specialty products.
- **GKN Land Systems**: A leading supplier of technology-differentiated power management solutions and services to the agricultural, construction, industrial and mining sectors.
GKN Aerospace

$3.5 billion Global Aerospace company, 35 sites in 9 countries, 11,700 people
Market leaders in airframe structures, engine components and transparencies
Increasing investment in technology and focus on deployment
Growing global footprint as part of drive for increasing competitiveness
Aerostructures - 45% of Sales 2013

Wing
- A380 Fixed Trailing Edge
- A350XWB Rear Spar
- A330 Flap Skins
- B767 Winglet

Fuselage
- J-UCAS Fuselage
- CH53K Aft Fuselage
- B787 Floor Grid
- HondaJet Fuselage

Nacelle and Pylon
- B747-8 Exhaust
- A400M Engine Intake
- B787 Inner Core Cowl
- Ariane 5 Exhaust nozzle

Engine structures - 50% of Sales 2013

Engine Systems and Services - 5% of Sales 2013

Engine systems

Engine rotatives

Transparencies and Protection Systems

Full Engine MRO and support

Global #3

GKN Aerospace - World class product portfolio

Global #2

Special products

Global #1/2
A broad customer base

2013 Sales

Military 27%
Civil 73%

Airbus Civil 22%
UTC 5%
GE 3%
Boeing Military 14%
Boeing Civil 8%
RR 5%
Sncema 3%
Honeywell 3%
MTU 2%
Spirit 2%
Lockheed 2%
Other 3%
Targeted Innovation – Technology

Engine Statics  Engine Rotatives  Future Wing Technologies  Advanced Fuselage  Nacelle, Pylon & Exhaust  Transparencies & Coatings  Protection Systems

Composite Technology

Metallic Technology

Supporting Technology
Aero structures – Composite Research and Assembly Sites

St Louis
Advanced Composites & Assemblies

Cromwell
Advanced Composites Structures - 30,000 SF

Tallassee
Composite Details & Assemblies 380,000SF

Western Approach
Advanced Composites & Assembly
330,000 SF

Munich
ATL Composites
325,000 SF

Cowes
Research, Composites & Assemblies
420,000 SF

Luton
Ice Protection, Composites
250,000 SF
Composite Technology Themes

High performance Structures
- Complex RTM
- Composite wing box
- ATL/DDF spar
- Composite fan case and fan blades

Advanced Manufacturing
- Rapid automated tape laying
- Advanced fibre placement
- Automated assembly
- Self heated tooling

Environmental Technologies
- Low weight
- Microwave curing
- Laminar flow wing
- Composite recycling
Technology Partnerships and Collaborations

Expanded our research capability

➤ UK Catapult Centres
  - National Composites Centre in Bristol
  - Manufacturing Technology Centre in Coventry

➤ Dedicated GKN Aerospace R&T Centres
  - Cowes, Munich, Bristol, Trollhättan, Luton, St. Louis, Cromwell

➤ Academic relationships with key universities
  - Bristol, Bath, Cranfield, Chalmers

Expanded our industrial technology relationships

➤ New relationships with Boeing Commercial, Airbus Group, Bombardier Aerospace Belfast, Timet, Alcan, Gulfstream

➤ Expanded relationships with Airbus, Rolls-Royce, Pratt & Whitney, Sikorsky, Ultra, Zodiac
GKN Aerospace – CRC
Composites Research Centre, Isle of Wight, UK
CRC Overview

GKN Aerospace’s Composite Research Centre (CRC)

➢ Osborne Site at East Cowes, Isle of Wight
➢ There is a full representation of design, manufacturing engineering and production/assembly skill sets
➢ The facility has been developing innovative composite products for ten years

GKN Aerospace CRC technologies:

➢ Acoustic intake liners
➢ Self heated tooling
➢ Robotic automated assembly
➢ Movables (leading edge slat)
➢ Wing box design
➢ Novel winglet
Acoustic Seamless Inlet Liner - Advantages

- Zero splice design
- 30% weight saving
- Superior noise attenuation
- Double degree of freedom (DDOF) honeycomb core technology
- Better bonding of splices on honeycomb core
- Tooling developed to enhance the concentricity

- Reduced build time
- Robotically drilled facing sheet
- Simpler than traditional metal/glass design
- Reduced part count: one part replaces 28 (reducing assembly time)

Original Design

Developed Technology
Self Heated Tooling

Self heated tooling technology

- Self heated tooling (SHT) is a generic technology that targets the replacement of autoclave curing
- This is to be developed on secondary structures to fit in with company strategy

Key benefits

- Reduction in CapEx (no autoclave required)
- Able to apply heat more directly to part
- Reduction of recurring costs:
  - Cure cycle time
  - Lower energy usage
- Ability to change factory footprint to improve process flow
Robotic Automated Assembly Development

GKN Aerospace is developing automated assembly to reduce production costs and re-work

- Two cells developed, adopting multiple technologies – drilling, fastening, assembly
- Drilling and fastening technology offers potential 50% capital savings vs alternative automated solutions
- 23% time saving per fastener operation vs manual baseline
- Both cells have potential for huge flexibility, making them applicable to a large product base
- Interaction with production facilities has received positive feedback of the assembly concept
GKN Aerospace is developing an electro thermal wing ice protection systems (WIPS) enabled composite slat assembly with intelligent ice detection system. This replaces the traditional exhaust fed metallic slat

- Composite front and rear skin
- Integration of hybrid IPS technologies
- Built in ice sensing
- High voltage robust thermoplastic heater mat
- Testing and validation programmes on-going

- Bird-strike predictive capability
- Targeted at high rate manufacture
- Spar-less design
- Reduced part count
- Single shot box structure in development

Original Design

Developed Technology
Leading Edge Composite Slat – Bird Strike

➢ To ensure the new slat design is successful a number of bird strike tests were carried out.
Wing-box Technology Development

Lean assembly wing-box

> An assembled structure with low level of part integration
> The demonstration is focusing on the assembly processes like positioning, clamping, shimming, drilling, hole inspection, fastening, sealing, but will also gain from a redesign and accurate manufacturing of the individual parts

CF front and rear SPARS, featuring integrated rib and hinge posts.

CF ribs

CF upper SKIN with co-cured stringers and co-bonded rib feet.
GKN Aerospace – CTC
Composites Technology Centre, Bristol, UK
Composites Technology Centre – based at the National Composites Centre in Bristol, UK

Situated in the Bristol and Bath Science Park

1 of 7 HVM Catapult Centers

Phase 2 currently in progress

CTC:
- Team of 25+ engineers working across a range of R&D projects
- Capabilities for composite and metallic design and stress modelling and analysis
- Manufacturing capability for small and large scale components and demonstrators
BLADE: Breakthrough Laminar Aircraft Demonstrator in Europe

Co-cured structures for natural laminar flow

- Leading edges and upper covers
- ‘Clean Sky’ funded project (EU)
- Natural laminar flow technologies
- Flying test bed

- 9m long composite upper cover
- 9m long metallic leading edge
Composites Technology Centre – Projects

**GBD: Ground Based Systems and Structural Demonstrator**

**Co-cured structures for natural laminar flow**

- Two leading edge configurations
- ‘Clean Sky’ funded project (EU)
- Natural laminar flow technology

![Diagram showing co-cured structures](image)

- 4.5m long leading edge with integrated Krueger flap
- Partial wing-box
- Integral ice protection
- Additive manufacturing

K4 Baseline  
K5 Innovative
Composites Technology Centre – Projects

**CTAL**: Composite Technology and Applications Limited

- Collaboration with Rolls-Royce
- Developing the composite deposition technology
- Fundamentals of the manufacturing process
- Transferable technology to future and existing components
STeM Case Study
Structures Technology Maturity
£12m programme led by GKN Aerospace and including Bombardier, Spirit AeroSystems and GE

Funded under the UK centre for aerodynamics programme by the UK government’s Technology Strategy Board and Department for Business, Innovation and Skills

Collaborative research project heavily influenced by composites technology

Also includes development of metallic design and assembly

“The aim of the STeM Project is to support new concepts in wing structure and manufacturing that enable expansion of the boundaries of aerodynamic performance and contribute to securing work in the UK for the next generation of aircraft.” UKAerodynamics.co.uk, 2013

Work carried out at both GKN Aerospace composites research sites in the UK

Main focus is GKN Aerospace’s advanced winglet programme
Conventional composite winglet vs advanced winglet programme

Conventional composite winglet build

- CFRP upper skin with honeycomb core
- Leading edge spar
- Metallic centre rib
- Mid spar
- Trailing edge spar
- Metallic root end attachment

GKN Aerospace’s advanced winglet programme build

- CFRP co-cured waffle and upper skin
- CFRP lower skin
- Metallic root end attachment
Structures Technology Maturity – STeM

- Automated Deposition Processes
- Assembly of more integrated structures
- One way robotic assembly
- Tool to component datum setting
- In Process Inspection using Thermography

- One-shot Cured Stiffened Structures
- Lightweight Structures
- Improved Spring Back Simulation

Advanced Winglet Programme

Automatic assembly cell at AMRC
Advanced winglet timeline

Initial concept investigation 2009
Initial quadrilateral proposal
(known internally as a waffle)

Grand Challenge 2010
Process time reduction
demonstrator proving ground for:
- Waffle moulding
- Co-curing
- Bagging development
- Tooling Concepts

STeM: 2012 – 2014
Development to TRL 4

Development to TRL5

Validation & Integration of manufacturing
Enablers for future Wing Structures
Structures Technology Maturity – STeM
Summary

Key points to take away……..

➢ Composite technology development and manufacture globally
➢ Pushing the boundaries of composite technologies
➢ Innovative processes and technologies
➢ Collaborations with other Tier 1’s and OEM’s
Thank you very much for listening.