The Future of Titanium in Aerospace Manufacturing
Titanium Europe 2014 – Sorrento, Italy
Rob Sharman – Head of Metallics Technology GKN Aerospace
GKN Overview
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**

- **Group £5.734m Q1 – Q3**
- **GKN Driveline 45%**
- **GKN Land Systems 12%**
- **GKN Aerospace 29%**
- **GKN Powder Metallurgy 13%**

**GKN Aerospace**
A leading first tier supplier to the global aviation industry focussing on aerostructures, engine systems and products and specialty products.

**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 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 International Aerospace enterprise
35 sites, 12,000 people

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GKN Aerospace – Markets and Customers

Market

Business Mix

Sector

Customer Base
### Aerostructures
53% of Sales 2012*

- **Wing**
  - A380 Fixed Trailing Edge
  - A350XWB Rear Spar
  - A330 Flap Skins
  - B767 Winglet
- **Fuselage**
  - J-UCAS Fuselage
  - CH53K Alt Fuselage
  - B787 Floor Grid
  - HondaJet Fuselage

### Engine structures
42% of Sales 2012*

- **Nacelle and Pylon**
  - B747-8 Exhaust
  - A400M Engine Intake
  - B787 Inner Core Cowl
  - Ariane 5 Exhaust nozzle
- **Engine Systems and Services**
  - Engine structures
  - Engine rotatives
  - Full Engine MRO and support

### Special products
5% of Sales 2012*

- **Transparencies and Protection Systems**
  - B787 Anti-icing System
  - V22 Fuel Tanks
  - B787 Cabin Windows
  - F35 Canopy

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Note: * Engine Systems proforma 12 months of 2012

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GKN Aerospace Proprietary and Confidential
Trends in Titanium and Aerospace
Metallic Trends

➢ Only so much value in a structure or engine and suppliers are fighting for their share

➢ The increase in CFRP use has driven the metallics industry to develop new competitive products – e.g. new 3rd generation Al-Li alloys

➢ A shift in metallics is also taking place
  ➢ Increase in range of alloys used
  ➢ Growth in use of Titanium

➢ But more advanced alloys and materials can equate to higher cost and processing challenges

![Use of Ti in Aircraft](chart.png)

Source: Counterpoint, ICF
Processing

- Processing is driven both by cost down and performance increase
- The industry has always used a range of different processing techniques
  - Forming, casting, welding, machining
- Manufacturing is dominated by subtractive processing techniques, especially for structural elements
- Machining continues to evolve with more thin walled monolithic structures being achievable
- However it is a wasteful process
  - Current throw away rate (or recycled) is typically up to 90%+
  - Need to move to net shape
- New challenges:
  - Increase use of Ti - harder material
  - Higher cost
  - Larger more complex structures
  - Environmental considerations
Assembly

➢ The aerospace industry has always used a range of different assembly/joining techniques

➢ Dominated by drilling and riveting for aerostructures
  ➢ Slow processes
  ➢ Challenging to automate
  ➢ Not very repeatable
  ➢ Heavy

➢ New challenges:
  ➢ Aircraft Production Rates Increasing
  ➢ Constant drive for higher quality
  ➢ Constant drive to reduce weight
  ➢ Need to reduce cost
## Technology – Targeted innovation

<table>
<thead>
<tr>
<th>Future product differentiation</th>
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<tbody>
<tr>
<td><strong>Future wing technologies</strong></td>
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### Next generation composite processes

### Advanced metallic processes

### Advanced process development
Production Triangle

Product

Material

Process
Titanium Processing Technologies

Advanced Metallic Processes & Materials

- High Performance Machining
  - Hybrid, Cryogenic, Thermally Assisted
- ECM
- Laser Welding and EB Welding
- Linear friction welding
- Advanced hold drilling & assembly
- Resistance Welded Honeycomb
- Super Plastic Forming
- New materials developments
- Powder Metallurgy
  - Net Shape HIPing
- Additive Manufacturing

Requires materials developed for process
Increase in use of powder metallurgy
## Additive Manufacturing

### LARGE PUDDLE DEPOSITION

- **Designated Icon:** P
- **Picture:** [Image]
- **Description:**
  - High material throughput deposition systems
  - Focus on Ti
  - Large-scale pre-forms
  - Initial cost-driven introduction
  - Applications including large aero structure components

### SMALL PUDDLE DEPOSITION

- **Designated Icon:** EB
- **Picture:** [Image]
- **Description:**
  - Lower material throughput deposition systems
  - Focus on Ti and Ni alloys
  - Nearer net-shape add-ons and prismatic pre-forms
  - Engine component fabrication, component repair and grow-outs (cost & performance)
  - Broad range of medium-size engine and structures components; fabrications

### LASER P/BED

- **Designated Icon:** L
- **Picture:** [Image]
- **Description:**
  - Lowest material thru-put
  - Ti, Ni and steel alloys
  - Nearest-net
  - Intricate hi-value components
  - Engine parts and small inserts

### EB P/BED

- **Designated Icon:** EB
- **Picture:** [Image]
- **Description:**
  - Low material thru-put
  - Ti6Al4V
  - Highly net-shape
  - Small – medium prisms
  - Structural brackets, engine parts and fabrications

### INDIRECT P/BED

- **Designated Icon:** B
- **Picture:** [Image]
- **Description:**
  - Low material thru-put
  - Cast-able alloys
  - Highly net-shape
  - Complex castings and inserts
  - Engine parts and fabrications
The possibilities and benefits are exciting

- Unlocks Materials Science
- Only uses the material you need - uses less material
- Design no longer constrained by conventional manufacturing processes
- Allows design for functionality
- Speed and flexibility of development

A revolutionary set of technologies – not evolutionary

Phased introduction is implicitly required

- Secondary derivative structure before primary optimised
- Need to pin variables to gain acceptance
- Process and material are now linked like never before

Big challenge to the industry in evaluation

- How to certify
- New and novel QA techniques required
Generic Conventional Component
Generic Conventional Component

- Mat’l = 1.08kg
- Swarf = 0.31kg

- Mat’l = 4.85kg
- Swarf = 4.08kg

- Part = 0.77kg

AM Route to Man’f

Machining Route to Man’f
Generic Conventional Component

- ~5 x less feed stock
- ~13 x less swarf

- Conventional design (not yet optimised for weight)
The range and mix of materials deployed is changing

Ti use in aircraft is continuing to rise

New alloys and products tailored to specific application

New processing techniques can help “unlock materials science”

But big challenges required to benefit fully from the opportunities now available (certification challenges)

The combination of the understanding of materials science and new processing techniques is an exciting future – is this the decade (or two) of materials?
Thank you