Linear Friction Welding: bottom line

Automated, repeatable, fast, **dependable** welds
Near-net-shape additive manufacturing of **forged** parts
Enables advanced structures through **material tailoring**
Opens to **new design freedoms**, and reduces part count
Helps to control material input and product **time-to-market**
World Centre for Materials Joining

- **TWI**
  - Non-governmental
  - Not for profit distributing
  - Independent
  - Impartial

- **TWI’s mission:**
  To be the best at what we do*
  * To deliver world class services in joining materials, engineering and allied technologies to meet the needs of a global membership and its associated community

- **Dedicated to Materials Joining**
  - Over $100m R&D per year
  - Over 850 staff in 4 UK centres
  - Over 700 Industrial Members
  - 60 years track record
TWI - Friction and Forge Processes

- Based in Cambridge
- 16 Engineers and Technicians
- 53 years of R&D in Friction Processes
  - One of the first in Friction Welding
  - Pioneered Linear Friction Welding
  - Invented Friction Stir Welding
Linear Friction Welding

High quality, automated, quick, self regulated, self cleaning, repeatable welding process

Linear Friction Stir Welding

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- Fast: typically under 30s cycle time
- Accurate: positioning under 0.10mm and reproducible: under 0.25mm
LFW: High Quality Weld in Ti Alloys

- Preserves a hot forged microstructure
- Thin heat affected zone
- Recrystallised to fine grained equiaxed microstructure at weld centre
- Can be post weld heat treated for performance
- Near-parent tensile and fatigue properties can be achieved

↑ Ti-6Al-4V ↓
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Both components fractured in the parent metal
LFW current products: Blisks

- Critical aero engine component: compressor rotor
- Mature production: fighters engines
  - Power to Weight ratio
  - Performance
- Uptake: large civil engines
- Fuel saving
- Environmental regulations
- In-house knowledge and qualification
Friction and Forge Processes activities

- Understand
- Explore
- Demonstrate
- Transfer
- Implement
- Qualify
Friction and Forge Processes activities

Understand

LFW
Analysis of LFW cycles: current work

- Independent monitoring of LFW cycles
  - Helps the LFW Process Engineer in making his/her decision
  - Offer evidence to support the welding operation
    - Unobtrusive addition of sensors
    - High sampling rate
  - Open, adaptable tools
    - Individual weld cycles (QC)
    - Series repeatability
  - Project should be transferable to other machines in the future
Anthony McAndrew
Contaminant Removal in Ti6Al4V
  ▪ 1st publication: 2013
  ▪ 2nd publication: 2014
  ▪ Thesis: 2015

Lucie Lee
Novel Industrial Applications
  ▪ 1st publication: 2016
  ▪ 2nd publication: 2017
  ▪ Thesis: 2018
Friction and Forge Processes activities

LFW

Understand

Explore

Demonstrate
Demonstrating capabilities of LFW

- Core Research
- Smart manufacture
- Like for like performance
- New design freedoms