FAST STEP 3

Titanium Swarf to Engine Components in 3 steps

Thursday 5th September 2019
Cenex Low Carbon Vehicle Event

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BENTLEY · Force Technology · Northern automotive Alliance · The University Of Sheffield. · TRANSITION Metals Ltd · w.h.tildesley ltd

Vision

- To utilise high-value titanium alloy swarf as a feedstock for the FAST and FAST-*forge* processes
- To generate near-net-shape components with the high strength & good fatigue life typically required within an automotive engine
- An indication of production volume capability and cost levels for the automotive industry
- The development of a new UK supply chain, resulting in growth opportunities:
  - **Niche vehicles to higher volume applications**
  - **Other sectors such as off-shore, rail, aerospace, non-auto engine, defence & low-cost desalination**

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Partners & Scope

Partner	Company Description
Bentley Motors Ltd	Manufacturer of luxury performance automobiles for world-wide markets.
Force Technology Ltd	Provision of advanced design, development, manufacture & test for advanced spring solutions. Automotive Tier 1 status with IATF 16949 certification, but also supply into other sectors.
WH Tildesley Ltd	Specialist supplier of forged & machined components to a wide range of markets.
Transition International Ltd	Bespoke manufacturer of Ferro-Titanium from titanium scrap to meet specific customer requirements.
Northern Automotive Alliance	Independent, not-for-profit, organisation providing support for all companies within the automotive sector within NW & Yorkshire.
University of Sheffield	Department of Materials Science & Engineering is one of the top materials departments in the UK with a long history in metallurgy. Part of the Faculty of Engineering, which is ranked 1st in the UK for research income, and 1st in the UK for industry focused R&D.

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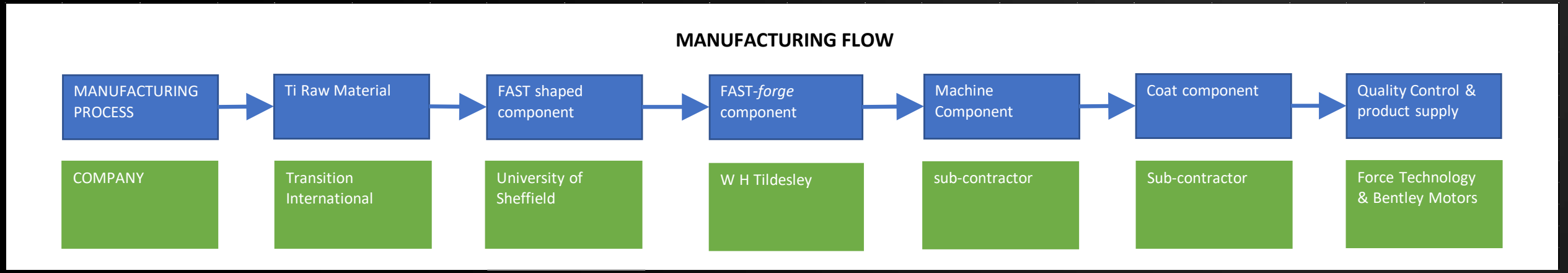
Partners & Scope



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Overall Project Outcomes

- Manufactured & functional bench test 4 components
- Process mapping & understanding of process variability, limitations & opportunities for swarf cleaning & grading
- FAST tooling & process development
- Forging tooling & process development for FAST near-net shape preforms
- Finishing processes for ready-to-supply components
- Development of the business process for a supply chain for supply into OEMs.

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Overall Project Outcomes

Sep 18 – May 19
Swarf Definition

Apr 19 – Feb 20
Retainer

Jul 19 – May 20
Piston Pin

Oct 19 – Dec 20
Rocker Arm

Apr 20 – Jul 21
Con Rod

Aug 21
Final report & Close-Out

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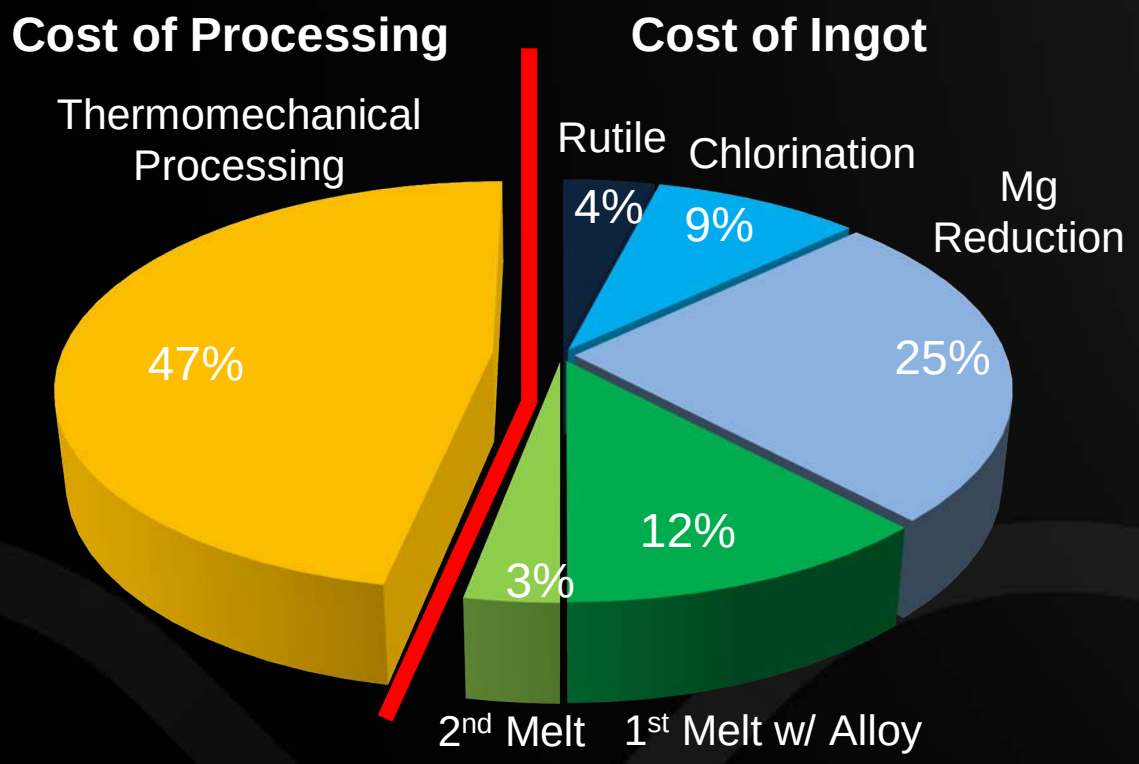
Lowering the Cost of Titanium

The Need for Cost-Effective Downstream Processing



Cost Breakdown of Producing 25 mm Thick Ti Alloy Plate [1]

The buy-to-fly ratio of titanium alloys for the F-22 is over 12:1[2]

- 45 of the 50 tonnes purchased per aircraft is turned into scrap – mostly as machining swarf/chips

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[1] E. Kraft, Summary of Emerging Titanium Cost Reduction Technologies, Vancouver, 2004. Plotted from data in: P.C.Turner and J.S.Hansen, "An Assessment of Existing Titanium Technologies", Albany Research Center, Department of Energy, July 28, 1999.

[2] Z. Zak Fang, P. Sun, Pathways to Optimize Performance/Cost Ratio of Powder Metallurgy Titanium – A Perspective, Key Eng. Mater. 520 (2012) 15–23.

Lowering the Cost of Titanium

The Need for Cost-Effective Downstream Processing

To achieve a true step-change in the economics of titanium components it is necessary to combine

lower-cost powder/particulate feedstocks

with novel solid-state processing

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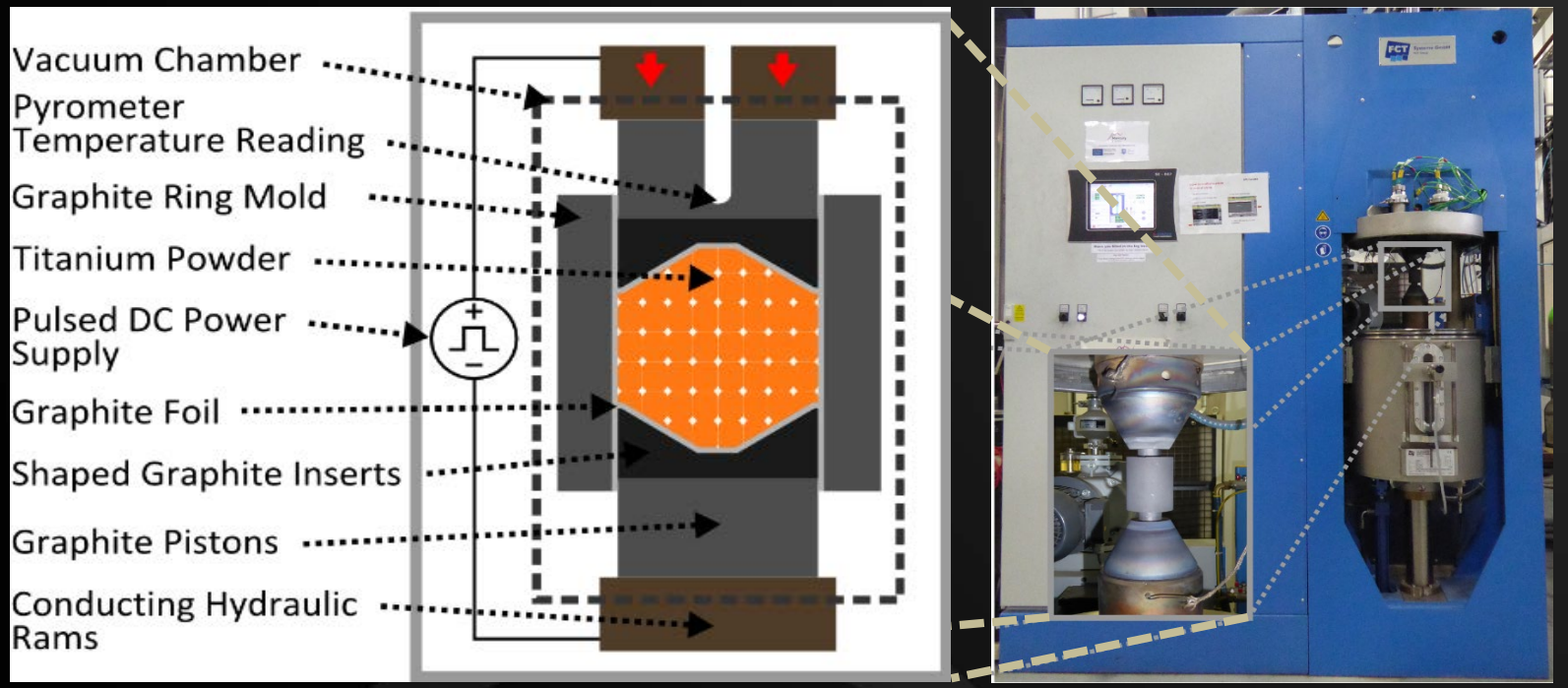
FAST – Field Assisted Sintering Technology

a.k.a. SPS – Spark Plasma Sintering



- Novel method of controlled rapid sintering to produce full density specimens that is faster and more flexible than other powder metallurgy methods
- Simultaneous application of uniaxial load and electric current, which causes Joule heating
- Consensus is FAST offers technological/economic advantages over conventional sintering techniques

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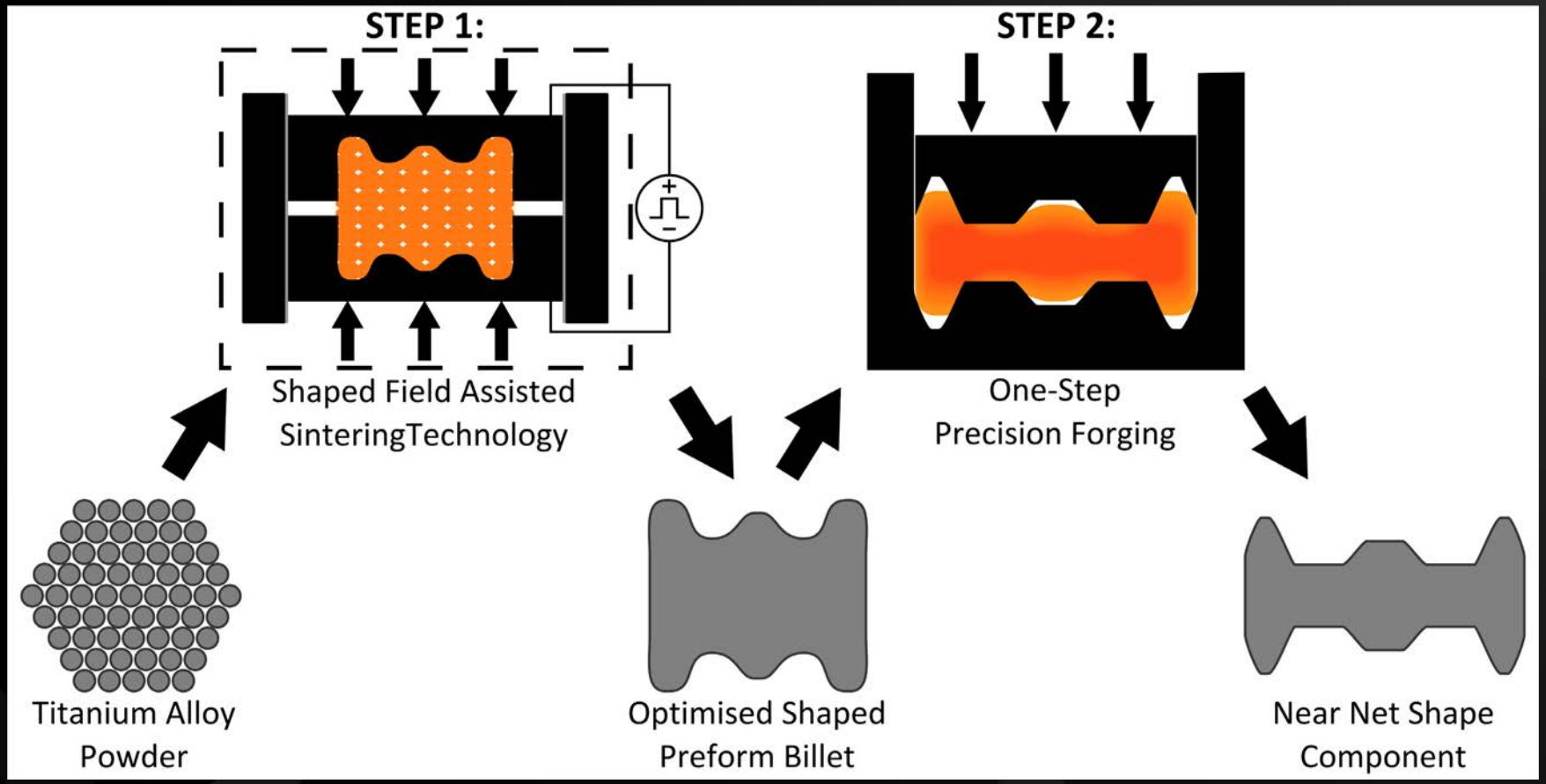
The FAST-*forge* Concept

From titanium alloy feedstock to forged component in 2 steps



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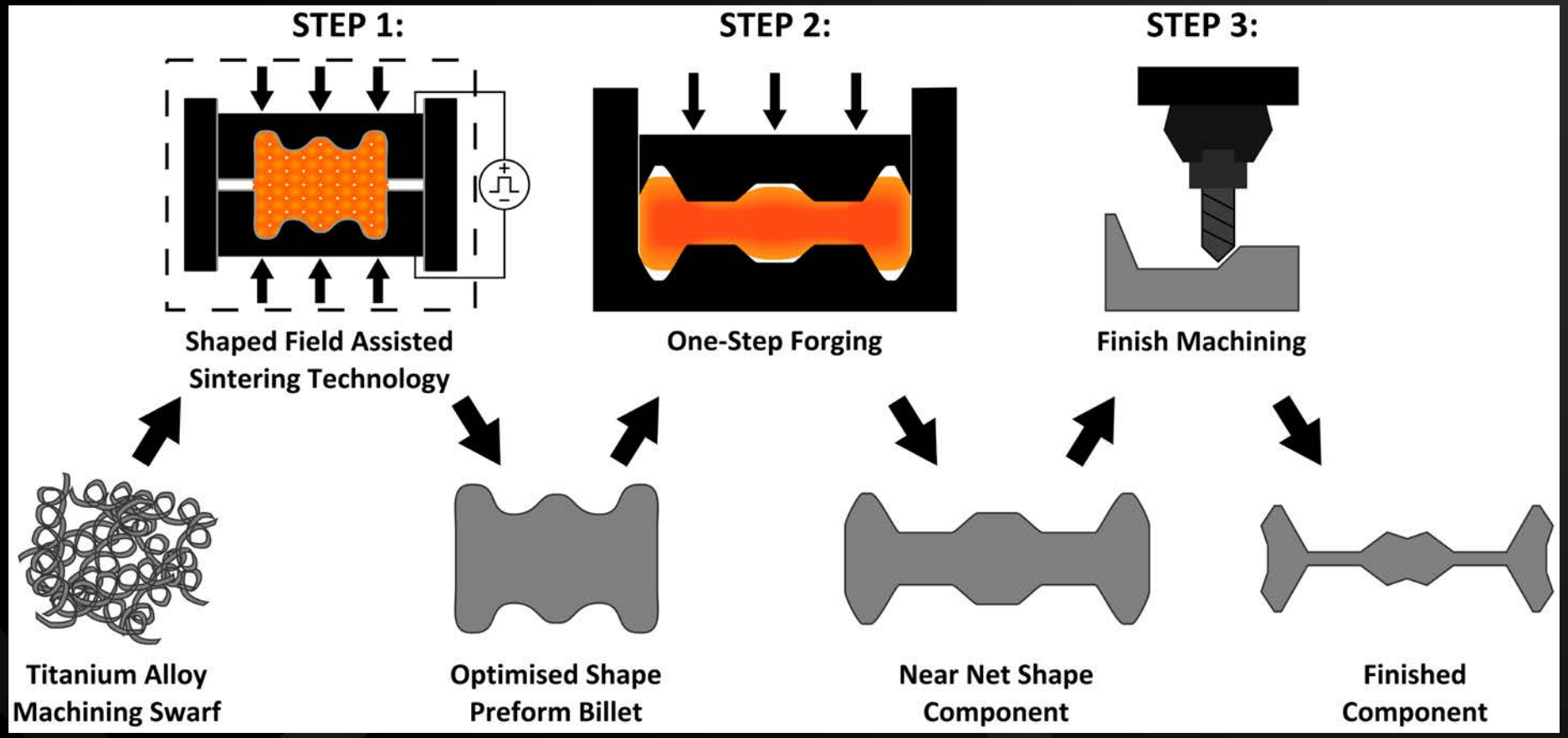
Weston NS, Jackson M. FAST-forge - A new cost-effective hybrid processing route for consolidating titanium powder into near net shape forged components. J. Mater. Process. Technol. 2017;243:335–346.

FAST STEP3 Programme 2018-2021

Field **A**ssisted **S**intering **T**echnology for **S**warf **T**itanium to **E**ngine **P**arts in **3** Steps



STEP3 will utilise Ti alloy swarf as feedstock for FAST and FAST-*forge* to produce near-net-shapes that will be finish machined to produce components with the high strength and good fatigue life typically required within an automotive engine

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The Future

Integrating with Royce@Sheffield

HENRY ROYCE INSTITUTE

The UK National Institute For Advanced Materials Research and Innovation

- A Different Kind of Research Institute; Open to Industry, Academia and the Public.
- Offering industry and academia the capability to make, test and characterise materials, components and systems; over £150m of equipment is available, easy to access and technically supported.

Royce@Sheffield is part of the Department of Materials Science and Engineering.

- As a major partner of the Henry Royce Institute, we are leading on the theme of Advanced Metals Processing
- www.sheffield.ac.uk/materials/research/centresandfacilities/royce

Royce@Sheffield has purchased an FCT Systeme Model HP D 250/C FAST furnace.

- Additional cooling chamber allows semi-continuous processing of parts up to 250 mm diameter
- Unique capability within the UK
- Will be utilised by FAST STEP3 project from mid 2020

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The Future

- Watch for progress on our website:
  - *WWW.FASTSTEP3.ORG.UK*
- Come back and see progress next year
- Come and talk to us if you have an interest in being part of our next phase, or take a leaflet

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