

Certification of Laser Powder Additive Manufactured Components for Industrial Adoption in the Energy and Offshore Sectors

JOINT INDUSTRY PROJECT – PUBLISHABLE SUMMARY

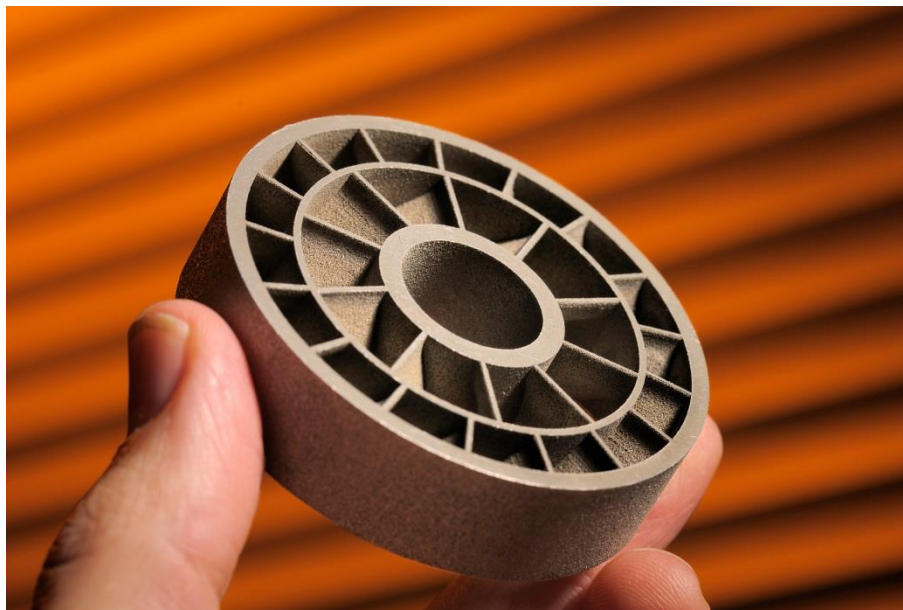
Summary

Additive Manufacturing (AM), widely known as 3D printing, is a direct digital manufacturing process in which a component is produced layer by layer directly from 3D digital data without the use of machining, moulding or casting. AM has developed rapidly in the last ten years and has demonstrated significant potential for reducing the cost of aerospace components and unique opportunities in the medical sector. Benefits can be realised through improved design freedom, weight reduction and lower tooling costs, complemented by reductions in carbon footprint and waste during manufacture.

This Joint Industry Project (JIP) will:

- Identify potential applications of AM in the Energy, Oil & Gas and Marine sectors.
- Undertake practical work to determine optimum build parameters and produce components.
- Determine required inspection activities to certify component.
- Generate AM Certification Guidelines, based on certification of the selected components.

Selective Laser Melting (SLM) and Laser Metal Deposition (LMD) are the processes that will be applied in the JIP, leading to qualification of components defined by the Sponsors.



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Project Concept

As the application of AM grows, a number of challenges/barriers to broader commercialisation have been identified; these include:

1. Assessment and understanding of specific materials and performance when producing AM components
2. Design for AM
3. Certification of specific AM components

For example, a manufacturer that currently designs and manufactures to a recognised standard (eg ASME VIII Division 1) using code rules and traditional 'subtractive' methods, but wants to optimise the design or lead time of manufacture by utilising AM techniques, has no guidelines on the steps required to ensure that the end product can be certified. Similarly, a Third Party Inspection Authority has no standard or guidelines to certify against as the existing standards do not include provision for parts produced using AM.

This project will develop guidance on how to achieve certification that can be used by designers, manufacturers and inspection bodies to complement existing, recognised standards in order to produce parts using AM that can be certified and applied in service.

It should be noted that there is an ASTM/ISO joint working group currently developing standards for AM:

- ASTM F42 Committee (ASTM F2792, ISO/ASTM 52915 and ISO/ASTM 52921).
- ISO TC/261 Committee (EN ISO 17296 Parts 1 to 4).

The standards listed above are several years away from adoption and an opportunity exists to support the immediate industry need. In order to provide manufacturers with the greatest opportunity to exploit AM, early publication of AM Certification Guidelines is paramount.

An opportunity exists to enhance and complement work being carried out by the standards committee and other industry-led quality/assurance framework development by carrying out this research project focussed on addressing the immediate needs of the industrial sponsors. This project will aim to deliver AM certification guidelines within 12 months of the project start date.

Standard operating procedures and protocols will be developed specifically for metal AM parts, aiming to quantify the quality and repeatability of parts produced by Powder Bed Fusion and LMD processes. In order to develop procedures and protocols, a list of factors that need to be controlled to ensure part consistency will need to be determined.

TWI and Lloyd's Register Energy will use their existing knowledge to ensure that robust AM production methods and inspection techniques are developed and optimised to ensure that parts can be certified and produced consistently, whilst maintaining process and material performance. Another key issue is qualifying that parts are true to the computer-aided design (product specification), and that parts produced are repeatable throughout a production run. Additional datasets and data collection capabilities will be determined to support qualification and certification of AM parts and processes. This includes standardised methods for capturing manufacturing data.

Objectives

The objectives of this project are to assist industry with the wider adoption of AM technology.

- Identifying the priority measurement and standard compliance challenges of the Energy, Oil & Gas, and Marine sectors.
- Undertaking certification of a range of representative parts selected by the project sponsors (one part per sponsor)
- Creating consensus-based guidelines that address the specific material and process needs of the relevant industry sectors while ensuring wide applicability across all likely areas of use.
- Setting an example and providing valuable information and data for AM standard development across industries and research fields.

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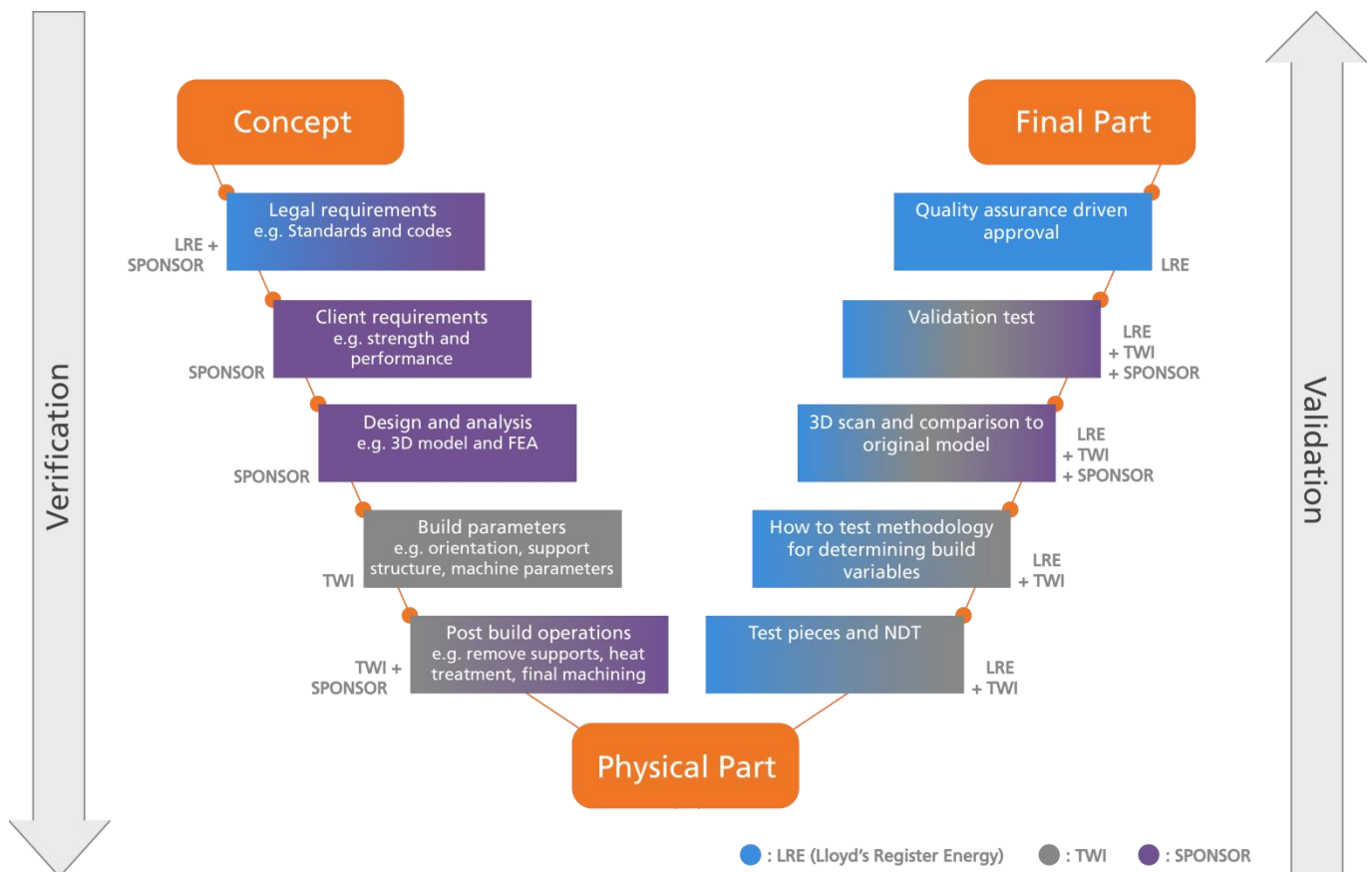
Benefits to Sponsors

- Certified parts that meet industrial requirements for quality, safety, and consistency, and which are qualified ready for market introduction.
- Improved knowledge of AM processes and practises to ensure repeatability and reproducibility and facilitate the certification of future parts.
- Decreased cost of certification by leveraging expert processing and certification knowledge and experience from both TWI and Lloyd's Register Energy.

Approach

This JIP will be jointly led by TWI and Lloyd's Register Energy and will be supported by several sponsors who will provide the detailed component designs to be the subject of case studies. Given the extensive variability that exists within AM, the case studies will be carefully selected to target key variables. The case studies will be limited to parts to be produced using Powder Bed Fusion and LMD processes with metallic powders. Ideally, the case studies will provide useful input to different aspects of the AM Guidelines; following selection, the project scope will be refined to suit the case studies.

The setup and delivery of the case studies will depend upon the nature of the selected components. A generic overview of how this might progress is illustrated below. There will be iterations within each stage, but the key outputs from each stage will feed into the AM Certification Guidelines. It is important these are developed in a timely manner in order to enable widespread application of the AM technology on an industrial scale. The methodology behind controlling and progressing through each stage and determining acceptance criteria will be included.



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Project Organisation Roles

TWI

TWI's role in the JIP is to lead the additive manufacturing element of the project, TWI has been involved in the development of laser based AM and powder materials processing technologies for a number of years. This has included the application, modelling and procedure development of NDT methods for validation of samples produced by its AM technologies. TWI has dedicated laser metal deposition and selective laser melting equipment along experienced staff available to support the project in both project management and delivery of results.

Lloyd's Register Energy

Lloyd's Register Energy's role in the JIP is to share its knowledge and expertise in a wide variety of disciplines from design and metallurgy through to final inspection. This will be vital in overcoming the engineering challenges encountered throughout the project. Lloyd's Register Energy's experience in certifying products to many global codes and regulations will ensure that the necessary steps are taken to achieve compliance to the standards of an independent, third-party certification body.

Deliverables

- Components produced by AM processes together with AM processing data and knowledge.
- Certification (conditional) of parts by Lloyd's Register Energy.
- Advisory services on AM processes by TWI.
- First edition of AM Certification Guidelines.

Price and Duration

The overall estimated price for the work is £300,000 (excluding VAT), which requires £60,000 per company for a duration of 12-18 months from each of the five Sponsors. It is anticipated that the project will commence with an agreed, reduced scope of work with a minimum of three Sponsors.

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

<http://www.twi-global.com/services/research-and-consultancy/joint-industry-projects/>

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