

mtc

Manufacturing
Technology Centre

NATIONAL CENTRE ADDITIVE MANUFACTURING



SETTING THE STANDARDS

Everything you
need from design
to delivery

Setting the Standards

The National Centre for Additive Manufacturing [NCAM] is here to accelerate the uptake of Additive Manufacturing [AM] by developing the technology and systems required to address the key challenges within the AM value chain.

As part of the Manufacturing Technology Centre [MTC], we're also proud to be home to The European Space Agency [ESA] AM Benchmarking Centre.



What is additive manufacturing?

Additive manufacturing (AM), also known as 3D printing, is a process where products are created by building layers of material on top of another until a complete 3D object is formed. The process can take digital design data and transform this information into a physical part within hours. AM has the potential to revolutionise the way products are designed, manufactured and even supplied. AM is already transforming the way some companies manufacture their products and has the potential to put the UK at the forefront of global manufacturing.

AM is not new, this groundbreaking technology has been used for Rapid Prototyping within sectors such as automotive and tooling for more than 30 years. However, rapid development of the technology means that AM is now becoming reality for end-use parts across a range of sectors, from aerospace to food production, as companies seek to take advantage of design freedoms, product performance enhancements and waste reductions that can be achieved with AM.



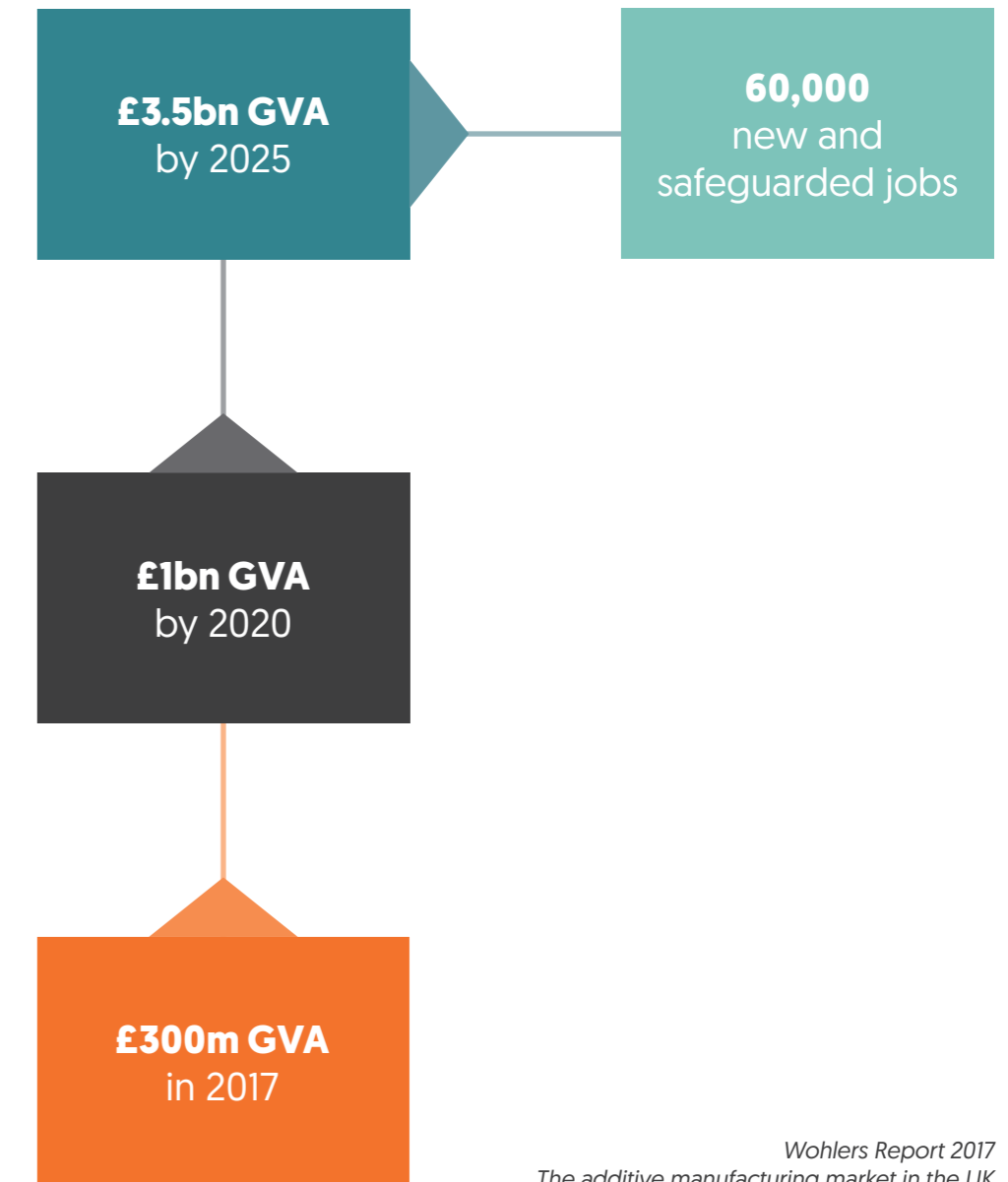
Growth potential of additive manufacturing in the UK

Growing importance of additive manufacturing

The worldwide market for all AM products and services is estimated to be worth over £6bn in 2017, growing to £20bn by 2022. In 2017 the UK has a 5% market share, and as a worldwide leader in High Value Manufacturing (HVM) the UK has strong foundations to expand its share of this global market opportunity resulting in new job creation and a significant increase in Gross Value Added (GVA). The opportunities for the UK include (but are not limited to):

- ▶ Direct revenues from the production of AM components
- ▶ Creating a robust UK supply chain for AM part manufacture
- ▶ Provision of best in class process chain equipment and services to the worldwide AM market

The UK however is not alone in identifying the opportunity of AM. Significant AM investment in countries such as Germany, Singapore, the United States and China could result in the UK HVM supply chains becoming uncompetitive and a loss of work to other countries.



The advantages of additive manufacturing

Product Function Attributes

Design freedom

Ability to design parts with geometric features that cannot be made any other way; allowing design freedom to create products with enhanced functionality such as air flow.

Mass customisation

As tooling isn't required for AM parts, each part can be tailored to its specific use, or user. This can create mass customisation from sunglasses to cars.

Material freedom

As AM matures, materials will be specifically designed for use in these processes, leading to parts with improved material properties such as toughness or wear resistance.

Reduced part count

AM can enable complex systems to be designed and manufactured as one part due to design freedom, leading to reduced part counts and assembly costs.

Product Supply Attributes

Waste reduction

AM builds components layer by layer to near final geometry resulting in significant material savings.

Lead time reduction

As tooling isn't required, parts can be manufactured in hours/days. Furthermore, rapid design iterations can be realised without expensive outlay on tooling.

Reduced inventory

AM can be used as an 'on demand' service, where parts are produced just ahead of when they are needed. This negates the need to hold extensive (and costly) product stocks.

Decreased cost

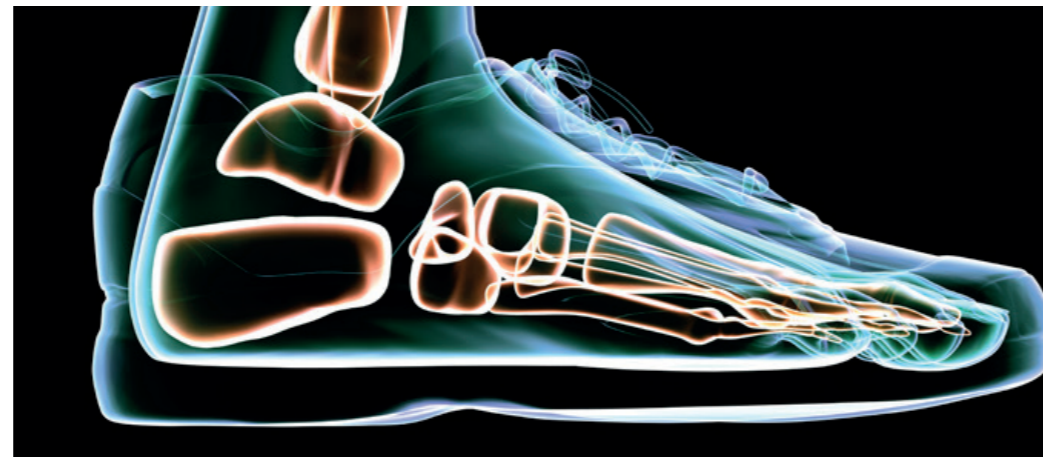
AM can offer significant through-life benefits over traditional manufacturing processes for a wide range of products and production volumes.

Current



Mass produced trainers are typically only available in standard sizes.

Future



Trainers will be designed using 3D scans on an individual's feet.



Bespoke trainer design is then 3D printed on demand.



Trainers are tailored to individual needs.

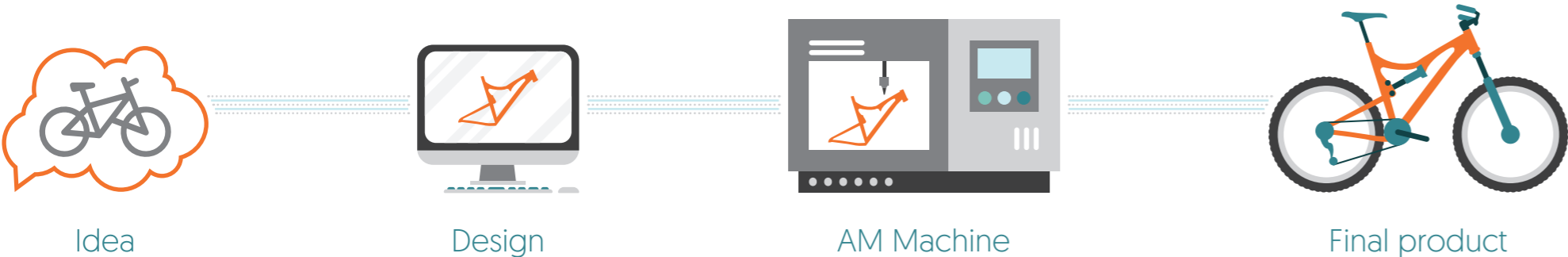
How simple is additive manufacturing?

A reality check

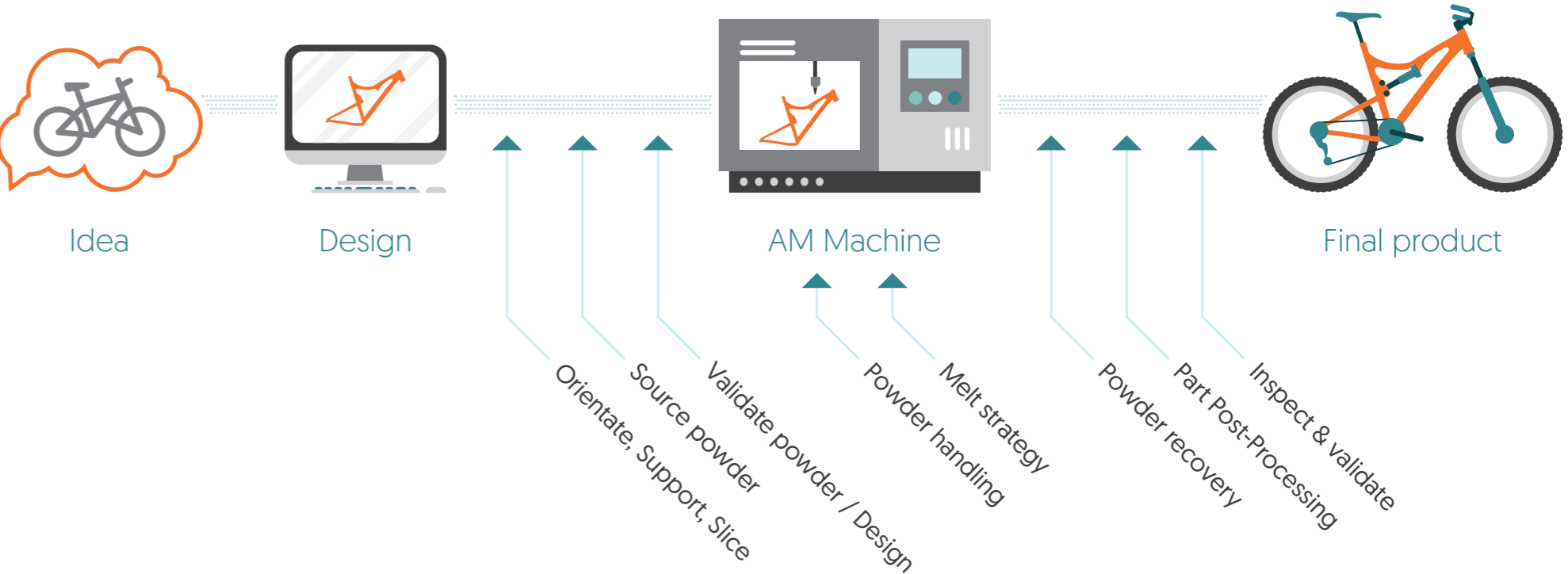
There is a significant opportunity for companies to improve their competitiveness by successfully adopting AM. However, the process is not as simple as it is often portrayed. The entire process from part design and production, to inspection and certification needs to be considered before the process can be successfully deployed.

The National Centre for Additive Manufacturing helps companies through their entire AM journey. We can provide advice and solutions for the whole process, from initial designs to product delivery, and even factory implementation, irrespective of their previous experience in AM.

A common view of the AM process



In reality...



Vision of the National Centre

Our aim is to rapidly commercialise AM for the UK HVM sector, by developing the technology and systems required to address the key challenges within the AM value chain.

DEVELOP A ROBUST UK ADDITIVE MANUFACTURING SUPPLY CHAIN:

- ▶ Offer UK supply chain a one-stop shop to develop AM capability
 - ▶ Demonstrate the latest advances in the entire AM process capability
 - ▶ Deliver solutions across the entire additive manufacturing process chain, from improvements to a particular bottleneck, through to delivery of digitally enabled AM production systems

DEVELOP BEST IN CLASS AM PROCESS CHAIN TECHNOLOGY:

- ▶ Provide an industrial scale demonstration facility and expert knowledge for AM technology providers to develop, test, and validate their innovations including materials, software, and hardware
- ▶ Minimise potential disconnect between service/ technology providers and AM users

IMPROVE THE UPTAKE OF AM BY UK PLC:

- ▶ Build confidence in additive manufacturing by:
 - ▶ Being central to standards and certification development for every aspect of the AM process
 - ▶ Improving awareness and education of AM
 - ▶ Creating a collaborative, independent environment
 - ▶ Helping companies explore new and disruptive business opportunities



We're helping to build the future of UK manufacturing

Ross Trepleton, Chief Engineer, MTC



How we can help

1

Awareness
[What is AM? When to use?]

- Training, advice and signposting
- Product portfolio assessment
- Literature / technology reviews
- Business justification

2

Understanding
[Proving AM suitability]

- Redesign and make projects
- Software evaluation
- Machine / hardware assessment and benchmarking
- Materials and manufacturing trials and testing

3

Development
[Making AM better]

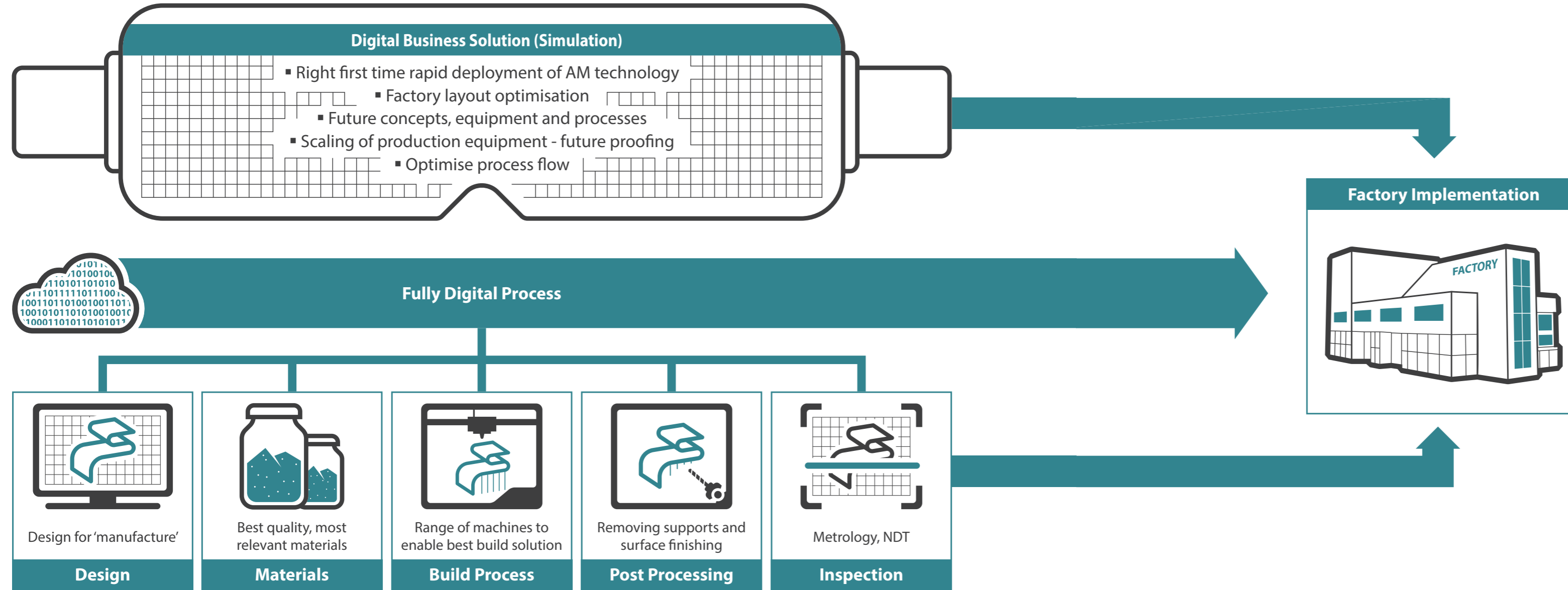
- Machine architecture
- Design capability
- Material / parameter development
- Rate capable inspection and post processing

4

Implementation
[Transferring to production]

- Pilot production [repeatability / rate trials]
- Development of procedures
- Facility design, including H&S
- Training

National Centre: Support across the entire additive manufacturing process



Design

Support the implementation of the correct software knowledge to optimise data flows, designs and exploit AM.

Materials

Validate material selection supply, and develop powder handling and quality assurance strategies.

Build process

Optimise build strategies for process chain efficiency [faster / cheaper, more reputable].

Post-Processing

Develop and validate efficient routes for support and surface finishing.

Inspection

Develop rate capable, cost effective inspection techniques.

Process Simulation

Modelling of the AM process to increase right first time manufacture.

Data Systems


Develop seamless data capture and analysis systems encompassing the whole process chain.

Factory implementation

Develop and validate AM quality processes, H&S procedures and workflows.

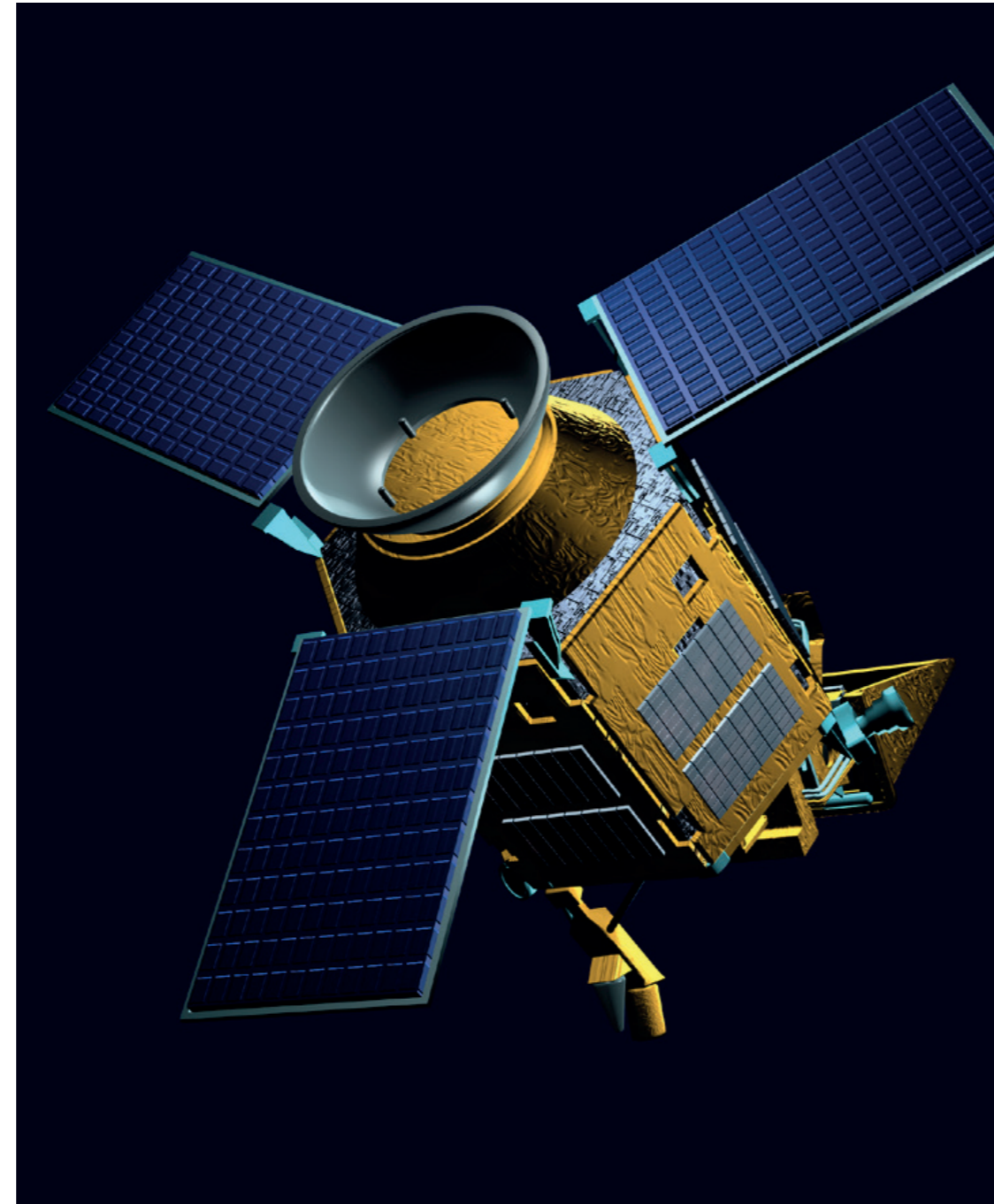
Leading partners

We work across all industry sectors and are home to exciting and influential partners.

 The **European Space Agency (ESA)** as their Additive Manufacturing Benchmarking Centre

We also work with:

- ▶ Government
- ▶ Industry
- ▶ Academia
- ▶ Trade Bodies
- ▶ Standards committees
- ▶ Media
- ▶ Catapult
- ▶ ATI
- ▶ Innovate UK
- ▶ EPSRC Future Manufacturing Research Hubs



The Sentinel-5 Precursor (Sentinel-5P) satellite image courtesy of ESA

MTC members supporting the National Centre

Design



Materials



AM Process



Post-Processing



Inspection



Training tomorrow's AM engineers

Developing the skills needed for the future and redressing the skills gap in industry is a key requirement for the successful exploitation of AM.

The Lloyds Bank Advanced Manufacturing Training Centre at the MTC is at the forefront of providing the skills and experience for the next generation to capitalise on the technologies of tomorrow.



AM Industrial Training Courses

- ▶ Design for AM
- ▶ AM Process
- ▶ Equipment Operation
- ▶ Material Handling & Management
- ▶ Post-Processing for AM Components
- ▶ Product Portfolio Assessment

Commercial Training

- ▶ E-Learning Modules
- ▶ Face-to-face Classrooms
- ▶ Virtual Classroom
- ▶ AMTC Virtual Learning Environment
- ▶ Additive Manufacturing Technology Collaborative Hub

Advanced Apprenticeship Programmes

- ▶ Level 3 - Advanced Apprentice
- ▶ Level 4 - Higher Apprentice
- ▶ Level 5/6 - Degree Apprentice
- ▶ Level 7 - Masters Apprentice

Case studies

Electron Beam additive manufacturing of front bearing housing aerofoils for test bed engines

Rolls-Royce discovered that development of AM is not limited to just small intricate components, but can also be used for large significant parts. The front bearing housing is the world's largest aero engine structure incorporating ALM components to fly.

To create the best solution, the MTC worked with Rolls-Royce and Arcam to develop processes from powder inspection and characterisation through component manufacture to post process and non-destructive testing of the AM components.

The outcome enabled AM components to be incorporated into ground and flying test bed XWB-97 engines. Hundreds of aerospace quality components were also manufactured under full Rolls-Royce control allowing extensive data capture.



This project has provided a key step in developing the industrial viability of ALM processes and has established a vital body of knowledge to inform and shape the next steps of this journey

Neil Mantle, Head of Additive Layer Manufacturing Centre of Competence, Rolls-Royce



This created clear benefits for the client:

- ▶ 30% improvement in lead time for first development parts to stores
- ▶ Fast iteration and design change implementation throughout project
- ▶ Transferable capability and knowledge obtained as a result



3D concrete printing

Skanska, Foster + Partners, Tarmac, ABB and Loughborough University approached the MTC to modify their 3D concrete printing (3DCP) system. The consortium aimed to create the world's first 3DCP system that would be portable, offer endless variability, increase productivity, reduce lead times and waste, compared to the current casting method.

The MTC redesigned the 3DCP system for safe handling and robot operation. The deposition head was upgraded to improve control, set up process and clean down process. Repeatability testing prints were designed to ensure robustness of the system.

The outcome enabled more complex shapes to be printed due to improvements in the tooling design. Development of the concrete dispenser resulting in the reduction footprint, mass and cost.



Until November 2016 we were doing everything ourselves and had taken it as far as we could, but by joining the MTC we now have proper lab and research facilities to conduct further tests and work on the project full-time

David Lewis, Innovation Manager, Skanska UK



This created clear benefits for the clients:

- ▶ Improvement in print design complexity (flexibility, repeatability and consistency)
- ▶ Elimination of manual handling activities
- ▶ Improved safety and reduced complexity for 3DCP operators
- ▶ Increased productivity, with reduced lead time and process downtime and waste



The MTC - Inspiring Great British Manufacturing

The National Centre for Additive Manufacturing (NCAM) is part of the MTC - a government-backed independent Research and Technology Organisation (RTO) that re-invests all profits to advance the development of technologies for UK industry.

The MTC bridges the gap between great ideas in academia and industry – often referred to as ‘the valley of death’ and is one of the seven centres that make up the High Value Manufacturing Catapult.

This is achieved by creating the very best innovative manufacturing processes and technologies, drawing on the skills and expertise of over 400 leading engineers and by having access to some of the most advanced manufacturing equipment in the world.

The MTC helps at every step of the way, from experimental research to implementation into industry, making the entire process run smoothly.

This approach ensures rapid and sustainable growth for the businesses we work with, by delivering end-to-end solutions and reducing the risks from manufacturing processes, supply chain and equipment investment.

We specialise in an extensive range of technologies and processes that are being adopted by industry, and our two large-scale workshop environments provide a perfect testing location for a wide range of projects.



Get involved in the future of additive manufacturing

Call us today to discover how we can help

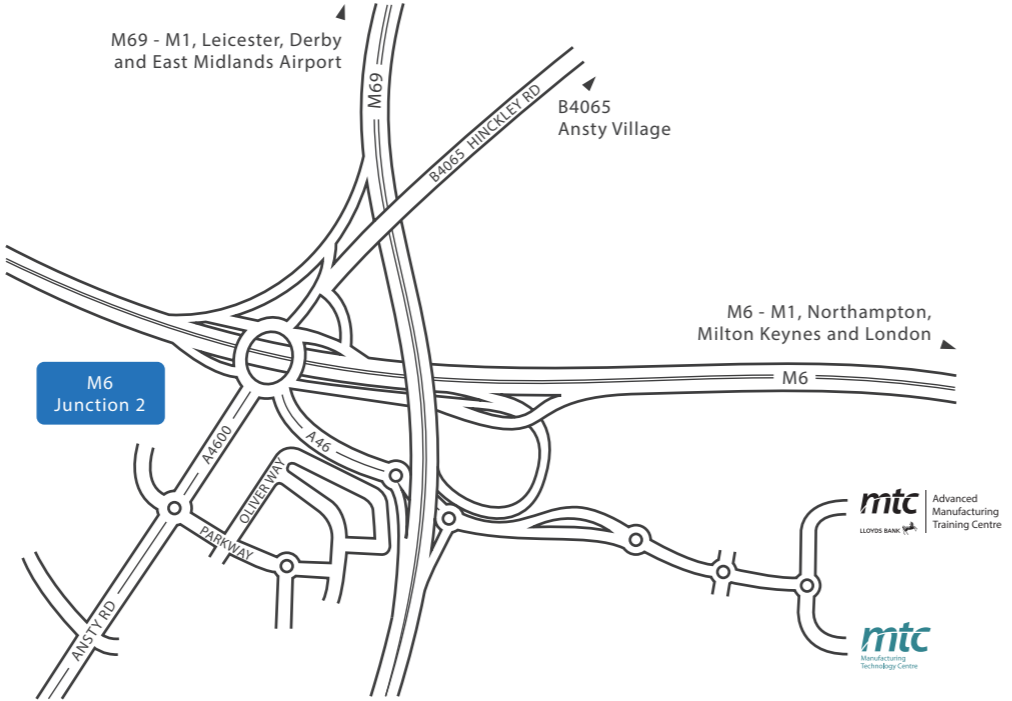
If you have any questions we'd like to hear from you.

If you're interested in working with us or would simply like to know more about additive manufacturing, don't hesitate to get in touch.

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High Value Manufacturing