
mtc
Manufacturing
Technology Centre
INSPIRING
Great British Manufacturing

mtc
Manufacturing
Technology Centre

IMPROVING PERFORMANCE AND PRODUCTIVITY FOR **DEFENCE** THROUGH ADVANCED MANUFACTURING **TECHNOLOGIES**

BACKGROUND

- Opened in 2011
- Independent RTO
- Secure facilities
- Prove innovative manufacturing ideas
- Manufacturing system solutions
- Training

MTC & HVM CATAPULT

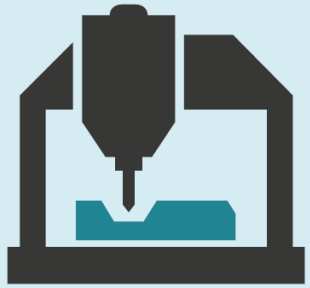
The High Value Manufacturing (HVM) Catapult is the catalyst for the future growth and success of manufacturing in the UK.

We are developing extensive capability in manufacturing technologies and process expertise to grow the contribution of the manufacturing sector to the UK economy.

The MTC will:

- Identify and implement new technologies
- Undertake research and development
- Complete client or collaborative projects
- Increase operational efficiency
- Support the supply chain
- Provide technical training and employee upskilling

INDUSTRY CHALLENGES



You want to make something

at a lower cost
better quality
quicker
in higher volume
you've never made before

You want to assemble something to

minimise reject rate
improve reliability
improve consistency
reduce waste
reduce errors

You want to use data more effectively for

improved design
better quality
efficient logistics
new business models

MANUFACTURING INNOVATION

Component Manufacturing

Additive Manufacturing

Non-Conventional Machining

High Integrity Fabrication

Assembly Systems

Advanced Tooling and Fixturing

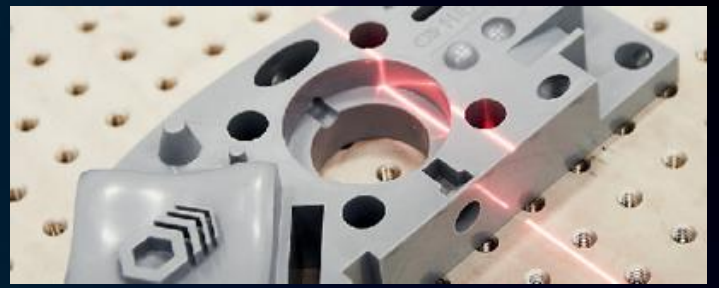
Electronics Manufacturing

Intelligent Automation

Data Systems

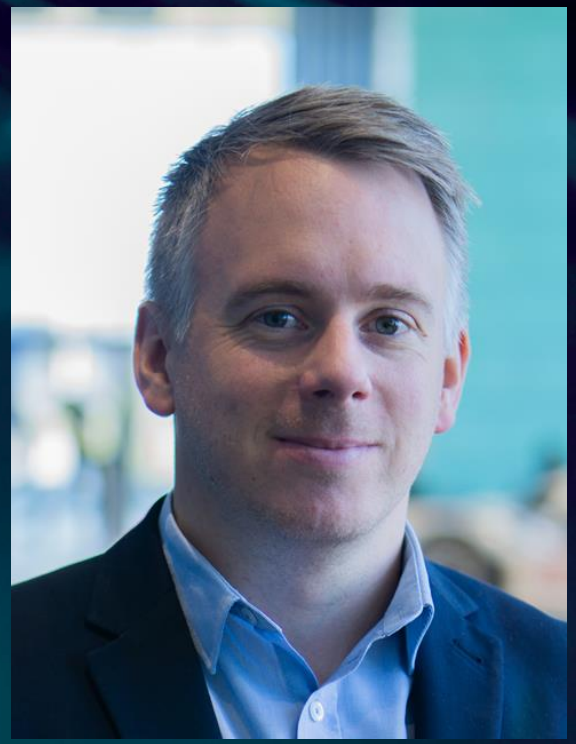
Design and Simulation

Manufacturing Informatics



Metrology and NDT

ADDITIVE MANUFACTURING IN DEFENCE



Dr. David Brackett

- Technology Manager for the National Centre for Additive Manufacturing
- Extensive knowledge of how AM can be used to create parts with improved performance

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NATIONAL CENTRE ADDITIVE MANUFACTURING

Dr. David Brackett, Technology Manager - AM

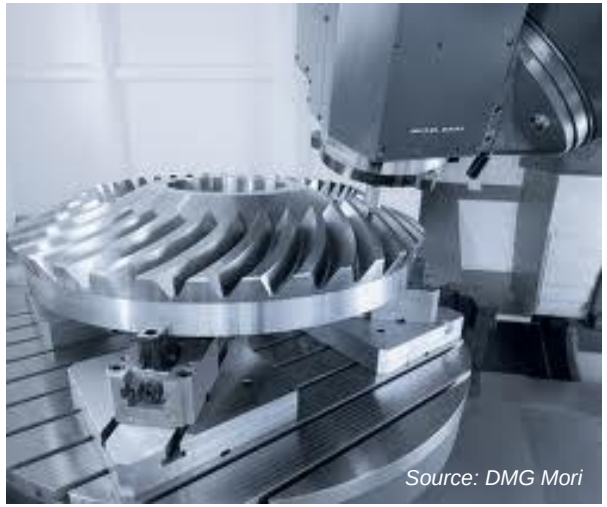
September 2019

david.brackett@the-mtc.org

CONTENTS

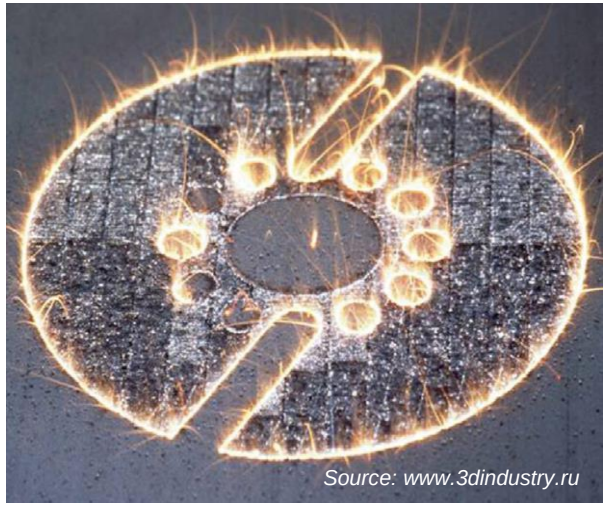
WHAT IS AM?

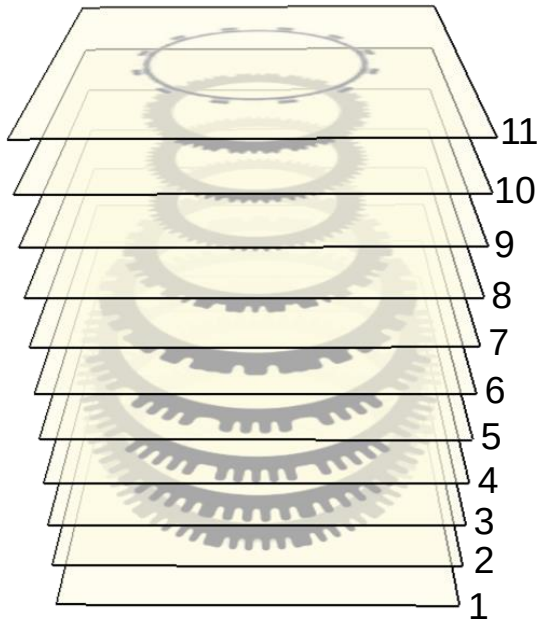
ADDITIVE MANUFACTURING


Source: DMG Mori


Source: James Peniston sculpture


Source: www.thomasnet.com


Source: www.3dindustry.ru




Source: Shapeways Magazine

BENEFITS - PRODUCT FUNCTION

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Design freedom

Material freedom

Mass customisation

Reduced part count

Courtesy: Within

BENEFITS - PRODUCT SUPPLY

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Waste reduction

Reduced inventory

Lead time reduction

Decreased cost

Source: 3D Hubs

KEY APPLICATION SECTORS

- Aerospace
- Defence
- Space
- Medical /dental implants & devices
- Power generation equipment
- Motorsport

- End use components
- Prototypes
- Manufacturing aids (jigs / fixtures)
- Tooling

Courtesy: GE

Courtesy: The MIA

Courtesy: Siemens

Courtesy: Renishaw

Courtesy: Renishaw & Thales Alenia Space

OPPORTUNITIES

OPPORTUNITIES

"It is my strong belief that 3D printing and advanced manufacturing are breakthrough technologies for our maintenance and logistics functions in the future."

Vice Admiral Philip Cullom, deputy chief of naval operations for fleet readiness and logistics.

Defence requirements:

- High performance components
- Fast response / Agility
- Cope with a disrupted supply chain
- Cost not necessarily main driver

https://www2.deloitte.com/content/dam/insights/us/articles/additive-manufacturing-defense-3d-printing/DUP_1064-3D-Opportunity-DoD_MASTER1.pdf

https://www.eda.europa.eu/what-we-do/activities/activities-search/additive-manufacturing-3d-printing-feasibility-study-technology-demonstration

WHY MIGHT AM BE USEFUL?

Improve the product itself and the product development process

PROTOTYPING

Manufacture of large scale test models for product development. Reduced cost of and more robust prototypes compared to traditionally made. (MSubs)

3D printed skulls created to test helmets (US Army)

Prototype of grenade launcher (50 parts) made out of SS, Al. Ammunition also printed. Similar performance to serial model.

[32] *Original source:* https://www.3trpd.co.uk/portfolio/submergencemsub-uuvs-modelled-using-am/gallery/defence-case-studies/. *The image used for illustrating this application is courtesy of 3T RPD Ltd.*

[33] *Original source:* http://www.3ders.org/articles/20140808-us-army-to-3d-print-synthetic-skulls.html/.

[36] *Original source:* https://gizmodo.com/the-armys-new-3d-printed-grenade-launcher-is-straight-o-1793135356. *The image used for illustrating this application is courtesy of the U.S Dep. Defense. The appearance of U.S. Department of Defense visual information does not imply or constitute its endorsement.*

Examples taken from EDA doc.

WHY MIGHT AM BE USEFUL?

Improve the product itself and the product development process

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END-USE PARTS

Nacelle hinge bracket (Airbus). Reduction in weight and overall cost.

AM components within missile and propulsion systems (MBDA, Raytheon)

AM of customized explosives (US Marine Corp). Tailor the blast and associated fragmentation.

AM of breaching tools (US Army Ex Labs)

[41] *Original source: http://www.3ders.org/articles/20160714-entirely-3d-printed-missiles-on-the-horizon-says-raytheon-missile-systems-president.html. The image used for illustrating this application is courtesy of the U.S Department of Defense. The appearance of U.S. Department of Defense visual information does not imply or constitute its endorsement.*

[38] *Original source: https://3dprint.com/151257/marines-3d-printed-munitions/. The image used for illustrating this application is courtesy of ChildishGiant under Creaive Commons CCO licence.*

[47] *Original source: https://www.army.mil/article/178822/army_explores_3_d_printings_future_applications_for_soldiers_force. The image used for illustrating this application is courtesy of the U.S Dep. Defense. The appearance of U.S. Department of Defense visual information does not imply or constitute its endorsement.*

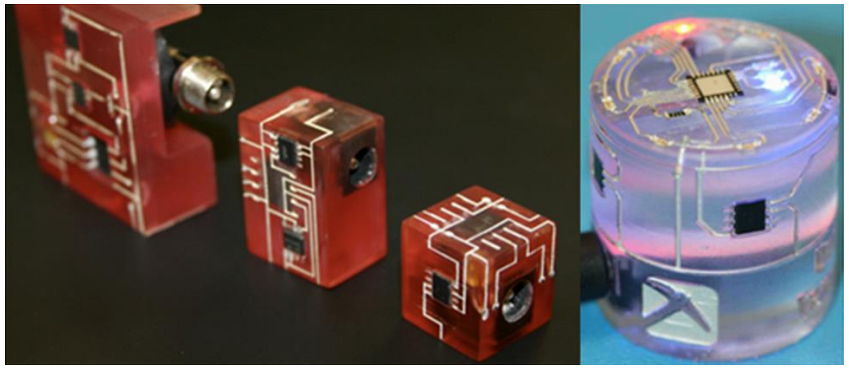
Examples taken from EDA doc.

WHY MIGHT AM BE USEFUL?

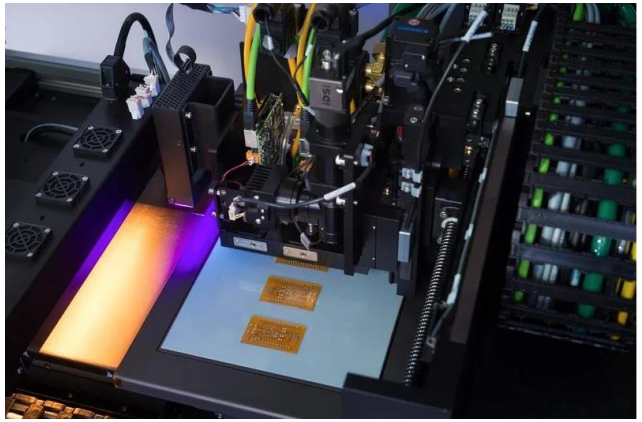
Improve the product itself and the product development process

END-USE PARTS

Printed / embedded electronics in AM parts



https://3dprint.com/98377/utep-america-makes-grant/



https://www.nano-di.com/blog/topic/printed-electronics

WHY MIGHT AM BE USEFUL?

Improve the manufacturing supply of the products

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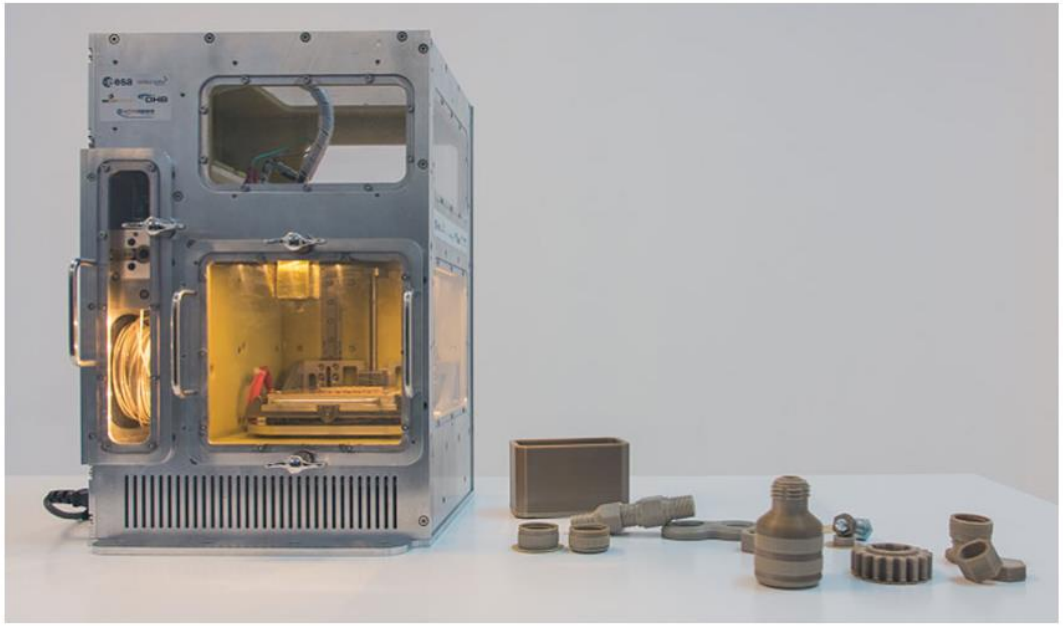
LOCAL MANUFACTURE

US Army's Rapid Equipping Force fabricated labs.

A new 3D printer aboard the International Space Station?

POSTED ON MAY 25, 2018

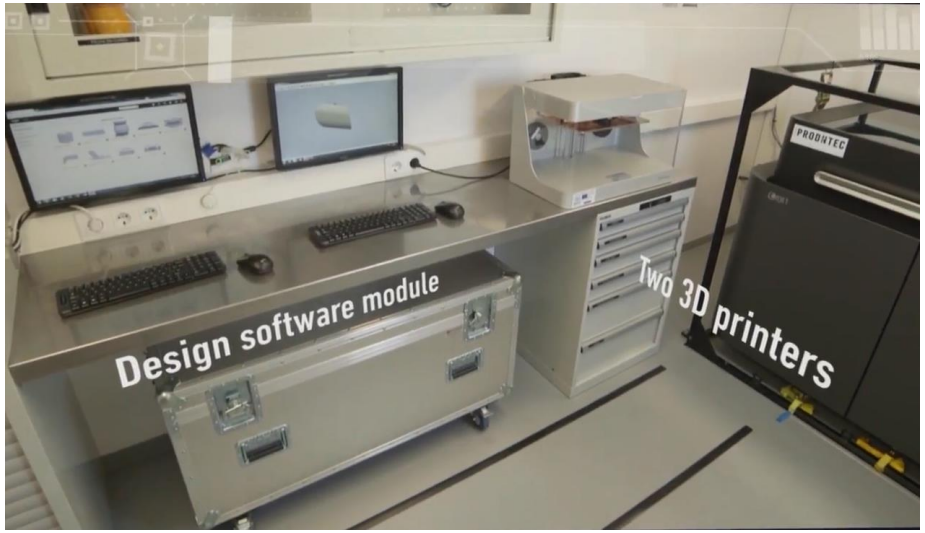


https://www.3dnatives.com/en/3d-printer-space250520184/

WHY MIGHT AM BE USEFUL?

Improve the manufacturing supply of the products

LOCAL MANUFACTURE



Self-sustainability at sea.
Handheld radio clasps (USS Harry Trumen), tools, utensils, broken handles etc.

https://www.eda.europa.eu/what-we-do/activities/activities-search/additive-manufacturing-3d-printing-feasibility-study-technology-demonstration

WHY MIGHT AM BE USEFUL?

Improve the manufacturing supply of the products

LOCAL MANUFACTURE

3D-printed plane flies from Royal Navy ship

24 July 2015 Share

A 3D-printed aircraft has been launched from a Royal Navy ship and landed safely on a Dorset beach.

https://www.bbc.co.uk/news/uk-33656489

Custom-made reconnaissance drones for planned missions. (US Army)

[43] *Original source: http://www.tctmagazine.com/3D-printing-news/us-army-research-engineers-3d-printed-drone-soldiers/. The image used for illustrating this application is courtesy of the U.S Dep. Defense. The appearance of U.S. Department of Defense visual information does not imply or constitute its endorsement.*

Example taken from EDA doc.

WHY MIGHT AM BE USEFUL?

Improve the manufacturing supply of the products

LOCAL REPAIR

Harbin Destroyer broken wheel gear (Chinese Navy 2014). AM was equipped with AM to produce spare part.

https://3dprint.com/35981/china-pla-navy-3d-printing/

Repair of fleet of F-15 fighter jets (Israeli Air Force Aerial Maintenance Unit) (polymer parts)

[55] *Original source: https://3dprint.com/130515/iaf-3d-printed-parts/. Image courtesy of the Israel Defense Forces. The appearance of Israel Defense Forces visual information does not imply or constitute its endorsement*

Example taken from EDA doc.

CHALLENGES WITH AM

- Low productivity of systems
- High cost of parts
- New – lack of understanding
- Rapidly developing
- Limited materials
- “just click print”…?
- Surface finish
- Process variability
- Inspection and testing
- Unfamiliar feedstock and material properties
- Unfamiliar opportunities for redesign
- Lack of supply chain

NCAM helps companies through entire AM journey

CAPABILITIES

ADDITIVE MANUFACTURING AT THE MTC

UK National Centre for AM
since 2014

European Space Agency (ESA)
AM Benchmarking Centre
since May 2017

ASTM Centre of Excellence for AM
since April 2018

CENTER of EXCELLENCE
RESEARCH TO STANDARDS
Additive Manufacturing

Founding partners

Strategic partners

OUR APPROACH

1	**Awareness** (What is AM? When to use?)	Training, advice and signposting	Literature / technology reviews
		Product portfolio assessment	Business justification
2	**Understanding** (Proving AM suitability)	Redesign and make projects	Machine / hardware assessment and benchmarking
		Software evaluation	Materials and manufacturing trials and testing
3	**Development** (Making AM better)	Machine architecture	Material / parameter development
		Design capability	Rate capable inspection and post processing
4	**Implementation** (Transferring to production)	Pilot production (repeatability / rate trials)	Facility design, including H&S
		Development of procedures	Training

AM EXPERTISE - METALS

METALS

- Powder bed fusion (laser & electron beam) & hybrid-PBF



- Metal binder jetting


- Directed energy deposition (laser-wire & arc-wire) + hybrid-DED



AM EXPERTISE - METALS

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METALS

- Powder bed fusion (laser & electron beam) & hybrid-PBF

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Electron beam AM of front bearing housing aerofoils for ground and flying test bed engines

The MTC worked with Rolls-Royce on the additive manufacture of a flight test front bearing housing – the largest aero engine structure to fly, incorporating ALM components, in the world to-date.

AM EXPERTISE - POLYMERS

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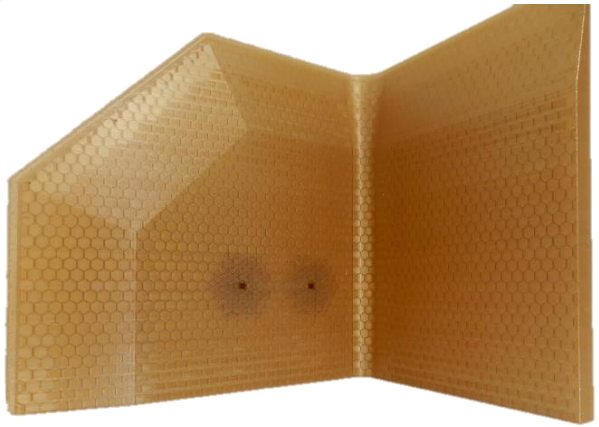
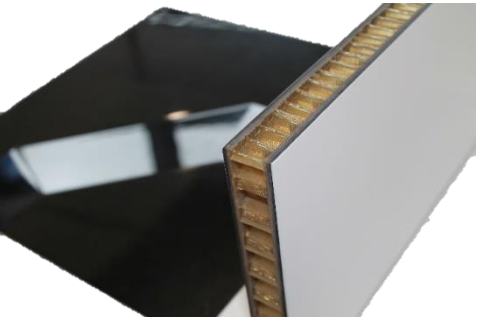
Shielding Gas Nozzle designed for application and built using HP Jet Fusion





Insert for a sandwich composite panel, conventionally machined out of foam was redesigned and printed to allow better mechanical performance around fasteners, pattern variation and thickness variation

Camera Holder designed for application and AM and built on EOS polymer PBF
(images courtesy of RNLI)

AM EXPERTISE - CERAMICS

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CERAMICS

- Ceramic vat photopolymerisation
- Ceramic binder jetting

AM EXPERTISE - CERAMICS

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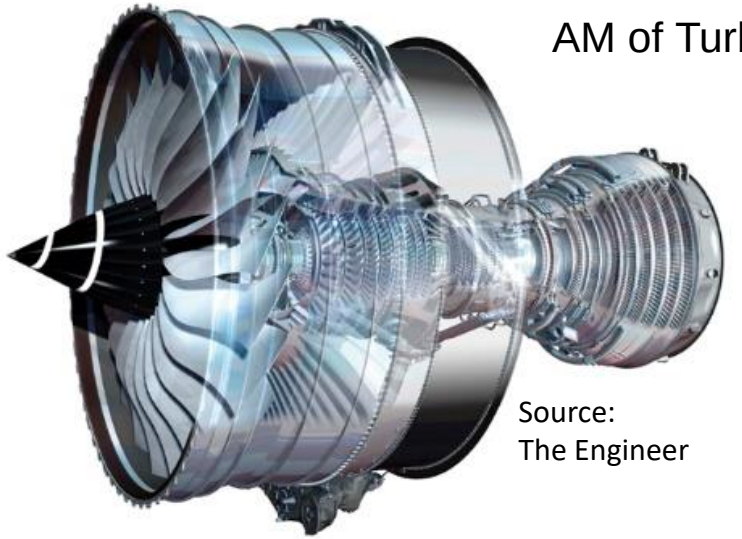
Ceramic AM of Foundry Filters

Re-design and print

Carbonization and firing

AM of Turbine Blade Casting Cores



Source: The Engineer

Source: Morgan Technical Ceramics

CERAMICS

- Ceramic vat photopolymerisation
- Ceramic binder jetting

AM EXPERTISE

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METALS

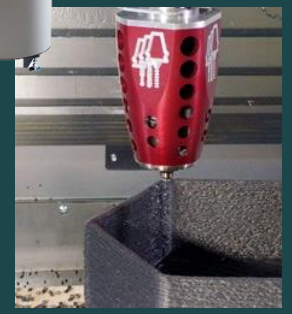
- Powder bed fusion (laser & electron beam) & hybrid-PBF

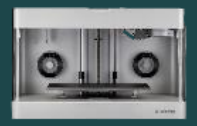
- Metal binder jetting

- Directed energy deposition (laser-wire & arc-wire) + hybrid-DED

POLYMERS

- Material jetting
- Material extrusion
- Vat photopolymerisation
- Powder bed fusion





CERAMICS

- Ceramic vat photopolymerisation
- Ceramic binder jetting

NEW FACILITY

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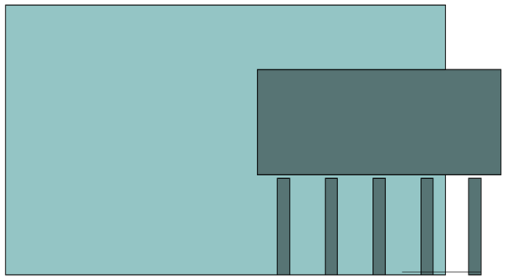


Innovate UK

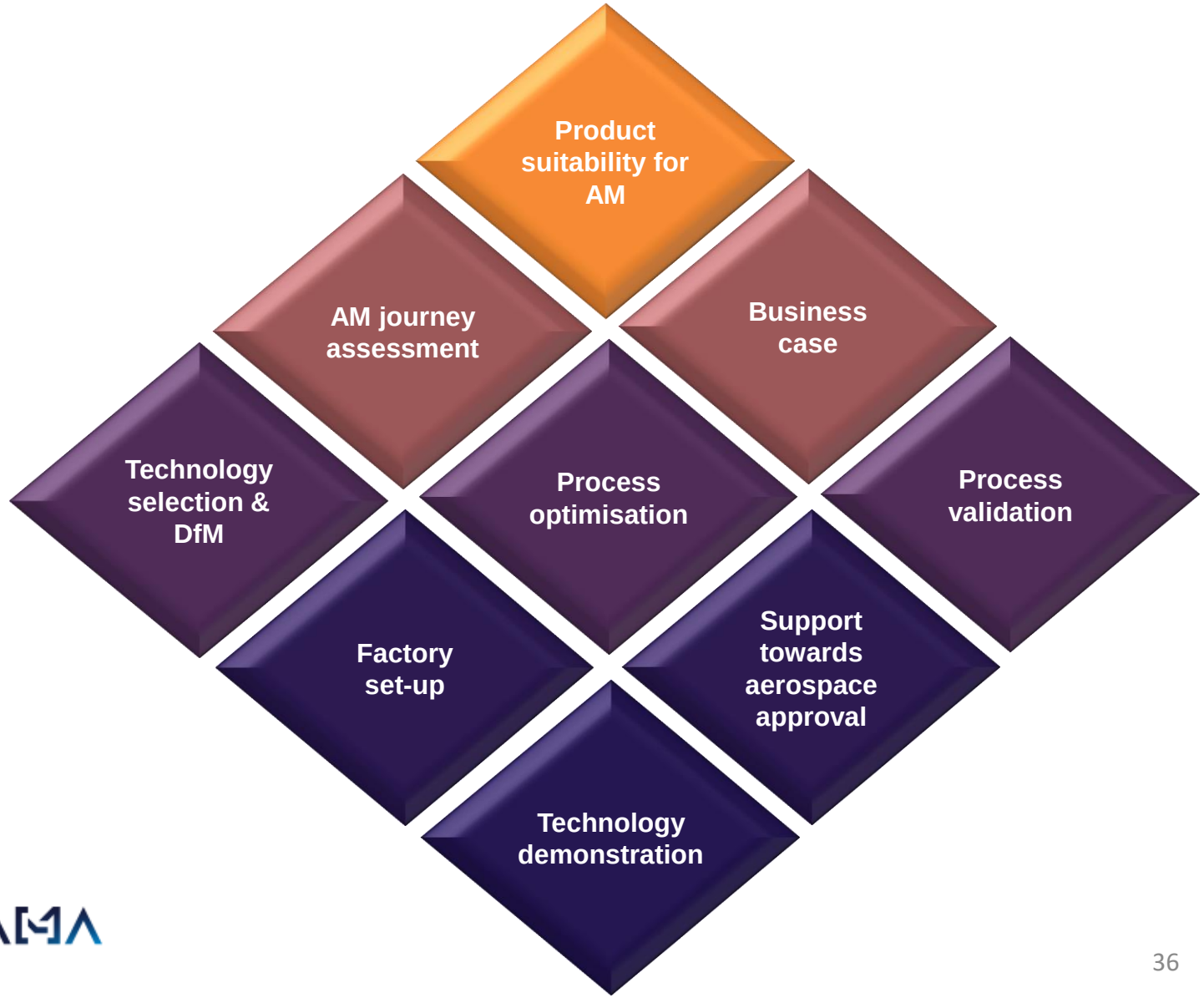
AEROSPACE TECHNOLOGY INSTITUTE

BUILT BY DRAMA

SUPPLY CHAIN ENGAGEMENT

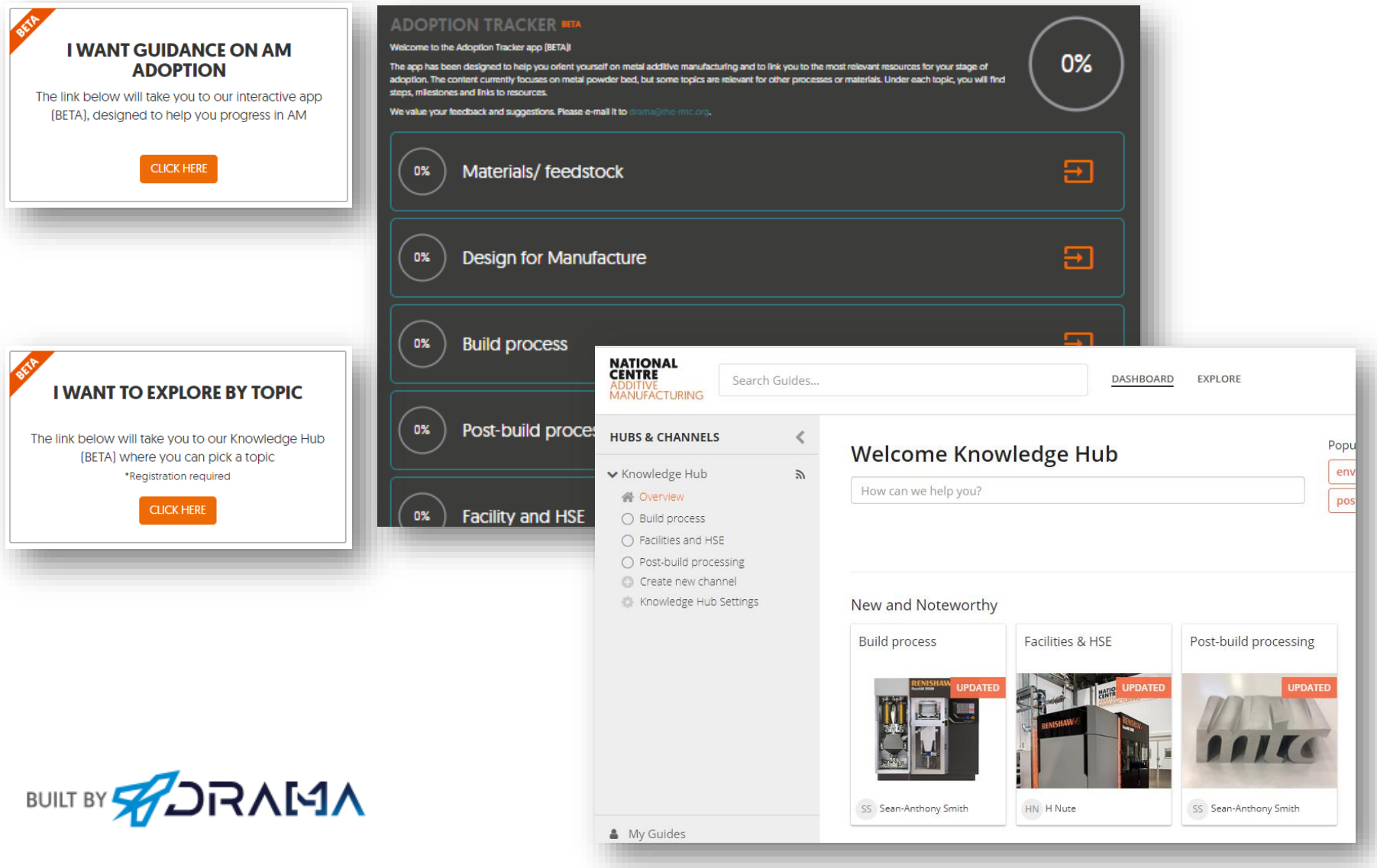
- DRAMA is developing support packages.
- We are looking for companies to road test our support packages now.

- Contact the Midlands Aerospace Alliance to find out more:
  - info@midlandsaerospace.org.uk



KNOWLEDGE HUB

- New online portal for information about AM for the UK supply chain.
- Beta-testing through summer 2019. Speak to someone on the DRAMA stand if you are interested in testing the Hub for us.
- Also looking for content contributors to this national asset.



Innovate UK

AEROSPACE TECHNOLOGY INSTITUTE

BUILT BY DRAMA

TRAINING

- A competency framework for Additive Manufacturing
- An online training needs analysis tool
- Signposting to AM training providers
- An AM apprenticeship
- A series of AM short courses for engineers and business leaders

For more information:

the-amtc.co.uk/training

SUMMARY

1. Intro to AM
2. Opportunities for defence sector
3. Capabilities of NCAM

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