

[dstl]

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Ministry
of Defence

Logistics technology investigation project:

Additive Manufacturing

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Additive manufacturing (AM) or 3D printing – the computer controlled manufacture of objects layer by layer.

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Outline

- Additive manufacturing (AM) at Dstl
- Deployed AM
- Logistics Technology Investigations Project (LTIP)
- Additive manufacturing work package
 - Outline
 - Current phase activities
 - Opportunities to work together
 - Next steps



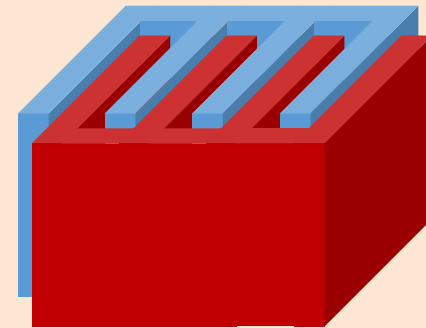
Additive manufacturing at Dstl

- Expanding the range of materials that can be printed
- AM for structures
- Removing the barriers to adoption of AM by the UK MOD
- Quantifying the logistics benefits of AM

Additive manufacturing at Dstl

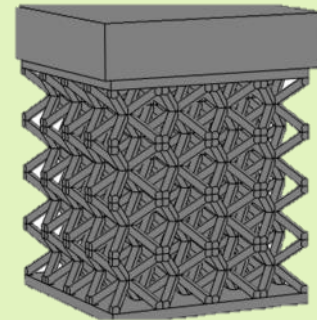
- Expanding the range of materials that can be printed
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- Dielectric materials
- Energetics
- 4D printing
- 3D Batteries



Additive manufacturing at Dstl

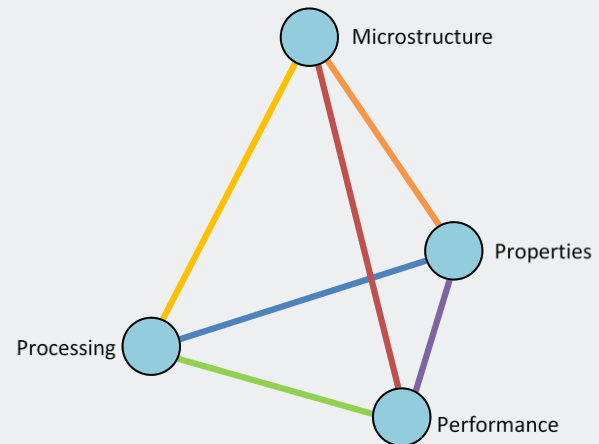
- Expanding the range of materials that can be printed
 - **AM for structures**
 - Removing the barriers to adoption of AM by the UK MOD
 - Quantifying the logistics benefits of AM
- Aero engine blisk repair
 - Complex engine/missile components
 - WAAM e.g. armoured vehicle repair
 - Lightweight lattice structures



Additive manufacturing at Dstl

- Expanding the range of materials that can be printed
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- Qualification and certification of AM – MASAAG guidance note released
- Corrosion of AM



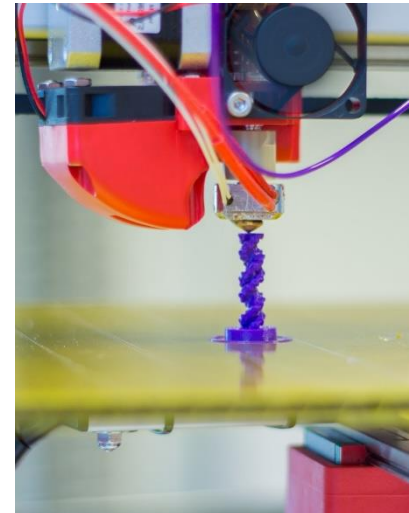
Additive manufacturing at Dstl

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- Today's focus

Deployed AM: where are we now?

- Technology focussed
 - Assessing what AM can do for us
 - Purchasing kit and training people up to use it
- Main parts manufactured using deployed AM:
 - New components
 - Modifications
 - Demonstrations



https://commons.wikimedia.org/wiki/File:Felix_3D_Printer_-_Printing_Head.JPG

Deployed AM: where do we want to be?

Def Logs AM concept note

Velocity	<ul style="list-style-type: none">• Speed of parts delivery will be improved by pairing distribution and manufacturing.• Speed of modification to equipment will be increased.• Improved obsolescence resolution.• Notice to Effect will be shorter because less spares need to be moved.• Delivery times for parts will be reduced.
Reduced Cost	<ul style="list-style-type: none">• Storage of spares will be reduced and change to increase 'E-spares'.• Print stock can be purchased and delivered to the JOA..• Recycling will reduce waste and enable new packaging to be developed and reused.• Generic feedstock purchased closer to JOA so specific parts don't need to be transported from the UK
Reduced Footprint	<ul style="list-style-type: none">• Reduced variance in support chain and greater interoperability with allies.• Stock holding sites will become smaller therefore easier to move and manage.• NATO Logistics support chains will use print stock and manufacture sovereign items.• Redesign of platforms to reduce weight and operating costs while increasing endurance and reducing fatigue.
Wider Benefits	<ul style="list-style-type: none">• Reduced demand on the strategic base.• Greater whole force interaction with smart contracting.• Quicker prototyping and adoption of modifications.• Swarming will enable: printing at speed or the manufacture of many items at the same time.

Deployed AM: what is needed to get there?

- Focus on replacement parts
 - More critical components and qualification and certification
 - Materials properties and standards
 - Develop strategies to identify which parts we should print
- Identify which AM kit we should use where
- Identify blockers to AM
- Training
 - Share training and best practise across defence

Logistics Technology Investigation Project (LTIP)

Additive
manufacturing

Data Science
and Analytics

Future
Distribution

Autonomy and
Automation

Maintenance
and Repair

Fossil fuels /
Alternative
Energy

Culture and
behaviour

Logistics Technology Investigation Project (LTIP)

Key features:

- Future focussed
 - looking at technology in the 10, 20 and 30 year timeframes
- Supported by data science
- Robust cost benefit achievability analysis
- Supported by development of future distribution model
 - Used to understand the processes, risks and costs in the supply chain, both as it looks today and what it could look like in the future.

LTIP AM work package (WP)

- Focussing on two key use cases for AM:
 - Mission critical defects/ operational defects - Caused by a parts shortage
 - Obsolescence - Parts which are no longer available from the original supplier, or that would require significant minimum buys for a minimal requirement
- The WP will progress in four phases:
 - Phase 1: Identifying components
 - Phase 2: Cost Benefit analysis
 - Phase 3: Trials
 - Phase 4: Outputs and decision support tools

LTIP linkages to AM WP

Additive manufacturing

Data Science and Analytics

- Understand defects caused by a part shortage

Future Distribution

- Enables the Systems of Systems trade off of AM

Autonomy and Automation

- Can we automate AM and print the part before we know we need it?

Maintenance and Repair

- How does AM impact our repair capabilities?

Fossil fuels / Alternative Energy

- What are the energy implications of AM?

Culture and behaviour

- Does AM lead to a whole new set of Behaviours issues?

Phase 1 and 2 outline

Core activity

Which parts are a problem?

Which parts can be made using AM?

Manufacture down-selected parts

Opportunities/ blockers for AM

Cost benefit achievability analysis (CBAA)

Phase 1 and 2 outline

Core activity	Method development
Which parts are a problem?	Method to identify what parts are a problem
Which parts can be made using AM?	Method to identify which parts can be made using AM
Manufacture down-selected parts	Testing the developed methods
Opportunities/ blockers for AM	Method for CBAA to decide which printer and where in the supply chain
Cost benefit achievability analysis (CBAA)	

Phase 1 and 2 outline

Core activity	Method development	Decision support
Which parts are a problem?	Method to identify what parts are a problem	What to print when you have a printer
Which parts can be made using AM?	Method to identify which parts can be made using AM	
Manufacture down-selected parts	Testing the developed methods	What printer and where in the supply chain to put it to get the best benefit
Opportunities/ blockers for AM	Method for CBAA to decide which printer and where in the supply chain	
Cost benefit achievability analysis (CBAA)		

Phase 3: Trials

- Key aims:
 - Test developed methodologies
 - Further identify blockers to deployment of AM
- Likely format:
 - Identify – redesign – manufacture – test - analyse
 - Aligned with existing exercises
 - Collaborative – within MOD and with Allies
 - Choosing difficult components to test our methods
 - Print parts using other MOD printers to compare properties.

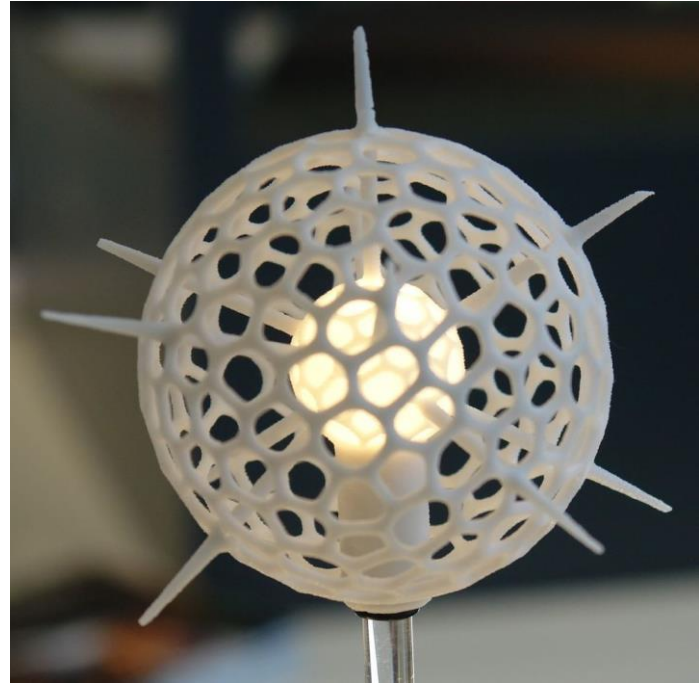
Opportunities to work together

- Identifying mission critical defects caused by a parts shortage
- Sharing data about parts
- Sharing data about AM capabilities
- Examples of parts printed using deployed AM
- Print parts using other MOD printers to compare properties
- Share information about blockers to AM being used

Next steps

- Identifying mission critical defects caused by a parts shortage
 - Further workshops planned, contact us if you'd like to be involved.
- Down-selecting and manufacturing parts
- Detailed planning of trials
 - Lots of opportunities to work together on this

Any Questions



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