National Armaments Director Group

Additive Manufacturing as a Service a.k.a Project TAMPA

Collaborative Working Groups

02-03 June 2026

Welcome, Housekeeping and Agenda for the Day

Edit Barbantan & Duncan Wood

10:00-10:05

Welcome!

•There are **NO** fire alarm test planned.

•Evacuation assembly points are located **outside the NEC atrium entrance 1 and 2**.

•Toilets located by Hall 8 and all around the public area at the NEC.

•Smoking is permitted outside NEC premises.

•Photos are permitted from personal devices. **NO video and audio recording.**

•Lunch will be provided in the **TCT 3Sixty VIP Lounge in Hall 8** from 12.30 - 13.30

ATRIUM ENTRANCE

If entering from the Atrium entrance, follow the pink lines to the right, and find the Concourse suites 22 and 23 for the project TAMPA meeting on your left.

TCT 3Sixty is taking place just next door in Hall 8 - follow the blue arrows.

Aim: The aim of the event is to present lessons learnt from Spirals 3 A and B.

Objectives:

1. Understand what progress has been made on the Executive Group (EG) priorities since March.
2. Understand the lessons learnt from Spiral 2, 3 A and 3 B.
3. Understand interoperability and equivalency challenges.

National Armaments Director Group

Agenda for adverts

Day 1 – 02/06/2026

09:30 Arrival – Tea & Coffee

10:00 Welcome & Agenda

10:05 Additive Manufacturing (AM) in Defence; update to include Accelerating the Adoption of Additive Manufacturing (ATAAM) Programme, Project TAMPA and Executive Group Priorities and Key Performance Indicators

10:25 NP Aerospace final PJ TAMPA Spiral 2 Lessons from Experience update, with Q&A

10:50 Update on MOD AM Use Case Repository

11:00 Babcock's Spiral 3 lessons on material equivalency analysis provided by Plastometrex

11:10 Qualification overview by America Makes

11:30 Lunch break (2 hours)

13:30 PJ TAMPA Spiral 3 A update from NP Aerospace and Thales, followed by a joint Q&A session

14:20 ASTM's launch of the AM Part Certification Guidance Document

14:35 RBSL's wider AM work

14:50 Wrap up of Day 1

15:00 Close

Day 2 – 03/06/2026

10:30 to 12:20 – Lessons from Experience sessions

10:30 Introduction to the challenge by the UK MOD and US DOW

10:40 UK Project TAMPA Spiral 3 B update from Babcock and RBSL, followed by a joint Q&A session

11:30 US Allied Additive Manufacturing Interoperability (AAMI) Project update from Eaton and Lockheed Martin, followed by a joint Q&A session

12:20 to 13:05 Panel: From Collaboration to Capability - the UK–US Path to Interoperable Defence Support

- With Babcock, RBSL, Lockheed Martin, Eaton, US DOW + MOD as panel chair.
- Opening remarks will be provided by the panel chair, with introductions from panel members, followed by a questions and answers session.

Additive Manufacturing (AM) in Defence: Project TAMPA Executive Group Update, Accelerating the Adoption of Advanced Manufacturing (ATAAM) Programme & Project TAMPA Update

Ross Trepleton, Charlotte Robinson &

Wg Cdr Jon McMahon

10:05-10:25

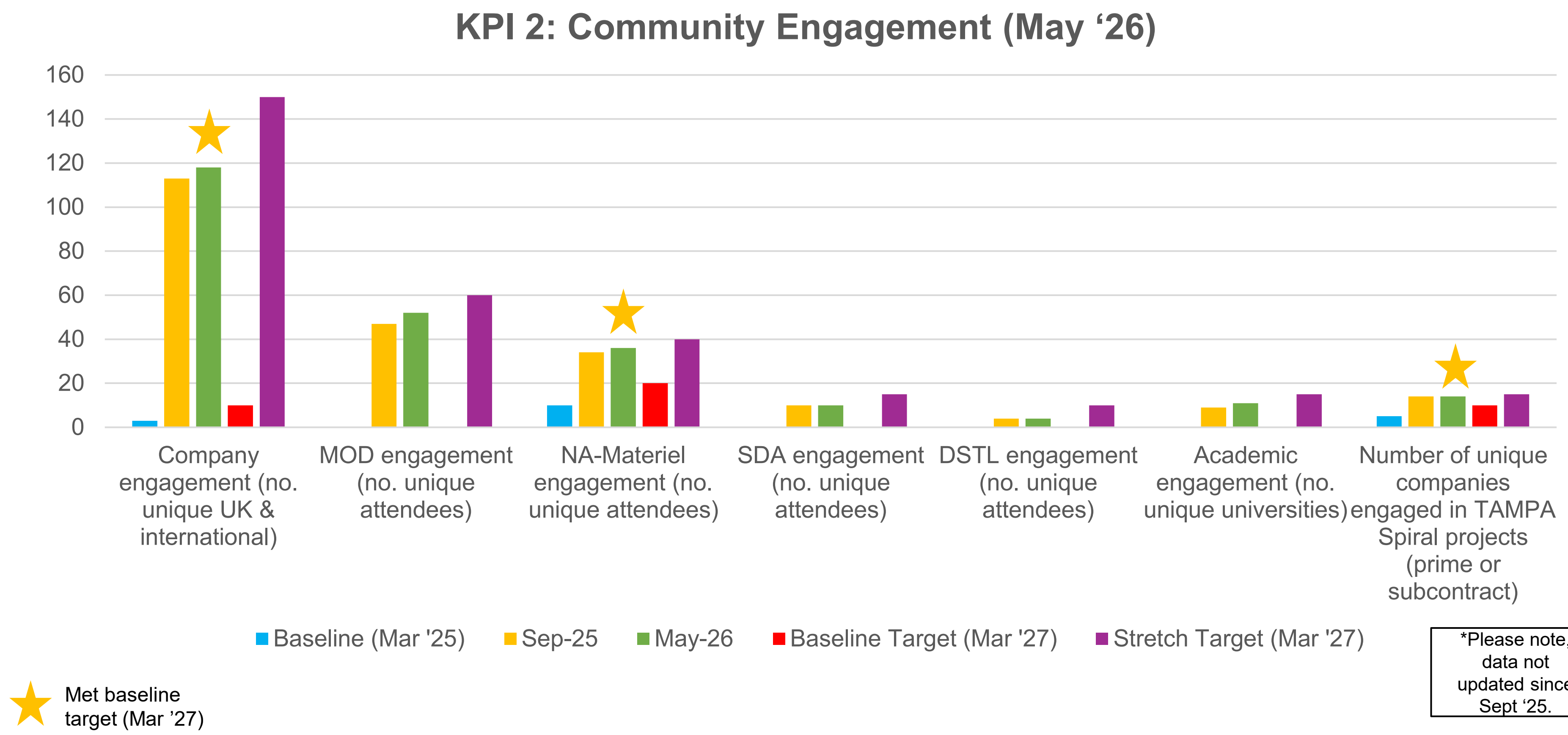
National Armaments Director Group

Executive Group Priorities 2026

#	Priority	% Complete	Tasks	Owner
1	**Complete Spiral 3 & Kick Off Spiral 4**		1. Complete Spiral 3a and 3b with lessons shared. Partially complete. Lessons shared today & tomorrow. 2. Commission Spiral 4 feasibility study. Complete. 3. Commission Spiral 4 – route to market proof of concept.	1. Spiral 3 suppliers 2. DefSp Innovation & Deca 3. DefSp Innovation & Deca
2	**Develop Defence AM Digital Thread**		1. Finalise and issue the template Technical Data Pack. In progress 2. Showcase Phase 1 Defence DT Testbed. Complete 3. Commission testbed Phase 2. In progress 4. Issue initial AM cyber security guidance. In progress 5. Complete Rapid-e on MODNET study. Complete	1. TDP Sub-WG 2. Testbed Sub-WG 3. Testbed Sub-WG (Deca, SDA) 4. Cyber Sub-WG (DSTL) 5. Rapid-e Sub-WG
3	**Develop AM Certification Guidance**		1. Publish *Certification Guidance Document v1* as open-source document hosted by ASTM. Launched today, 2 Jun 26. 2. Publish *Military Additive Manufacturing - Production Organisation Exposition*. To include: a. Platform agnostic decisions flows for AM certification including responsible individuals. b. A test and inspection template signposting to relevant standards.	1 & 2. Certification WG
4	**Improve understanding of UK AM Supply Chain and broader ecosystem**		1. Update & refresh the UK AM Supplier Database. 2. Complete annual analysis of the UK AM Supplier Database. 3. Conduct UK AM Supply Chain vulnerability assessment. In progress. V1 dashboard created. 4. Handover MOD-Industry-Catapult materials circularity WG. Discussed at ATI AM COP.	1. MTC 2. MTC 3. DefSp Innovation via GSCIP 4. DefSp Innovation/ MTC
5	**Maintain & build the AM Defence community; developing our relationships & communications**		1. Deliver Annual Review 26. 2. Deliver 3x F2F WGs, vary locations around the UK & organisations. 3. Complete Benefits Phase 2 task. Complete. To feed strategy update. 4. Develop a central repository for AM Use Cases. In progress. Home page built, migration of use cases ongoing. 5. Develop series of supply chain benefits storyboards, including Mastiff Cradle Millbrook testing Comms. 6. Develop AM technical guidance booklet. 7. Develop a guidance note for accepting, codifying and onboarding parts into Defence Inventory. 8. Increase engagement with Dstl and the academic community. Academic lead embedded into EG.	1. DefSp Innovation 2. DefSp Innovation 3. DefSp Innovation 4. DefSp Innovation/ MTC 5. DefSp Innovation/ MTC 6. MTC 7. IM & SC WG 8.Exec Group

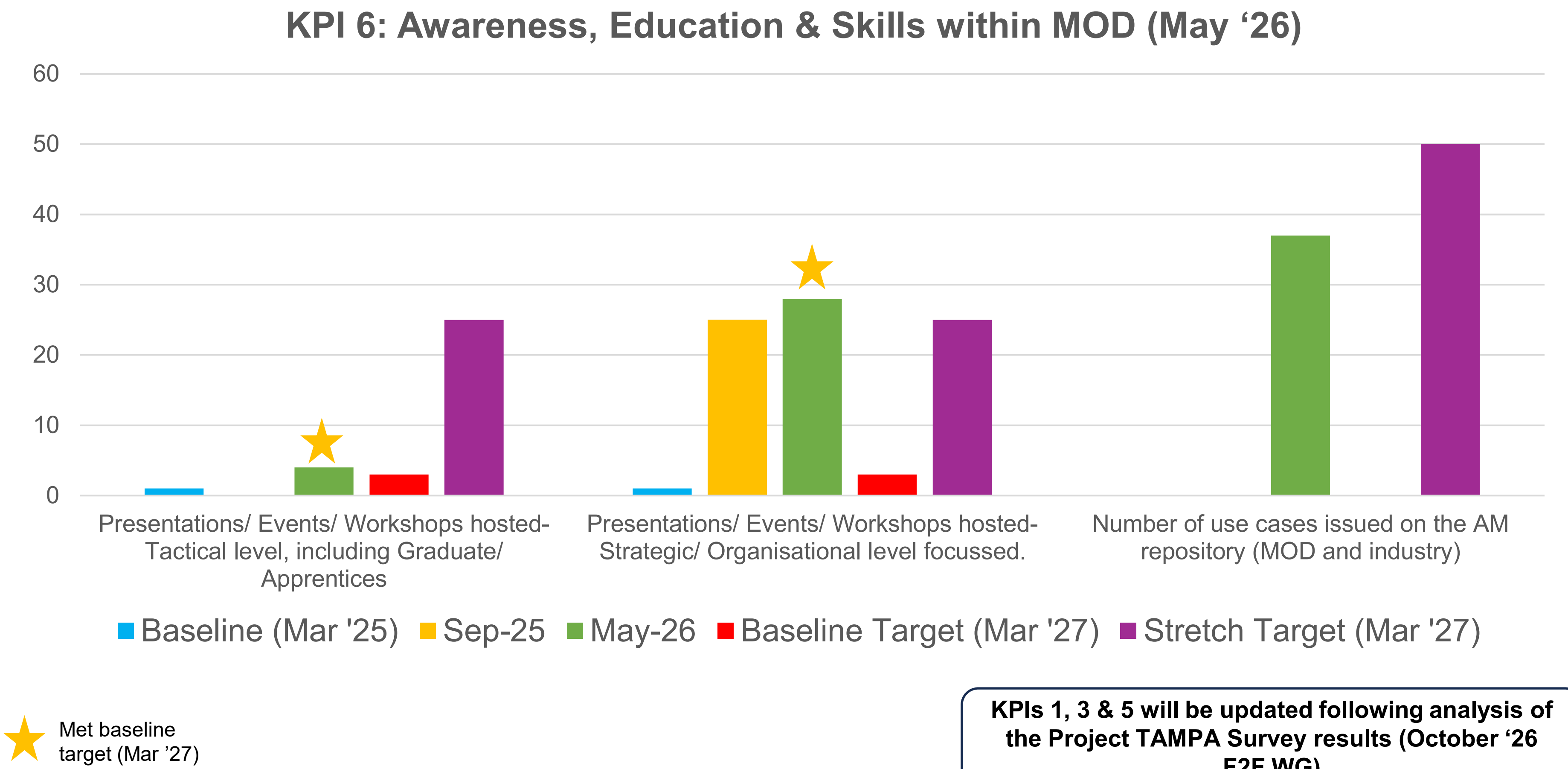
The EG priorities do not cover all WG deliverables and highlight only a few for priority tracking

Key Performance Indicators (KPIs): Progress updates



*Please note, data not updated since Sept '25.

Key Performance Indicators (KPIs): Progress updates



KPIs 1, 3 & 5 will be updated following analysis of the Project TAMPA Survey results (October '26 F2F WG)

Project TAMPA Spiral 4

Jon McMahon

TAMPA SPIRAL 4 Options

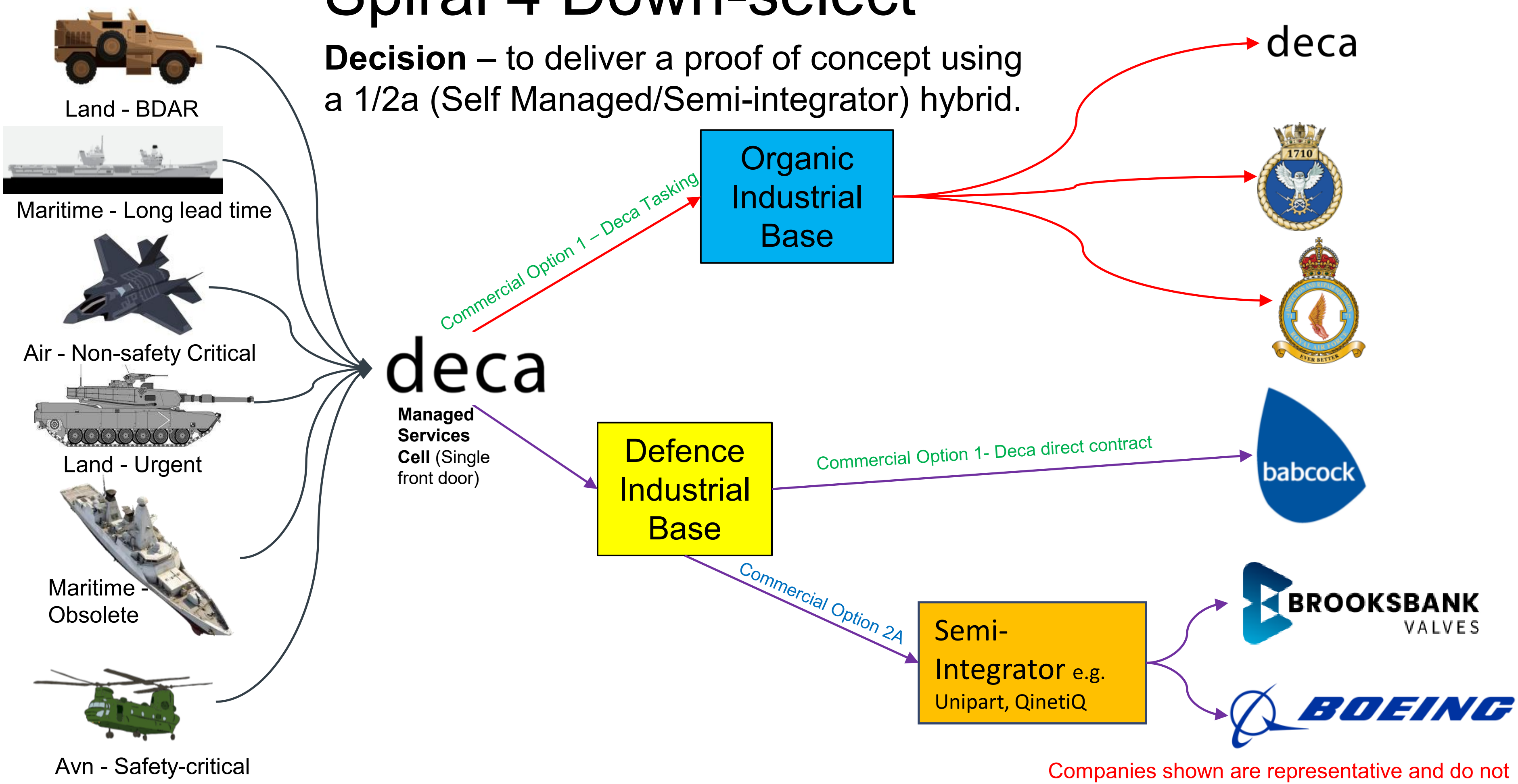
CommX Developed Options

- Option 1 – Self-Managed: an Open Framework Agreement under the Procurement Act 2023 (PA2023), structured by lots, with vendor-neutral primes permitted to operate a sub-contractor pool.
- Option 2a – Semi-Integrator (Third-Party Coordinated): a single-supplier framework awarded to a vendor-neutral integrator that coordinates a sub-tier supplier pool but does not itself manufacture.
- Option 2b – Full-Integrator (Third-Party Delivered): a single-supplier framework awarded to a supplier with end-to-end AM capability and global manufacturing footprint, which delivers parts itself with full performance risk transferred.
- Hybrid (Option 2a + 2b): a two-lot framework combining a semi-integrator lot for steady-state, cost-optimised demand with a full-integrator lot for urgent, global, or risk-transferred demand.

- **Selected option for further development – Hybrid 1/2a Self managed with a semi-integrator**

Spiral 4 Down-select

Decision – to deliver a proof of concept using a 1/2a (Self Managed/Semi-integrator) hybrid.



Companies shown are representative and do not reflect any pre-selection for the proof of concept.

Accelerating the Adoption of Advanced Manufacturing

Jon McMahon

Defence's AdvM Pg Risks

There are three unmanaged risks relating to AM that fall to the 2* champion for ownership

- **A FLC designed and produced part fails in service causing damage/ injury**
- **That the proliferation of Chinese produced AM machines builds an unmanageable cyber risk**
- **The incoherent, unintegrated and unsustainable adoption of AM across Defence does not deliver next generation support across a capabilities lifecycle**

Additional risks identified against Spiral 4/AdvM Pgm Delivery

- **Vendor bias by the integrator/semi-integrator fails to ensure diversity and dispersal of the supply chain**
- **Inability to fully resource delivery of the programme outputs and outcomes results in the failure to adopt advanced and digital engineering practices**

What?

Year 1 Statements of Work

Statement of Work 1 - ATAAM Concept Development. Development of an Additive Manufacturing (AM) Joint Capability Concept (JCC) and a Concept of Employment (CONEMP) for RAPiD-e aligned MOD's strategic AM objectives.

Statement of Work 2 – Advanced Manufacturing Policy. Outlines the policy and process improvements needed to accelerate AM adoption in Defence acquisition and service phases to realize AM benefits. Two-phases are policy review for AM adoption and a pipe-cleaning exercise to enhance commercial order processes across the CADMID cycle.

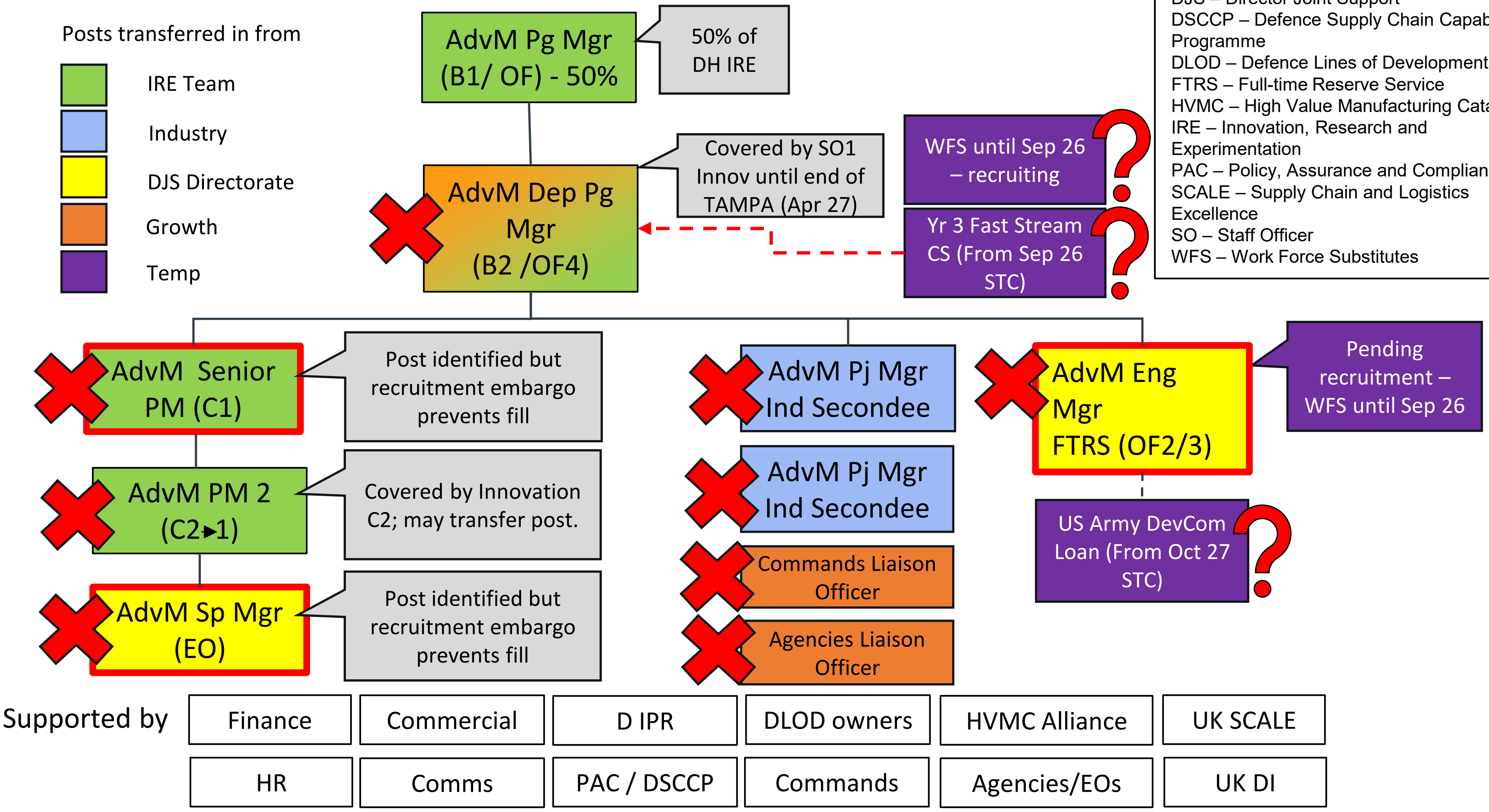
Statement of Work 3 – Capability Audit. A Capability Audit for AM aimed at assessing current and planned capabilities within the MOD aligned to the JCC. Assess AM capabilities, identifying Defence Lines of Development (DLOD) gaps, and securing pan-Defence stakeholder agreement and generate ROM costings to inform a Strategic Planning Cycle(SPC) 28 business case to close identified gaps.

Statement of Work 4 – Training Needs Analysis. Conduct a comprehensive Training Needs Analysis (TNA) for AM within the MOD, to establish a formal and sustainable training pathway. Full TNA including a review of existing AM training, mapping to roles, and identifying gaps and risks aligned with MOD policies and health and safety requirements. Deliver training model proposals and assurance recommendations aligned with MOD policy, regulatory and statutory requirements.

Statement of Work 5 - Programme Plan and Governance. Described the ATAAM Pgm plan and governance framework required to manage and deliver the project effectively addressing resource, governance and risk. Phase 1 focuses on detailed Pgm planning, resource validation, and artefact creation; Phase 2 establishes a governance regime aligned with best practices and manageable by the Pgm team.

AdvM Pg Team – **Minimum Viable Product and Growth Reqt**

Acronyms
DevCom – Development Command
D IPR – Defence Intellectual Property Rights
DJS – Director Joint Support
DSCCP – Defence Supply Chain Capability Programme
DLOD – Defence Lines of Development
FTRS – Full-time Reserve Service
HVMC – High Value Manufacturing Catapult
IRE – Innovation, Research and Experimentation
PAC – Policy, Assurance and Compliance
SCALE – Supply Chain and Logistics Excellence
SO – Staff Officer
WFS – Work Force Substitutes



NP Aerospace final PJ TAMPA Spiral 2 Lessons from Experience update, with Q&A

Wilf Paduano

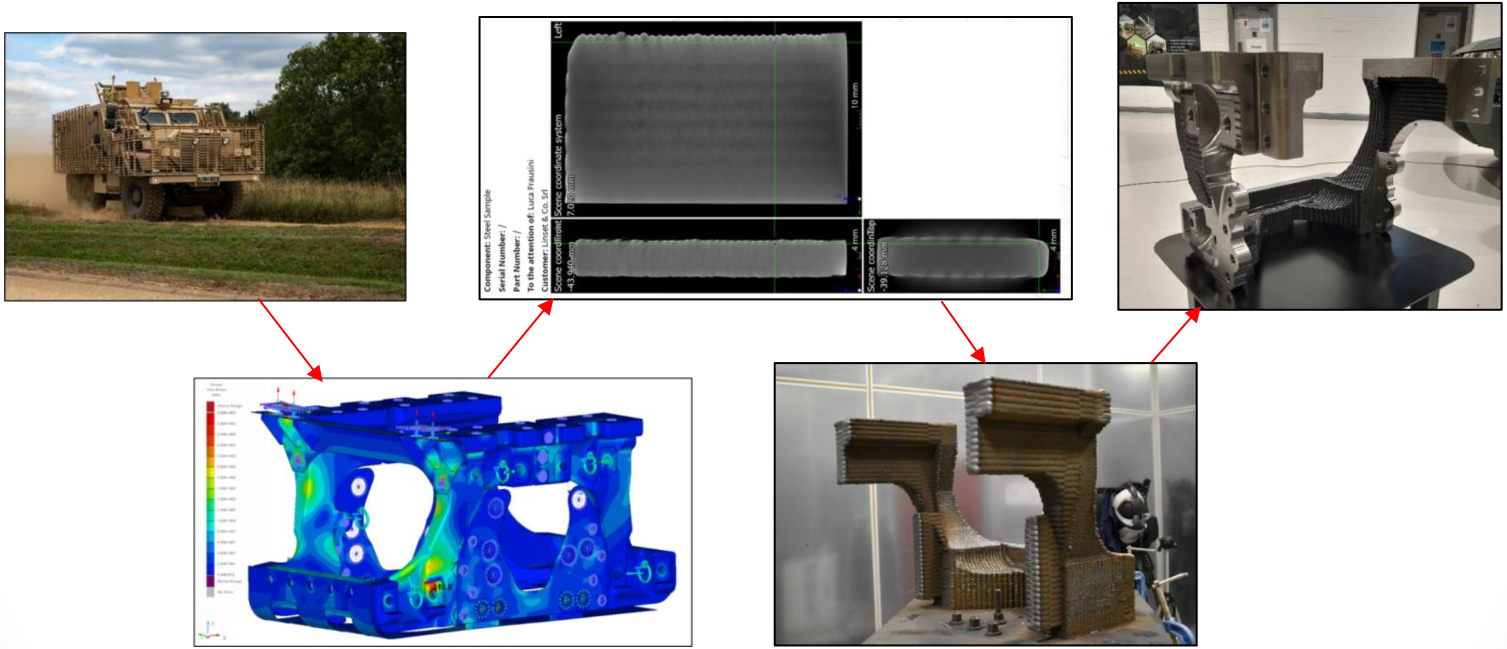
10:25-10:50

NP Aerospace Spiral 2 Knowledge Share

Cougar Platform XC Differential Cradle

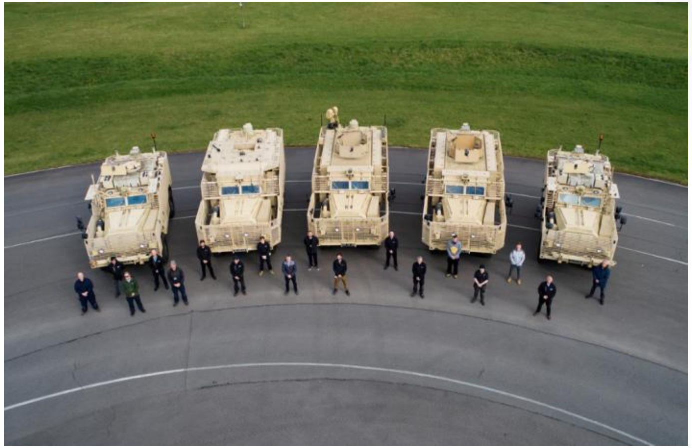
Task Introduction

Spiral 2 Aim - "In this Spiral 2 the Authority intends to derive learning from a broader range of parts than just a safety critical item……"



The Application – Cougar XC

- Cougar heavy armored vehicles now feature state of the art high mobility suspension systems, ride height control, upgraded driveline
- 4 Wheel or 6 wheel troop and equipment carrying vehicle upgraded to meet an Urgent Capability Requirement
- Max laden mass up to 29 Ton (Mastiff/Wolfhound triple axle), 20 Ton (Ridgback dual axle)
- Max speed of 35 MPH on any terrain, 350 mm step climb and up to 60% gradient capability



THE APPLICATION – COUGAR XC DIFFERENTIAL AND SUSPENSION CARRIER

Design constraint that the original differential wishbones and chassis mounting remain.

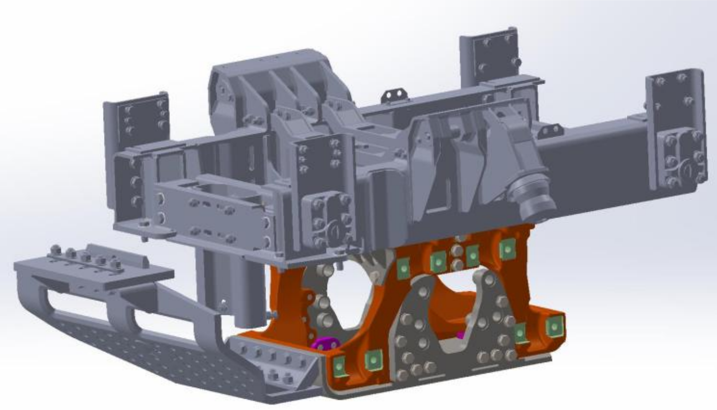
Differential should also be removable from the cradle

Current design is a handed fabricated part with multiple bending, jigging and welding operations

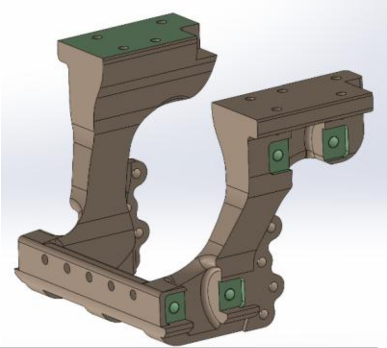
Typical lead time 12 – 16 Weeks

COMPONENT REDESIGN AND DEVELOPMENT

- Redesigned component now only requires one NSN number as opposed to four
- Component was designed with both casting and additive in mind
- CAD mass ~96 kg maintaining overall system mass

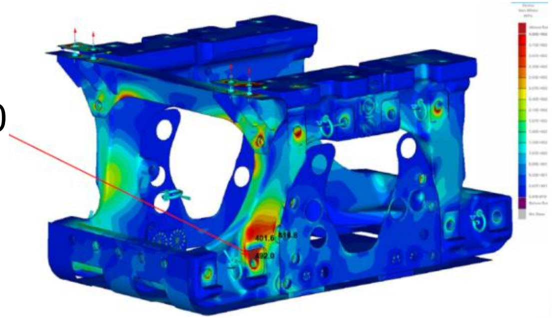


Developed Concept Assembly



Developed Concept

~490 MPa



FIRST COMPONENT PRINT

First cradle print was broken into stages over a 2- 3 week period adapting parameters as the build progressed

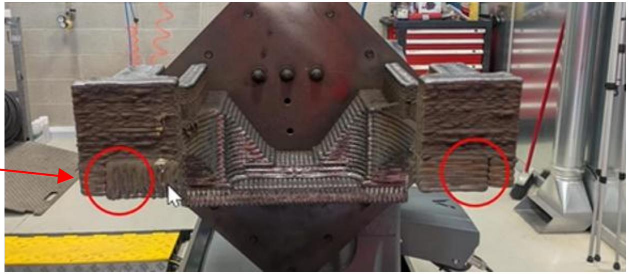
First Cradle - Outcomes

- Very positive proof that a part can be made !
- Material is similar to other generic steels in terms of machining feed and speed requirement suggesting heat treatment parameters are good – concern that the part would be extremely hard
- No indication of skin effect on heat treatment and material generally is consistent throughout
- Mating surfaces can have very good surface finish and tolerance
- Expectation that with design updates for cradle 3 and 4 machining should take ~2 working week with potential to reduce further
  - A lot of time was lost in initial jigging and setup
  - Time also lost due to insufficient material stock allowances
  - Updated CAM has also simplified and reduces features
- From birth to final part prediction:
  - ~1 week to print
  - ~4 days to heat treat
  - ~2 week to machine

First Attempt Outcomes

Defect seen in this area. This was due to the path planning.

Areas where material has sagged as part is rotated on machine. This has caused some layers to not adhere and cause a "crack"



Difficulties encountered in this area due to the steepness of the overhang. A geometry change will be made to improve print stability adding roughly 1kg of material.

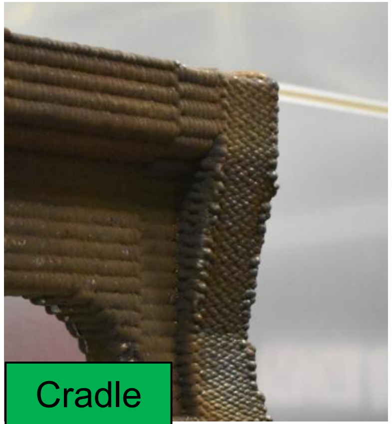
Second Attempt Improvements

Material support defects

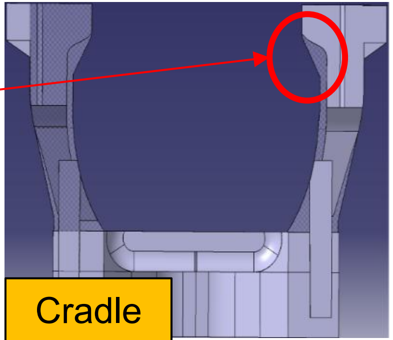
Cradle 1 – Material not always supported leading to messy welds and sagging material

Cradle2 – More support added and much cleaner weld beads. Defect on top layer not seen

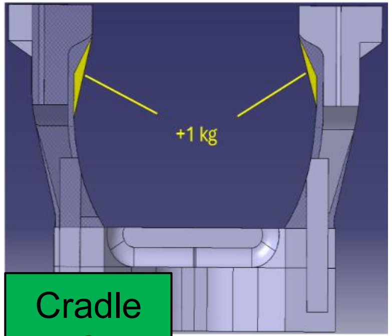
Cradle 1



Cradle 2



Cradle 1

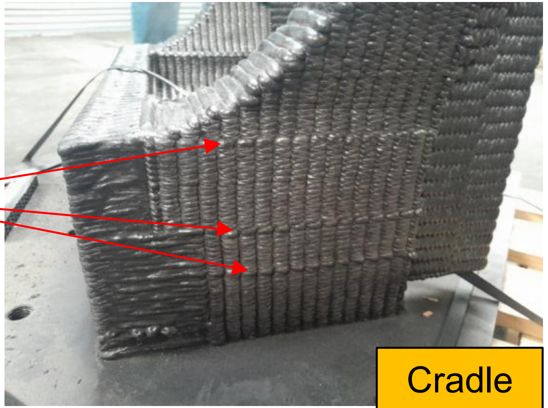


Cradle 2

Second Attempt Improvements

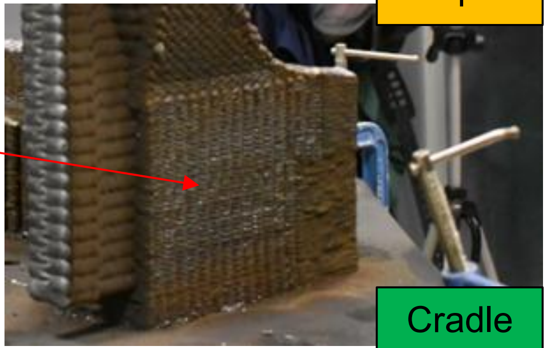
Build pause layer adhesion

Cradle 1 – Clear layers where print has started and stopped. Cause for concern with regards to adhesion



Cradle 1

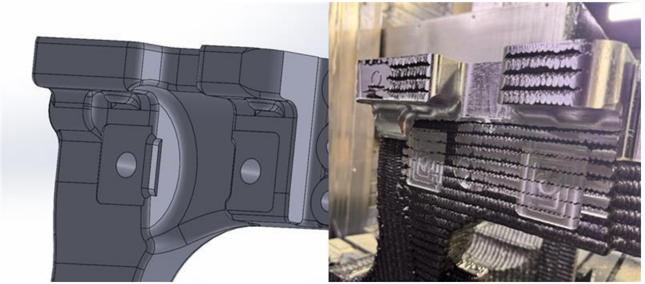
Cradle 2 – Continuous print with less heat cycles. Layers are not obvious or shown at all

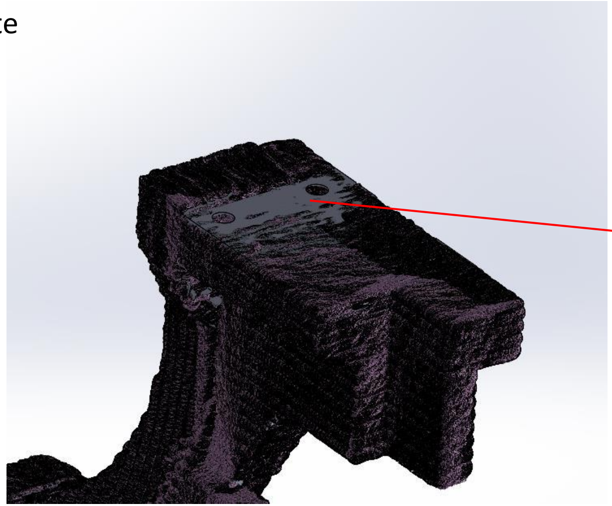


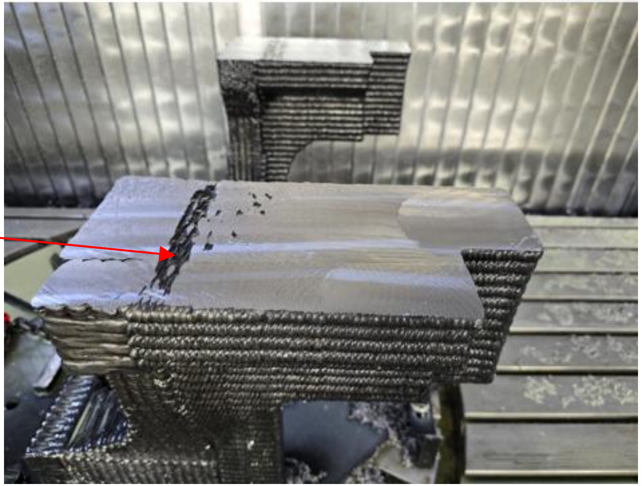
Cradle 2

First Cradle - Machining

- Insufficient material stock was left on the blank prior to machining
- The main root cause of this is the initial blank design and understanding of the depth the of the weld beads
- Material shrinkage was more of a concern than warpage, but both of these have contributed to the issues shown opposite

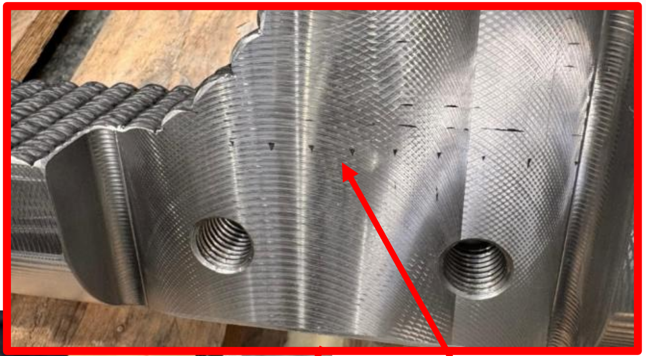






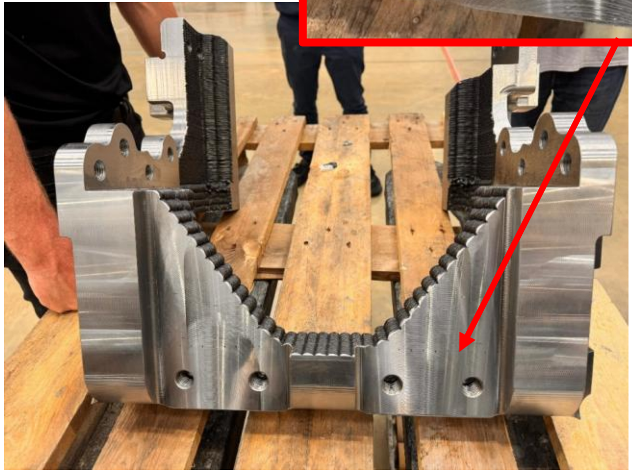
First Cradles - Outcomes

- “Porosity” was noted which was not clear from the x-ray tomography samples
- This porosity is not random and follows the patterns of the weld beads and can be as far at 80 mm deep in the part



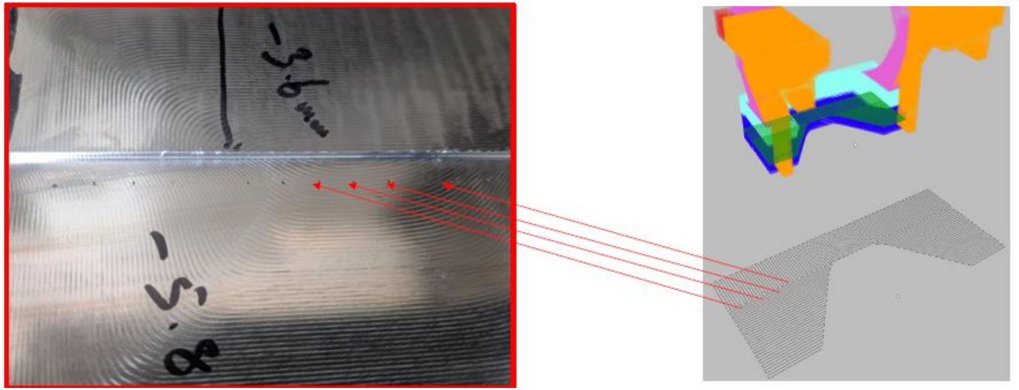
Pattern aligns with the print path and weld beads

Pores at bottom of threaded hole



Porosity trials

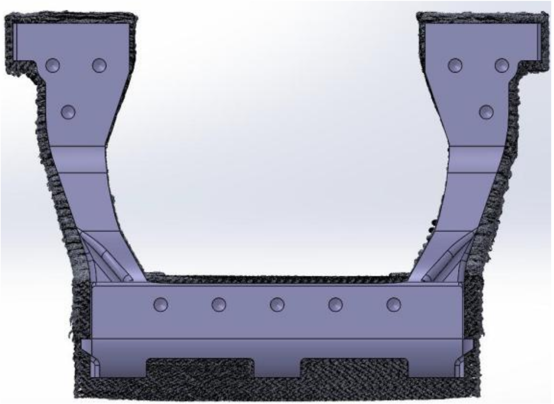
- Test prints were produced to find solutions to the block to block porosity defects seen in Cradle 1
- Alternative path planning and changes to the overlap percentages were investigated
- Block to block overlap percentage increase was found to solve the issue completely

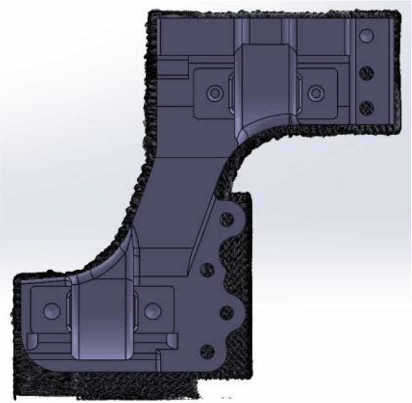


NP Aerospace

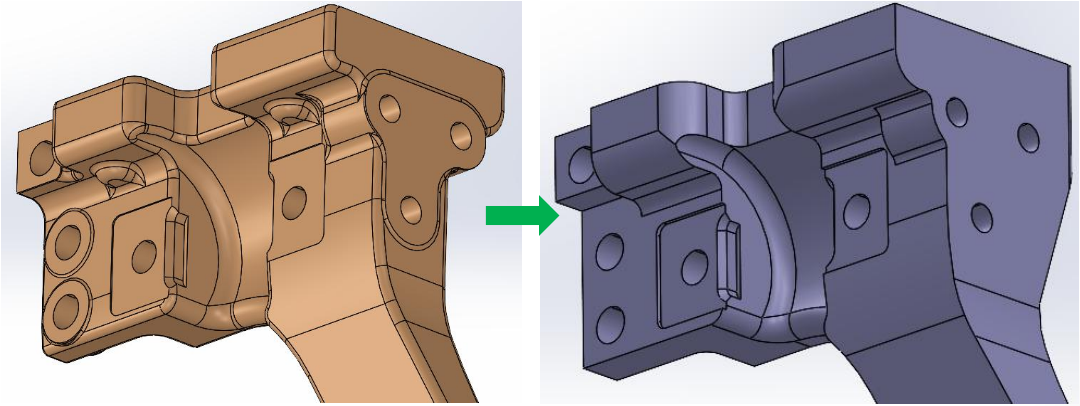
MATERIAL STOCK ALLOWANCES AND GEOMETRY

- Using scan data from Cradle 1, minimum material stock limits were set



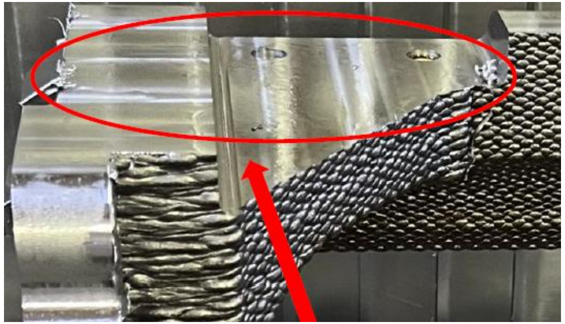


- Using learnings from Cradle 1, the geometry was simplified to speed up the machining process



FINAL BUILDS

- Cradles 3 and 4 built to identical specification
- Significantly cleaner lay of weld bead due to the path planning and overlap percentage changes following Cradles 1 and 2
- No section interface porosity issues



No porosity seen in section interface

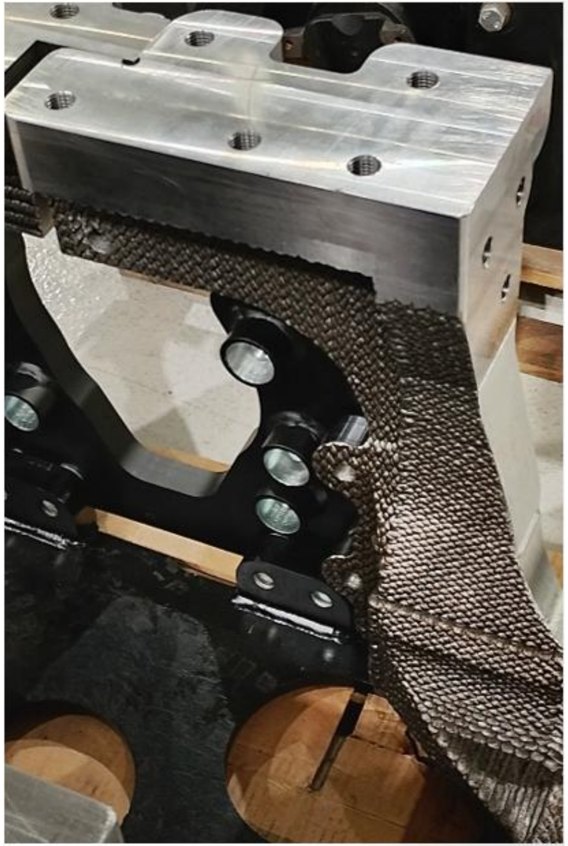
THIRD CRADLE - OUTCOMES

- Porosity issue solved with changes to overlap percentages.

- Sufficient excess material to meet required geometry once machined.

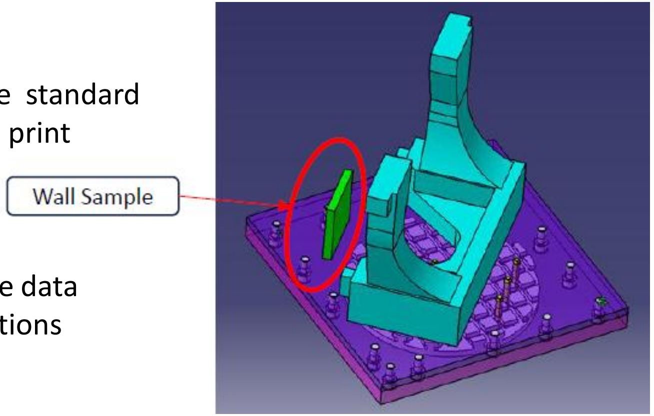
- Less machining time due to the learnings from the first attempts and modifications to the geometry. From 4 weeks to ~2 weeks.

- Trial fitment t leted successfully.



Future work

- Fatigue testing
    - Wall samples were printed with each build. These include standard samples and samples that were allowed to fully cool mid print



- Vehicle trials
    - A full off road vehicle trial will be completed with suitable data logging. This will be a typical BFM profile to mimic operations

Questions?

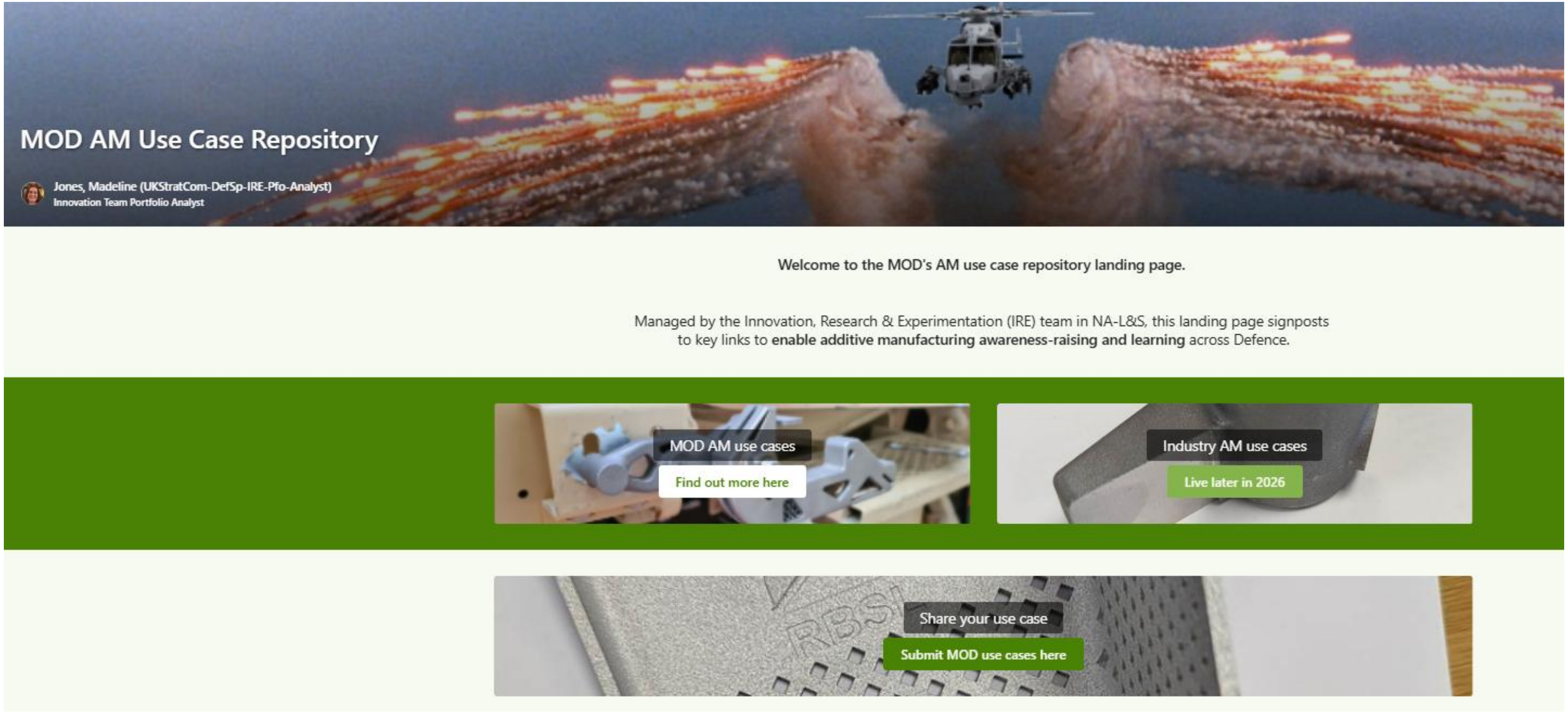
National Armaments Director Group

Update on MOD AM Use Case Repository

Maddy Jones

10:50-11:00

MOD AM Use Case Repository



MOD AM Use Case Repository

Submit an MOD Additive Manufacturing (AM) Use Case

Hi Jones, Madeline (UKStratCom-DefSp-IRE-Pfo-Analyst), when you submit this form, the owner will see your name and email address Madeline.Jones118@mod.gov.uk

Use Case Title *

A unique name to identify the AM use case.

Enter value here

Image

+ Add an image

Security Classification *

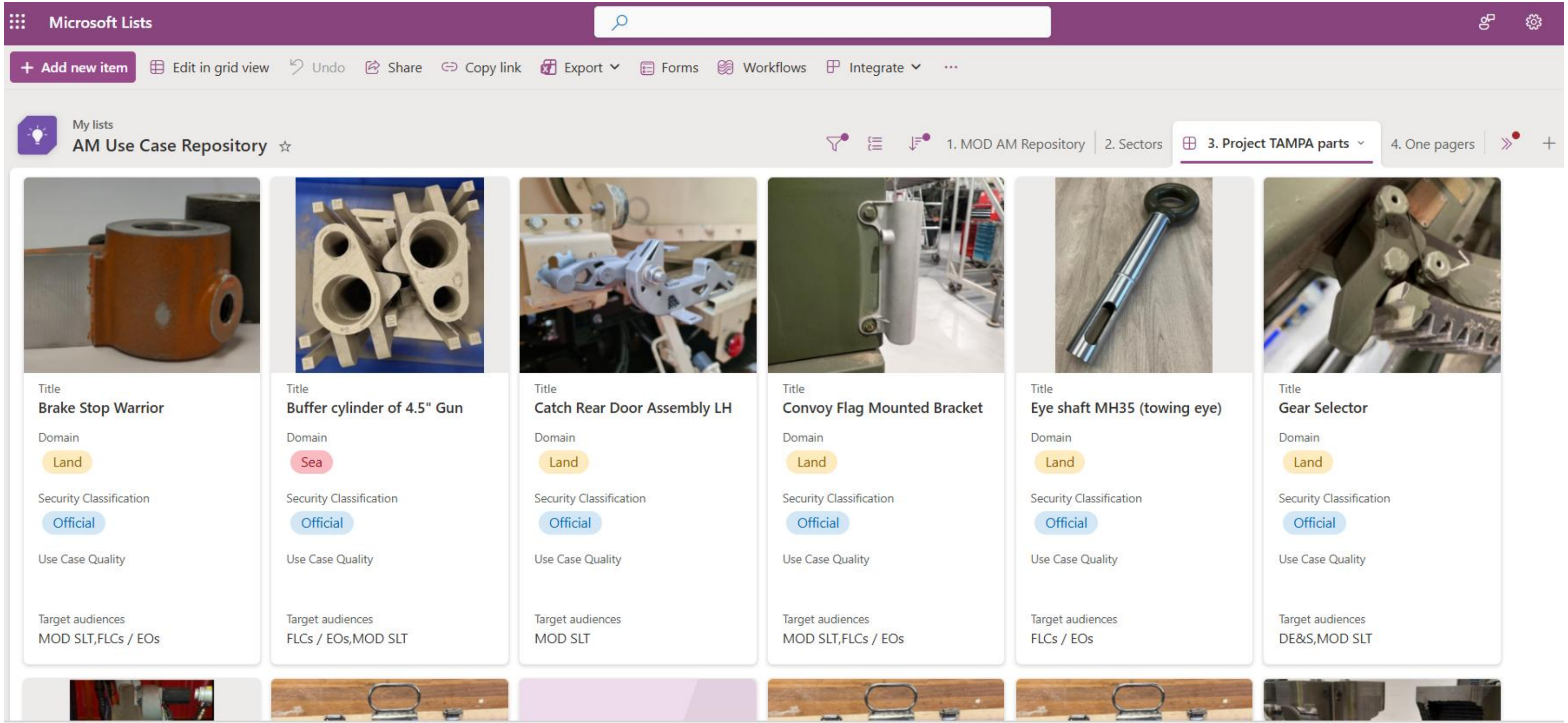
The security classification of the use case. Only Official use cases can be shared with the Defence AM Use Case Repository stored on MTC's website.

—

Owner(s) *

The individual who is responsible for this use case and empowered to make decisions about its security.

MOD AM Use Case Repository



AM One-Pagers: Template

Ministry of Defence [ID] [FLC]

[Case Study Title]

[AM Tech Type] - [Company]

mtc where progress happens

Summary

Summary Text

Quality & Efficiency

[Key Improvements]:

- [1]
- [2]
- [3]

Cost Saving

[X] %	£[X]
Cost Reduction	Total Savings

Cost Breakdown:

- [Saving area 1]: [Amount/Perc]
- [Saving area 2]: [Amount/Perc]

[Additional AM Benefit]

[Benefit]

Description

Impact Metrics:

- [Metric]: [Improvement]

Supply Chain

[Key Improvements]:

Description

Key Impact:

Key Points:

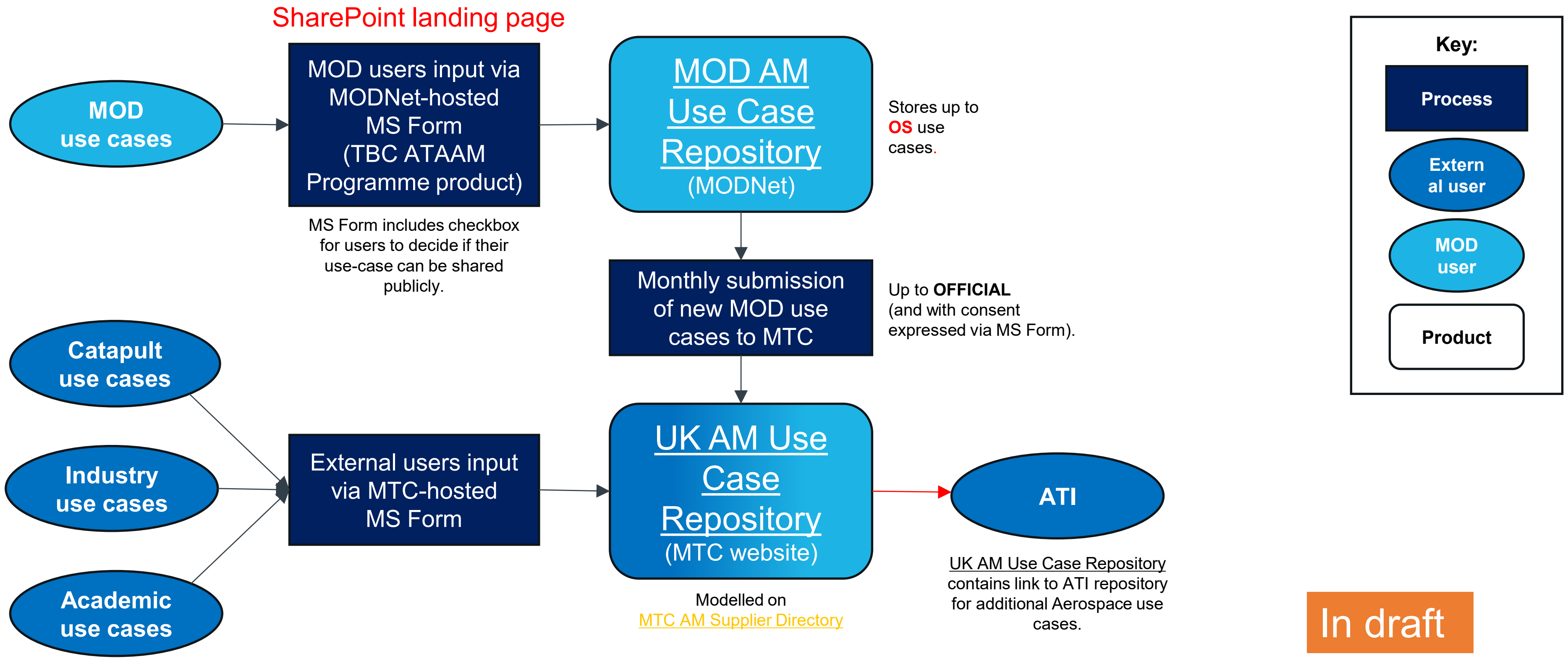
Scale of Implementation:
[Scale/Volume Details]

Key Success Factors:
[Critical success elements]

[IMAGE]

[Official - Commercial in Confidence]

Enterprise Map: UK AM Use Case Repository



Babcock's Spiral 3 lessons on material equivalency analysis provided by Plastometrex

Henry Begg

11:00-11:10

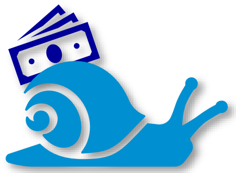
Spiral 3 learnings

Summary of material assessment using PIP

National Armaments Director Group
2nd June 2026
Dr Henry Begg – Application Engineering Manager

Plastometrex

Motivation



Current practice for qualification in AM is **expensive and slow.**

Current practice could carry the **hidden risks** that aren't surfaced.

TAMPA CONTRIBUTION

Explore whether PIP (a form of mechanical testing) could be a viable alternative to traditional tensile testing for LPBF 316 builds as part of a project led by Babcock.

Introducing PIP

The principle of Profilometry-based Indentation Plastometry (PIP) has four key steps:

Indent sample

A small indent is created on the material's surface using the PLX-Benchtop.

Measure shape

The indent is scanned by an integrated profilometer, which captures the shape of the material deformation.

Analyse data

The software runs a simulation, adjusting the material properties until the simulated indent matches the real one.

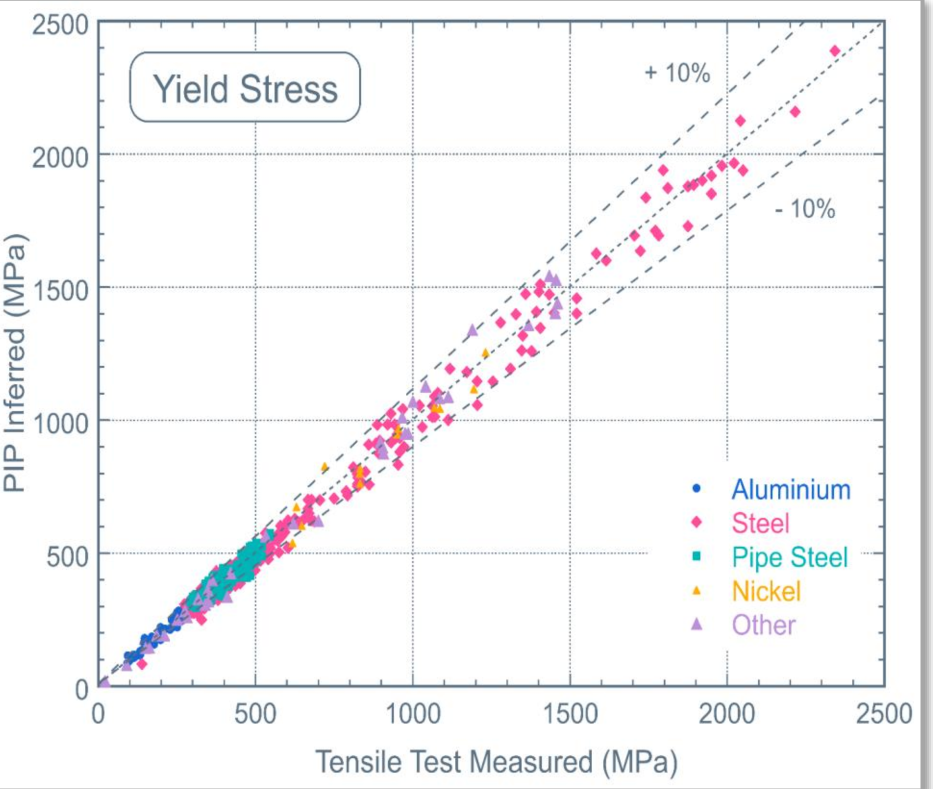
Stress-strain curves

Once matched, the user is presented with a stress-strain curve,.

Time and cost savings

Data resolution

Plastometrex



Tensile-PIP equivalency

To date, there have been numerous data points collected to show that for most isotropic metals, average agreement is ~5%.

This includes LPBF examples, such as an extensive study performed by Nikon AM Synergy.

TAMPA Sp3 aim:

Validate for 316 builds, where PIP agreement can be more limited due to transformation.

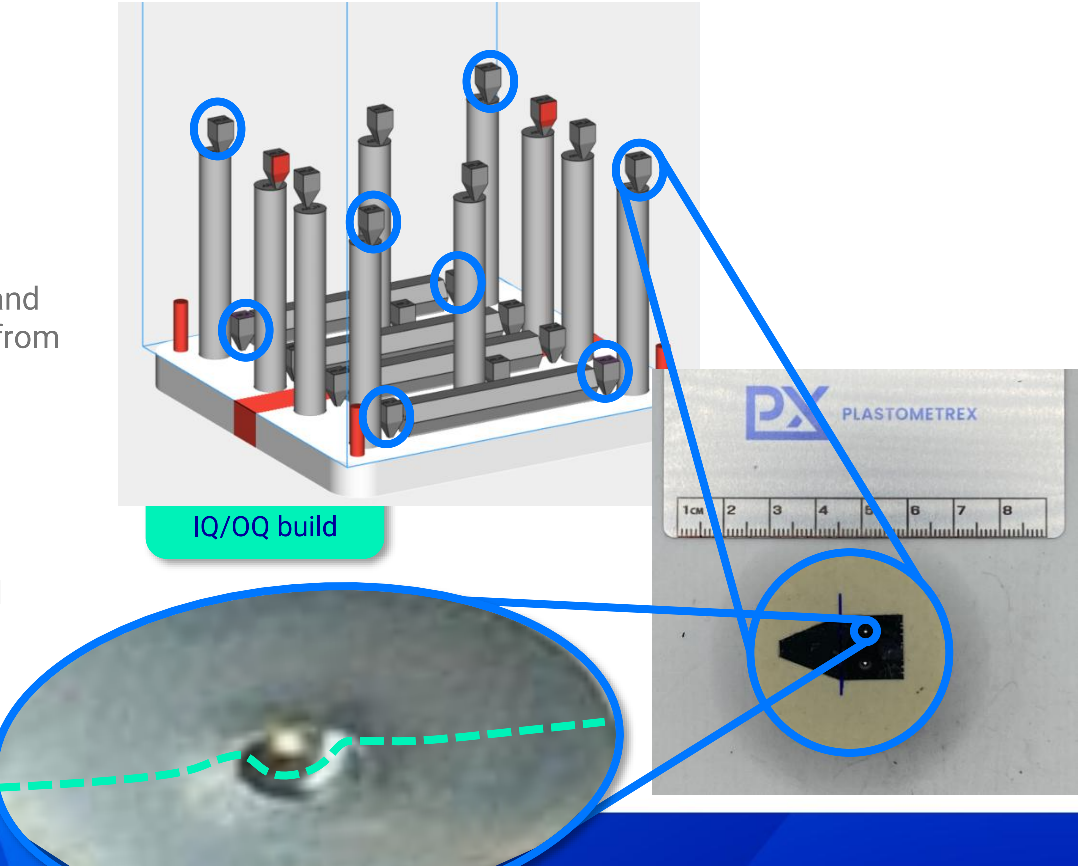
TAMPA Spiral 3

Phase 1

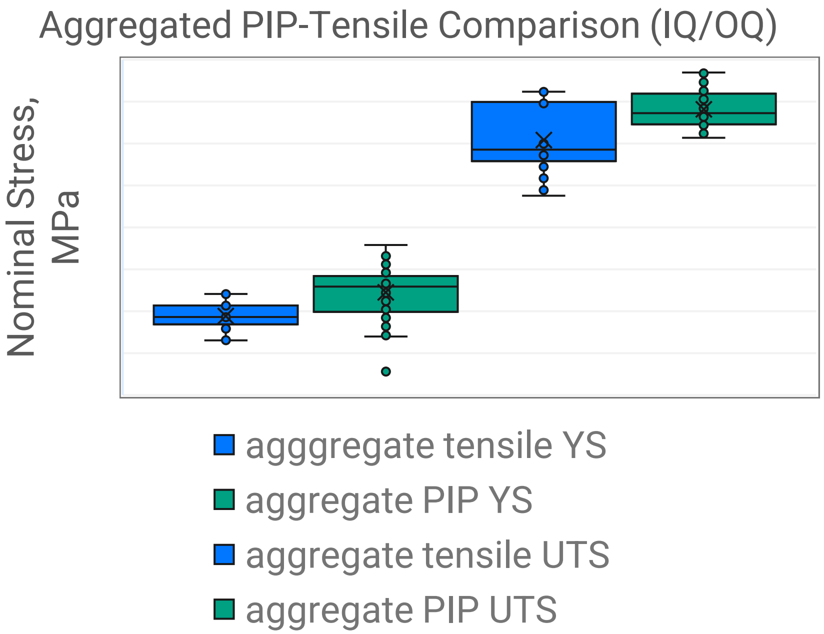
IQ/OQ builds from three suppliers – density cube tokens tested from eight corners of the build plate and compared with vertical and horizontal tensile tests from similar locations.

Phase 2

PQ builds from three suppliers – ends of vertical cylinders cut off and PIP tested; cylinders machined into dog-bones and pulled.



Phase 1 Results



Minimal differences were observed between the different suppliers and build plate location.

Therefore, all results were aggregated and PIP and tensile outcomes were compared.

Generally saw good agreement between the two techniques across both YS and UTS.

HOWEVER...

Phase 1 Results

However, if we split things out into

- horizontal and vertical tensile bars, and
- XZ and XY indent planes

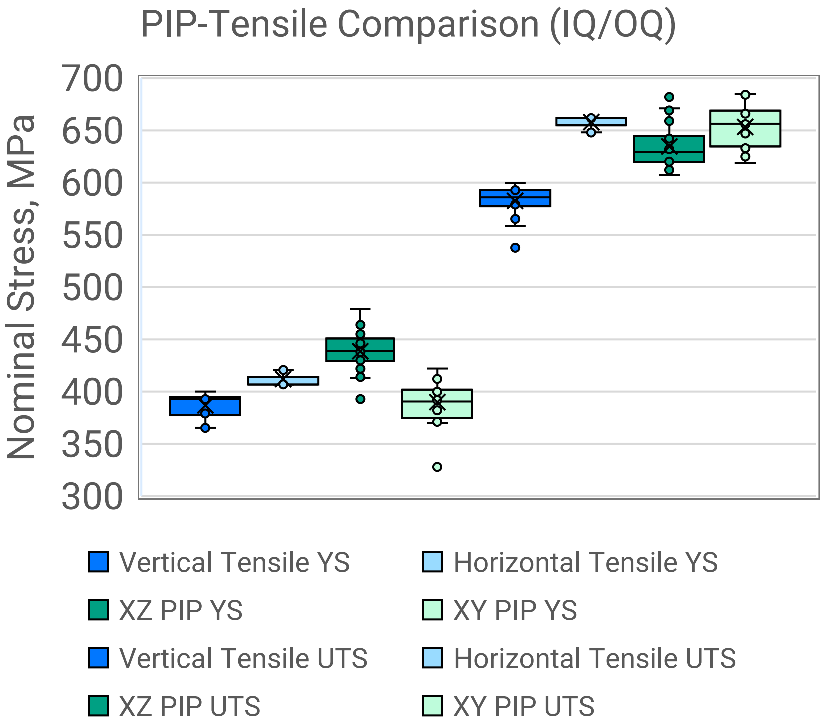
we see some differences due to anisotropy.

PIP creates strain in all directions during indentation and provides a ‘direction averaged’ response. It can detect in-plane anisotropic directions, but the inferred response has contributions from X, Y and Z directions.

If average PIP is compared with average of vertical and horizontal,

AVERAGE YS AGREEMENT = 4%

AVERAGE UTS AGREEMENT = 4%

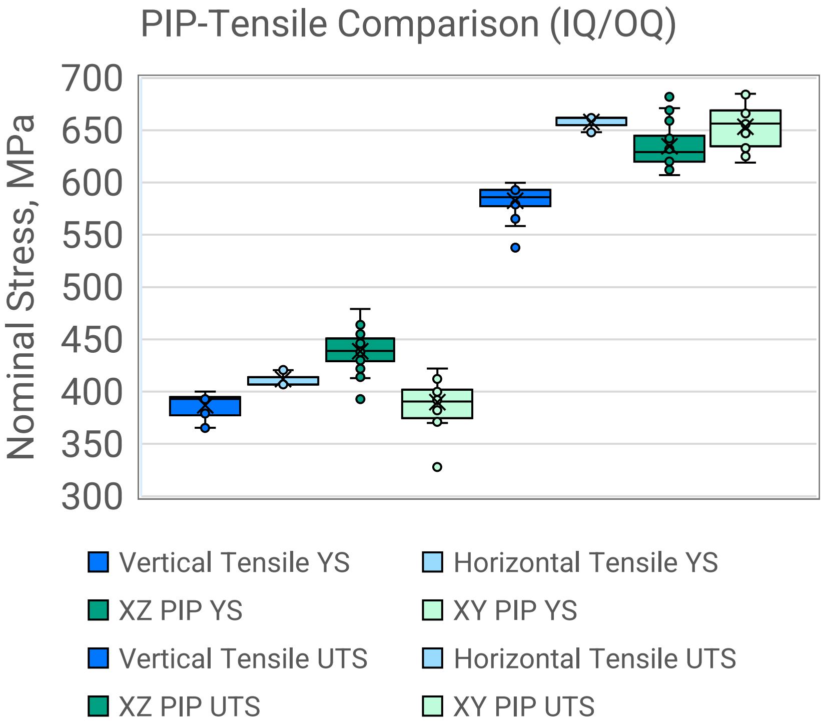


Phase 1 Results

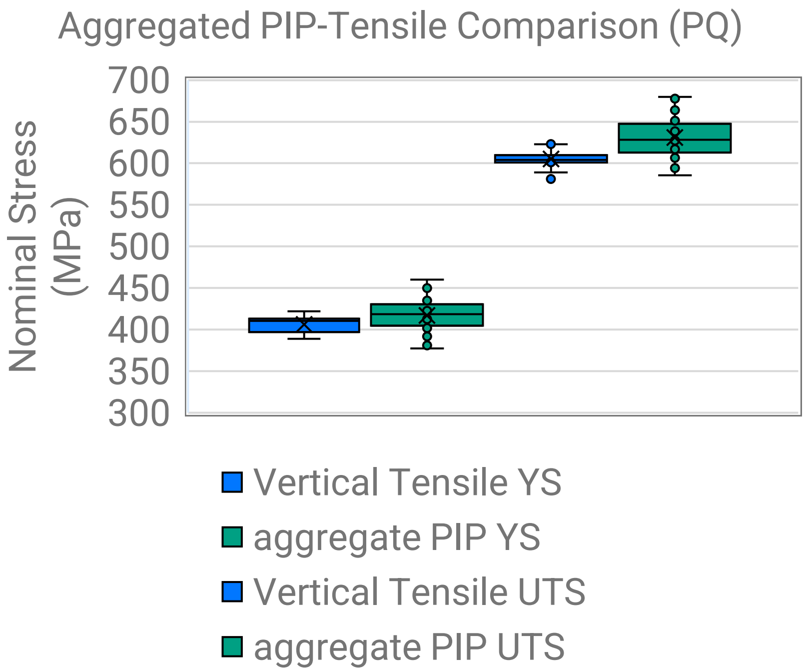
Anisotropy could be a barrier to adoption.

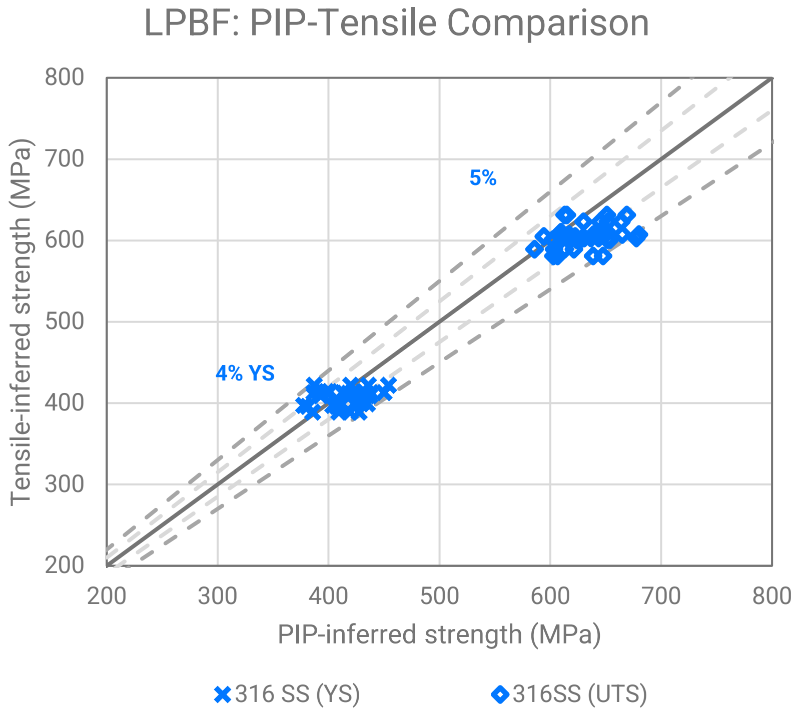
<u>Worth considering other potential barriers:</u>

- Standards compliance
  - (Partially addressed by publication of ASTM E3499-25)
- Fatigue and fracture properties
  - (PIP only measures plastic properties)



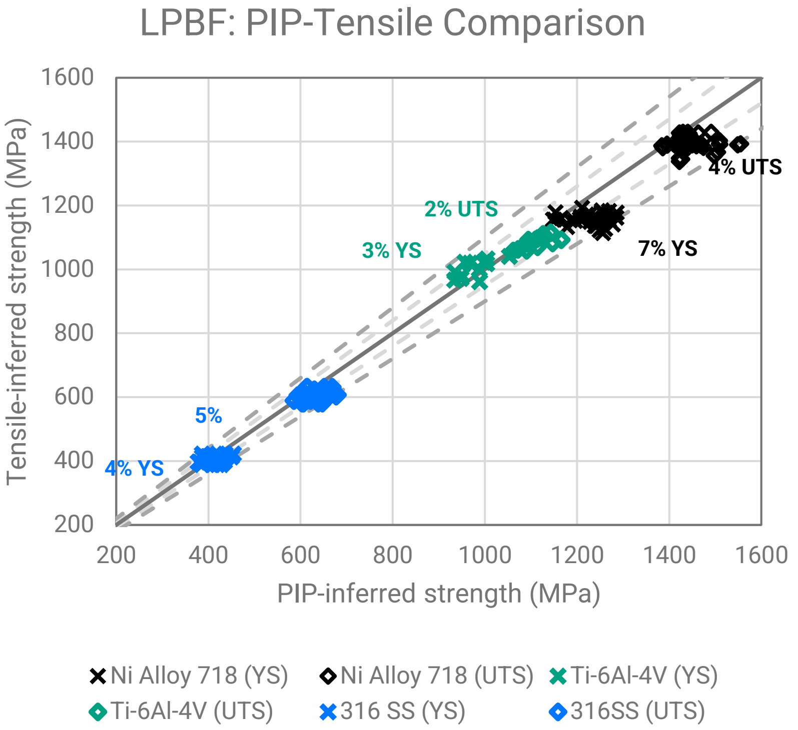
Phase 2 Results





Phase 2 Results

	YS MAPE	UTS MAPE
Stainless Steel 316L *UK MOD 'Project TAMPA'*	4%	5%
Nickel Alloy 718 *ASTM CMDS Study*	7%	4%
Titanium Grade 5 *EOS Delta Qual Study*	3%	2%



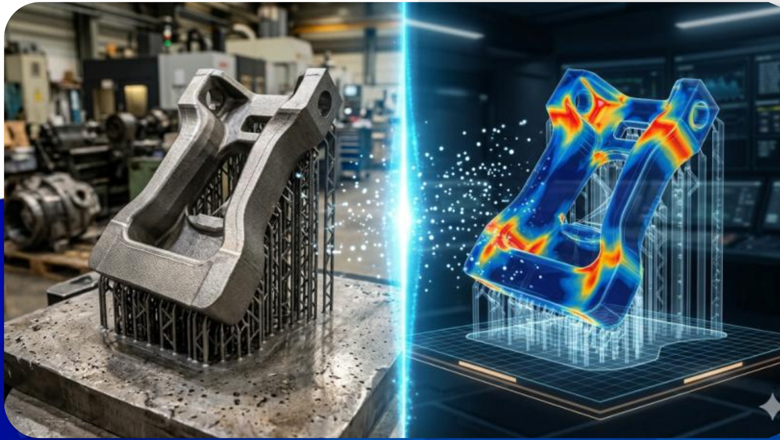
Future of qualification and verification in AM

Future qualification in AM is going to change. Likely going to need to move from an inflexible, testing-heavy model to a more agile framework.

Likely to encompass a lot of digital tools to make better use of data:

- In situ process monitoring
- Digital twins
- “virtual qualification”
- Advanced NDE

However, full confidence might still mean some degree of physical testing!



Future of qualification and verification in AM

PIP offers a route to:

a) faster, less expensive generation of mechanical strength properties

b) a method for determining local properties, allowing increased levels of confidence and uncovering risks.

c) coupling this to advanced simulations and in situ monitoring could prove a powerful approach to accelerating AM qualification.

But still challenges to solve relating to:

a) Anisotropy

b) Acceptance criteria

c) Other properties of interest (like fracture)

Qualification overview by America Makes

Ben DiMarco

11:10-11:30

AmericaMakes.us

America Makes

The National Additive Manufacturing Innovation Institute

Accelerating the Qualification of Additive Manufacturing (AM) Machines and Materials

Ben DiMarco

Proud to partner with:

Manufacturing USA

America Makes – Who We Are

- OIB and DIB Modernization and Scale-up partner
- Public-Private-Partnership focused on delivering Additive and Adaptive Manufacturing Innovation
- Expanding collaboration with non-traditional partners
- Voice-of-Industry with access to available technologies and capabilities
- Industry-grounded Additive Manufacturing EWD programs
- Effective and efficient program management and execution

Why aren't we done yet?

Important things still need to be solved in all three strategic focus areas: Technology, EWD, and Ecosystem Development

Challenges

- Repeatability and reproducibility
- **Qualification**
  - Material
  - Process
  - Product
- **Qualification cost and efficiency**
- **Inspectability – technology and efficiency**
- Fracture critical parts
- Certification
- Cost and cost reduction
- **Scaling to full production**
  - Equivalence and requalification efficiency
- Can vs. should
- Access to capital
- **Vendor qualification**

Known Limitations

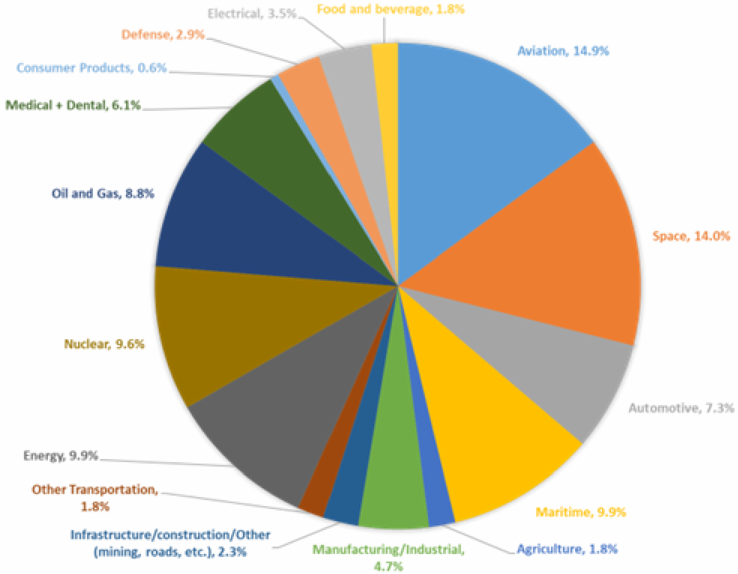
- **Limited number of commercially available materials**
- **Limited number of qualified sources of supply**
- Limited knowledge base
- Limited implementation of DFAM
- **Limited trained workforce**
- Limited manufacturing operations experience
- **Limited size of parts**
- Limited feature sizes (e.g. section thickness)
- Most suited towards high mix, low volume applications
- **Serviceability, maintenance, and limitations** not well understood

These challenges and limitations are recurring in numerous markets and industries leading to product development delays or even abandonment

Application driven focus

Informed by industry

- Aug 2025 – Youngstown, OH
- Prioritize applications for incorporation into AM Technology Roadmap
- Focus our research efforts and increase potential for commercialization and transition
- 342 unique products identified
- High priority applications include:
    - Structures
    - Spares, legacy parts, and repairs
    - Forging manufacturing
    - Housings, cases, and shielding
    - Heat exchangers, combustors, and thermal protection systems
    - Pressure vessels
    - Tubing and fittings
    - Orthopedic and dental implants

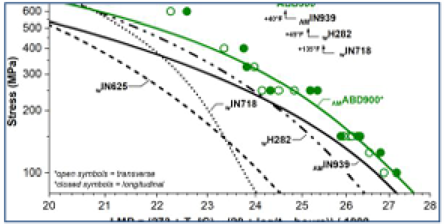


Products aligned with aerospace, maritime, oil and gas, energy, nuclear, defense, and medical industries

How is the Institute addressing the need?

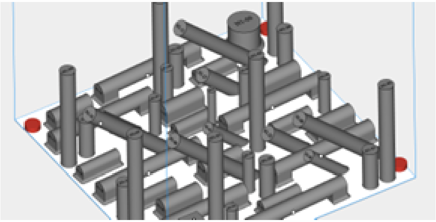
Multi-faceted approach

Materials Data



- Maturing various material/process combinations
- Delivering design allowable datasets (per MMPDS vol 2)
- Building data resources and management methods for access to these datasets

Protocols/Practices



- Sharing best practices and lessons learned
- Developing and validating efficiency improvements
- Demonstrations
- Documentation of key process variables

Specs/Standards

Istockphoto.com

- Material and process specs
- Process control documentation
- Guidance
- Lessons learned
- Partnership with standards development organizations

Training

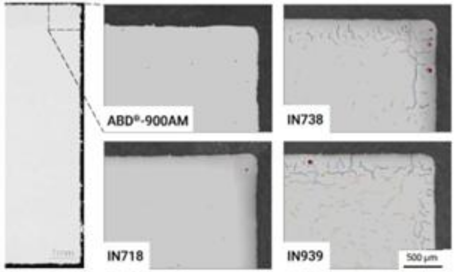
- Training focused on QMS development in line with DoD needs and requirements

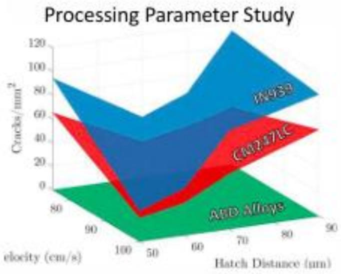
Collaboration between industry, academia, government, and standards development organizations

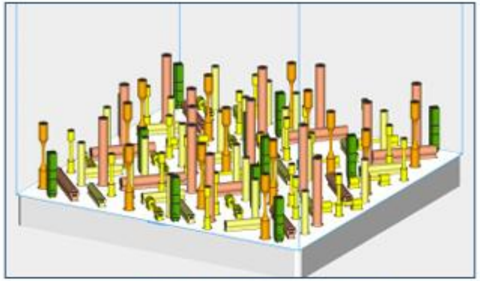
Materials Data Activities

Maturing Material Process Combinations

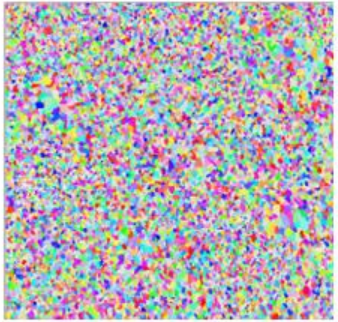
- Addressing MMPDS vol 2 requirements
- Exploring reused powder
- Single and multiple machine makes and models
- Single and multiple laser powder bed fusion
- Laser powder bed fusion and laser powder fed directed energy deposition
- Materials **(C/D basis allowables is the goal!)**
  - Ti-6Al-4V grade 5
  - 7050 RAM2
  - ABD900
  - C103
  - ATI-1700
  - CP1







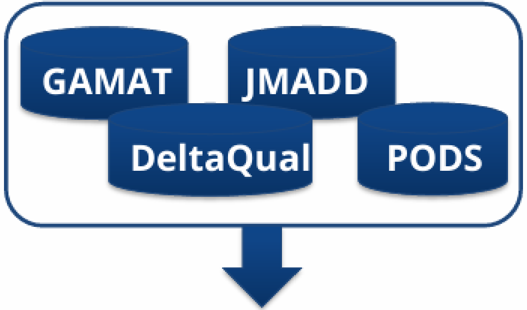
SLM NXG XII 600



Feedstock and materials specs, process control documentation, and lessons learned are available from these efforts

Data Management on CORE

- CORE is the America Makes data repository
  - Reports, presentations, spreadsheets
- Hosting structured datasets is a highly desired opportunity
- Offers tremendous value considering the current and foreseeable efforts in materials data generation
- Development of a Neo4j data structure which offers a standard, templated method to hosting connected data in CORE
  - In addition to existing blob database (reports, presentations, images)

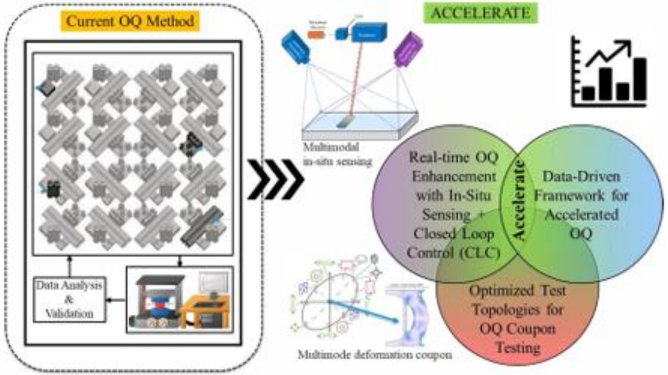


Access to reliable, connected, structured data will deliver the quality of data our members need

Operational Qualification (OQ)

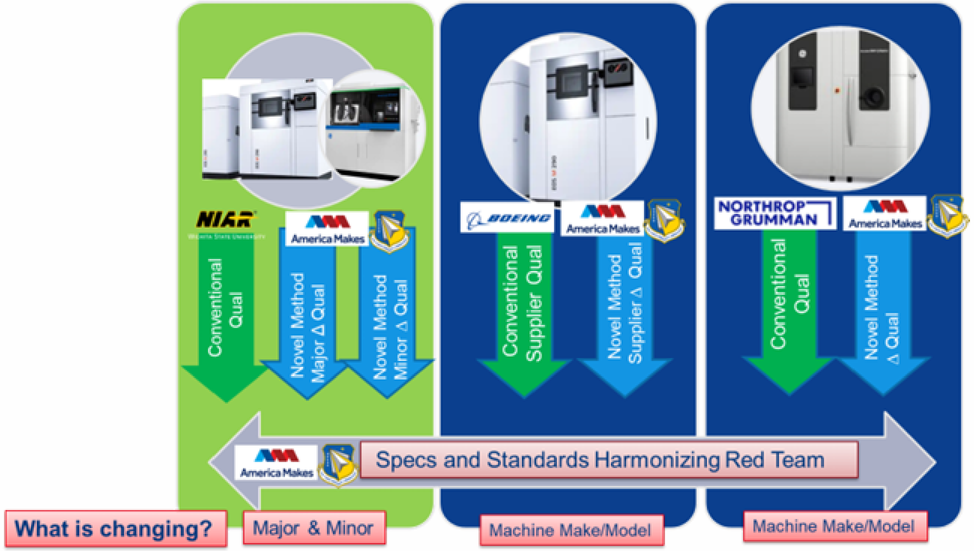
- Automating build design tasks
- Improvement in build design to address downstream product development cycle risk
  - Derisking PQ
- Addressing qualification for multiple make/model platforms using common frameworks
- Delivering guidance and documentation
  - **Publicly available guidance/resources**
- Identifying opportunities for improvement in methods and standards
  - Lessons learned
- Validating interoperability by leveraging international partnerships
  - U.S./UK collaboration
  - Focused on performance qualification

CONTENTS



Delta Qualification (Re-qualification)

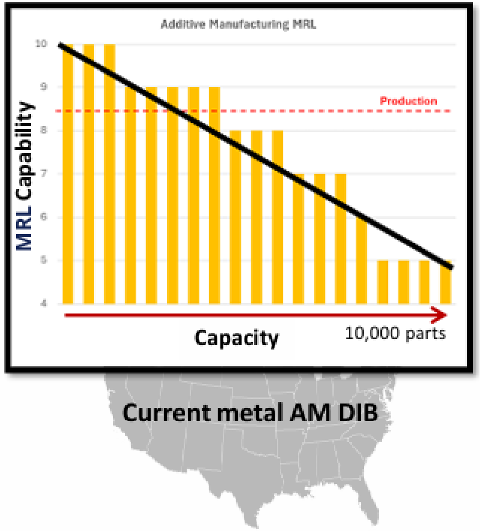
- Supply chains and technologies are evolving
- Validation approaches to rapidly and affordable establish a qualified process
- Consideration of major and minor changes
    - Major – number of lasers
    - Minor – software upgrade, moving machine
- Six validation efforts
    - AM modality
    - Vendor
    - Single to multi laser
    - New machine – same make/model
    - Single laser – new make/model
    - Software version
    - ML approach
- Red Team – Work across teams to identify AM standards harmonization opportunities
    - Lessons learned
    - AM qualification frameworks
    - Comparisons to existing standards



Supplier Training and Development

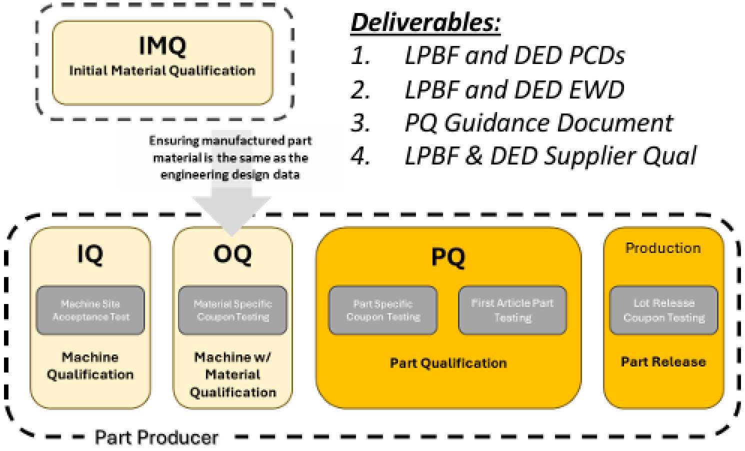
Problem Statement

US AM supply base lacks a prolific understanding of metal production AM know-how.



JAQS Objectives

JAQS will create and disseminate a DoD owned uniform AM qualification standard.

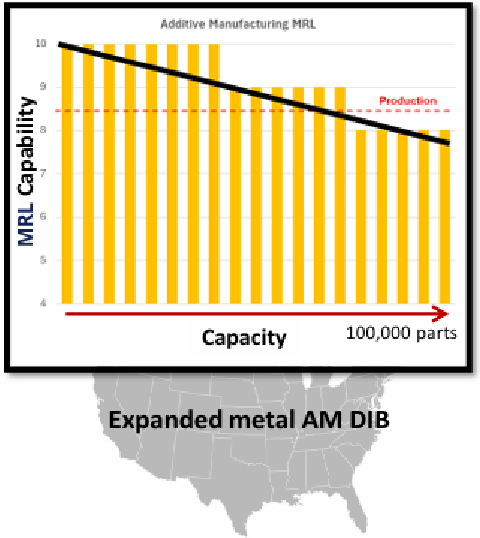


Deliverables:

1. *LPBF and DED PCDs*
2. *LPBF and DED EWD*
3. *PQ Guidance Document*
4. *LPBF & DED Supplier Qual*

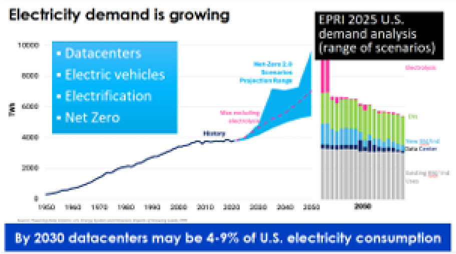
JAQS Benefits

Creation of a "DoD AM Approved Supplier" listing ensures DoD additive suppliers are knowledgeable & capable of printing qualified hardware.

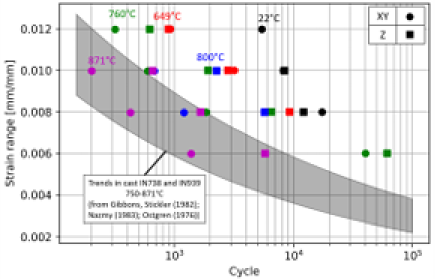


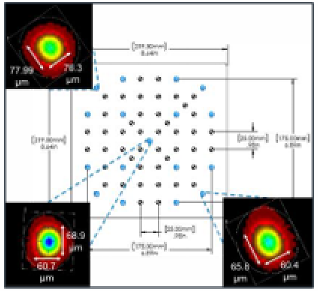
Gaps and Future Opportunities

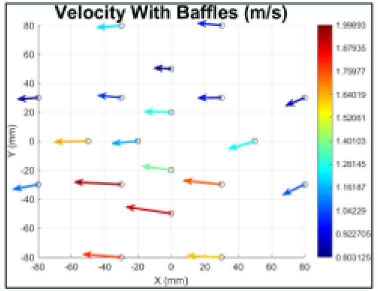
- Supply chain demand signal
- Installation Qualification – machine calibration
  - Ensuring equipment capability
- Additional material process combinations
  - Expanding access to data
- Demonstrating the value and validity of AI/ML approaches
- Addressing economic risk factors which impede AM scaling



Courtesy of EPRI







When America Makes America Works

America Makes

AmericaMakes.us @AmericaMakes /AmericaMakes

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Lunch Break

11:30 - 13:30

PJ TAMPA Spiral 3 A update from NP Aerospace and Thales, followed by Q&A

13:30-14:20

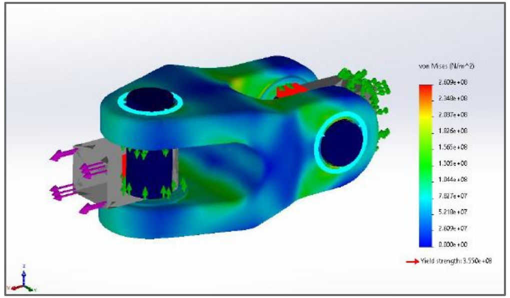
NP Aerospace

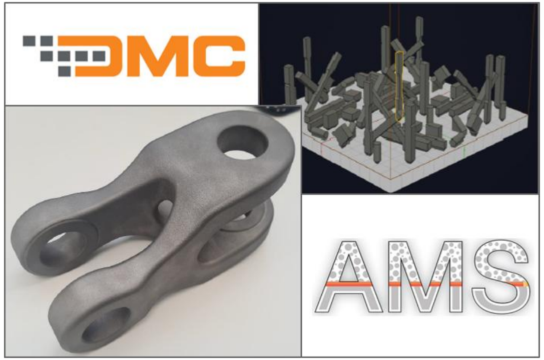
NP Aerospace Spiral 3 Update and LFE

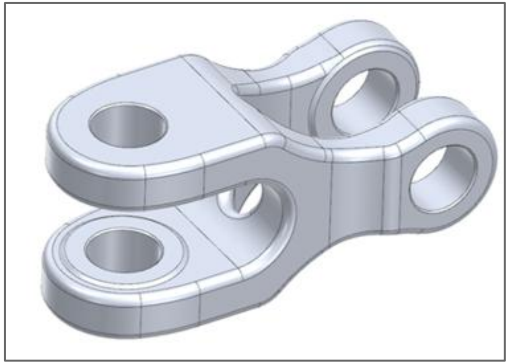
Cougar Platform Towing Shackle

Task Introduction

Spiral 3A - *Assess equivalency of AM parts produced between UK companies*







Titanium Recycling

THE APPLICATION – TOWING SHACKLE

- Cougar vehicles consist of Mastiff, Ridgback and Wolfhound. Max laden mass across the fleet is 29 ton.
- Cougar features a towing A Frame with two shackles. Originally steel forged parts. This part is obsolete with no clear supply route.
- Must be capable of recovering damaged vehicles from difficult environments.
- Accounting for terrain conditions, gradient and vehicle damage this can become a force equivalent to an 80 ton pull.

Realistic worst case estimated pull

Assumptions:
- Deep mud/bog
- 25 degree slope
- Multiple missing axles

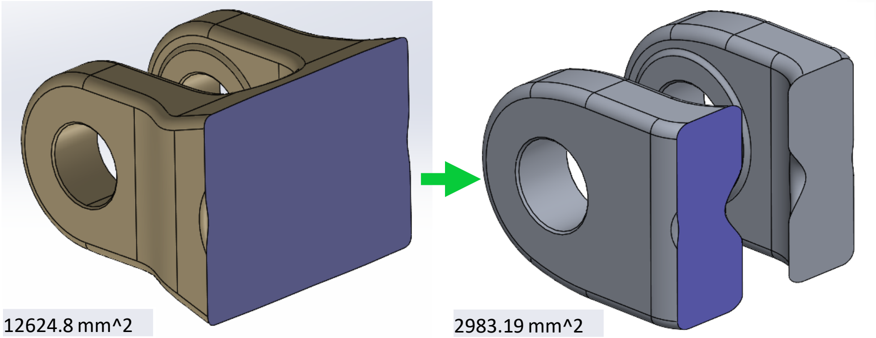
WOV (Weight of Vehicle)	29000		Kg
RR (Rolling Resistance)	Ground factor	2	NA see 11.6
	14500		Kg
GR (Gradiant Resistance)	Degree of slope	25	Degrees
	12083.33333		Kg
DR (Damage Resistance)	Damage resistance	1.33	NA see 11.8 and 22.4
	38666.67		Kg
SF (Safety Factor)	16312.5		Kg
EP (Estimated Pull)	81562.50		Kg

Reverse engineering and optimisation

- The part was reverse engineered using traditional methods. No CAD or material data available.

- Cross sectional areas reduced for more uniform cooling whilst meeting structural restraints. Largest longitudinal cross-sectional area reduced by over 75%.

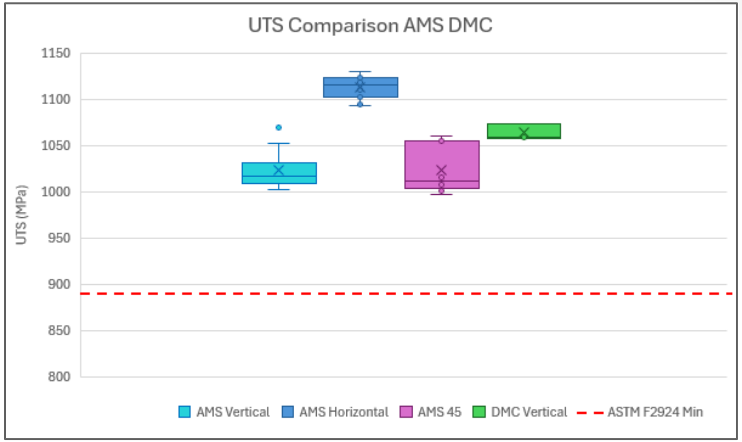
- Significant weight reduction achieved using topology optimisation. 8kg down to 3kg.

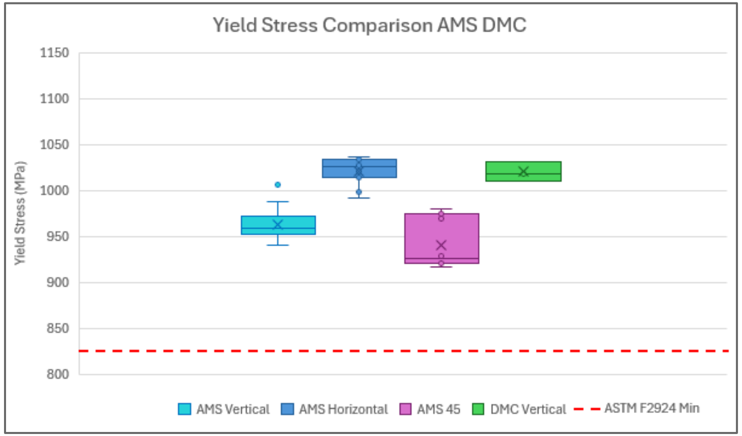


Initial part
Generative shape
Final part

TEST PLAN - SAMPLES

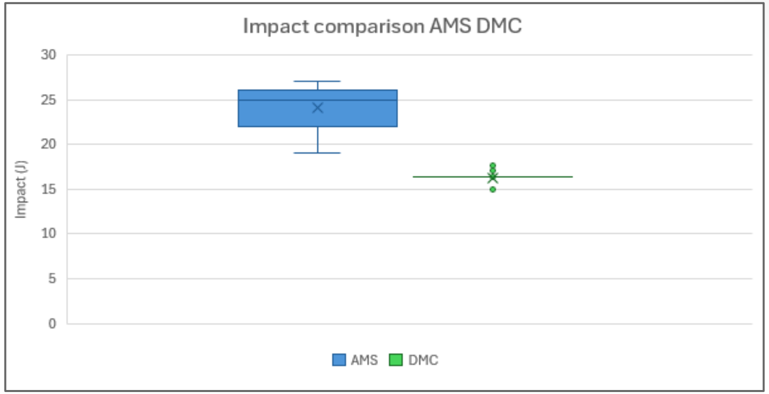
- AMS produced samples for Tensile, Compression, Impact and Hardness in horizontal, 45 degrees and vertical orientations.
- DMC produced samples for Tensile, Compression, Impact and Hardness in the same build orientation as their shackle (vertical).
- Analysis from this showed relatively similar results for Yield Stress and Ultimate Tensile Strength between suppliers.
- Increased scatter was seen at 45 degrees for the as built samples due to enhanced surface roughness from printing at an angle.
- All samples meet the minimum requirement from ASTM F2924.

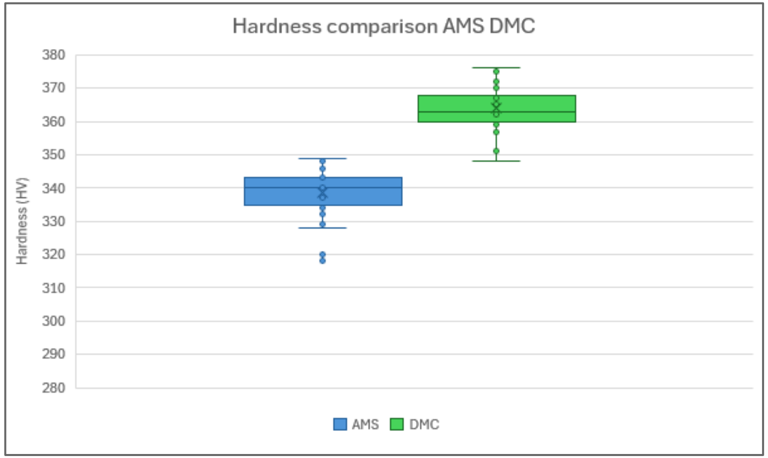




TEST PLAN - SAMPLES

- A bigger difference between Impact and Hardness results was seen. All within acceptable range for this part.
- These tests are generally more sensitive to process changes than tensile tests. Discrepancies are likely due to a combination of factors.
- Impact could be influenced by factors such as oxygen content or minor discrepancies in material density.
- Hardness could be influenced by the different heat treatment methods used or discrepancies in oxygen content.





EQUIVALENCY LEARNINGS

- Test results can vary between suppliers but were all within acceptable limits.

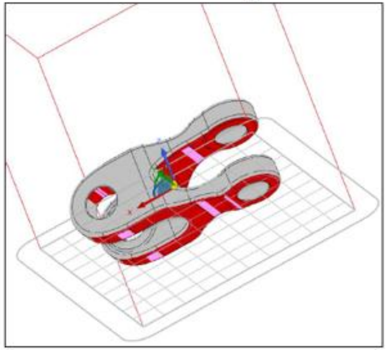
- Many factors can influence these results such as:
  - Powder reuse times
  - Oxygen content (due to powder itself or machine oxygen control)
  - Machine
  - Heat treatment method and process

- One is not necessarily 'better' than the other. The entire picture and use case of the part needs to be considered.

TEST PLAN - SHACKLES

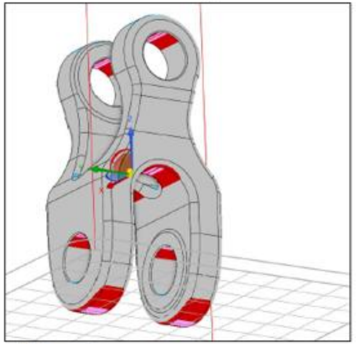
- Both suppliers received the same CAD and drawing data.
- Both suppliers were given load directions and use case of the part.
- Both suppliers suggested different build orientations with justification. Green was selected.

Minimum z height



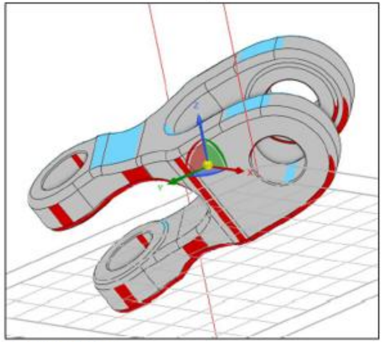
Pros:
-Fastest build time
-Lowest risk of distortion
Cons:
-Most support area
-Poor suitability for batch production

Minimum tray area



Pros:
-Most efficient for batch production
-Low support area
Cons:
-Highest risk of distortion
-Longest build time

Minimum supports



Pros:
-Least support area
-Low distortion risk
Cons:
-Poor suitability for batch production

Test plan - Shackles

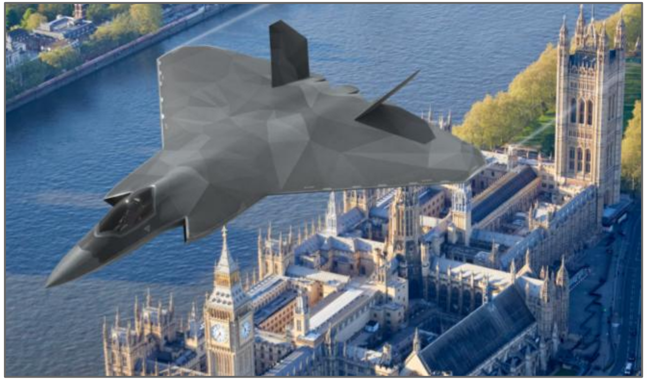
- Parts received from AMS and DMC both have acceptable dimensional tolerance to drawing.

- Differences observed:
  - Colouration. This is likely due to different heat treatment methods (Argon vs Vacuum) – Not a concern based on material test data.
  - Different finish in areas with support due to the different support strategies used – Not a concern given use case of part.

RECYCLED POWDER INVESTIGATION

- AMS have been working to reduce the amount of titanium waste by recycling it into powder for use in LPBF machines. This is part of project Tornado 2 Tempest.
- This waste titanium is predominantly from end of life aerospace parts.
- Spiral 3 raised an opportunity with AMS to see if recycled powder blends are a viable alternative to virgin powder.

TORNADO 2 TEMPEST



Recycled powder learnings

- A powder blend of 12.5% recycled powder produced from scrap aerospace parts was trialled.
- Initially the part failed due to significant surface porosity. The second attempt produced a usable part.
- Further proof that recycled powder blends can be used to print parts successfully.
- We are waiting on material sample data for comparison to virgin powder. This includes 25% and 50% recycled powder blend coupons for Tensile, Impact, Hardness and Compression testing.

Recycled build #1

Recycled build #2

THALES
Building a future we can all trust

Project TAMPA Spiral 3: Learning From Experience

AdMAAS Working Groups
June 2026

www.thalesgroup.com

Dr Tanya Sabin
Senior Materials Engineer

Dr Ashleigh Buck
Materials Engineer

Max Walters
Lead Environmental Engineer

Overview

> Technology selection

> Supplier selection

> Part selection

> Some lessons learned from experience

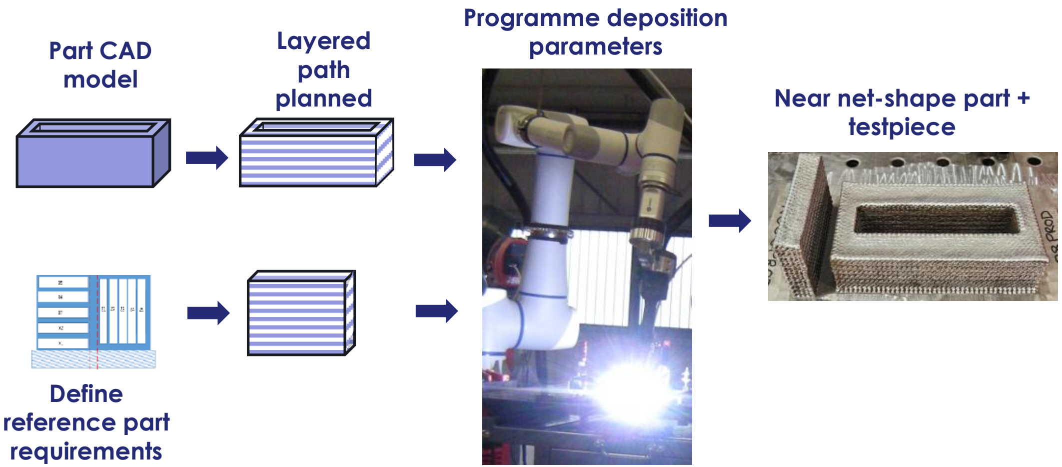
> Life Cycle Analysis

> What next?

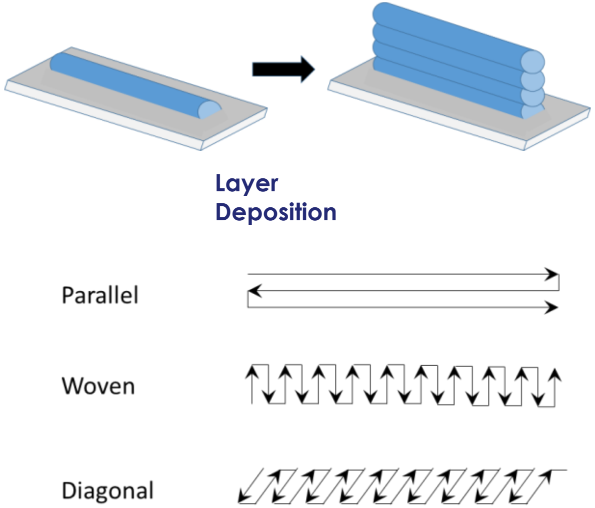
Technology selection: Wire Arc Additive Manufacturing - WAAM

> Suited to large metallic parts: of interest to various Thales business units

> Used for TAMPA Spiral 1 and Private Venture R&D



Outline of WAAM Process



Alternative Weld Paths for Thicker Walls

Supplier selection

Additure

- Supplier selected for Spiral 1
- WAAM using Gefertec arc40x machine: 5-axis manipulation with Fronius TPS 400i welding unit

Arc Additive

- SME incorporated in January 2024, team has extensive experience with welding and WAAM
- WAAM using bespoke robotic systems + Fronius welding unit: MIG and TIG options

Image credit: Gefertec

Image credits: Arc Additive

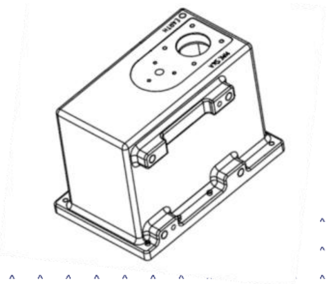
Part selection

Sonar 2193 housing – Hunt class minehunters

> Material Titanium 6Al 4V

> Manufactured under Spiral 1

> Selected for manufacture by a second UK supplier under Spiral 3

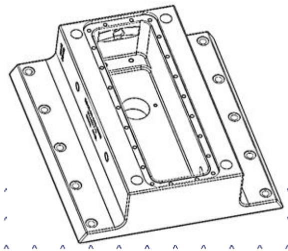


Sonar 2093 housing – Sandown class minehunters

> Legacy part in special stainless steel: long lead times, high cost

> Proposed to replace with Inconel 718

> Selected for manufacture by two UK suppliers



Lessons learned: system

> Configuration control – questions remain

- What changes require new part numbering? New Certificate of Design?

> Procedure for qualification + reference parts per ISO/ASTM effective

- Variability in thermal cycle of individual regions affects properties in a one-off part
- Similar to established practice for forgings/castings in various industries (FAI cut up, traveller test coupons)

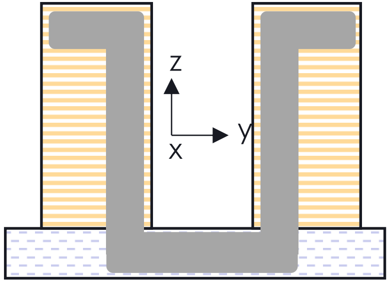
> Definition of qualification part learned by experience: may depend on Supplier's choice of build strategy

- Need to communicate along both directions in a Digital Thread

Lessons learned: system/manufacturing

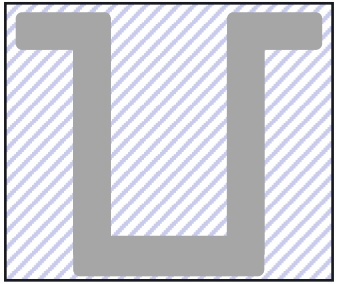
> Different equipment set-ups lead to very different build strategies

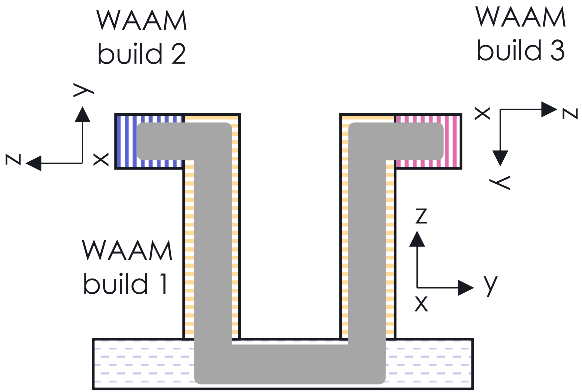
- Making of features e.g. corners, flanges



WAAM option A

Conventional





WAAM option B

Lessons learned: manufacturing

> Different materials and build strategies can result in very different geometries

Image credits: Additure

No start stop ramp up procedure

Alternating start stop end points

Outside wall in toolpath

> Different build strategies and paths can have many knock-on effects

- Shorter paths (woven rather than parallel stringers) -> more reversals, potentially more time and gas consumed

Image credit: Arc Additive

Lessons learned: manufacturing

> Correct selection of machining datums complicated:

- Distortion

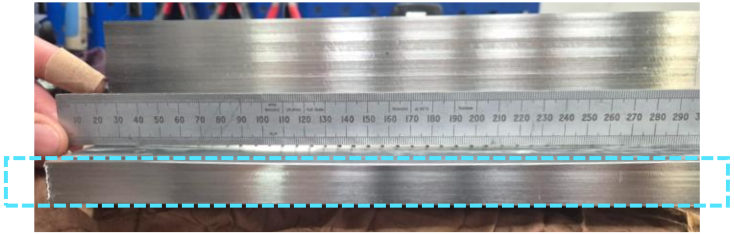


Image credit: Whittaker Engineering

- Wavy surface finish

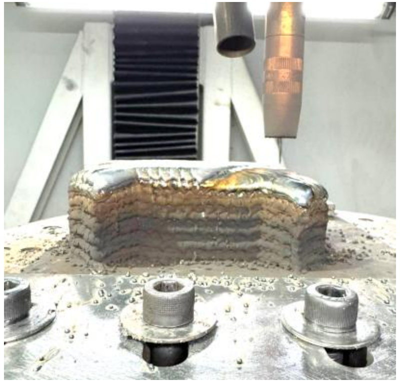


Image credit: Additure

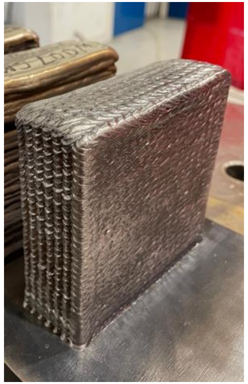


Image credit: Arc Additive

> Further supply chain limited, especially machinists for

- small volumes (one-off spares)
- wire DED parts – little experience, perceived as difficult

> Machine shops' assumptions may need to be adapted; AM supplier may need to specify more details

Lessons learned: sustainability - Thales Life Cycle Analysis (LCA) tool

> Uses data gathered from the WAAM manufacturing process in TAMPA Spirals 1 and 3 and compares with conventional processes

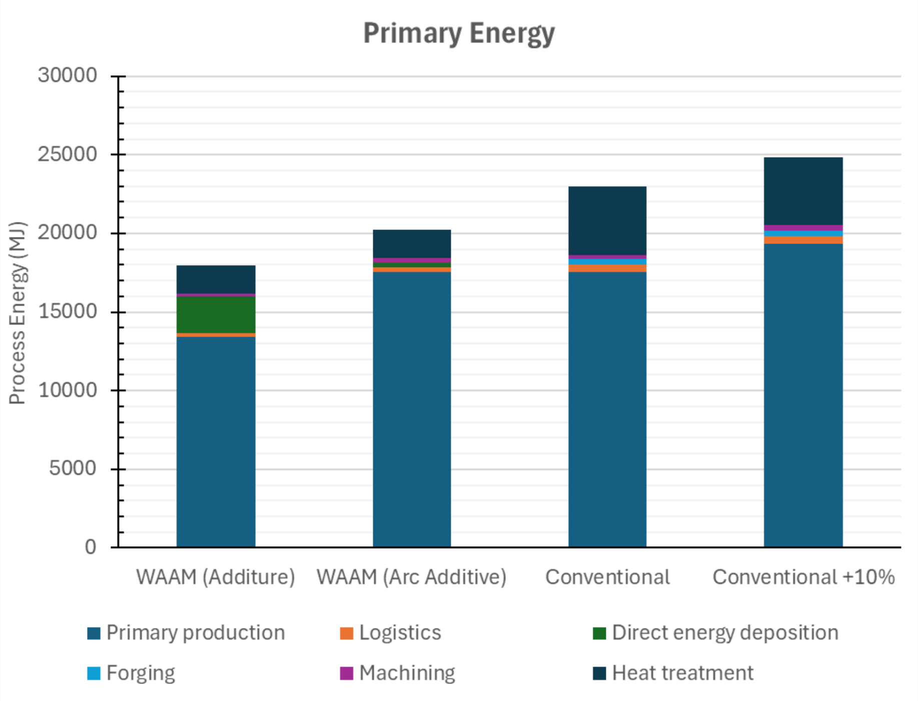
- Cradle-to-gate process (raw material to release)
- Environmental performance measured by quantifying relevant primary energy and resultant greenhouse gas emissions from manufacturing processes
- Assumptions use reputable information sources e.g. scientific papers
- Use of conversion factors from DESNZ and material databases such as Total Materia
- Assumptions made about billet size for machining of conventional parts, transport methods, heat treatment oven types ….

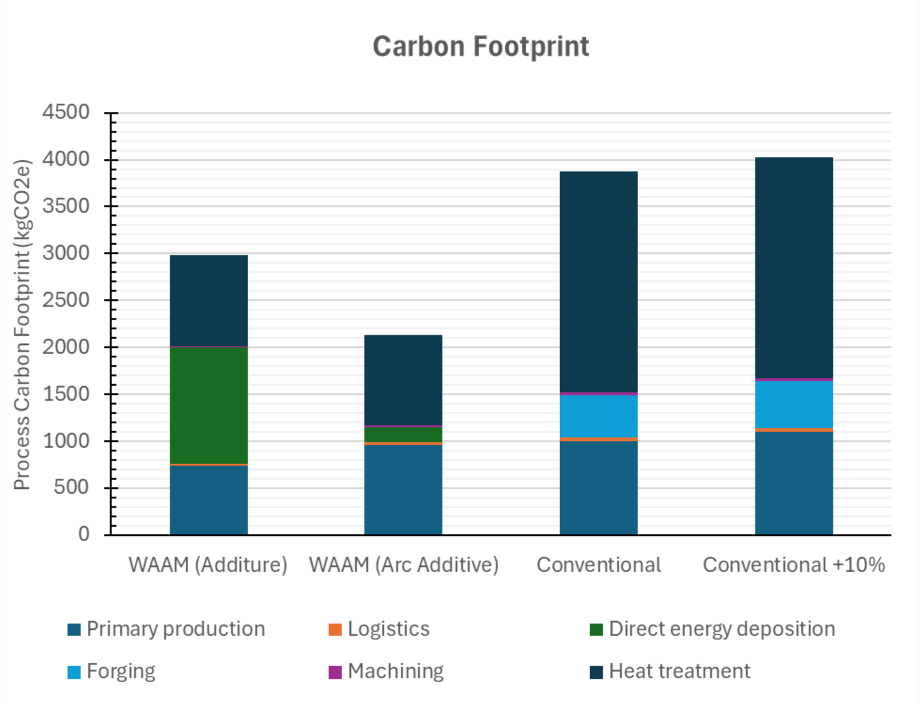
> Conclusions show WAAM applied to these parts can reduce energy consumption and carbon footprint by 10’s of % compared with conventional manufacturing for both materials

> Strong dependencies on certain parameters which may guide procurement decisions:

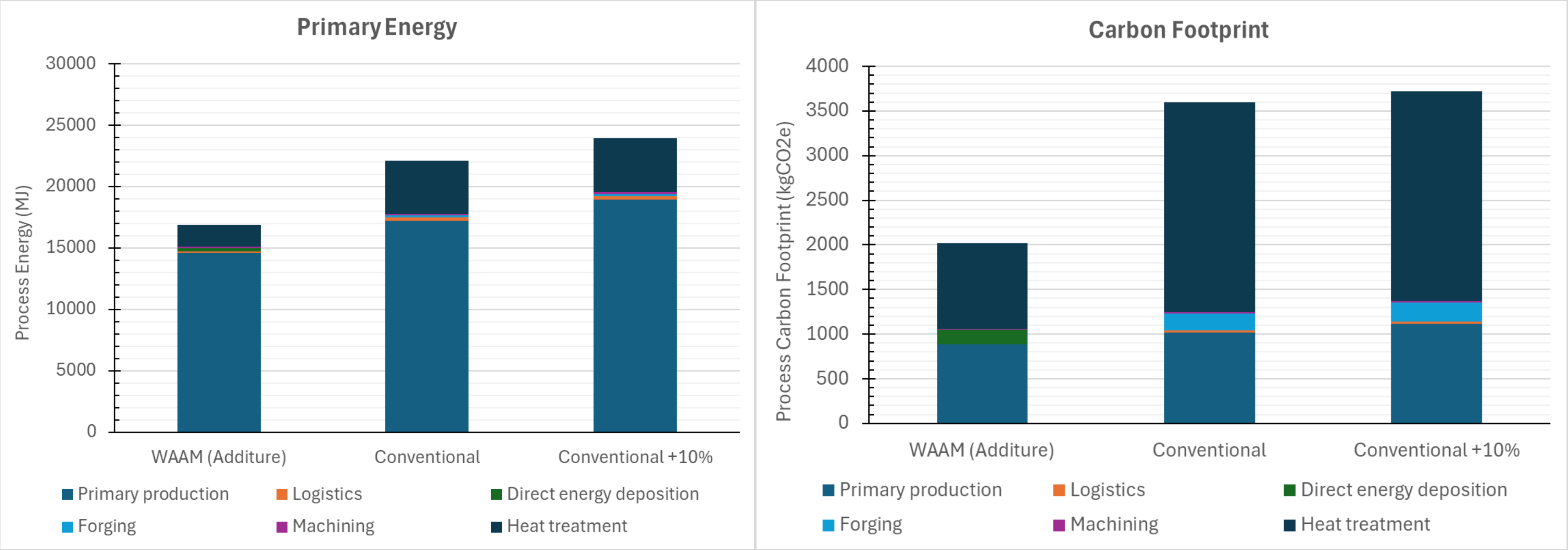
- Countries of processing
- Buy-to-fly ratio
- Percentage of recycled material

LCA analysis: S2093 housing - Inconel 718





LCA Analysis: S2193 housing – Ti 6Al 4V



Lessons learned: non-technical

> Communication with Delivery Team lacking – increased communication expected on completion

- No pull on these particular parts
- Interest in polymer parts so useful as a feasibility study

> Effective communication up and down supply chain is crucial to success

- Learning required: unconventional requirements and expectations
- Experience among supply chain lacking compared with conventional manufacturing

> Building a supply chain with SMEs

- Very agile and responsive – quick resolution of in-house issues
- Need to ensure they have sufficient resource with each skill/knowledge area – could we have supported better?

What next?

> Thales LCA tool only applicable to Wire DED – potential for extension to other technologies

- Wire drawing process simpler to quantify than powder manufacture?

> Utilises published data for melting, forging, rolling, drawing, machining “per kg”

- No current consideration of machining types
- No input for complexity

> No optimisation of parts for process in this Spiral

- Replacing mostly like-for-like for legacy parts but could improve
- Can we develop protocol for leaving as-built surfaces to maximise efficiency?

SUMMARY

Valuable lessons learned to feed into Working Groups

Communication in both directions along customer-supplier chain is vital

Increased supply chain robustness to feed into PV work

Data-based tool for assessing sustainability of wire DED vs conventional manufacturing

Opportunities identified for further learning and improvement

Questions?

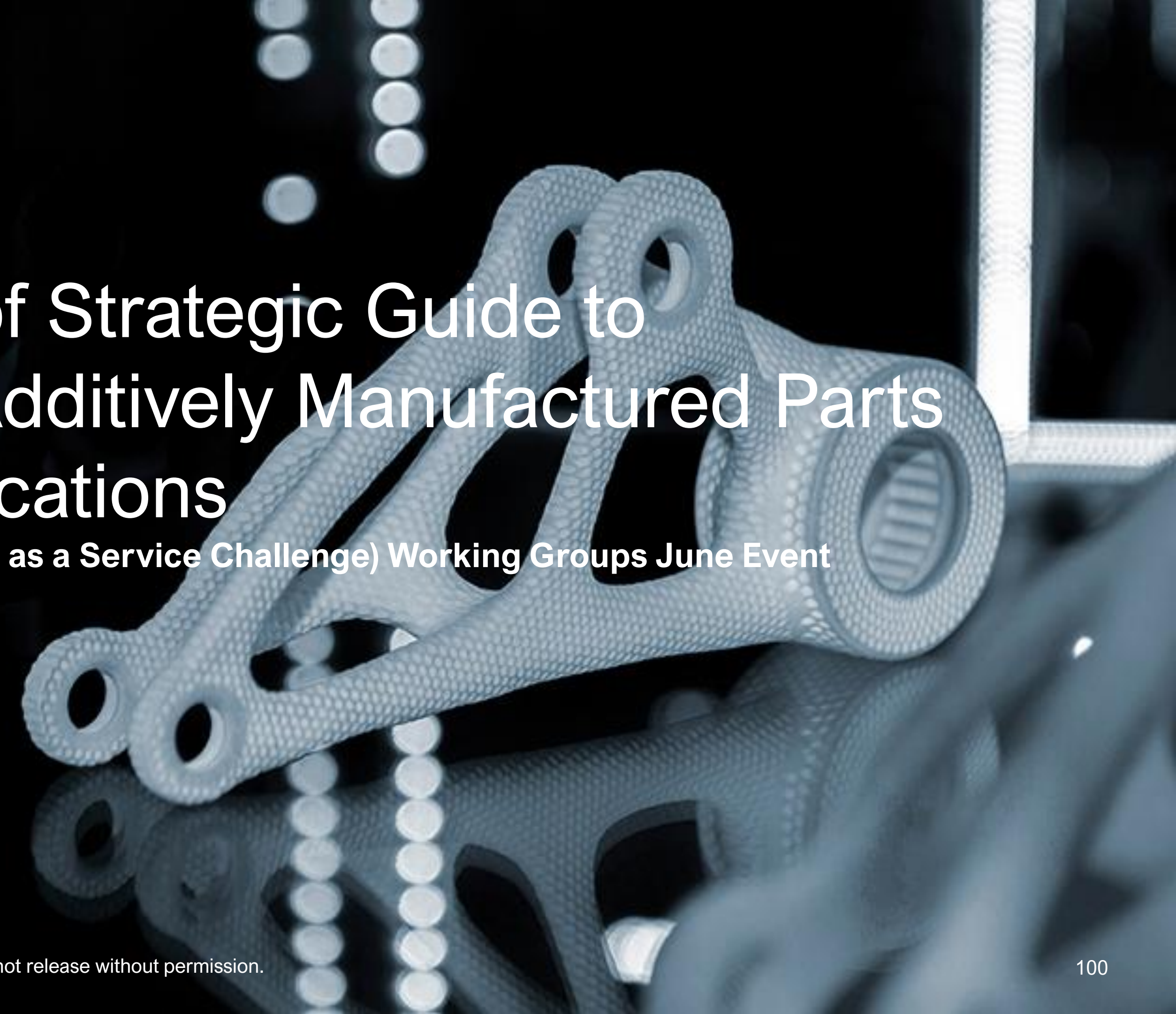
National Armaments Director Group

ASTM’s launch of the AM Part Certification Guidance Document

Alberto Bordin

14:20-14:35

ADDITIVE MANUFACTURING CENTER OF EXCELLENCE



Official Launch of Strategic Guide to Certification of Additively Manufactured Parts in Defence Applications

PJ TAMPA (Additive Manufacturing as a Service Challenge) Working Groups June Event

Alberto Bordin Ph.D

2 June 2026
NEC Birmingham

Biography

ADDITIVE MANUFACTURING
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- Dr. Alberto Bordin is a Technical Manager at the ASTM Additive Manufacturing Center of Excellence, with over 10 years of experience in Additive Manufacturing.
- He earned his PhD in Additive Manufacturing from the University of Padova, Italy, in 2016.
- Dr. Bordin held key position in motorsport and advanced manufacturing, including AM R&D engineer at Ferrari Formula 1, Head of Applications Engineering at Pankl Racing Systems, and engineering manager at 3T-AM, where he industrialized AM products for aerospace, space, and medical sectors.
- At ASTM, he specializes in qualification for Additive Manufacturing and has worked on multiple projects advancing the field.

Motivation

ADDITIVE MANUFACTURING
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A fragmented certification landscape is slowing AM adoption

Fragmented requirements

Each prime has developed its own internal AM certification process, drawing on different standards and requirements.

Inconsistent expectations

AM suppliers are asked to meet different criteria by different customers, with no shared, criticality-based reference.

Slowed deployment

Without a unified approach, certified AM parts reach platforms more slowly, affecting availability and supply chain resilience.

Project TAMPA — accelerating certified AM adoption for UK MOD

The project TAMPA Certification Working Group commissioned the creation of a **unifying AM part certification guide.**

Purpose and Scope

A signposting guide — not a regulation, not a standard

PURPOSE

A common reference for AM part certification across defence

- Helps Design Organisations, Manufacturing Organisations, suppliers and delivery teams identify the certification evidence expected for AM parts.
- Tiered to part criticality and grounded in international AM standards.
- Applies to all MOD suppliers, across air, land and maritime domains.
- Guidance only — not policy, not regulation, not a mandatory requirement.

IN SCOPE

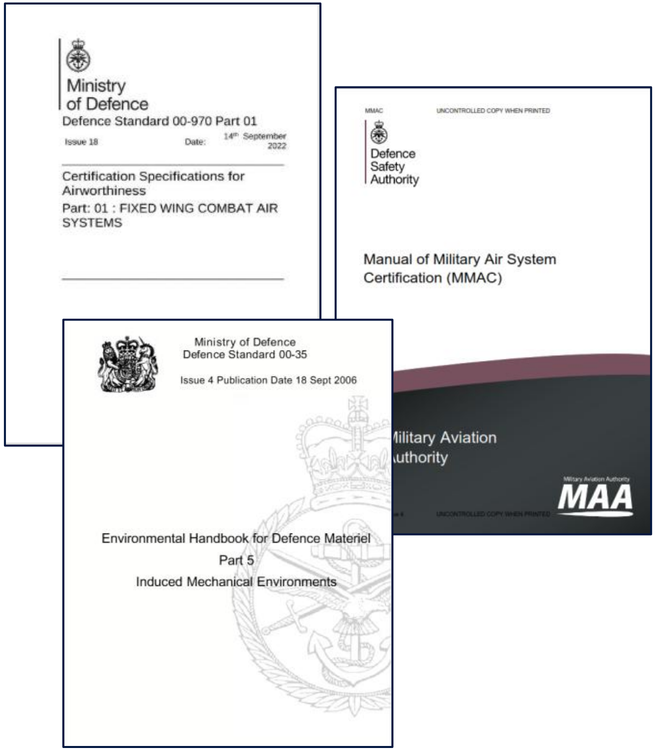
- AM parts produced in regulated industrial settings
- All AM processes and feedstocks (process-agnostic)
- New parts and replacements for legacy spares
- Tiered guidelines by part classification (A → D)

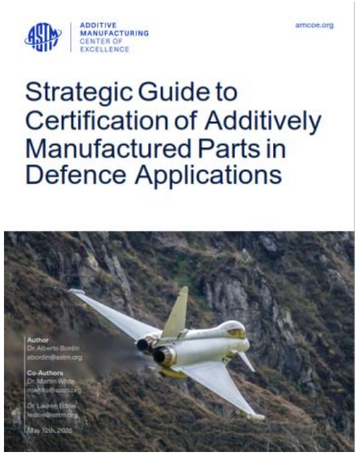
NOT IN SCOPE

- Explaining AM technologies, processes or applications
- Deployed manufacturing or field repair using AM
- AM repair of existing, non-AM parts
- Replacing company QMS or contractual obligations

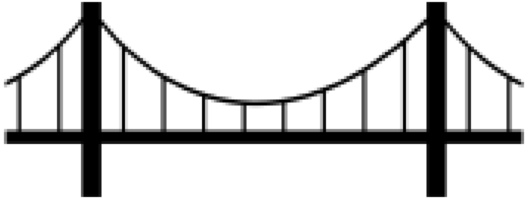
A Bridging Document Between AM Standards and Certification Requirements

ADDITIVE MANUFACTURING CENTER OF EXCELLENCE





Drafted by PJ TAMPA certification working group and developed by ASTM



PRI
PERFORMANCE REVIEW INSTITUTE
DIN
ASTM INTERNATIONAL
ISO
SAE INTERNATIONAL
bsi.
afnor CERTIFICATION

INTERNATIONAL AM STANDARDS LANDSCAPE

Foundational Principle

Certification effort should be scaled according to safety-related part criticality

“

The rigour of certification evidence required is proportionate to the consequence of failure of the part in service.

Aligned with EASA CM-S-008 and translated into the MOD defence context

CERTIFICATION EFFORT → scales with part class

Class A
Catastrophic / Hazardous
Most comprehensive evidence

Class B
Major
Broad property and process controls

Class C
Minor
Reduced, focused controls

Class D
No safety effect
Minimum

Lower evidence **Greater evidence ▶**

AM Part Classification Used in This Guide

ADDITIVE MANUFACTURING CENTER OF EXCELLENCE

Adapted from EASA CM-S-008, ASTM F3572 and ISO/ASTM 52967 — wording adjusted with MOD stakeholders for air, land and maritime domains.

Part Classification	Consequence of Failure	General Description	Probability of Failure Classification
A	High	Part whose failure can directly affect continued safe operation Part whose failure can result in serious or fatal injury to crew or maintenance personnel Part whose failure can result in excessive workload of crew	CAT HAZ
B	Medium	Part whose failure can indirectly affect continued safe operation Part whose failure can result in injury to crew Part whose failure can result in significant increase in workload of crew	MAJ
C	Low	Part whose failure has no effect on continued safe operation Part whose failure has no effect on crew Part whose failure can result in slight reduction in operational / functional capabilities Part whose failure can result in slight increase in workload of crew	MIN
D	Negligible or no effect	Parts not covered above Part whose failure would pose no risk of damage to other equipment or personnel Parts not affecting operational / functional capabilities	No Effect

Note: CAT = Catastrophic; HAZ = Hazardous; MAJ = Major; MIN = Minor; NSE = No Safety Effect.
Probability of failure classifications are representative and should be mapped to the terminology required by the applicable Authority.

Certification Approach and Courses of Actions

AM parts are certified against existing regulatory requirements; no additional AM-specific certification frameworks are assumed. Where existing requirements are not directly applicable, appropriate means of compliance or special conditions may be defined in agreement with the relevant Authority.

This guide supports Certification Course of Action 1; however, the courses of action are not mutually exclusive and may be combined. *Ref: Manual of Military Air System Certification [MMAC]*

COA 1

Process-qualification-based certification

Qualifies a defined feedstock–machine–process combination for repeated use across many parts.

- Material qualification through coupon test campaign
- Established material and process specifications
- Machine equivalence demonstration
- Process control coupons across the build volume

Best when: many parts share the same material, machine and process — initial investment amortises at scale.

COA 2

Test-based certification

Conformity demonstrated through direct testing of each specific produced part.

- NDE of the actual produced part
- Destructive testing of equivalent part / witness specimens
- Evidence not transferable to other geometries
- NDE acceptance commensurate with criticality

Best when: small numbers of parts, or where full process qualification is not practical.

Certification Evidence by Part Classification

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Expected level of compliance evidence by part classification and certification topic

Requirements for Structures, Equipment, and Installations	Classification		Materials/ Fabrication Methods	Material Strength Properties and Material Design Values	Strength and Deformation/ Proof of Structure	Damage Tolerance and Fatigue Evaluation of Structure	Equipment, Systems and installations/ Hydraulic Systems
Part Classification	A	CAT	§6.2-ClassA	X §6.3-ClassA	X §6.4-ClassA	X §6.5-ClassA	As required §6.6-ClassA
		HAZ	§6.2-ClassA	X §6.3-ClassA	X §6.4-ClassA	TBD §6.5-ClassA	As required §6.6-ClassA
	B	MAJ	§6.2-ClassB	X §6.3-ClassB	X §6.4-ClassB	TBD §6.5-ClassB	As required §6.6-ClassB
	C	MIN	§6.2-ClassC	S §6.3-ClassC	S §6.4-ClassC	TBD §6.5-ClassC	As required §6.6-ClassC
	D	NSE	N §6.1-ClassD	N §6.3-ClassD	N §6.4-ClassD	N §6.5-ClassD	N §6.6-ClassD

Table Key:
X = full Means of Compliance, S = simplified MoC, N = no/negligible MoC.
TBD = To Be Determined

For definitions of full and simplified MoC, see EASA CM-S-008 Supplemental, Appendix 4 [11]

CAT = Catastrophic, HAZ = Hazardous, MAJ = Major, MIN = Minor,
NSE = No Safety Effect

§ = A designated section of this document accompanied by relevant supporting note references

The guide provides tiered guidelines for all certification topics included in the table, with particular emphasis to materials and fabrication methods

Material and Fabrication Methods Certification Guidelines

ADDITIVE MANUFACTURING
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Ten certification topics, each tiered by part classification and aligned with the ISO/ASTM 52920 process-agnostic framework

MATERIALS

Feedstock control

Tiered material specs; lot, reuse and traceability controls

Finished part properties

Mechanical, chemical, microstructural, density, anomalies, more

Anomalies & flaws acceptance

Defined acceptance limits, scaled to criticality

FABRICATION METHODS

Facility & infrastructure

Controlled industrial environment, equipment baseline

Process qualification & validation

IQ/OQ/PQ, machine equivalence, requalification triggers

Build definition

Build files, parameters, layout, orientation, frozen builds

Process control

In-process monitoring, witness coupons, statistical control

Product verification & NDT

Inspection plans, NDE methods, acceptance criteria

Data & digital traceability

Digital thread, configuration management, cyber-security

Operator training & competence

Qualification of operators and coordination personnel

Tiered Guidance and AM Standards Signposting

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For each certification topic, a signposting box is provided that identifies relevant AM standards, both published and under development, from different standards bodies.

Materials

FEEDSTOCK CONTROL

Material specifications are the primary means of controlling feedstock quality and repeatability in AM. The applicant's specifications should be tiered to part classification, following the guidance set out below, and those feedstock properties that may affect the fabrication process or degrade the material properties used as design values, and establish suitable control limits or acceptance criteria.

Relevant standards include ISO/ASTM 52928 [23], covering metallic powder life-cycle management (particularly relevant to PBF and DED-powder processes), and ISO/ASTM 52907 [24], covering characterisation methods for metallic powders.

Class D (NSE) — See section 6.1

Class C (MIN) — Material specifications may be applied with reduced scope relative to Class A/B, subject to agreement with the DO, with controls focused on the feedstock properties most relevant to the specific application. Reduced expectations may apply for lot-variability assessment and qualification evidence. Where reuse is permitted, reuse procedures should define quality requirements for the reused feedstock proportionate to the application. The rationale for any reduction in scope should be documented and agreed with the DO. Batch identification and traceability are expected, with scope adapted relative to Class A/B.

Class B (MAJ) — Comprehensive material specifications are typically applied, defining control limits on feedstock characteristics that may affect the fabrication process or degrade the material properties used as design values. This may include proprietary specifications or alignment with recognised international standards. Acceptance criteria are typically established for the relevant feedstock characteristics, which may include chemical, physical, morphological, density, flow, contamination, and thermal properties, as appropriate to the material type and process. A Process Failure Modes and Effects Analysis (PFMEA) should be performed to identify feedstock characteristics and feedstock-related changes that

Materials and Fabrication Methods Certification Guidelines

WHERE TO LOOK FOR METAL POWDER FEEDSTOCK CONTROL AND LIFE-CYCLE GUIDANCE

- **ISO/ASTM 52920:** Feedstock storage, traceability, batch control, contamination prevention
- **ISO/ASTM 52904:** Metal PBF production control, including used-powder handling, sieving, blending, and storage
- **ISO/ASTM 52925:** Qualification of materials for PBF-LB/P
- **ISO/ASTM 52928:** Metal powder life-cycle management, including reuse, traceability, and quality assurance.
- **ASTM F3489:** Polymer MEX material handling and static mechanical property evaluation
- **ASTM F3456:** Powder reuse schema for medical-device PBF
- **SAE AMS7031:** Batch reuse of used metal powder for aerospace AM parts
- **SAE ARP 7032 (In development):** Continuous closed-loop reuse of used metal powder
- **SAE ARP 7044:** Guide for powder history metric and labelling schema
- **AWS D20.1:** Feedstock storage and change-control requirements, including multi-material machines
- **LR-GN-046:** Feedstock storage, handling, labelling, segregation, traceability

WHERE TO LOOK FOR POWDER CHARACTERISATION AND SAMPLING GUIDANCE

- **ISO/ASTM 52907:** Methods to characterise metal powders (process-agnostic)
- **ASTM F3701:** Ceramic slurry characterisation for vat photopolymerisation (VPP) AM processes
- **ASTM F3049:** Guide for characterising metal powders for AM
- **ASTM B215:** Sampling practices for metal powders

From shared framework to shared practice

Free and Available Online from June 2026

amcoe.org/research-development/publications

SCAN TO ACCESS

Free download · June 2026

amcoe.org

Apply
Use the guide to plan certification evidence proportionate to your part class.

Share feedback
Share lessons learned and good practice to inform the next revision.

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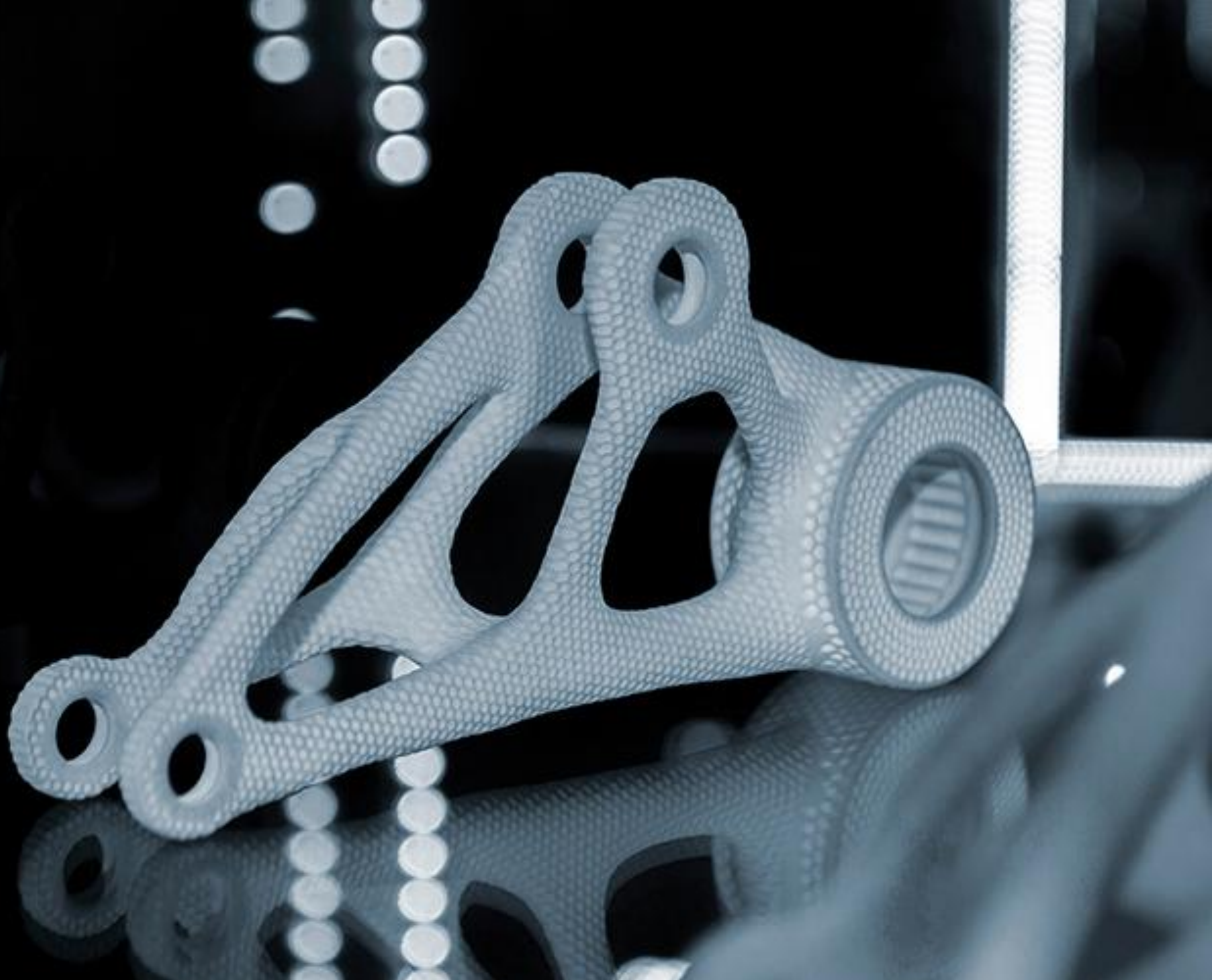
Thank you.



Questions? Please contact:

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amcoe.org

RBSL's wider AM work

Julian Wright

14:35-14:50

METAL PASTE DEPOSITION FOR COST COMPETITIVE METAL AM

Julian Wright

Technology Programmes Manager

02/06/2026 – Project Tampa TCT 3Sixty Event

Rapidia Conflux 1 printer and furnace at RBSL Telford

Prototype Land Rover Brake Pedal, >400mm long, 24hrs print, 12hrs sinter in 17-4PH SS. Holes reamed (no machining or post surface finishing), 4 sections MIG welded together with stainless steel wire. 40% lighter than the original, £86 of AM materials, £14 sintering costs + labour

RBSL
Rheinmetall BAE Systems Land
A Joint Venture Company

ACCELERATING ADOPTION OF METAL AM IN THE LAND DOMAIN

The **#1 challenge** to AM adoption is now **affordability**:

- Parts required in the land domain tend to be bulky and do not command a high price unlike in aerospace
- Metal AM parts are typically more expensive than machined or fabricated parts stifling adoption
- This leads to a lack of AM parts libraries

If metal AM parts were quicker and cheaper to make than in the current supply chain, adoption would happen organically

For metal AM, only Metal Paste Deposition offers:

1. Low cost of adoption
2. Competitive production costs

Whilst still able to manufacture relevant parts

A suitable technology to meet requirements

RBSL

- Low cost feedstocks
- Minimal post processing
- **Small parts can be less than half the cost**

COST

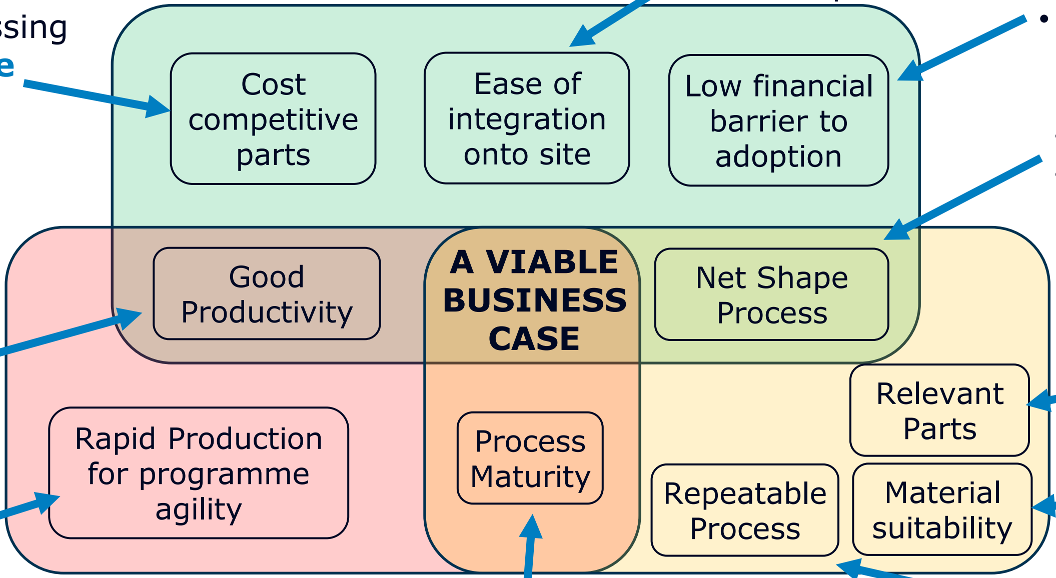
- Safe process
- Minimal footprint
- Simple install

- Low equipment CAPEX
- Minimal post processing equipment

- <0.5mm tolerance
- As printed surface ready for painting

TIME

QUALITY



- Low cost to scale production with additional printers

- Small parts can be finished in 24 hours

- Can print thick sections

- High strength Stainless Steel

- FDM like printing
- Can apply AM standards

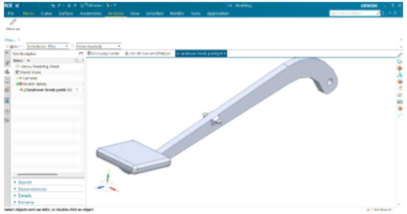
- Straight forward production process

Metal Paste Deposition is a great solution for rapid production of small steel or Inconel parts

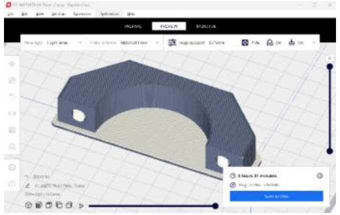
WHAT IS METAL PASTE DEPOSITION?

Manufacturing Process:

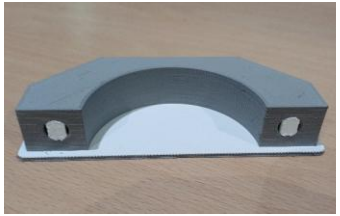
1 Design



2 Slice (Cura)



3 Print



Print Speed 7.7min/cc
Cost <£0.46 per cc

Very similar to FDM process

4 Pre-process

- Sanding to debur and smooth accessible surfaces
- Part marking

5 Sinter

Standard sinter = 12hrs

6 Post Processes

- Hand removal of supports
- Surface finishing as required
- Fabrication / Welding
- Drilling, Reaming & Tapping
- Machining critical surfaces

Two pieces of equipment required
a Printer and a Furnace

MATERIALS PERFORMANCE – 17-4PH

My findings as tested at BAE Systems Parc laboratories

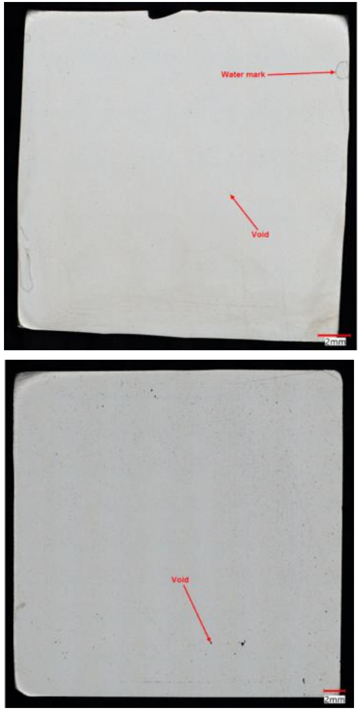
Print Orientation	Sample	UTS (MPa)	Elongation (%)	0.2% Yield (Mpa)
Horizontal	1	974.7	10.1	697.1
	2	985.7	8.8	694.0
	3	986.9	8.6	728.6
	4	990.8	8.8	750.1
	5	976.4	8.0	728.1
	Average	**982.9**	**8.9**	**719.6**
45° from horizontal	1	788.9	3.2	641.3
	2	814.2	4.4	641.3
	3	805.2	3.0	621.8
	4	833.8	3.3	630.8
	5	808.7	4.2	632.4
	Average	**810.2**	**3.6**	**633.5**
Vertical		**In Test**	**In Test**	**In Test**

*All sintered with a 12hr rapid cycle

For comparison:

Steel Grade	UTS (Mpa)	Yield (Mpa)
s275	430	275
s355	490	355

Metal Paste Deposition 17-4PH in its weakest orientation has over twice the yield strength of s275 and over 50% more than s355



Stitched optical image of 100% infill 30mm x 30mm sample cubes

As a substitute for commonly used steel grades, 17-4PH offers a significant performance margin

BENEFITS OF METAL PASTE DEPOSITION

1. **Lower piece part cost** – than small machined, fabricated or cast parts
2. **Low Capital expenditure** – one of the lowest cost metal AM technologies
3. **Low operating costs** – £27.50 per sinter run, 27 sinters per gas cylinder
4. **A very low hazard process** – easy to integrate onto site, no loose powder
5. **Minimal installation requirements** – small equipment footprint, just add power
6. **Minimal or no post processing** – supports break away by hand
7. **Low training requirements** – a cold extrusion process but similar to FDM
8. **Equipment is easily moved** – opportunity for production at the point of need
9. **Low cost to scale capacity** – 4 to 5 printers per furnace at £13.5k per printer

General AM advantages

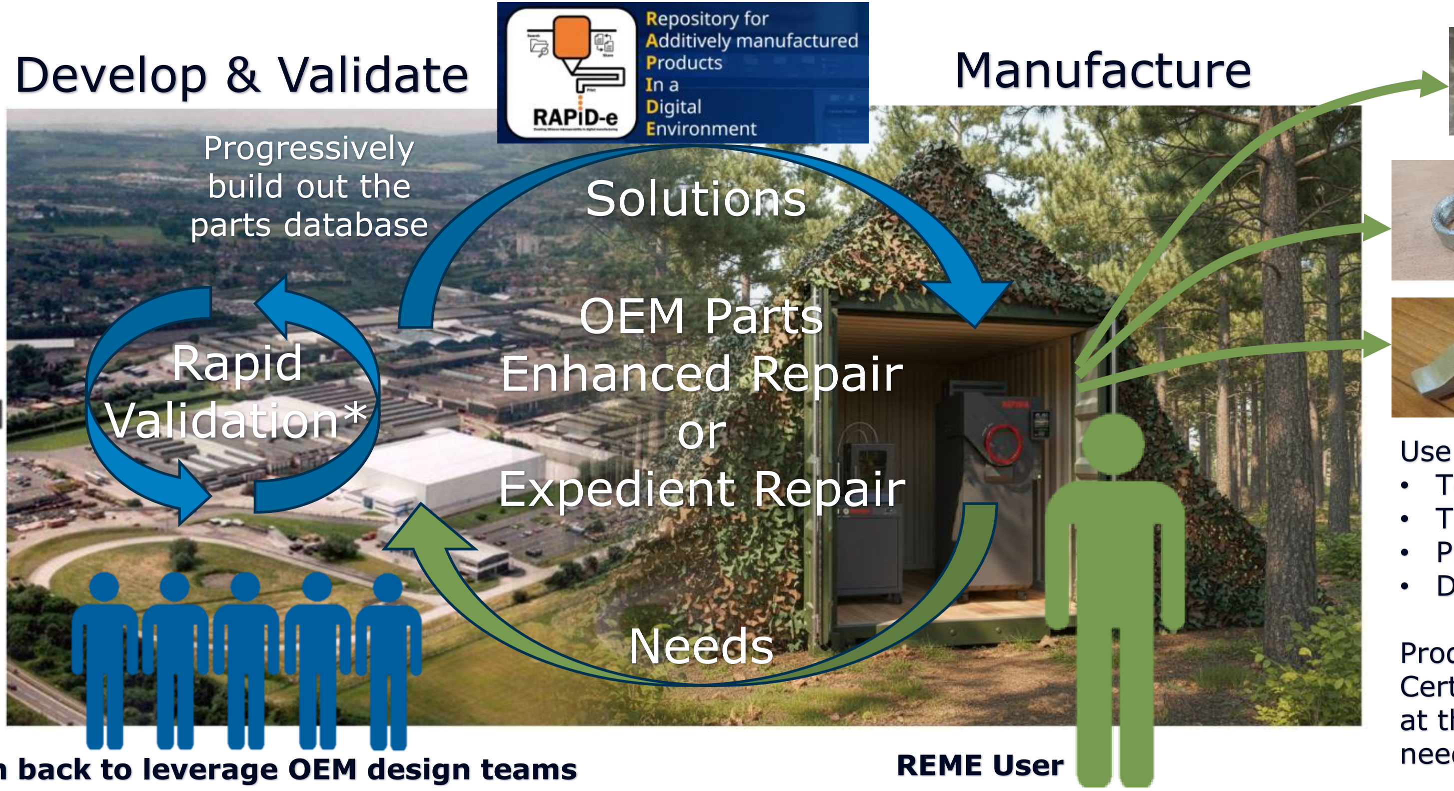
- **Smoothing part procurement costs** – just in time parts manufacture
- **Greater agility** – can achieve rapid development cycles
- **Light weighting** – design optimisation to remove waste material
- **Fewer engineering drawings** – consolidated parts require only one drawing
- **No Minimum Order Quantity** – produce what you need when you need it

SOME EXAMPLE APPLICATIONS AT RBSL

ENABLING TACTICAL METAL PARTS MANUFACTURE

Leverage OEM CAD Databases

TEAMCENTER



Finished Parts

Use the same:
- Tools
- Training
- Processes
- Data

Produce Certified Parts at the point of need

* Pace of release dependent on part criticality, assurance route / certification requirement

DEVELOPING NEW SERVICES

What we've achieved to date

1. **Users can manufacture parts** – Army REME secondment to RBSL
2. **Show the equipment can be easily deployed** – AM Village 2026, Albacete air base collaboration with the British Army
3. **RAPiD-e Data exchange** – RBSL demonstrated UK industry transferring AM data to REME on PCC5 in the USA

Next Steps

- **Acceptance of MPD parts into build standard** – e.g. CR3
- **Establish collaborations with other equipment OEMs** – one solution to meet more of the British Army's needs
- **Demonstrate the service** – pilot the capability with the British Army

THANKYOU

To discuss further:

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RBSL
Rheinmetall BAE Systems Land
A Joint Venture Company

National Armaments Director Group

Wrap up of Day 1

Edit Barbantan, Charlotte Robinson, Ross Trepleton, Jon McMahon

14:50–15:00

Day 2 – 03/06/2026

10:30 to 12:20 – Lessons from Experience sessions

10:30 Introduction to the challenge by the UK MOD and US DOW

10:40 UK Project TAMPA Spiral 3 B update from Babcock and RBSL, followed by a joint Q&A session

11:30 US Allied Additive Manufacturing Interoperability (AAMI) Project update from Eaton and Lockheed Martin, followed by a joint Q&A session

12:20 to 13:05 Panel: From Collaboration to Capability - the UK–US Path to Interoperable Defence Support

- With Babcock, RBSL, Lockheed Martin, Eaton, US DOW + MOD as panel moderators.
- Opening remarks will be provided by the panel chairs, with introductions from panel members, followed by a questions and answers session.

Date of next events:

- **21 Oct 2026** at The Welding Institute (TWI) in Cambridgeshire - jointly sponsored by Titomic and TWI
- **March 2027** at NMIS in Glasgow

Thank you!

2-4 JUNE 2026
NEC, Birmingham, UK

TEAM DEFENCE INFORMATION