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LTI AM Work Package
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Aims and Objectives

“The focus for this work package is to assess where additive manufacturing (AM) could provide benefit to the Defence logistics support and supply chain.

In particular, identify where we could have used AM to address mission critical defects, particularly where there was a shortage of appropriate parts to enable the repair. From these identify where AM and which AM capability could have most impact.”

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The following activities were conducted as part of WP3:

- WP3a: Identification of a range of mission critical parts (~100) across maritime, land and air domains.
- WP3b: Identification of where AM could have a positive impact.
- WP3c: Identification of most appropriate AM capability (Cost Benefit Achievability Analysis).
- WP3d: Production of AM demonstrator parts.
- WP3e: Summary report covering the key findings from WP3a to WP3d.

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Presentation Content

Identifying parts and opportunities → Where and what AM? → Defence Implications → Summary

Identifying parts and opportunities
- Challenges
- Insights from candidate parts analysis

Where and what AM?
- Where to place AM capability?
- Which AM technologies?

Defence Implications
- Benefits
- Costs
- Achievability

Summary
- Recap of key insights

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Identifying parts and opportunities

Data Challenges:

- Data to enable analysis/decisions takes time to obtain
- It is fragmented over multiple systems/organisations
- It requires special permission to access (varies per source)
- Often lacking in context

Key Insights:

- Slow access to data which lacks detail and context is a significant risk to decision making
- Make sure sufficient time and effort is allocated to identify, understand, access and assess data
- Logistics and engineering data needs to be brought together in a way that enables rapid access and appropriate points of contact to give context to part demand data

Identification

Permission

Access time

Understanding

Completeness

Fragmentation

Context

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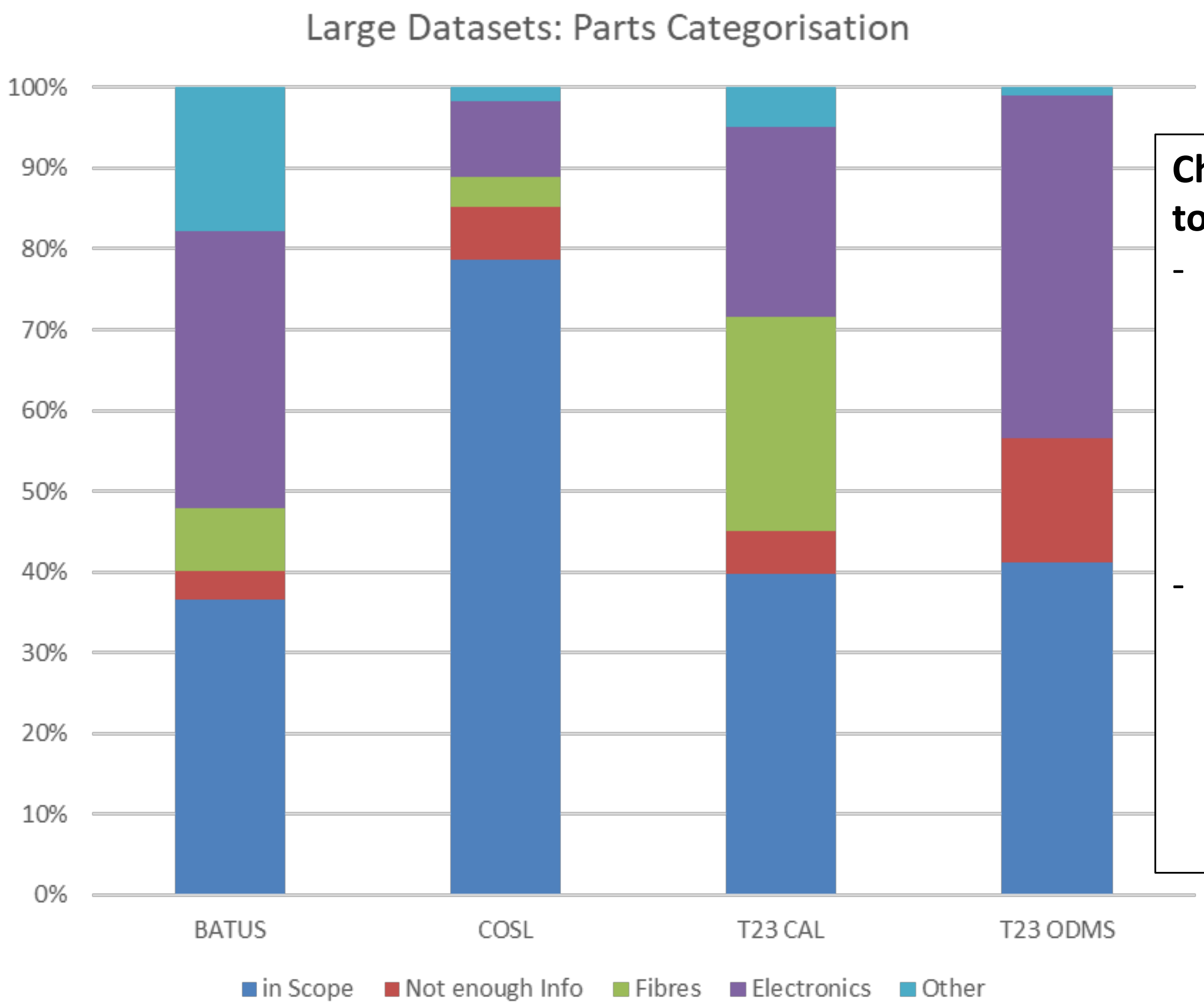

Characterisation of hard to obtain, critical parts:

- Around ~37% to 80% of items within the sample set were identified as being potentially ‘in scope’ for AM production.
- Within the ~100 parts chosen for a more detailed look, most are metal parts with a maximum dimension of 0.5m or less

Where and what AM?

Locations

In the near term and context of the study:

- 12 use cases were considered to represent different locations from the strategic base to the front line across front line commands
- A UK centre of excellence appears to deliver the most benefit as a wider range of AM equipment would be supportable.
- The issue currently is getting parts made rather than transport to the front line.
- In this context the marginal additional time benefits of an AM capability at the front line is outweighed by challenges in operating some technologies in these locations
- Certification for the most critical parts is also likely to be easier at the strategic base

Longer term, wider view:

- There may still be benefit in locating some form of AM capability further forward e.g. restorative metal or high performance polymers for temporary replacements
- Further analysis work to assess the case for this would be needed

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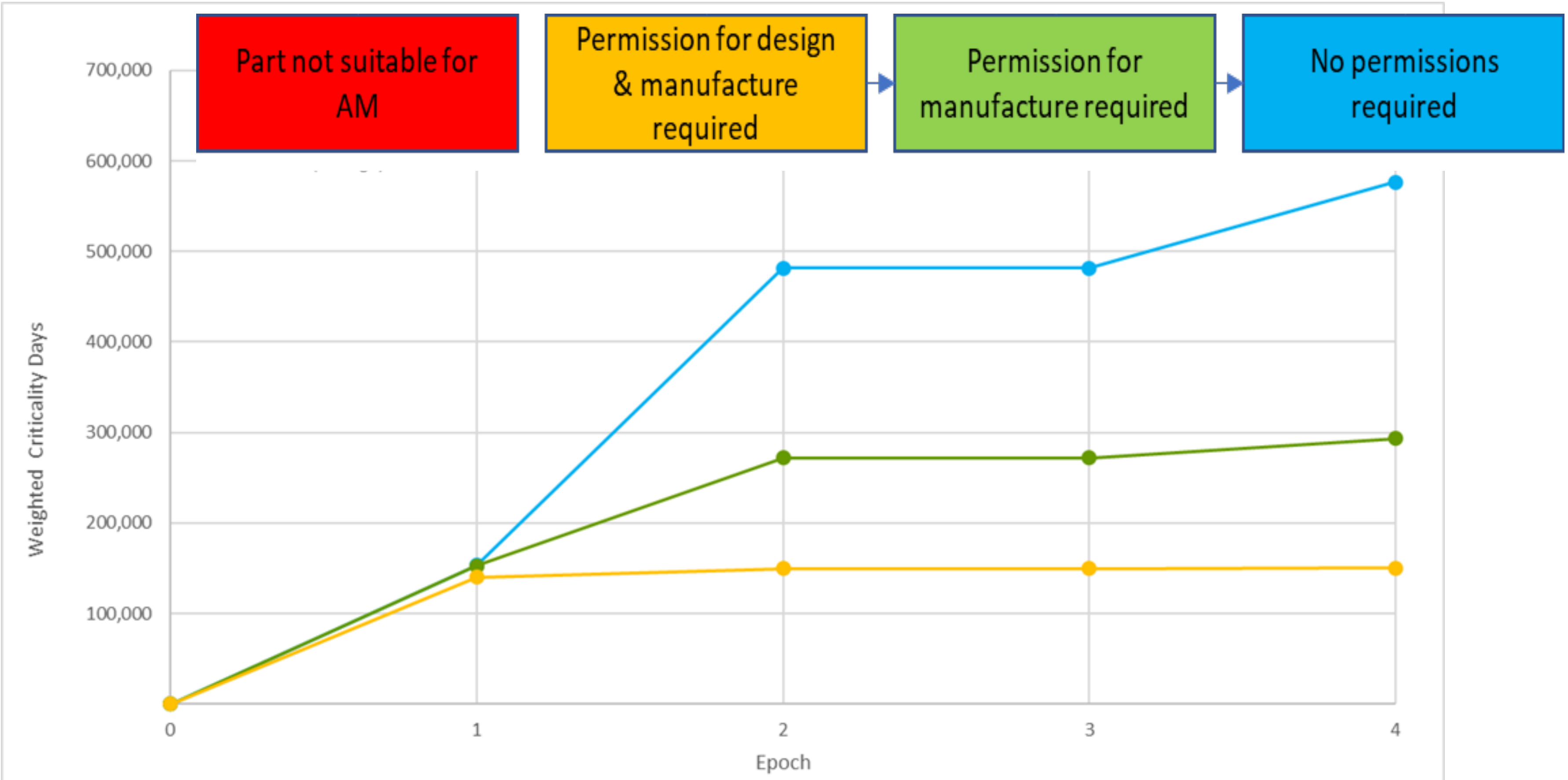
Most promising technologies

AM Technology	UK COE	Deployed
Powder Bed Fusion	**Core technology**	Not recommended
Binder Jetting	Not recommended	Not recommended
Material Jetting	Low priority: Reactive Material Jetting to enable the production of rubber parts	Potential for large-scale deployments depending on technology development
Vat Photo-Polymerisation	Not recommended	Not recommended
Direct Energy Deposition	Low priority for larger parts	Not recommended
Polymer Material Extrusion	Not recommended	**Core technology**
Sheet Lamination	Low priority to print composites	Not recommended

Defence Implications

Benefits



- The main benefit suggested by the study from the use of AM is time saved
- Some demands assessed in the study were months, or even years outstanding
- Use of subtractive techniques could deliver a high proportion of this benefit as well

Costs

Key Insights:

- Cost is highly variable and part dependent – not always lower or higher
- ~30% of parts in the sample set were expected to cost less using AM
- But sample set had an average cost of x4 higher for AM produced parts
- Given that parts were designed before AM existed in many cases this is to be expected
- Redesign of parts for AM may reduce costs for some parts
- Primary driver of cost is material prices – expect this to reduce as AM adoption increases
- Larger cost reductions are likely when AM is 'designed in' from the start

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Key Insights:

- A significant number of hard-to-source components could be made using traditional manufacturing techniques, implying technology maturity is not on the critical path. Drivers for this are likely to include:
  - A lack of appetite for the transfer of technical/commercial risk ownership from the OEM to MOD, or from OEM to a Tier 2 supplier.
  - A lack of understanding around the art of the possible within the manufacturing community.
  - Support contracting methods.
  - The inability for MOD to access parts data, possibly despite being contractually empowered to do so (IP & commercial SQEP).

Summary

Summary (1)

- **AM can have a significant impact on 'Challenge Parts' by reducing waiting times with potential knock-on improvements to system/platform availability**
  - Greatest step change in shortest timeframe is likely to be through investment in Centre of Excellence (CoE)
    - Metal powder bed fusion was found to be the most promising technology due to diversity of parts producible
    - Can also see a role for Direct Energy Deposition (restorative and large items) and high performance polymer material extrusion (replace metals and make-do parts.
- **Further analysis and data**
  - Remains a challenge to identify all the 'desirability' data elements & technical engineering data
  - Further data analysis on larger data sets is possible
  - Cost/benefit/achievability analysis of innovative applications would be useful (restorative, make-do, new tools, etc)
  - Study results focus on maritime/land equipment – more air data is needed
- **AM as part of a suite of workshop equipment – complement not compete**

Summary (2)

Additional topics (including LTI showcase discussions):

1. **Enterprise layer:** Who should own/operate AM capability (MOD/industry/both)?. Need to explore possible different roles and balance across the enterprise – advantages and disadvantages of different approaches – how does this vary by FLC?

2. **Decision support tool:** A reusable approach was developed which could assess other parts (make vs buy and AM vs non-AM)

3. **Leveraging the supply chain:** A DE&S supply problems report explored the question about how to resolve a lack of utilisation of the tier 2 supply chain. How this could be resolved and whether AM would help with (or be affected by it) remains unanswered.

4. **Enabling AM up-front:** Should support contracts be adjusted to help mitigate supply chain fragility? ‘right to print’ (with appropriate royalties for industry) if supply chain fails to deliver? parallels with ‘manufacture under licence’ model?

5. **Better decisions through better data:** Logistics and engineering data needs to be brought together in a way that enables rapid access and appropriate points of contact to give context to part demand data.

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Questions?

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