



REEVES
INSIGHT

Understanding The Business of 3D Printing

PAS6001 – Do industrial
adoption drivers for
AM make sense in a
defence context

14th July 2021

A quick introduction

- 27-years involvement in the AM/3DP
- Expertise in mapping AM/3DP technologies to applications and understanding the economic, environmental and social benefits of the technology to industry & government
- Approached in 2019 by Innovate UK (UKRI) & BSI to write a guide to help businesses evaluate and understand the benefits of AM/3DP adoption

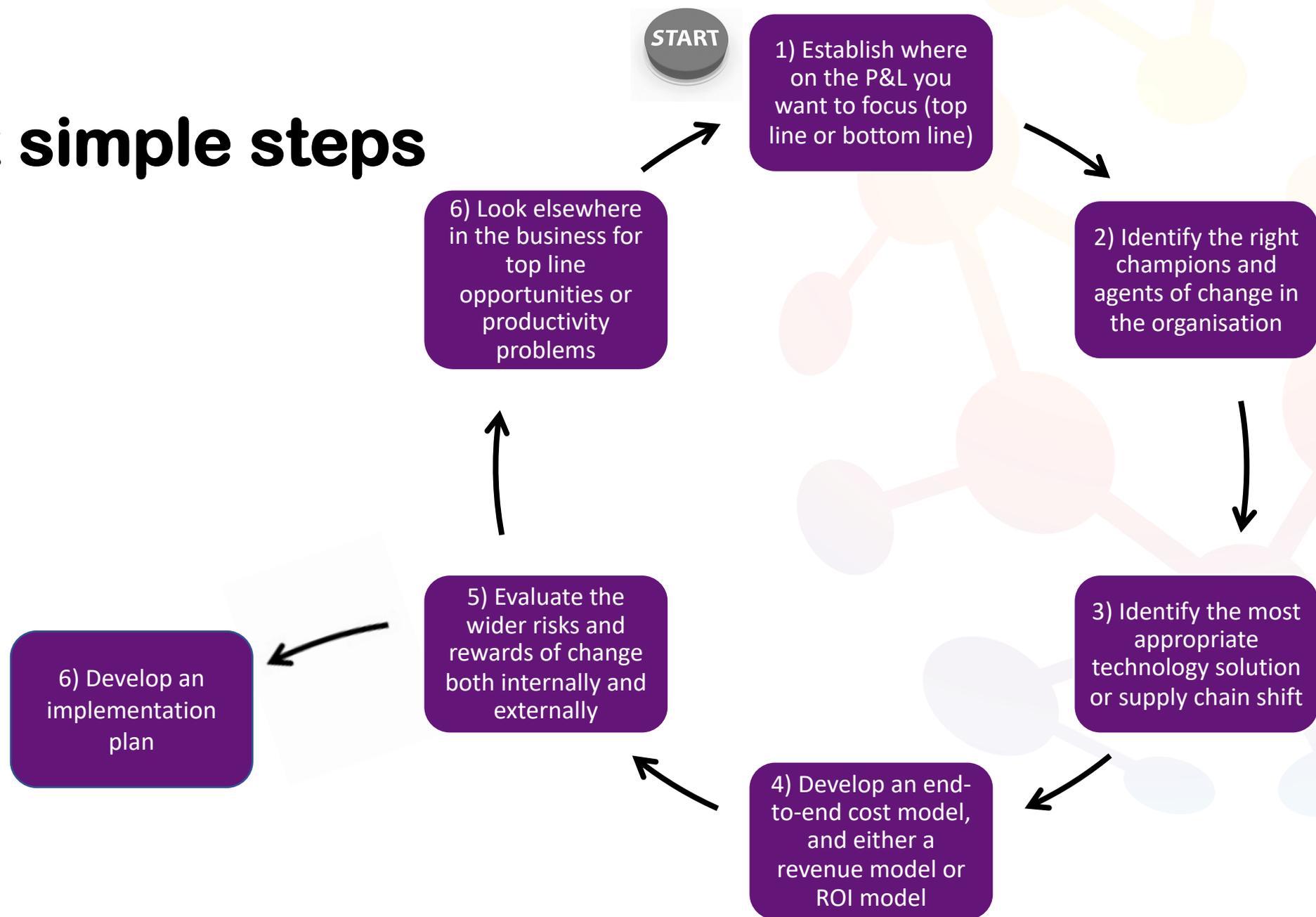


In late 2020 BSI published PAS 6001

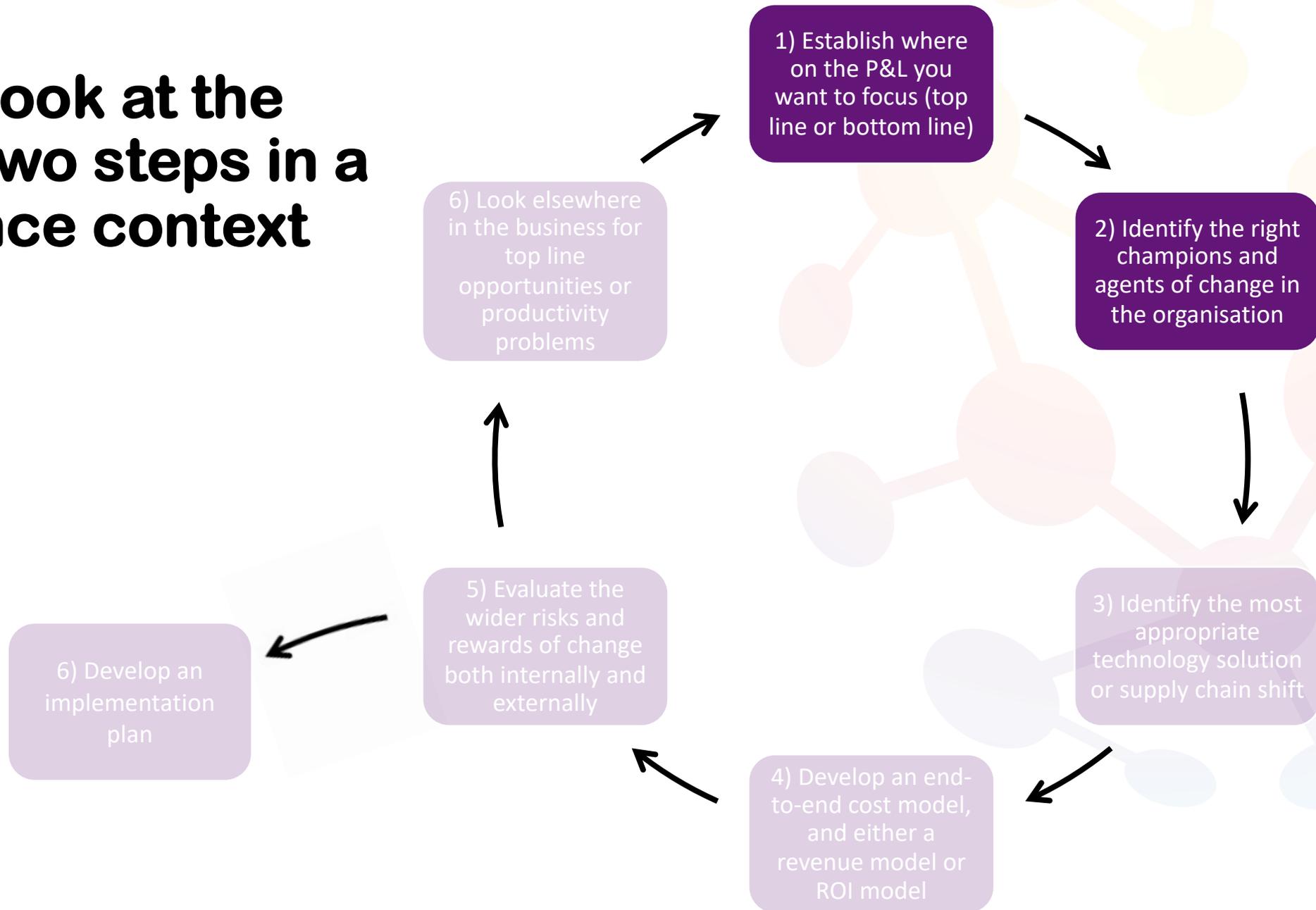
A useful resource to help
business executives and
engineers to speak a
common language



Six simple steps



Lets look at the first two steps in a defence context



Understanding the impact on P&L

	Customers	Company and its suppliers
Externally	AM/3DP for improved customer service and engagement	AM/3DP for streamlined and lean supply chains
Internally	AM/3DP for new advanced and efficient products	AM/3DP for more efficient (lean) production methods
	Top-line growth	Bottom-line profit



AM/3DP drives revenue (for some)

AM/3DP for improved customer service and engagement	AM/3DP for streamlined and lean supply chains
AM/3DP for new advanced and efficient products	AM/3DP for more efficient (lean) production methods

New advanced and efficient products	
What does AM/3DP enable?	How does this drive revenue?
Production of low-volume batches	Capture new markets by providing products and services to ever-smaller customer demographic groups
Products with new styles and aesthetics	Capture and retention of further market share by ensuring products remain on-trend to all with no cost penalty
Products with optimized design such as weight or flow	Increased market share and revenue by providing products that financially benefit the customer during use
Consolidation of assemblies into single parts	Increased market share and revenue by providing products that cost less to maintain during service life
Products with "designed" material properties ⁶⁾	Enables new classes of products to be brought to market currently unattainable using traditional manufacturing
Products with "designed" material density ⁷⁾	Enables new classes of products to be brought to market with minimal if no cost implications over current products
Products with "embedded" functionality ⁸⁾	Enables products to be brought to market with cost savings over current multi-part assembled products
Products made from new high-performance materials	Increased market share and revenue by providing products made from materials only available via AM/3DP



AM/3DP drives revenue - example

New Advanced & Efficient
Products

GE Leap Engine

Top line growth



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AM/3DP drives revenue (for some)

AM/3DP for improved customer service and engagement	AM/3DP for streamlined and lean supply chains
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Improved customer service and engagement	
What does AM/3DP enable?	How does this drive revenue?
Product customization	Drives customer spending by providing an increased level of aesthetic choices and options to the product mix
Product personalization	Enables higher value individualized products to be sold with improved ergonomics and function
Product co-design	Allows customers to be an integral part of the product design process providing "stickiness" and spend loyalty
Point of sale experiences	Enables in-store "retail-theatre" or experience leading to impulse purchasing and cross-selling opportunity
Product servitization	Enables new responsive business models that shift revenue away from single transaction to ongoing spend
Spare parts on demand	Captures revenue from third party spare part suppliers, while maintaining customer loyalty
Repair on demand	Captures short term "repair" revenue but ensures longer-term customer loyalty and continued service revenue



AM/3DP drives revenue - example

Improved Customer Service & Engagement

Siemens combustor repairs

Top line growth



Improved customer service and engagement

What does AM/3DP enable?

How does this drive revenue?

Product customization

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Product personalization

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AM/3DP drives profitability (for some)

AM/3DP for improved customer service and engagement	AM/3DP for streamlined and lean supply chains
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More efficient lean production methods	
How does AM/3DP address lean waste?	How does this drive profitability?
Reduction in <i>defects</i>	As a digital technology, errors are both traceable and can be rectified quickly with minimal risk. Some mistakes can also be corrected using AM/3DP repair technologies reducing scrap rates and financial losses.
Reduction in <i>overproduction</i>	AM/3DP parts can be printed to order or to maintain minimal inventory. Printing to order frees up working capital while also reducing the associated cost of part storage and disposal of excessive end of life stock.
Reduction in <i>waiting</i>	Part consolidation and replacing multiple manufacturing operations reduces inefficient waiting time during production, enabling faster task-times and freeing up working capital more quickly. AM/3DP can also be used to manufacture temporary or "bridge" jigs, fixtures and tooling, allowing more seamless production to take place with less down time.
Reduced <i>transportation</i>	By reducing manufacturing production steps and by utilizing concurrent AM/3DP manufacture close to the point of product use, transportation time and associated costs decrease, while enabling products to reach customers more quickly.
Inventory <i>excess</i>	AM/3DP processes require significantly less raw material to be held in stock, while also producing less scrap. Digital inventories enable the manufacture of spare parts, reducing the cost associated with storage and end of life disposal.
Reduction in <i>motion waste</i>	As a digital "light-out" technology, AM/3DP requires a minimal level of human intervention. With a well-designed and automated facility, operator motion can be minimized, leading to higher levels of labour efficiency.
Reduction in <i>excess processing</i>	As a digital technology, the acceptable level of part quality can be set before production, such as the use of thicker layers or lower resolution. These changes can significantly reduce the cost of manufacture while achieving a quality level acceptable to the customer.
<i>Non-utilized</i> talent	Companies can increase productivity by utilizing the talents, skills and knowledge of employees that have experience of AM/3DP technologies and processes. These experiences may have been gained at prior employers, through academic study or through the use of low-cost consumer 3D printing in the home.



AM/3DP drives profitability - example

More Efficient (lean) Production Methods

MTU/Pratt borescope eye

Bottom line profit



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Streamlined and lean supply chains	
What does AM/3DP enable?	How does this drive profitability?
Reduced part count through assembly consolidation	Less chance of supply chain failure, missing parts or delays
Reduced supplier base through reduced part count	Lower transactional costs such as invoicing, supplier accreditation, quality compliance or bad debt
Reducing or eliminating the need for tooling within suppliers	Enables suppliers to pass on cost saving to customers and for customers to use multiple supplier as no tooling is necessary
Reduced supplier stockholding	Lower part cost due to the reduction of supplier waste streams such as warehousing and end-of-life write-offs
Manufacturing process consolidation	Results in less manufacturing operations necessitating lower demand for distribution and logistics infrastructure
Optimized manufacturing location	Enables concurrent manufacture at multiple locations close to the point of demand, reducing distribution costs



AM/3DP drives profitability - example

Streamlined & Lean Supply Chains

Singapore MRO cabin refit

Bottom line profit



Streamlined and lean supply chains

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Question – Does PAS6001 also work in a defence context?

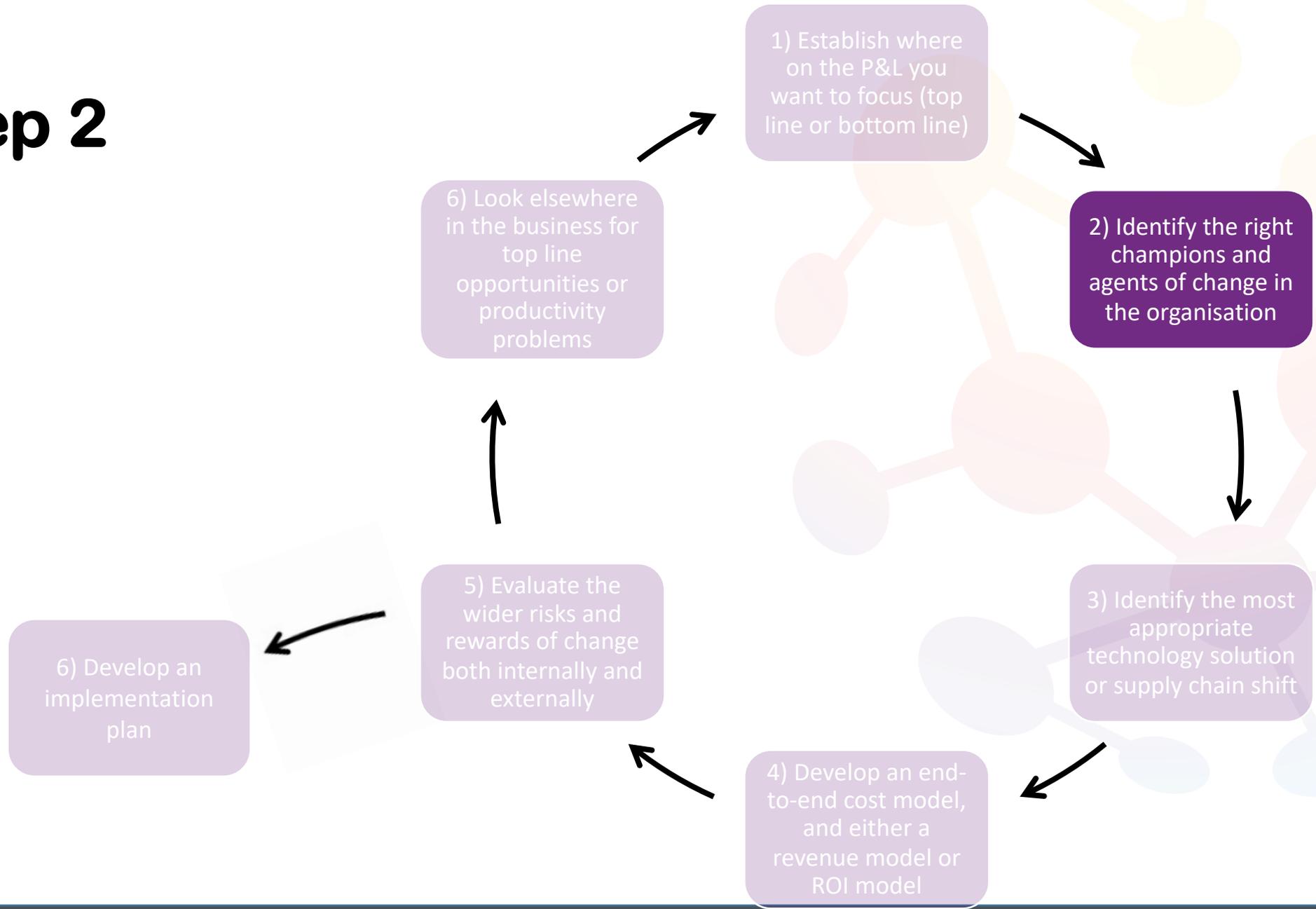
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	Front line	MOD and the supply chain
Externally	Improved part availability	Long term support/availability
Internally	Improved lethality	Expedient manufacture
	Operational benefit	Cost reduction



Step 2



The customer, champion & decision maker is no longer obvious

	Engaging with customers and products	Engaging with the supply chain and the organization
Externally (retail or supply chain)	<p>Improved customer service and engagement</p> <ul style="list-style-type: none"> Marketing Sales Product engineering Manufacturing Procurement (raw materials) Procurement (Capex) HR Business Systems Finance Quality Legal 	<p>Streamlined and lean supply chains</p> <ul style="list-style-type: none"> Manufacturing Procurement (parts) Logistics Finance Quality
Internally within the organization	<p>New advanced and efficient products</p> <ul style="list-style-type: none"> Marketing & Sales Product engineering Manufacturing Procurement (raw materials) Procurement (Capex) Facilities Quality Legal Maintenance H&S 	<p>More efficient (lean) production methods</p> <ul style="list-style-type: none"> Manufacturing Procurement (raw materials) Procurement (Capex) Facilities Quality Maintenance H&S



So who needs to champion AM/3DP within the organisation?

	Engaging with customers and products	Engaging with the supply chain and the organization
Externally (retail or supply chain)	<p>Improved customer service and engagement</p> <p>Marketing</p> <p>Sales director / Operations director</p> <p>Business Systems Finance Quality Legal</p>	<p>Streamlined supply chains</p> <p>Operations director / Financial director</p>
Internally within the organization	<p>New advanced and efficient products</p> <p>Marketing & Sales</p> <p>Engineering director / Sales director</p> <p>Quality Legal Maintenance H&S</p>	<p>More efficient (lean) production methods</p> <p>QA director / Operations director</p> <p>H&S</p>



So who needs to champion AM/3DP within the defence context

	Engaging with customers and products	Engaging with the supply chain and the organization
Externally (retail or supply chain)	<p>Front line deployed forces?</p> <p>? ? ? ? ? ?</p> <p>?</p> <p>Improved part availability</p>	<p>MOD procurement?</p> <p>? ? ? ? ? ? ?</p> <p>?</p> <p>Long term support/availability</p>
Internally within the organization	<p>DSTL?</p> <p>? ? ? ? ? ? ?</p> <p>?</p> <p>Improved lethality</p>	<p>Hard infrastructure/bases?</p> <p>? ? ? ? ? ? ?</p> <p>?</p> <p>Expedient manufacture</p>



Table D.1 – Business drivers for AM/3DP adoption

	Not applicable or no Impact	Low Impact	Noticeable Impact	Extensive Impact
The ability to cost-effectively manufacture low-volume or small batch production				
The ability to produce customized or personalized products for consumers or patients				
The ability to increase the functionality of products adding value to the end-user or customer				
The ability to rationalize and reduce the size and complexity of the supply chain				
The ability to improve the life-cycle sustainability of products and services				
The ability to reduce or eliminate stock				
The ability to introduce a more flexible production environment to allow for more responsive manufacture				
The ability to better support aftermarket repairs and the reuse of existing products through spare part provision				
The ability to reduce raw material consumption and associated waste streams				
The ability to eliminate end-of-like stock write-offs				
The ability to improve shop floor efficiency through the introduction of personalized or job specific jigs, fixtures and tooling				
The ability to improve the green credential and sustainability of the organization through more efficient production processes				

PAS 6001:2020
 Factors to be considered in making
 and assessing the business case
 for additive manufacturing and
 3D printing – Guide



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Dr Phil Reeves
phil@reevesinsight.com

