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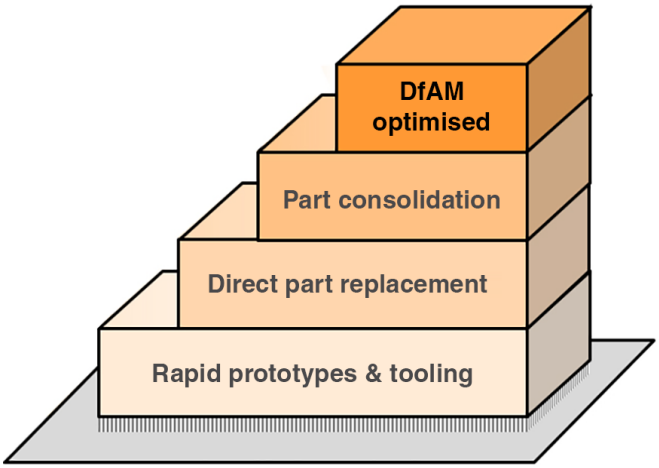
Additive impact part #1 - how additive manufacturing could disrupt your market

Everyone is talking about how 3D printing is going to change the world of manufacturing, part of the wave of Industry 4.0 innovation that will sweep aside established ways of working. That's a bit hyperbolic perhaps, but the point is that additive manufacturing (AM) does present tremendous opportunities to do things differently.

The pace of adoption in each sector will depend on the characteristics of the industry - the level of regulation, for instance - and the attitude of current and potential new players towards innovation and risk. There's a great opportunity to disrupt the status quo. The question is, how can you position your business to win as this disruption occurs?

Well, a good place to start is to think about the nature of the potential changes that AM could bring to your market, and to think about the strength of the play that you want to make using AM. In my feature article entitled How can you get the most from additive manufacturing? I outlined a staircase model showing different levels of AM adoption:



New product designs that:
1. Deliver lifetime benefits in use
2. Provide mass customisation

Complex parts that simplify assembly & enhance reliability

Re-production parts, that avoid complex manufacturing

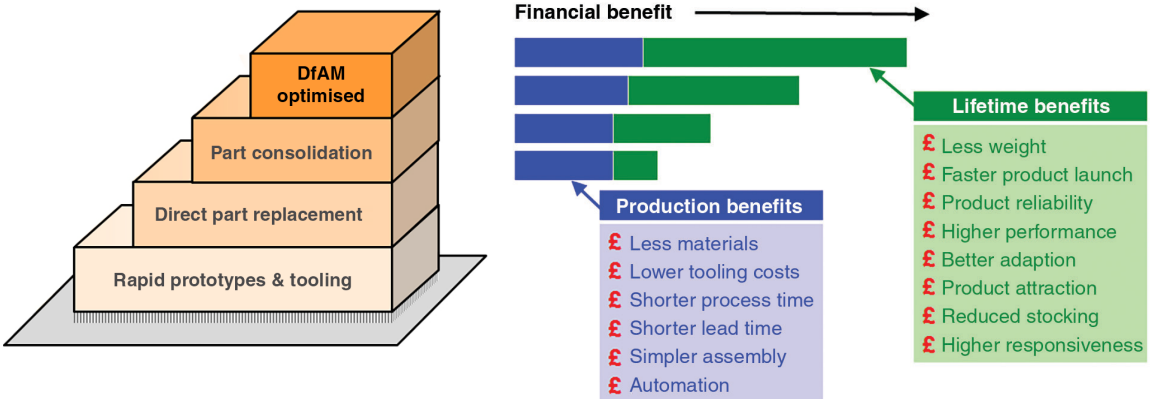
Low volume parts made direct from CAD

Additive manufacturing production benefits

I also talked about the different types of benefit that can flow from deploying AM: production benefits that are accrued whilst you are making the product, and lifetime benefits that accrue once the product is in use. Moving up through the levels requires increased commitment to design and qualify radical new products as well as a new manufacturing process, but the benefits tend to rise too:

The benefits rise as you move up through the levels because you are taking advantage of more and more of the unique capabilities that AM offers. The more of these capabilities that you deploy, the more disruptive and valuable your AM product is likely to be.

So, what does this mean in practice? What are these capabilities that you can progressively deploy? The rest of this article will focus on the capabilities that you can use on the first two steps of the staircase, whilst the article Additive impart part #2 will cover the top two steps.



Level 0 - Rapid prototyping & tooling

This is the starting point for many firms on their AM journey, making models and tools quickly whilst the product design is still in flux. There are two AM capabilities available at this level:

a. Repeatable CNC process

AM is a highly automated process, with no operator intervention in the build once the powder hopper is full and the laser fires. It can therefore be used to replace traditional craft processes, yielding benefits for production costs as well as far greater precision and predictability in outcome. Dentistry is a good example, where manually created models are replaced with digitally designed and automatically produced implants. As this characteristic is inherent to AM, these benefits are available at all the staircase levels.

b. Conformal cooling

This is a sophisticated capability that can be deployed very successfully on mould tools. Conformal cooling involves building channels that follow the contours of the part, to ensure even and rapid heat transfer. The channels themselves should be designed with smooth corners to avoid dead spots that can lead to corrosion, and to ensure that the cooling fluid flows easily with little pressure drop. Multiple cooling channels can be designed into a complex mould tool, each of equal length, to ensure even cooling. The result is a tool with a shorter cycle time and longer operational life.

It is also possible to build conformal cooling into products themselves, but this requires a product design change and so sits in the top level of the staircase.

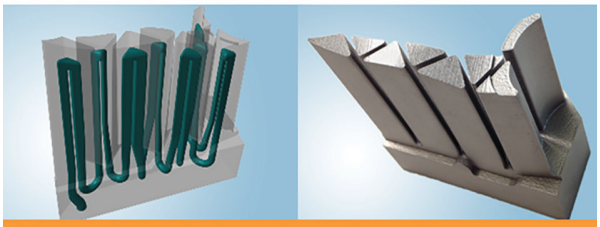
Repeatable 'CNC' process

Replacement of craft processes with predictable, controllable technology

Replace manual 'wax-up' & investment casting

Conformal cooling

Cooling passageways which match a component profile to perform rapid, uniform cooling



Cooling channels just below mould tool surface reduce press cycle time

Production benefits

£ Shorter processing time
£ Automation

Lifetime benefits

£ Product reliability
£ Increased performance
£ Better adaption

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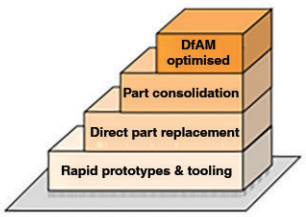

Production benefits

£ Shorter processing time

Lifetime benefits

£ Product reliability
£ Increased performance

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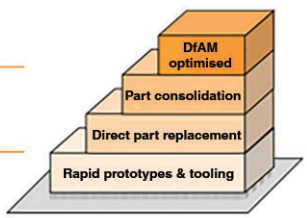


Level 1 - direct part replacement

The next step on the staircase is to make production parts, but only replicas of existing components. It's only the production process that changes, not the part geometry. Two further AM capabilities can be deployed here:

a. Near-net-shape manufacture

A key characteristic of AM is that you waste very little material when you grow parts, compared to when you produce them using subtractive techniques. Waste per unit become significant now that we are thinking about series production.

In aerospace, the 'buy-to-fly' ratio is a key measure of process efficiency - how many times the final part weight is turned into swarf as the part is produced? It's important to note that AM is a 'near' net shape process, and often there is still some finishing to do, whilst support structures that can be essential for a successful build are also waste. AM is not perfect, but the gains here can be compelling.

b. Localised production

AM does away with production tooling, and so also removes one of the big fixed costs associated with component manufacturing. This can have the effect of reducing the dis-economies of small scale - in other words you can compete on cost even if you are a small business, and you can gain the advantages of proximity to your customer to offer a superior service. There may be opportunities to disrupt existing supply chains or adapt your existing supply chain to be more responsive.

Near-net-shape manufacture

Part 'grown' close to the final shape, with little material subsequently to be removed

No waste material: improved 'buy-to-fly' ratio

Localised production

Small manufacturing units, positioned where they are needed to produce parts when required

Elimination of expensive tooling and simplification of production process chain makes small scale production viable

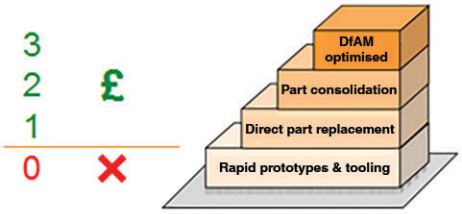
Dis-economies of small scale reduced with AM

Production benefits

- £ Less wasted materials
- £ Lower tooling costs
- £ Shorter lead times

Lifetime benefits

- £ Less weight
- £ Faster product launch

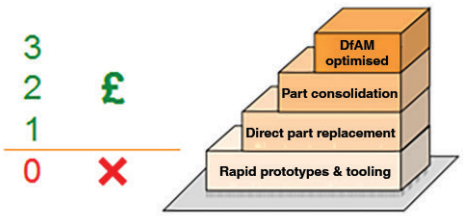


Production benefits

- £ Shorter lead times

Lifetime benefits

- £ Better adaptation
- £ Product attraction
- £ Reduce stocking
- £ Higher responsiveness



Summary - part #1

So that's the first two levels of the staircase explained, with some of the basic capabilities of AM covered. Part #2 completes the journey to the top, exploring some of the more advanced characteristics of AM.

Next steps

Visit www.renishaw.com/amguide for more educational resources and to access downloadable versions of feature articles and white papers by Renishaw authors.

About the author

Marc Saunders, Director of AM Applications

Marc Saunders has over 25 years' experience in high tech manufacturing. In previous positions at Renishaw, he played a key role in developing the company award-winning RAMTIC automated machining platform, and has also delivered turnkey metrology solutions to customers in the aerospace sector.

Marc manages Renishaw's global network of Additive Manufacturing Solutions Centres, enabling customers who are considering deploying AM as a production process to gain hands-on experience with the technology before committing to a new facility.

www.renishaw.com/additive