Is the Additive Manufacturing bubble about to burst?

Enthusiasm for AM may wane if barriers for production are not removed

WHITE PAPER

July 2020

ENABLE
PRINT. CAST. DELIVER.

ABOUT THE SURVEY

Enable Manufacturing Ltd. conducted an open survey via its LinkedIn platform in June 2020 to explore how engineers and designers use Additive Manufacturing today.

Participants could choose to take part anonymously or by leaving an email address.

Whilst we specifically promoted the survey to engineers, designers and product manager across different manufacturing industries, anybody with an interest in Additive Manufacturing was able to participate in this survey.

This survey has collected a total of 85 responses that were subsequently evaluated and interpreted by the Enable team.

For further information or queries about the collection of the data, please feel free to contact us at office@enable.parts.

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INTRODUCTION

Additive Manufacturing (AM) has been around for decades but despite its promising attributes of design flexibility, fast turnaround, and ability to produce complex parts, AM has not yet become a mainstream production method. Many businesses have dipped their toes in the water and have used AM for prototyping or small production runs but came away with mixed feelings.

None the less, the advancements in AM are continuing and the industry has grown to $10.4 billion over the last 40 years, with expectations to triple its value by 2025. By 2029 the AM industry is expected to grow to $55 billion which will represent a 2% share of the global manufacturing market, leaving plenty more room for further growth.[1]

However, as more and more businesses are starting to utilise AM, the more apparent become the teething problems associated with this manufacturing method. Many share the view that AM is uncompetitive and unsuitable for production due to high cost, material unavailability and quality issues.

Is AM finally turning a corner after 40 years of incubation? Or is AM truly not suitable for production and will therefore remain a niche technology?

1 Global additive manufacturing market 2019 worth over $10 billion (https://www.3dprintingmedia.network/the-additive-manufacturing-market-2019/)

> *"The industry has grown to $10.4 billion over the last 40 years, with expectations to triple its value by 2025.*

THE SURVEY

How is AM being utilised?

To understand why AM has not widely arrived in production yet, Enable Manufacturing Ltd (Enable) conducted a survey in June 2020 to explore how engineers and designers use AM today.

85 people, predominantly from the 3D printing and other manufacturing industries, took part in this open survey that was launched via the Enable LinkedIn platform. Respondents job roles include engineers, designers, and product managers.[2]

2 Participants in this survey could choose to remain anonymous in which case their job role or industry alliance is unknown.

The perfect storm for AM?

> *"80% of respondents are having to deal with product development cycles becoming shorter.*

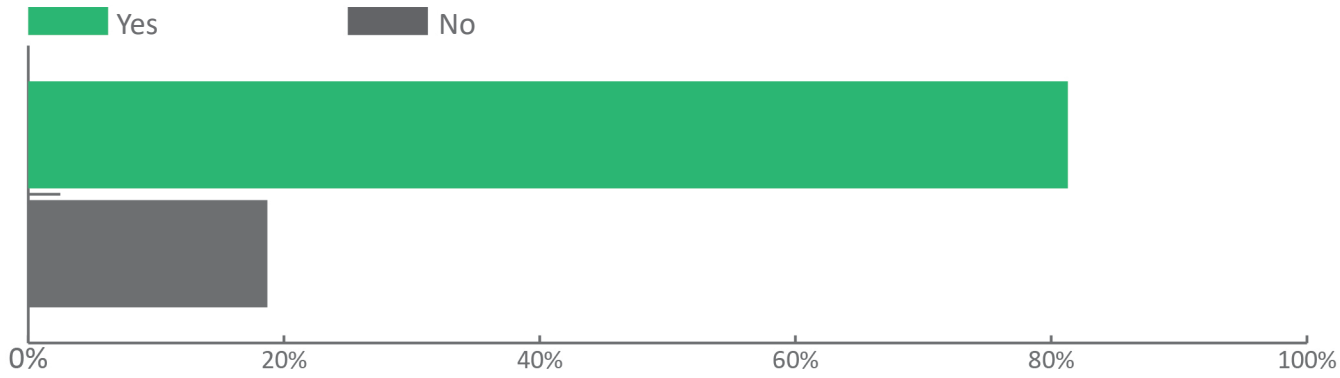
Over the last decades, our lives have become increasingly fast paced. We are connected 24/7 thanks to our smart phones and information is readily available to us at our fingertips, so much so, that our attention span has decreased from twelve seconds to only eight seconds over the last 20 years.[3] We want things now and we want them fast!

This trend applies to website visits, the way we order food and how we purchase items on the internet. Manufacturing businesses, need to pick up the pace to meet the increasingly accelerating demand of their customers.

Research shows that more than 80%[4] of respondents are having to deal with product development cycles becoming shorter, a challenge not only for design departments but also manufacturing processes.

Figure 1:

In your line of work, are new product development cycles becoming shorter?



3 Are declining attention spans killing your content marketing strategy? (https://www.cision.com/us/2018/01/declining-attention-killing-content-marketing-strategy/#:~:text=According%20to%20a%20study%20by,seconds%20in%20the%20year%202000.)

4 Enable survey June 2020

Teams are having to rethink ways of working, taking time out of existing processes and bringing products to market quicker. All aspects of the design cycle are being scrutinised to gain valuable time.

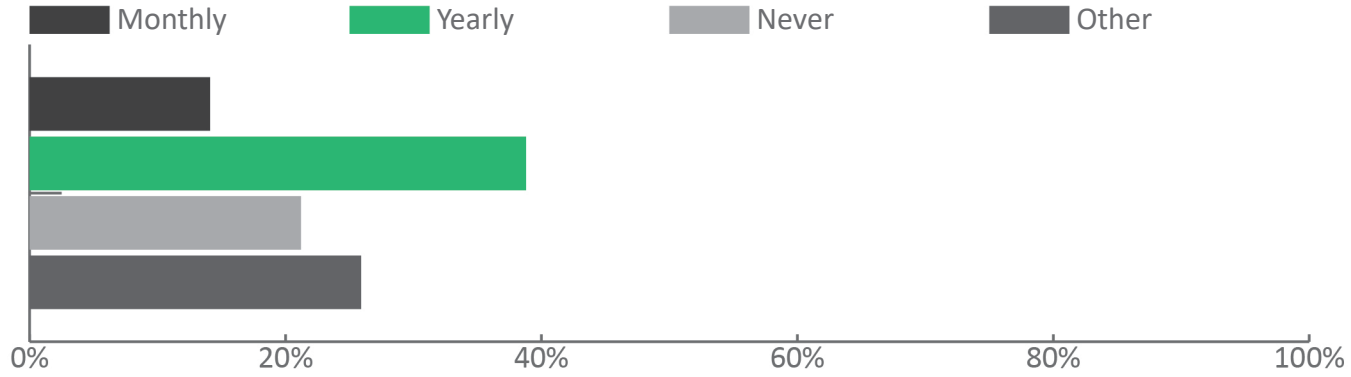
In many businesses, a large amount of time during the new product development process is taken up by prototyping and tooling for example. For a new part to be tooled and manufactured ready for launch, ten weeks would be considered fast and even six to twelve months is not uncommon.[5] A long time for today's 'I want it now' culture.

In addition to increasingly fast-paced development cycles, also existing manufacturing processes are being reviewed on a regular basis to achieve cost reductions, reduce lead-times, and improve quality.

Over half of the respondents review manufacturing processes either monthly or yearly and many respondents who chose the 'Other' category indicated that processes are often reviewed on a daily or project by project basis.

Figure 2:

How often do you review an existing manufacturing process for a mature part?



With product development cycles getting shorter and manufacturing process reviews on increasingly shorter intervals, are market conditions for AM finally right after 40 years? Is this the perfect storm for AM to emerge as a mainstream manufacturing method?

5 Czinger set to launch its first 3D printed hypercar, 0-62MPH in 1.9S (https://3dprintingindustry.com/news/czinger-set-to-launch-its-first-3d-printed-hypercar-0-62mph-in-1-9s-173190/)

The manufacturing reality

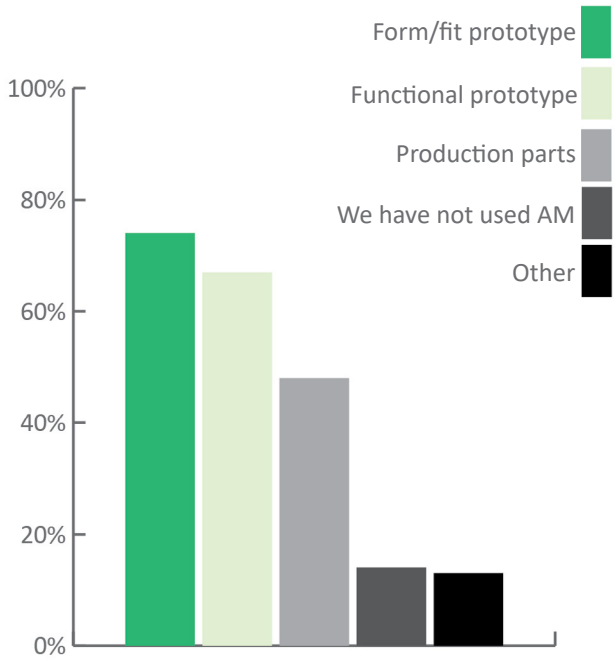
With AM, businesses have fresh opportunities to take time and cost out of the production process, helping them to keep up with the ever-accelerating nature of manufacturing.

AM has the reputation to allow for maximum design flexibility and fast turnaround for even highly complex parts. But is this a manufacturing reality? Is AM living up to its full potential?

Research suggests that half the respondents to the survey have already used some form of AM for production parts[6] and only 14% have not used AM at all. These numbers inspire confidence for the future growth of AM across all stages of the product lifecycle.

Figure 3[7]:

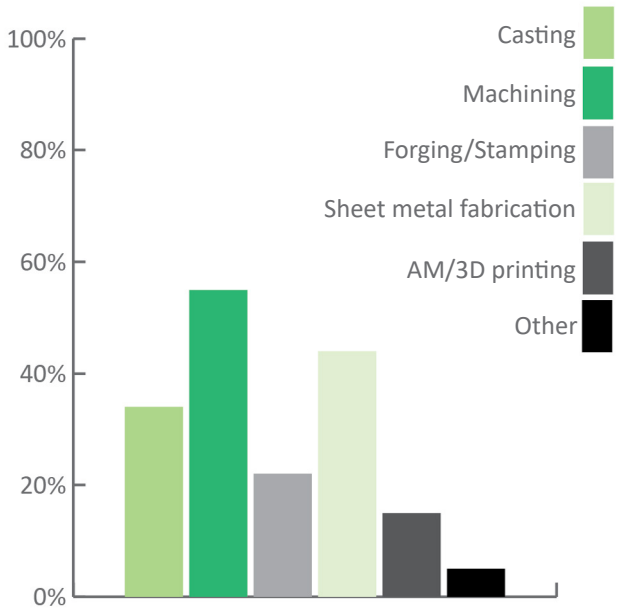
Have you ever used AM for:



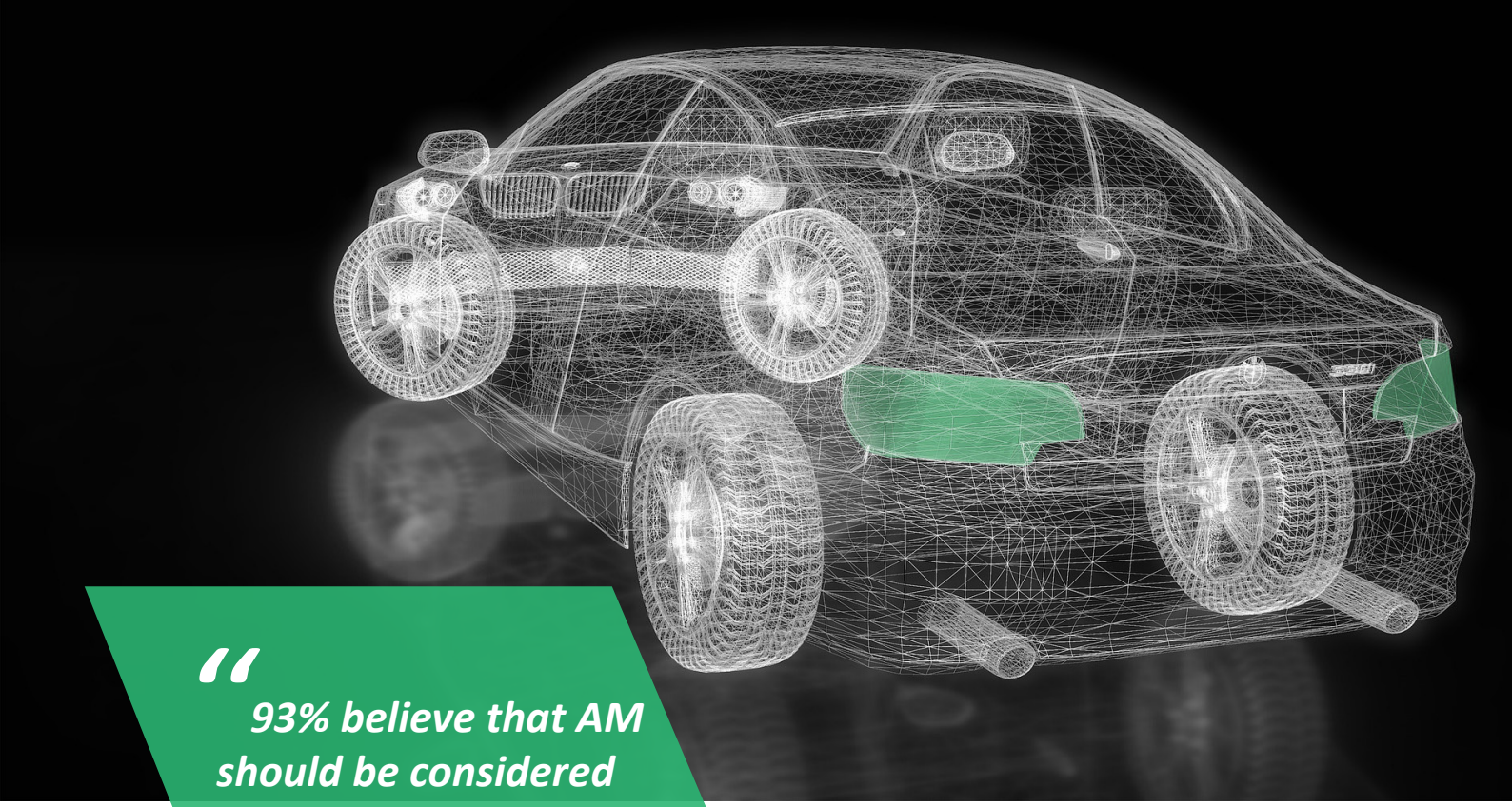
However, when it comes to the production of metal parts in particular, only 15% of respondents commonly use AM as a production method.[8] In this market, traditional processes including casting, machining and sheet metal fabrication still make up the lion's share of production methods.

Figure 4[9]:

What is the most common manufacturing process for your metal parts?



6 We would expect this number to be lower outside of the additive manufacturing industry.
7 Participants could tick all answers that apply leading to more than one answer per 85 participants.
8 Enable survey June 2020
9 Participants could tick all answers that apply leading to more than one answer per 85 participants.



> *"93% believe that AM should be considered during the design process.*

For a technology that has been around for 40 years, why are not more businesses considering AM as a production method, in particular for the production of metal parts?

Most respondents to the survey have a reasonable amount of experience with AM and knowledge of up to twelve different 3D printing processes[10].

But this also poses part of the challenge. The AM market is highly fragmented and keeping track of all the different AM processes, their benefits and production suitability is not an easy task. Manufacturing entities have decades of experience with casting, machining, injection moulding and other manufacturing processes that have grown into tried and tested procedures. Finding the right AM method to improve on long standing processes takes time, commitment, and willingness to change entire supply chains.

However, despite the challenges, a strong majority of 93% do believe that AM should be considered during the design process.[11]

But as we saw in Figures 3 and 4, only 48% of respondents have used a form of AM for production and only 15% commonly use AM for the production of metal parts. This suggests 45% of respondents who believe AM should be considered during the design process, abandon it as a manufacturing process somewhere along the way. And for the production of metal parts, this number grows to 78%.

10 Enable Survey June 2020
11 Enable Survey June 2020

A similar picture presents itself when we asked respondents at what stage of the design development process AM is being considered.

Figure 5 indicates that AM is predominantly being considered during the design and prototyping stage and less so during the sign off and production tendering stage. This might suggest that for some reason AM is being dropped as the final manufacturing method.

And following on from this, AM seems to influence the design of a part in most businesses only sporadically.

Figure 5[12]:

At what stage does Additive Manufacturing get considered within your design development process?

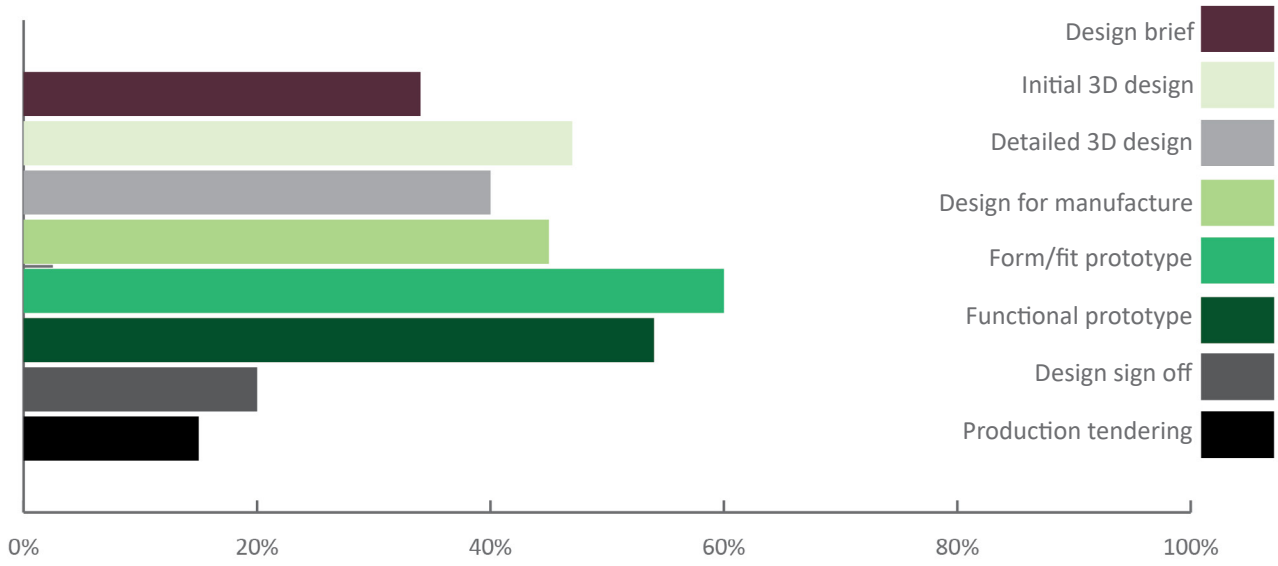
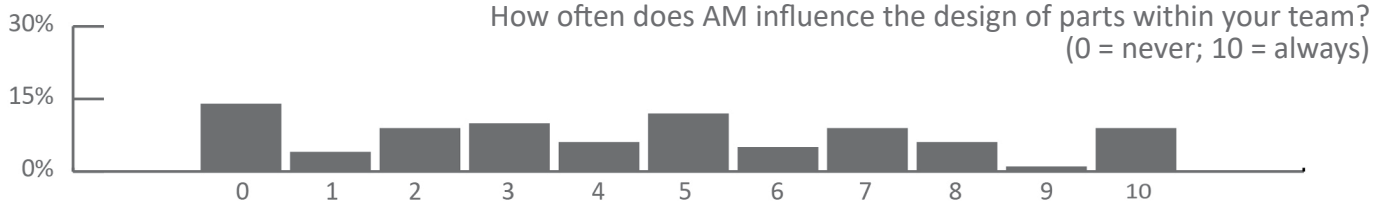


Figure 6:



12 Participants could tick all answers that apply leading to more than one answer per 85 participants.

What is holding us back?

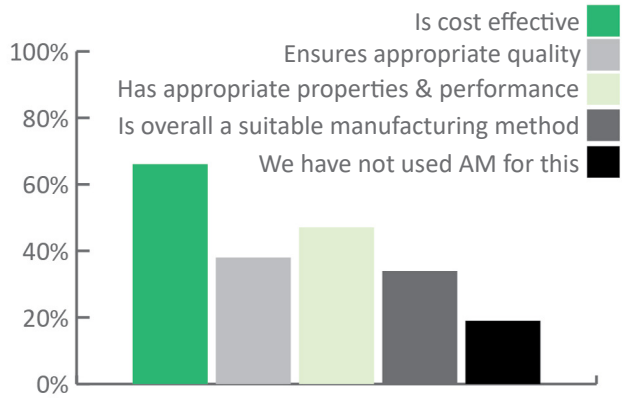
The survey revealed that the majority of respondents did not believe AM was an overall suitable production method for either prototyping or production.

More than half felt that AM is not a suitable manufacturing method for form/fit or functional prototypes and 68% said AM was not suitable for manufacturing production parts.

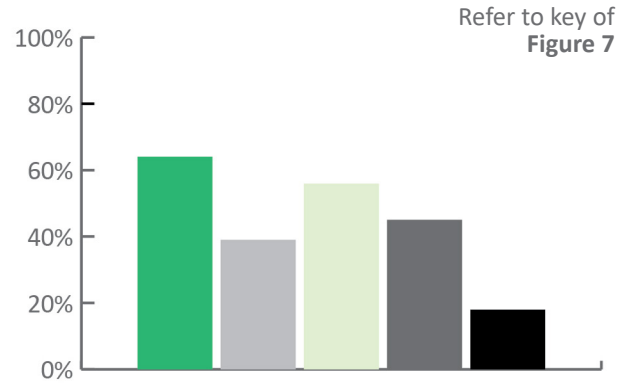
Main concerns were quality and performance for both prototyping and production, whilst cost was one of the major obstacles for the use of AM in production.[13]

> *"68% said AM was not suitable for manufacturing production parts.*

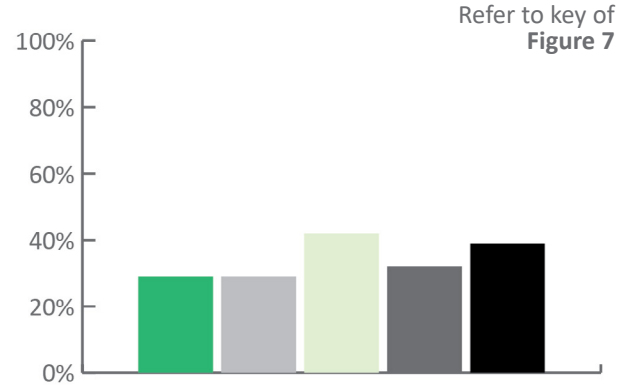
AM for form / fit prototypes... **Figure 7[14]:**



AM for functional prototypes... **Figure 8[15]:**



AM for functional production parts... **Figure 9[16]:**



13 Enable Survey June 2020
14 Participants could tick all answers that apply leading to more than one answer per 85 participants.
15 Participants could tick all answers that apply leading to more than one answer per 85 participants.
16 Participants could tick all answers that apply leading to more than one answer per 85 participants.

> *"More than 80% belive that AM parts could be cheaper and perform better if the process is considered within the design of the part.*

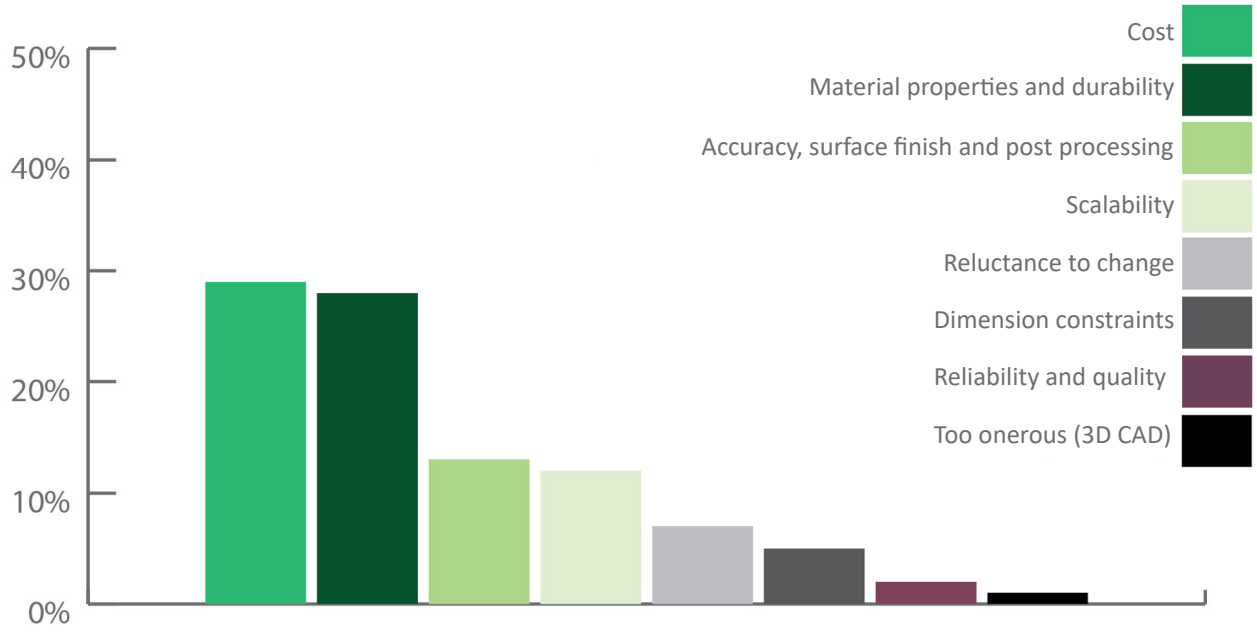
Whilst there is an overall willingness amongst respondents to use AM, data suggests that the overriding barriers to the advancement of AM to becoming a widely accepted manufacturing method are predominantly cost, quality, scalability and confidence.[17] In fact, material properties, as part of the quality barrier, and cost are the most significant obstacles that respondents encounter on a daily basis.

But at the same time, most respondents believe cost and quality can be improved if AM is considered early in the design process.

If these barriers are reduced or removed then we could expect to see more use of AM in production, particularly for metal parts.

Figure 10:

What do you consider to be the bigger barrier to you using Additive Manufacturing for production parts?



17 Enable Survey June 2020

OVERCOMING THE BARRIERS

Cost

According to the 'Design to Cost' model, the design process is the most vital stage in a product lifecycle to control the cost of parts. In fact, designers and engineers can influence up to 70% of product cost by determining material choices, processing, or assembly[19] [20]. On the other hand, only 20% of cost can be influenced by decisions relating to production methods, including process planning or machine tool selection.[21]

Since most engineers (68% as per figure 9) believe that AM is not suitable for production, is it possible that designs are not created with AM in mind, making components expensive to manufacture? Might this be preventing AM from being used for production and reinforcing the belief that it is not a suitable production method?

Only when the unique advantages of AM are used to re-evaluate part designs and implement cost reductions, will this cost barrier be broken. More complex designs can be realised with AM, allowing engineers to reduce the total number of parts in a product which in turn leads to a reduction of inventory levels, engineering time, purchasing time and assembly difficulty.[22]

This makes design for AM a key driver for cost and an area that needs to be considered for a successful AM strategy. Designing and optimising parts for AM early in the design cycle will set a solid foundation for AM manufacturing.

19 What is design to cost? An overview with examples (https://www.apriori.com/blog/what-is-design-to-cost-an-overview-with-examples/)
20 Design for Manufacturing - Guidelines (https://www.unm.edu/~bgreen/ME101/dfm.pdf)
21 Design for Manufacturing - Guidelines (https://www.unm.edu/~bgreen/ME101/dfm.pdf)
22 Design for Manufacturing - Guidelines (https://www.unm.edu/~bgreen/ME101/dfm.pdf)

> *"Only 15% commonly use AM to produce metal parts.*

Quality

Respondents to the survey had several concerns with the quality of AM manufactured parts. Some of these were relating to porousness of materials, poor finishing, material strength and overall material properties. This might explain why only 15% commonly use AM to produce metal parts.

Any manufacturing process will result in unique material properties. Engineers know, for example, that a cast metal component will have different properties to a component machined from billet. This is also true for AM. However, engineers cannot easily find the properties for AM materials and so tenders will refer to a known material specification, typically from another manufacturing method, which AM will therefore struggle to fulfil. Furthermore, properties tend to vary from process to process and sometime from supplier to supplier.

Quality in terms of surface finish and tolerances may need some technical development from AM providers. However, in the case of metal components, rarely does a near net shape manufacturing process create the final part without further steps such as machining and polishing. If the industry was to accept this and streamlined its workflows and supply chains, AM parts could get closer to the expectations of the engineers.

There are also several hybrid processes available that allow manufacturing businesses to use certified materials through the casting process whilst still benefiting from the speed and flexibility of 3D printing. Companies including voxeljet, 3D Systems, Enable and Solidscape use additive manufacturing to produce moulds that are then used for traditional casting in foundries, also known as Additive Casting.[23]

AM manufacturers can help address this challenge by extending material choices and making more documentation about material properties available. As an industry, more standardisation around material properties is needed to break down this barrier.

23 Enable Manufacturing expands metal 3D printing service with over 130 materials (https://3dprintingindustry.com/news/enable-manufacturing-expands-metal-3d-printing-service-with-over-130-materials-172202/)

Scalability

Scalability is another issue that is preventing manufactures from using AM. To successfully scale production of a component, quantity, quality, and consistency are key. Whether a production run puts out hundred or hundred thousand parts, these parts need to be consistent and cannot deviate from each other.

AM printers are small and ultimately their capacity is dictated by how many parts will fit into the space available in the printer. For small parts, this might work but for medium sized or large parts, this process does not offer enough capacity. There are only three ways to scale production for AM: Adding printers, increasing the printing speed and increasing the size of printers

Adding printers comes with a significant cost and quality is a big concern for all three options. Especially for the direct metal printing processes, parts might vary slightly depending on where they are positioned in a printer and from printer to printer. This has brought about the creation of a complex certification process for metal parts produced with AM, which makes it particularly onerous for companies to adopt AM for the production of metal parts.

As of today, scalability remains a major challenge with no acceptable solution in sight.

Confidence

It is a monumental challenge to keep track of all the innovations in manufacturing, gaining enough knowledge to make confident choices and staying on top of the day-to-day workload. To drive adoption for AM in manufacturing, it is vital to provide manufacturing businesses and engineers with the tools to help them assess manufacturing methods quickly and accurately. These tools could include:

- Design guides
- Information on available materials
- Material specification sheets
- Compatibility with international standards
- Case studies

And most of all, support by people. A conversation over the phone can clarify many questions in a fraction of time, without having to wade through pages and pages of data.

It is up to AM businesses to drive communication into the marketplace that helps inform stakeholders of benefits and shortcomings of certain AM manufacturing methods, enabling engineers and designers to take informed decision based on facts.

> *"BMW reduced the weight of the roof bracket by 44%.*

SUCCESS WITH AM

But what if parts and processes were designed from the outset for AM? Would AM be a sustainable and viable production method, even for metal parts?

Industries including aerospace, medical and automotive have started to adopt AM to either replace current processes or simply to manufacture parts that were impossible to manufacture with previously available manufacturing methods.

After 10 years of development, the German car manufacturer BMW, presented one of the first metal 3D printed parts to be used in production for the 2018 BMW i8 Roadster. The part was a highly complex and small sized metal roof bracket that lifted, lowered, and folded the soft roof of the car and its complexity made it impossible to cast using traditional tooling. By utilising metal 3D printing for this part, BMW reduced the weight of the roof bracket by 44%, compared to the bracket that was conventionally manufactured for the previous Roadster model.[24]

Another great example can be found in the medical industry. In summer 2019, the Hospital for Special Surgery (HSS) in New York and Italian based medical device company LimaCorporate announced the creation of an onsite AM facility for bespoke orthopaedic medical implants. AM has allowed medical device companies like LimaCorporate to develop custom made devices for specific individuals based on their unique bone structures, helping to improve lives all over the world.[25]

From one-off, highly specialised productions to mass produced parts, there are many more success stories like this that are a testament to the opportunities AM can bring to manufacturing businesses. What many of these success stories have in common is a new approach to designing parts for AM. With the ability

24 BMW impresses with 3D printed roof bracket for BMW i8 Roadster (https://3dprint.com/222268/bmw-3d-printed-roof-bracket/)
25 LimaCorporate breaks ground on 'world first' hospital-based Additive Manufacturing facility (https://www.metal-am.com/limacorporate-breaks-ground-on-world-first-hospital-based-additive-manufacturing-facility/)

to combine several different parts into single, more complex parts, reducing part counts, simplifying production and supply chain processes, eliminating tooling costs and improving material properties, AM is setting a new paradigm for design and manufacturing.

After 40 years, AM has arrived at a point where market forces and overall enthusiasm for AM have created the perfect conditions for this technology to finally reach its full potential. But this enthusiasm may wane if we cannot overcome the barriers that have left AM as an overall unsuitable production method. The time to tackle those barriers is now and with more awareness, experience, and AM conscious design, we will start to see an acceleration of AM for the production of all kinds of parts, including metal components.

ABOUT ENABLE

We make metal parts with Additive Casting™.

Founded in 2019, Enable is a UK based business that specialises in additive manufacturing, including the manufacturing of moulds for metal casting to produce high quality metal production parts without the limitations of traditional tooling.

This method is called **Additive Casting™** and bridges the gap between direct 3D metal printing and traditional metal casting.

For more information, please visit ww.enable.parts or contact our office at office@enable.parts.

CREDITS

CONTENT:
85 amazing people who responded to our survey.
Thank you for sharing your experience in the name of Additive Manufacturing.

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