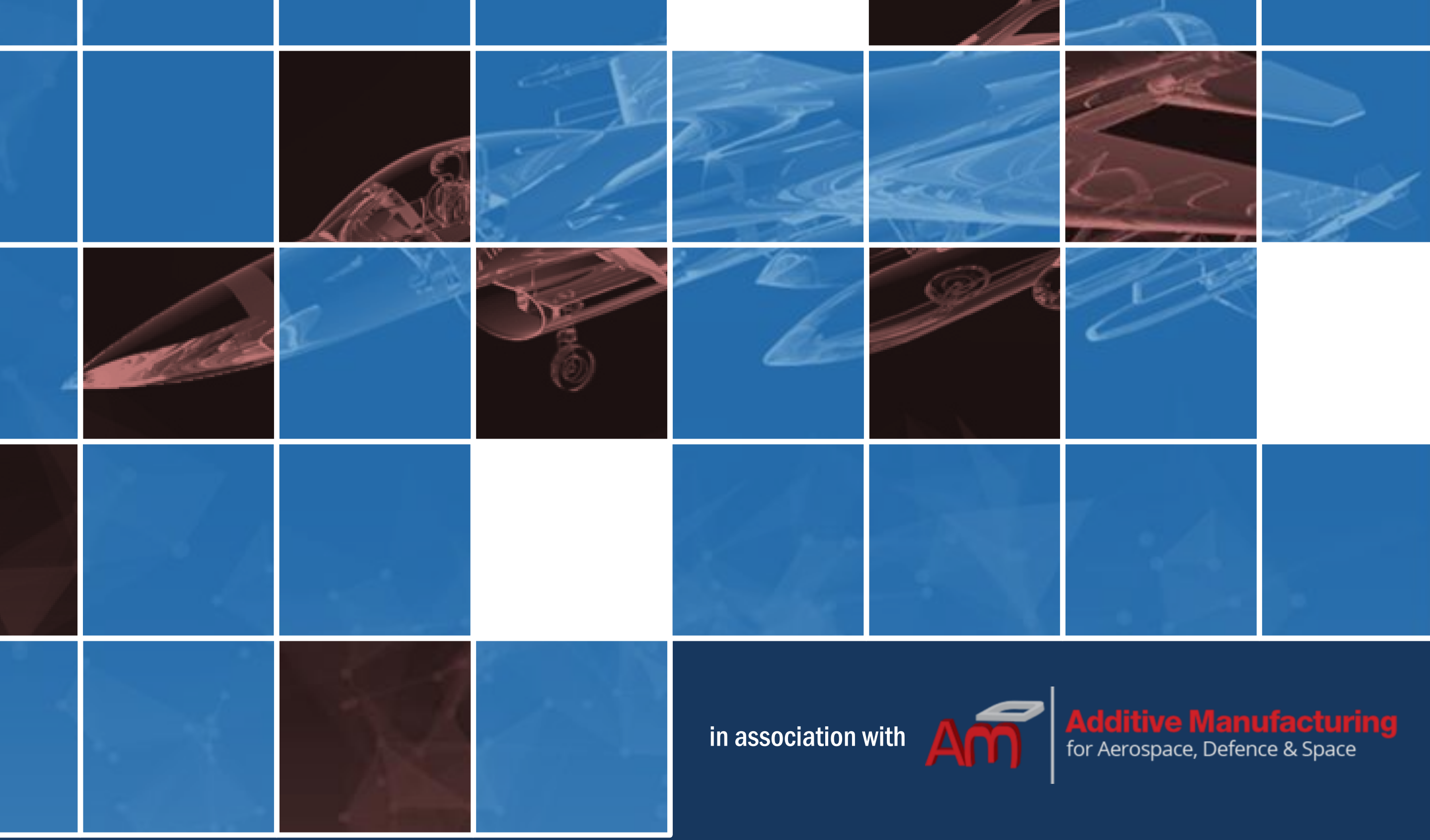


in association with Additive Manufacturing for Aerospace, Defence & Space

Additive Manufacturing in Aerospace, Defence & Space

Trends and Analysis 2016

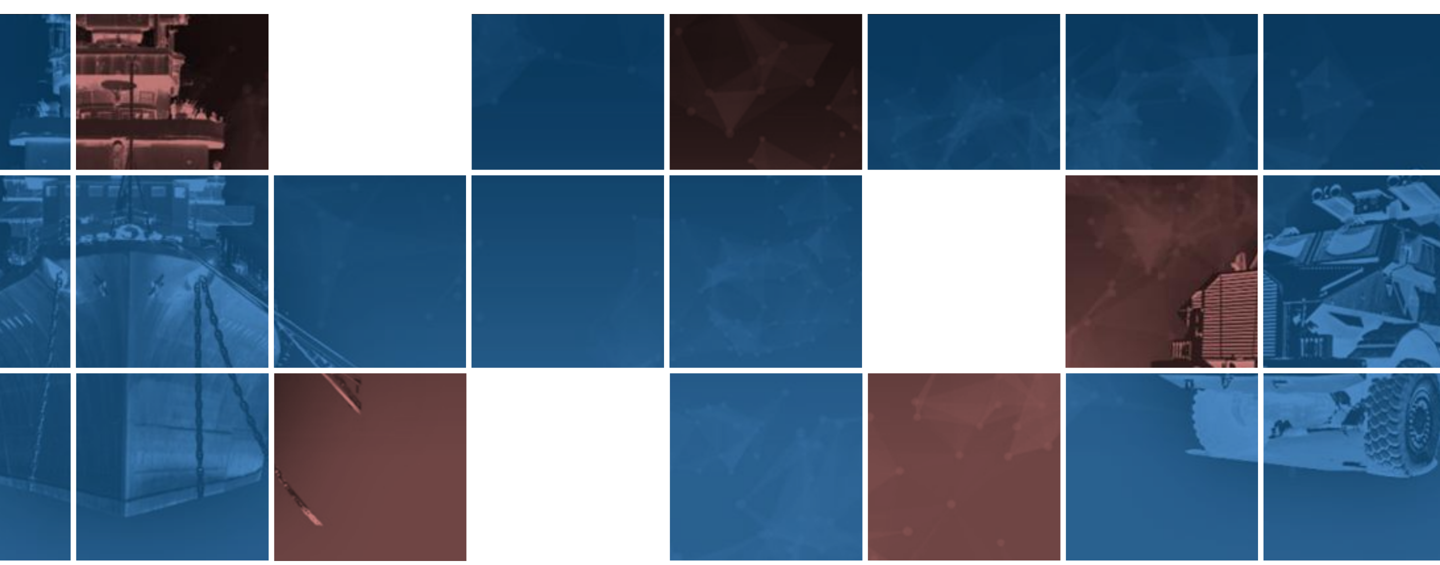
Defence iQ

About

Additive manufacturing (AM) has the potential to transform military supply chains and profoundly change the dynamics of the aerospace and defence industry. Despite being around since the 1980s, the technology is rapidly developing into a commercially viable alternative to traditional manufacturing processes, pushing engineering boundaries and allowing companies to make complex objects and products never before possible.

Ahead of the Additive Manufacturing for Aerospace, Defence & Space summit in February 2016, *Defence IQ* commissioned a survey of AM experts and A&D industry professionals, which is the first of its kind, to gauge how the market is evolving and to identify the key trends as AM methods grow from small research projects into large scale production runs.

Based on a survey of 126 industry experts, this report looks to analyse the data and provide an insight into the AM market for defence and aerospace. It explores the key benefits and challenges of the technology, who the market leaders are in this space, which organisations should lead efforts to standardise certification and quality controls, and asks the likelihood of AM being standard practice in the future.



AM "guaranteed" to be standard in 20 years

More than a third of respondents (36%) think that the use of additive manufacturing will be standard and ubiquitous in the defence industry in 20 years time while almost half (45%) think it is highly likely. It's an opinion whitewash. Just 8% of survey participants didn't think or were not sure if AM would be fully integrated into manufacturing in the sector during this period. Although the likelihood of this occurring is notably less during a ten year timeframe (Figure 1), the majority still believe it is at least likely that AM will have established itself as commercially viable during this period.

The analysis supports long-held hope and confidence in additive manufacturing and goes some way to validating the research and investment being ploughed into this developing technology. While respondents to the survey nominally identified themselves as having an interest in the AM market and therefore making it misleading to extrapolate and apply the results to the industry as a whole, the data does indicate a clear trend towards the inevitable adoption of AM as a standard manufacturing practice in the future.

> It's an opinion whitewash. Just 8% of survey participants didn't think or were not sure if AM would be fully integrated into manufacturing in the sector during this period.

Figure 1
Likelihood of additive manufacturing being standard and ubiquitous in 10 years

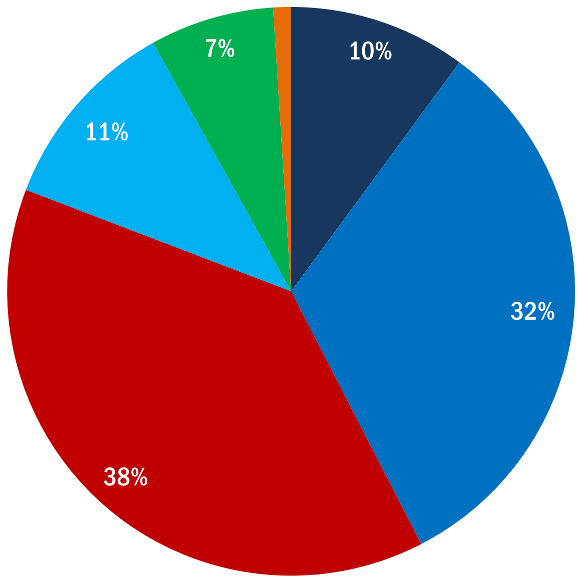


Figure 2
Likelihood of additive manufacturing being standard and ubiquitous in 20 years

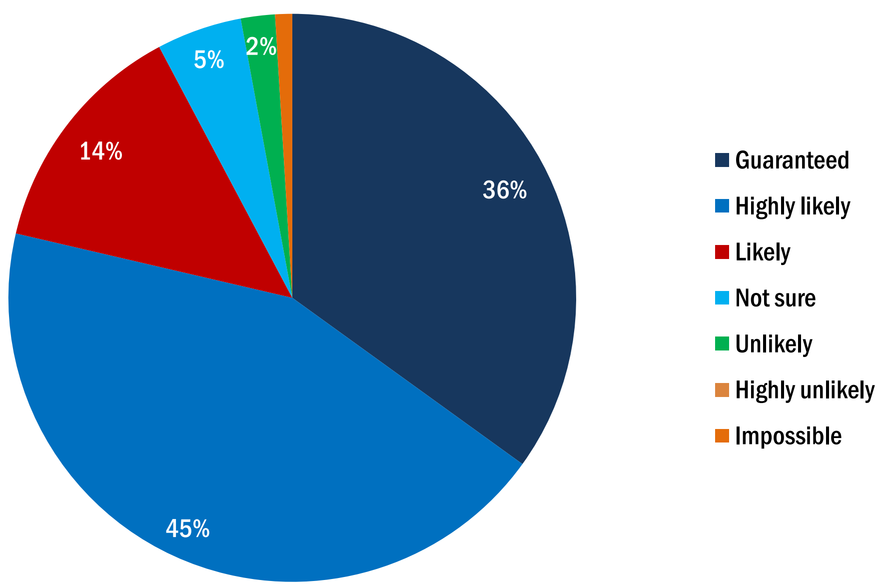
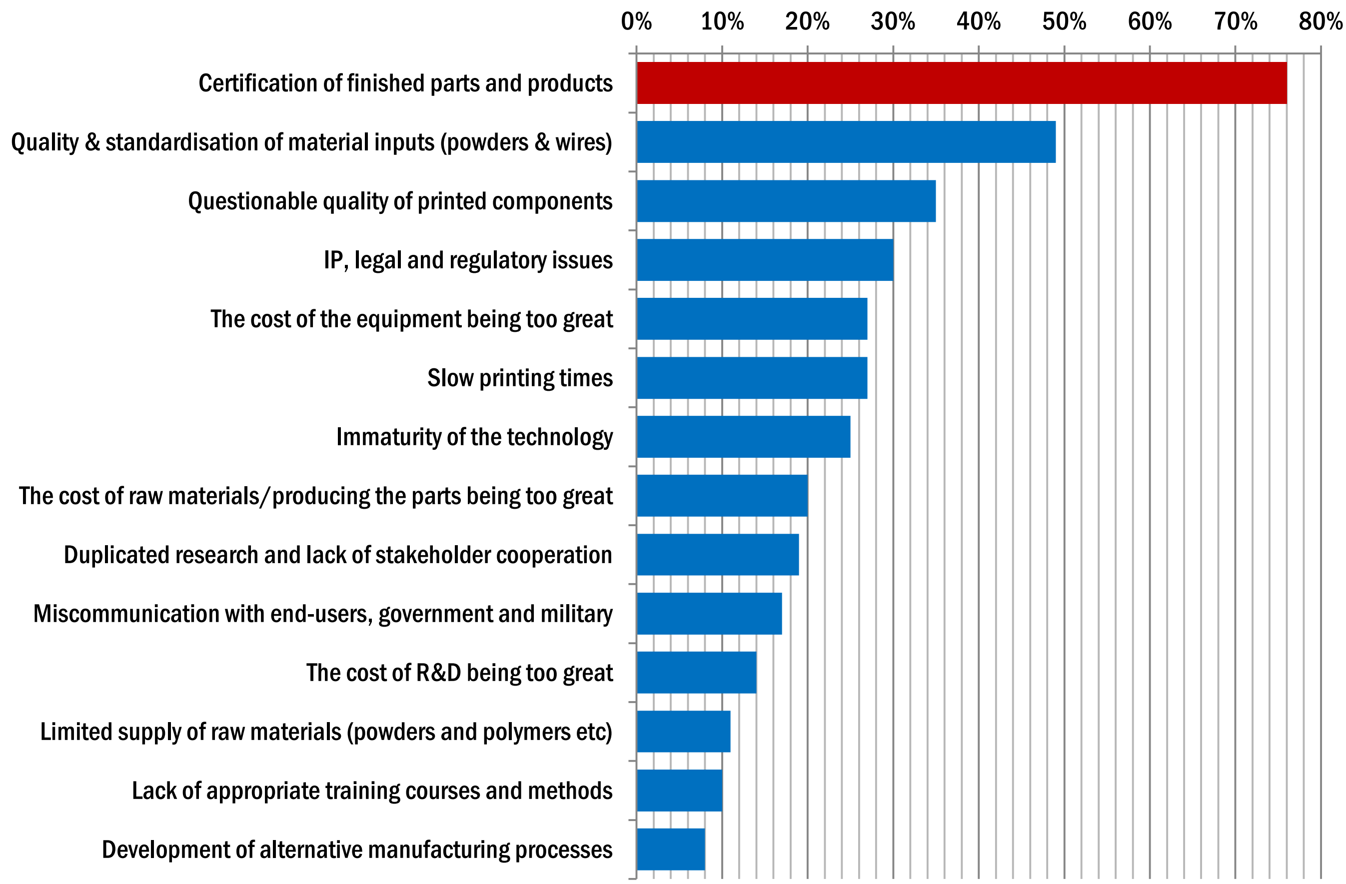


Figure 3
The key challenges hindering advancement of AM over the next ten years



The certification of finished parts and products represents the most significant challenge for additive manufacturing, hindering its mainstream commercial uptake in the future. Over three-quarters of survey respondents identified certification as the biggest challenge. The quality and standardisation of material inputs (49%), unknown quality of printed components (35%), and IP, legal, and regulatory issues (30%) were also identified as key issues clouding the effective use of AM in the defence and aerospace sector over the next ten years.

Too few aerospace businesses, particularly SMEs, have the resources or funding to exploit additive manufacturing effectively.

The reality is that that the top two responses – certification and quality issues – go hand-in-hand. “How can a part be certified, if we do not know the end quality of the part?” one respondent questioned. Another said, “the quality and standardisation of material inputs is the key challenge – solving that issue should help ease the path to addressing the others.”

The key term underscored by participants was “standardisation.” There are a number of AM techniques and processes in development at the moment, so it is unclear what a standard finished part will even look like. The issue of certification and standardisation is explored further in Figure 4.

While cost is an issue, this is true for any new and developing technology. This has been taken into account by respondents, who indicated that while it is currently a challenge to justify the costs, the assumption is that prices will drop as the technology matures and the supply chain shores up.

Other challenges highlighted by Defence IQ’s survey include the questionable durability and long-term performance of printed parts. There is also the issue of awareness: Although those plugged into the industry – and specifically the engineering elements of it – know about additive manufacturing and the benefits it offers, but do enough decision makers know enough about it?

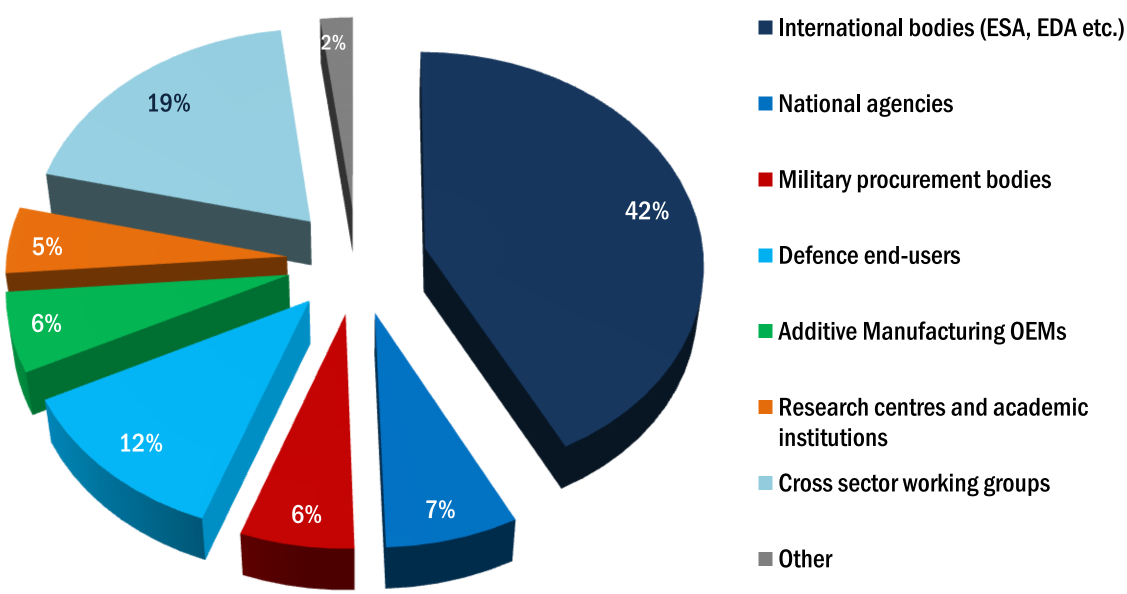
Moreover, it was suggested that it is not just miscommunication or red tape issue between government and industry, but, going further, that there is an underlying lack of support from government. Bringing that same issue down a tier, some respondents cited a lack of internal board level support and investment that is hampering AM progress.

Certainty about certification

Certification and standardisation was identified as the key challenge for additive manufacturing's mainstream rollout in the future. Who should lead efforts to certify and ensure standardisation (and quality assurance) of printed components and finished parts in the defence and aerospace sector is a central question to the future success of this market. While there was no consensus among respondents, international bodies such as ESA or the EDA were recognised as the most likely group to lead certification effots. Nearly half (42%) stated that international bodies should be responsible for certification while 19% suggested cross sector working groups and 12% said defence industry end-users should be.

Certification ahnd quality Assurance is of course important in any sector, but in defence and aerospace there is more added weight behind this issue. This must be addressed – at least in terms of where the responsibility should lie, even if not the process for implementing these standardisation methods – before any real commercial progress can be made.

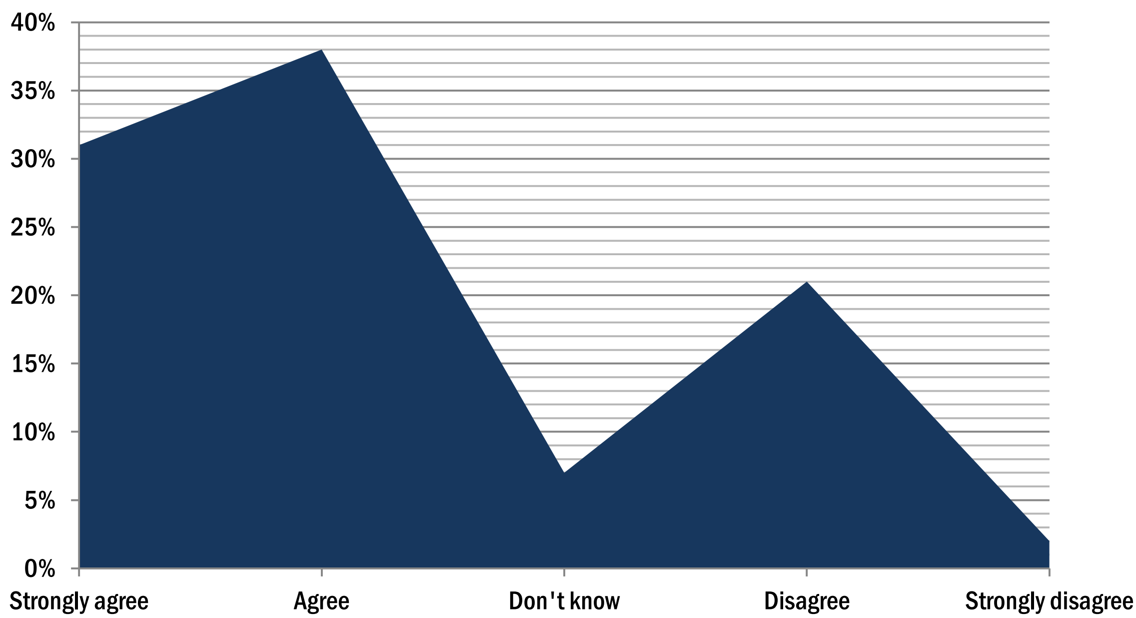
Figure 4
Analysis of which organisations should lead AM certification and standardisation efforts



> We need more of a collaboration effort from different companies to help push this technology forward.
>
> **Scott Kraemer, PTI Engineered Plastics**

Figure 5

To what extent do you agree with the following statement: "Training for traditional manufacturing is hampering the progress of AM. We can’t fully maximize the capabilities of additive manufacturing until engineers are trained to consider problems



Training important, but not time critical

The majority of respondents either agreed (38%) or strongly agreed (31%) that the capabilities of additive manufacturing cannot be maximised until engineers are trained to consider problems in non-traditional ways.

That is despite just 10% indicating in Figure 4 that the lack of appropriate training courses and methods presented a significant challenge for the industry. Only the development of other manufacturing processes was identified as less of a challenge.

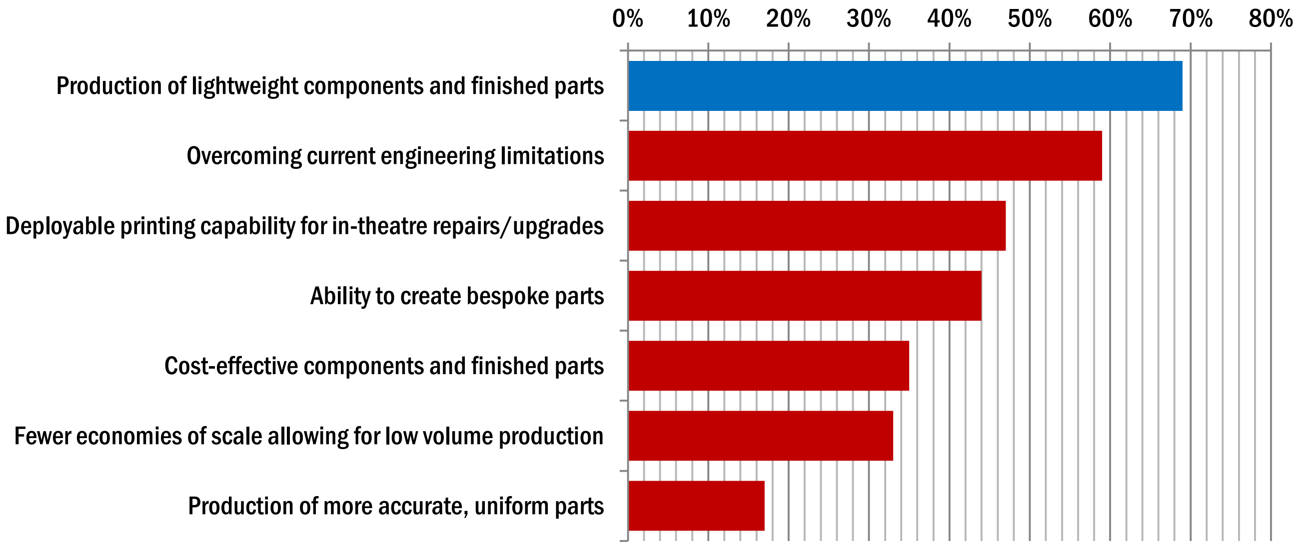
This suggests one of two things: Either that there is not a lack of appropriate courses in terms of volume (as suggested in Figure 4) but that the content of those courses still focuses too heavily on traditional methodologies (as suggested in Figure 5); or, that training does present a significant challenge like the majority of respondents indicated in Figure 5, but it is simply that there are far more pressing and problematic issues to consider before training even comes onto the radar.

The answer falls somewhere in the middle of both conculsions. Training is not up to standard, but what is the standard? What specific type of AM are we even talking about training for? Figure 4 clearly underlines the lack of standardisation in AM, and until there is clarity on that it is difficult to standardise new training material.

There is a knowledge gap between traditional and modern (future) manufacturing processes. Designers at universities are primarily taught using traditional manufacturing methods, meaning many may struggle in the short-term to bridge the gap between what we know now and what AM engineering can offer in the future.

The training issue is certainly an issue – it needs addressing in order to maximise the benefits of AM but the technology must catch up with the hype and momentum first. There are other challenges industry must tackle beforehand.

Figure 6
The key benefits of additive manufacturing over the next 10 years



Lighting up the market

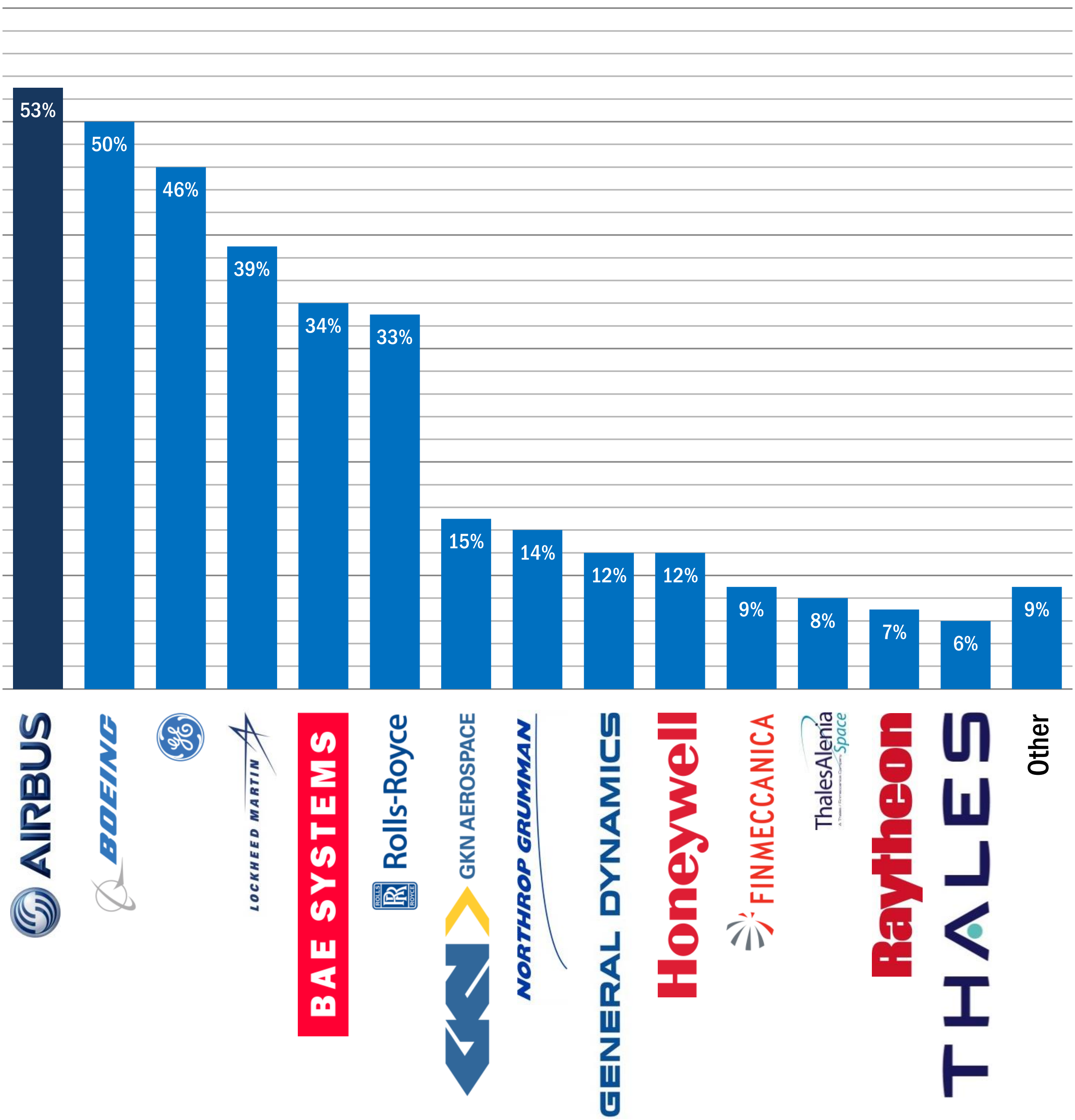
The lightweight properties promised by printed components and finished parts are seen as the chief benefit of AM according to 69% of survey respondents. Where most manufacturing processes involve single component parts, AM can build free form designs and sub-assemblies of complex, interconnected parts, working with lattice structures and cavities to reduce weight without sacrificing structural integrity. The sophistication of these assemblies will only advance as the technology matures. In terms of applications in the aerospace and defence sector, lighter equipment poses obvious advantages. AM parts and equipment are lighter, meaning it will be less of a burden on troops, it will require less fuel to transport it as well as making it easier and cheaper to transport.

In-theatre repairs and upgrades are also an obvious – and much publicised – benefit of additive manufacturing although this is in reality a more long-term vision. For example, in-theatre printing will be limited until more parts are produced using AM in the initial design of the part.

The ability to overcome traditional engineering limitations (59%) and to produce bespoke parts (44%) were also identified as key benefits.
Pushing the boundaries of engineering and breaking the old rules of manufacturing with AM will ultimately result in better products and more innovation. Additive manufacturing allows engineers to create complex geometries out of polymers, metals, and composites that are not possible through traditional manufacturing techniques. Ensuring the structural integrity and through-life performance of components is not compromised will be the challenge, but the potential for AM is almost limitless.

The bespoke nature of AM is critical, allowing for smaller and more cost-effective production runs. AM is ideally suited to aerospace and defence since many contracts require bespoke designs in low quantities. It's an expensive game buying new equipment to fulfil each small contract. Additive manufacturing promises to wipe out the need for specialist machines for one-off jobs; in theory in the future all you'll need is a 3D printer.

Figure 7
A&D market leaders in additive manufacturing



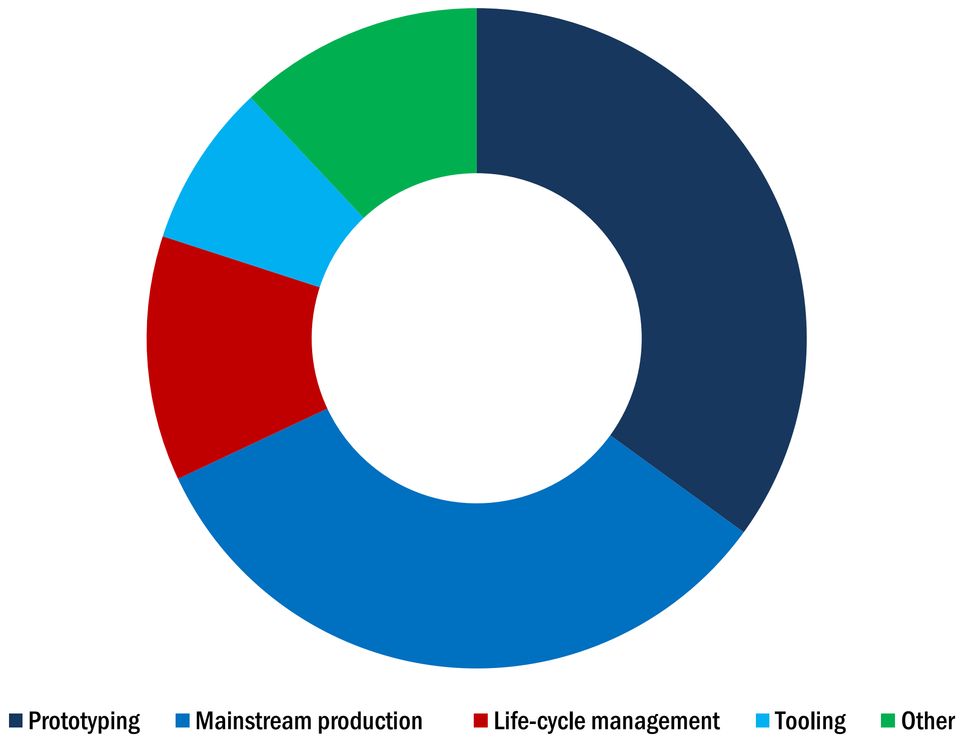
Aerospace in the slipstream?

Airbus Defence & Space was identified as the market leader in additive manufacturing by Defence IQ's survey respondents with over half (53%) underscoring the European consortium's work in this field. It was closely followed by Boeing (50%), General Electric Aviation (46%), and Lockheed Martin (39%). All of the front-runners have significant aerospace offerings, which is likely the reason for their high ranking since AM is a more mature technology in the aerospace sector compared with defence. Aside from the companies mentioned, Pratt & Whitney and Stelia Aerospace were also identified by respondents as leaders in this space.

Despite these results, it is difficult to judge who is leading the market for AM in this industry due to it being such a highly commercially sensitive and research intensive topic. While this gives a good indication of which companies are being proactive and investing in AM technologies, it should not be taken as a definitive ranking.

> "There is hardly a company in the A&D sector that is not looking to diversify its products and services into other adjacent verticals. AM can be a route into new markets, helping firms diversify what they can manufacture.

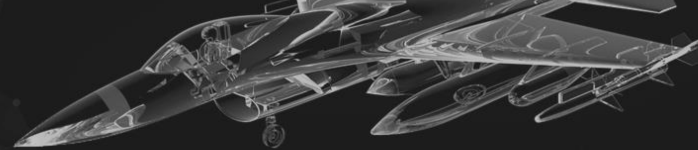
Figure 8
What applications will AM be used for?



The oil tanker is turning

The majority of respondents indicated that prototyping (35%) and mainstream production (33%) are the applications they are primarily interested in for additive manufacturing. Historically, AM has been used almost solely for making prototypes because the speed, cost and quality of printed parts did not make the process a commercially viable option. Things are changing, the oil tanker is turning. A third of respondents are primarily interested in additive manufacturing for its potential to revolutionise the mainstream production of components and parts.

This report aimed to better understand the future of additive manufacuring in the defence and aerospace sector by identifying key trends. It is clear that AM will have a major impact on the design of complex, bespoke products that break existing material and engineering limitations in the future, although given the number of challenges, such as certification and quality, it is unlikely to be a smooth or swift route to market. Further research – and significantly more investment – is required to bolster the case for AM in commercial large scale production. But this report has made evident that, first and foremost, the certification issue needs resolving.



Additive Manufacturing
for Aerospace, Defence & Space

29 - 30 March, 2016 – London, UK

The aerospace and defence sector continues to lead in the additive manufacturing space. In 2015 alone, successful AM production projects have emerged in satellite construction, missiles and unmanned aerial systems.

Stakeholders across the sector are now looking to short-term applications and return on investment as the crucial first steps towards fulfilling the potential of AM technology. Organisations from defence procurement, transnationals, major contractors & academic research continue to increase their interest and investment in the area as the positive results come in.

Download the agenda here!

Agenda themes will include:

- Certification and standardisation strategies delivering critical assurance for defence and aerospace applications
- Space, air, land and sea applications for additive manufacturing processes
- Complete production cycle evaluation and assessment of through-life costs
- Training engineers to 'think in additive manufacturing' terms to utilise AM's full potential
- Innovation and new technologies developing additive manufacturing for defence & aerospace
- Commercialisation of research and developing short-term additive manufacturing strategies
- The National Additive Manufacturing Strategy and its consequences for the defence & aerospace agency

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