AMUK Annual Action Plan

2024


Additive
Manufacturing
UK

Executive Summary

Additive Manufacturing UK (AMUK) was setup in 2014 by the Manufacturing Technology Centre (MTC) with the purpose of bringing together the UK's Additive and 3D Printing community. This was to ensure that the AM community in the UK, was well placed to capitalise on the world-class AM research, development, and manufacturing expertise available to it. This culminated in in the delivery of the 2017 strategy report 'Additive Manufacturing UK National Strategy 2018-25: Leading Additive Manufacturing in the UK' which set out the challenges and recommendations needed for the UK to remain at the forefront of AM technology.

One of the key recommendations set in the 2017 report was for the establishment of a key contact point organisation for AM. In 2020, the AMUK brand was passed to the Manufacturing Technologies Association (MTA) with the requirement for them to establish AMUK as that key contact point organisation.

This report provides a top-level view of the current state of AM technology in the UK, as well as establishing the member set challenges and subsequent actions that AMUK will aim to undertake over the next 12 months, to drive forward the development, adoption, and use of AM technology in the UK. The three challenge areas are as follows:

- Supply Chain – Education, Adoption, Visibility and Qualification
- Skills – Education, Training and Recruitment
- Standards – Roadmap, Testing, Certification, Inspection and Materials.

The actions taken against each of these challenges will be assessed annually to help determine if they are having the required impact in helping drive the AM eco-system in the UK forward and refined and adapted as is necessary.

There is a significant opportunity for the UK to grow its share of the global AM market. Currently the UK share of the global AM market is approximately 4% and valued at $690million (£560million). However, with the right support, input, and action to create an environment in the UK where Additive technology thrives, it is thought that the UK could capture almost 7% of the global market by 2030 which is expected to be in the range of $4billion to $6billion.

Contents

AMUK aims to establish the UK as a world leader in the development, adoption and use of 3D Printing and Additive Manufacturing Technology.

AMUK: An Introduction

Background

AMUK is the trade association representing UK companies engaged in every aspect of the additive manufacturing value chain, spanning materials manufacture to post-processing of parts. Established in 2014 the original aim was to disseminate knowledge, and guide and drive the strategic direction of additive manufacturing technology in the UK.

In 2015, the group published its first report, "The Case for Additive Manufacturing." A positioning paper developed from extensive consultations and workshops conducted across the UK. This marked the beginning of an ongoing dialogue with industry, academia, and professional bodies, aimed at refining the understanding of the opportunities, challenges, strengths, and barriers hindering the full commercialisation of additive manufacturing in the UK.

In 2016, a second report was released, "Leading Additive Manufacturing in the UK: A platform for engagement to enable UK industry to realize the full potential of Additive Manufacturing & 3D Printing." This report provided a structured framework for engaging with the UK's additive manufacturing community, a foundation upon which the 2017 report titled, "Additive Manufacturing UK National Strategy 2018 – 25: Leading Additive Manufacturing in the UK" was written.

This third report outlined seven strategic challenge areas, each essential to unlocking the UK's additive manufacturing and 3D printing potential in research, development, design, and manufacturing. The details of these challenges and their explanations are outlined in the table below:

Challenge Title	Challenge Summary
Design	One of the key drivers for using additive manufacturing is the design opportunity it presents. This challenge looked at supporting effective design, resolving CAD workflow issues, and providing optimised design tools for additive geometries. Businesses need to provide designers with additive manufacturing design capability and leverage design thinking to help identify, validate, and communicate high-value propositions enabled by additive technology.
Materials and Processes	The range of materials and processes covered by the term additive manufacturing is broad. This challenge covered equipment options, materials properties, processing parameters, research on knowledge gaps, and innovation opportunities. Uncertainty surrounding future supply chain capacities and sector-specific challenges such as process selection, scale-up, automation and digital manufacturing approaches may slow the adoption of additive manufacturing.
Inspection, Test and Standards	Additive manufacturing brings a new approach to manufacturing while still relying on established standards. This challenge considered the standards, inspection, certification, and regulations for additive within the context of industry, safety, compatibility, processes, and materials. The wide range of technologies, materials and processing steps underline the importance of identifying production steps and relevant standards for additively manufactured parts.

Challenge Title	Challenge Summary
Commercial, IP and Data Management	Key lenders are keen to fund additive manufacturing adoption. This challenge looked at the need for quick and easy wins to help generate momentum for additive within the commercial community. Many of the barriers to greater investment are not additive specific, for example Brexit, Skills Shortages, and security concerns. Protecting IP and ensuring production integrity are vital for maintaining quality and reaping financial benefits.
Skills and Education	Additive specific skills and the education and training needed to harness the benefits are a key component to the success of additive technology. This challenge considered the standards, delivery mechanisms, industry needs, and building awareness across the additive and education sector. Managing difference in skills between new recruits and experienced employees was recognised, and various options were developed to address the lack of a compelling commercial case for additive manufacturing training due to volume requirements.
Supply Chain Development	This challenge had no specific working group in the previous strategy. However, several recommendations to raise visibility of the UK supply chain, identify gaps and address areas of strategic weakness were made.
Implementation	This challenge area was co-ordinated by the top-level AMUK Steering group and brought together the work of the original working groups. It looked at the implementation of the National Strategy from a top-level view and considered the actions required to make it a success.

Following the release of the report titled "Additive Manufacturing UK National Strategy 2018 – 25: Leading Additive Manufacturing in the UK," the working groups established by AMUK continued their work to address specific challenges and implement the recommendations as outlined in the report. However, a clear structure for ownership, execution, and coordination of these recommendations was not firmly established. This, coupled with significant external factors like Brexit, shifts in government leadership, evolving policies, and a growing emphasis on digital technologies, including Artificial Intelligence, caused a slowdown in the work being undertaken[1].

In the final quarter of 2019, the Manufacturing Technology Centre (MTC), custodians of the AMUK network, initiated discussions with the Manufacturing Technologies Association (MTA) with the aim of transitioning AMUK to the MTA. In 2020, this transition was successfully completed, with the MTA assuming stewardship of AMUK, and an intent on establishing it as the preeminent national association for companies contributing to and shaping the Additive Technology value chain. This value chain encompasses materials, design, AM build, post-processing, testing, inspection, and more.

[1] A report titled: 'The UK Additive Manufacturing Landscape: A Data-Centric Review of AM Innovation and Entrepreneurship 2010-2020 based on Public Spending' which was released in August 2022, undertook a full review of the status of the recommendations that had been set in the national strategy from 2018. In conclusion, the report stated that AM in the UK is a healthy and active field, however it was found that the recommendations to be lacking in progress and that this was something that needed to be addressed.

Following its integration into the MTA, AMUK experienced a successful restart at MACH 2022. This moment signalled the beginning of AMUK's official re-establishment as an association, a process that culminated in April 2023 with it being recognised as the professional body for companies operating in the additive technology value chain. For an overview of key milestones in AMUK's journey, please refer to the timeline depicted below:

- **AMUK Established by MTC**
- **Report Released: The Case for Additive Manufacturing**
- **Report Released: Leading Additive Manufacturing in the UK**
- **Report Released: AMUK National Strategy 2018-25**
- **AMUK Network and Branding passed from MTC to MTA**
- **AMUK Network restarted at MACH 2022 Exhibition**
- **AMUK Estbliahsed as a trade association.**

Aim and Services

AMUK's main aim is to position the UK as a global frontrunner in the research, development, adoption, and application of technologies and services that comprise the AM technology value chain. This objective underlines our commitment to fostering innovation, creating economic growth, and enhancing the UK's reputation as a key hub for AM technology advancements and applications.

Through collaborative initiatives with industry partners, academic institutions, and governmental bodies, AMUK is seeking to leverage the transformative potential of AM technology, to create opportunities, bolster productivity, and effectively tackle diverse challenges across a variety of sectors. In doing so, AMUK will actively contribute to enhancing the overall technological landscape and competitiveness of the UK on the global stage.

AMUK's membership services are there to benefit our members, equipping them with the tools and support necessary to thrive both within the UK and on the international front. The following table provides an overview of the services provided:

Service	Description
Business Support	These services aid with the administrative side of running a business, allowing companies to do more of the things which are core to their mission. The services cover areas such as, HR, HSE, Legal and Tax advice and providing access to training at significantly reduced rates.
Industry Intelligence	Members are provided information on Additive Market Trends, Technology Trends as well as insights into wider additive industry around areas such as standards, IP, and funding as well as networking opportunities.
Marketing and Promotion	These services aim to promote the membership and aid in raising awareness of their brands, as well as the additive industry. There are discounts to exhibit or attend at certain events and opportunities to speak at conferences.
Academic/Industry Engagement	These services are around helping the academic and industrial community engage to ensure that members have opportunities to take advantage of the world class R&D that happens in the UK.
Strategic Partnerships	This area looks at creating collaborations with organisations which are already providing world class services to the additive industry and helping our members access them.

Current Membership

3D Squared	76 Additive	Additive Industries	Additive International	Additive Manufacturing Solutions
Additive-X	Advanced Forming Research Institute	All 3D Labs	AME-3D	AMufacture
APEX	Arrk Europe Ltd	Atomik AM	Atomic Weapons Establishment	Bowman 3D
Co Print	Cooksongold Additive	CREAT3D	Create Education	Digital Manufacturing Centre
DiManEx	Duet3D	Dyndrite	Enable Manufacturing	FDM Digital Solutions
Gateshead College	GFH Additive	GKN Aerosapce	HP 3D Printing	Incremental Engineering
Industrial Forms	IPFL			

JCB

Kaizen PLM

Kene Partners

Kerstar

Laser Lines

Laser Trader

Leonardo Electronics

M A M Solutions

Marks & Clerk LLP

Measurement Solutions

Ogle Models & Prototypes

Phoenic Scientific Industries

Piab

Plastometrex

Primetals Technologies

Rapid News Group

Reliance Precision

REM Surface Engineering

Renishaw UK

Ricoh 3D

Righton Blackburn

Russell Finex

Siemens

The MTC

Theta Technologies

TRUMPF

University of Warwick

Valuechain Technology

VELO3D

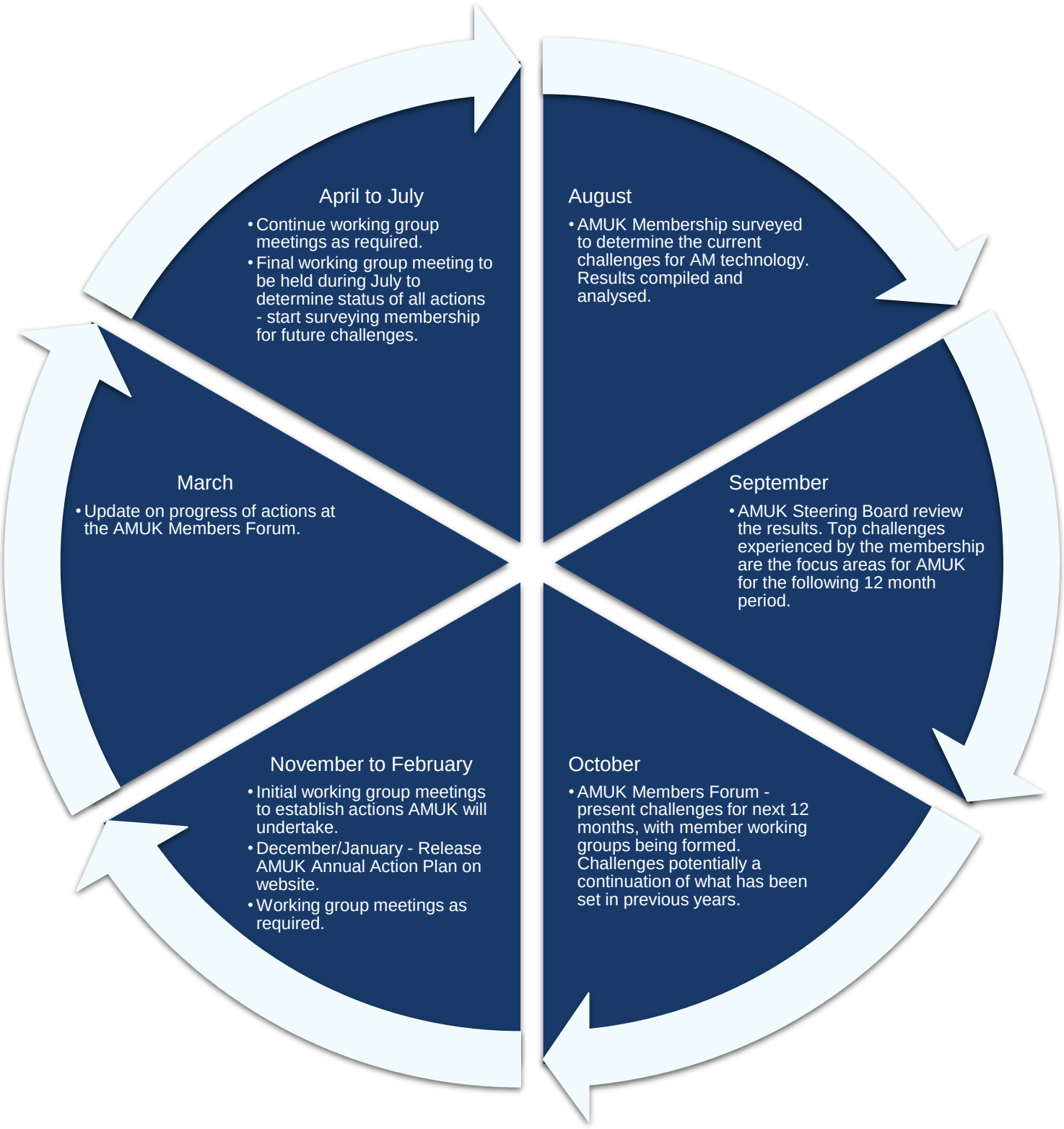
Voestalpine Bohler Edelstahl

WAAM3D

Zentech International

AMUK Annual Action Plan Process

The purpose of this report is to provide an annual update on the work achieved by AMUK during the previous 12 months, along with updating the actions for the next 12 months. The process by which this annual action plan will be updated is as follows:



Additive Technology in the UK

Current State of Play – Market Size

In the report titled: "Additive Manufacturing UK National Strategy 2018 – 25: Leading Additive Manufacturing in the UK" it stated that the Additive market in the UK was valued at approximately $359 million (£235 million) in 2015, which was roughly 6.9% of the $5.2 billion[2] a global market value at that time. In 2022 the global market for AM technology was valued at $17 billion[3]. For the same period, the UK market for AM technology was valued at approximately $690 million[4] (approx. £560 million). This equates to an approximate UK share of the global AM market of 4%.

The UK global market share shows a drop from 2015 to 2022. This could be due to several reasons. Firstly, the COVID pandemic was seen as a stimulus for the increased use of AM technology globally, due to its ability to respond quickly to sudden demands. It could be that other countries, that were initially trailing the UK, responded with greater impetus allowing them to catch and surpass the UK position. Furthermore, events such as BREXIT have introduced other issues for UK companies to deal with, such as exporting and supply chain resilience, which has potentially diverted their focus towards operational adjustments rather than looking to adopt novel technologies, such as AM.

With regards to the future of the global AM market, there are numerous perspectives and growth rates around its size and potential. Predictions for the size of the global AM market by 2030 range from $60 to $90 billion. An estimate from Grand View Research is that it will be valued at approximately $76 billion in 2030[5]. If the UK can maintain its current global position, it will capture around $3 billion of that market. However, if the right environment can be put in place in the UK, where companies are actively encouraged to adopt, use, and develop AM technologies, then the UK can aim to regain its 2015 global position. Such a position would mean the UK Additive market would be worth in excess of $5 billion.

UK Research and Development Landscape

A comprehensive overview of the state of AM in the UK was covered in the August 2022 report: 'The UK Additive Manufacturing Landscape: A Data-Centric Review of AM Innovation and Entrepreneurship 2010-2020 based on Public Spending'. This report detailed the status of the recommendations that had been set in the September 2017 report, 'Additive Manufacturing UK National Strategy 2018 – 25: Leading Additive Manufacturing in the UK' as well as providing a detailed analysis of the UK in the following areas:

- Additive and 3D Printing Research Funding Landscape
- Research Publications
- Patent Landscape
- Start-up Landscape

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[2] $5.2billion is from the report titled "3D Printing Trends Q1 2019" from the Hubs website. The average USD to GBP exchange rate during 2015 was 0.6545.
[3] $17billion figure from the report titled "3D Printing Trends Report 2023" from the Hubs website. The average USD to GBP exchange rate during 2022 was 0.8115.
[4] https://www.nextmsc.com/report/uk-additive-manufacturing-am-market.
[5] https://www.grandviewresearch.com/industry-analysis/additive-manufacturing-market#:~:text=The%20global%20additive%20manufacturing%20market%20size%20was%20estimated%20at%20USD,USD%2016.75%20billion%20in%202022

As part of the AMUK Annual Action Plan, the amount of funding in the UK which goes towards projects related to AM technology, and the number of AM patents registered in the UK along with origin country of the applicants will be tracked. Though not as detailed as the August 2022 report, it is assessed that tracking these metrics will provide a top-level indication on the state of AM in the UK on an annual basis.

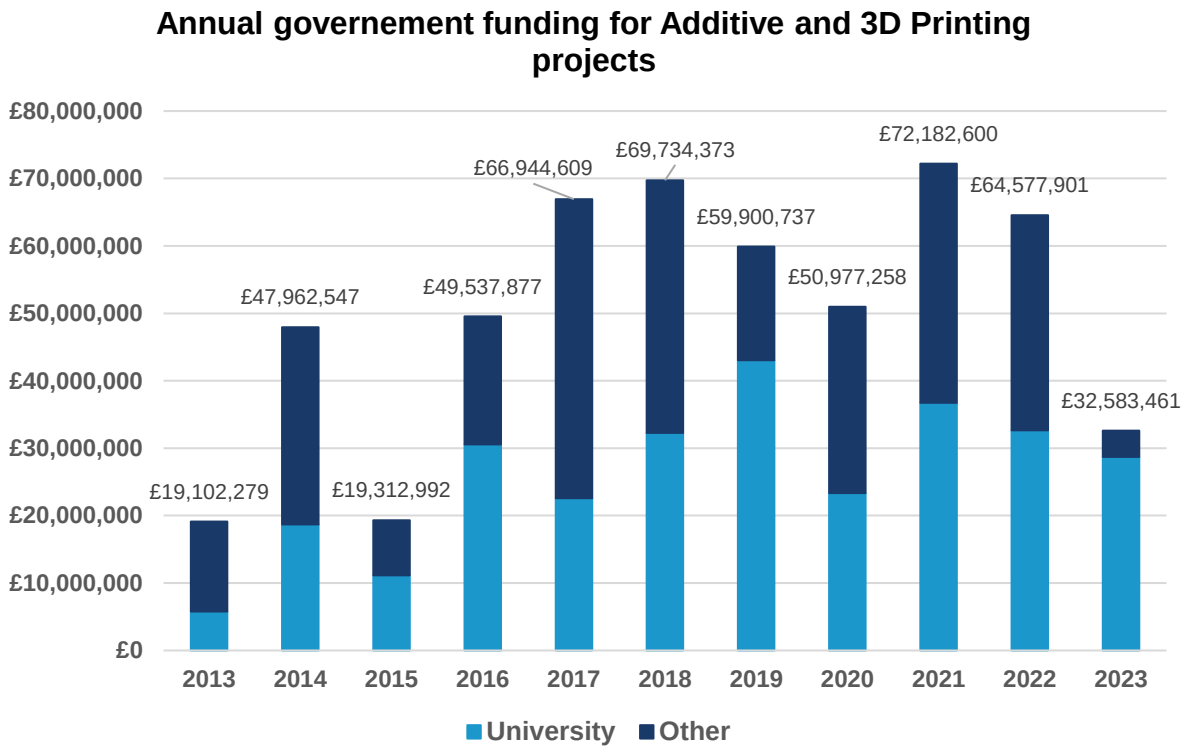
Funding Landscape

As per the process set out in the August 2022 report, 'The UK Additive Manufacturing Landscape: A Data-Centric Review of AM Innovation and Entrepreneurship 2010-2020 based on Public Spending', using the search terms "Additive Manufacturing" and/or "3D Printing"[6] in "Project Abstract" or "Project Title" in the publicly available UKRI data (https://gtr.ukri.org/) between 1/1/2013 and 25/07/2023 resulted in the following data:

A total of £552,816,634 was spent, funding 811 Additive and 3D Printing technology related projects between the 1st of January 2013 and 25th July 2023. This is a significant amount and perhaps reflects potentially some of the hype surrounding the technology between 2012-14, but also the potential importance the Government sees in the technology in the context of UK sovereignty and the drive towards a net zero economy.

The year-by-year analysis in the following graph indicates that public funding for AM ramped up between 2013 and 2016, levelled off during 2017 and 2018, took a slight dip during 2019 and 2020 (assessed to be due to the change in priorities by government funding bodies because of the pandemic), before picking up again to pre-pandemic levels in 2021, with a slight drop seen again in 2022. The full results for 2023 are not yet available, and therefore it can't be fully assessed as to whether the drop between 2021 and 2022 is part of a trend or just part of the general variability of accessing funding.

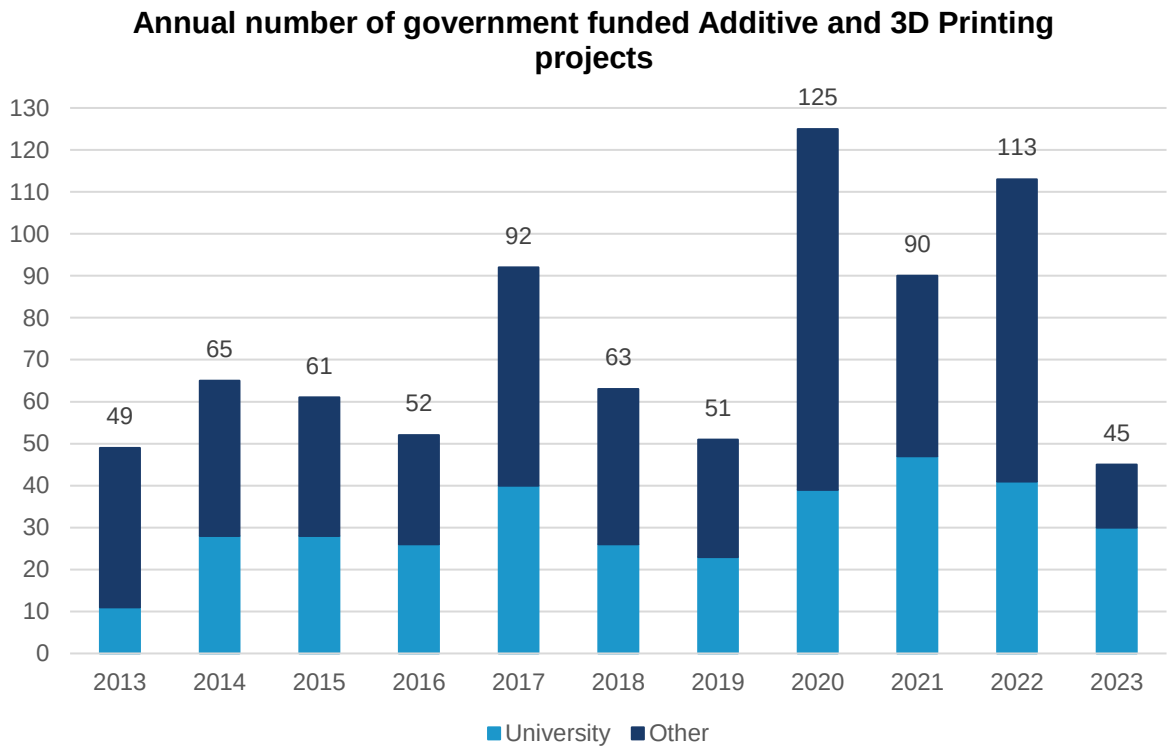
[6] Search term to be written as follows: "additive manufacturing" "3D Printing". Note that studentships will need to be removed from the data to identify the number of projects undertaken.



The split of funding between University or Industry/RTOs lead projects over the period, showed a near 50/50 split with university lead projects receiving 51.6% of the funding and Industry/RTO lead projects receiving 48.4% of the funding.

From a number of projects perspective between the 1st of January 2013 and 25th July 2023 we can see in the following graph, that the number of projects doesn't necessarily correlate directly to the level of funding available. For example, 2014, 2016 and 2020 all saw similar total levels of funding given to projects – just under £50million a year on average. This is lower than the annual funding provided in the years 2017, 2018, 2019, 2021 and 2022 where average funding was approximately £67million a year. However, despite a low level of funding, 2020 saw the largest number of projects undertaken at 125. For context, 2014 saw 65 projects and 2016 saw 52 projects. It is assessed that this large number may be in due to the big number of industry projects that happened that year which were likely in response to the COVID pandemic for national initiatives such as addressing the shortage in PPE and the Ventilator challenge.

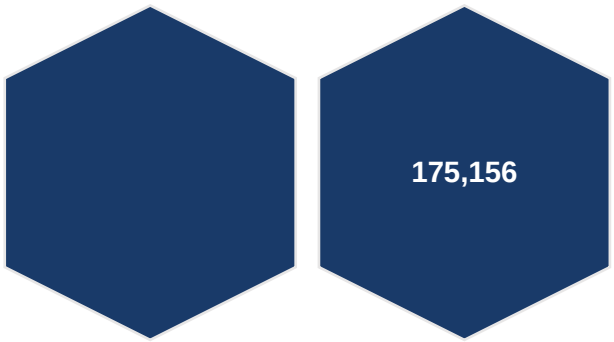
The split between University or Industry/RTOs lead projects over the period, shows an industry/RTOs leading far more projects at 57.7% and universities leading just 42.3%. This imbalance mostly stems from the years 2020-22 where there is significant number of industry/RTO lead projects which as stated above are assessed to be linked to the national response to the COVID pandemic.



In conclusion, the R&D landscape for AM technology in the UK currently looks to be well funded, with lots of projects occurring within industry and academia. It remains to be seen as to whether the Government's current interest in digital technologies has an adverse impact on this, and if the drop in funding between 2021 and 2022 was a one off or part of a trend. Further analysis is also required to determine what sectors have received this funding, and the impact that that funding has had.

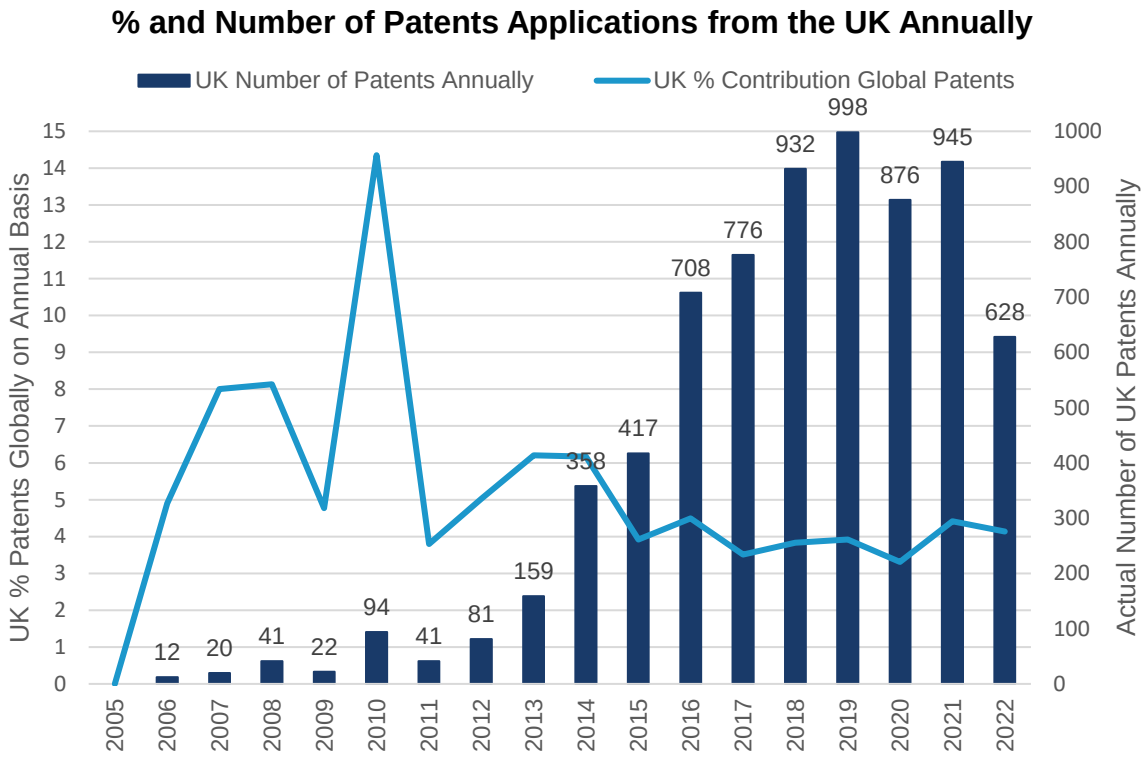
Patent Landscape – UK and Abroad

Adapting the process used in the August 2022 report, 'The UK Additive Manufacturing Landscape: A Data-Centric Review of AM Innovation and Entrepreneurship 2010-2020 based on Public Spending', using the search terms "Additive Manufacturing" and/or "3D Printing" in either the "Title", "Abstract", "Description" or "Claims" in the Espacenet database (https://worldwide.espacenet.com/) between 2005 and 2022[7] returned the following data on patents registered for Additive and 3D Printing technology:



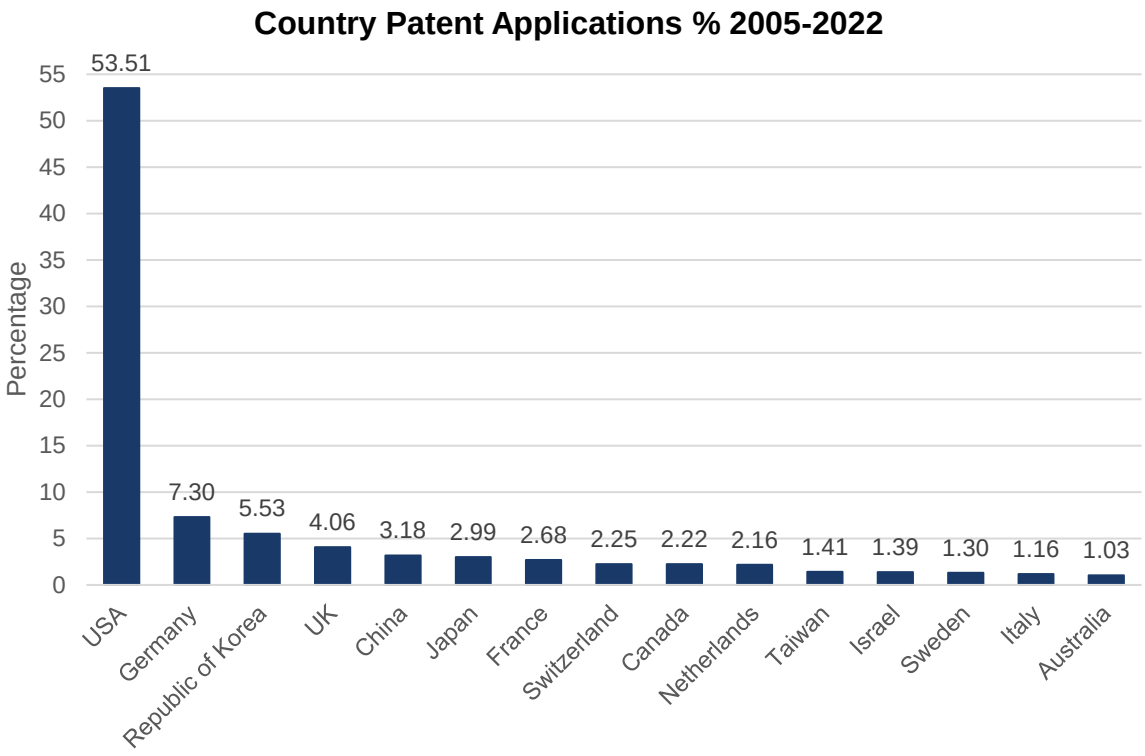
[7] Specific search term used as follows: ta = "Additive Manufacturing" OR ta = "3D Printing" OR desc = "Additive Manufacturing" OR desc = "3D Printing" OR claims = "Additive Manufacturing" OR claims = "3D Printing"

Firstly, to note, there are significant limitations to the results obtained via this search method. There is no differentiation made between awarded and pending patent applications. Furthermore, there is likely extra patents that have been included which aren't applicable to AM technology, or maybe miss patents which would have been applicable if a different term has been used (i.e. SLS, Solid Freeform Fabrication etc). Finally, there are potentially duplicate entries as a company may put in the same patent application in multiple jurisdictions. However, it is assessed that the information obtained via the search undertaken provides a good indication of the strength of the UK AM eco-system, as you can compare countries and assess the level of innovative research and development being patented and therefore potentially commercialised.



The graph above shows the number of patents applications that occur each year from UK based applicants. From 2006 to 2015 there was a steady period of growth in applications with 2016 to 2021 showing a peaking and levelling off. The drop in number of applications in 2022 is assessed to be due to it taking 18 months post filing for a patent to appear on the database (i.e. anything filed in June 2023 will not be published until December 2023) rather than the start of a downward trend. Looking at the percentage of applications, UK applicants annually account for around 4% of the global total from 2015 onwards.

Looking at the total number of patent applications made by countries from 2005 to 2022 gives the following view:



The UK currently sits in 4th place with a share of just over 4% of global patents. It is currently sitting above both China and Japan which suggests that the UK is providing an innovate R&D landscape for AM technology.

Additive Adoption Landscape

Though there is data on the level government funding and AM patents in the UK – which is assessed to be an indication that AM technology is being developed, adopted, and used in the UK – there is currently a lack of specific data around the adoption rates (i.e. AM machine installation numbers) and use of AM technology (i.e. AM material consumption).

In the absence of data on adoption and use rates, we can look at some of the industries that are using AM technologies. The sectors covered below are Aerospace, Automotive (incl. Motorsport), Medical & Metal Products and Machinery.

Aerospace

Estimates based on output data for 2022 suggest that the UK has the 2nd largest aerospace industry, accounting for just over 8% of the global total; however, it is well behind the USA which was just under 48% of global output. Indeed, Europe, only accounted for just under 32% of global output, with Germany (6% of the global total) and France (5%) a little behind the UK. The Asia-Pacific region is relatively less important in this industry, accounting for only 14% of total output in 2022.

The latest forecasts for the sector by Oxford Economics suggest global growth of +4.4% per annum between 2021 and 2027 but within an overall positive trend, there are winners and

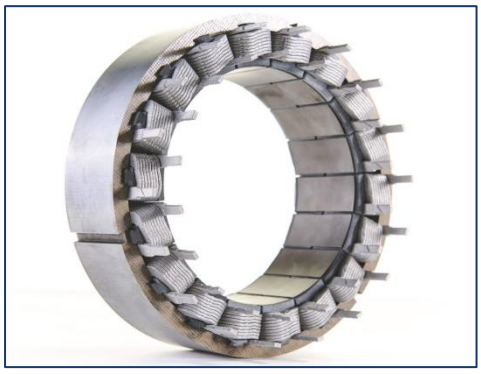
losers globally. Growth is expected to be most rapid in Asia at +12.5% over this period (this is partly a catch-up, partly because it is easier to generate large percentage changes from smaller levels and partly because the post-Covid recovery occurs slightly later so more of the recovery is in 2022 which is part of this calculation). In contrast, growth in the USA over this period is only expected to be +2.5% and in Europe it is put at +3.7%; however, within Europe, the UK has the slowest rate of growth at just +1.0%, with both France (+5.4% pa) and Germany (+5.2%) expected to grow more rapidly.

This data covers both civil and defence aerospace activity, and this is part of the reason for the dominance of the USA where defence aerospace is a very large sector. The other factor to bear in mind while assessing the significance of this for the AM sector, is the parts of the aircraft where the new technology can be applied. Especially within Europe, there is quite a high degree of specialisation in this sector; the UK is the major producer of aircraft wings for Airbus and has a significant presence in engines, landing gear and electronics but if the innovations in the AM sector are concentrated in other parts of the aircraft (such as fuselage manufacturing), then the UK would lag behind in adoption rates.

The AM sector is important in the aerospace market because of the focus placed on whole-life costs (manufacturing, operating and maintenance) in this sector and, in particular, the drive to reduce weight to save on fuel costs over the life of the aircraft. This creates opportunities for the use of AM technologies in the manufacturing process where the volume requirements (a weakness of the AM process is the time it takes to manufacture components) are relatively low but weight-reduction while maintaining strength is highly valued.

Automotive

The dominant region for this industry is Asia which accounted for 52% of global output in 2022 with the USA at 18.5% and Europe just under 21%; within Europe, Germany is the dominant producer with 40% of the regional total (over 8% of the world figure), with the UK, France, Sweden, Czechia, and Italy) at between 6.7% and 5.3% of the regional total.



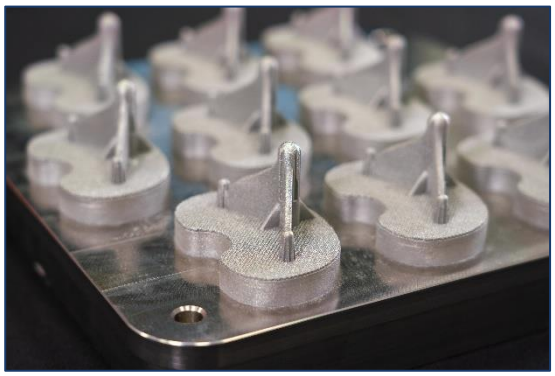
The forecasts for growth for this sector are around +3% across the 2021-27 period and, for this industry, the rates are similar in most countries. Germany and France are slightly ahead of this and the USA a little less but the major exception in the current forecast is the UK where output is predicted to be broadly flat over this period; this is partly a timing issue because 2022 was significantly weaker here but it also reflects technical threats in this industry which affect the UK more than other countries.

Data for the automotive industry is not just the building of vehicles as it includes the production of engines. The unknown factor here is the pace with which the internal combustion engine will be replaced by electricity (or perhaps other fuels) as the power source. The UK makes roughly twice as many IC engines as it does cars, so the move to “e-mobility” is relatively more significant in the output forecast, even though other countries make more IC engines in absolute terms.

However, the automotive industry is high volume - 90 to 95 million units per year for light vehicles - which means it is likely that applications for AM technologies will be in the more specialised aspects of the industry where its advantages can be exploited more easily. The obvious example is motorsport, and this is an area where the UK has a much more

significant share of global activity – the lower volumes and the importance of weight saving play to the advantages of AM technology.

Medical & Metal Products



Here we run into the problem of classifications on which data analysis is based. While there are headings for medical equipment, this really refers to instrumentation of various types rather than the typical applications for AM technologies which lie, for want of a better term in "body parts". On the other hand, confining this type of activity to medical applications may be overly restrictive as there could well be applications in other areas. Within the overall "metal products" category, data for the UK suggests that subcontracting activity in the machining of metals (where a significant proportion of "body parts" manufacturing is likely to be recorded) accounts for 20% of the total output of metal products and that sub-contracting activity in metal forming processes is another 5%.

Global production of metal products is spread relatively evenly, although Asia again leads the way at about 35%, Europe is around 30% and the USA just over 20%; within Europe, the UK ranks 4th behind Germany, Italy, and France. Global growth for metal products is relatively muted and for the period from 2022-27 ranges from +2.5% in Asia, though +1.9% for Europe (UK is at +1.3%) to just +0.4% for the USA.

Machinery

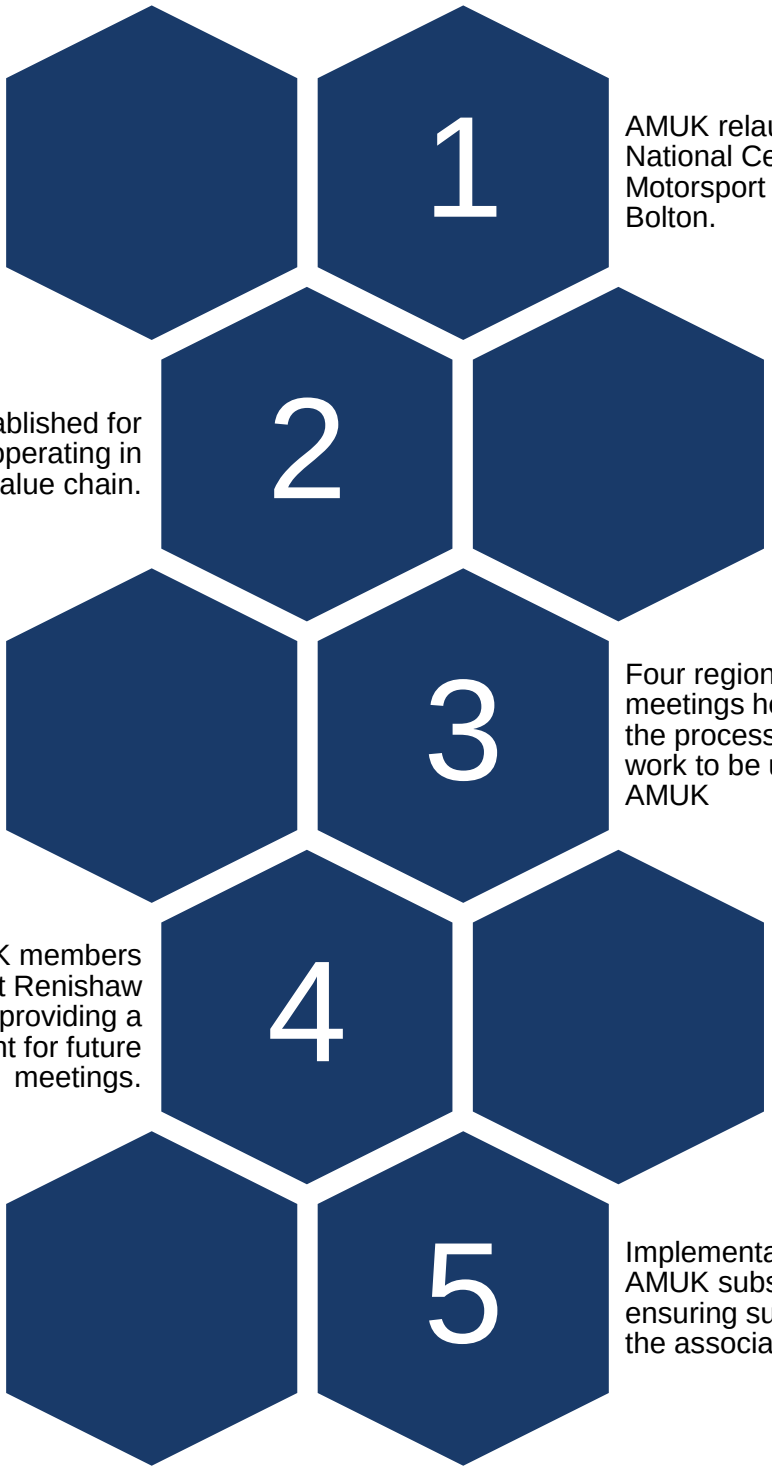
Another possible application for AM technology is in machinery, sometimes called mechanical engineering. The applications are probably more limited and, at least in part, related to other industries, but a brief overview of this end-user group may be of interest to some in the AM spectrum. Asia is the leading producer in this field accounting for over 55% of global output with both China (37%) and Japan (12%) being significant; the USA provides about 13% of global production and Europe (26%) roughly double that, led by Germany (8% of the world total) and Italy (3.5%) with the UK 3rd in the region (just under 2%).

However, some care is needed as this is a wide ranging sector and covers a number of diverse products from pumps & valves with a relatively high potential for AM technology in smaller sized examples through to machine tools and machinery for specific products where the scope for the use of AM is likely to be lower – an example of this is the fact that the Netherlands ranks just behind the UK as the 4th largest producer in Europe but this is driven strongly by having the world's leading manufacturer of machines for producing semi-conductors.

Output growth for 2022-27 is forecast to be +3.3% for Asia, +2.3% for the USA and +2.2% for Europe overall, although the UK is expected to virtually show no growth over this period. Given that this industry is more reliant on individual contracts rather than supply chain relationships typical of the automotive industry, changes in trading conditions resulting from Brexit will probably have more of an impact on the UK for both this and the metal products industry.

AMUK: October 2022 to November 2023

As of October 2022, AMUK has embarked on a journey, with the aim of establishing its position as the primary industry voice for companies comprising the AM technology value chain in the UK. This covers companies operating the areas of materials, design, manufacture, post-processing, and testing & inspection. In the 14 months since relaunching, AMUK has achieved several milestones, marking the initial period of evolution:



AMUK: December 2023 to December 2024

In February 2023, AMUK held a series of regional meetings with members, starting the process to explore the future for AMUK and establish its longer-term objectives. These meetings brought together the AMUK membership to engage in open discussions regarding the challenges slowing the progress of the adoption and use AM technology in the UK, as well as the hurdles preventing companies from expanding their operations.

Members were encouraged to articulate these challenges, offering insights into their specific issues, as well as provide recommendations aimed at addressing them. A detailed compilation of these challenges and the ensuing recommendations can be found in Annex 1.

Following the regional meetings, an in-depth analysis of the members challenges was conducted. This highlighted that certain challenges were reoccurring, which allowed for the creation of thematic challenge groups. The table below lists these groups, along with the total number of members who identified each challenge as a pertinent issue within their company:

Challenge Group:	Number of Member Responses:
Supply Chain – Education, Adoption, Visibility & Qualification	**9**
Skills – Education, Training & Recruitment	**9**
Standards – Roadmap, Testing, Certification, Inspection & Materials	**8**
Government Engagement (incl Funding)	**6**
Technology – Sustainability & Recycling	**2**
IP Protection	**1**
Bid Writing Support	**1**
Technology – Software to Generic	**1**

These results were presented to the AMUK Steering Board. Following discussion with the Steering Board, the decision was made that it would be most practical for AMUK to allocate its resources toward tackling the top three challenges as determined by the membership.

The Board provided the following reasons for not picking any further challenges:

- Government Engagement (incl Funding) – It was deemed that matters concerning Government Engagement could be more effectively addressed through the primary MTA cluster of association, and through leveraging AMUK's affiliation with EAMA[8] – a larger group of associations.
- Technology Sustainability and Recycling & Technology Software to Generic – It was assessed that complexities surrounding technology issues were deemed better suited for the specialised research organisations in the UK such as the catapult centres or universities.
- IP Protection and Bid Writing Support – It was agreed that the membership would be best served by bringing associate members into AMUK who possess and can offer this expertise.

Following the setting of the challenges by the AMUK Steering Board an open invitation to the AMUK membership was made, inviting them to join a working group around one of the challenge areas. The purpose of the working groups would be to determine the actions that AMUK would undertake to help move that challenge forward, and consequently contribute towards AMUKs central aim of driving forward the development, adoption, and use of AM Technology in the UK.

The following sections outline the actions that AMUK will undertake over the next 12 months, as determined by each of the working groups.

[8] https://www.eama.info/

Challenge 1: Supply Chain – Education, Adoption, Visibility and Qualification

The challenge with the UK manufacturing supply chain, with regards to Additive Manufacturing technology is multi-faceted. At one end of the spectrum there are still companies who need educating on what the technology can do for them, and at the other end you have companies looking for pathways into sector supply chains with the capability they can offer. This challenge looks at what AMUK can do to support the supply chain in the following areas:

1. Education of the supply chain on the capability of Additive technologies.
2. Aiding companies in their adoption journey of Additive technologies into their design to manufacturing processes.
3. Making the capabilities and capacity of the UK Manufacturing supply chain with respect to Additive technologies visible.
4. Determining how to qualify the UK Manufacturing supply chain with regards to Additive capabilities.

The following people are part of the AMUK Working Group looking at the supply chain challenge:

NAME	COMPANY
Martin McMahon	M A M Solutions
Ben Chadwick	Bowman Additive
Kartik Rao	Additive Industries
Olivier Diegerick	Siemens
James Reeves	Enable Manufacturing
Simon Chandler	CREAT3D
Rhodri Evans	Primetals Technologies
Nigel Robinson	Digital Manufacturing Centre
Mikael Olsson Robbie	Phoenix Scientific Industries
Anthony O'Riordan	Kazien PLM
Ruaridh Mitchinson	MTC

There was a meeting held on the 30th November 2023 at Additive Industries, Bristol with members of the supply chain working group. A full list of the ideas and actions suggested by the working group to support the additive supply chain is available in Annex 2. The table below lists the agreed actions that AMUK will aim to deliver over the next 12 months to help move forward the supply chain challenge.

TITLE	DESCRIPTION
Comprehensive Case Study Database	On the AMUK website the case study database will be be further populated and look to provide a full range of AM examples across a range of processes, sectors, and materials.
Greater Membership exposure and engagement via existing social platforms (i.e. LinkedIn)	Explore the possibilities with using existing social networks to promote the AMUK membership, as well as platform for member communication. In the first instance LinkedIn should be looked at due to volume of members already engaging with the network.
Creation of an Adoption Guide	Identify the current tools and guides already publicly available which help companies adopt AM technology. Form them into a single process and fill any gaps identified to create a comprehensive AM adoption guide. This guide should then be part of the AMUK website for any company to engage with.
Get Into AM Event/Mastering AM	AMUK to organise an annual event where both beginners and experts can attend and knowledge share and improve their knowledge on AM technology.
Funding Guide	AMUK to create a guide to what funding routes are available for UK companies along with a guide on what companies need to do to apply. This should be an AMUK member benefit.

Challenge 2: Skills – Education, Training and Recruitment

Having the right skills in place is essential to the growth of Additive technology in the UK. Without the skills, companies will be unable to adopt and take advantage of Additive Manufacturing in their own design to manufacturing processes. This challenge will look at what AMUK can do to aid in the creation of a talent pathway for individuals to come into the Additive technology sector in the UK.

The following people are part of the AMUK Working Group looking at the skills challenge:

NAME	COMPANY
Jono Munday	APEX
Bradley Hughes	GKN Aerospace
Joe Winston	Measurement Solutions Ltd
Gwilym Rowbottom	Reliance Precision
Robert Higham	Additive Manufacturing Solutions
Mark Dickin	Ricoh 3D
Rhodri Evans	Primetals Technologies
Anthony O'Riordan	Kaizen PLM
Tom Wasley	MTC

There was a meeting held on the 29th November 2023 at Ricoh 3D, Telford with members of the skills working group. A full list of the ideas and actions suggested by the working group to support skills in additive is available in Annex 3. The table below lists the agreed actions that AMUK will aim to deliver over the next 12 months to help move forward the skills challenge.

TITLE	DESCRIPTION
AM training course review.	Working with AM companies (users and technology providers) understand the skills requirements that are out there and consequently create an AM curriculum. Map this against currently available training and identify any gaps that need filling. This should be a precursor to a form of AM certification.
AM Open Days	AMUK will look to organise a series of regional open days with members with the purpose of promoting the technology to Non-AM companies.
AM Competition	Working with AM companies look to scope out a competition which is aimed at apprentices, student and graduates which aims to get expose them to AM technology and has them solving a real industrial issue.

Challenge 3: Standards – Roadmap, Testing, Certification, Inspection & Materials

Additive Manufacturing has created a whole new way of manufacturing parts and components. There are many standards out there for companies to use when using AM technology, however the standards landscape for Additive is complex – especially for companies who are entering AM for the first time. Furthermore, the Materials data to make parts and components through Additive is not easily accessible for all companies. This challenge will look at what AMUK can do to aid companies in understanding the available standards for them to adopt and use when manufacturing parts and components and look at ways of creating a centralised Materials database that AMUK members can take advantage of.

The following people are part of the AMUK Working Group looking at the standards challenge:

NAME	COMPANY
Matt Parkes	Renishaw
Charan Prakash	Bowman Additive
Rob Poyner	Siemens
Nigel Robinson	Digital Manufacturing Centre
Ian Marsh	Digital Manufacturing Centre
Anna Terry	AWE
David Macknelly	AWE
Ruaridh Mitchinson	MTC

There was a meeting held on the 28th November 2023 at Bowman 3D, Abingdon with members of the standards working group. A full list of the ideas and actions suggested by the working group to support standards in additive is available in Annex 4. The table below lists the agreed actions that AMUK will aim to deliver over the next 12 months to help move forward the standards challenge.

TITLE	DESCRIPTION
Sector Standards Database	Engaging with the regulators for different sectors, AMUK will document the standards the regulators are expecting companies to follow with regards to AM parts. This list of standards should be accompanied by regulator guidelines on what they are looking for to meet those standards.
Peer Review of Materials Databases	AMUK to produce a guide on the currently available materials databases for AM. Peer review each of the databases and identify where there are gaps.
AM Standards Event	AMUK will host an AM standards event – this could potentially be part of another event. This should look to include speakers from LRQA, a Regulator, BSI and opportunities to share best practice between members.

Annexes

Annex 1: Regional Meeting Responses

#	Challenge Title	Description	Recommendations
1	Recycling Centre for Materials	No centre to recycle/reuse material. There are schemes in the US and mainland Europe. UK currently goes to incineration or landfill.	Collate all users/ pink xx using powder, for example PA12 nylon. Advise how materials can be stored, collected and recycled.
2	Materials and Methods	So many manufacturing methods. Don't always uses methods that have work in the past	Material comparisons against injection moulded material.
3	Design	Products in Polymer designed for Injection. Restricts manufacturing design.	Training existing designers Training with India and Conxxx USA Casxx Short/mid-term
4	Sustainability/Supply Chain	Lack of visibility as part of supply chain solutions/ sustainability. 3 Fold – Not being used anywhere to cxx as supply chain solution Not recognised by supply chain solutions No one organisation looking at recycling of waste and materials.	Look at/set up a roadmap for Polymer waste recycling. Set no?
5	Dedicated Software for Prices?	Industry software is too broad and as a result too costly, i.e. Materidise Mags = £10K+ we only use half the functionality.	
6	Government rush to grow the UK AM industry	UK AM market lags behind the USA, Germany, France etc.	Government initiative similar to Biden government. AM Forward scheme whereby large US companies (particularly those who receive US govmt. Money) pledge to purchase 3D printed parts from small to mid-size US AM manufacturers.
7	Government Engagement	Some other trade bodies have huge influence in government and attract their own funding to support industry (look at Niche Vehicle Network and Advanced Propulsion Centre)	Long term – 10 years. Look to be the holder of grant funds for distribution into the AM sector. It will take several years of lobbying but could be hugely beneficial to the industry. Aim for funds like the Automotive Transformation Fund. The AM sector requires significant capital investment which is typically the hardest to find finance for. A Transformation fund can help to change that.
8	Funding	Lack of AM-focused CRCSD funding in the UK. Preventing industry (particularly SME) to exploit AM - New materials - New applications	Lobby UK Gov/ UK NI to address this lack.
9	Cross funding (sustainability and AM Automation)	-	-
10	Funding (Government) around R&D	Fraunhofer Germany examples (not strictly AM focused). 76 sites €2B funded/year! Expand Catapult centres	
11	Key Industries are shrinking in the UK	Industries like Oil and Gas, Steel, Automotive etc would be good fundamental growth market for industrial high margin AM, if they are shrinking then AM has less market for growth.	Contact trade bodies from other key industries and help lobby on their behalf via MTA or by itself. Generally for manufacturing to grow UK has to ensure fundamentals for it: dead-cheap electricity and access to cheap resources, AMUK would also keep lobbying for it via MTA.
12	Map of AM Industry	State of UK AM industry. Difficult to identify who is doing what. Connecting potential users to suppliers.	A database for industry (2-5 years)
13	End User Hand Holding	Ensuring new potential customer (machines, material or parts) find the best supplier(s) and or technologies for their needs. We are losing opportunities when new users use the wrong technology /provider and it goes wrong.	Mid-Term – 5 years. Marketing Training & Education Sign-posting Opportunity diagnostics AMUK needs to be the place that new customers turn to first to find out what

#	Challenge Title	Description	Recommendations
			technology/service is the right one for them.
14	Companies Relocating to Europe	Manufacturing moving out of UK to Europe due to Brexit/cheaper labour etc.	Suggest incentives for manufacturers to move back into UK, for example; - Better access to key markets (USA/Japan) - Tax incentives - Less political risk - Help fxx manufacturing sites - Access to resources - Cheap electricity - Access and collaboration with British universities.
15	Industrial Digitisation	Definitely need to link up with industrial digitalisation groups and programmes.	SIC Codes and a recognised sector/industry "Additive Manufacturing"
16	Recruitment	Difficult to recruit, especially applications. Slows down our growth in developing new materials and applications. Having to look outside of the UK.	More links to education institutes, right down to high schools. Industry specific qualifications?
17	Hiring location	-	Matching skills
18	General/ Skills & Education	You need SME's to adopt the tech by working with UK suppliers. Awareness is not there.	Focus awareness campaign on SME manufacturers – address the reasons not to adopt up-front. Accessible Easy to learn UK experts to help you Government funding – 3D printers, training, re-training.
19	Getting the Government Involved/Education	How do we get AM into the school curriculum! Who do we talk to? Keeping the industry from growing and stopping the correct skills for the future workforces.	EDUCATION EDUCATION EDUCATION
20	Specific Academic Qualifications at Universities	AM is a bolt on for many engineering courses, needs to be a standalone course. Not enough understanding of design for AM or design for applications.	Work with Uni's of academic institutes to establish qualifications.
21	Skills & Education	No curriculum for AM. Lack of trained students coming through to employment. Employment/skilled workers gap.	- Easy picking: amend D&T GCSE qualification to specifically include AM. (5 Years) - Develop an AM Curriculum – attracts girls into STEM, include post 16 course at colleges/FE/HE (5-10 Years). - Gather intel on current curriculum/training, e.g. Lulzbot, 3DGBIRE – World Schools, NCAM – AM course, others… (2 Years).
22	Skills and Knowledge to adopt AM	There currently isn't enough knowledge and skills tin industry for successful adoption of AM. Therefore industry is reluctant to adopt AM or train 1 individual so don't support growth.	- Roadmap for AM adoption of skills - Make clear what skills and knowledge and tech/team are required for successful AM adoption in an organisation. - Training on to skills – 3DGBUK offer this. - Certified recognised endorsed courses/training.
23	Slow rate of adoption of AM/manufacturing methods incompatible/uneconomic for AM	Education skills problem. Engineers are set in their usual way of manufacturing, not "sticking their neck" out to trial new ways, possibly not knowing about AM or not thinking it can be economic/make economic sense, while in other countries same level of manufacturing is applied via AM.	Some sort of education of young generation of engineers/business managers of AM, enabling the use of AM in educational institutions early on. I think this is a long-term solution but it will make a huge impact once the new generation comes.
24	Adoption	Narrow approach to cost analysis – no adoption.	Business case = Print costs – understand re-usability – design for AM – Future state production (2 years).

#	Challenge Title	Description	Recommendations
25	Adoption of 3D technology	Difficult to get manufacturing companies onboard with AM, use traditional manufacturing methods. Industry remains stagnant which impacts innovation within specific industries.	Implement success stories/use cases within AMUK to show how adoption can improve companies etc. More awareness of how AM applications can benefit customers. Short to mid-term priority.
26	Lack of awareness of 3D Printing at lower-level education	Current 3Dp education all appears to be only from Uni level onwards. Impact means a smaller workforce as lots of people are either less educated or don't know AM is an option when Job/education searching. Lots of 3D designs are poorly optimised for 3D printing.	3Dp needs to be integrated in lower level educations. Lots of establishments cant afford the "professional" printers without realising cheaper alternatives exist. There is also very little reason for schools to use 3D printers with their current education plans.
27	Technical Innovation, Developing new Technologies	I think UK academic IP could be better exploited and utilised to help existing or new AM companies to introduce and develop new solutions. UK has very good IP potential within its universities and that could be used better.	Add British IP related to AM that is ready for licensing or development at value chain website. This would be both short and long term solution. UK also have good grant funding opportunities for development of technologies (Innovate UK) so this would have good combined effect.
28	Digital Modelling	Digital modelling of existing data and physical verification – needs parallel studies to drive innovation and optimisation of processes.	Upskilling and collaborative forums with primes to leverage lessons learnt.
29	Design for AM/Change of Design for AM	The expectation of management that AM can be used as a direct replacement to conventional manufacturing. Lack of AM adoption as it can't directly replace conventional manufacturing. Furthermore, people can't decide for AM so the technology can't be up taken.	Update Training modules from universities and teach people the process. Showcase the potential of parts and industries benefits. Short term: training of design engineer. Mid term: change to university education to get AM a full module in university Long term: Apprenticeship for additive manufacturing.
30	Bid Writing (Skill)	Specialised skill set. Difficult to develop in house for an SME and expensive to engage an expert.	Part-funded bid-writer supported by AMUK.
31	Standards	Understanding what Standards apply to AM and what can be introduced. Adhoc production parts	Draw up a list of relevant Standards – Qualification £/p 2- 5 years
32	Inspection, Test, Standards	Pt 3 – develop and maintain an accessible AM material properties and standards database for current and emerging additive manufacturing technologies.	Use current existing materials centres to collate info and feed into centralised database. (2 Years). Could use collected data for FEA analysis.
33	Testing and Valuation	No defined regulations or testing. Expensive to offer and deliver consistent value or performance.	Standard testing procedures /practices to cover all grades and guidelines for custom grades.
34	Test Data	Not enough test data to go with materials. Material is being compared to injection moulded of extraction grade of materials.	Tighter standards/regulations for material data of testing.
35	Standards/Accreditation	In particular Auto/Repo	Standards/Accreditation for parts not just materials
36	Standards	Industry Standards for power and printing. Slows the implementation of stress loaded parts in Aerospace industry.	International standards bodies to work together to write Global Standards. Short to mid-term 2-5 years.
37	Standards Landscape Confusing	Which standard body to follow – seems to be no single source of truth.	Map of standards – what standards to adopt for which processes. Which standards to adopt for which sectors.

Annex 2: Supply Chain Working Group

#	ACTION RECOMMENDATION
1	Make membership of AMUK a funded contribution based on their activity input (America Makes model more you do less you pay)
2	Hero case studies of companies doing production by AM – not just 1 off products but serial production. Consider different industries and sectors.
3	Case Studies & success stories
4	Describing journeys of adoption for AM
5	Create open-source database for all funded projects from AMUK/Catapult Centres to UK Members
6	Create Buyers Guide/Buying Criteria – establish company goals, risk appetite, investment level, metal/polymer, buy a printer/use a bureau.
7	How to help customers moderate and be comfortable with risk?
8	Service bureaus visibility in the UK – how many different ones are there? Where is the central 'go to' hub to get the right contacts and find the right supplier?
9	Engage Government – get more support and engagement
10	Agreement with MoD for AM content that is 'Made in UK' – reduce the risk for manufacturers – more engagement with MoD
11	Financing – AMUK relationships with asset finance to benefit members
12	Channel all ATI and Innovate UK funding via AMUK – to non-OEM's only
13	Material/application development grants for academia/catapult centre with OEM's (design/application owner)
14	Public relations/comms messaging in UK – create marketing campaign
15	LinkedIn – Members are group owners – post case studies, host webinars, advertise open days & events – greater collaboration between website and LinkedIn
16	Events – UK Roadshow, beginner scale, advanced up – Talks, Success Stories, Halo projects, also SME's solving day to day challenges – engagement with TCT
17	Create Supplier Down Selection Tool – web based, value chain, material – process, supplies
18	Annual 'Hackathon Events' to highlight real world industry challenges and challenge the teams taking part to find the solutions through Additive. This could be scaled across different industries/AM technologies etc.
19	Adoption/Educate – create guide SME Manufacturers on technology, linked in
20	Adoption – Innovate UK funding, AMUK to promote available funding, put together consortiums – funding guide
21	Viability – non hero xx case studies – case studies of basic components.
22	Visibility – Promotion of/intro to AM technologies and case studies in one place-brochure/video/website – promote AMUK website – make central hub.
23	Visibility/Education – webinars of/from suppliers. Use LinkedIn more as a forum.
24	Educate – use catapult centres, open days, technology access for non-members.
25	How many people are exploring the art of the possible with regards to designing to fully take advantage of AM. If businesses aren't doing this, then why?
26	Increase of AM Education to academic groups (i.e. universities) on AM technologies and designing for AM.

Annex 3: Skills Working Group

#	ACTION RECOMMENDATION
1	Create Sustainability Advantages report on Life cycle cost analysis and Life cycle analysis
2	Create benefit study of what is going on through the life of an AM component.
3	Awareness of Additive Manufacturing – Create comprehensive case study library etc.
4	Greater clarity with comms/marketing specialists for key messaging and USP's (currently still very engineering heavy).
5	AM is engineer driven – need to appeal to others who can influence
6	How do we attract non-AM engineers into AM related roles- manufacturing, design, project lead
7	Make Engineering cool (Gen Z) – not just a AM problem
8	Make AM accessible – engagement with school age – GCSE or even younger
9	STEM engagement – STEM charities engagement?
10	Engage with existing STEM Charities (e.g. Industrial cadets)
11	Can AM break into the STEM in schools dialogue syllabus? – engage schools from primary upwards.
12	Internships in companies – link students with company's – create the platform
13	Collaborate with specialists – get into schools?
14	Research to highlight skills that are transferable into AM
15	Wider skills gap analysis from uni leavers – what topics, are they balanced, do they cover the right topics?
16	Coordination of Uni course content. Do all courses cover AM? Is it consistent? Share best practice and industrial involvement.
17	DfAM is about the integration rather than design rules
18	Design contest (students?) – redesign an existing part – add features – why? Justify.
19	AM Competitions – for apprentices, for young engineers, for old engineers?
20	UK Apprenticeship competition? Best application in manufacturing?
21	Assistance to develop internal training and make it certifiable
22	Back to basics learning and terminology for all (AMUK hub/module)
23	Holistic manufacturing Course
24	Training course @AM for non-AM Engineers' – MTC/HVMC led?
25	Tailored workshops to see added value = Personalised
26	Tailored to individual requirements – real life case study
27	Certified training courses (preferably short)
28	AM Fundamentals course – ½ days – Practical and theory course
29	In-situ training – develop applications with customer appeal to talent – what do they value? What does it mean to them?
30	CPD points training
31	Informative resources on what AM is not i.e. it won't replace machine parts
32	One Manufacturing Show - simplify the industry – make it clearer somehow. Or split it up? Industrial?

Annex 4: Standards Working Group

#	ACTION RECOMMENDATION
1	Work with MOD and Team Defence - Need standards – understand their standard requirements.
2	Work with government DBT and UKRI
3	Look at the America Make Strategy for the UK
4	Make Standards modular + interactive + regulators Flow chart/wizard
5	Matching system of standards to an application
6	Chat GPT for Standards
7	Contact NPL to develop testing methods
8	AM Data Consortium (SAE) - members pay for submitting parts – member collaboration coordination
9	Develop a Guide for what material data is needed for FEA (link to NPL)
10	Challenge/validate manufacturer data sheets (NPL? Other companies)
11	Standard materials property – To be able to recommend with confidence the right materials
12	Certificate of Conformity, First Article inspection, working document on ASTM
13	Testing Database of Materials – Member data
14	Partner companies (cross-sector?) for lessons learnt approaches – share best practice between members
15	Lobby for joint working across standards bodies e.g F42180261
16	Networking for UK AM professionals – standards on agenda
17	Standards Engagement Guide/ Chaperone for BSI/ASTM/SAE etc
18	Single sector practical guidance on regulatory submission re: standards co/regulatory authority e.g. CAA, (FAA/EASA), MARA, UKAEA etc
19	Polymers vs. metals – what standards are applicable for each material – create guide.
20	Operator training – standard training and certification.
21	Data pack for final part – possibly levels – what standards need to follow for each application.
22	Post processing standard guide.
23	Supply Chain Management standard guide
24	Look at LRQA's polymer + metal and ANSI database – peer review
25	AM Qualification guide, references all standards as of 2022
26	Feedstock standards – listed on website for members?
27	Realistic material property database – capturing feedstock, process parameters and test conditions – peer review of databases for members.
28	Accredited test Houses in the UK – list on AMUK website?
29	More accessible visible standards for AM – free for members? Can we have selection on website?
30	Agreed Data Format – needs to be standardised
31	Tolerances – needs to be standardised.


mtc

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Image Sources: WAAM3D | MTC | MTA | Renishaw