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Additive Manufacturing MES Software: The Essential Guide

How You Can Use Additive MES to Scale Your Additive Manufacturing Operations

February 2020 Whitepaper

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Executive Summary

Like many companies, your organisation has decided to invest in the potential of additive manufacturing (AM). However, now you're also faced with a key challenge: how can you manage your additive manufacturing operations in a way that maximises productivity and secures a return on your investment?

The vast majority of manufacturers must tackle these questions and more when adopting additive manufacturing for production.

Fortunately, however, there is a solution: Additive Manufacturing Execution Systems.

Also referred to as Additive MES or AMES, this category of specialist software enables manufacturers to successfully manage their AM workflows, scale up their operations and, ultimately, harness the full potential of the technology.

This whitepaper is designed to guide you in the process of researching and selecting the right Additive MES software for your needs. It will explore the role of Additive MES as part of your wider AM strategy and how you can leverage its capabilities to optimise your operations — and thereby support your efforts to drive innovation with AM.

We hope you find it an informative guide.

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Additive Manufacturing: Moving Towards Production

Additive manufacturing has made huge strides towards industrialisation in recent years.

A recent report by EY shows that 46% of companies expect to use additive manufacturing for end-use parts and serial production by 2022 [1]. To understand why, we must look at the important factors transforming today's manufacturing landscape.

In the era of Industry 4.0, additive manufacturing is helping to solve key business challenges for manufacturers. With customers demanding greater personalisation and product innovation, AM is enabling greater product complexity, mass customisation and economic low-volume production.

As a result, manufacturers are adopting AM in a bid to respond to increasingly complex consumer demands, drive innovation and maintain their competitive edge.

As AM continues to industrialise, companies will need to have the right processes in place to support this shift.

However, the majority of manufacturers face significant challenges when it comes to adopting AM for production. One of the biggest barriers is the lack of an end-to-end platform that can connect all data, processes and operations. Issues around traceability, standardisation and connectivity also pose real obstacles to establishing a scalable operation for high-volume production.

Additionally, operational processes are becoming increasingly complex to manage. For example, global manufacturers will typically have multiple production sites, each of which may have different equipment and processes. It is also not uncommon for these sites to have different enterprise software that are not fully integrated with the overall business or other shop floor systems.

Taking these factors into account, current approaches to managing the AM workflow are severely limited. Conventional MES software, developed for traditional manufacturing processes, lacks the capabilities to adequately manage the specificities of the additive manufacturing process. Similarly, traditional ERP and PLM systems are also not sufficient for the requirements of AM.

Additive MES software plays a critical role in addressing these challenges by enabling manufacturers to leverage data to achieve greater visibility, facilitate better decision-making and establish best practice processes across the entire enterprise.

The purpose of this whitepaper:

This whitepaper has been written as a guide to help you as you embark on your search for an Additive MES provider. We will explore:

- What an Additive Manufacturing Execution System is,
- The benefits of Additive MES and the core functionality to look out for,
- How to choose the right Additive MES solution for your needs.

If you'd like to talk to us in more depth about how you can begin to use Additive MES solutions to scale up your operations, you can contact the AMFG team at **info@amfg.ai.**

[1] '3D printing: hype or game changer?: A Global EY Report 2019', EY.

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A recent report by EY shows that 46% of companies expect to use additive manufacturing for end-use parts and serial production by 2022.

1. What is an Additive Manufacturing Execution System?

Fundamentally, an Additive Manufacturing Execution System supports the **management, monitoring and automation of all real-time processes related to AM production.** This encompasses all of the stages of the production workflow, such as ordering, scheduling and quality assurance management.

A robust Additive MES solution has the ability to track and document all AM production data in real time. This could, for example, include production costs, material usage and order turnaround time, to enable greater process control, facilitate better decision-making and maximise efficiency.

As manufacturers look for ways to optimise their AM processes, Additive MES plays a strategic role in enabling manufacturers to control and manage their AM production.

When integrated with other enterprise systems, Additive MES also provides the flexibility needed to adapt to an ever-changing manufacturing landscape and meet business objectives.

While any company looking to adopt AM for production applications can benefit from considering Additive MES at an early stage, the following industries can particularly benefit from the software:

- Automotive
- Aerospace & Defence
- Consumer Goods
- Industrial Goods
- Medical

The rise of MES for additive manufacturing

Manufacturing Execution Systems have long been a staple of traditional manufacturing processes.

Global research firm, Gartner, defines traditional MES as software that "manage[s], monitor[s] and synchronize[s] the execution of real-time, physical processes involved in transforming raw materials into intermediate and/or finished goods.[2]"

However, additive manufacturing, although a manufacturing technology in its own right, requires a radically new approach, both to design and to the required management processes. As a result, traditional MES software is highly limited in its ability to manage the unique requirements of AM. This has led to the rise of specialist MES systems developed specifically for additive manufacturing

Broadly speaking, Additive MES aims to address four key challenges:

Value creation

Deriving value from your investment in 3D printing is a key priority for manufacturers. When it comes to adopting the technology for production, value can be achieved in two key ways: by a) reducing costs and b) increasing productivity.

[2] 'Gartner Glossary: Manufacturing Execution System', https://www.gartner.com/en/information-technology/glossary/mes-manufacturing-execution-system, Gartner

Without Additive MES software, measuring the success of both of these objectives becomes arduous. Spreadsheets, paper or disparate software platforms are inadequate for the task of tracking and measuring ROI.

Additive MES enables manufacturers to reduce manufacturing costs by identifying ways to optimise processes and make productivity gains. Automation, coupled with real-time performance tracking, provides the data and real-time analytics needed to be able to make immediate adjustments where necessary, and therefore reduce labour costs.

Additionally, AMES ensures that company objectives and expectations for lead times are met. Advanced platforms are able to support increases in production volumes, thereby helping an organisation meet its growth objectives and KPIs.

Standardisation

Standardising manufacturing and operational processes is vital for success.

A lack of standardisation leads to inefficiencies across the workflow. For example, without a standardised way for internal teams to receive orders from other areas of the business, the ordering process becomes incredibly time-consuming, with endless emails typically becoming the norm.

For manufacturers operating from multiple sites and in multiple locations, standardised processes offer economies of scale and significant cost-savings. However, successfully standardising AM processes on a global scale is often easier said than done.

Additive MES software addresses this by providing a centralised way to manage operations across multiple sites. It establishes a standardised management process that can be deployed multinationally. Taking the example above, a standardised interface for ordering optimises the order management process and facilitates better communication between stakeholders.

Connectivity

Most companies' experience of their AM process is of one that is highly disconnected, due to the use of separate, disparate systems that are used to manage the entirety of the workflow.
Connectivity, sometimes referred to as the 'digital thread', refers to the concept of establishing a workflow that consists of integrated hardware and software systems that can communicate with each other for maximum efficiency.

Increasing efforts are being put into establishing connectivity for additive manufacturing, on both the hardware and software side.

Additive MES plays a critical role here, first by enabling integration with existing business-critical software, such as ERP and PLM systems. Increasingly, MES vendors are also seeking to integrate directly with AM machines and other physical systems, which will enable manufactures to gain more in-depth insights into the overall performance of their operations and improve the decision-making process.

Traceability

The lack of traceability across the additive manufacturing process is a key barrier to being able to scale operations.

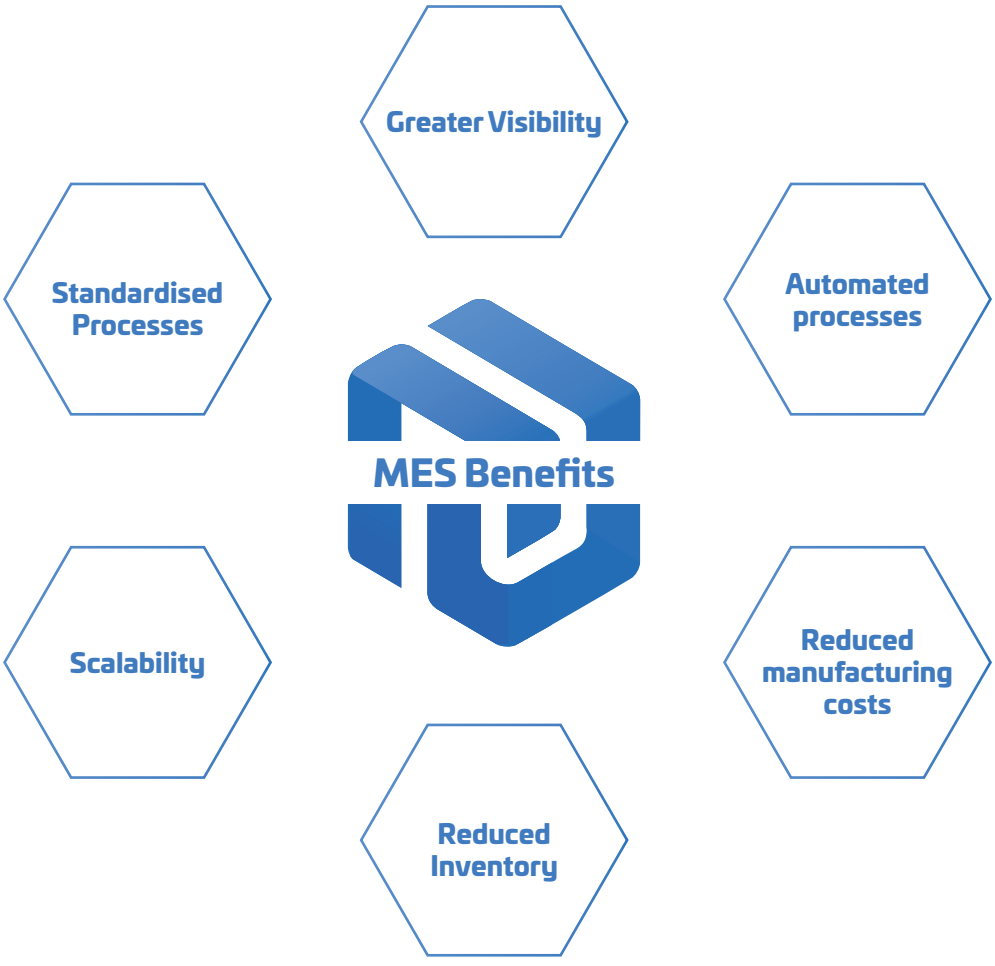
For manufacturers, traceability is vital for identifying key bottlenecks and optimising operations. For example, if a part fails, it is important to be able to accurately pinpoint the root cause of the failure before the problem becomes critical. A lack of visibility becomes even more of an issue when operating across multiple sites. In this case, having a clear overview of each site's operations becomes critical to maximising efficiency and productivity.

Additive MES addresses these issues by tracking and documenting data throughout the production workflow, enabling stakeholders to access key information at any stage of the process. It also enables teams to track the status of jobs in real time, which in turn allows for the optimisation of production planning and, ultimately, greater productivity.

2. What are the Benefits of Additive MES?

Today, manufacturers must manage, automate and execute operations across their supply chains. This requires highly integrated, end-to-end management processes that can accommodate real-time demands, regardless of where facilities and operations are located.

Additive MES enables manufacturers to optimise their management and operational processes, and provides the essential foundation to scaling up operations.



6 key benefits of Additive MES Software

1. GREATER VISIBILITY

Additive MES software provides a centralised platform with which stakeholders can gain complete visibility into the organisation's AM operations. It offers a 'single version of truth' that facilitates collaboration between stakeholders, regardless of function, to optimise operations and reduce costs. By eliminating silos of data, stakeholders are better equipped to make informed, data-driven decisions.

An additional advantage is access to historical production data and statistics, which are tracked by the software. Through KPI tracking, reporting and analytics, companies are able to take a deeper dive into the key factors that are driving productivity.

2. AUTOMATED PROCESSES

Manual processes are time-consuming and prone to human error. As manufacturers gear up to use AM for production, tools like spreadsheets, paper and back-and-forth email will no longer be adequate to deal with an increase in production volumes and demands.

Additive MES software replaces these fragmented systems to connect the shop floor to the rest of the organisation, and ensure a digital thread across the AM workflow. Key stages of the workflow that are often done manually, such as order management and production scheduling, can be automated to save time and reduce the chance of human error.

3. REDUCE MANUFACTURING COSTS

Manufacturing costs can be reduced by using Additive MES to streamline and optimise operations. It can be used to monitor job status automatically, freeing up labour costs and enabling operators to prioritise other tasks. Another example is using Additive MES to track material consumption and thereby reduce wastage.

4. REDUCE INVENTORY COSTS

Additive manufacturing has made the prospect of digital inventories a reality. The ability to produce parts from digital files opens up new opportunities for distributed manufacturing. This is particularly exciting for the production of spare parts, where typically lower-demand parts can be produced on demand, more economically.

However, for this to be effective, manufacturers need detailed and accurate inventory data that can be made available to the right user at the right time. An Additive MES platform with digital inventory capabilities is essential to helping manufacturers manage their spare part production more effectively and ultimately reduce inventory costs.

5. SCALABILITY

As an organisation's AM strategy and operations evolve, scalable Additive MES solutions are flexible enough to adapt and respond to the needs of the business. Therefore, the right Additive MES provides a scalable platform upon which an organisation can expand its AM operations.

6. ESTABLISH STANDARDISED PROCESSES

As we've seen, Additive MES software is the foundation for establishing a standardised additive manufacturing process. A robust Additive MES platform can be easily rolled out across the organisation, establishing a set of procedures and best practice processes to ensure operational efficiency and continuous improvement.

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3. Essential Features of Additive MES

As you begin to research ways to better manage your additive manufacturing operations, it is useful to understand the core functionalities of Additive MES.

The table below, although far from exhaustive, provides a practical guide as to what you should expect from an Additive MES solution.

OPERATIONAL AREA	PURPOSE	BENEFIT	EXAMPLE FUNCTIONALITY
Ordering	Standardise the task of processing orders between departments, business units and/or external suppliers.	Establishes an automated ordering process and simplifies communication between the AM department and other business units and/or external suppliers.	> Standard interface for order entry, including recommendations for technology, material and post-processing selection. > 3D printability analysis to avoid misprints. > Lead time estimates. > Access to real-time status updates.
Job Costing	Provide accurate costs for specific jobs based on specified parameters, e.g. build time estimates and historical data.	Able to keep track of production costs for reporting purposes, and removes the need to price manually.	> Accurate pricing capabilities. > Integration with ERP and/or accounting software for financial reporting.
Production Planning & Scheduling	Management of the production process, including build preparation, scheduling, machine usage and work order creation.	Enables complete traceability, down to single process steps. Ability for shop floor operators to optimise machine utilisation and respond quickly to real-time developments such as scheduling changes.	> Dynamic scheduling (& rescheduling) of work orders based on real-time machine availability or part prioritisation. > Clear production overview and scheduling visualisation.

Post-processing & Quality Management (QMS)	Management of all post-production steps, including part identification, post-processing tasks and quality control documentation.	Easily track part history, e.g. ratio of failed to successful parts, and ensure parts meet required standards.	> Ability to establish sequence of post-processing operations. > Configure and review inspection requirements and conduct QA checks. > Advanced AMES software allows data to be collected and modelled so that the system learns what parameters lead to the best results - a form of machine learning-based recommendations.
Logistics	Ensure the successful delivery of parts to the internal customers and/ or external suppliers.	Simplifies complex logistical processes and ensures visibility.	> Tracking number/ID for parts. > Automated status notifications and updates.
Supply Chain Management	Manage the relationship between an OEM and its existing suppliers and subcontractors.	Greater efficiency by automating more of the process, and ensures traceability throughout the supply chain.	> Ability for OEM to compare offerings between preferred suppliers > Ability to automatically or manually route specific jobs to selected supplier(s).
Digital Inventory	Create and manage a digital inventory for spare parts and other applications.	Significant cost savings in having a digital inventory for lower-demand parts as opposed to maintaining physical warehouses. Makes on-demand production economically viable, as inventory can be shared across the company to authorised personnel.	> Digital catalogue for qualified parts to be saved for repeat, on-demand AM production. > File revisions and updates, version control.
Analytics & KPI Tracking	Track all production and machine data throughout the production process.	Helps to identify bottlenecks and optimise processes to improve efficiency. Data can be used to identify opportunities to implement agile manufacturing processes and establish operational excellence.	> Dashboard capability to track and document KPIs related to Overall Equipment Efficiency (OEE), such as machine usage, production output and time to repair. > Can include material tracking to control machine material consumption, provide analysis about material inventory and ensure a sufficient level of material stock for production.

Integrating Additive MES with other enterprise software

Today, the vast majority of manufacturers use a range of different software to ensure the successful running of their operations. For this reason, integration between business-critical systems are vital to ensuring the seamless flow of data between different areas of an organisation.

Additive MES software that can be successfully integrated into an organisation's existing IT infrastructure provides an unprecedented level of visibility, synchronisation across and control over the entire additive manufacturing process.

What is the difference between Additive MES, ERP and PLM software?

There is often confusion about the difference between Additive MES, ERP and PLM software.

The important thing to remember is that each system has a distinct purpose. However, when successfully integrated, they provide a powerful foundation for scalable additive manufacturing.

The table below illustrates the relationship between Additive MES and ERP and PLM software.

SOFTWARE	PURPOSE	EXAMPLE FUNCTIONALITY
Product Lifecycle Management (PLM)	Manages a product's development and lifecycle.	> Bill of Materials (BOM) Management > Computer-aided design (CAD) Management > Computer-aided engineering (CAE) > Computer-aided manufacturing (CAM) > Manufacturing Process Management (MPM) > Product Data Management (PDM) > Product Compliance
Enterprise Resource Planning (ERP)	Manages key areas of the entire enterprise, e.g. HR, supply chain, logistics.	> Order Processing & Entry > Inventory Management > Human Resources Management System > Financial Management & Accounting > Purchasing > Sales & CRM
Additive Manufacturing Execution System (AMES)	Specifically manages and tracks the execution of additive manufacturing operations.	> Order Management > Cost Analysis > Production Planning & Scheduling > Build Preparation > Digital Inventory Management > Post-processing Management > Quality Management System (QMS) > Supply Chain Management > Machine Connectivity > Reporting & Analytics

Additive MES and Machine Connectivity

One of the biggest barriers to establishing a fully connected additive manufacturing workflow has been the lack of machine connectivity.

Machine connectivity facilitates the seamless transfer of data between the hardware and MES platform, ensuring that machine and production data can be leveraged to enable better decision-making and process optimisation.

However, despite the huge benefits of machine connectivity, integration with Additive MES platforms has traditionally been a bottleneck due to closed systems and other technical hurdles.

Fortunately, however, progress is being made in this area. As companies continue to invest in a diverse range of industrial 3D printers, hardware manufacturers are increasingly recognising the value of ensuring their systems are open to integrating with Additive MES software.

For this reason, a robust MES software should offer some ability to integrate with machines. Currently, the industry protocol, OPC-UA is one of the most common ways to establish machine connectivity, as it allows for the fast transfer of large quantities of data. Alternatively, an MES vendor may offer plugin play solutions through open API's. This is particularly common for manufacturers with a fleet of desktop machines, for example.

With companies wanting an open ecosystem to facilitate their operations, machine connectivity is just the first step on the journey towards creating a connected AM factory. In the years ahead, technological advancements will see the introduction of robotics and other automated solutions to enhance the efficiency of manufacturing operations.

4. Ask the Expert: Timm Kragl, Senior Consultant

"With all of the different material and post-processing options, additive manufacturing can easily get complex. The question then becomes, how can we keep track of these complex workflows and large amounts of data?"

Timm Kragl is the Senior Consultant at Phanos GmbH, an independent consultancy firm headquartered in Munich. The company specialises in advising clients across industries on all aspects of their additive manufacturing strategy, including hardware, software and all inter-related aspects.

In this interview, Timm discusses the best time to consider Additive MES software, how best to approach the evaluation process and the key criteria you should take into consideration when comparing solutions.

> How would you describe the current landscape of Additive MES solutions?

The market is growing, and with new industries and vendors, it can be confusing for customers to really understand what is the right system — especially if you're not already experienced with different solutions.

Generally speaking, we can split the market into three main groups.

First, you have existing players who already offer conventional MES software for traditional manufacturing. However, since it has been developed for other manufacturing processes, this type of MES software is often not appropriate for 3D printing.

Then you have software companies who focus on different areas, but who have seen the potential of AM and want to take their customers in that direction.

Finally, you have a smaller group of specialised, niche players whose sole expertise is Additive MES. Even though the pool is smaller, their workflows and features can be quite unique.

The diverse range of potential suppliers makes it all the more important that companies have a clear idea from the outset of what they are looking for from a solution.

> At what point should a company start to consider an Additive MES solution?

There are a number of different factors to consider. For example, a well-established MES solution will likely be the right choice if you're operating multiple sites, or if you're dealing with industries that have their own certification and quality assurance requirements.

The size of the company is another important factor, as is the extent to which a company needs to track its operations.

But where Additive MES software is really necessary is when traceability and transparency become key priorities for the company.

For example, perhaps a user wants to have immediate feedback on the status of their order or a company-wide dashboard is needed for visibility — these are scenarios in which you should start to look for an MES system.

Another potential use case is if you want to establish a more automated workflow and therefore reduce

the workload on your end. In this case, a customer-facing frontend, provided by a specialist MES, can help to reduce time and costs.

> Why are more companies looking into Additive MES solutions?

If we consider the increasing importance of customisation, any manufacturer that wants to streamline customer interaction and pursue a customer-oriented product and service strategy will need to reduce the workload and achieve greater efficiency internally.

And this is where data becomes really important. You must have visibility on information like what has been ordered, by whom and in what time period, as well as the different steps that are required for production, how to schedule and so on. Then you have things that relate not only to production but also to the external customer demand and internal process requirements.

This need for transparency and efficiency requires an MES system.

> How would you advise a company that is just beginning their search for an Additive MES solution, but doesn't have a solid process in place?

My advice would be to look at it from a process and a customer perspective.

By this I mean: define the procedures that are needed and what this will require from a solution. Be thorough in analysing what your process is currently lacking and how you may be able to fill that gap with software. It's also very important to consider different and potentially new workflows and scenarios. For example, what should happen if a part was printed but failed?

From here, you can drill down and group these scenarios into different main topics. For example, clustering features under main headings such as "quality assurance" or "process stability".

Once you've mapped out these areas, you'll be much better placed to compare and benchmark different software solutions against each other, ask the right questions to potential suppliers and ultimately find the most suitable partner.

> From your experience, what do companies need to successfully make the transition to production with AM?

While individual processes will vary from company to company, the first step is to be able to ensure traceability so that should something occur, the cause can be tracked down quickly. This accumulated data can ultimately be used to further improve the offerings and overall quality.

We know from other conventional manufacturing technologies that quality assurance is key, and for additive manufacturing, it is no different.

Therefore, traceability is also about being able to track and document quality. And when it comes to AM, this not only includes the printing of the part, but also all the other steps involved, such as post-processing, 3D data acquisition or preparation. Finally, it is the finished product and the customer experience which matter and, of course, your overall efficiency to get there.

5. How to Find the Right Additive MES Vendor

Selecting the right Additive MES vendor is critical to establishing a scalable and efficient additive manufacturing facility.

Compared to other AM segments, there are a relatively small number of Additive MES solutions on the market. However, since the capabilities of each solution varies greatly, it is important to carefully evaluate and validate the merits of each solution during the research phase.

While no solution will meet 100% of your needs, the right MES solution is one that is flexible enough to adapt to your requirements.

Therefore, before beginning the research process, it is important to first document your current processes and specific requirements. This will enable you to identify the 'must have' versus 'nice to have' features, and thereby prioritise the functionality you need the most. In turn, you'll be better placed to evaluate whether a specific vendor is the best match for your needs.

Important criteria you should consider include:

> How will the Additive MES improve your overall additive manufacturing process?

> How will it help reduce manufacturing costs?

> Does it offer an end-to-end platform for the entire production process, or just part of the workflow?

> Is it flexible enough to support future developments, such as an expansion of your facility or an increase in production volumes?

> How easy will it be for internal teams to adopt and use the software?

Additionally, you should also consider:

> Whether the vendor is willing to offer a proof of concept demo to demonstrate that they can deliver on your specific requirements,

> Whether the vendor can provide references of having worked with enterprise companies in a similar capacity,

> The level of support and training the vendor is able to offer during the onboarding and implementation process.

Additionally, the relationship that you establish with your MES vendor will become a long-term partnership, as your needs and their solutions evolve over time. For this reason, it is important to choose the right partner from the outset.

To summarise, you will need to decide what you need an Additive MES for, and choose the solution that not only provides what you need it to deliver today, but also is best placed to become a partner that enables your team to scale your AM operations as you move forward.

13 Questions to Ask Your Potential Additive MES Vendor

As a provider of Additive MES solutions, AMFG helps its clients answer and evaluate their options when making the important decision to choose an MES platform.

To help you on your search, we've put together a checklist of the key questions that you should ask your future MES partner.

Scalability

1. Can your software scale as we add more 3D printers and/or increase our production volumes?

As you continue to find new applications for 3D printing, it is important to consider your long-term AM strategy, particularly if this includes plans for future expansion. Your Additive MES vendor must be able to demonstrate that their software can easily handle any plans to scale up, whether that is in the form of an increase in additional hardware, or an increase in the volume of parts produced.

2. Can the software easily support multiple production sites across geographical locations?

If your AM operations span multiple production sites, you will need your MES platform to provide visibility and collaboration across these locations. Depending on circumstance, this may also include multi-language interfaces.

Deployment & Security

3. Do you offer cloud/on-premises/hybrid solutions?

Depending on your requirements, your MES vendor should be able to offer either cloud, on-premises or a hybrid solution.

With cloud-based solutions, data is maintained, operated and backed up remotely through the cloud. This is managed by a cloud storage service provider on its storage servers, allowing users to access the application from any location, typically through a web browser.

Cloud solutions offer a great deal of flexibility and scalability, as features and upgrades can be deployed relatively quickly. They can also be incredibly cost-effective, since all maintenance and upgrades are conducted by the software vendor.

Despite the growth of cloud-based Additive MES solutions, for some organisations, an on-premises solution may be the only possible option. On-premises software is installed locally on a company's servers, with data stored on servers in a private cloud. Since on-premises (and hybrid) solutions may require additional time and cost for configuration and set up, first check that your vendor has the capacity to offer on-premises deployment.

4. How do you ensure data security and compliance?

Due to the often sensitive and confidential nature of the data being processed, security is a vital criteria, particularly for critical industries such as aerospace and defence.

For this reason, your MES software will need to ensure that it meets data security standards and government accreditations, such as ITAR compliance and ISO certifications. Be sure to understand your vendor's approach to this and, if necessary, request to see the company's data protection policy.

5. Can user access permissions be set?

Depending on the size and structure of your organisation, you may need to be able to set specific user access permissions to restrict access to areas of the platform by unauthorised users. As a basic level of functionality, Additive MES software should offer the flexibility to set different user access permissions as per your requirements.

Integrations

6. Can your Additive MES integrate with my ERP/PLM/CAD software?

Creating a truly end-to-end digital thread requires seamless integration between your enterprise systems. Therefore, you will need to establish how easily your Additive MES software can integrate with your existing software, as well as the type of integration provided. A good way to gauge this is to ask for the vendor's experience in integrating with similar systems in the past.

7. Does your software support integration with my machines?

As we've seen, machine connectivity is fast becoming an integral part of the future of Additive MES software. However, not all vendors offer the same level of machine integration. As a result, you must clearly establish with which hardware the software is currently able to integrate (and to what capacity). It is also helpful to know what integrations are planned for the future.

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Customisability

8. What level of customisation does your software offer?

Since each company's workflows and processes are unique, it is important to determine to what degree the software can be customised to your needs. For example, companies may want to track specific KPIs, in which case the vendor should be able to provide an out of the box dashboard that can be adapted to show your desired metrics.

Costs

9. What is your pricing model?

Since choosing your Additive MES platform will be a long-term investment, make sure that the cost of your investment aligns with your budget. Before investing in any software, you should have a complete understanding of both current and future costs, as this will ultimately impact your ROI.

For example, is the pricing based on production volumes, number of printers, number of factories and/or other factors? If there is a variable involved, is it in line with your expectations? Are there additional fees for custom integrations, implementation etc.?

Also keep in mind that the cheapest platform is not necessarily the wisest option if its functionality does not align with your requirements.

Product capabilities & updates

10. How often do you roll out updates to the software?

It is vital to stay on top of software updates and understand how they may potentially impact your operations. A vendor should be able to provide insight into how often to expect upgrades to the platform, as well as how you will be notified of future updates. Additionally, it is worth understanding whether the update roll outs are done through configuration versus requiring development, as the latter will take more effort to implement.

11. What is the product roadmap?

Knowing your vendor's product roadmap provides valuable insight into the future scope of the software, as well as the direction of the company. You can use this information to establish whether the future product features and milestones align with the overall objectives of your organisation.

Delivery and Support

12. How long will it take to implement the software?

The process of implementing the MES solution will not happen overnight. However, your vendor should be transparent and provide a clear breakdown of the agreed scope of work as well as the main milestones and overall timescale required to successfully deliver your project. This should also reflect a clear understanding of the challenges you are aiming to solve and how the software will deliver on addressing these challenges.

13. What training and support do you provide during the onboarding process?

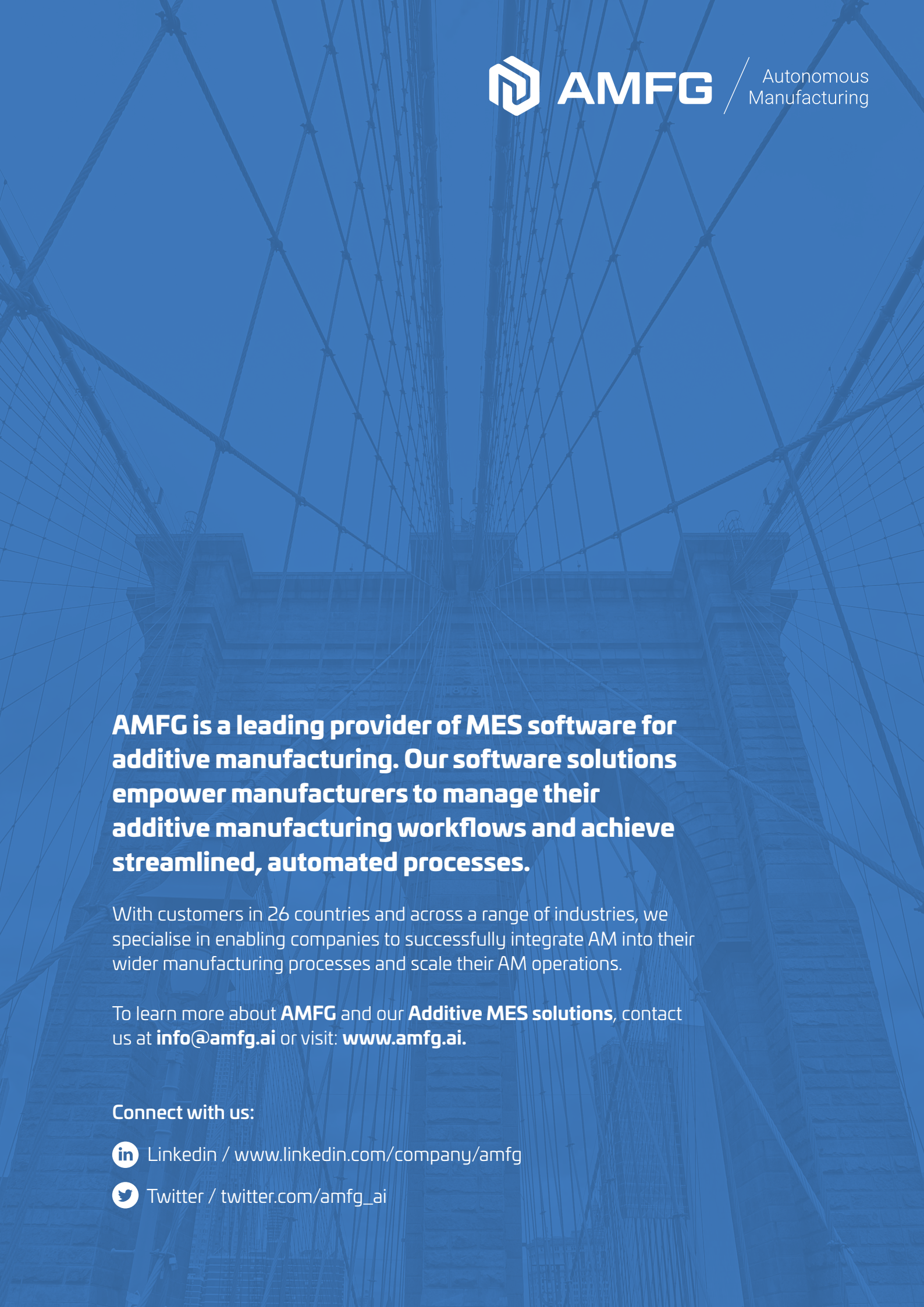
As there will be several stakeholders involved during the onboarding process, it is important to ensure that your vendor can provide systematic and comprehensive support during the implementation phase. Ask your provider whether training for the platform (both in person and online) is provided, as well as what training documentation they can make available to facilitate the internal rollout and adoption of the software.

Additive MES: Unlocking the Full Potential of AM

As additive manufacturing continues to move towards industrialisation, Additive Manufacturing Execution Systems are becoming essential for manufacturers looking to manage their AM operations successfully.

In this whitepaper, we've explored the role of Additive MES in managing the AM workflow, and the key criteria you should consider when looking for a solution.

Ultimately, Additive MES software will play a critical part of your wider AM strategy, helping you to power new business models, connect your supply chains and establish a smart, connected digital factory worthy of Industry 4.0.



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AMFG is a leading provider of MES software for additive manufacturing. Our software solutions empower manufacturers to manage their additive manufacturing workflows and achieve streamlined, automated processes.

With customers in 26 countries and across a range of industries, we specialise in enabling companies to successfully integrate AM into their wider manufacturing processes and scale their AM operations.

To learn more about **AMFG** and our **Additive MES solutions**, contact us at **info@amfg.ai** or visit: **www.amfg.ai.**

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