



cecimo

European Association of
the Machine Tool Industries

European Additive Manufacturing Strategy

Foreword



The European machine tool industry has always been at the forefront of innovation and R&D-generated solutions across Europe's manufacturing base.

In the array of emerging industrial technologies sprouting in Europe, additive manufacturing (AM) comes as one of the most relevant.

Its impact on the efficiency, sustainability and competitiveness of companies is potentially vast. AM pushes the boundaries of parts' design, makes easier the production of different parts at no extra cost, minimizes manufacturing footprint and reduces inventory costs. A new era will be heralded for those industries capable of employing AM. While companies' present is characterized by high warehousing and transportation costs, their future may come in the form of flexible arrangements and closeness to the customer. Requiring minimal tooling operations and based on the creation of finished parts directly from a digital CAD file, AM will shorten time-to-market and open a myriad of possibilities for on-demand production.

As more and more investments are poured into the development of additive technologies, the entry barriers to AM adoption are likely to lower over time. Yet, policy and

regulatory issues, if not properly addressed, may be a drag on the rise of AM in our industrial landscape. From skills and education to IPR and standardization, Europe faces a series of challenges and it is imperative to act fast and determined.

In this context, it is easy to understand CECIMO's call for EU-level action as, CECIMO catalyses the concerns of the AM industry in the EU policy landscape. Therefore, in 2015 CECIMO organised the first conference on this topic at the European Parliament (AMEC), bringing together public sector and manufacturers to discuss the best measures to encourage AM industrialization in Europe. The success of AMEC as a regular event in the industrial circles points to the clear interest of EU authorities and stakeholders on policy aspects of AM. CECIMO has been stressing that a common approach at the European level can accelerate the dismantling of technological barriers and overcome major policy and regulatory obstacles. The European advanced manufacturing industry has maintained over time a global leading position, and it can be considered a gem of the European economy. With the rise of additive manufacturing (AM) technologies on the shop floor, industry entered a

new round of innovation. If Europe aims to remain a leader on advanced manufacturing production, it will need to succeed in the global race to industrialise additive manufacturing.

After all, we have to remember that our AM machine producers and application sectors alike are competing nowadays on the global scale with countries such as the US, China and Japan.

This document provides an overview of the policy fields that deserve priority attention of EU authorities. It collects the inputs of a wide range of experts, including those from CECIMO's AM Working Group, and details recommendations to speed up the AM uptake. We trust it to be an informative reading for stakeholders and policy-makers.

Filip Geerts
Director General

Education and skills



CECIMO has long underlined how the success of the overall European advanced manufacturing sector rests on a mix between solid engineering know-how and highly skilled shop-floor employees. This recipe has been one of the main drivers of strong innovation capacity matched with quality production, tailored to customer needs. Yet, companies have been increasingly vocal about the emerging skills shortage in the AM context. At factory level, analyses, as those of the EU METALS project led by CECIMO, yielded a clear conclusion. As AM moves closer to series production, workforce interacting with conventional machines will need to develop new competences. Its skill-set

will gradually evolve into a hybrid one, where abilities in subtractive manufacturing will be coupled with new skills specific to the production process with additive machines. Equipping technicians and operators with these additional competences will be of paramount importance to avoid the slow-down of industrial AM.

Today, industry alone often takes responsibility for the training and re-training of workers interacting with additive systems. The public sector should support companies in this respect.

It is of utmost importance the formation of a large pool of engineers competent in AM.

Education systems across European countries have at times shown signs of obsolescence. Educators find difficult to catch up with the fast-paced developments of AM technologies. As a result, skills acquired by entrants to the AM labour market are at risk of misalignment with the current skills' needs of companies. There is a need for a step change in approaching the preparation of curricula and setting out teaching strategies.

Top-down support

- Share best practices on the modernization of engineering curricula through greater involvement of private actors. Engage additive system producers in curricula creation so educators can keep up with the latest developments.
- Connect fab-labs across Europe to foster matching of complementary strengths.
- Support AM-related courses at all stages of education from middle school to university and post-graduate specialization, including VET at higher education level.
- Increase EU funding to address skills shortages in the AM industry. Studies emphasized new skills will be increasingly needed for the production stages of design, STL conversion and file manipulation, post-processing and maintenance. Demand for application engineers and design engineers will surge to fully exploit the advantages of the AM process. And in the VET context, the Sector Skills Alliances financed by the Erasmus+ programme are a valuable platform for exploring industry-university partnerships.
- Promote the use of existing skills-based job matching tools, such as the EURES Job Mobility Portal, to tackle skills shortages in the short-term.
- Explore financing options, especially through the EIB, for schools and universities to access AM equipment as recent examples shown¹.



Case in point

A survey conducted in 2016 by a print management solutions company showed 87% of schools across the world limited students' access to 3D printing.

The three main reasons were: educators' inability to manage and control access to the 3D printer available in the school, educators' inability to manage 3D printing time and materials cost in order to allocate classroom/department expenses, as well as lack of guidance on adding 3D printing to classroom curricula. A greater engagement of industry in education would help tackling some of these aspects².

Standards and certifications



As well described by a study of the EU Joint Research Council, “standards are very important as they provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose. They contribute to remove technical barriers to trade, leading to new markets and economic growth for industry”³.

The general trend in AM sees AM players developing their own internal sets of standards. The fragmentation that derives has an impact on the pace of adoption of AM in the industrial context, as extra time is spent on qualifying and validating materials, processes as well as end-products. Standardization-development efforts are currently channelled on design and data formats, test methods, process materials and terminology⁴. The development of standards and an extensive certification system are crucial, especially for the fabrication of customized, repair, and low-volume components. They also guarantee repeatability in the additive production process.

Globally, there are three main existing bodies whose Technical Committees (TCs) deal with AM standardisation issues. They aim at common, world-wide standards. These are ASTM (F42), ISO (TC261), and CEN CENELEC (TC438). In Europe, further national standardisation bodies work on AM in parallel (AFNOR in France with its committee UNM 920 Fabrication additive, VDI in Germany with the GPL Committee on Production and logistics, AENOR in Spain with the committee AEN/CTN 116 including AM, SIS in Sweden with the committee SIS/TK 563 and BSI in UK with the committee AMT/8). The EU has then a major role in supporting better coordination among the different activities at national and European level.

In 2012, it approved a Regulation on standardisation⁵, which recognized that standards are voluntary and promoted EU-level standards in replacement of those at Member State level.

In 2016, the European Commission proposed a set of new measures to reinforce the cooperation between national governments, national standardisation bodies and EU standardisation bodies such as CEN-CENELEC⁶.

Among these, it launched the Joint Initiative on Standardisation to speed up standards development, align the objectives of European standardisation and EU research projects and raise the profile of European standards on the international stage⁷. Yet, in its Annual Programme on standardisation priorities, the European Commission excluded AM from the five focus areas selected (5G, cloud computing, internet of things, data technologies and cybersecurity)⁸.

EU funding represents another valuable instrument to foster standardisation. The SASAM⁹ project, for instance, delivered a roadmap for standardisation activities coordinating a group of over 100 European and international AM industry stakeholders. It indicated the need and type of standards to be developed, specifying categories such as design, specific industrial needs, quality of manufactured parts, safety (regulations) and education.

Case in point

For metal materials in the aerospace industry, the qualification procedure for the introduction of new alloys is very rigorous and precise because of functional safety. Yet, this qualification process for new metal materials often costs millions of dollars and requires, sometimes, up to fifteen years to be completed¹⁰. By supporting more coordination on standardization efforts, industry can spare time and financial resources for qualification in AM.

Efforts across the board

- Strengthen the coordination among AM specialized Technical Committees Standardization bodies: ASTM F42, ISO TC261, CEN CENELEC TC 438 and avoid the duplication of activities.
- Include AM among the priorities areas in the Annual Union Work Programme for European standardisation set out by the European Commission.
- Emphasize in third countries the effectiveness of the EU approach to standardization, conceived as a voluntary regulatory tool.
- Build upon successful EU-funded standardisation projects such as SASAM, and earmark greater funding for initiatives in this domain.
- Underpin industry engagement in the ISO/TC261, CEN and ASTM to collect inputs on AM.
- Explore whether existing non AM-specific standards in conventional manufacturing are applicable to the AM sector.

Intellectual property rights and patents development



Intellectual property rights (IPR) must be considered in the group of relevant aspects for AM in Europe. Industries such as the aerospace, the surgical planning and the spare parts are concerned by the developments. Since its importance is set to grow in parallel with the industrialization of AM, decision-makers should place this issue high in their agenda. They will need to better enforce the current rules to provide assurances, for instance, to conventional manufacturers fearing the theft of their digitally created designs or the reproduction of parts/tools of it. The ownership of these files is an area where greater legal certainty is needed. Better enforcement of the current regulatory framework would contribute to reduce these fears¹¹.

More can be done, too, about improving the European patent system. Compared to other areas in the world like the US, the costs of patenting in Europe are significantly high. In Europe, costs of patenting are then multiplied by the number of countries in which the patent is intended to be enforced. This leads to fragmentation of the European system and proves to be a relevant obstacle for start-ups and small companies. Moreover, the time between filing and granting a European patent application represents another problematic aspect. The granting procedure takes much more time than in Japan and the US, two of the main competitors on the AM stage.

Provide greater opportunities

- Better enforce the current IPR provisions so to provide incentives for manufacturers to adopt AM and create their own designs, for instance by exploring opportunities to set up an Observatory monitoring designs and reproduction.
- Lower IP costs, as well as patent grant times, in particular for SMEs.
- Define comprehensively IPR, so as to assess the extent to which a CAD file can be distributed for additive production.





EU-funded R&D activities on AM have been growing substantially over the last three decades. While in the 1991-1994 period only three AM-oriented projects obtained funding from the EU's science-based programme, in the 2007-2013 spending period there were 66 projects focused on the materials, processes and end-use aspects of this technology¹². The overall EU funding for the latter exceeded €160 million. Additional money has also been earmarked through other programmes such as Erasmus +, whose topic addresses skills and implications for the labour market, and COSME, which aims to support SMEs.

Funding opportunities for AM have not only come in the form of grants. EU policy-makers have promoted the implementation of public-private partnerships (PPPs) to foster the technological development of AM. They unlocked the provision of public seed money which is expected to trigger

additional private investments. The Factories of the Future (FoF) PPP aims at achieving the same objective in collaboration with stakeholders such as the Additive Manufacturing Platform and the ManuFuture European Technology Platform (ETP). Further financing through the European Fund for Strategic Investments, the European Investment Bank and the European Investment Fund have a multiplier effect. Other actions, like the Vanguard Initiative (VI) for New Growth, portray a mixed funding model for AM-specific R&D.

The latest available figures bode well for the future financing of R&D in the AM sector. Horizon 2020 (the EU science programme for 2014-2020) funded over 21 AM projects during the first two years of its implementation, for a total of at least €95 million in funding. It is therefore overt the attention of the EU authorities in terms of funding allocation.

A comprehensive research environment

- Encourage start-up and SME participation by lowering the administrative burden and the lead time of granting proposals.
- Establish an online portal for project proposals, where SMEs can increase the visibility of their project ideas by compiling and submitting a project form.
- Reinforce funding for high-TRL projects so as to accelerate the commercialization stage of AM technologies.
- Support the creation and the constant update of a comprehensive database of AM service providers to be open to EU industries and supported by EU manufacturing stakeholders.
- Multiply the practical opportunities for SMEs to test AM technologies with the help of EU's platforms/sites/centres, and consider the opportunity to establish a one-stop-shop in each EU country to raise awareness about AM technologies and provide support in financing AM investments.

Businesses, however, reckon that to achieve the industrialization of AM, policy-makers must promote a more comprehensive approach to R&D. SMEs, which represent about 80% among CECIMO's enterprises, struggle to navigate throughout the bureaucratic procedures related to the participation in EU-funded projects. A company with less than 15 employees has often limited resources and, consequently, a disadvantage vis-à-vis large businesses in EU grant awarding. They also have more difficulties in finding potential project partners located abroad. In line with the EU "Think Small First" principle, policy-makers must fully consider SMEs in their decisions. More support to SMEs' access to R&D funding allocation would go in this direction. It would level the playing field and bring fresh ideas to the EU's policy-making community. Ultimately, greater participation of SMEs in EU R&D activities would increase the application of AM systems by Europe's end-user sectors.

Collective research at European level has an added value and here lies the opportunity to pool expertise together and avoid duplication of efforts. It is important to connect AM centres of excellence across Europe, especially at a time when established international competitors earmark new research investments and emerging countries have entered this field. Under the umbrella of R&D initiatives, decision-makers should bring together technology institutes, large companies, SMEs and players from application sectors. A heterogeneous partnership would be more likely

Case in point

In the context of the Juncker's Investment Plan, the European Commission established the European Investment Project Portal (EIPP). This is a platform where public project promoters can register their project proposals and boost their visibility to international investors¹³. The project proposals in the portal have earlier met an eligibility check by European Commission officials.

A similar portal for the EU Horizon 2020 programme is lacking today. Setting it up would help SMEs in voicing their ideas on AM-related calls for proposals and in reaching out more quickly and comprehensively potential project partners across Europe.

to tackle looming issues such as quality of the AM production process and size of the parts produced. It would also offer Europe an edge on knowledge in these key aspects.

This framework should lead to the design of a more coherent European research system. The TRL is, for example, a field where discrepancies in the system are visible. Europe is remarkably effective in low-TRL basic research, where studies and analyses are mostly conducted in a lab-based environment. But its efforts in high-TRL research activities, where technology and products are tested in an industrially relevant environment, are comparably less intense. As a consequence, the commercialization of research results is left to non-EU players, with derived implications for the competitiveness of its advanced manufacturing sector.

Close-to-market research activities should focus on already promising technologies and aim at marketable results to support AM's industrialization process in Europe.

Access to finance for SMEs and AM companies



At CECIMO, about 80% of companies represented are small or mid-sized. The most innovative among them are exploring the possibilities envisaged by AM. They are eager to exploit its potential and are succeeding step by step. But they are also facing the constraints of the European venture capital ecosystem. Many SMEs claimed public support to grow bigger and make their way into the market. The European Commission identified this situation of impasse as the “Valley of Death”. This is an appropriate metaphor to describe the current circumstances. Small businesses face extremely challenging conditions in translating their ideas into marketable products. They are also over-dependent on bank loans, at the time when banks’ credit conditions are still tight. Today, insufficient access to finance is one of the causes of their struggle.

Studies show European SMEs receive five times less funding from capital markets¹⁴ than in the US. This is a telling figure. Moreover, SMEs point to the difficulty in having financial institutions accepting intangible goods (as ideas or invention) as a collateral¹⁵.

From this picture, it emerges a conservative financing environment in which innovative AM players grapple to introduce their ideas in the market. Support should come from the public sector, as authorities could match demand and supply of capital and push forward with forms of “blended” finance that mix private and public capitals. EU decision-makers should also bring about coherence in the European Venture Capital market. High fragmentation implies that venture capital managers face large costs when raising funds across Europe. Thus, initiatives like the European

Commission’s proposal for a pan-European venture capital fund of funds are welcomed. It would go in the right direction of creating more opportunities and strengthening an underdeveloped European venture capital market¹⁶. Also the completion of the Capital Markets Union would improve access to finance by SMEs. The EU legislative proposal to breathe new into the securitisation market would free up balance sheets of banks and facilitate lending. Cooperation among regions would also be an effective supporting mechanism for SMEs. For example, they can put their resources on pilot networks and demonstrations. Such actions would be helpful for the creation of venture capital firms with a specific focus on innovative market actors. These firms play a tangible role in increasing market acceptance of high-technology start-ups.

From patchwork to harmonization

- Take more initiatives for a pan-European venture capital fund of funds, and expand opportunities for coupling EU public sources with greater volumes of private capital.
- Enhance the creation of European Venture Capital firms specifically focused on technology-based firms, as these help the latter in gaining market acceptance.
- Complete the Capital Markets Union project on the integration of capital markets across EU countries, starting with the approval of the EU proposal for a regulation on securitization markets.
- Expand the opportunities offered by financing via inter-regional cooperation mechanisms for the support and development of networked pilots and demonstrations.
- Make available financing instruments to support entrepreneurship, start-ups and SMEs growth, since AM is a field offering important opportunities for start-ups (e.g. service companies or software providers).



Cyber-security plays a relevant, though often not sufficiently recognized, role in AM. As software occupies a substantial part of the production process through additive techniques, the risk of cyber-attacks must be appropriately considered. Cyber-security risks encompass different stages of the production process. The CAD file containing the digital design of the product can be stolen or corrupted. This leads to the premature failure of the process, with implications for the whole value chain. Attacks of a similar kind may also be conducted in the STL stage, when the file is converted from CAD into STL format, readable by the machine. In the stage of production, risks are linked to the

alteration of the proper process parameters, leading to situations like misaligned printer head or altered laser intensity¹⁸.

Cyber-security is therefore essential to guarantee AM models and data are safely stored, transferred and executed. With the growing number of companies embracing AM, there is an increasingly great need for policy measures. The recent EU Cyber-Security Directive has paved the way for a minimum level of security for digital technologies, networks and services. Now attention should turn on minimizing the probabilities of cyber-attacks in the first place. The current European cyber-security regulatory landscape

remains still characterized by fragmentation. Cooperation among law enforcement agencies will be a valuable tool in preventing these threats and for information-gathering activities. To minimize cyber-risks, these bodies will also need to boost expertise in a fast-evolving environment. Training of officials will therefore be needed. Along these lines, in July 2016 the EU launched the first European PPP on cyber-security. It aimed at pooling cyber-security expertise and bringing together different actors from EU countries. More should be done in this direction. Only a coordinated vision will provide robust and lasting solutions.

A cyber-secure environment

- Design more EU public-private initiatives on cyber-security based on those already achieved.
- Boost EU funding for training on cyber-vulnerabilities in the AM process.
- Explore regulatory measures to minimize cyber-attack risks in the first place, as to protect the AM value chain.

Case in point

Researchers at Virginia Polytechnic Institute and State University presented in a 2017 paper the impact of a cyber-physical attack case study on a nylon-based additive machine. The attack concerned the .STL file structure.

Researchers estimated the attack led to a reduction in the mechanical strength of the part. The average reduction in yield load was of 14%, that of strain at failure of about 5%. The voids generated in the part proved also difficult to identify with common techniques.

More work is needed to protect AM systems against cyber-physical attacks¹⁹.

Health and safety



A set of EU rules help protecting workers and the environment in the AM process. Concerning health and safety aspects, the EU Machinery Directive appears to be one of the most important among these. This directive remains a key piece of legislation for the European engineering sector, though a review of its current provisions is ongoing. It harmonised essential health and safety requirements in machinery. Industrial additive machines are firmly considered to fall within its remit²⁰, while there is instead more uncertainty about desktop 3D printers. There is currently a looming question on whether the latter are covered by this Directive or the EU Low Voltage Directive, which applies to ordinary office machinery.

Under the Machinery Directive, the industrial additive machine is self-certified by the manufacturer based on a set of requirements to abide to. It then gets the CE marking as a result. In its self-certification, the producer lists health and safety hazards linked to the use of the machine. It must be noted, however, that this law has a broad domain. The development of a specific AM-related group of harmonised health and safety standards would further ease its application.

Additional standards are set out by the EU ATEX Directive²¹, which applies to equipment and protective systems used in

potentially explosive atmospheres and the related components, as well as devices for use outside potentially explosive atmospheres. The Directive is particularly relevant for the metal segment of the market, as powders such as titanium or aluminium are highly flammable. The storage and handling of these materials for AM must therefore be conducted with systems that meet ATEX-defined safety standards. In 2016, the European Commission took further steps to deepen legal predictability on the applicable standards set out by this Directive and the type of information to be communicated by the producer to the authorities²². Looking at the overall health and safety regulatory framework in the EU, however, there are still gaps. They point to the need for greater research. For example the high temperatures achieved in AM production urge for clearer rules in the use of equipment. Broadly speaking, equipment for process industries, including the high-temperature ones, is covered by the EU Pressure Equipment Directive. A wide range of products falls within its remit. While the application of this Directive has been simplified in 2016, its underlying content dates back to its approval in 1997, at a time when the volume of the AM industry was a fraction of today. Decision-makers need to look more in-depth into the relationship between this law and equipment used for AM production²³. That legislators must

catch up with the development of AM and fill regulatory gaps is a conclusion also visible when addressing the issue of materials. There is a risk in the exposure to metal powders such as aluminium, which implies workers must observe strict safety standards when handling such materials. EU-level harmonised guidelines are needed in this domain.

Policy-makers will also need to explore whether applicable health and safety provisions can be borrowed from other sectors. Existing standards for conventional machines, for example, may prove to be suitable for new generation machines. Experts described the similarity between traditional and additive machines when it comes to mechatronic devices.

Immediate actions

- Clarify the legal interpretation of desktop 3D printers and give more guidance on their potential link with the EU Machinery Directive.
- Encourage the development of AM-specific standards in the context of the EU Machinery Directive by fostering dialogue between national, European standardisation bodies and industry.
- Issue guidelines on the relationship between the EU Pressure Equipment Directive and equipment for AM production.
- Provide common standards on the storage and handling of metal powder for AM production.
- Explore whether existing health and safety standards in conventional manufacturing can be also applied to the AM context, so to facilitate industry's application of such standards.





An efficient trade environment is key to facilitate the growth of European actors along the AM value chain. CECIMO identifies two gaps.

The first concerns the provisions of the so-called EU “dual-use” export control regulation. This law governs the trade of products that can have both a civil as well as military use. Some additive machines and the components they use, such as fibre lasers and specific types of metal powder, fall within its remit. These products are subjected to export control restrictions and need an export license to be sold to certain countries, depending on their specificities and the authorization granted. A review of this regulation is currently in place. The proposal to amend it seeks to harmonize the implementation of export controls among EU countries. Yet, it also entails higher compliance costs for EU companies producing AM equipment subjected to the provisions of this regulation. This

implies a competitive disadvantage for European companies. To avoid it, and to ensure the achievement of a fairer international playing field in this respect, the European authorities should further engage in talks and cooperation with third countries. Policy-makers should aim to minimize any possible distortion of competition. Moreover, any revision of the current regulation should bear in mind that the more the system is complex, the higher are SME’s compliance costs with regulatory obligations, given their limited structure and availability of resources.

A second point of concern is the international product nomenclature developed by the World Customs Organization (WCO): the Harmonized Commodity Description and Coding System, which is generally known as Harmonized System. It comprises 5,000 commodity groups, each identified by a six tariff digit

code that provides a uniform classification of products. This arrangement, applied by most of the countries around the world, is used to calculate custom tariffs and international trade statistics. To date, the WCO is discussing the review of its harmonized system code nomenclature, to be approved in June 2019 and implemented from 2022 onwards. Among the potential revisions envisaged, one considers the opportunity to create a specific heading and/or related sub-headings for classifying additive machines.

EU decision-makers that take part in the talks should underpin the inclusion of such specific codes for AM machines. It would improve the collection of international trade statistics and offer more comprehensive data on trade of additive machines around the world. This would lead to a better informed EU policy community and more effective policy choices.

Concrete measures

- Engage with actors outside the international regime on export controls and seek to involve them, so to level the international playing field for European producers of AM equipment which falls under the «dual-use» export control provisions.
- Support the development of specific headings/subheadings in the international product nomenclature, under which classifying the trade of additive machines.

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cecimo

is the European Association representing the common interests of the Machine Tool Industries globally and at EU level. We bring together 15 National Associations of machine tool builders, which represent approximately 1300 industrial enterprises in Europe (EU + EFTA + Turkey), over 80% of which are SMEs. CECIMO covers 98% of total Machine Tool production in Europe and about 36% worldwide. It accounts for almost 150,000 employees and a turnover of nearly €24 billion in 2016. Approximately 75% of CECIMO production is shipped abroad, whereas around half of it is exported outside Europe. CECIMO assumes a key role in determining the strategic direction of the European machine tool industry and promotes the development of the sector in the fields of economy, technology and science.