cecimo

European Association of the Machine Tool Industries and related Manufacturing Technologies

ENABLING THE CIRCULAR ECONOMY WITH ADDITIVE MANUFACTURING

Exploring Best Practices

November 2022

www.cecimo.eu

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INTRODUCTION

The transition towards **sustainable** and **circular manufacturing** demands a gradual shift towards new practices and technologies that minimise environmental impact and preserve energy and natural resources.

The **Circular Economy action plan** launched in 2020 by the European Commission includes several policy initiatives that aim to increase the level of sustainability in all industrial ecosystems.

Such ecosystems have now the goal and the challenge to lower their carbon footprint and increase the sustainability of their processes and value chains. The use of **key enabling technologies** can help these sectors respond to these challenges and develop new sustainable products.

Additive manufacturing (AM) has the potential to provide multiple sustainability advantages by proposing a novel paradigm for design, manufacturing, and business models. This enables more cost and resource-efficient production. Although the sector could further improve its own carbon footprint, particularly during the phase of raw material production and AM product manufacturing (two steps in the value chain that require the highest energy consumption), the use of AM can be offset with the saving achieved by using the end products.

Why a brochure?

CECIMO, with the support its network of National Associations decided to collect best practices from AM industries with the goal to promote AM as a true enabler of circular economy. The Brochure gives examples of different technologies and how their application can help different sectors to improve their production sustainability.

How can any industry benefit from using AM?

- AM can reduce waste in the production process since they only use the necessary material to produce a part.
- AM supports circular design strategies by creating opportunities to extend a product's lifespan and enabling repair or upgrades, even if these products were not originally designed for ease of repair or upgrading.
- AM can make repairs and remanufacturing easier and more cost-effective.

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The ambition to create a brochure focused on additive manufacturing arose from the opportunity to support the European targets set in the Circular Economy Action plan. In that respect, the brochure provides a list of case studies in Additive Manufacturing technologies that could help companies across different industrial ecosystems improve their product sustainability.

Filip Geerts, CECIMO Director General

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Additive manufacturing can help speed up industry's green transition. CECIMO will continue to champion the application of Additive Manufacturing with policymakers, ensuing that this technology plays a role in the European Green Deal.

Stewart Lane, Chairman of the CECIMO Additive Manufacturing Committee

Part 1-Spain

National Association ADDIMAT

ADDIMAT, the Additive & 3D Manufacturing Technologies Association of Spain, groups together more than 100 players with an interest in developing and promoting additive manufacturing and 3D printing. ADDIMAT defends and represents the industry's interests and offers services to its members in the fields of cooperation, technology, internationalization, markets, marketing and people.

ADDIMAT is part of the AFM Cluster, an organization that represents the advanced and digital manufacturing industry in Spain. It comprises of six industrial associations and groups more than 700 companies with 16.500 employees. The six related and synergetic sectors which AFM Cluster serves are the following: machine tools and advanced manufacturing technologies (AFM), additive manufacturing and 3D printing (ADDIMAT), hand tools, hardware, and industrial supply (ESKUIN), machining and metalworking (AFMEC), smart technologies for the Manufacturing industry (STECH) and startups for advanced and digital manufacturing (UPTEK). AFM Cluster also groups more than 90 partners who offer services for the manufacturing industry.

109
ADDIMAT
members

700
AFM Cluster
members

Main activities of ADDIMAT

- Raising awareness of the AM sector: news, case studies, webinars, newsletters, conferences, etc.
- Catalogue of Spanish AM capabilities
- ADDIT3D Spanish AM show
- Joint booth and participation at Formnext
- Networking and B2B events
- R&D cooperation
- AM Industry studies on trends and market evolution
- JOIND, employment platform for the Spanish advance manufacturing industry

ADDILAN
WAAM TECHNOLOGY MACHINES

Company Highlights

Addilan Fabricación Aditiva S.L. produces high deposition rate additive manufacturing machines using WAAM (Wire Arc Additive Manufacturing) technology. Some of the company's goals are:

- To offer an additive manufacturing system of metal preforms complying with the required mechanic standards in a dependable and repetitive way.
- To provide a competitive manufacturing alternative for consumers and manufacturers of medium to large size high added value pieces.

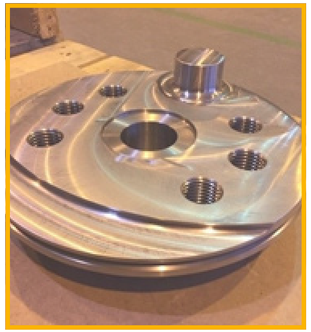
To this end, Addilan focuses its efforts on process development, machine design and mechanical characterisation.

Best practice example

Technology used: DED - WAAM (Wire Arc Additive Manufacturing)

Model of the Machine: Addilan ArcLan M850-3X

AM Material used: High Strength Steel



Description of the Application:

Addilan has developen a component in a controllable pitch propeller. Conventional crank discs are made in forged steel and machinning, which requires complex process and generates large waste of raw material. Component from KONGSBERG MARITIME.

Added Value with the use of AM

- Enabled distributed production
- Material use reduction
- Energy efficiency in final products
- Waste reduction
- Downtime reduction
- Repair and re-use

WAAM technology has demonstrated flexible production, opening new opportunities for the Naval sector (in terms of distributed production) and making it feasible to consider repairing components. The latter is produced via the forging process, fulfilling the high technical requirements, which are expensive in energy terms and highly rigid in geometric terms. WAAM uses a minimum quantity of materials to produce parts, thus reducing the manufacturing lead time by 60% and saving close to 50% of the current cost of production.

Enabling Circular Economy with AM Solutions

Addilan believes that developing appropriate **certification guidelines** would enable AM to become a real enabler of the circular economy.

Examples of main contributions to the EU Circular Economy targets

- Improving access to repair and maintenance
- Enabling re-manufacturing
- Reducing waste production
- Improving resource efficiency

Company Highlights

MELTIO

Meltio's mission is to help their customers, partners, employees and shareholders by pioneering the development of affordable metal 3D printing systems that are reliable, safe and easy to use, continually reinforcing their status as disruptors.

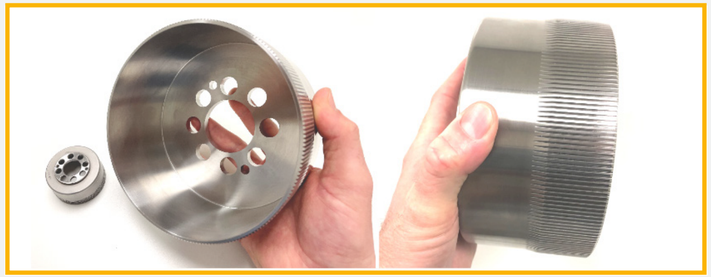
Incorporated in June 2019 through a joint venture of Additec, a Las Vegas based technology company, and Sicnova, a leading 3D printing equipment distributor. Meltio proudly counts on the strategic support of ArcelorMittal, the largest steel producer in the world.

Best practice example

Technology used: Wire Laser Metal Deposition

Model of the Machine: Haas CNC system equipped with the Meltio Engine CNC Integration

AM Material used: 17-4 PH Stainless Steel welding wire



Description of the Application:

The part was manufactured using a wired LMD and the precision-machining into the final shape. The prototype is compared to a common size-20 flexspline, measuring approximately 2 inches in diameter. For larger flexsplines, additive manufacturing can provide significant cost savings and open the ability to tailor material properties. The machining of flexsplines with 6 to 8 inches in diameter can reduce their large steel feedstock to as little as 10% of its original volume. That is a detriment from both cost and sustainability standpoints, as manufacturing requires lots of energy and material to produce a part that is a shell of the original stock. Therefore, Meltio's wired LMD process greatly benefits component fabrication and enhances component sustainability.

Added Value with the use of AM

- Material use reduction
- Energy saving in final products
- Waste reduction
- Weight reduction (final product)

Additive manufacturing becomes a promising alternative since the machining costs can be dramatically reduced while allowing for the cost-effective use of high-performance steels. The total manufacturing cost and production time of components were minimised by approximately 70% and 50%, respectively. 17-4 PH stainless steel is a difficult to machine material, so extensive usage of high-value tools is necessary. However, with Meltio's wired LMD process, the machining element is reduced by 90%, thus saving total energy consumption and costs involved in replacing tools.

Enabling Circular Economy with AM Solutions

Meltio believes that additive manufacturing allows an eco-friendly part production, as it provides an exceptional alternative for waste and energy reduction during the manufacturing process. With the **more widespread adoption of pioneering technologies** such as Meltio's wired Laser Metal Deposition, additive manufacturing could become a tangible enabler for the Circular Economy.

Examples of main contributions to the EU Circular Economy targets

- Reducing waste production
- Improving resource efficiency
- Improving product design

ITALY

best practice examples

Part 2 - Italy

National Association

AITA-ASSOCIAZIONE ITALIANA TECNOLOGIE ADDITIVE is a cultural association aiming to represent the interest of Italian Additive Manufacturing Sector (producers of machines, end-users, enabling technologies suppliers, service centers, universities, research centers, etc.), helping the dialogue with public stakeholders and other industrial associations, in order to spread and develop the use of Additive Manufacturing (and the related knowledge) in manufacturing environment.

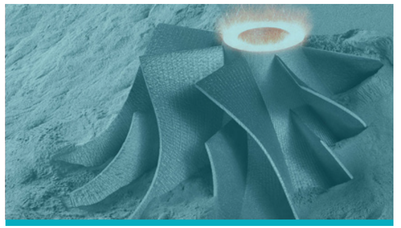
MISSION

- to highlight this emerging sector coherently with its role in mechanical manufacturing;
- to carry out activities related to research and innovation;
- to create competitive advantage and «push» the industrial application of industrial technologies and their connection to the other mechanical manufacturing processes.

120
AITA
members

Main activities of AITA

- Standardization
- Communication and Promotion
- Training
- Research and Development
- Events and exhibitions



Company Highlights

HP 3D Printing

HP is a technology company born of the belief that companies should do more than just make a profit. Our technology – a product and service portfolio spanning personal systems, printers, and 3D printing solutions – was created to inspire meaningful progress.

HP's Personalization and 3D printing business aims to create a more personal, healthier, and sustainable world through the power of additive manufacturing. We enable our customers, communities, and colleagues to challenge conventional thinking and deliver entirely new innovations.

Our data-driven additive manufacturing solutions help transform industries with unprecedented personalization, performance, and design possibilities.

Best practice example

Technology used: Multi Jet Fusion (powder bed fusion)

Model of the Machine: HP Jet Fusion 3D 5210

AM Material used: HP 3D HR PA 11, HP 3D600/700 Fusing and Detailing Agents

Description of the Application:

HP has developed Multi Jet Fusion (MJF), a 3D printing technology that enables the production of tooling for moulded fibre packaging made from polyamide 11 (PA 11) and derived from castor oil. MJF technology revolutionises the tool making process and enables agile and adaptable creation of the moulded fibres to adapt to the different designs of the product, as is the case in consumer products (e.g. electronics). Moulded fibre packaging is employed in almost every market segment, notably in fast-changing sections where 3D plastic tooling is favored due to a lower carbon footprint and simple adjustment to changing packaging designs. Therefore, switching the milled aluminium to 3D printed MJF tooling will reduce carbon footprint.

Added Value with the use of AM

- ✔ Components consolidation
- ✔ Material use reduction
- ✔ Reduction in carbon footprint

The conventional tooling consists of 5 parts: a milled aluminium mounting plate, form, stainless steel screen, deckle, and transfer (made from milled aluminium or milled high-density polyethene – HDPE). MJF tooling set consists of four parts: a milled aluminium mounting plate, a transfer tool, a 3D printed form and a 3D printed "screkle," which combines the screen and the deckle plate in one part. Both sets of tooling contain an additional transfer mounting plate that is identical. Conventional tooling sets have a larger mass than the MJF tooling from 5 to 12, depending on the comparison. Based on the design, the carbon footprint reduction varies between 60% to 78%, thanks to the 3D printed PA11 parts replacement of the metal part.

Examples of main contributions to the EU Circular Economy targets

- ✔ Improving product design

Enabling Circular Economy with AM Solutions

HP thinks that improving the recycling infrastructure for plastics used in AM (to include more plastic types and shapes in municipal recycling) would be a great step towards turning AM into a real enabler of the circular economy.

Company Highlights

NORBLAST
THE FINAL TOUCH

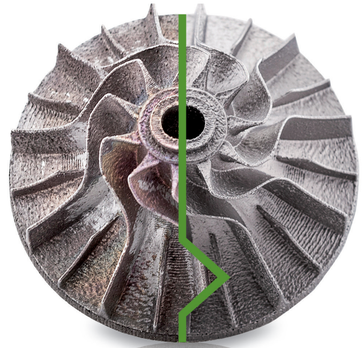
Norblast is an Italian company based in Bologna that produces sandblasting and shot-peening systems. For four decades, Norblast has been synonymous with vision, innovation and evolution in the world of high-tech surface treatments. Due to the inherent limitations in the current additive processes, the products obtained have a surface quality and roughness values that may be unacceptable for most applications. Norblast's new line of 3D-Printing Line products offers manual and automatic post-processing solutions and is custom-designed for cleaning, finishing and roughness reduction of components produced with all additive manufacturing technologies (SLS, MJF, SLM, EBM, FDM and Binder Jetting).

Best practice example

Technology used: Fused deposition modeling

Model of the Machine: RAISE PRO 2 PLUS

AM Material used: COMMON FDM POLIMERICAL MATERIALS - ABS, ASA, TPU



Description of the Application (plastic materials)

The components realized with powder bed printing technologies (SLS, MJF) are extracted from the build with a leftover semi-fused powder layer, which is partially recovered and reused in the next printing operation and the remaining has to be removed with an appropriate peening treatment. NORBLAST has developed solutions able to quickly and efficiently clean the parts surfaces, including inner canals and undercuts, with the maximum attention to fragile details. Depending on the needs, it is possibile to treat the parts singularly in manual mode or carrying out an automatic massive processing. At the end of the process, the components show a homogenous finishing and are ready to use, or suitable for further treatments (dyeing, painting, etc). For color-printed parts the developed process is perfectly efficient: the colors are preserved and, where possible, revived.

Description of the Application (metals)

The different metallic additive printing technologies allow to realize complex components, with different surface finishing degrees. The most widespread laser or electron beam technologies (SLM & EBM), at direct deposition and metallic MJF or even the technologies for small batches (Metallic FDM & Binder Jetting) usually leave the part with a surface roughness not suitable for its final use. The Norblast treatment allows to uniform the surface in a very short time, clean through channels and reduce the surface roughness following the design specifications. The common materials in the metallic additive manifacturing field that reach excellent finishing results are, for example: Alluminium, Stainless Steel, Titanium & Inconel. In case the part needs to be prepared for a painting, for a coating or for a further galvanic treatment, we confer it a surface with great adherence features. When a roughness to be obtained with a further chemical finishing process is required, the Norblast treatment reduces by 70% the time of the following vibro-finishing. Shot peening Norbast treatment on metallic additive printing components can increase the fatigue life.

AM is used for prototyping, as it allows for testing of functional parts and fixtures, which are directly produced in Norblast from the Draw. The 3D Printer is "open", hence it will be possible to use recycled materials (filaments).

Examples of main contributions to the EU Circular Economy targets

- Improving product design
- Improving resource efficiency
- Using recycled material

Added Value with the use of AM

- Short leadtime
- Cost savings on prototype parts and/or complex geometry

Enabling Circular Economy with AM Solutions

Norblast believes that better cost reduction using Additive Manufacturing will help improve the technology's reputation as an enabler of the circular economy.

Company Highlights

Elmec 3D is a service provider and reseller of additive manufacturing solutions. The company takes care of every aspect of your project: technology, materials, design, modeling, 3D printing and post processing operations.

Elmec 3D offers 3D printing solutions for your additive manufacturing projects: from rapid prototyping, to small and medium productions. You will be guided step by step in the selection of the most suitable technology for you by specialized personnel.

Best practice example

Technology used: Fused deposition modeling; MJF, MBJ, DLP

Model of the Machine: HP 5200, HP 4200, Desktop Metal Shop System, Desktop Metal Studio System, 3Dsystem Figure4, Desktop Metal Fiber, Various FFF/FDM

AM Material used: Thermosets Polymers, Thermoplastic Polymers, Elastomers, PMC, Metals

Description of the Application:

The increase in the overall sustainability production is not just by using recycled materials. It is defocusing thinking that the problem is only the type of material and its recyclability. The main issues are related to the number of materials the producer consumes in manufacturing the final part, the water usage, the lubricants usage and the tooling consumption. Therefore, the sustainability of the AM process lies in the fact that producers use only the necessary materials to produce a specific part and they recycle the rest of the materials.

Added Value with the use of AM

- Weight reduction (final product)
- Enabled distributed production
- Components consolidation
- Energy saving in final products
- Waste reduction
- Downtime reduction
- Repair and reuse

Examples of main contributions to the EU Circular Economy targets

- Improving access to repair and maintenance
- Reducing waste production
- Improving product design

Enabling Circular Economy with AM Solutions

Elmec 3D lists the following factors when it comes to turning AM into a real enabler of the circular economy: validations, certifications, procedures, industrial AM ecosystems and a change in mindset.

Company Highlights

F3nice believes in a more sustainable world. By rethinking the traditional industrial production cycles, they help in introducing enabling technologies in your business. They propose smart ways to confer additional value to your waste. Their goal consists in promoting an efficient resource utilization, in order to be green, innovative and economically successful.

In a short time, f3nice's efforts towards sustainability and challenging the status quo of Additive Manufacturing feedstock have been internationally recognized. The company has been invited to participate in multiple joint industry projects, part of paid pilot projects, received soft funding through two Horizon Europe projects and has even generated several commercial sales.

Best practice example

Technology used: VIGA

Model of the Machine: Amazemet RePowder

AM Material used: Inconel

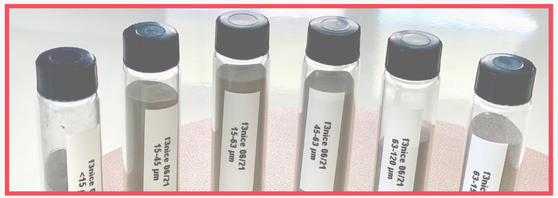
Description of the Application:

The metal waste from the Oil&Gas industry (bulk metal scrap) and the AM value chain (exhausted powder, failed prints) are collected to strenthen the AM feedstock for BJT, PBF, and DED applications, which was tested on different systems to ensure quality. LCA offers a smart cradle to grave evaluations on the CO2 savings of the Circular Economy Ecosystem versus the standard Linear Economy practice, without quality losses and component sustainability.

Added Value with the use of AM

- Enabled distributed production
- Energy saving in final products
- Waste reduction

A grave to cradle LCA was performed to evaluate the CO2 savings of this Circular Economy Ecosystem versus the standard Linear Economy practice, with the support of the Environmental Engineering Department at Politecnico di Milano. A Critical Review by a third-party quality assurance body, such as DNV, will be performed to certify the data.



Enabling Circular Economy with AM Solutions

F3nice argues that economic incentives and a regulatory framework that would certify the real Circular Economy applications and avoid greenwashing practices, are some of the most important steps to be taken in order to turn AM into a real enabler of the circular economy.

Examples of main contributions to the EU Circular Economy targets

- Enabling re-manufacturing
- Using recycled material
- Improving resource efficiency
- Reducing waste production

Company Highlights

3D4MEC, a leading company for capital and know-how in the production of 3D printers for metals, was created as a spin-off of the Au. Te.Bo group to meet the growing need of speeding up production of metal mechanical components.

3D4MEC printers were created with the aim of speeding up the production flow and time to market of the products of mechanical companies.

In particular, each 3D4MEC printer is:

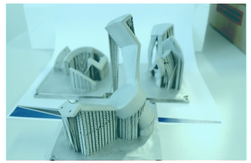
- Built, in all its details, to achieve the best components for the mechanical sector;
- Specialized to perform at its maximum with a product range of specific material;
- Customized to meet the needs of each single customer.

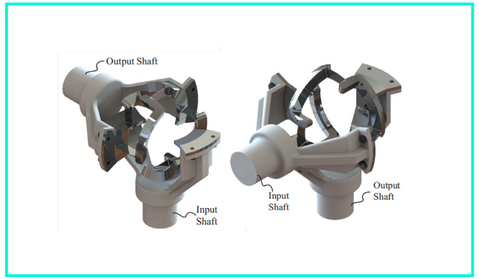
Best practice example

Technology used: Selective laser melting

Model of the Machine: 3D4STEEL

AM Material used: AISI 316L





Description of the Application:

Compliant mechanisms are a special kind of articulated system in which motion, force or energy are transferred or transformed through the deflection of flexible members. Despite the potentialities, exploitation and study of CMs to date have mainly focused on planar motion cases. The main reason hampering the development of flexures specialized for 3D motion lies in the limited geometrical complexity realizable by the technologies that were used for the manufacturing of CMs; specifically: precision milling, laser or water jet cutting and electrical discharge machining. This case study focuses on a compliant spherical joint designed by Professor Giovanni Berselli and his collaborators. The joint geometry is innovative and takes about 44 hours to get manufactured with a 3D4STEEL printer. The production with AM enabled the use of transformed material into the final objects (total volume of about 180 cm ^ 3 - 1.8 kg) and a small amount of waste (approximately 110 grams), less than 8% of the component material. If the component had been made by milling process it would have resulted in a much higher generation of waste material estimated at 35 kg. The production with 3D4STEEL plants has enabled the production of new complex geometries combined with a reduction of waste by 95% (around 33 kg of material) that deriving from traditional technologies.

Added Value with the use of AM

- Material use reduction
- Waste reduction

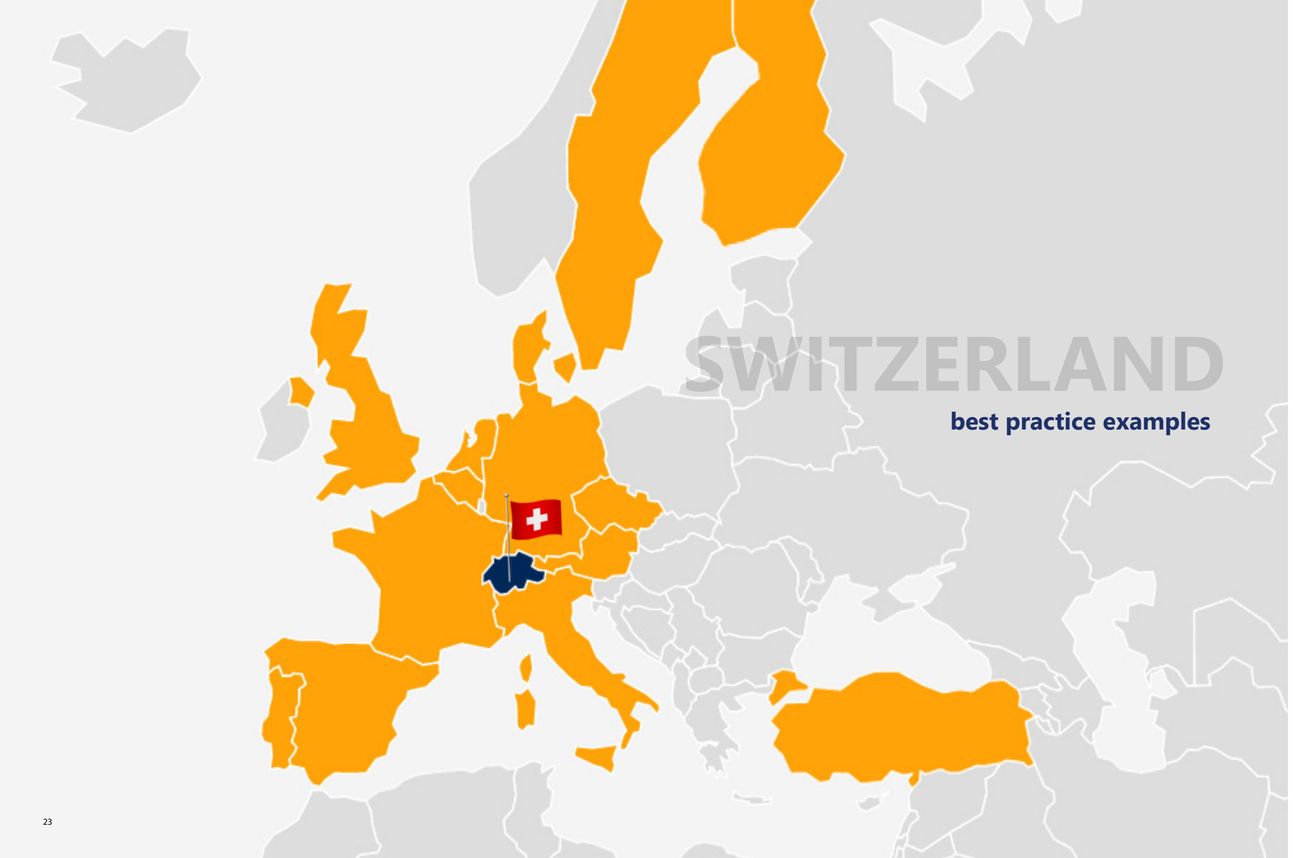
In the PBF process, powders are utilised with a particle size between 25 and 70 microns. The production process generally involves a waste of about 2-3%, given by fused powders in the contour of the object that comes into contact with the laser and undergoes a melting process. The 3D4STEEL printer, with a working chamber of 110x110x110 millimetres, is used in the manufacturing of the Cardan joint. The plant is loaded with 30 kg of powder for production in job one and afterwards in job two and job three. At the end of the manufacturing of the three print jobs, 27 kg of powder were available for the next production (about 98% of the powder was not transformed into the final product). In particular, the 3D4STEEL printers have an integrated system that allows the continuous recycling of powders even during the printing process. Hence, 3D4STEEL employs the minimum volume of poweders necessary for the process, shortening operator's interaction with the powders and their dispersion in the environment.

Examples of main contributions to the EU Circular Economy targets

- Using recycled material
- Reducing waste production
- Improving resource efficiency
- Improving product design

Enabling Circular Economy with AM Solutions

3D4Mec engineers opine that the production of mechanical components with AM technologies is already an enabler for the circular economy, but limited to small size components required in a small number per year. The availability of a small number of powders is another limit for the technology use in the mechanical fields. 3D4Mec is involved in technology development that will boost productivity (e.g. the recoating time reduction to maximize the efficiency) and speed-up the evolution of new powders (e.g. development and production of the first printer for brass alloys).



SWISSMEM | Swiss Additive Manufacturing Group

Part 3 - Switzerland

National Association

The Swiss Additive Manufacturing Group (abbreviated to SAMG is a sub-group within the Swissmem association. Any industry partner from Switzerland or Liechtenstein which is a member of Swissmem and which is involved in additive manufacturing as a producer, user, service provider, consultant or researcher can join SAMG.

We strengthen the development of our members' business ties and information network, facilitate contact with universities and research institutions, maintain the industry's public reputation, provide services for members and partners, and promote collaboration with other organizations both in Switzerland and abroad.

65
SAMG
Members

47
companies
+
9 universities

Main activities of SAMG

- **Research and development**: overview of current and future research topics, link to research network.
- **Basic and further training**: overview of the training opportunities available, developing and holding AM training courses.
- **National network**: regular exchanges between the division and external partners on current topics and projects.
- **International network:** international exchange and overview of research and project partners, standardization bodies and legislation.
- **Materials**: clarification and overview of questions relating to plastic, metal and ceramic materials and special materials.
- **Industrialization**: From AM research to the industry

Company Highlights SINTRATEC

Sintratec is a Swiss provider of selective laser sintering (SLS) solutions. The professional 3D printing systems and resilient materials meet the highest industrial requirements. From the consultation to the service – Sintratec offers a user-friendly and overall package for modern, scalable additive manufacturing. To realize your ideas and designs in a fast and cost-effective way.

Sintratec created the first Selective Laser Sintering benchtop 3D printer in the world – the highly praised and awarded Sintratec Kit. Since then, they have been continuously improving their machines and developing new solutions.

Best practice example

Technology used: Selective laser sintering

Model of the Machine: Sintratec S2 Starter Cell

AM Material used: Polymer powder (TPE & PA12)

Description of the Application:

With the Sintratec S2 Starter Cell, the powder can be reused sustainably: After a print job, there is inevitably a lot of residual powder outside and perhaps even inside the produced parts. This powder is not thrown away but recycled by mixing it with new powder (Sintratec Virgin Powder). The mixing ratio with PA12 is 70% (used powder) to 30% (virgin powder), while with Thermoplastic Polymer, the mixing ratio is even lower. Thereby, Sintratec confirms a modular and sustainable process.

Added Value with the use of AM

- Material use reduction
- Energy saving in final products
- Waste reduction
- Weight reduction (final product)

The Sintratec S2, the all-in-one solution, allows for reducing downtimes, thus benefitting from a cost-effective operation. The selective laser sintering system contains three high tech machines: the Laser Sintering Station (LSS), the Material Core Unit (MCU) and the Material Handling Station (MHS). Together these modules make up a uniquely self-contained process system for AM. Once the high-quality SLS printing in the Laser Sintering Station is finalised, the printed objects are easily removed in the Material Core Unit and then cleanly de-powdered in the Handling Station. Furthermore, the ingenious Material Core Unit allows switching from one print material to another, reducing downtimes and expanding SLS machinery. To elucidate, the modular process of the Sintratec S2 Starter Cell reduces downtimes by printing directly material core unit instead of waiting for cooling down. Moreover, 3D printing provides an opportunity to minimise the parts' weight and maximise their strength through the innovative lattice and honeycomb structures. Furthermore, the Sintratec's Nesting Solution saves valuable printing time and material by automatically arranging 3D objects within the Sintratec S2 build volume. Likewise, the algorithm quickly places 3D objects in the print space with an ideal packing density, saving up to 40% of material and printing time.

Examples of main contributions to the EU Circular Economy targets

- Reducing waste production
- Improving product design
- Improving resource efficiency

Enabling Circular Economy with AM Solutions

Through AM, economic contestants are less dependent on suppliers since the parts are constructed in-house, thus reducing the time-to-market and increasing flexibility. A great benefit is that prototypes can be adapted as often as necessary until the product fully meets the requirements. In this way, errors in large series productions can be avoided. Digitalising the design saves many resources in terms of material and time, given the 3D files can be modified as often as required before printing. Prototypes and series production can be generated in an all-in-one machine, leading to costs saving and cost efficiency in financial and time aspects.

Company Highlights

9T LABS

Founded in 2018 by a team of pioneers, passionate about bringing the next generation of high performance manufacturing, 9T Labs aspires to mass-produce high-performance composites as easily as metals. They do this by automating and digitizing the production workflow of composite production at the most innovative companies.

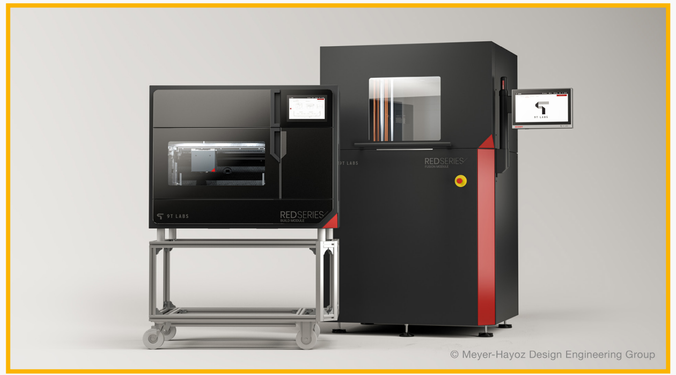
The team understands the complexities of anisotropic materials and the manual process in manufacturing carbon composites. To simplify this, they set out to provide an all-in-one solution to help customers radically ramp up their composites series production and turn their series production ideas into production cases within months - not years.

Best practice example

Technology used: Fused deposition modeling

Model of the Machine: Red Series Build Module

AM Material used: Thermoplastics (PEEK, PEKK, PPS, PA) with continuous fibers (carbon, glass, basalt)



Description of the Application:

The 9T Labs' technology platform enables a desktop size high-performance structural parts to be produced in CFRTP composites in production volumes, ranging from 100 to more than 100,000 parts per year. It combines software and 3D printing with compression molding in matched metal dies for a more sustainable and high-performance alternative than traditional metal and plastic manufacturing technologies.

Added Value with the use of AM

- Weight reduction (final product)
- Components consolidation
- Material use reduction
- Energy saving in final products
- Waste reduction
- Repair and re-use

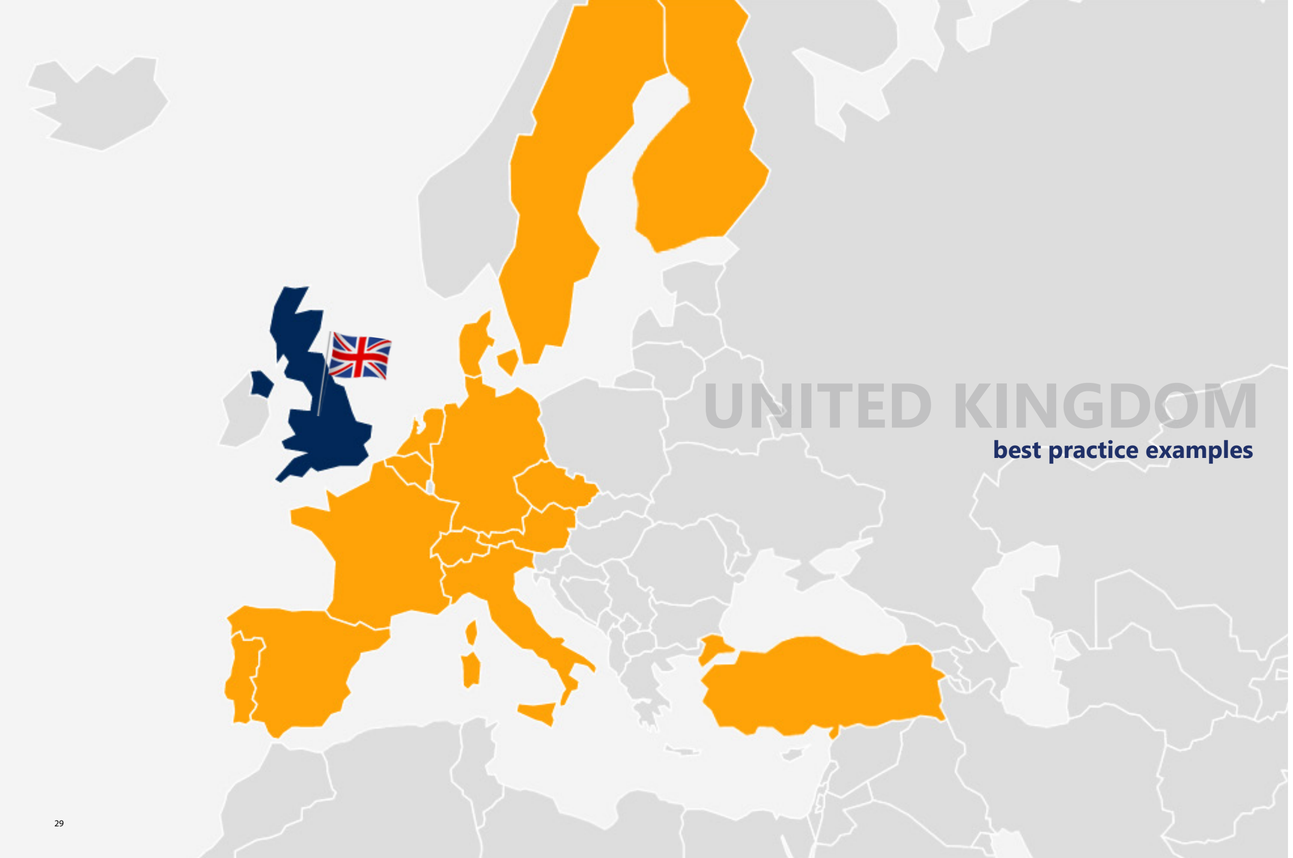
The additive fusion technology combines 3d-printing - for increased automation, low material waste, high precision of material deposition (decreasing the necessary amount of fibres while maintaining the performance level), high R&R, low void content, maximal interlaminar strength and excellent tolerances. The use of thermoplastics allows remelting operation (repair & re-use), whereas combination with continuous fibres ensures long-lasting stable properties & lightweight parts, thus having a positive impact in use.

Examples of main contributions to the EU Circular Economy targets

- Enabling re-manufacturing
- Using recycled material
- Reducing waste production
- Improving product design

Enabling Circular Economy with AM Solutions

To become a real enabler of the Circular Economy, it is necessary to prove that AM technology is scalable, therefore proving that it is possible to produce specific applications in higher volumes.



UNITED KINGDOM

best practice examples

Part 4 - United Kingdom

National Association

The Manufacturing Technologies Association (MTA), established in 1919, is the UK's trade association for companies in the manufacturing technology sector. MTA members design, manufacture and supply the advanced machinery, equipment and intellectual property that enable the creation of the products we rely on from day to day and that drive our economy. Key aspects of manufacturing technology include machine tools, tooling, metrology equipment, additive manufacturing, surface finishing, robotics and software, as well as the technology which is enabling the digitalisation of manufacturing, the fourth industrial revolution, such as sensors and AI. These technologies are increasingly being combined to create complete systems – which are ever more automated and adaptive - that manufacturers deploy, making the sector fundamental to the prosperity, health and defence of the nation.

The MTA provides a range of services for members, such as marketing support, networking, specific and relevant economic and technical information, Government and stakeholder representation, exporting advice and support for learning and development. The MTA also owns and runs MACH, the UK's premier exhibition to showcase manufacturing technologies. The biennial exhibition, held at the NEC, attracts around 25,000 visitors and 600 exhibitors.

The MTA also manages and provides services for the Engineering Industries Association (EIA) and Additive Manufacturing UK (AMUK). The EIA represents the UK engineering manufacturing supply chain, with a focus on SME's. AMUK represents the Additive Manufacturing (AM) and 3D Printing eco-system within the UK. AMUK's main purpose is to establish the UK as a world leader in the development, adoption and use of 3D Printing and AM technology.

377
MTA
members

110
AMUK
members

Main activities of the MTA

- **Industry Intelligence** – Free Standards Access, Standards Development, Legislation Information, Health and Safety Information, Public Funding Opportunities, Market Intelligence
- **Events and Networking** – MACH Exhibition, Annual Dinner, Golf Day, Seminars, Conference Facilities, International Pavilions, Weekly members Newsletter, Quarterly Magazine Update
- **Government Liaison** – MP Engagement, Government Department Contacts, Media Engagement
- **Business Support** – Trade Press Contacts, MACH Email Directory, HR Support, General Business Support, Export Advice, MTA Website
- **Education and Development** – Training Grants, Apprenticeship Grants, Apprenticeship Jobs Board, Influencing Government Skills Agenda, TDI Challenge, MACH Education and Development Zone

Company Highlights

WIRE ARC ADDITIVE MANUFACTURING

WAAM3d developed state-of-the-art WAAM additive manufacturing technologies that help their customers create outstanding AM solutions for large-scale industrial metal components. They have experience in creating components for the aerospace, energy, marine and mining industries. The company also support a number of Catapult centres and other research bodies that are working on the latest innovations in manufacturing.

Best practice example

Technology used: Wire Arc Additive Manufacturing

Model of the Machine: RoboWAAM

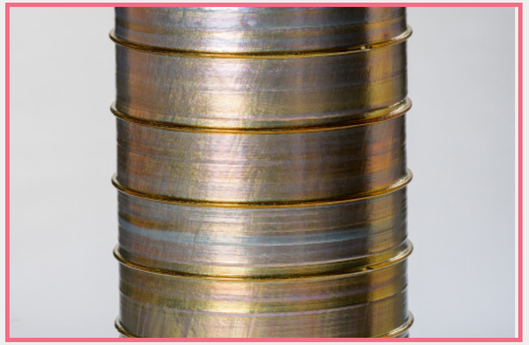
AM Material used: Titanium

Description of the Application:

A team, comprised of Thales Alenia Space, WAAM3D, Cranfield University and Glenalmond Technologies has successfully produced a first full-scale prototype of a titanium pressure-vessel for future space exploration. The vessel is approximately 1 metre in height, weighs 8.5 kg in mass and is composed of the titanium alloy Ti-6Al-4V, using the WAAM process. As a result, the latter has reduced lead times and has used 30 times less raw materials than the traditional processes. Therefore, following the WAAM process, more than 200 kg of Ti-6Al-4V has been saved for each item.

Added Value with the use of AM

- Components consolidation
- Enabled distributed production
- Material use reduction
- Waste reduction
- Energy saving in final products



Examples of main contributions to the EU Circular Economy targets

- Reducing waste production
- Improving resource efficiency
- Improving product design

Enabling Circular Economy with AM Solutions

According to WAAM3D, research funding to support methods that develop the production of first-class feedstock with heavy utilisation of recycled materials, would be essential for turning AM solutions into a real enabler of the circular economy.

Company Highlights

RENISHAW
apply innovation™

Renishaw is a global, high precision metrology and healthcare technology group. They design, develop and deliver solutions and systems that provide unparalleled precision, control and reliability. Renishaw is also a world leader in the field of additive manufacturing (also referred to as metal 3D printing), where they design and produce industrial machines which 'print' parts from metal powder. From transport to agriculture, electronics to healthcare, their breakthrough technology transforms product performance.

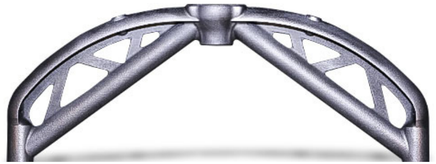
Renishaw has more than 77 offices in 36 countries, with over 5,000 employees worldwide. Over 3,000 people are employed within the UK where they carry out the majority of their research and development and manufacturing.

Best practice example

Technology used: Powder bed fusion

Model of the Machine: AM250

AM Material used: Prototyping in stainless steel (inox) and manufacturing a lighter weight part in titanium



Description of the Application:

In the development of new components in Moto2 bike design, achieving a weight reduction is a priority. In particular, reducing the 'unsprung mass' of the bike is a key consideration. The lower the unsprung mass, the better the suspension is in terms of vibration management and responsiveness to both braking and acceleration.

Of equal importance is the speed with which the design of a new component can be modified, and how long it takes to remanufacture. Achieving perfection in a highly competitive environment demands fast, accurate component iteration. In a high reliability environment, mechanical strength is a further prime consideration. The TransFIORmers' wishbone component needs to assure best possible rigidity, while handling significant levels of dynamic steering force.

"To improve overall motorcycle performance, reducing the weight of all components located behind the shock absorbers is absolutely vital. Failure to optimise component weights can have an adverse effect on vibration, braking and acceleration, so weight reduction is a really high priority", says Jérôme Aldeguer, TransFIORmers.

The company produced the metal 3D printed wishbone using a Renishaw AM250 additive manufacturing system; initially prototyping in stainless steel (inox) and finally manufacturing a lighter weight part in titanium. Key to the new 3D component design was an iterative process of topological optimisation, whereby the wishbone layout was successively rationalised in software within tight space constraints to withstand a set of predefined front fork loading conditions.

Importantly, using the AM250's dedicated Optical Control System (OCS) software, I3D Concept was able to very accurately control laser steering which helped to enhance precision, definition of features and surface finish.

Added Value with the use of AM

- ✔ Weight reduction (final product)
- ✔ Components consolidation
- ✔ Material use reduction
- ✔ Cost reduction
- ✔ Energy saving in final products
- ✔ Stronger part
- ✔ Efficient process

Enabling Circular Economy with AM Solutions

Renishaw believes that AM's widespread adoption for industrial applications will help us turn the dial on sustainable manufacturing.

Examples of main contributions to the EU Circular Economy targets

- ✔ Reducing waste production
- ✔ Improving resource efficiency
- ✔ Improving product design

OTHER ASSOCIATIONS OF THE CECIMO AM NETWORK

.AGORIA

Agoria

Agoria paves the way for all technology-inspired companies in Belgium that develop and apply innovations to realise growth and progress worldwide, representing over 310,000 employees. Agoria has more than 2000 technology companies from the manufacturing industry, the digital and telecom sectors among its members, 70% of which are SME's. This makes Agoria the largest federation within the Federation of Belgian Enterprises.

Agoria does not only provide individual services to its members, but also strongly focuses on a collective operation between member companies from the technology industry. Agoria's purpose is to connect all those inspired by technology (like Additive Manufacturing), to help companies grow and to help shape a sustainable future.

Agoria serves as a platform to bring together a whole Additive Manufacturing ecosystem, connecting universities, research centers, services providers, machine producers, software companies and end-users. Agoria also has its own technology center, Sirris, which supports companies in introducing new technologies into their products, processes and business.

2000
Agoria
members

70%
SMEs

Main activities of Agoria

- **Inform and inspire** members on sector specific regulations and technological themes
- **Influence and advice** governments for a healthy entrepreneurial climate
- **Initiate and stimulate** cooperation by and between companies and external stakeolders

FPT-VIMAG

The Production Technology Federation (FPT-VIMAG) is the trade association of innovative manufacturers and importers of machines, tools and services for the metal industry, and suppliers of automation and control systems for the (inter)national manufacturing industry. Members provide the technology and knowledge needed to produce smartly, efficiently and competitively.

Their 3d printing department focuses on increasing the level of knowledge about 3D printing among SMEs. The department has a broad representation with manufacturers and importers, but also software and post-processing. The department has drawn up a clear project plan that mainly focuses on the promotion of the relatively new production technology.

FPT-VIMAG has a growing number of members in the field of 3D printing. This increases the collective interest in being visible to different stakeholders and the market. FPT-VIMAG is affiliated with the European umbrella organization CECIMO and therefore the Dutch representative for additive manufacturing.

150
FPT-VIMAG
members

11
3d printing
companies

Main activities of FPT-VIMAG

- **Organising** trade shows, network events and meetings
- European **representation and information** provision
- Sector-specific added value through **participation** in sections and departments

VDMA

The Working Group Additive Manufacturing within VDMA exists since 2014 and is part of the Federation for Mechanical Engineering. In this context, the main goal of the group is the industrialization of the innovative manufacturing technology. Focus topics of the group are machine connectivity, process chain automation, smart factory, EHS, part certification as well as education, information and spread in new application areas.

Currently, the steadily growing group has around 200 international members. The companies are equipment manufacturers from the entire additive manufacturing process chain, their suppliers, material manufacturers, service providers with various materials and processes, as well as a large group of machine builders who (want to) use AM as an industrial manufacturing process. Research institutes are also involved in the group. The board of the working group consists of 9 representatives of major companies.

AM is of high interest to member companies of the VDMA who use the technology as an enabler in the area of freedom of design (function integration, weight etc.), individualization (prototypes, personalized solutions etc.) or service (spare parts, repairs etc.). At the same time, the VDMA-network includes a number of leading technology providers for the development and integration of the manufacturing process into the industrial production environment.

3500
VDMA
members

200
3d printing
companies

Main activities of VDMA:

- **Education initiatives**
- **Market surveys**
- **Trade fairs and PR-activities** (e.g. Formnext)
- **Networking opportunities** with the 3500 VDMA members of different industry sectors
- **Working groups** (industrialisation)

cecimo

European Association of the Machine Tool Industries and related Manufacturing Technologies

Credits

Publisher:

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Editor:

Vincenzo Belletti

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Diana Anichitoaei

CECIMO is the European Association of the Machine Tool Industries and related Manufacturing Technologies. We bring together **15** national associations of machine tool builders, which represent approximately **1500** industrial enterprises in Europe (EU + UK+ EFTA + Turkey), over **80%** of which are SMEs. CECIMO covers **98%** of the total machine tool production in Europe and about **1/3** worldwide. It accounts for approximately **150,000** employees and a turnover of around **22.6 billion euros** in 2021. More than three quarters of CECIMO production is shipped abroad, whereas half of it is exported outside Europe.

CECIMO National Associations

Austria: FMTI, Association of Metaltechnology Industries
www.metalltechnischeindustrie.at

Belgium: AGORIA,Federatie van de Technologische Industrie
www.agoria.be

Czech Republic: SST, Svazu Strojírenské Technologie
www.sst.cz

Denmark: DI - Confederation of Danish Industry
www.di.dk

Finland: Technology Industries of Finland
www.teknologiateollisuus.fi

France: EVOLIS, Organisation professionnelle des biens d'équipement
www.evolis.org

Germany: VDW, Verein Deutscher Werkzeugmaschinenfabriken e.v.
www.vdw.de

Italy: UCIMU, Associazione dei costruttori Italiani di macchine utensili robot e automazione
www.ucimu.it

Netherlands: FPT-VIMAG, Federatie Productie Technologie / Sectie VIMAG
www.ftp-vimag.nl

Portugal: AIMMAP , Associacâo dos Industriais Metalúrgicos, Metalomecânicos e Afins de Portugal
www.aimmap.pt

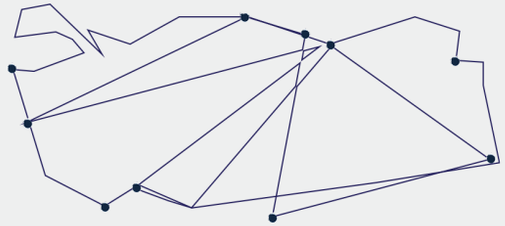
Spain: AFM, Advanced Manufacturing Technologies Asociación española de fabricantes de máquinas-herramienta, accesorios, componentes y herramientas
www.afm.es

Sweden: SVMF, Machine and Tool Association of Sweden
www.svmf.se

Switzerland: SWISSMEM, Die Schweizer Maschinen-, Elektro- und Metall-Industrie
www.swissmem.ch

Turkey: MIB, Makina Imalatcilari Birligi
www.mib.org.tr

United Kingdom: MTA, The Manufacturing Technologies Association
www.mta.org.uk



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