



Additive manufacturing on its way to industrialisation

A game changer?





Additive mandufacturing on the global rise Tim Caffrey, Wohlers Associates



"The EU needs to invest in additive manufacturing," Reinhard Bütikofer, MEP



Opportunities in digital manufacturing Bernhard Langefeld, Roland Berger Strategy Consultants

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Additive manufacturing: pushing the frontiers



Is additive manufacturing (AM) the real "Fourth industrial revolution", with the related innovative technical, economic and social impacts? With the increased accessibility to AM capabilities, the possibilities of more widespread mass customization is real in industries such as automotive, healthcare, aerospace, oil & gas and consumer markets.

Since 1987, additive manufacturing was mainly used for rapid prototyping: the high degree of design freedom allows manufacturing functional prototypes with complex shapes, cost- and time-

efficiently, without manual processing. While rapid prototyping is still used to quickly produce a scale model of a physical part or assembly using 3D computer aided design (CAD) data, today's applications allow manufacturing production-quality parts. After huge developments, it is now possible to print end-use products as well, in relatively small numbers without the typical unfavorable short-run economics. Additive manufacturing is expected to become the leading technology for manufacturing high-performance products. It could even be the next revolution if its applications reach mass production levels.

CECIMO is always on the forefront of R&D-generated solutions in all industrial sectors, including automotive, aerospace, power generation, medical products and general engineering, Evidently, AM is one of those Key Enabling Technologies (KETs) that must be monitored closely: it can lead to increased efficiency, accuracy and speed, as well as reduced costs and environmental impact in manufacturing. A certain set of circumstances could encourage the development of AM technologies: the rising cost of raw or precious materials, the development of CAD software and IT systems, the need for more sustainable manufacturing (in terms of costs and environment), and an increasing demand for ready-to-market products.

When we started discussing which impact AM could have on manufacturing in general and on machine tools specifically, we realized that costs, time of production and low economies of scale remain the main obstacles to a widespread utilization of AM technologies. However, manufacturers of industrial AM machines joined our network as a reference which can provide a strong support for the healthy development of the industry... and this is why CECIMO Additive Manufacturing Initiative came to life: to support new technologies and the development of European manufacturing.

Filip Geerts Director General

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Additive Manufacturing – Manufacturing opportunities in digital production

Dr.-Ing. Bernhard Langefeld, Principal at Roland Berger Strategy Consultants

Digital production

Digital products and services are entering every aspect of our day-to-day life. Cheap, user friendly platforms such as smartphones and tablets, declining prices of sensors and cheap options for mobile data are driving this trend, in turn creating new business models. Examples include 3D glasses for touring virtual factories, coffee machines that automatically order new capsules when required and the ability for users to analyze numerous sets of data gathered from sensors in armbands and items of clothing that record their movements on their smartphone.

Given the growing importance of the digital revolution, Roland Berger Strategy Consultants estimates that Europe's "lead industries") could enjoy productivity gains and add value of approximately 20-30% per industry in their ICT (Information and Communication Technology) share worth Euro 1.25 trillion by 2025²).

Additive Manufacturing – The direct transformation of digital data into products

Unlike traditional manufacturing processes such as turning, milling and

grinding, Additive Manufacturing (AM) adds material in layers rather than gradually taking it away. The technology was developed around 30 years ago in Germany and for a long time it was used mainly for producing prototypes.

AM makes it possible to produce components of almost any form out of a variety of materials (plastics, metals, sand/ceramics) without the use of tools. The cost of a component does not increase in proportion to its complexity. Complex cooling, mixing and lightweight geometries can be produced without generating an extra cost, even in difficult to process turbine materials. The geometric data of a component is directly transferred into a product in a very short space of time. Only the required quantity of material is used as is necessary for the manufacturing of the component, thereby saving resources. AM also allows new repair strategies for valuable components, saving both time and money, and enables the production of new, high-performance materials.

As a result of these characteristics, AM has a disruptive impact on traditional

If Europe misses out on the digital transformation, it could forfeit EUR 605 bn in lost value added



Potential losses arising from a shift in the shares of value added

1) Gross value added (GVA) foregone by the EU-17 countries id the increase in ICT's share of GVA is lost to international competitors

production techniques and value chains, along three dimensions:

- Faster, cheaper production of custom-made products in smallscale production, e.g. prototypes and implants
- The ability to manufacture components of new geometries and materials leading to higherperformance products, e.g. turbine burners and aero-structures
- Decentralization of production as manufacturing can be done locally, e.g. using printers in remote service centers or on board ships

The disadvantages of AM are its high cost and the lack of economies of scale when production in large lot sizes is required. Furthermore, metal components, in particular, cannot be used immediately after being "printed" as heat or surface treatment, mechanical processing and inspection are required. As AM technology is relatively young and the process and material parameters are seldom published by the firms that use it, the entry hurdles for its acceptance as a mainstream technology are still relatively high, especially in the case of metallic materials and the aerospace industry.

AM's technological maturity for series production depends on the industry in question. It is already used for series production in medical technology and in the construction of tool inserts for enhanced component cooling. In the aerospace industry it is at the point of break through into series production. In the automotive industry, by contrast, given the large lot sizes and cost pressure, AM technology is not expected to enter series production in the medium-term.

Compared to series components that can be manufactured conventionally, the costs for AM are significantly higher. Therefore, the business case to implement AM only becomes favorable when it can produce series components with superior performance characteristics, such as lighter or more streamlined items that cut fuel consumption.

AM is an integral part of the digital economy: it enables to transform data into high-performance components, generating economic, societal and environmental benefits.

Due to the geometrical freedom it offers, AM for the first time has made it possible to build "bionic structures", thus opening up new avenues in lightweight construction. For example, Airbus is installing bionic cabin brackets made of titanium powder in its A350 XWB: 30% lighter than their predecessors and with 90% less raw material waste. What is the result? A lower production and operating cost!

The technological advances in AM have led to an annual market growth of around 20% p.a. between 2004 and 2014 which will increase substantially over the coming years. The market for raw materials, the manufacture of components and production infrastructure is estimated to be worth about Euro 7.7 billion by 2023. Increase in efficiency of AM production

Examples of metal additive manufacturing products



technologies combined with falling prices for materials will support this trend.

Today in Europe, complex products and the corresponding processes are mainly driven by large corporations, who will need highly efficient suppliers as volumes increase.

Challenges for AM in European industries

Additive manufacturing has a key strategic role to play, not just through the increasing digitalization of the economy but also by producing highperformance metal components, particularly in the medical, turbine and the aerospace industry.

Currently, the design and the production of all machines for the manufacturing of metal parts is concentrated in Europe. Targeted support by European institutions for this technology and its development would result in Europe retaining its lead as a metal AM equipment supplier over other economic areas. However, competition is fierce. Companies in the US currently have the lead in technology when it comes to component development and production in the aerospace industry. Europe lacks a robust structure in the AM supply chain for series production and gualified engineers in AM technology that can meet the expected high levels of demand for high-performance products. Currently in Europe, AM products and the corresponding manufacturing processes are mainly driven by large corporations, who will require suppliers that can meet the demand in volume increase. Further standardization of processes and material specification will ease this process.

Global AM market



1) World machine tool production excl. parts and accessories 2) Professional systems only

¹ Automotive, logistics, medical technology, electrical engineering, mechanical / plant engineering, energy systems, chemicals and aerospace industries

² The digital transformation of industry: A European study by Roland Berger Strategy Consultants on behalf of the Federation of German Industries (BDI)

About the author Dr.-Ing. Bernhard Langefeld is Principal at Roland Berger Strategy Consultants

His activities are in the field of manufacturing technologies and production performance improvement. Key clients are the manufacturers of long life cycle products such as energy generation equipment (steam/gas/wind and hydro turbines, generators, boilers, heat exchangers etc), aero-turbines, tool machines, heavy Diesel engines etc.

Focusing on this client group, Bernhard analyzed the status and growth potential of Additive Manufacturing (AM) for metal structures and summarized the results in the study "Additive Manufacturing – A game changer for the manufacturing industry ?". Bernhard has supported various clients in developing their AM Strategy on corporate level (Corporate AM Strategy) as well as on component level (AM Industrialization Strategy). Further he is a production specialist for the topics Digitalization and Industrie 4.0, which are very closely linked to AM.



3D printing transforms manufacturing and whets appetite for new investment

By Onno Ponfoort, Practice leader 3D Printing at Berenschot, the Netherlands

The term "3D printing" got worldwide attention after an article published in The Economist in April 2012, in which a third industrial revolution was predicted, made possible by the virtue of layer-by-layer additive manufacturing technology. In the near future, moulds and casting or costly machining of parts and products would not be required anymore. Using 3D printing, "on demand and on location production" could be done in the vicinity of the end user. The software that drives the machines allows for designs to precisely meet the demands of the user. The material that is saved is used for the next production run, which results in less waste and less pollution.

Nowadays, 3D printing (or additive manufacturing) is seen as one of the components within the realm of "digital manufacturing". In both large scale factories and within SME's, the digitisation of production will have a disruptive effect. The ecosystems in which production takes place will be organised along new lines, with new communication protocols. That is why large and smaller companies are investing heavily in 3D printing, but governments and regional authorities also are looking for ways to make sure that their economy will benefit from these developments.

Issues in business

Whereas 3D printing was first used for prototyping purposes, the technology has matured in such way that tooling and production parts can now be obtained meeting end-product specifications and quality. In many sectors, 3D printing is currently used as a valid alternative for traditional production.

3D-printing orders on demand and on location instead of producing parts and stock them might still be a bridge too far for most mass produced products. Nevertheless GE, for instance, has increased its 3D printing research budgets. They focus on small series of highly complex parts. A fuel nozzle, with a more productive design and or lighter weight than the ones currently used, will be fuelling their Leap engines as of 2017. The nozzle comes straight out of a 3D printer of the same technology Siemens used for the repair of the burner heads in their gas turbines. The burner is place in the 3D printer, and the tip is 'simply' printed on the burner head in the 3D printing machine. There are only two examples so far, but they already suggest the great impact this technology will have on the tooling industry.

Impact for the tooling industry

So, will everything be 3D printed in the future? Well, certainly not everything, but for many parts and products 3D printing now already offers new and better solutions. In the near future the number of applications and possibilities will only grow.

Having the possibility to produce parts from a file, on demand and on location instead of keeping them 'on stock', lower the capital demands and transportation costs.

We see many new applications coming up, but we also see a lot of entrepreneurs and managers who are still reluctant to step in. "Is this a technology that we

Lower costs	Better design	Customisation	Sustainability	New business models
No tooling	Complexity for	 Ergonomics 	 Less waste 	 Prototyping,
or cheaper	free			
tooling		 Interfaces with 	 Light weight 	 Shorten lead
	 Added features 	other products		time or time-to-
 Less 	(cooling, isola-		 Less fuel 	market
transportation	tion, structures,	 Body contours 	consumption	
	porosity, con-	(external and		 Small series
Lower	ductivity, etc)	internal)	 Efficient supply 	
warehousing			chains	 Supply chains
	 Hybrid materials 	 Aesthetics 		(on demand, on
Less working			Life Cycle	location)
capital required	 Light-weight 	Use specific	Analysis	
		variations		 Services
	Less assembly			0
	by integrated			Co-creation /
	aesign			nome creation

Additive Manufacturing Benefits

should invest in?", "Will our customers accept the parts that we produce with this technology?" or "Can we already print with the materials currently used in traditional manufacturing techniques?" are some of the questions we get.

The main reason 3D printing has received major attention in the past five years, is that new production techniques, new process and design software and new materials have emerged, dramatically increasing the range of possibilities for use. Besides, the costs of production have fallen quite substantially. Not so much yet with regards to the materials, which are still relatively expensive compared to costs of materials used in mass production. But the price of 3D printing machines has dropped significantly, and the availability of easy-to-use and cheap design software has exploded.

The biggest economic impact of AM will come not from the consumer market, but from industry itself: it opens the door to improved tooling and production process innovation.

Many industry leaders expect that the biggest economic impact of AM will come not from the consumer market, but from industry itself. 3D printing opens the door to improved tooling and production process innovation. For instance, dies and moulds with cylindrical cooling structures could be produced, that allow for faster cooling and thus for more production cycles per hour. Investments in such moulds can be recovered easily by the increased productivity it brings.

Having the possibility to produce parts from a file, on demand and on location instead of keeping them 'on stock', will lower the capital demands and transportation costs. Again, the investments in the additive manufacturing infrastructure is recovered quickly, once quality and speed of production of the machine reaches industrial standards.

Benefits of 3D Printing

The added value of using 3D printing must be substantial to offset the high investments in machines and the use of costly materials. As Prof.-Drlr. Jean-Pierre Kruth of the Catholic University of Louvain explains "when you do not make use of the freedom of form and design that 3Dprinting offers, you might as well use other traditional production methods".

There are already many examples of products and projects that required additive manufacturing to deliver optimal results. In the medical arena, you can find many impressive stories about scull reconstructions or prostheses that have saved human lives. Almost 100% of all hearing aids are nowadays produced via additive manufacturing. In the aerospace industry, improved components have been produced that save weight, are smaller and perform better that the traditional parts.

The advantages that 3D printing can bring are manifold. The major areas often mentioned are listed below:

- · Cost savings;
- Design improvements;
- Customisation possibilities;
- Sustainability advantages;
- New business models.

There are a number of important future developments which will be realised in the coming 5 to 10 years. If you have not done so already, I advise you to jump on the additive manufacturing train and start making use of the benefits.



About the author

Dr. Onno Ponfoort is Senior Managing Consultant, Berenschot

He is an expert in the fields of strategy, marketing and business modeling. He primarily consults large international companies, helping them find and exploit new markets and new opportunities. In recent years, he has been involved in numerous large-scale international Additive Manufacturing projects, focusing on the business development side for this new technology.

Interview with Tim Caffrey, Senior Consultant, Wohlers Associates

Additive manufacturing is on global rise

Wohlers Associates, Inc. is a 28-year old independent consulting firm based Fort Collins, Colorado. The company provides technical and strategic consulting on the new developments and trends in rapid product development and additive manufacturing (AM). Moreover, for the last twenty years, it has published the Wohlers Report, an in-depth worldwide study of the additive manufacturing (AM) and 3D printing state of the industry. Wohlers Associates is a member of the National Additive Manufacturing Innovation Institute and also it serves as a member of the ASTM F42 Executive Committee. CECIMO interviewed Tim Caffrey, who works as Senior Consultant with the company, as regards latest developments on the global landscape for AM.

What happened in the last few years so that everyone started speaking about additive manufacturing?

Despite the fact that the first commercial additive manufacturing/rapid prototyping system was brought to the market in 1988, additive manufacturing has only got considerable attention during the last three to five years. The mainstream media, investment communities and consumers suddenly discovered additive manufacturing as if it never existed before. It feels almost like somebody flipped a switch.

A few factors contributed to this sudden buzz. In 2007, the RepRap project of the University of Bath brought on the market inexpensive open source 3D printing equipment in the form of kits. Two years later, a patent owned by the company Stratasys, covering one of the inexpensive AM techniques, expired. Academic interest combined with open source technologies caused consumer interest in 3D printing to explode. Also, several articles were published in the Economist magazine early 2012, which pushed the collective awareness over the top. But it is not only lots of excitement or hype, we can see substantial growth of the sector. Additive manufacturing has been growing over 30% annually during last three years, reaching to 35.2% in 2014.

Although it made its first appearance in 1988, public interest in AM only recently exploded. It feels almost like somebody flipped a switch.

How widely are additive manufacturing technologies used in the manufacturing industry?

First used for rapid prototyping, in the product development phase, the AM technologies are now used to produce end-use parts. The end-products share of AM production has gone from almost nothing in 2003 to more than 40% of overall industry in 2014. Boeing uses 3D-printed parts such as environmental control ducts that carry cool air to electronic equipment and the passenger



Sales of additive manufacturing industry consisting of all products and services worldwide. Source: Wohlers Report 2015



Tim Caffrey, Senior Consultant, Wohlers Associates cabin, the dental industry has converted to the digital industry, and over 1 million of hearing aid shells are made with the help of additive manufacturing today to provide perfect fit with patients' ears.

Which are the leading countries in research, development and innovation in the field of AM?

Today, several big companies providing systems, materials and software are established in the US, giving the country a leading role in additive manufacturing. North America is home to two out of five AM systems in the world, making it the world's leading region. Japan is not to be forgotten, hosting several companies in the field of 3D printing. The German Fraunhofer Research Institute is very active in the area of metal AM. Through its research activities, a number of companies were created and now contribute to putting Europe on the map in the field of metal additive manufacturing.

The AM industry is going from its prototyping past to its production future.

For their part, emerging Asian countries have made substantial efforts to grow their advanced manufacturing infrastructure and capacity over the last years. The governments of China, Taiwan and South-Korea have invested a lot in additive manufacturing. Those countries make serious efforts to develop their manufacturing ecosystem and invest in companies creating new AM systems and applications. Consequently, several additive manufacturing system providers, including for metal printing, have come to the market over the last three years. Other emerging economies like Turkey, Brazil and India are beginning to embrace digital manufacturing.

What are the opportunities and challenges facing a wide market uptake of AM technologies?

Compared to other traditional manufacturing techniques, the range of used materials in AM is quite limited and today, most 3D systems use photopolymers or thermoplastics. However, the materials are constantly developing. The metal branch of additive manufacturing is growing much quicker than the rest of the industry. In 2014, the unit sales of metal additive manufacturing systems increased more than 50%, considerably above the overall industry, and it also reflects in metal material sales.

Beside, new families of materials are developing: filled materials, for example metal-filled thermoplastics, carbon fibreof graphite-filled materials, and ceramics, mostly used for complex metal casting.

One driving force of additive manufacturing is mass customisation. Logically, 3D printing technologies are more widespread in areas where quick and cost-effective mass customisation gives a competitive advantage, like digital dentistry or the medical sector. Dental implants or hearing aids combine additive manufacturing techniques with the use of 3D scanning, resulting in successful mass customisation that takes into account the uniqueness of every single customer.

Which regulatory issues should be tackled as a priority in order to facilitate these technologies' market uptake?

Intellectual property and product liability issues will certainly contribute to shaping the future of AM and there is no benchmark or precedent pointing how these legal issues will be resolved. Most of the metal applications are focused in aerospace and medical industries, which are both highly regulated and very risk averse. Therefore, they are extremely careful to make sure that the equipment they produce has the same level of performance and reliability that one would expect from any aircraft or implant.

The need for a regulatory framework is definitely part of industry's transformation. The industry is going from its prototyping past to its production future. This transition brings many challenges regarding simulation, close-loop feedback control, process monitoring, non-destructive inspection, repeatability, traceability, and reliability.

Interview by Maret Veiner, CECIMO

Industrial 3D printing is coming to mainstream CNC

By Jason Jones, Co-founder and CEO, Hybrid Manufacturing Technologies

Hybrid Manufacturing Technologies Ltd. is the winner of the International Additive Manufacturing Award (IAMA), sponsored by CECIMO, the first ever international additive manufacturing award. The company shares why it makes sense to upgrade CNC machines, allowing them to 3D print metal, not only remove it.

Additive manufacturing (AM), also known as industrial 3D printing, is perceived by many as a threat to the CNC machining industry. However, it also represents a tremendous opportunity – one that is epitomized by recent innovations combining these two technologies into hybrid CNC machines.

Bringing AM Capabilities to Mainstream CNC

Have you ever made a mistake when machining a part and wished to be able to add some metal back? Or would you like to build up some features onto an existing billet or part? This is the promise of deploying industrial 3D printing of metal inside a CNC machine.

Beginning as an academic-industry research project seven years ago, a consortium set out to make changing between adding and removing metal as easy as a tool change. The result, first shown in 2012, is the AMBIT[™] tool changeable laser cladding system, which can upgrade CNC machines into industrial 3D printers for metal. Early demonstrations of its capability have included build-up of features onto existing parts and all-in-one repair of blades and impellers – including in-process inspection and finish machining of restored metal surfaces, all in a single setup.

The system can be retrofitted onto existing CNC machines, or be fully integrated with additional functionality into new CNC machines, such as the Hamuel HSTM 1000 and Mazak INTEGREX i-400 AM. By using mainstream CNC machines as a platform, this innovation represents a new way to adopt AM.





AMBIT laser cladding onto blade into a Hamuel machine tool



As-clad cummins impeller

How does it work?

AMBIT[™] laser-based metal deposition heads are stored in the tool magazine and are loaded into a milling spindle using the standard tool changer. Once loaded into the spindle, a supply unit fitted to the spindle, docks with a head and delivers laser energy and feedstock powder to enable directed energy deposition (a form of 3D welding) of non-reactive metal powders onto parts. It is controlled using he same CNC controller that is used for subtractive tool paths with some customized M-codes. Once deposition is



Adding metal vs. removing it

Summarizing at a very general level, 3D printing metal is significantly (1 to 2 orders of magnitude) slower and less precise, than removing it by CNC machining. However printing metal gives unprecedented ability to make complex geometry, can combine different materials in the same part, and is far less wasteful than machining.

Machining has been used to make critical components for 3D printers and systems since its commercialization in the mid-1980s. It has regularly been used to drill and tap holes and to perform other finishing operations on 3D printed polymer parts.

Accelerating adoption of AM systems that print metal (especially in the last 5 years) has increased the reliance of AM on machining, because nearly all parts printed in metal require some post-processing – most often machining, grinding, or polishing. To shorten print time, metal parts are often printed at a more coarse resolution to a "near net" shape relying on post-print machining to achieve the desired surface finish and accuracy.

The tandem use of these two technologies has set the stage for their convergence.

complete, the head is replaced into the magazine and machining can be resumed.

Industrial 3D printing of metal and CNC machining are complimentary digital manufacturing technologies with a bright future.

The addition of the AMBIT[™] system to a CNC machines requires a laser, powder feeder, and extraction unit. The machine enclosure must be made laser safe. The installation does not compromise the milling capability of the CNC machine. An early adopter release of this product is available in selected regions.

This development, in conjunction with the announcement of further hybrid offerings in the market, is evidence that industrial 3D printing of metal and CNC machining are complimentary digital manufacturing technologies with a bright future.

¹The combination of CNC with Powder Bed Fusion AM, such as the LUMEX Avance-25 by Matsuura, is acknowledged to be a very important step in the development of hybrid machine tools, however it is not considered to be a "mainstream" CNC machine due to the extent the CNC is modified to handle loose powder in the machine.

² Project: RECLAIM (REmanufacture of high value products using a Combined LAser cladding, Inspection and Machining system), undertaken with support of the UK Technology Strategy Board Project No: TP11/ HVM/6/I/ AB194F with consortium members: Airfoil Technologies International Llc, Cummins Inc, De Montfort University, Delcam plc, Electrox Ltd, Manufacturing Technology Centre Ltd, TWI Ltd, Precision Engineering Technologies Ltd, and Renishaw plc.



3D Printing will have a major effect on supply chains

By Graham Tromans, Principal Consultant, G P Tromans Associates

As additive manufacturing enters mainstream manufacturing, we will see a drastic change and shrinkage in supply chains: the number of production steps will be reduced, the transportation of goods, cut down and the need for warehousing, eliminated.

3D Printing otherwise known as additive manufacturing (AM) has been around for about 25 years. It is only in the past few years that industry has finally woken up to the impact these technologies could, and in some cases already are having on the way goods are made and developed.

In the initial stages of design and development, these technologies are playing a significant part in design verification, quality of design and speeding up time to market.

The use of the AM technologies is limited as far as manufacturing is concerned, owing to the speed, materials and sheer size of the systems. Nevertheless, many industries that only require small quantities or customised parts have seen major changes in the way they are using AM, moving from just a design tool to a serial production capability.

Industries such as aerospace and medical companies are using the technologies in

real world applications. And these are not the only ones seeing major time and cost benefits to employ the technologies into specific applications, along with greater flexibility in design. 3D Printing allows the manufacture of complex shapes and structures that were not feasible before.

With additive manufacturing, the only storage requirement for spare parts will be that of a hard drive to store the part data.

The overall impact of these technologies is still generally guite small but in the near future we can expect the technologies to drive the demand for much smaller and more localised capabilities. Industries that could not even consider offering customized and personalised products will now find it possible to do so and benefit financially from being able to do so. The possibility of re-shoring some of our currently lost manufacturing is another benefit we will see, as customer requirements change to much less of the high volume type products. Cutting the transportation of goods across the globe will result in great environmental benefits, such as a lowering of the carbon footprint, and the reduction in fuel requirements. The technologies also eliminate the impact of waste material that produced during the more traditional subtractive processes,

and as the processes can combine geometries to be made in one piece instead of multiple pieces this has an effect on easier recycling A UK report also highlights that using 3D Printing reduces the energy usage.

We will also see a drastic change in the areas of spares, repair and the manufacture of legacy parts. Traditionally, we see companies spend large amounts of money transporting small amounts of parts across the world and storing them in expensive warehouses until needed by the end customer. These technologies will provide a capability to manufacture these parts as and when required, with the only storage requirement being that of a hard drive to store the part data. This will also facilitate the upgrading of components at no extra cost, owing to the reduction of the need for hard tooling to complete each modification. It also greatly reduces the number of unsold components sitting on shelves.

It is hardly efficient to send parts across the globe to a customer when they could be made locally for the same cost.

It is estimated that inventories for the US stand at \$1.7 trillion, that is 10% of the GDP. All of these cannot be 3D printed but estimates show that a considerable number could employ the technologies in some way.

The traditional supply chain has many constraints, the needs of mass production, the need for low-cost high-productivity human resource, the cost of factory facility to house the various stages of production and many more incurred costs. The value of 3D printing is in the printing of low volumes, items designed to customers specific requirements, including much more complex designs than is possible using traditional manufacturing methods. The removal of traditional manufacturing processes highlighted here will greatly reduce the supply chain, probably by as much as 50%.

Taking into account these points, it is hardly efficient to send parts across the globe to a customer when they could be made locally for the same cost.

Looking at the supply chains that are capable of employing 3D Printing, or additive manufacturing as it is also known, we will see a drastic change and shrinkage from what was previously seen. They have the potential to cause chaos in the not too distant future. I believe the emergence of 3D printing/additive manufacturing into mainstream manufacturing will come round sooner than expected. Companies need to look hard at business requirements and where these technologies could have a significant benefit, and work out where the technologies could affect it.

Make no mistake, it is vital that companies start planning ahead and be early adopters and innovators, ensuring they have the lead over their competitors. Otherwise, they could find themselves playing catch up with the competition and trying to understand what needs to be done to start competing again.



About the author

Graham Tromans has 25 years' experience in the 3D Printing/Additive Manufacturing industry. He is the President and Industry Consultant at G P Tromans Associates with offices in the UK and China. He has worked with Rover Group - Boeing Aircraft Company, Airbus - JCB, Jaguar Cars - BAE Systems, Land Rover - Perkins Engines, Volvo - Rolls Royce, Daimler Chrysler amongst other industry leaders.

Prima Power

Prima Power – a leading specialist in laser and sheet metal processing machinery

Prima Power is a leading specialist in the high tech fields of laser systems for industrial applications and sheet metal processing machinery. With almost 40 years of experience in the sector, its offering is one of the widest and covers all technologies: laser processing, punching, shearing, bending, automation.

Prima Power manufacturing facilities are in Italy (Prima Industrie SpA and Finn-Power Italia Srl), Finland (Finn Power Oy), USA (Prima Power Laserdyne Llc) and China (Prima Power Suzhou Co. Ltd.). Its sales and service network is active in over 70 countries, with direct presence or through a network of specialized dealers. At present its installed base counts more than 10,000 systems.

With its product lines ThePUNCH, TheLASER, TheCOMBI, TheBEND, TheSYSTEM and TheSOFTWARE Prima Power covers all stages of the sheet metal working process.

The family of highly advanced servo-electric solutions for punching, bending and integrated processes is the widest in the world, marketed under the slogan "Energy in Efficient Use".

Undisputed leader in 3D laser machines, Prima Power is among main world players in the 2D laser segment with a wide range of top performance and highly efficient machines used in a multitude of fields all around the globe.

For a long time the ecological aspects have been included among design criteria of all Prima Power products, which are developed according to the Green Means[®] concept, combining sustainability and productivity. Some of the results of this approach are:

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Services are an important part of Prima Power activities and are meant to give a professional, dedicated and effective

support to each of our customers all over the world. Over 400 skilled service engineers across the globe and the use of the most modern communication systems for remote service and support allow Prima Power to stay close to its Customers wherever they are.

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Prima Power is the Machinery Division of Prima Industrie Group, listed on Milan's Stock Exchange. The Group today employs 1,580 people distributed over the five continents. The workforce employed is constantly growing (+ 16% versus 2010). Further to Prima Power, it includes Prima Electro, a Division specialized in industrial electronics and laser technologies.

With nearly 6% invested yearly and eight R&D facilities in Italy, Finland and USA, Research and Innovation are central activities for Prima Industrie. Main R&D guidelines are increasing performance and productivity reducing at the same time energy consumption and the impact on working environment.

The Group has a long history of innovation: the first laser machine for automotive application in 1979 and its pioneering experience in servo-electric technology for efficient and eco-friendly punching and bending systems are just some examples.

Among the latest innovations of the Group, Laser Next, the high-performance laser machine processing of automotive components, and Platino 2.0 Fiber, the new model of 2D machine with laser fiber.

For further information: www.primapower.com info@primapower.com

Additive manufacturing techniques and major application areas

By Giorgio Magistrelli, Additive Manufacturing Project Manager, CECIMO

Additive manufacturing (AM) techniques are not new comers in the manufacturing landscape. Starting from the second half of the 1980s, AM has been utilized for prototyping purposes. Since then, the AM development has been steady but constant, with a strong acceleration in the past five years.

The medical and the dental industry exploit advantages of mass customization.

While prototyping still remains the most popular AM application, the sectors utilizing AM techniques have also been expanding the scope of applications, leading to innovative and more consolidated manufacturing methods. Improvements and progress in material and processes allowed a constant development not only along the whole AM value chain, but also along products development process chains. Notably, casting and tooling applications have been utilizing the advantages offered by AM, which spilled over to diverse industrial sectors.



AM systems Sectorial distribution (Wohlers Report, 2015)

Aerospace, automotive, medical, dental, consumer products, electronics, industries are beginning to successfully integrate additive manufacturing with traditional subtractive techniques. This allows them to benefit from substantial reductions in manufacturing costs and enables the development of innovative and lighter new products for customers.

Industrial/business machines is the largest user sector of AM technologies followed by consumer products & electronics, motor vehicles and aerospace.

The newly released Wohlers Report 2015 publishes the results of a questionnaire concerning the sectorial distribution of AM systems. The questionnaire was circulated to 40 manufacturers of industrial AM systems and about 90 service providers. Although the results were quite diversified, the most common sector of application is related to Industrial/business machines (17.5%), while consumer products/electronics reach 16.6% and motor vehicles and aerospace respectively 16.1% and 14.8% of the total. Medical & dental are the fifth sector with a share of 13.1%.

Industrial/business machines still form the leading sector, even if their share lost 1% in the last year. Consumer products & electronics manufacturers play a key role, covering a large spectrum of merchandises, from mobile phones to home appliances and computers, tools and toys. In these sectors, additive manufacturing is specifically utilized to shorten the product development process and for design optimization purposes.

Large manufacturers in the motor vehicle industry use AM mainly for rapid prototyping and for rapid product development, while AM is not yet suitable for mass production.

The aerospace sector grew its share of 2.5% (year to year) and has been historically one of the first areas of application. Experimentation with the technology for aviation and defense began already in 1988. By offering more flexibility to design complex geometries which are difficult to build using subtractive techniques, AM helps reducing parts' weight without compromising their mechanical performance. Moreover, the use of topology optimization software helps reduce the amount of scrap materials, for example the precious titanium, used by the aerospace sector.

The medical sector saw an increasingly wide range of applications and adopted AM for surgical tools, implants and models, especially in the US where the Food and Drug Administration provided clearance for more than twenty different medical implant products. The medical and the dental industry can exploit the advantages of mass customization, design precision and value density, considering their combination of high value with relatively small physical volume. The waste reduction in this sector is also a key advantage, given that production costs are inflated by expensive material inputs.

Recently, other sectors also started to benefit from AM related advantages. For example, the oil & gas industry is using it as a rapid prototyping tool. Potential applications include major process equipment innovation for improved reaction vessels, heat exchanger, machine and valve part design.



Many hearing aids are already manufactured using 3D printers

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3D printing is dead, long live manufacturing!

By Thierry Rayna, Professor of Economics, Novancia Business School

3D printing has thus far been too selfcentred, something that may become an important hurdle to its broad diffusion towards the industrial base. Actually, the current success of 3D printing/additive manufacturing might be the very thing that prevents us from seeing the wood for the trees.

At a time when 3D printing and additive manufacturing (3DP/AM) industries are booming (the market has quadrupled in five years, according to the latest Wohlers Report), and when these technologies have become increasingly fashionable leading to such a large media coverage that they started to become 'hype' - the title of the present article might seem out of place.

In Rapid Prototyping/Tooling, the 3D printer is the endgame whilst in a manufacturing process, 3D printing is likely to be 'just' an element in the chain.

> Yet, while the adoption of 3DP/AM has sharply increased over the past couple of years, this does not, by any means, signify that it has reached a point where the diffusion of these technologies is unstoppable. As a matter of fact, the current success of 3DP/AM might be the very thing that prevents us from seeing the wood for the trees.

> Indeed, while the terms '3D printing' and 'additive manufacturing' (often used interchangeably) are generic terms for quite a few different technologies (SLA, DMLS, SLS, SLM, EBF, EBM, FDM, among others), they correspond to only three main types of usage: Rapid Prototyping, Rapid Tooling and Direct Manufacturing.

> Rapid Prototyping is the 'historical' use of 3D printing, as originally the materials available and the high cost/low quality of the technology did not allow for any other usage. In the late 1990s, the advent of heat-resistant polymers and metal alloys sintering enabled the use of 3D printers to build casts, moulds and

jigs used in 'traditional' manufacturing processes. More recently, the decrease in cost coupled with the increase in quality has led to the utilisation of 3D printing to directly manufacture end-use parts and products.

Looking at the usage of 3D printing nowadays, it is quite clear that the overwhelming majority of applications are related to Rapid Prototyping and Rapid Tooling, while Direct Manufacturing is seldom used outside a couple of niche applications (e.g. prosthetics, aerospace, automotive, gadgets).

Although one could expect a natural transition to occur in time (as cost decreases and quality increases) between Rapid Prototyping/Tooling and Direct Manufacturing, thereby ensuring a wide diffusion of 3D printing technologies, a thorough analysis of the market and of the current technology reveals that a smooth transition is far from likely. As a matter of fact, it could even be argued that it is the very success of Rapid Manufacturing and Rapid Tooling that hinders the development of Direct Manufacturing.

While this might seem at first surprising, the reason for it is clear: Rapid Prototyping and Rapid Tooling, on the one hand, and Direct Manufacturing, on the other hand belong to quite different 'philosophies' and have not only different sets of requirements, but also different users. While the two former generally relate to 'one-off' products, for which it is even acceptable that the product is finished by hand, Direct Manufacturing involves series of end-use products (even if they are customised) that have to be built rapidly and generally as a part of a fully (or at least semi) automated process. Hence, while in Rapid Prototyping/Tooling, the 3D printer is the endgame, in a manufacturing process, 3D printing is likely to be 'just' an element (albeit, in some cases, a critical one) in the chain.

All industries have a particular history that creates 'path dependency' and a certain degree of inertia. Whether it is because of established routines, networks or knowledge base, companies within and industry often have difficulties to break free of the past and seize new opportunities. This is particularly the case when the needs of the historical users are radically different from those of new potential clients. The economics and management literature refers to this issue as a 'chasm' between early adopters and the majority of potential adopters that established firms may have difficulties to cross, thereby preventing the technology to become mainstream.

In the case of 3D printing, this issue is particularly visible. While historical manufacturers have made efforts to reach beyond their traditional customer base, it is obvious, speaking to actual and potential users, that barriers to adoption beyond Rapid Prototyping and Tooling still exist. Besides issues related to technology or standardisation, it is generally a lack of integration of 3D Printing within traditional manufacturing processes that is cited as the most critical hurdle.

Hence, it is perhaps time for 3D printing to become less self-centred and start playing ball with the rest of the team. FabLabs have shown the ways by integrating 3D printers, CNC routers, laser cutters, milling machines, etc. What was acceptable for Rapid Prototyping and Tooling is far less so for Direct Manufacturing.



But because of the path dependency mentioned above, the future of 3D printing technologies lies perhaps much more in the hands of the machine tool industry than just in those of the traditional 3DP/AM industry. In fact, there is little doubt that the machine tool industry will play a great role in integrating 3D printing within traditional manufacturing processes and systems, thereby enabling these technologies to 'cross the chasm' and finally become mainstream.

The future of 3D printing technologies lies perhaps much more in the hands of the machine tool industry than just in those of the traditional 3DP/AM industry.

When that will be done, the time might come to forget altogether about 3D printing or AM. After all, isn't it all 'just' manufacturing?



About the author:

Thierry Rayna is a Professor of Economics at Novancia Business School, Paris and affiliate to the Internet Centre at the Imperial College, London. He is a Digital Economy specialist and his research investigates the radical changes that digitisation brings to businesses, industries, and the economy as a whole.

Interview with Reinhard Bütikofer, Member of the European Parliament

Europe needs to invest in additive manufacturing

Reinhard Bütikofer has been a member of the European Parliament (Greens/EFA) since 2009 and is an active member of the Industry, Research and Energy Committee. In the previous parliamentary term, he was the rapporteur of two important reports on EU industrial policy and raw materials strategy. CECIMO asked his views on additive manufacturing, its impact on the European economy and the role of the EU in advancing emerging technologies.

Additive manufacturing (AM) is recognized as a disruptive technology. What is your view on AM and its potential impact on the European economy and society?

Europe is in dire need of a new economic dynamism. For this we need an ambitious European industrial policy that promotes competitiveness and sustainability. After all, competitiveness and sustainability go hand in hand. Energy and resource efficiency are a prime example as they enable cutting costs, reducing raw material input and slicing CO2 emissions. Additive manufacturing is a key technology in this context. The United States Department of Energy has estimated that additive manufacturing techniques can reduce material costs by up to 90% and in some cases achieve energy savings of 50%.

Additive manufacturing has a key role to play in promoting a competitive and sustainable European industry.

If Europe wants to stay ahead of the curve and not fall behind in this new industrial revolution, then it needs to invest in additive manufacturing in terms of R&D, skills and machinery while simultaneously ensuring that the current EU regulatory framework minimises the risks and maximises the opportunities offered by this new technology.

The Group of Greens/European Free Alliance contracted in 2013 a study entitled "3D Printing Risks and Opportunities". What were the main conclusions of this study?

Our Green Group saw a great range of potential applications for AM technologies

but also possible problems, particularly with regards to additive manufacturing in the consumer sector. In order to get a better sense of the current state of play regarding the technology and identify areas in which the EU should focus on more, we decided to contract this study.

The findings of the study painted an interesting picture. First and foremost, it highlighted again that the global race for the leadership in additive manufacturing is on. The United States have established Manufacturing Innovation Institutes researching AM technologies, China has formed a 3D Printing Technology Industry Alliance and announced the establishment of a 3D printing industrial park as well as a medium- and long-term strategy for AM, while the EU has yet to come up with any particular strategy. Important in this context, the study also came to the conclusion that European research efforts in this area need to be better coordinated.

Promoting standardisation in this field, adjusting regulations to make legal responsibilities in case of accidents more clear, and further researching the total lifecycle emissions and material use of additive manufacturing were some of the other recommendations made by the study.

Do you think that the EU's industry and research & innovation policies are fit for purpose to embrace opportunities offered by emerging technologies such as AM?

The European Commission under the leadership of former Vice-President Antonio Tajani has made great efforts in ensuring that industrial policy again receives the attention it deserves. In the last couple of years, the European Commission has put a greater emphasis on additive manufacturing technologies, for example by launching the Advanced Manufacturing Task Force and publishing a range of calls for tenders for R&D projects in this field. What is lacking for the moment, however, is a clear strategy for additive manufacturing. A comprehensive strategy that touches not only on the necessary R&D needs for AM but one that also looks into standardisation, skills and qualifications, financing, what role AM can play in the context of the EU's energy and climate policies, etc. This is a blind spot and I would hope that the new Commissioner Bienkowska could at least address some of these issues in her planned industrial policy roadmap foreseen in June of this year.

In addition, the EU Member States are not necessarily playing a very constructive role when it comes to a European industrial policy. In my experience, EU Member States are loath to engage in a common industrial effort in Europe. However, particularly for new technologies and industrial trends, we need common, coordinated efforts with regards to R&D, standardisation, the single market, and so on.

Do you see any barriers to the uptake of AM in the EU regulatory and business environment which need to be addressed as a matter of priority? What role can the European Parliament play to this end?

This is a very important point and it should be the task of the EU's industrial policy to consider the barriers to the uptake of AM by engaging in industrial stakeholder dialogues and consultations in order to get a real picture of the situation on the ground and hear from businesses. The results of such investigations and dialogues should be addressed in the foreseen industrial policy roadmap.

From my side, two particular issues come to mind. The first is awareness raising and the need for consulting and advisory services, given that not every small and medium sized enterprise is aware how additive manufacturing techniques can fit into their particular production chain. The second is financing. Although the cost is falling over time, new additive manufacturing production machines can be very expensive, which may hold SMEs back from making the necessary purchases.

I'm certain that the European Parliament would support any efforts by the European Commission in identifying and solving barriers to the uptake of AM and addressing the issues I raised above. It could even, in some cases, propose a specific pilot project on AM in the context of the annual EU budget.



Reinhard Bütikofer is Co-Chair of the European Green Party (EGP) and a Member of the European Parliament (Greens/EFA) sitting on the Industry, Research and Energy Committee. His regular industrial policy newsletter can be subscribed to at: http://reinhardbuetikofer.eu/industrialpolicy-newsletter/

For new technologies and industrial trends in particular, we need common and coordinated efforts in Europe.

Is it possible to reconcile the EU's environmental policy agenda and the reindustrialisation objective? Do you think that new production technologies like AM could play a role in this?

This is not only possible, this is imperative. An industrial policy that would not be founded on the basis of a sustainability strategy, an industrial policy that would view environmental goals and parameters as an economic impediment, would undercut one of the decisive factors for future European competitiveness. European industry has benefitted over the years from integrating environmental goals and environmental innovation into its approach and in particular from pursuing energy efficiency and resource efficiency policies. In many sectors, European technological leadership is built on that basis. But other countries are not easily conceding that ground. We should not underrate the ambition of our competitors. I believe Thomas L. Friedman from the New York Times was right when he wrote: "the country that gets the greenest the fastest, with the smartest technology, that's the country that will lead the 21st century."

3D printing in the European Union

By Germán Esteban Muñiz, Programme Officer, Directorate-General Research and Innovation, European Commission

Additive Manufacturing (AM), including 3D-Printing, is one of the potential game changers that, for some applications, has already reached a tipping point of maturity. These days, we are already witnessing the growing enthusiasm and an increased adoption of these technologies.

AM is disrupting the manufacturing value chain, allowing a shift from mass production to full customisation. This is why it is essential that this technology is welcomed and developed in a positive light in order to keep the European economy at the forefront of innovation.

Additive Manufacturing in EU Research

The European Union (EU) provided funding for research in AM since the first Framework Programme (FP), during 1984-1987. Those initial projects built basic prototypes of AM machines, with resins containers pouring layers cured by UV light.

The following FPs (from 1988 till 2013) ensured continuous support. Only in the seventh FP (FP7, 2007-2013) more than 60 successful projects on AM technologies were funded, with over €160 million in EU



Additive Manufacturing in Horizon 2020

In Horizon 2020, the "Advanced Manufacturing and Processing" area, under the Industrial Leadership pillar, is the main contributor to the Additive Manufacturing technologies. Other areas, like Photonics, Advanced Materials and Nanotechnologies will also promote close multidisciplinary collaboration for the development of AM.

These areas are linked to the group of technologies (six in total) called Key Enabling Technologies, the KETs, which will enable the development of new goods and services and the restructuring of industrial processes needed to modernise EU industry. Additive Manufacturing is considered as part of the "Advanced Manufacturing" KET.

AM in Factories of the Future and other Public Private Partnerships In order to solve problems together with industry and to strengthen European Industrial Leadership, the European Commission (EC) established several Public Private Partnerships (PPPs) in H2020. These PPPs will implement Research and Innovation activities of strategic importance with a strong involvement of industry, helping research results to cross the "valley of death" and reach the market.

The Factories of the Future (FoF) contractual Public Private Partnership (cPPP) will remain the main actor in AM within the KETs, and its activities will be primarily developed through the relevant industrial roadmaps, in collaboration with the stakeholders. Other PPPs, like Photonics 21, or Clean Sky, the largest aeronautical research programme ever launched in Europe for aeroplanes and air transport will also contribute to the development of AM.



AM in the Societal Challenges In H2020, the Societal Challenges pillar is designed to encourage a "challengebased approach" research in order to address major concerns shared by citizens in Europe. For example, the Societal Challenge of Health can combine AM with other key enabling technologies (KETs): Advanced Materials, Nanotechnologies, Microelectronics, Photonics, Biotechnologies and other Advanced Manufacturing technologies. The results are fully customised and personal products of very high added value which help to improve the quality of life of patients. In the Societal Challenge of Transport, AM can combine with other KETs to make extremely complex products with a significant reduction in the bill of materials and in the time from design to the real component.

There are many other sectors with potential of growth for AM, e.g. Automotive industry, Microelectronics, Consumer Goods, Cultural Heritage, Ageing Population, Jewellery.

AM success stories

After almost three decades of R&I investment, there are many success stories from European funded projects, for example:

The Performance project is a good example on how AM is positively impacting society through improving quality of life. The main idea of the project is to develop a personalised supply chain of special textured food for elderly people in nursing homes, ambient assisted living facilities or at home.

The project ARTIVASC 3D develops a synthetic soft tissue graft which can be used in a vast array of clinical applications, including bio artificial vascularised skin in trauma treatment for scar-free wound healing, vessel replacement, and also works with other more complex synthetic biomedical constructs.

The project AMAZE is the largest EU funded project about AM and has the ambition to make the best quality metallurgical products, using layerupon-layer melt deposition of advanced



alloys, and focused in producing AM large components. The project covers aeronautics, space, automotive, nuclear fusion and tooling high-tech sectors.

European Commission services have started various initiatives in order to explore and identify barriers and gaps in relation to the development of additive manufacturing.

Additive Manufacturing within the context of EU industrial policy

The research and technological development supported by European funding was important for the growth of AM technologies in Europe and Horizon 2020 will bring new opportunities. Nevertheless, and despite the EU support, European companies are facing these days a tough business environment. The strong investments of the US and China in the field of AM are overtaking in just a few years the accumulated EC funding from the FPs. Other countries, like Israel, Singapore, Korea, Japan and South Africa are also seriously investing in AM to face this global competition.

Even if losing edge at international level, Europe is still in a position to recover ground. Many EU projects generated a lot of knowledge in Additive Manufacturing, which still remains unexploited and would benefit from a European strategy. The European Commission is committed to bring all the excellence in science to the citizens, and to foster the innovations that can improve our lives.

Recent developments

It is important to underline that the role of the European Commission in Additive Manufacturing has not been limited to funding. The Commissioner for Research and Innovation Carlos Moedas explicitly mentioned Additive Manufacturing and 3D-Printing during his hearing at the European Parliament (EP) and the EC has already addressed some policy aspects related to AM challenges. AM, including 3D-Printing, was highlighted in the EC Industrial Policy Communication from 2012, in the Industrial Landscape Vision 2025 and by the EC Task Force for Advanced Manufacturing Technologies for Clean Production.

Currently, different EC services (DG RTD, DG CNECT, DG GROW, JRC) and EU institutions (European Economic and Social Committee, European Parliament) have started initiatives in relation to AM in order to explore and identify the gaps and barriers for AM in Europe, and to look for bridging synergies across European efforts.

Future challenges in AM

The Key Enabling Technologies Directorate (RTD.D) from DG Research and Innovation organized on the 18/06/2014 the first dedicated Workshop about Additive Manufacturing in the European Commission with the participation of experts from industry, academia and research and technology organizations. The objective of the EC was to identify the needs of the AM sector and to understand the impact of potential policy measures at the EU level that could enhance the competitiveness of the AM sector.

The main elements identified in the discussions with the experts are:

 Technological Challenges: Awareness and Industrialisation of AM / New materials and combination / Modelling &



Germán Esteban Muñiz Research Programme Officer -Key Enabling Technologies European Commission DG Research & Innovation RTD.D.2

Simulation / Process stability, capability and productivity

- Standardisation, Regulation, Qualification and Certification: Certification of materials and parts/products / Regulations, Guidelines, CE marking / Standardisation / IP, copyright, patent protection and liability / Health and safety
- Training and Education: Education and training at all levels / "Best practice" cases / Technology transfer centres with industrial focus and regional support
- EU Initiatives and Policy Measures: Clear EU strategy and coordinated R&I investments / Taxation and cross-border duty surrounding data / Support entrepreneurship on the professional and individual level

European Strategy on Additive Manufacturing?

It will take a lot more than just pure technology development for Additive Manufacturing to generate wealth creation, since AM needs to tackle other challenges as well. European AM stakeholders and EU Member States act in a fragmented manner, which leads to gaps and inefficiencies preventing the creation of necessary links across the wide range of applications, disciplines, manufacturing sectors and countries concerned.

Therefore, Europe would benefit from a strategic approach and a common vision for AM, where the European Commission could have an essential role to play as a facilitator to accelerate the market uptake of new applications.

In the short term, the upcoming Work Programmes 2016-2017 will generate new opportunities for AM. Moreover, the ongoing efforts carried out by the different EC services and EU institutions could be the first step to a common EU strategy. The coordination of these EU institutions and their dialogue with external stakeholders will be of critical importance for the further development of AM in Europe.

"All views expressed herein are entirely of the author, do not reflect the position of the European Institutions or bodies and do not, in any way, engage any of them."

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Multi laser melting system on its way to series production.



Demo turbine wheel from GE made of Inconel 718. The gear is general tool steel.



General automotive gear 3 D printed from Metal powder on the SLMmachine.

* 12 to 15 hours were necessary to print each part. The development of the generative process enabled the creation of the laser melting systems for metals. Initially they were used only for prototype, but the rapid developments of the past 10 years allow the use in the production.

Today the layer manufacturing technologies help companies increasing the process of implementing new constructions such as lightweight and bionic design, integrating more and more functionality within a component, using new materials and developing competitive advantages. The limitation in the design gives a way to the freeform surfacing. A new quality arises on the original assembly of parts and components: installation savings by merging assemblies in a building process, which is completely created in a "printing process". At the same time, weight savings are already achieved in many cases, fewer resources are needed, less waste will be produced, and the excess powder from the building process will be reused. This development invites companies rethinking their production processes.

Currently, the laser melting process used in the transformation of prototypes is evolving into a manufacturing technology that allows to the serial production of large quantities of customized components at reduced costs. Further "industrializing" the technology will allow operating to four lasers at the same time. The technology will be integrated into existing production chains, ensuring that the quality of reproducible parts is 100% guaranteed.

Already, additive manufacturing, as an innovative technology, integrates industry 4.0. We aim to achieve automation of all intermediary steps into a closed loop of the entire process - from reading the data to the output of the finished component and the launch the next automated production process. 3D printing will play an essential role in the creation of competitive conditions - and allow each company to make the most of the opportunities of new markets worldwide.

This vision will be greatly boosted by the expanding capabilities of 3D printing itself. As a part of the Horizon 2020 framework programme, the project "Repair" with European funding, performs the work-up of worn parts in the work area MRO in aviation. Initial results are very promising. The advanced printing capabilities allow faster and more cost-effective work-up than previously tested methods.

For more than 20 years, SLM Solutions is working in research and development of additive manufacturing technologies. The company is a leading provider of metal based additive manufacturing technology. On May 2014, the company has gone public. In the past 12 months the SLM Solutions Group AG has doubled its workforce from 70 employees to 180 employees. SLM Solutions focuses on the development, assembly and sale of machines and integrated system solutions in the field of selective laser melting and provides two lines of machinery that work with Mulitlaser. The company makes an important contribution to the creation and preservation of jobs in Germany, Europe and worldwide.



Standards to enable the take-off of additive manufacturing



By Pat A. Picariello, J.D., CStd, Director, Developmental Operations, ASTM International

ASTM is a globally recognised international standards organization that develops and publishes voluntary consensus technical standards used on a world-wide basis. Its Committee F42 on additive manufacturing (AM) technologies promotes knowledge of the industry, helps stimulate research and encourages the implementation of technology through the development of standards for AM technologies.

ASTM International Committee F42

Following a 2008 survey of standards developing organizations (SDO) by Rapid Technologies and Additive Manufacturing (RTAM) technical community, the Society of Manufacturing Engineers selected ASTM International as the SDO for a new standards initiative for additive manufacturing.

Close cooperation between ASTM and ISO respond to industry's pledge for global standards in additive manufacturing

Officially organized in 2009, ASTM International Committee F42 on Additive Manufacturing Technologies hosts a current roster of over 330 stakeholders from 22 countries, including 50 members from eleven European Member States, namely Belgium, France, Germany, Italy, The Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland and the United Kingdom. The committee has approved 11 standards to date, and has an additional 20 in various stages of development. The standards define terminology, measure the performance of different production processes, ensure the quality of the end products, and specify calibration procedures for additive manufacturing machines. The F42 Committee promotes knowledge, stimulates research and implements technology through the development of standards for additive manufacturing technologies.

For more information contact: Pat A. Picariello ASTM International tel +1.610.832.9720 ppicariello@astm.org www.astm.org The next meeting of the committee will take place from July 13 to 16, 2015 at the German Institute for Standardization (DIN) in Berlin, Germany.

Striving for global standards

The work of the main Committee and of its six sub-committees is coordinated with other ASTM technical committees and other national and international organizations having mutual or related interests. Recognizing the need for coordination while maximizing resource allocation within the additive manufacturing industry, in 2011 ASTM entered into a cooperation agreement with the International Organization for Standardization (ISO) Technical Committee 261 on Additive Manufacturing.

ASTM encourages its technical committees and the industries they represent to carefully develop a standards strategy that meets the needs for minimizing the duplication of international standards and for promoting technical and commercial collaboration with other SDOs to achieve greater compatibility.

CECIMO's recent engagement with ASTM International enriches an already established broad partnership of experts on both sides of the Atlantic and worldwide.

Direct participation model

ASTM's direct participation model of standard development allows individual experts to contribute directly to technical committees where they have full voting privileges and an equal opportunity to shape standards. They can, therefore, maximize the likelihood that their needs, business objectives, or recent technological developments are reflected in the standards-making process.

Within Committee F42, there is an additional structure that defines multiple levels and a hierarchy of AM standards, covering a variety of aspects from general concepts and common requirements to characteristics that are specific to a material category or process.

Interview with Alison Bettac, Director of the AMRC Training Centre (UK)

Additive manufacturing calls for new skills

Additive manufacturing (AM) removes production limitations on design, allowing to make complex shaped products which could not be produced by using traditional production techniques. AM is thus poised to create a change in the nature of design. Some experts point to a paradigm shift from design-for-manufacturing to manufacture-for-design, which allows to place product design optimisation on top of considerations during the product development process. This alters the way engineers and designers see the product development process, in a way not taught yet in educational institutions.

Enabling the integration of the product development and production process, AM allows to bring high quality products more quickly to the market. AM will therefore affect not only the design skills but also skills of the workforce in production, testing and qualification, supply chain design and services. CECIMO interviewed Alison Betac from the AMRC regarding the impact of AM on skills and training.

Additive manufacturing is an emerging technology with great potential. What will be the impact of this technology on skills and jobs in advanced manufacturing?

The skills required will be of higher level than previously in this field, as this technology takes hold of manufacturing. Additive manufacturing technologies were first seen in areas such as rapid prototyping, and manufacturers are now looking at ways of utilising these new technologies in mainstream processes. Knowledge of additive manufacturing will be required in positions such as: manufacturing engineer, specialist process technician, senior manufacturing engineer, mechanical engineer, 3D manufacturing inspector, design technician, automation specialist and toolmaker. High level skill requirements will result in hard-to-fill vacancies and therefore it may restrict growth of entire industrial sectors.

What are the skills and qualifications needed by industrial sectors in additive manufacturing and how to cater these needs?



In general, there will be a requirement for the following skills that have an additive manufacturing perspective: CAD modelling, additive manufacturing technology, powder management, sampling, machine operating and programming, scientific principle of materials and materials applications. In the automotive sector for example, AM skills will be needed for the production of live parts for high-end motorsports prototypes and tooling, therefore both in design and finishing processes. In the aerospace the focus is currently on R & D type activities. However, the automation of this technology will be needed. Generally, there will be a requirement to facilitate knowledge transfer via a number of provision levels which would include STEM in schools, Colleges, Graduate HE delivery, Apprenticeships and Continual Professional Development in the form of short courses.

It is vital that policy makers ensure that this technology is embedded at all levels of education at an early stage.

What does your organization do/ plan to do in the field of additive manufacturing training?

The AMRC University of Sheffield develops and delivers programmes within the Additive Manufacturing topic across a number of sectors and applications. In addition to this we provide R & D services in developing new technology and processes in this field and identification of applications where this can be used.

What role can policy-makers play in the area of education and employment to contribute to building additive manufacturing skills?

It is vital that policy makers ensure that this technology is embedded at all levels of education. Organisations require support, specifically SMEs, in developing their knowledge and processes around this technology. Policy makers should also be aware that investment in new equipment is required to facilitate the mainstream adoption of this new technology. Therefore, funding may be required to enable AM technologies to be embedded across the manufacturing sector and to raise the new skills required to facilitate this transition.

About the AMRC

The United Kingdom-based University of Sheffield Advanced Manufacturing Research Centre (AMRC) with Boeing is a world class centre for research into the advanced manufacturing technologies used in the aerospace, power generation, medical and other high value manufacturing sectors. The AMRC has built a global reputation for delivering

research-based solutions to manufacturing problems for local, national and international companies and has become a model for collaborative research involving universities, academics and industry worldwide.

It has specialist expertise in machining, casting, welding and additive manufacturing and has an extensive composite manufacturing facility with unique capabilities in weaving, microwave curing and machining.

For further information, visit www.amrc.co.uk



Alison Bettac

Interview by Emir Demircan, CECIMO

Additive manufacturing mirrors the global race for industry leadership

By Gökalp Gümüşdere, EU Public Affairs Manager, CECIMO

Additive manufacturing (AM) technologies have become a genesis for re-imagining product design and development as well as materials, business models and services. Governments over the world are launching one-by-one policy initiatives on AM in an attempt to secure their share in future markets for advanced processes and products. There are strong signals that advanced manufacturing technologies are becoming a battlefield for countries competing over global technology and economic leadership.



Offering a new source of innovation and productivity, additive manufacturing has sparked great interest amongst governments in advanced economies and a few emerging economies. Governments take action in the field of AM mainly because they

are eager to participate in the definition of the future economy and to secure a competitive position for their industries. They generally play a role as risk-taker, financier and through coordination between researchers, industry, investors and other stakeholders.

US, China, Japan and the EU

Currently, the US government pursues the most pro-active policies to support AM; the Obama administration made AM a high priority in the National Manufacturing Strategy. Out of the 1 billion dollar National Network for Manufacturing Innovation¹ initiative, 260 million dollar worth of federal funds (matched by 400 million dollars from private partners) have been allocated for the establishment of a public-private partnership (America Makes Institute) as well as three research institutes focusing respectively on digital manufacturing, lightweight technology and advanced composites.

The Chinese government made, back in 2013, a pledge to invest 1.5 billion yuan (245 million dollar) in AM in a seven-year project, as reported by Wohlers. Moreover, the recently released Additive Manufacturing Promotion Plan² (2015-2016) aims at developing a functioning and healthy industrial system for 3D printing in the country. The Chinese government announced thereby its intention to fund development, application and demonstration centers, and to seek for establishing two or three 3D printing companies with a high level of international competitiveness.

Cumulative additive manufacturing machines, installed by region, 1988-2014 (percent of global total)

According to figures from the European Commission, public funding distributed to AM-related research projects in the 7th Framework Programme (2007-14) amounted to €160 million. In the EU Industrial Policy Communication and the new Horizon 2020 programme, AM also receives high attention as a strategic enabling technology. Furthermore, individual EU member states, led by the UK and Germany, invest in innovation centers for basic and applied research and via grant programmes.

The revival of manufacturing

The US sees a high potential for AM to ensure American leadership in the manufacturing technologies that support national competitiveness for years to come. AM offers an opportunity to 'rebuild' critical US manufacturing capabilities lost to offshoring. As for China, the government is keen to ensure, by investing in research and technology centers, that Chinese businesses keep up with the overall level of industrial 3D printing in the international markets. China actually perceives as more promising to compete with advanced economies on emerging technologies rather than in traditional sectors in which those latter enjoy a long legacy.

In Japan, the government also considers AM as a key driver to help regain manufacturing competitiveness internationally. The Technology Research Association was founded with the aim to develop a firm technological foundation in metal AM processes. The EU, on its end, issued an industrial policy strategy which identified innovation in six priority areas (advanced manufacturing technologies for clean production; key enabling technologies; bio-based products; sustainable industrial and construction policy and raw materials; clean vehicles and vessels; and smart grids) as a prerequisite for triggering an European "industrial renaissance". The ultimate objective being revitalizing the domestic industrial tissue and increasing its competitiveness in the era of globalization.



Source: Wohlers Report 2015

Preparing for tomorrow

In the aftermath of the global economic crisis, countries have become especially eager to deploy industrial and technology policies as a way to respond to stubbornly sluggish growth rates. As traditional drivers of GDP growth, such as government investment and consumption, hit an impasse, governments see in a number of disruptive technologies which have recently flourished a high potential to boost productivity, efficiency and innovation. They keep an eye out for opportunities to tap into new markets with new products whose development is driven by a few key technologies such as big data, industrial internet and 3D printing.

Advanced economies see AM as an opportunity to regain international manufacturing competitiveness.

There is growing consensus amongst industry experts and politicians that those furnishing their industrial base with advanced technologies will be tomorrow's global industry leaders. The broad-based deployment of additive manufacturing can have a pervasive impact and can transform at once multiple sectors. Today, North America leads the world in the adoption of AM technologies. The pie chart provides estimates of the number of cumulative industrial AM systems installed in major regions around the world. The breakdown of these figures by country reveals that the US has the world's largest installed base with its share representing 38.1% globally. It is followed by Japan (9.3%), China (9.2%), Germany (8.7%), UK (4.4%) and Italy (3.4%).

The digitization trend in manufacturing is redefining industrial competitiveness.

Companies with an American origin have dominated the global AM market since the introduction of this technology in late eighties. According to the Wohlers Report, 12 850 industrial systems were sold worldwide in 2013 (representing 30.1% growth over 2013). Cumulative figures on sales show that more than 50% of industrial systems sold between 1988 and 2014 came from the US compared to 15% coming from Europe. In 2014, Europe's share in global sales reached 22%.

Changing dynamics of industrial competition

The US has traditionally dominated the world in R&D intensity sectors³ (e.g. pharmaceuticals, technology hardware and equipment, software etc.). The EU industry, on its end, has a robust technology base in medium-to-high R&D intensity sectors such as automotive, engineering and machinery, household goods but also in a high R&D intensity sector like aerospace. For instance, Europe is the world's number one producer of equipment in metalworking technologies (machine tools) with 40% of the global market share. In robotics and factory automation, the global market share of EU producers is around 50%. A competitive production and research base in manufacturing technologies underpin the strength of Europe in automotive, aerospace, med-tech, mechanical engineering and other sectors.

Nevertheless, those countries that make a leap forward in new key enabling technologies (with a pervasive impact on industry) may tilt the scales in global competition. In particular, there are strong signs that the digitization trend, which is strongly present in AM and shows rapid development across the manufacturing technologies sector, is poised to redefine industrial competitiveness. A country like the US enjoying a leading position in ICT could take advantage of this to advance its competitiveness in other industry sectors. This points out a phenomenon that policymakers and industry leaders in Europe (and elsewhere) pursuing high ambitions for a strong industrial future will need to consider carefully.

¹http://manufacturing.gov/Institutes.html ²http://www.3ders.org/articles/20150302chinese-government-unveils-national-plan-fordevelopment-of-3d-printing-industry.html ³According to the EU R&D scorecard, R&D intensity shows the ratio between R&D investment and net sales of a company or group of companies. If this ratio exceeds 5% for a given sector, that sector is classified as having high R&D intensity. Sectors with and R&D intensity of 2-to- 5% are in the category of medium-high R&D intensity.



R&D investment trends by the Scoreboard companies for main world regions R&D investment (Euro bn)



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Additive manufacturing: what role for government policy?

By Gökalp Gümüşdere, EU Public Affairs Manager, CECIMO

As manufacturing becomes increasingly complex, it requires combining multi-sectoral and multidisciplinary capabilities in technology development. Advanced manufacturing technologies like additive manufacturing (AM), develop at the intersection of production technology, ICT and materials science. The EU, given its experience in supporting pre-competitive collaborative research, has a great potential to facilitate the development and market uptake of AM.

Additive manufacturing (AM) is faced with various technical barriers to its industrialization (i.e. reaching a convincing scale). The major challenges that need to be tackled include repeatability, process reliability, workpiece maximum size and surface finish quality, leaving vast areas to explore for the research community and industry. Most of these challenges are either too difficult or too risky for businesses to tackle on their own. This justifies governments' participation and investment in research and innovation efforts.

Risks in emerging technologies may be too difficult or too risky for businesses to attack on their own, which call for collaborative efforts.

Innovation cooperation and networks Looking at the US, where AM applications are flourishing at an unprecedented speed,

we notice a strong public policy strategy

acting as a key driver. Governmentbacked manufacturing innovation centers and collaborative networks are devised to pool resources, knowhow and skills from a variety disciplines. Industrial and research actors work altogether to address complex innovation challenges on a joint infrastructure. This is completed by the provision of grants for market-driven research and by efforts invested in raising skills.

The America Makes Institute, jointly funded by government and private funds, has thus far been instrumental to generate a strong stimulus for innovation efforts in AM in the EU. This model of innovation cooperation works with a simple logic: companies bring concrete problems they are facing in their production and research partners concentrate on finding the solutions, helping bridge basic research and innovation. Moreover, it facilitates SMEs' access to information as well as to expensive infrastructure and equipment that would otherwise be out of reach.

Enhanced cooperation between industry and the research world also creates opportunities to raise new skills both for VET and graduate students, engineers and machine operators. The development of manufacturing technologies and their broad-based adoption depends heavily on the availability of a skilled workforce.

Mobilizing private investments

Governments fund AM technology and infrastructure for a purpose: the availability of cutting-edge research capability and skills in a given region serves as a magnet for investments. For instance, General Electric (GE) recently announced a \$32 million investment in a new 3D printing research facility in Knoxville, Tennessee, citing the advantages of locating near America Makes . In Germany, the €13 million worth Direct Manufacturing Center at the Paderborn University is cofinanced by state funds as well as Boeing, EOS Electro Optical Systems, Evonik Industries and SLM Solutions GmbH. The Sheffield Advanced Manufacturing Centre (UK), funded under a £200 million worth six-year government programme for creating a network of innovation and technology centers, attracts investment from Boeing and Rolls Royce. The center was supported by EU structural funds during the creation phase in 2001. Similarly, the Manufacturing Technology Research Center (Coventry), specializing in Net Shape and Additive Manufacturing, was established in 2010 with support from Airbus and Aero Engine Controls.

The role of European policy

In recent years, the EU has put forward initiatives favouring a number of key enabling technologies (KETs) within the framework of an enhanced industrial policy which is part of the Europe 2020 Strategy. The European Task Force on Advanced Manufacturing Technologies launched in 2013 and drafted an important report about the state of advanced manufacturing in the EU¹. Nevertheless, the European Commission has not come up yet with a strategy for additive manufacturing that can match the scope and ambitions of the US or Chinese policies. Despite the apparent US domination in polymer-based AM applications, Europe takes the lead in the production of metal AM systems globally – capitalizing on its legacy in industrial production technologies. However, international competition is growing. Europe cannot afford to lag behind competitors in advanced manufacturing technologies which will determine tomorrow's leaders in traditional and emerging sectors.

The EU should seriously consider conveying to the global business and investment community a powerful message: Europe is in the AM race. An effective way of doing this would be to launch an European AM Strategy. It should be endorsed politically and present a comprehensive programme and concrete objectives supporting the industrialization of AM.

The EU has to stay in the global race for disruptive manufacturing technologies.

Where to start?

A European AM strategy will provide a framework and direction for the development of AM. To start with, carrying out a stakeholder mapping exercise in Europe is indispensable. Currently, there is an information gap which prevents obtaining a global overview of research and technological AM capabilities in the EU. The AM landscape is made up of industry and research actors operating in diverse areas (e.g. software, material, services, equipment builders, laser applications etc.). A specific EU-wide platform could facilitate the exchange of information and innovation cooperation in this fragmented landscape. The European Commission is well-positioned to facilitate the creation of such networked structures

Moreover, sufficient amount of research grants in the Horizon 2020 Programme should be earmarked for AM, notably for application-oriented projects to help bring AM into the production environment and AM products to the market. The successful Factories of the Future publicprivate partnership has shown that using industry-driven research roadmaps² is an effective way of guiding public funding towards market innovation. The key will be providing high enough visibility to AM in the EU research programmes so that the EU commitment resonates strongly with the global investment community. Finally, EU funding alone will not be enough to create a real momentum, Member States also need to come on board by increasing national R&D funding for AM.

EU regions, on their end, could also play a role by identifying local AM capabilities and by investing their share of structural funds in the development/upgrading of manufacturing RDI centers. They should step up efforts for promoting their RDI infrastructure globally to attract private investment. Furthermore, AM is a field in which there are important opportunities for start-ups (e.g. service companies or software providers). Financing instruments should there be made available to support entrepreneurship, start-ups and SME growth. Another type of support mechanism is inter-regional cooperation (see the Van Guard Initiative³) supporting the development of networked pilots and demonstrations.

A European additive manufacturing strategy could provide a framework and direction for the development of AM.

A European AM strategy should also contribute to knowledge generation in the AM field and its dissemination towards SMEs. Most of the state-of-the-art technological developments in AM are taking place inside large original equipment manufacturers (OEMs), and data on processes and materials remain behind factory walls. By funding studies on AM, the EU could help understand its suitability for various applications and sectors via technical, cost-benefit and market analysis. This would contribute to building a common European body of knowledge accessible by all relevant stakeholders who are willing to join the technology development efforts. It is positive to see that DG GROW recently commissioned a study to with these aspects in mind⁴.

It is more than research and innovation Government policy can be instrumental in guiding the market development of new technologies. AM presents unique characteristics that make roles of actors in the product design and development process of the industrial value chain reshuffle. This creates issues related to liability and intellectual property and their clarification will be important to reassure the industrial community envisaging to use AM.

Furthermore, a lack of data related to the production process and material properties call for greater efforts in standardisation⁵ so as to facilitate the broad-based adoption of AM technologies. AM-made parts used in sectors where safety is especially critical like aerospace or medical need to go through qualification and certification procedures, which requires attention from regulatory authorities. Finally, AM is a highly digitalized process; a sound ICT infrastructure coupled with data protection and security rules will be key to create market confidence around the use of AM.

Leaving these questions unanswered may hamper the market uptake AM by discouraging early-adopters and failing to ensure consumer confidence. The EU could step in to help fill this strategic knowledge gap and to build the framework for the development of AM. An early, inclusive dialogue with the industrial community and other relevant stakeholders will be of utmost importance to identify areas of action.



 ¹ http://ec.europa.eu/enterprise/policies/ innovation/policy/amt/index_en.htm
 ² See also the AM strategic research agenda developed by the AM Platform where CECIMO is a member: http://www.rm-platform.com/
 ³ http://www.s3vanguardinitiative.eu/
 ⁴ CECIMO is part of the research consortium for this study which started in May 2015: "Identifying current and future application areas, existing industrial value chains and missing competences in the EU, in the area of additive manufacturing (3D Printing)"

⁵ An important step in standardisation was the EU funded SASAM project which drew up a roadmap identifying AM standardisation needs: http://www.sasam.eu/



The Additive Manufacturing conference is designed to cover additive technologies that are important to industrial manufacturing professionals. As a result, we have arranged five distinct keynote addresses offering expertise in key emphasis areas – applications, equipment, processes, industry, and inspiration.

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Breaking Barriers in Additive Manufacturing



Industry Keynote: Greg Morris GE Aviation

An Update on Additive Manufacturing at GE Aviation



Equipment Keynote: Jason Jones Hybrid Manufacturing Technologies Hybrid CNC Machines: A New Platform for AM



Inspirational Keynote: Jay Rogers Local Motors

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OFFER EXPIRES: AUGUST 1, 2015

CECIMO Additive Manufacturing Working Group – up and running!

The CECIMO Additive Manufacturing Working Group (AMWG) was established in 2014 to promote and support the creation of favourable framework conditions for the development of AM as a key driver of industrial competitiveness in the EU. AM has opened up new opportunities for advanced production equipment builders in terms of innovation, competitiveness and market creation. The vision of CECIMO is to ensure the development of AM to industrial scale and its seamless integration into the production environment in full compatibility with existing production processes. AMWG, gathering experts from CECIMO's member associations and industry, is active on diverse fronts: technology, markets, regulatory and advocacy. Current activities are as follows.

Research and innovation: an important mission of the CECIMO AMWG is to create opportunities for innovation cooperation amongst the machine tool builders' community and other players in the AM value chain, including software, services and material suppliers. It offers a platform to exchange information and best practices but also to initiate joint actions in research and development. Via its participation in the AM – Platform and EFFRA, CECIMO communicates the R&D related needs of industry towards the European Commission.

Market intelligence: the AMWG provides a single platform through which latest developments in technology and markets are monitored, and information and best practices are exchanged between members. The information is made accessible on an extranet accessible to all participants. Also, the CECIMO website and social media tools are used to disseminate information.

Standardisation: standards are key to the broad-based adoption and market uptake of

AM. CECIMO is a member of the ASTM F42 Committee on Additive Manufacturing, and holds direct contacts with other standardisation bodies: ISO/TC261 and CEN/CENELEC. This allows grasping a global overview of standardisation activities whilst ensuring cohesion.so as to secure open and global standards.

Regulatory and policy: CECIMO establishes dialogue between industry and EU decisionmakers to explain the regulatory and policy related challenges facing the development of AM. CECIMO provides expert's input into inquiries of the European Commission on regulatory aspects (e.g. liability, certification, health and safety, IPR). CECIMO has recently joined a research consortium to carry out a study funded by DG GROW on current and future AM applications and European capabilities (see page 34)

Communication and marketing: CECIMO organizes and gives support to conferences, seminars and other events to raise awareness about AM amongst industry players, policymakers and the broader society. The first edition of the Additive Manufacturing European Conference is scheduled on 23 June 2015, at the European Parliament in Brussels. Moreover, EMO Milano, the world metal working exhibition - promoted by CECIMO -, will host a special area on AM and an international conference in this year's edition taking place on 5-10 October.

AM is a multidisciplinary area which requires cross-sectoral and cross-disciplinary cooperation. Therefore, the CECIMO AMWG remains a platform open to all relevant and interested stakeholders. Do not hesitate to get in touch with us!



For more information contact: Gökalp Gümüşdere, EU Public Affairs Manager: gokalp.gumusdere@cecimo

Additive manufacturing comes on stage at :

MILANO 2015 fieramilano 5-10 October

EMO MILANO 2015, the world metalworking exhibition will be held at Fiera Milano from October 5-10, 2015. For the first time, an exclusive area will be dedicated to additive manufacturing, a fast developing sector yet to be fully explored, which has chosen EMO as the ideal stage to present itself to the metalworking industry.

In this area, exhibitors will display machines alongside other products designed for the mechanical engineering industry. A whole series of meetings, workshops and conferences will be held. The Additive Manufacturing conference jointly organized by CECIMO, UCIMU and AITA will take place on 6 October. This landmark event aims at highlighting the competitive edge arising from the use of additive technologies for specific manufacturing processes and processing techniques.

EMO, sponsored by CECIMO, is the most important occasion for the world's manufacturing industry to familiarize itself with the latest technologies. The exhibition's comprehensive offer attracts representatives of all user sectors: automotive, aerospace, engineering, energy, etc. as well as from household appliance, biomedical, nanotechnology and earthmoving machine companies. This year, 1,500 exhibitors and 150,000 visitors from 100 countries are expected to the show underlines UCIMU. The organisation of EMO MILANO 2015 has been entrusted by CECIMO to the operating structures of UCIMU-SISTEMI PER PRODURRE, the association of Italian manufacturers of machine tools, robots, and automation systems.

"EMO has always played a pioneering role, anticipating market trends and presenting innovative solutions both in the machinery sector as well as in the fields of accessories and auxiliary technologies, with a particular focus on unexplored sectors", says Pier Luigi Streparava, General Commissioner of EMO MILANO 2015.

"For these reasons" - he continues - "a special area of the exhibition has been devoted to additive manufacturing, thus completing the 2015 world exhibition's index of products with one of the fastest growing technologies, whose groundbreaking impact will be felt in a very near future".

EMO is the global showcase for the state-of-the art technologies in metalworking. 1,404 exhibitors, with a 65% share of them coming from 39 foreign countries. More than 125,000 visitors attended the last edition of the exhibition in Milan (EMO MILANO 2009), with 51,500 foreign visitors coming from 99 countries. The coverage of technologies showcased at the exhibition cover metal cutting, metal forming, welding, heat and surface treatments, robots and automation, mechatronics, tools, parts, components and accessories, metrology and quality control, safety and environment, services.

Visit www.emo-milano.com



Pier Luigi Streparava, General Commissioner of EMO MILANO 2015



Austria hosted the world's first metal additive manufacturing conference

3D manufacturing of metallic components by "metal additive manufacturing" (MAM) meets enormous interest of users in Austria. In order to highlight and interconnect MAM processes, the first Metal Additive Manufacturing Conference was held in Vienna in November 2014. This was the first event in the world to focus exclusively on the generative production of metallic materials and covered the entire value chain of this manufacturing process. About 150 experts from 19 nations were keen to attend the event. Among the numerous Austrian research institutes working on this issue we would like to mention two examples:

Huge interest from aerospace industry

FOTEC is the research subsidiary of Fachhochschule (University of Applied Sciences) Wiener Neustadt. The institution is working at full stretch on the production of highly complex metal components which is of huge interest for the aerospace industry as weight savings are essential in this branch. The AM technology allows for weight savings of up to 70% per work piece, and in the case of highly complex components, real cost benefits have also been achieved.

In cooperation with industrial project partners, the manufacturing processes are continuously optimized. For example, cameras are used to detect and subsequently eliminate possible faults in the melting process.

Cooling of tools on the brink of revolution

Fachhochschule (University of Applied Sciences) Wels works on and experiments on the production of revolutionary metalworking tools. Instead of resorting to the expensive conventional procedure of integrating cooling/lubrication ducts in tools such as forging dies or drawing tools, these cooling structures can simply be built up by additive manufacturing. Limits to tool design are eliminated and the service life increases massively. "Complexity for free" is the magical phrase...



For more info, contact: Austrian Association of Machinery and Metalware Industries Martin Baminger, Sector Manager Machine Tools baminger@fmmi.at +43/590900-3477 www.fmmi.at

Belgium's 3D printing businesses compete globally



A growing number of new Belgian companies make an entry into the market with the use of 3D printing whilst more and more existing companies consider using 3D printing technologies to produce their traditional products- if haven't already started doing so.

Additive manufacturing (AM), better known as 3D printing, creates an unprecedented potential for products in terms of freedom of form, complexity and the economical use of materials. For years, it has been the reference technology for the production of hearing aids, surgical guides, customized prosthetics, dental applications and other medical products. Within this field, innovations just seem to follow one another. Today, many opportunities exist for increasing the use of AM in the manufacturing industry. AM is already ideally suited for the costeffective production of prototypes and very complex pieces in small series. Improvements in the robustness and the speed of the techniques will bring the prices down, improve the productivity of the processes and in doing so, make new applications economically viable. Combining the machines with control and monitoring systems will also provide the necessary quality guarantees for printed parts. Finally, 3D printing will take a prominent place among the traditional processing and production technologies. It will never completely replace them, but will create markets by making new applications possible.

Belgium has had a pioneering position in AM since the 1990s. Sirris, the collective center for the technology industry, can claim 25 years of knowledge and experience with AM, in both materials and production methods. It has an extensive infrastructure for development and testing, and gives the Belgian industry access to 15 technologies for 3D production with metal, (bio) ceramics and plastics.

Belgian companies and spin-offs from universities also got into 3D printing very early: LayerWise, originally a spin-off from the University of Leuven and now a part of the American 3D Systems company, was the first production center in Belgium to focus exclusively on AM of metal parts. The company systematically invests 30 percent of its resources in R&D in order to push the boundaries of AM. The usual markets are precision components, process industries, aerospace, and medical and dental applications. The core business of the company is the production of functional prototypes and production series from metal alloys, which uses less material and produces no waste.

The company Materialise is the market leader in AM software and AM solutions. It is targeting industrial and medical niche markets with 3D prototyping and patientspecific or customer-specific solutions. It also serves the general public by producing contract custom products via a userfriendly online service.

Another example is Melotte, the company transformed itself from a mould builder into a major player in the 3D printing of metal objects. This Limburg-based breakthrough technology business, which is a subsidiary of Picanol, makes complex 3D objects or precision parts for numerous applications on the basis of computer data. It offers a great range of products, including prostheses, but also unique components. Its customer base is as wide,



Sun Sensor

with European and American multinationals like ExxonMobil and DuPont, as well as NASA.

As the technology further evolves and gains more traction in industry, more companies are likely to follow and compete on the international marketplace with these three pioneers.

For more information, contact: SIRRIS Benjamin Denayer, Senior Business Developer Additive Manufacturing +32498919370 benjamin.denayer@sirris.be www.sirris.be



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German machine tool industry to capitalize on generative manufacturing

In the future, development, manufacturing and business processes will change dramatically through generative manufacturing because this technology allows direct transformation of data into products. At the present time, Germany dominates the market for metallic components, so the German Machine Tool Builders' Association (VDW) participates in a wide variety of activities related to additive manufacturing and actively takes on these subjects.

The VDMA working group "Additive Manufacturing" (AG AM) was born on 28 May 2014, jointly founded by the VDW and led by the VDMA sector association "Printing and Paper Technology". The aim of this working group is the crosstechnological bundling of all industry relevant 3D printing activities along the entire value chain. Currently, about 80 member companies are engaged and are working on topics on a wide scale including application, materials, networking, standardization, technologies and the future potential of AM, amongst others. All VDMA and VDW member companies dealing in some way with additive manufacturing are invited to participate.

In this context, VDW represents metallic based additive manufacturing and pays utmost importance to raising awareness at the level of the EU about this strategic strand. Hence, the importance of the CECIMO "Additive Manufacturing Working Group" (AM WG) which brings together the national machine tool associations on a single platform to discuss challenges and concerns about the 3D printing of metallic materials and to present them to EU policy makers. VDW is an active member of the AM WG and, as other CECIMO national associations are also establishing their own sub-groups or sector associations for additive manufacturing (e.g. Italy and Spain), the importance of the topic becomes obvious.

On another front, together with CECIMO and the American Association for Manufacturing Technology (AMT), the VDW has initiated the "International Additive Manufacturing Award". The jury consists of high-ranking American and German representatives from industry, science, the important branch of medical technology plus media and associations. The price has a total value of \$ 100,000 and is divided into \$ 20,000 prize money and \$ 80,000 media services for the worldwide announcement of the innovation. The IAMA award is not limited to metallic materials, and the entire value chain is included. One of the main objectives of this competition is the creation of networks on an international level.

Also, in the bodies of the VDW there is great interest in the topic of additive manufacturing. This applies especially to the Technical Committee and the Research Group "machining with geometrically defined cutting edge". Existing studies on additive manufacturing hardly refer to the machine tool industry and for this reason, the VDW is planning its own study to be made in 2015.

To identify the relevant topics for the study, a workshop was held on 20 November 2014 in Frankfurt/Main. The findings were that members are interested in questions about future markets, the cost-effectiveness of the various processes (benchmarks), the materials used (availability, characteristics, costs), the possible substitution of established processes, and about quality. The specification book has recently been finished and an appropriate partner for the realization of the study has been found.

If, after the completion of the study, a sufficient number of member companies are found to have an interest in pre-competitive research in additive manufacturing, the integration of the topic into the VDW Research Institute is conceivable. For example, a new research group could be founded to deal with additive manufacturing of metallic materials.

Judging by the variety of activities as well as the future outlook, it is clear that the field of AM is vibrant at the moment. By getting involved in the field, VDW addresses its members' concerns and interests as a permanent and competent partner.

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The Portuguese metalworking industry invests in 3D printing



Additive manufacturing / 3D printing has huge unexplored potential for industrial growth, Europe's re-industrialization, especially via smart specialization, and for economic prosperity. The Portuguese metalworking industry is scaling up on the value chain through additive manufacturing and 3D printing

AIMMAP and its Technological Center (CATIM) are developing a project with the objective of bridging the gap between Key Enabling Technologies (KET) in additive manufacturing and metalworking SMEs. This project will allow to develop innovative and differentiated approaches to industrial processes, design, products, supply-chains and markets. Although the technology readiness level (TRL) for 3D printing is already high, many SME's have mismatched conceptions about it, namely concerning incorporation level, available technologies, raw materials and costs.

The project intends to foster network synergies and technology knowledge, and the internalization of the following 3 steps: i) mapping knowledge regarding technology, raw materials, industrial process, design, new or renewed supply chains and markets; ii) establishing networks and matching potential partners in the value-chains; iii) technology ownership and/or incorporation.

3D printing is an important asset for the new economic revolution although it raises key questions concerning industrial manufacturing and value chain integration. For example, new certification processes based on validated advanced process inspection and quality control techniques are needed to ensure that standards are being applied and up-to-date with technology and its incorporation in industry.

> For more information about activities of AIMMAP and CATIM, contact: Alberto Fonseca, Centro de Apoio Tecnológico à Indústria Metalomecânica, +351 226 159 000 / +351 217 100 790 afonseca@catim.pt www.catim.pt



Model for additive manufacturing in metalworking

catim

The Dutch industry eyes on opportunities in metal 3D printing

FPT-VIMAG (the Federation Production Technology) is the Dutch platform for production technology and the machine tool industry. Manufacturers as well as distributors of machines, tools and production automation for the metal working industry are members of the association. The binding element in the association is that all 170 member companies together, in their diversity, form the basis of the industry in the Netherlands, with their activities extending in the rest of the world.

In the Netherlands, there are a lot of initiatives concerning additive manufacturing. The last edition of the Euromold exhibition showed the importance of 3D metal printing for industry. 3D printing has developed into a real production technique, which the industry can no longer ignore. In The Netherlands, there are four distributors of 3D metal printing machines, distributing 5 brands of machines. All four are member of FPT-VIMAG.

Hybrid machines

Aside from the upcoming market of 3D metal printing, FPT-VIMAG notices the emerging trend of hybrid machines. These machines are characterized by the use of multiple machine translation approaches within a single machine translation system. The motivation for machine suppliers to use these machines relates to the incapacity of a single technique to achieve a satisfactory level of accuracy. Many hybrid machines have been successful in improving the accuracy of the translations.

In response to this upcoming trend, FPT-VIMAG organised a forum discussion together with NEVAT, the association for suppliers, in order to discuss this technology's state of affairsand to ensure the seamless integration of AM in our business processes.

TechniShow 2016

FPT-VIMAG is the owner of TechniShow, the largest and most important exhibition in the field of industrial production techniques, processing and treatment of metals, appliances and tools in The Netherlands. The next TechniShow will take place on March 15-18 2016, in Utrecht, in co-location with ESEF, European Subcontracting and Engineers Fair.

During this exhibition special attention will be paid to additive manufacturing. The purpose is to increase awareness and visibility, and to demonstrate several case studies from the process chain. To know more about the show, visit: www.technishow.nl/en/Bezoeker.aspx.

> To get in touch with FPT-VIMAG: info@fptvimag.nl +31 088 400 85 50.



The Italian association for additive manufacturing comes to life



AITA-ASSOCIAZIONE ITALIANA TECNOLOGIE ADDITIVE is a cultural association which aims at representing the interest of the Italian Additive Manufacturing (AM) Sector (producers of machines, end-users, enabling technology suppliers, service centers, universities, research centers, etc.) AITA-ASSOCIAZIONE ITALIANA TECNOLOGIE ADDITIVE will help establish a dialogue between AM stakeholders and public authorities and other industrial associations in order to support the development and promotion of the use of additive manufacturing (and the related knowledge) in the manufacturing environment.

The association's mission is defined as follows:

- to highlight this emerging sector coherently with its role in mechanical manufacturing;
- to carry out activities related to research and innovation;
- to create a competitive advantage and help realize the industrial application of AM whilst ensuring

their connection to other mechanical manufacturing processes.

The main areas of activities include the following:

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

At the moment, AITA-ASSOCIAZIONE ITALIAN TECNOLOGIE ADDITIVE has around 70 members.

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ADDIMAT, Spain's new association of additive manufacturing technologies takes off



On 17 December 2014, the creation of the Spanish Association of Additive Manufacturing and 3D Technologies, ADDIMAT, was announced. Since its foundation, the association has managed to bring eighty companies on board. In just five months, the pioneering actors of this technology, which promises to open new horizons for the industrial activity, have requested to become part of this initiative. They include equipment manufacturers, suppliers of components, consumables and accessories, companies engaged in the design and/ or manufacturing of 3D parts, dealers, technology centres and training centres. The new association is run by AFM, the advanced manufacturing technologies Association.

ADDIMAT has contributed, together with the Bilbao Exhibition Centre (BEC), to the creation of a special exhibition area dedicated to additive manufacturing at the Subcontracting Fair in Bilbao, a reference fair for subcontractor SMEs. The fair's 17th edition was held from 26 to 29 May 2015, coinciding with the exhibitions FITMAQ, FERROFORMA, MAINTENANCE and PUMPS & VALVES. The companies, Análisis y Simulación, Asorcad, Astedeco, IK4, Leartiker-Mymat Mizar, Pixel Sistemas, Renishaw, RMS, Sariki, Sicnova, Tecnalia, Tumaker, UPV as well as ADDIMAT itself were present. Parallel to the fair, a conference on additive manufacturing with speakers from companies that exhibit in the additive manufacturing area was held on 27 May 2015.

The first General Meeting of ADDIMAT was held in BEC on Thursday, 28 May 2015. The Governing Bodies (President and Board) of the association were set up, objectives by sectors for the coming years were established and ADDIMAT's service offer defined.

Some major events addressed AM in the past few months, in Spain. The AFM General Meeting, on 17 April 2015, addressed "Additive manufacturing and 3D printing" via presentations by Aitziber Eizagirre from Tumaker, Aitzol Lamikiz from UPV/EHU, David Sánchez from Tecnalia and Javier Laucirica from IK4. In June, the twentieth Congress of Machines-Tool and Manufacturing Technologies, that AFM has been organising since 1976, will hold a special session by Terry Wohlers specifically about additive manufacturing and the enormous possibilities of industrial applications. ■

AFM - Advanced Manufacturing Technologies, is the Spanish association of manufacturers of machine tools, accessories, parts and tools. AFM represents 90% of machine tool and advanced manufacturing technology companies in Spain. It is based in San Sebastian and has an office in China (Tianjin),

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Swissmem and the new Swiss Additive Manufacturing Group



In Switzerland, Additive Manufacturing (AM) is in a hype phase, as indicated by the Gardner hype -cycle. Many industrial companies are starting to analyse its potential and applicability for their own businesses. The newly created Swiss Additive Manufacturing Group is eager to promote innovation cooperation between industry and the research world. Moreover, they are preparing to promote training courses for design engineers and mechanicians with a view to fostering the wide use of AM in industry.

In order to align AM activities in Switzerland and to facilitate exchange of information between industrial users of AM and research partners, Swissmem* has launched the Swiss Additive Manufactruing Group (SAMG). The group welcomes existing and potential Swissmem members to actively participate in its work.

It has been recognized that the successful usage of AM starts with optimized geometries and structures, and highly depends on well-trained people. AM is in many cases more costly from a production point of view. However, if added value can be brought into the part to be produced – such as internal channels, lightweight structures and/or functional integration – the use of AM can result not only in technical but also economic advantages.

Therefore, the SMAG will work at, among other things, the development of specific education and training courses for design engineers and mechanicians, where the active participation and support of the industry partners is required and desired. Herewith, the group will focus its efforts on building a strong knowledge base in Switzerland to foster the wide use of AM on a fundamental level. Further goals are to facilitate the exchange of industrial experience between partners, to enable mutual support building to address AMrelated problems, and to accelerate the development and implementation of best practices. In addition, partners are willing to formulate joint proposals and participate in national and international research projects.

The SAMG is scientifically and technologically supported by inspire AG, its institute for rapid product development, and its Manager R&D SLM, A. B. Spierings. Inspire AG has been an active research and manufacturing partner in AM since 1996. The institute's core focus is on professional additive manufacturing for plastic and metallic parts, using Selective Laser Sintering (SLS) and -Melting (SLM), and in contrast to semi-professional 3D-printing technologies. Inspire supports industry in all questions related to AM: from design for additive manufacturing to materials, material characterization and final parts and applications. It also participates in international standardisation activities, a cross-disciplinary domain which is the basis for industrial usage of additive manufacturing. In the future, inspire-irpd will support and help develop new AM-machine concepts with improved performances, together with industry partners.

* Swissmem is the association of the Swiss mechanical and electrical engineering industries.

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UK set to launch a national strategy on additive manufacturing



In October 2014, a number of leading UK manufacturing companies wrote to Matthew Hancock, UK Government Minister of State for Business, Innovation and Skills, on the importance of additive manufacturing (AM) to the prosperity of the UK. Seeking government support for a National Strategy, the letter highlighted the need: "...to define and explore the AM landscape, identify gaps in capability, evaluate the UK's capability to address opportunities and put in place a plan to deliver an enhanced and integrated UK AM competence".

On the back of that initiative, a Strategy Development Group (SDG) stakeholder consortium presented their 19-page Positioning Paper "The Case for Additive Manufacturing" to a March meeting between leading industrialists and Mr Hancock. The key recommendation was: "[...]Government engages with the already ongoing effort by industry and the research community to develop a UK National Strategy in AM...This will involve allocation of resources and direct involvement.[...]The strategy development process will provide recommendations for investment".

The Paper, authored by TWI Ltd with expertise from business and research across the UK, adds: "As a first step, the UK Strategy for AM will be developed to bring together the key activities in R&D, the multi-disciplinary skills

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provision, and the industrial capacity development. The phase 2 will develop the evidence further, canvassing industry for information on their chosen route to AM exploitation, and what they see as the challenges and opportunities. [...] Government authorities are encouraged to endorse and engage with Phase 2."

The reasons for a UK national strategy include "gaps in the AM supply chain - materials supply, equipment, post processing and validation; multi-sectoral importance; and, other countries' emerging initiatives raising the base level of competition as they co-ordinate and focus their research, innovation and commercialisation activities". The detailed proposal is supported by industry/economic statistics, and its implementation will build on national strengths, focusing on "key areas ranging from technical issues to supply chain and addressing the current AM market failings."

Wider industry participation has begun. On 10th March 2015, a wellattended strategy conference was held at the MTC in Coventry, and the SDG is canvassing people interested in volunteering for their Additive Manufacturing Working Group (AMWG).

Timeline:

March 2015:

- Phase 1 presented to Government
- Phase 2 in planning stage

End-April 2016 estimated:

 Publication of AM Strategy assuming official UK Government support following the UK general election on 7th May 2015



Member Associations

Austria: FMMI Fachverband Maschinen & Metallwaren Industrie www.fmmi.at

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

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

Denmark: The Manufacturing Industry a part of the Confederation of Danish Industry ffi.di.dk

Finland: Federation of Finnish **Technology Industries** www.teknologiateollisuus.fi

France: SYMOP Syndicat des Entreprises de Technologies de Production www.symop.com/fr

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: VIMAG Federatie Productie Technologie / Sectie VIMAG www.ftpvimag.nl

Portugal: AIMMAP Associação dos Industriais Metalúrgicos, Metalomecãnicos 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: MTAS Machine and Tool Association of Sweden www.mtas.se

Switzerland: SWISSMEM Die Schweizer Maschinen-, Elektround 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

"Where

manufacturing

begins"

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 1500 industrial enterprises in Europe*, over 80% of which are SMEs. CECIMO covers more than 97% of total machine tool production in Europe and more than one third worldwide. 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. *Europe = EU + EFTA + Turkey

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