



D.2.1.2 Analysis of the wider European region

Contact details

Project coordinator: Maja Mešl, maja.mesl@ftpo.eu, +386 51 315 970
 Address: Faculty of Polymer Technology (FTPO), Ozare 19, 2380 Slovenj Gradec, Slovenia

Project details

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Work package leader	Herfried Lammer (Wood K plus)
Task leader	Simona Knežević Vernon (TECOS)
Author(s)	Simona Knežević Vernon (TECOS), Zala Lorber, Maja Mešl, Matic Petrič (FTPO), Sandra Schulnig (CUAS), Vanja Stolcer (WOOD)
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1. EXECUTIVE SUMMARY

Additive manufacturing sector in EU has been fast developing. From micro, small and medium sized companies, to institutes and various institutions, all the way to wide ranging funding support (on the EU level but also on national levels in some countries and regions). The Initiatives such as Vanguard, AM Platform, Smart regions serve various purposes:

- Mapping and collaboration opportunities
- Leverage for funding
- Promotion and marketing, as well as establishing stakeholders in the EU map.

The AM Platform amongst other offers the best overview of the AM ongoing in EU, and is also serving as the interface to European commission, whereas Vanguard initiative on the other hand joins various pilots (not just Additive manufacturing) and is also supported by regional policy makers, thus has a better political stake.

Supported projects in EU are numerous. In this report we only highlight the most important/relevant ones for Addcircles project, as otherwise the list would be non-exhaustive. If other relevant projects come to our attention we will update the report accordingly.

The competence map, which is an additional deliverable of Addcircles will on the other hand complement this report with relevant references of stakeholders in Austria and Slovenia.

2. METHODOLOGY

This report starts by building on the knowledge of partners on current and previous projects in Additive manufacturing, in Europe. The report is not focused on Slovenia-Austria cross border regions, but is taking into account national, cross border and interregional projects in the EU. From the available projects relevant organizations as well as other stakeholders are identified, to be taken in consideration when developing technologies and projects on Additive manufacturing in the EU. Smart specialization strategies of regions, where available, are also taken into account and consideration.

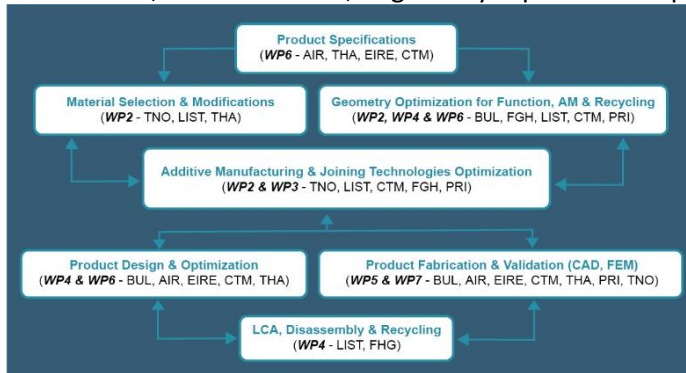
The report thus consists of three parts:

- Relevant funded projects, and identified partners in the projects
- Identified other stakeholders and initiatives
- Strategic outlooks in regions.

3. ANALYSIS OF THE WIDER EUROPEAN REGION

3.1. Funded projects

The tables below identify known and found projects, funded from EU or other sources, and highlight their relevance for Addcircles.

1. PROJECT TITLE, WEBSITE: MULTHEM (www.multhem.eu)	
Brief description	Carbon Fibre Composites (CFC) have been increasingly replacing metals in products requiring lightweight features. However, due to the traditional manufacturing process and poor thermal conductivity, the use of CFC has been limited to structural applications. For example, the casings for batteries, electrical motors, and power electronics are typically manufactured entirely in aluminium because they require to dissipate heat efficiently. The result of using pure aluminium is a heavier and less cost-effective solution than using pure CFC. The vision of MULTHEM is to use the different benefits from metals and CFC materials to develop and validate new reliable additively manufactured processes and new metal-polymer multi-materials with structural and cooling features with a more cost-effective approach than traditional methods.
Main activities and results	Using AM in Carbon Fibre Composites, due to lightweight, high strength-to-weight ratio, ideally using in aircraft, satellites and sporting goods, causing weight reduction. Nanotechnology is used to create wide variety of materials for new and innovative applications. The following substantive workpackages are defined: Material & Production technologies; Joining Technologies; Life Cycle Analysis; Disassembly and Recyclability; Use Cases Design; Use cases validation; Certification, Standardization, Regulatory aspects and Exploitation.  <pre> graph TD PS["Product Specifications (WP6 - AIR, THA, EIRE, CTM)"] --> MS["Material Selection & Modifications (WP2 - TNO, LIST, THA)"] PS --> GO["Geometry Optimization for Function, AM & Recycling (WP2, WP4 & WP6 - BUL, FGH, LIST, CTM, PRI)"] MS --> AMJO["Additive Manufacturing & Joining Technologies Optimization (WP2 & WP3 - TNO, LIST, CTM, FGH, PRI)"] GO --> AMJO AMJO --> PDO["Product Design & Optimization (WP4 & WP6 - BUL, AIR, EIRE, CTM, THA)"] AMJO --> PFO["Product Fabrication & Validation (CAD, FEM) (WP5 & WP7 - BUL, AIR, EIRE, CTM, THA, PRI, TNO)"] PDO --> LCA["LCA, Disassembly & Recycling (WP4 - LIST, FGH)"] PFO --> LCA LCA --> PDO LCA --> PFO </pre>
Partners	Cetemet (Spain), Fraunhofer (Germany), LIST (Luxembourg), TNO (Netherlands), Airelectric (Spain), Eirecomposites (Ireland), Thales (France), Prima Additive (Italy), Brunel (UK)
Relevance for Addcircles	carbon fiber additive manufacturing, carbon fiber composites, similar structure of the project, LCA, expanded to regulatory and standardization processes and regulations, smart mobility.

2. PROJECT TITLE, WEBSITE: FiberEUse, Large scale demonstration of new circular economy value-chains based on the reuse of end-of-life fiber reinforced composites. | FiberEUse | Project | Fact sheet | H2020 | CORDIS | European Commission (europa.eu)

Brief description	Glass and carbon fiber reinforced polymer composites (GFRP and CFRP) are increasingly used as structural materials in many manufacturing sectors like transport, constructions and energy due to their better lightweight and corrosion resistance compared to metals. Composite recycling is a challenging task. Although mechanical grinding and pyrolysis reached a quite high TRL, landfilling of EoL composites is still widespread since no significant added value in the re-use and remanufacturing of composites is demonstrated. The FiberEUse project aims at integrating in a holistic approach different innovation actions aimed at enhancing the profitability of composite recycling and reuse in value-added products. The entrepreneurial idea originates from the European project FiberEUse (GA No. H2020-730323-1), coordinated by Professor Marcello Colledani, which has demonstrated large-scale circular value chains based on recycling and reuse of end-of-life composites into high-value-added products. With a funding of 9.8 million euros within the Horizon 2020 program and the collaboration of 21 partners from 8 EU Countries, FiberEUse integrated various solutions and technologies over 4 years using a holistic approach, developing 20 demonstrators in different sectors (from sports to design, from furniture to construction, and automotive), showcased in a high-impact exhibition at Milan Design Week 2021. The project arose from a significant industrial need. Composite materials are materials composed of a polymer matrix and a reinforcement (typically fiberglass or carbon fiber). Due to their excellent mechanical properties, low density, high tensile strength, and excellent corrosion resistance, these materials are widely used in various sectors, from transportation and construction to wind energy. However, despite these advantages, they pose a problem: when they reach the end of their life cycle, there are no robust industrial solutions for their sustainable and economically viable treatment. Currently, they are disposed of in landfills (where still possible), used for energy recovery through incinerators, or used in low-value-added applications such as co-processing with cement.
Main activities and results	The project is based on the realization of three macro use-cases, further detailed in eight demonstrators: Use-case 1: Mechanical recycling of short GFRP and re-use in added-value customized applications, including furniture, sport and creative products. Emerging manufacturing technologies like UV-assisted 3D-printing and metallization by Physical Vapor Deposition will be used. Use-case 2: Thermal recycling of long fibers (glass and carbon) and re-use in high-tech, high-resistance applications. The input product will be EoL wind turbine and aerospace components. The re-use of composites in automotive (aesthetical and structural components) and building will be demonstrated by applying controlled pyrolysis and custom remanufacturing. Use-case 3: Inspection, repair and remanufacturing for EoL CFRP products in high-tech applications. Adaptive design and manufacturing criteria will be

	implemented to allow for a complete circular economy demonstration in the automotive sector. Through new cloud-based ICT solutions for value-chain integration, scouting of new markets, analysis of legislation barriers, life cycle assessment for different reverse logistic options, FiberEUse will support industry in the transition to a circular economy model for composites.
Partners	Politecnico di Milano, Consiglio nazionale delle ricerche, Rivierasca SPA, Fundacion Tecnalia Research / Innovation, Maier Scoop, Aernnova, Batz, Tampereen Korkeakoulusaatio sr, University of Strathclyde, SIEMENS Gamesa, Tecnalia, Novellini, GreenCoat, HOLONIX, Design Austria, Fraunhofer, EDAG, INVENT, AVK, Head Sport, Saubermacher Dienstleistungs ag, Automotive parts Remanufacturers Association Europe
Relevance for Addcircles	Recycling and reuse of long fibres, new uses through additive manufacturing

3. PROJECT TITLE, WEBSITE: SMARTFAN, https://www.smartfan-project.eu/	
Brief description	Microparticles and nanoparticles possess unique physicochemical properties that make them suitable for the development of smart materials. The EU-funded SMARTFAN project will leverage these materials in order to create smart components for application in intelligent structures. The project aims to develop lightweight composites and transfer the advantageous properties of these smart materials, including compatibility, low cost, and recyclability, into bulk composites with polymer-based matrices for structural component systems. To achieve this, SMARTFAN will implement various processes during the manufacturing of composites to preserve the physicochemical properties of the nanomaterials included.
Main activities and results	Smartfan aims at the micro and Nano components, which will be used due to their special physico-chemical properties, in order to develop smart (bulk) materials for final application on intelligent structures. CFs for reinforcement and conductivity variance, CNTs and CNFs for sensing, Micro-containers for self-healing, Electro-Magnetic nanoparticles for fields detection and shielding, colouring agents for marking cracks and defects, piezoelectric materials can be the base for manufacturing new smart materials. In order to develop lightweight composite materials and transfer the properties of smart components into bulk materials polymer based matrices, such as Epoxy, PEEK, PVDF etc., will be used because of their compatibility with the above mentioned components, their low cost and their recyclability/reusability. During synthesis of composite bulk materials several processes should take place in order to preserve the special physico-chemical properties of composites and to achieve the best dispersion in the bulk.
Partners	Ethnicon Metsovision Polytechnion, Warrant Hub SPA, Centre Technologique nouvelle-Aquitaine Composites&Materiaux Avances, Dallara Automobili SPA, Instituto Tecnológico de Aragon, Elica SPA, Idryma Technologias Kair Erevnas, Innovation in Research and engineering solutions, Techedge GMBH, INEGI- Instituto de Ciencia E inovacao em Engenharia Mecanica e Engenharia

	Industrial, Politecnico di Torino, Thales, Università degli studi di roma tor vergata, The University of Birmingham, BIOG3D IKE, Open source management limited, Stratosphere Sa, Etaireia axiopoiseos kai diacheiriseos tis periousias tou ethnikou metsoviou polytechniou (E.M.P.)
Relevance for Addcircles	Innovation radar > Innovation > Hardware and software tools for continuous fiber 3D printing in conjunction with shape-morphing design algorithms for toolpath generation (europa.eu)

4. PROJECT TITLE, WEBSITE: RETPAIR, https://cordis.europa.eu/project/id/101008183/results	
Brief description	The future of the aeronautics industry is high-performance and green thanks to materials like thermoplastic composites (TPCs) that can make components lighter and cost-effective. In this context, the EU-funded RETPAIR project will develop new high-performance, flexible and cost-effective, automated and robotised net-shape technologies to rework and repair TPC parts to be integrated in the manufacturing line. Specifically, it will develop an induction welding solution for structural damage repair based on pre-manufactured patches and two in situ consolidation solutions for structural and non-structural applications based on automated and robotised layer-by-layer patch in situ creation. RETPAIR will also investigate new repair technologies for different damage scenarios.
Main activities and results	The future of aeronautic factories is oriented to manufacture lighter and cost-effective components using greener materials like thermoplastic composites (TPCs). In this sense, given their increasing use, providing with cost-efficient repair methods for their complete integration in production is needed. The main objective of RETPAIR is the development of new high performance, flexible and cost-effective, automated and robotized net-shape technologies to rework and repair TPC parts to be integrated in the manufacturing line. The proposed solutions assure one-side accessibility and are supported by a digital-based methodology to assist the patch design and manufacturing. An induction welding solution for structural damages repair based on pre-manufactured patches will be developed, and two in-situ consolidation solutions for structural and non-structural applications based on automated and robotized layer-by-layer patch in-situ creation: an automated laying (AL) solution based on ATL/AFP technologies (automated tape laying/automated fibre placement) will be investigated for structural and large size repairs, and a 3D printing FFF-based (Fused Filament Fabrication) solution, using both continuous carbon fibre filaments and short fibre filaments will allow to tune patches' strength for different repair requirements (structural and cosmetic). To assure the thermal and mechanical quality of the repair, the critical process parameters (temperature, pressure, times/rates) will be monitored and controlled. The applicability of the new repair technologies for different damage scenarios (Single Part Level, on Major Component Assembly Level, Final Assembly Line) will be investigated, and the required work of a future industrial implementation for the technologies towards TRL6 will be analyzed. RETPAIR developments will result in flexible and accurate repair technologies.

	for high performance and quality solutions, thus collaborating in TPCs growing use in the aeronautic industry
Partners	Asociacion De Investigacion Metalurgica Del Noroeste, Ct Ingenieros Aeronauticos De Automocion E Industriales Sl, Msquare Gmbh
Relevance for Addcircles	continuous fiber additive manufacturing for repair

5. PROJECT TITLE, WEBSITE: PRE-ECO, <http://www.pre-eco.eu/>

Brief description	Additive manufacturing brought to the emergence of a new class of fibre-reinforced materials; namely, the Variable Angle Tow (VAT) composites. AFP and FDM machines allow the fibres to be relaxed along curvilinear paths within the lamina. In theory, the designer can conceive VAT structures with unexplored capabilities and tailor materials with optimized stiffness-to-weight ratios. In practise, steering brittle fibres, generally made of glass or carbon, is not trivial. Printing must be performed at the right combination of temperature, velocity, curvature radii and pressure to preserve the integrity of fibres. The lack of information on how the effect of these parameters propagates through the scales, from fibres to the final structure, represents the missing piece in the puzzle of VAT composites, which today are either costly or difficult to design because affected by unpredictable failure mechanisms and unwanted defects (gaps, overlaps, and fibre kinking).
Main activities and results	The main objectives of the project are as follows: - Implement global and local models for the simulation and analysis of printed composites with unprecedented accuracy from fibre-matrix to component scales - Defect quantification and propagation develop a (hybrid) metamodelin platform based on machine learning for defect sensitivity and optimization - Design for manufacturing: bridge the manufacturing signature with the final structure in a multi-scale sense for setting new rules and best practices to design for manufacturing.
Partners	Politecnico di Torino
Relevance for Addcircles	continuous fiber 3D printing and optimization, rules and best practices to design for AM

6. PROJECT TITLE, WEBSITE: SPECTRAL, <https://cordis.europa.eu/project/id/737845>

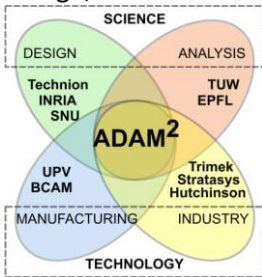
Brief description	The technology known as Fused Filament Fabrication (FFF) is one of the oldest known methods for 3D printing of objects. In fact, it was the first technology to be widely commercialized, and still has, by far, the largest presence on the market. In addition, printers based on FFF technology commonly have prices far less than comparable designs using photo polymerization or sintering technologies. However, to date, FFF has been largely limited to polymers with fairly low melting points: less than 280°C. This has limited its success from an
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	industrial standpoint, where high-performance polymers such as ULTEM (poly etherimide) and PEEK are needed in order to provide thermal and mechanical performance in extremely demanding scenarios. In the aerospace market, PEEK has become the reference high-performance engineering thermoplastic. PEEK is an attractive material due to its high thermal and mechanical performance, coupled with its low density (about one third that of titanium) . It is therefore being widely investigated for replacing titanium and other metals in aerospace applications, in order to reduce overall weight. Current solutions for additive manufacturing using PEEK require investment is extremely costly systems. PEEK-capable industrial-grade machines need not be astronomical, however. In this context, the main ambition of the project will be to provide the Topic Manager with access to a complete FFF supply chain: industrial-grade PEEK FFF printers at a price point ten times less than current industrial-grade FFF printers, along with a supply of high-quality PEEK filament tested and validated on the printer and in accordance with the Topic Manager's performance specifications. In addition, the PEEK materials will be accompanied by a high-temperature compatible breakaway support matrix material custom-designed for PEEK usage.
Main activities and results	Engineers with the SPECTRAL project developed a new 3D printer based on fused filament fabrication technology that speeds up the printing process and costs 10 times less than its existing commercial counterparts. Fused filament fabrication (FFF) is one of the earliest additive technologies for building 3D products, prototypes or models. The process utilises a heated nozzle that ejects molten plastic and deposits it in thin layers, one on top of another, onto a printed bed, eventually forming the 3D printed part. With great potential to become the 3D printing technology of choice, FFF can cut costs and lead times in different industries. However, it has so far gained insufficient momentum for revolutionary industrialisation and commercialisation as it can only extrude material up to temperatures of around 280 °C. Other affordable 3D printers on the market are geared towards photopolymerised or sintered materials, ruling out certain high-performance polymers such as polyetherimide (ULTEM) and polyether ether ketone (PEEK). Higher-temperature materials push the operating envelope of 3D printers. High-performance thermoplastics such as ULTEM and PEEK are unique compared to other 3D-printed plastics. High strength and stiffness, excellent fatigue, long-term heat resistance and broad chemical resistance are just some of the mechanical properties that make this family of thermoplastics highly sought after in aerospace applications. These engineering plastics require much higher temperatures to print properly. Although some FFF 3D printing systems have made some progress in processing materials that have higher melting points, they are still in beta stages. FFF is considered the most promising technology for low-cost PEEK or ULTEM 3D printing, but has not yet seen great success in aerospace applications.

	The aerospace industry currently utilises the certified and widely available electron beam melting for the production of 3D-printed PEEK parts. The investment in a PEEK-capable electron beam melting system can reach around EUR 1 million. FFF 3D printing gives back tenfold Funded under the EU's Clean Sky 2 programme, SPECTRAL succeeded in developing new affordable and reliable technology for printing 3D products with high added value. As part of the Clean Sky 2 initiative, the 3D printer was developed according to specifications laid down by European aerospace company Airbus. To process high-performance polymers, the new 3D printer is equipped with a print chamber that can reach temperatures of up to 240 °C. This high-temperature print chamber minimises warping and ensures interlaminar fusion. Apart from the excellent price-to-print ratio, the system operates quickly and prints with non-proprietary filaments. Project researchers also developed a database that enables the automatic recording and tracking of 3D-printed parts. The SPECTRAL project has provided aerospace manufacturers with affordable technology to produce lightweight parts that contribute to cuts in fuel consumption and thus emissions. The new machinery is one of the few 3D printing technologies available that meet an acceptable quality level for the industry.
Partners	RESCOLL, IDEAL-FORM SRL, AIRBUS (associate partner)
Relevance for Addcircles	Development of a 3D printer for high performance thermolastic composites

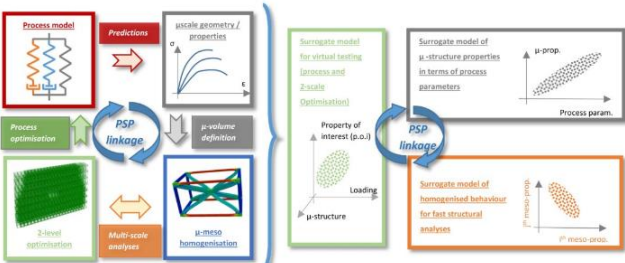
7. PROJECT TITLE, WEBSITE: SeaBioComp, http://www.seabiocomp.eu/partners/	
Brief description	SeaBioComp aims to develop and produce novel bio-based composite materials to replace conventional oil-based products in the maritime industry. The project will produce analytical protocols to evaluate the long-term durability and reduced ecological impact on the maritime environment. SeaBioComp wants to deliver demonstrators of innovative bio-based thermoplastic composites; with at least equivalent mechanical properties compared to oil-based alternatives proven mechanical durability for the marine environment reduced impact on the environment - with reduced CO2 emission, the possibility of recycling and reduced ecotoxic impact (due to microplastics and leachates). It is hoped that the results of this project will lead to a shift in mindset along the value chain, that biobased composites offer a realistic alternative for oil based counterparts.
Main activities and results	The core outputs of SeaBioComp are: - a set of min. 4 semi-industrial pilots of thermoplastic biocomposites, representing the different composite production techniques and with tailored durability

	- realisation of a pilot production machine for additive manufacturing of fibre-reinforced thermoplastic biocomposites at a large scale (1 by 1.5 by 2 meter) - optimised analytical protocols to characterise and prove the tailored durability and measure the ecotoxicity effects of the biocomposites in a marine environment - proven reduction of ecological impact by at least 50% - the formation of a collaborative transregional cluster that will promote a closer, more effective and operational cooperation among the key stakeholders within the bioeconomy (Key Enabling Technology) and more specific the biocomposites for marine environment
Partners	Centexbel, Ceti, Vliz, Armines, Poly Products, University of Plymouth, University of Portsmouth, Marin South East, EuraMaterial, Ifremer, Rewin,
Relevance for Addcircles	pilot production machine for large scale AM of fibre-reinforced thermoplastics; material development of thermoplastic biocomposites

8. PROJECT TITLE, WEBSITE: ADAM ² , https://www.adam2.eu/	
Brief description	The geometric computer aided design (CAD) field is on the brink of a major leap with a rapidly increasing demand for more efficient, accurate and controllable manufacturing processes as well as the evolution of new manufacturing technologies. To manufacture a complex curved 3D shape, such as a turbine blade or a 3D scanner portable mechanism, requires powerful and user-friendly Analysis, Design, And Manufacturing (ADAM) tools that operate under tight synergy and efficiently and automatically create 3D artefacts. The evolution of new manufacturing technologies such as multi-material 3D printers gives rise to new type of objects that may consist of considerably less, yet heterogeneous, material, consequently being porous, lighter and cheaper, while having the very same functionality as the original object when manufactured from one single solid material. We propose a unified manufacturing pipeline that will focus on all stages involving Analysis, Design, And Manufacturing using Microstructures (ADAM2>). 
Main activities and results	ANALYSIS: Additive manufacturing (AM) techniques allow for the manufacturing of volume components using microstructures, leading to a number of advantages, for example regarding light-weight design or multi-

	material products. At the same time, AM not only supports, but can also benefit from porous microstructure, improving upon efficiency. For engineers, the microstructural design is difficult to handle, as they typically have little intuition that will help in the design. We will develop numerical analysis and optimization tools that will assist the engineer in the design of the whole part, and especially the related microstructure(s). DESIGN: In recent years, interest in porous geometry is on the rise, mostly due to the introduced ability to fabricate and manufacture highly complex porous objects, using additive manufacturing technologies (i.e. 3D printers). Recently, an ability was introduced by one of the PIs to precisely synthesize freeform repetitive parametric micro-elements as complete microstructure of arbitrary freeform shapes. The synthesized geometry can be heterogeneous using a volumetric geometric modelling representation (V-rep) and is fully compatible with contemporary boundary representation (B-rep) design and modern (iso-geometric) analysis tools. We will explore the full potential of this recently-proposed methodology. MANUFACTURING: Manufacturing processes for curved geometries designed in WP1 will include machining processes, also known as Subtractive Manufacturing (SM), and, Additive Manufacturing (AM) processes. This two existing technologies, 5-axis SM and new multi-axis AM into Hybrid Manufacturing (HM), will be combined in order to use only one methodology to manufacture complicated microstructures. The additive part will be used first to produce the rough structure, while the subtractive counterpart will be applied in the (semi-)finishing stage. Moreover, Biomachining manufacturing process, an environmentally-friendly manufacturing methodology that uses bacteria to eliminate microscopic residues of material, will also be performed for finishing operations. Recent methodology designed by one of PIs will be performed for the use extremophile bacteria for the polishing stage of the microstructured objects. MICROSTRUCTURES: Design of porous and lattice-like structures goes along with the blossoming of additive manufacturing technology. These structures exist and are designed using specific type of micro-elements with minimal (or no) control over physical properties of the designed objects. Furthermore their manufacturing is a complex procedure that is accomplished using a specific sequence of steps that are associated with one particular type of microstructure, leading to one particular manufacturing algorithm. In contrast, ADAM2 proposes a unified methodology that will further strengthen the use of microstructures. To the best of our knowledge, the optimal layout of the internal parameterized micro-elements in freeform microstructure, the ability to design and to analyze them, as well as its manufacturing using hybrid machining (3D printing and 5-axis CNC machining) is radically new. Consequently, ADAM2 offers a geometric modeling framework for the 21st century that will allow for design, analysis, optimization, and manufacturing of highly complex porous and microstructured heterogeneous geometries.
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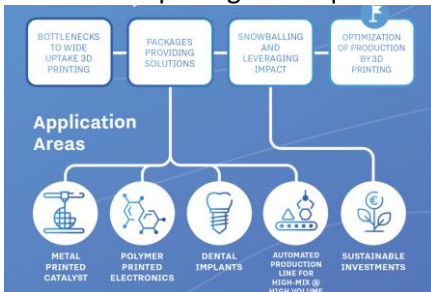
Partners	Basque Center for Applied Mathematics, Israel Institute of Technology, Ecole Polytechnique Federale de Lausanne, Universidad del Pais Vasco/ Euskal Herriko Unibertsitatea, Institut National de Recherche en Informatique et Automatique, Technische Universität Wien, Trimek Sa, Stratasys Ltd, Hutchinson Sa, Seoul National University
Relevance for Addcircles	numerical methods/tools to design AM micro-lattice structures

9. PROJECT TITLE, WEBSITE: MOAMMM, https://www.moammm.eu/	
Brief description	Goal of MOAMMM project is to develop a data-driven design methodology for mechanical components made of metamaterials and produced by additive manufacturing Design, 2-scale optimisation and process optimisation of shock-absorption devices in the following targeted applications: Bi-stable metamaterials to improve shock-absorption devices, Regularly organised lattice metamaterials to improve dissipative absorbers through the following methodology: 
Main activities and results	- Developing a process-(micro)structure-(structural)properties (PSP) linkage, with: - Simulation of the manufacturing process - Prediction of microscale properties and geometry - Uncertainty quantification at different scales - Stochastic homogenisation - Optimisation of: - The manufacturing process - The geometries at two scales (metamaterial and structural geometries) - To this end, current multiscale Integrated Computational Materials Engineering (ICME) methodologies have to be surpassed: the recent emergence of data-driven approaches in computational mechanics offers a change of paradigm, which could make ICME approaches realistic for process and 2-scale stochastic optimisation to be conducted through the use of surrogate models
Partners	University of Liege, Applied Mechanics and Mathematics (MEMA) – Université Catholique de Louvain, IMDEA Materials Institute, Institute for Polymer Product Engineering (Ippe)– Johannes Kepler Universität Linz, Cirp GmbH

Relevance for Addcircles	Optimized shock absorbing AM micro-lattices (could be manufactured with FFF short fibers or
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10. PROJECT TITLE, WEBSITE: ShapeForge, https://cordis.europa.eu/project/id/307877	
Brief description	Despite the advances in fabrication technologies such as 3D printing, we still lack the software allowing for anyone to easily manipulate and create useful objects. Not many people possess the required skills and time to create elegant designs that conform to precise technical specifications. 'By--example' shape synthesis methods are promising to address this problem: New shapes are automatically synthesized by assembling parts cutout of examples. The underlying assumption is that if parts are stitched along similar areas, the result will be similar in terms of its low--level representation: Any small spatial neighborhood in the output matches a neighborhood in the input. However, these approaches offer little control over the global organization of the synthesized shapes, which is randomized. The ShapeForge challenge is to automatically produce new objects visually similar to a set of examples, while ensuring that the generated objects can enforce a specific purpose, such as supporting weight distributed in space, affording for seating space or allowing for light to go through. This properties are crucial for someone designing furniture, lamps, containers, stairs and many of the common objects surrounding us. The originality of my approach is to cast a new view on the problem of 'by--example' shape synthesis, formulating it as the joint optimization of 'by--example' objectives, semantic descriptions of the content, as well as structural and fabrication objectives. Throughout the project, we will consider the full creation pipeline, from modeling to the actual fabrication of objects on a 3D printer. We will test our results on printed parts, verifying that they can be fabricated and exhibit the requested structural properties in terms of stability and resistance.
Main activities and results	Due to project closing in 2017, results are not visible
Partners	Institut National de recherche en informatique et Automatique
Relevance for Addcircles	advanced modeling and slicing for FFF, software characterization and duplication with lower cost and better predictability.

11. PROJECT TITLE, WEBSITE: 3DOP, https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/partnership_industrial_mod_high_performance_3d_printing_en	
Brief description	Among the most innovative manufacturing solutions of the last years, additive manufacturing (AM) technologies proved to be one of the most promising production technologies. AM empowers the transition from mass production to mass customisation in several leading sectors. AM is an instrumental technology in the green and smart transitions. AM corresponds to relative high levels of technology maturity or even market maturity already: some applications have reached TRL 9 and are broadly deployed, but many more

	are at post-prototyping level and should be fully deployed soon. In order to embrace the full potential of AM, it was (and still is) demonstrated that cross regional cooperation is needed, especially in the field of 'demonstration activities' ('test before invest'): to ensure a supported and facilitated access to relevant infrastructures, to reach critical mass for the development of strategic projects enabling mass deployment of the smart and green solutions, etc.
Main activities and results	The idea of the project comes from the Vanguard initiative and the partnership formed in this initiative. The main goal of the project is to stimulate additive manufacturing and the production capacities of companies and to encourage investment by companies in additive manufacturing technologies. As part of the work group, TECOS will develop technologies and approaches for the direct installation of electronic circuits in 3D printed products and products through the search for the best technologies, their testing, the development of pilot production lines and the search for new applications. We will establish a European value chain and promote the acquired knowledge among small and medium-sized companies. We believe that the project's activities will be reflected in the increased investment of companies in 3D printing technologies, the identification of new areas of application, improved knowledge of companies and the promotion of 3D printing and additive technologies among companies and innovators. Optimisation of Production by 3DP (3DOP). 3DOP (3D Printing Optimised Production) aims at removing the bottlenecks in competitive price and quality levels of strategic AM solutions. The project will contribute to lowering cost of metal printing, automate AM factories, deploy electronics printing solutions and improve AM-based repairing techniques. More information here. 

Partners	Meet our partners 33 TECH PARTNERS CONNECTING THE DOTS UNLOCKING INVESTMENTS OF EU COMPANIES SUPPLYING THE COMMUNITY LOCALLY 3 RESEARCH INSTITUTES 6 AM-TECHNOLOGY SUPPLIERS 4 COMPLEMENTARY TECHNOLOGY SUPPLIERS 4 DEMONSTRATION FACILITIES 4 GOVERNMENT & CLUSTER DEVELOPMENT AGENCIES 10 AM-USING COMPANIES >7 APPLICATION MARKETS 20 SMALL AND MEDIUM ENTERPRISES 5 SUSTAINABLE DEVELOPMENT GOALS NETHERLANDS addcat AM-FLUX HEGAGON MICRO CENTRUM OCEANIX opilones 3D @ignify STELLA tracxon TNO W BELGIË Guaranteed IDEAS TechTour VALCUN POLAND HITCUM GERMANY 3-faktor BMBF I-PRODENTS mmb SLOVANIA CAP TCCCO CROATIA SPAIN phibo ITALY TECHNOLOGIUM valand HIF
Relevance for Addcircles	Additive manufacturing in different application fields, however without consideration for LCA, LCCA. Usable as test beds, creation of support environments, upscaling of innovations, and investments.

12. PROJECT TITLE, WEBSITE: CUBIC, <https://specificpolymers.com/cubic/>

Brief description	The general objective of CUBIC project is to improve the sustainability and circularity of complex products made of high-tech advanced multi-material composite thermoset and thermoplastic structures, by developing novel circular biobased alternative materials. CUBIC project designs novel materials (biobased polyamide grades, biobased endured 3R-CAN-epoxy prepeg & and biobased lignin derived carbon fibre.) to obtain circular by design 100% biobased and recyclable thermoplastic and thermoset B2B intermediate products (sub-assemblies) that permits to eco-design complex products adapting their intrinsic characteristics to novel unconventional manufacturing processes as new paradigm to advance in mass production advanced products. The novel approach on which CUBIC project relies is based on modularity or pre-fabrication: the development of high-tech biobased intermediate formats (filaments, sheets – organosheets and UD-tapes, pellets, powder...). The smart combination of these intermediates into a final end-product allows to overcome the current technical and environmental limitations to meet the demanding requirements of a specific sector/application where a single biobased material doesn't. Two end-products or specific applications will be validated within CUBIC project: type IV H2 gas storage pressure Vessel & automotive seat, that satisfy the technical and environmental requirements. The project demonstrates the de-manufacturing, recycling and valorization of the components too.
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Main activities and results	 1 Improve materials biobased content Design & synthesis of bisphenol free bio-based epoxy resins 2 Improve materials recyclability Design of biobased and reversible epoxyde and curing agents 3 Adjust material properties to fit specifications Iterative approach by adjusting formulations and molecule design 4 Resin production for B2B testing Upscale of selected bio-based materials
Partners	Aitiip, Cidetec, Q-plan, DITF, Idener, Circe, Comfil, Moses, University of Limerick, Tequinson, Centexbel
Relevance for Addcircles	Biobased polyamides, covalent adaptable networks, carbon fibre

13. PROJECT TITLE, WEBSITE: STEP UP, https://cordis.europa.eu/article/id/86711-customised-polymeric-components-at-a-profit	
Brief description	An innovative mechano-chemical approach (based on the high energy ball milling) will be used for the development of innovative nanopolymers to be used in Rapid Manufacturing (RM) based on Selective Laser Sintering (SLS), by: 1. Structural modification (up nanopolymers stage) using a currently widely used polymer like Polyamide PA (a “nanoPA” will be produced); 2. Alloying (at nanoscale) with different polymers to tune mechanical properties; 3. Nanocharging of polymers (development of nanocomposites). Moving from this background, the project will make a real, LARGE, step up in polymers and composites properties by including nano features into the base materials and the final products. The final products will benefit from radically extended performances (i.e. operating temperatures, increased strength). In this way it will be possible, using existing prototyping machines, to realize freeform manufacturing technologies for the direct automated and customised production of parts and products from small to medium size batches for a wide range of possible applications (from vehicle applications to biomedical devices). The following are the project S/T objectives of SLS materials and parts produced using the modified PA -New nanostructured materials based on Poliammides (PA) -Agglomerated (scale of 20-50 micron) nanophased (scale of 10-20 nm) particles suited for RM via SLS -Properties improvements in materials and RM/SLS parts properties (referred to conventional PA) of more than 200%. -Parts having improved properties and wider application window for automotive sector, consumer goods and medical instrumentation. For these reasons STEPUP responds quite well to the call topics by: introducing new concepts for the micro/nano fabrication (usage of nanopolymers); enabling transition of RM to customised solutions integrating materials design and simulations.
Main activities and results	While mass manufacturing will always be an important part of most economies, demand for customised components is growing. Scientists

	developed novel polymers suited to cost-effective and rapid manufacturing (RM) of tailor-made parts. RM, also called additive manufacturing, enables faster production through a bottom-up layering approach (additive) rather than cutting components from a large piece or requiring moulds for shaping. In addition, there is less materials waste and programmes can automatically generate machine process parameters via computer-aided design, all of which increase speed, decrease costs and enhance flexibility. A current drawback in the production of polymeric components is the lack of polymers suited to conventional processing techniques. The EU-funded project 'Step up in polymer based RM processes' (STEPUP) sought to bring RM technology to its maturity for selective laser sintering (SLS) of polymers through the development of novel polymeric materials. SLS is a RM technique that uses a laser beam to selectively fuse powders to be processed. STEPUP developed cost-effective synthesis routes to produce nanostructural modifications to conventional polymer powders. The modifications enhanced the final mechanical and thermal properties of products while being compatible with existing SLS production equipment. In addition, decision support software and modelling tools enabled design engineers to identify the best new candidate to replace conventional materials based on predicted performance of the SLS-compatible materials. The most promising materials developed exhibited enhanced mechanical properties at elevated temperatures and facilitated good accuracy and surface quality of components. Process costs were comparable to currently available SLS powders and promising reductions in material cost due to recycling are also expected. The STEPUP project developed novel nanopolymers including synthesis methods to enable RM using existing SLS equipment. Design tools and models will help engineers choose the appropriate alternative to currently available polymers based on desired mechanical and thermal properties. Optimisation and commercialisation of concepts has the potential to significantly enhance the quality and types of customised polymeric products that can be inexpensively manufactured.
Partners	MBN NANOMATERIALIA SPA, Matres SCRL, Inspire Ag for Mechatronische produktionssysteme und fertigungstechnik, Bayerische Motoren Werke Aktiengesellschaft, Artidoksan Hizli Imalat Teknolojileri Sanayi Ve Ticaret as, The Chancellor Masters and Scholars of the University of Cambridge, Granta Design LTD
Relevance for Addcircles	Novel polymeric materials, development of optimization of software products for reducing waste and customization through layering.

14. PROJECT TITLE, WEBSITE: REPAIR 3D, <https://cordis.europa.eu/project/id/814588>

Brief description	Lightweight and strong, carbon fibre reinforced polymer (CFRP) is increasingly being used in aeroplane and ship structures as well as wind turbine blades and high-tech bicycles. Its growing use has also highlighted the need to
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	develop waste disposal methods of end-of-life plastic and CFRP components. The question is how to recycle efficiently and without harming the environment. The EU-funded Repair3D project will develop reclamation and repurposing routes. It will implement advanced nanotechnology solutions, additive manufacturing and recycled resources for the production of high-added-value 3D-printed products. By harnessing the potential of eco-design and allowing for integration of smart intrinsic self-sensing, self-repairing and recycling options, the project will create a distributed recycling process that can be implemented at local scale.
Main activities and results	The project aims at the development of innovative reclamation and repurposing routes for end-of-life plastic and carbon fibre reinforced polymer (CFRP) components. This will be achieved by employing advanced nanotechnology solutions, Additive Manufacturing (AM) and recycled resources, for the production of high added value 3D printed products with advanced functionalities. In this way, the combination of AM, polymer processing and recycling technologies could constitute a new paradigm of a distributed recycling process, easily implemented at local scale in collaboration with the industrial sector and collection facilities, in order to create competitive, highly customisable products at lower production costs, in a flexible digital environment that fully unravels the potential of eco-design and allows for integration of smart intrinsic self-sensing, self-repairing and recycling options. The project aims to address all aspects and stages of thermoplastic and CF reinforced thermoplastic 3D printing material development from recycled resources, starting with the selection of suitable waste streams, strategies for material repair, compatibilization and upgrade towards AM processing, compatibility between different thermoplastic matrices and the reinforcing fibres and nanoparticles, comparative assessment of various AM thermoplastic processing technologies and closed-loop material optimisation in terms of processability and performance.
Partners	Warrant hub SPA
Relevance for Addcircles	CFRP recycling, characterising reclaimed CFRP carbon filaments

15. PROJECT TITLE, WEBSITE: SUSTAINABLE SLS, <https://www.tckt.at/en/research-projects/recycling-of-plastics/sustainable-sls>

Brief description	The most important goals of the plastics industry are the reduction of the CO2 footprint by switching from fossil to bio-based raw materials, as well as the avoidance of plastic micro- and nanoparticles as a waste problem due to accumulation in soil and water. In the field of conventional injection moulding production, great efforts have been made for more than 15 years to develop new, "green" materials and the appropriate resource-saving equipment and the necessary recycling chains. This greening is completely lacking in the area of additive manufacturing (AM, 3D printing) as an alternative technology with significantly higher potential for lightweight construction and weight savings. Optimisation potential exists here with a holistic view of the entire plastic 3D
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	printing production chain, e.g. in the case of selective laser sintering (SLS), in all areas: from material selection for powder production to industrial AM process technology and post-processing. Optimised recycling in this context requires the elimination of multi-materials (consisting of different materials), as well as the introduction of impurities (e.g. by replacing fillers for wear protection, high UV resistance or oils and greases with highly functional coatings).
Main activities and results	• Production of bio- and recycle-based SLS materials (PA 10-10 and PP) for the future industrial production of components in specially highly stressed drive trains (automotive, consumer and mechanical engineering sectors). • Thus, also extended lightweight construction possibilities through additive manufacturing • Reduction of powder costs through maximised use of recycled material • Development of a recycling-optimised protection of highly stressed SLS polymer surfaces against friction, wear and UV degradation from pure carbon coatings The industrial utilisation of the results is planned two years after the end of the project within the framework of the already established "One-Stop-Shop" for SLS component development and series production. This has a broad network of manufacturers and OEMs in the automotive and consumer product sectors with a high level of interest in new, "green" materials in ecologised AM processes.
Partners	DISTECH Disruptive Technologies, Inocon Technologie, Joanneum Research Polymer Competence Center Leoben, Transfercenter für Kunststofftechnik
Relevance for Addcircles	Creation of an ecosystem on additive manufacturing through concept of one stop shops, using additive manufacturing to reduce CO2, reduction of waste through additive manufacturing and production of lightweight components.

16. PROJECT TITLE, WEBSITE: EFFECTIVE, <https://www.effective-project.eu/>

Brief description	The non-biodegradability of most plastic materials and their accumulation affects both oceans and land. To secure a greener future for our planet, the EFFECTIVE project connects 12 companies and institutes who have joined forces to redesign two of the today's most widely used materials: polyamides and polyesters. Our aim is to design bio-based polyamides and polyesters from renewable feedstocks rather than crude oil, and manufacture greener and structurally improved fibers and films. We also intend to showcase the use of our bio-based ingredients in a wide array of mass-produced consumer products across multiple markets, such as construction, automotive, packaging, garments, carpets and textiles. Finally, we want to demonstrate innovative and improved ways for the end-of-life treatment of our products by introducing a circular economy approach and validate the recyclability or biodegradability of the EFFECTIVE materials.
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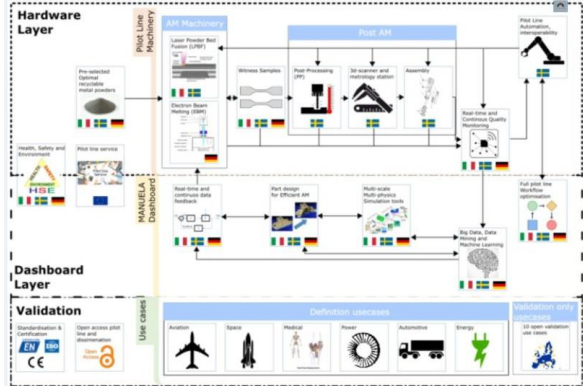
	EFFECTIVE is a combination of technology, economics and commercial adoption. Members of our consortium share a common vision for the future of textiles and packaging: to create innovations that entire economic sectors, as well as end consumers, will benefit from.
Main activities and results	The innovative process introduced by the EFFECTIVE project begins with creating and manufacturing bio-based polyamids and polyesters, and continues with a demonstration of their usability in large consumer products. Finally, by demonstrating circular ways of end-of-life treatment of our products, the loop is closed, and the EFFECTIVE circle continues. Move your mouse over different steps of the process to learn more about the activities behind each step of the journey towards creating innovative bio-based materials and products.
Partners	Aquafil, Circular Change, Fundacion CIRCE, Novamont, Balsan, CBE JU, Bio-mi, Carvico, Circe
Relevance for Addcircles	ECO-DESIGN, remanufacturing in monomers, bio based polyamides

17. PROJECT TITLE, WEBSITE: AEROSINT, <https://cordis.europa.eu/project/id/835545/it>

Brief description	Additive manufacturing, or 3D printing, is often associated with inkjet printers. Powder bed fusion 3D printing technology is based on the selective consolidation of powders into 3D objects through heat or pressure. Currently, both metal and polymer powders can be joined, but not in the same part, and the market for such components is huge. Belgian SME Aerosint is changing the rules of the game. The EU-funded Aerosint project is supporting the team in developing the business plan for their multi-material powder bed 3D printing process, the first to combine polymers and metals.
Main activities and results	Powder bed 3D printing was invented over 30 years ago, has not changed since and is only able to print single material parts. Aerosint intends to change that. Aerosint invented a 3D printing technology capable of printing truly multi-material parts with the ultimate goal to be able to combine metals, polymers and ceramics. This capability paves the way to unique parts optimization and functionalization and will bring 3D printing into a new era. Aerosint is the first multi-material powder bed 3D printing process enabling unique polymer and metal combinations. Our patent-pending technology can print parts that are made of different materials by melting powder layers composed of more than one powder. To achieve that, the Aerosint patterning drums selectively deposit fine powder voxels line by line. The result are powder layers composed of more than one material and ready for sintering. What best illustrates Aerosint unique approach to multi-material. Aerosint's multi-powder dispenser achieves material change between and within layers. No other existing technology is today capable of doing this. We will have two streams of revenue upon market entry: royalty incomes from licensing our technology to 3D machine manufacturers. To help us with revenues faster and to invest in further improvements, we are also

	considering retrofitting old machines. Considering the sales of 7,000 SLS units worldwide at an average price of €200,000 (current price of SLS printer), our serviceable obtainable market would be €98M (7% of the total sales price). There is no competition in terms of technology but there are substitutes such as printers without Aerosint technology. The Phase 1 funding will help us determine the best way to progress and Phase 2 to upgrade the technology. We will benefit the EU by helping advanced manufacturing techniques with the new 3D printing technology, creating more jobs in manufacturing and reducing energy consumption and waste in the process.
Partners	Schaeffler Aerosynt
Relevance for Addcircles	Small scale project, multi-materialsintering, printing services, resulting in a large scale use case

18. PROJECT TITLE, WEBSITE: MANUELA, https://manuela-project.eu/	
Brief description	Manuela's ambition is to provide the European industry with world class, reliable Pilot line manufacturing service leveraging metal Additive Manufacturing products. This will be achieved by having the hardware solutions cost-efficiently connected to the best possible competences and capacities across Europe to cover the full range of powder bed fusion technologies from medium to large scale LPBF as well as EBM. Since, no single machine solution can fit all necessary end user demands, this concept is expected to best possible solution from cost and agility point of view. Leading European institutes in the field of AM have hence agreed to link their manufacturing capacity, technological know-how and facilities in the MANUELA project to develop a pilot line service capable of producing high quality series of products on state-of-the-art equipment in a reliable and production efficient way. The strenght of the MANUELA pilot line lays in the cooperation between the RTD partners enabling industrial partners and end users to request most advanced demonstrators by selecting from various manufacturing routes and functionalities provided. This ensures that the end-users can expect optimum output with respect to costs, reliability and performance. Hence, MANUELA is the most comprehensive AM pilot line service related to AM-parts realization, involving designing methods, the AM processes, post-AM treatment and part characterization. The principle five inovations, leading to the pilot line deployment, combined in MANUELA, are: 1. Tailored recyclable metal powder, for robust and reliable part manufacturing 2. Comprehensive pilot line dashboard allowing to designm simulate and follow the manufacturing process 3. Full pilot line workflow optimisation and automation 4. Exploiting collected process data on the full pilot line and part, towards real-time in-line process monitoring feedback and process adaptation 5. Establish the qualification and certification standard for full chain process in the aim improve the productivity, particularly in such fields where

	the certification is mandatory: automotive, aeronautic and medical (MANUELA's use cases)
Main activities and results	MANUELA's ambition is to provide the European industry with world class, reliable Pilot line manufacturing service leveraging metal Additive Manufacturing products. This will be achieved by having the hardware solutions cost-efficiently connected to the best possible competences and capacities across Europe to cover the full range of powder bed fusion technologies from medium to large scale LPBF as well as EBM. Since, no single machine solutions can fit all necessary end user demands, this concept is expected to best possible solution from cost and agility point of view. Leading European institutes in the field of AM have hence agreed to link their manufacturing capacity, technological know-how and facilities in the MANUELA project to develop a pilot line service capable of producing high quality series of products on state-of-the-art equipment in a reliable and production efficient way. The strength of the MANUELA pilot line lays in the cooperation between the RTD partners enabling industrial partners and end users to request most advanced demonstrators by selecting from the various manufacturing routes and functionalities provided. This ensures that the end-users can expect optimum output with respect to costs, reliability and performance. Hence, MANUELA is the most comprehensive AM pilot line service related to AM-parts realization, involving designing methods, the AM processes, post-AM treatment and part characterization.  The diagram illustrates the MANUELA architecture, divided into three main layers: Hardware Layer, Dashboard Layer, and Validation. The Hardware Layer includes Pilot Line Hardware (Pilot Line Hardware), AM Machines (Laser Powder Bed Fusion (LPBF), Electron Beam Melting (EBM), and Hybrid Laser/Electron Beam Melting (HL/EBM)), and Post AM (Post-processing, Surface treatment, and Assembly). The Dashboard Layer features the MANUELA Dashboard, which connects to the Hardware Layer and the Validation layer. The Validation layer includes Use cases (Aerospace, Defense, Healthcare, Industrial, Automotive, Energy, and All open technologies) and Certification (CE, ISO 9001, ISO 13485, and ISO 14957). The diagram also shows the flow of data and materials between these components, with a central 'MANUELA' box indicating the core service.
Partners	Chalmers University of Technology Sweden, CSEM Switzerland, Friedrich-Alexander Universität Erlangen-Nürnberg Germany, RISE Sweden, Cardiff University United Kingdom, Politecnico di Torino Italy, Höganäs Sweden, Electro Optical Systems Finland, ABB Sweden, Osai automation system Italy, Federal Institute of Metrology METAS Switzerland, MSC Software Germany, Siemens Industrial Turbomachinery Sweden, Qioptiq Limited United Kingdom, Biomedical Engineering Slovakia, Enel Produzione Italy, O.E.B Italy, Stiftelsen Chalmers Industrietechnik Sweden, Amires The Business Innovation Management Institute Czech Republik, RUAG Slip Rings Switzerland.
Relevance for Addcircles	Pilot lines, business models, robust AM manufacturing and online process control.

19. PROJECT TITLE, WEBSITE: DeMans, https://www.demans.eu/	
Brief description	DeMANS seeks to produce world-class innovation in the design and additive manufacture (AM) of parts, components and devices using sustainable (bio)polymer materials through the research expertise of a global network of leading academic and industrial organisations. There is an urgent need to reduce reliance on fossil fuel derived plastics. The vast majority of these polymers cannot be recycled due to additives within them; developing more sustainable material approaches is an imperative. This international and intersectoral project has the ambitious goal of world-class innovation in the design and additive manufacture (AM) of parts, components and devices using sustainable (bio)polymer materials. DeMANS will explore replacing traditional synthetic plastics with biomaterials in consumer products, simultaneously reducing our reliance on fossil fuels and developing new innovations and markets for bio-based products, contributing to the circular economy objectives of the European Green Deal. In line with the principle of 'transforming knowledge into innovation', DeMANS will define the key challenges that have to be met to move from laboratory to manufacturing by demonstrating the feasibility of the approach in the area of computer peripherals. DeMANS brings together complementary world-leading expertise from a network of seven academic and industrial organisations from three European and two Southern Hemisphere countries.
Main activities and results	The technical approach includes: - identifying suitable biopolymers with properties matching industry standards - identifying printing methods - fabricating demonstrators and prototypes - The information will be synthesised to define a technological roadmap for sustainable approaches in additive manufacturing. - Knowledge sharing will be undertaken through a series of secondments, complemented by network-wide training events. - DeMANS will enhance the quality of research and innovation in Europe, leading to increased competitiveness and growth. - DeMANS will develop skills, offer exposure to new research environments, and widen the career perspectives of the staff involved.
Partners	Trinity College Dublin, University Hospital Würzburg, Natural Resources Institute Finland, Logitech, WAZP, New Zealand Forest Research Institute, University of Wollongong
Relevance for Addcircles	Bio-based, recyclable plastics compatible with additive manufacturing, development of biopolymers for AM, selection of AM methods, biopolymer products

20. PROJECT TITLE, WEBSITE: ECOSIGN, http://www.ecosign-project.eu/sl/	
Brief description	ECOSIGN is a Sector Skills Alliance co-funded by the Erasmus+ Programme of the European Union, that started on 1st November 2015 and ending on 31 October 2018, aiming at creating an Eco-Innovation Skills partnership in four European countries (Slovenia, Spain, Romania and Italy) addressing the lack of knowledge of designers coming from the three economic sectors in which the Environmental Indicator Report 2014 focuses: food packaging, electronic goods and textile/ clothing. ECOSIGN will allow industrial designers from those sectors to reduce environmental impact during the product life-cycle from the earliest stage of design, including the use of raw materials and natural resources, manufacturing, packaging, transport, disposal and recycling, avoiding the risk of uncoordinated product planning that could lead to a negative impact for the environment (for example, eliminating a toxic substance should not lead to higher energy consumption).
Main activities and results	The main results of this alliance will be a new joint curriculum and a training course for European eco-designers that will add skills and competences to the designers regarding environmental technologies. Also, it will allow designers, from one specific sector, to change their industrial activity to other sector. As the theme is very wide and it's needed a multi-sectorial perspective, the partners of the project are from different countries specialized in eco-innovation in different sectors, as research centres and associations, educational providers or authorities like VET centres or independent certification bodies.
Partners	TECOS, FERI, CPI, CETEM, CTC, CNFPO-SEF, CENTROCOT, TEXTCLUBTEC, AICQ SICEV, CSFPM, IBA, ECOEVALIND
Relevance for Addcircles	Ecodesign e-learning contents

21. PROJECT TITLE, WEBSITE: IPPT-TWIN, https://www.ippt-twinn.eu/	
Brief description	Study of the interfacial bonding strength. First, the bonding strength between the components of different or the same materials produced by two technologies (T-RTM/IM and AM) will be studied. Most of the work will be performed on the combination of PA6 with other polymers. The influence of various parameters such as processing conditions, roughness, surface modification, etc and bonding strength will be determined. The results will be used to prepare a mathematical model of the bonding strength between the substrate and overmoulded / overprinted components. Synthesis of CAN using reactive extrusion and compounding. Different thermoplastic materials will be functionalized using a reactive extrusion to obtain CAN. A laboratory twin screw extruder will be used for optimum results. The chemical structure of new materials will be determined by FTIR and NMR, thermal properties by DSC and TGA, and mechanical by DMA and tensile test. We expect substantial changes

	in mechanical properties, however, in crystalline polymers, this might not be always positive, due to the reduction of crystallinity. Prepared CAN will also be modified with functional fillers (photo-thermal particles, conductive particles,...) that will enable spatio selective heating of materials via various mechanisms to facilitate thermal triggering of static-to-dynamic transitions. These CAN will be tested as a reversible glue between two parts, thus enabling triggered bonding and debonding and therefore easy recycling of composite parts. Recycling the products made with a combination of various polymers is usually complicated and does not give good results. Triggered debonding would present a huge step forward compared to the state of the art polymer recycling. At the end of this task several CAN and composites will be prepared and . Characterised. Study of improvement of interfacial bonding strength between different polymers. Different materials (unmodified thermoplastics, thermoplastic composites, CAN, CAN composites) will be injection overmoulded onto substrates. Adhesive and self-healing properties of prepared samples will be evaluated by autogenous welding of substrates, various post-processing procedures (such as annealing,...) and subsequent characterization of mechanical and thermomechanical properties. Best performing materials will be selected for the preparation of materials in suitable forms for various AM processes. Use of CAN in hybrid technologies. All four beneficiaries and one associated partner possess various AM printers, which need materials prepared in a specific form such as filaments, granules or powders. The same prepared materials will be distributed among partners to be used for overprinting on substrates prepared by IM or T-RTM. Bonding strengths will be determined according to standards and compared to results from Task 1.1. Best strategies for high bonding strength between the components will be evaluated Besides, filaments will be used for the round-robin test of FFF, since all four beneficiaries and one associated partner possess FFF printers of various producers. The processing conditions will be as similar as possible. Comparing the results of mechanical and other properties from all four beneficiaries and one associated partner will give valuable info about the repeatability of data. Task 1.5: Development of demonstrators A demonstrator will be chosen in the first period of the project and improved. The goal is to improve the bonding strength by at least 50% and/or make it recycling friendly by triggered debonding. Role of participants: All four beneficiaries and one associated partner will participate in this work. BME will do, in cooperation with others, the most work on the T- RTM/AM, while others will work mostly on IM/AM combination.
Main activities and results	- Advanced hybrid processing technologies for future demands - IPPT Capacity building - IPPT Networking - Events for early+ stage researchers - Support for research management and administration
Partners	FTPO, PCCL, Aitiip, BME

Relevance for Addcircles	Capacity building, technology transfer and use case development
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22. PROJECT TITLE, WEBSITE: SURE-Poly	
Brief description	The concerns connected to petroleum-based origin of polymeric materials and the problems related to the accumulation of plastic waste in the environment need an urgent solution. One possible strategy to address this dramatic situation is the exploitation of bio-based resources as precursors for polymers. In particular, the valorization of agro-food wastes via extraction of polymeric precursors could be a winning strategy. Furthermore, the implementation of dynamicity in crosslinked polymeric materials with the introduction into the polymeric networks of labile noncovalent and dynamic bonds capable of undergoing reversible formation and cleavage, will give to the corresponding materials innovative recyclability properties. Within this frame, this project aims to face the complex challenge of the production of sustainable and recyclable polymeric thermosets. The proposed target can be reached by exploiting the peculiar properties of vitrimers, which allows a direct recyclability or reprocessability of the polymeric networks. On the other hand, the use of bio-based polymers holds great promises for the development of sustainable materials. Therefore, the integration of vitrimer properties with bio-based materials appears a great combination of choice to achieve the expected aim. For this reasons, SURE-Polymer has assembled an international team of researchers whose expertise spans green chemical synthesis, biopolymer functionalization, polymer photochemistry, vitrimer design and 3D-printing technology for object fabrication. The project will be run within the international and intersectoral consortium where different and complementary competences of the partners will be shared and exploited creating synergisms. The aim is within the objective of the MSCA-SE call, where transfer of skills and competences will lead to improved employability and career prospective of the involved seconded staff members.
Main activities and results	The concerns connected to petroleum-based origin of polymeric materials and the problems related to the accumulation of plastic waste in the environment need an urgent solution. One possible strategy to address this dramatic situation is the exploitation of bio-based resources as precursors for polymers. In particular, the valorization of agro-food wastes via extraction of polymeric precursors could be a winning strategy. Furthermore, the implementation of dynamicity in crosslinked polymeric materials with the introduction into the polymeric networks of labile noncovalent and dynamic bonds capable of undergoing reversible formation and cleavage, will give to the corresponding materials innovative recyclability properties. Within this frame, this project aims to face the complex challenge of the production of sustainable and recyclable polymeric thermosets. The proposed target can be reached by exploiting the peculiar properties of vitrimers, which allows a direct recyclability or reprocessability of the polymeric networks. On the other hand, the use of bio-based polymers holds great promises for the development of sustainable materials. Therefore, the integration of vitrimer

	properties with bio-based materials appears a great combination of choice to achieve the expected aim. For this reasons, SURE-Polymer has assembled an international team of researchers whose expertise spans green chemical synthesis, biopolymer functionalization, polymer photochemistry, vitrimer design and 3D-printing technology for object fabrication. The project will be run within the international and intersectoral consortium where different and complementary competences of the partners will be shared and exploited creating synergisms. The aim is within the objective of the MSCA-SE call, where transfer of skills and competences will lead to improved employability and career prospective of the involved seconded staff members.
Partners	Politecnico di Torino
Relevance for Addcircles	Human resources and curricula development, exploitation of bio-based resources as precursors for polymers, production of sustainable and recyclable polymeric thermosets

23. PROJECT TITLE, WEBSITE: InShaPe

Brief description	The additive manufacturing process powder bed fusion of metals uses a laser beam (PBF-LB/M) to melt and fuse metal powder together. Its importance is growing in industries that have huge demands for lightweight or individualised designs. The EU-funded InShaPe project will develop a novel PBF-LB/M process underpinned by technical innovations. Specifically, it's an AI-based beam shaping module combined with a novel multi-spectral imaging technique for process monitoring. Its potential will be demonstrated in the aerospace, energy, space, and automotive sectors. It intends to disrupt the manufacturing industry by transforming PBF-LB/M into a green manufacturing technology that surpasses traditional techniques concerning resource efficiency and the precision of manufacturing parts. The project should boost the European PBF-LB/M manufacturing sector's global reputation as a leading supplier of highly complex parts.
Main activities and results	The overall goal of InShaPe is to further develop and demonstrate an innovative powder bed fusion process for metals (PBF-LB/M). Compared to the current state of the art, the following advantages should be achieved: - Seven times higher production rate - 50% lowering of costs, - 60% less energy consumption - 30% reduction of waste. In the long term, the successful development and marketing of InShaPe technologies is intended to strengthen the European PBF-LB/M manufacturing industry as a leading provider of highly complex parts and set new best-in-class standards for digital, resource-conserving and agile laser-based production methods.
Partners	Technische Universitaet Muenchen (Coordinator), Eos Gmbh Electro Optical Systems, Oerlikon Am Europe Gmbh, Technische Universiteit Eindhoven, Silios

	Technologies Sa, Beamit Spa, Aenium Engineering SI, Amexci Ab, Bayerische Forschungsallianz Bavarian Research Alliance GmbH, Technion - Israel Institute Of Technology, Institut Za Kovinske Materiale In Tehnologije.
Relevance for Addcircles	Pursuing innovation in AM techniques, InShaPe aims to disrupt the manufacturing industry by transforming PBF-LB/M into a green manufacturing technology that surpasses traditional techniques in terms of resource efficiency and precision of manufacturing parts.

24. PROJECT TITLE, WEBSITE: SuMAM, website NA

Brief description	Metal additive manufacturing (MAM) is a key technology for Industry 4.0 because it is an environment-friendly, cost- and energy-efficient processing method for metallic components. However, existing post-surface treatments negatively impact the environment, consume energy, and the resulting corrosion resistance does not meet service life requirements. The Marie Skłodowska-Curie Actions SuMAM project aims to develop an innovative multipurpose methodology to deliver the best possible corrosion resistance during printing. This will eliminate the need for post-treatment. It will employ surface creation via in-situ laser processing and incorporate additives during printing. Common materials in the transport industry will be used, namely four aluminium alloys and one stainless steel alloy.
Main activities and results	Metal Additive Manufacturing (MAM), also known as 3D metal printing, has attracted a great deal of attention from scientists and industries due to its potential in the state-of-the-art production of complex-shaped designs in the transport industry. MAM is considered the fundamental technology for Industry 4.0 since it is a low-cost and energy-efficient processing method for metallic components with a minimal environmental impact. Nevertheless, the surface finishing of MAM components is uncontrolled during the fabrication, resulting in low corrosion-resistant components. So far, current post-surface treatments are non-eco-friendly, non-energy efficient, and the achieved corrosion resistance does not fulfil the service life requirements. In this scenario, the main goal of the SuMAM project is to achieve the full exploitation of MAM in the transport industry following the European Green Deal. Namely, as a major innovation, we will develop an innovative All-in-one methodology to achieve the highest corrosion resistance during printing, removing the need for post-treatment. We will combine two approaches: surface creating by (i) in-situ laser processing and (ii) incorporation of additives during printing to control the surface without affecting the bulk properties of the final components. Our target materials are four aluminium alloys and one stainless steel, widely used materials in the transport industry. This project is an outstanding opportunity for the fundamental advancement of MAM science by a technological and economically feasible methodology. The SuMAM project presents the best research scenario for Dr. Rubén Del Olmo Martínez (candidate) to further develop his scientific career. The SuMAM project is led by Prof. Dr. Ir. Iris de Graeve and Prof. Dr. Ir. Herman Terryn from the SURF research group of the Vrije Universiteit Brussel (VUB),

	with a proven outstanding track record in both academic and industrial sectors in the scope of the proposal.
Partners	Vrije Universiteit Brussel
Relevance for Addcircles	Existing post-AM surface treatments are environmentally and energy-consuming, and the resulting corrosion resistance does not meet service life requirements. AddCircles can learn about a way to eliminate the need for post-treatment. It can follow in SuMAM the development of an innovative multi-purpose methodology to ensure the best possible corrosion resistance during printing using in situ laser surface creation and the inclusion of additives during printing of four aluminum alloys and one stainless steel alloy.

25. PROJECT TITLE, WEBSITE: ADDI-OPTIMISE,

Brief description	Additive manufacturing (AM) enables the processing of different materials to produce 3D printed parts and is used in a wide range of applications. Croom Precision Medical (CPM) uses the method to produce precision parts and medical instruments for healthcare and aerospace companies. However, metal AM processes require advanced methods for isolating foreign particles, as well as cleaning and recycling, to meet the stringent regulations that affect the aerospace and healthcare sectors. The EU-funded ADDI-OPTIMISE project will develop a superior AM process technique that can lower costs and increase competitiveness. This innovative solution offers system validation, reduced waste, improved quality and shorter lead times.
Main activities and results	Croom Precision Medical (CPM) is an SME with over 35 years' experience in partnering with global healthcare and aerospace companies as an outsourced manufacturing service of high precision components and medical devices. The overall goal of this ADDI-OPTIMISE project is to achieve a significant step change in the quality and yield of regulated components produced by metal Additive Manufacturing (AM) and as a result to deliver enhanced cost competitiveness. CPM wants to capitalize on our existing practical know-how to develop new services for application in its own business but also as a service to other European AM businesses. When evaluating the metallic AM process in a regulated medical, aerospace or automotive production settings, there is significant process flow challenges in place which requests high value metallic volatile material enter multiple environments for sieving, cleaning and recycling. This introduces multiple opportunities for hazard and material contamination from foreign particles. The competitive advantage for this project and its innovation will be realized by the ability to translate advanced technology, in-situ process monitoring information, post-processing and validation into superior product performance, reduced process waste and improved lead times against current AM processes. The output of the project will provide a robust platform that will allow us to develop multiple product lines and services to meet the needs of a rapidly developing sector. We have a vision of accelerating the uptake of additive manufacturing and disruptive technologies from the SME right through to the multinational in a bid to meet market demands in the highly regulated aerospace and medical fields.

	Additive Manufacturing or 3D printing in metals is disrupting these global market segments at an accelerating pace where new approaches and engineering challenges are presented for part quality, system validation and process control.
Partners	Croom precision tooling limited
Relevance for Addcircles	Learn about an innovative solution that offers system validation, waste reduction, better quality and shorter processing times. Metal AM processes require advanced methods for foreign particle isolation, cleaning and recycling to meet the strict regulations set by the aerospace and medical sectors. The ADDI-OPTIMISE project has developed a superior AM processing technique that lowers costs and increases competitiveness.

26. PROJECT TITLE, WEBSITE: MotionEst	
Brief description	The development of triboelectric nanogenerators (TENGs) can be an effective approach to transforming biomechanical energy to power up and increase the lifetime of the batteries used in our multimedia devices such as smartphones, smartwatches and tablets. However, TENGs generate low energy. To tackle this issue, the EU-funded MotionEst project aims to develop integrated devices that will connect a high-performance TENG with a supercapacitor (SC) able to store the transformed biomechanical energy. What is more, the energy density of the SC will be increased through porous Ti3C2 MXenes as electrode materials. The methodology will be based on the 3D printing of a Ti3C2/graphite-based polyethylene terephthalate (PET) filament followed by pyrolysis. Moreover, plastic bottles will be used as a PET source, providing an innovative waste to wealth solution.
Main activities and results	Portable and wearable devices including smartwatches, health monitoring, and multimedia devices are becoming increasingly popular in our daily lives. These devices are generally powered by batteries that have a limited lifetime. Recently, the development of triboelectric nanogenerators (TENGs) has shown to be an effective approach to transforming biomechanical energy to power up these devices. However, TENGs generate low energy and AC signals which limit their use in continuously powering up electronics. The AC signals of TENGs must be converted and stored in energy storage. Among energy storage devices, supercapacitors (SCs) are found to be a promising device due to their high power density, moderate energy density, long cycle life, and safe use. Hence, this project aims to develop an integrated device (TENGSC), connecting a high-performance TENG with an SC, which can store the transformed biomechanical energy. However, the TENG and SC are susceptible to undergoing damage during biomechanical actions. This mechanical damage can be overcome by developing self-healable TENG and SC. The self-healing nature will help to restore their properties if any damage happens during the cyclic movements. Moreover, to harvest high power from the TENG, a 3D printing technique will be followed, which can easily introduce micropatterns on the film surface. The micro-patterns provide higher frictional effect which is the key factor in increasing the conversion efficiency

	of TENG. Besides, the energy density of the SC can be increased through using porous MXenes –Ti ₃ C ₂ as electrode materials. This can be developed through the 3D printing of a Ti ₃ C ₂ /graphite-based polyethylene terephthalate (PET) filament followed by pyrolysis. The waste drinking water bottles can be used as PET source. Thus, through this work, biomechanically driven smart power source will be developed along with concept of waste to wealth transformation, which can be used in portable and wearable electronics.
Partners	VYSOKE UCENI TECHNICKE V BRNE
Relevance for Addcircles	Familiarization with new, innovative solutions where 3d printing is also used for the development of triboelectric nanogenerators (TENG). The methodology will be based on 3D printing of Ti ₃ C ₂ /graphite-based polyethylene terephthalate (PET) filament, followed by pyrolysis. In addition, plastic bottles will be used as a source of PET, providing an innovative solution for a sustainable approach.

27. PROJECT TITLE, WEBSITE: ITS3D, <https://cordis.europa.eu/project/id/101105208>

Brief description	In a race to meet more sustainable goals in the polymer industry, three emerging topics are taking the lead: polymer informatics, biodegradable polymers and additive manufacturing. With the support of the Marie Skłodowska-Curie Actions programme, the PITS3D project aims to bring these three topics together. By designing a bottom-up computational approach for the production of two biodegradable polymers widely used in 3D printing, the project tackles the challenges related to the relationship between the structure, properties, processing and performance of these popular materials. The generic and open-access methodology developed by the project will facilitate digital polymer design. Moreover, it will accelerate the process of implementing computational tools into sustainable design practices.
Main activities and results	Polymer informatics supports sustainable development goals by implementing versatile computational tools which allow users to move the polymer design from the laboratory to the digital world. To connect the links between the structure, properties and performance of the polymer materials, many pieces of puzzle need to be collected over a wide range of time and length scales, starting from the quantum and progressing hierarchically towards continuous methods. Due to their relative novelty, systematic bottom-up approaches for biodegradable polymers are in short supply. Owing to their rich structure stemming from the natural origin, they need to be simulated with a great detail, what leads to an increased computational complexity and researchers' frustration. Consequently, the computational studies struggle to keep pace with the emerging applications and technologies such as additive manufacturing. PITS3D project aims to speed up the progress in the field by proposing a systematic bottom-up study of two biodegradable polymers widely used in 3D printing techniques. The atomistic description of the local processes of the selected samples represents the first pillar of the approach. In the second

	stage, the computational study is extended to longer time and length scales, while going beyond the state-of-the-art by mimicking the characteristics of commercially-produced biodegradable polymers. By providing the simulation input files as open-source starting packs, PITS3D aims to encourage the further development of these computational tools. Another objective is to bridge a gap between the theoretically studied systems and those used for the 3D printing, by establishing an iterative passage of properties between the computational and experimental techniques. The combination of both approaches optimizes the use of resources, providing economic and ecological benefits and represents a unique training opportunity for the fellow as well as for the students of the host institute.
Partners	Universidad de Cadiz
Relevance for Addcircles	PITS3D project aims to optimize the use of resources, providing economic and ecological benefits.

28. PROJECT TITLE, WEBSITE: FLEXCRASH, https://cordis.europa.eu/project/id/101069674	
Brief description	Handling unexpected events is difficult, particularly in today's complex manufacturing environment. But it's possible. The EU-funded FLEXCRASH project will develop a flexible and hybrid manufacturing technology by applying surface patterns using additive manufacturing onto preformed parts. Hybrid manufacturing offers a property tailoring capacity that allows the development of a new type of crash-tolerant structure with outstanding performance in an imminent crash. The project will define these structures according to the collision parameters identified by the different mixed traffic scenarios and are the ideal solutions for active safety devices. The technology can be applied to other safety-related structures in vehicle parts, decreasing the number of materials and processes used in crash structure manufacturing and reducing manufacturing costs.
Main activities and results	- Crash simulation from advanced material models to virtual testing - Advanced testing on crash, toughness, fracture and fatigue - Flexible and hybrid manufacturing technologies - Identification of safety needs for current and future mobility - New crash tolerant structures
Partners	Fundacio Eurecat (Coordinator), Lulea Tekniska Universitet, Centro Ricerche Fiat Scpa, Autotech Engineering Spain Sl, Virtual Vehicle Research Gmbh, Gemmate Technologies Srl, Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev, Imc Fachhochschule Krems Gmbh, Aerobase Innovations Ab, Asociacion Espanola De Normalizacion.
Relevance for Addcircles	An exemplary demonstration of the capabilities of AM technology is its ability to reduce material consumption and reduce production costs - An example on safety-related structures.

29. PROJECT TITLE, WEBSITE: MMO3D, http://www.si-at.eu/si2/mmo3d/	
Brief description	The overall objective of the project is, on the promising fields of mechanical engineering and robotics, to connect competent R&D stakeholders and existing knowledge in the program area and encourage the transfer of technology and expertise for developing new products, technologies and services, and thus contribute to improving economic cohesion and regions competitiveness. Currently, R&D players are insufficiently cooperating; therefore it is coming to diversification and weaker activation of development potential in the region. There is a significant need for better cooperation. Battery box for electric vehicles will be an object, where the new technology and its potential will be demonstrated. The robot cell is designed as a mobile unit and will be available for all partners for demonstration and learning purpose.

	Development institutions and the regions economy, which is very closely related to the field of mechanical engineering, technological and computer-aided processes, as well as educational institutions and students, will acquire knowledge and benefit from outputs. The consortium consists of partners who have previous experience in this area. The results cannot be achieved without cross-border cooperation, as joint partnership brings together complementary strengths and added value.
Main activities and results	The main output of the project will be a robotic cell for 3D printing of composite, light and natural materials. The core of the innovation is the combination of two technologies: plastic injection and fiber application (consolidation) with a manipulator. The new technology will enable the production of geometrically complex products from high-strength, lightweight materials.
Partners	OPREMA RAVNE pnevmatika, hidravlika, orodja in tehnološke linije d.o.o., Fachhochschule Kärnten –gemeinnützige Privatstiftung, Wood Carinthian Competence Center, ROBOTEH avtomatizacija in robotizacija d.o.o., Fakulteta za elektrotehniko, Univerza v Ljubljani
Relevance for Addcircles	Multi-axis printing, composites

30. PROJECT TITLE, WEBSITE: A fully Robotic and 3D Printing solution for large scale building delivery(EVO Constructor)

Brief description	The computer-controlled sequential layering of materials to create three-dimensional shapes, otherwise known as 3D printing, was first developed in the 1980s. It is now used in a wide range of applications – from aerospace engineering to dental applications. 3D printing systems have also been developed for the construction industry but there are still many challenges and limitations to overcome such as scalability and working at heights. The EU-funded Evo Constructor project has developed a mobile system based on a robotic machinery technique that enables the automation of all processes necessary for the construction of buildings and other civil works. This project will validate its commercialisation for construction companies as well as for architectural studies.
Main activities and results	3D Printing for construction sector is booming in the last few years, emerging as an automated manufacturing process that produce complex shape geometries automatically from a 3D computer design model. Although construction 3D Printing has become a revolutionary technology for building, the industry will have to face many challenges related to scalability, work at heights, delivery system, suitability to adverse environment and initial investments. Aware of the limitations of current 3D printing systems for construction, we have developed Evo Constructor, which is a unique mobile system based on a robotic machinery technique that allows to automate all the constructive processes necessary for the execution of buildings and other civil works. The great innovations that differentiates Evo Constructor from any current alternative in the market are its unique cloned axis system, the

	economic and environmentally friendly characteristics and its self-climbing system, which translates into important cost and time savings. Now, we already have the support of potential customers within the building sector. Nevertheless, we still need to carry out full operational test to validate our solution for its subsequent commercialization. Our market, the 3D Printing Construction Market, was valued at € 0.06bn in 2017, and it is estimated to grow with a CAGR of 78% reaching € 40bn by 2027. Based on our commercialization plan we will offer our solution mainly to construction companies of the building sector, but also architecture studies. It will include the sale and rent of Evo Constructor, but also maintenance and consultancy services. Following our business strategy, we establish an average price of € 0.82M per unit for sale, and € 287k for 6 months rental. Based on the profitability of the project we expect a cumulative revenue of € 22.4M by the third year, meaning a cumulative cash flow of € 13.1M. Considering a total investment of € 1.5M we expect to get a ROI of 463% by 2022.
Partners	EVOLUTION CONSTRUCTION SYSTEM S03L
Relevance for Addcircles	Construction, robotics, automation, synthetic materials

31. PROJECT TITLE, WEBSITE: AMABLE, https://www.amable.eu/	
Brief description	AMable supports you in the bringing your idea to an additively manufactured product. We support technologies from plastics through polymers to metals with our competence centres (CC) that target individual challenges for you. We connect you to the right people if you are a newcomer, enthusiast or if you are an experienced expert.
Main activities and results	Business Services The business service area aims to support your additive manufacturing ambitions from the economic and financial perspective. We assess your product idea with respect to viability and your facilities with respect to existing the equipment, software, and workforce for the manufacture of AM products. As a result, you will receive a plan with recommendations for make-or-buy. We then, if requested, connect you to relevant funding programs or venture capital. Production Services This service area focuses on the efficient and robust production of your products at the required scale. After an assessment of your manufacturing set up with respect to the production of AM components at scale, we create with you a roadmap for implementation of the required infrastructure and skills for an operational production facility that will also meet certification requirements. The service can provide support in assessing the benefit of the introduction of robots as a means of optimising product handling and product quality. As a result, you will be able to proceed with acquisition of the necessary and relevant equipment and workforce to achieve the production targets of your business plan. Materials Services

	The materials service area will enable you to find suitable materials for AM, considering the applications, handling and processing. It will guide you in selecting or qualifying high-quality materials with respect to properties and recyclability. This service will assist you on choosing materials that will meet the design and mechanical property requirements of your part and enable you to select the appropriate post-processing. If you have a challenging application case where a suitable material cannot be found on the market, our experts will support you in sourcing such a new material. Certification Services The certification service area provides guidance on quality assurance and certification of parts manufactured by additive manufacturing. The scope of this service ranges from defining the route to certification of a machine, a single manufacturing process, an additively manufactured part, up to embracing the entire production facility. Likewise, it will provide alignment with regulations, codes and standards. Our experts support the assessment & validation of current QA practices. As a result, you will know how to setup a quality system in the AM context, how to deal with customers concerned by certification and how to reach an efficient certification. Data Services The data service area provides advice on acquiring, handling and storing data along the whole AM process chain. This covers data that is collected from real-world measurements and used to draw conclusions about the state of materials, processes and parts. As a result of using this service, SMEs will know what data formats are needed and how much storage capacity to expect as well as drawing conclusions on material allowables, process health, inspection results and know about readiness for Quality Assurance requirements. Post Processing Services The post-processing area offers you the guidance on different post-processing technologies for parts manufactured by AM, to bring the AM parts closer to the customers' specifications. Being the last manufacturing step for AM, this service can assist with the improvement of mechanical proprieties, surface smoothness and finishing, as well as cosmetic surface treatments for general aspects. This service will support you in processes like Heat Treatments, support removal, Plastic deformation methods, Cleaning & depowdering and also, Inspection. This service will give your customers confidence in your finished product. Design Services This service will provide knowledge to enable the creation of an AM-buildable product. The Design service includes the guidance on AM design methods and DfAM workflow, considering specific design requirements and rules for machinability, manufacture (DfM) and post-processing, for each AM process. The design process may include structural optimisation, design concepts, customisation, modelling and validation techniques, reverse engineering or simply the redesign of a component. The objective is to optimise the design
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	for AM benefits, while minimizing manufacturing risks and to be cost-effective. Preparation of manufacturing instructions including AM technical drawings and the Technical Data Package is comprehended in this service as well. With this service, it will also be possible to present end results through an immersive design environment. This allows for a pre-assessment of product design and provides the ability to realistically visualize the product. By applying digital design tools, it is possible to predict and display the distortion, surface texture of a built component or assembly. Simulation Services Simulation is valuable in the AM process chain for design validation, buildability assessments and planning for post-processing, for example CNC machining. This service area offers access to state of the art simulation methods and tools for advanced thermo-mechanical analysis of components and systems and prediction of component build distortion together with applying geometry compensation. In addition the service offers the use of photogrammetry for reverse engineering of existing components and comparing built parts to the nominal CAD geometry. As a result, the customer will be able to design their AM parts with confidence in what their functional performance will be and how well they can be manufactured.
Partners	Fraunhofer ILT, Fraunhofer ISST, Aimen, Danish Technological institute, EWF, Frederick Research Center, Inspire, LMS, IK40LORTEK, MTC, Politecnico di Torino, Sirris, SUPSI, TNO, TWI, ATOS, Industrial data Space Association, Strategy&, Zabala
Relevance for Addcircles	AMABLE SUCCESS STORIES IN ADDITIVE MANUFACTURING https://www.amable.eu/solutions/cases

32. PROJECT TITLE, WEBSITE: AM PLATFORM, https://rm-platform.com/am-related-projects/projects-list	
Brief description	The AM-platform is the largest and oldest community of stakeholders for all subject related to Additive Manufacturing (hereafter named AM) in Europe. Currently, more than 700 members from more than 25 countries are part of this network. The AM-platform is active since 2007 (formerly as the RM-platform). The objective of the AM-platform is to contribute to a coherent strategy, understanding, development, dissemination and exploitation of AM. A point of networking, reference and coordination. AM is still fragmented. Many organizations and initiatives are working or doing research and innovation in this area but there is no coherent strategy and several interpret the subject differently. There is no central organization or place for people to, for instance, get directions on Am trends and current activities, get to know the existing ecosystem, ask questions, to start a

	discussion, to find expertise, or to up- or download an interesting paper or article. This platform helps to achieve the Lisbon & Gothenburg objectives as defined by the EC (to become the most dynamic and most competitive knowledge-based economy by 2010 and achieving sustainability by 2030).
Main activities and results	- Repository of knowledge, key projects on additive manufacturing, ranging from projects, projects in defense, AM skills and training, non technological projects, and AM materials projects. - Roadmapping activities, community and database - Free of charge
Partners	NA
Relevance for Addcircles	AM roadmap – strategy

33. PROJECT TITLE, WEBSITE: AACOMA PROJECT, <https://aacoma-interreg.eu/>

Brief description	AACOMA stands for Accelerate Advanced Composite Manufacturing. The aim of the project is: - to identify Who-is-who in the EMR (innovative SME's) across the entire value chain in order to connect them with each other and establish the links to the world-class institutes and technical centers in the region - to establish a Virtual Technology Center (database) in the EMR - to identify and realize demonstrators (incl. innovative materials and processes as well as data regarding feasibility, quality and productivity), in cooperation with an international advisory board to organize 6 roadshow events, addressing key topics like automated manufacturing, additive manufacturing or bio-based material systems, combined with match-making and training events - with our activities in the Euregio Meuse-Rhine, we are going to inspire the parties to mutually increase their competitiveness, to initiate and run joint demonstration projects, to strengthen the economy in all involved regions and finally to secure working places
Main activities and results	- Use of innovative materials, - Stimulating innovation - Creation of company database
Partners	Flanders Make, Fontys, AMI, AMAC, CENTEXBEL, SIRRISS LIEGE UNIVERSITE
Relevance for Addcircles	Community building through virtual technology center and training offers

34. PROJECT TITLE, WEBSITE: PhoCam, <https://cordis.europa.eu/project/id/260043>

Brief description	Lithography based additive manufacturing technologies (AMT) are capable of fabricating parts with excellent surface quality, good feature resolution and precision. With recent developments in the field of ultra-short-pulse lasers and light engines based on light emitting diodes, robust and economical light
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	sources have become available. This project aims at developing integrated lithography-based additive manufacturing systems which will, for the first time, facilitate the processing of photopolymer-based materials for the factory of the future. The focus of the project is to unite industrial know-how in the field of supply chain management, software development, photopolymers and ceramics, high-performance light-sources, system integration and end-users in order to provide a fully integrated process chain at the end of the project. The consortium will rely on two core-technologies: (1) Digital light processing (DLP) based processes will be used to process ceramic-filled photopolymers, leading to fully dense ceramic parts at the end of the process chain. (2) Two photon polymerization (2PP) will be used to fabricate high-resolution structures with features in the range of 100-200nm. Both processes will be tuned to reduce system cost, and significantly increase throughput and reliability at the same time. Goal is to deliver 'first-time-right' strategies for the involved end-users. This necessitates the development of supply chains with integrated quality sensors. Targeted applications include thread guides for textile machinery, ceramic moulds for the fabrication of high-performance turbine blades and microstructures for computer tomography equipment.
Main activities and results	Researchers employed digital light processing (DLP) and two-photon polymerisation (2PP) to overcome issues with inadequate mechanical properties and low resolution faced by current AM technologies. DLP was used to process ceramic-filled photopolymers for fully dense ceramic products. 2PP was employed in fabrication of small, high-resolution features on the scale of 100–200 nanometres (nm). For both technologies, the team developed suitable materials, hardware, software and the associated light sources. Ceramic processing with DLP used novel light-emitting diode-based light engines. 3D-printed ceramic parts had excellent strength, reliability and surface quality. 2PP relied on a commercially available femtosecond laser. The process chain includes a prototype web platform covering the entire workflow from geometric CAD model uploading to quote calculation, ordering and payment. Thread guides for textile machinery, a high-precision lattice mould for production of a computed tomography device and a patient-specific middle ear prosthesis showcased the novel AM technologies. Several press releases promoted project achievements on the international scene. PHOCAM successfully proved the industrial viability and quality of their technologies with major progress in on-demand micro-manufacturing and significant improvements in throughput and feature resolution. The fully integrated supply chain for cost-effective AM in a variety of sectors will positively impact EU manufacturing of high-throughput as well as customised components.
Partners	Technische Universitaet Wien

Relevance for Addcircles	Testing of new materials, with cost effective techniques
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35. PROJECT TITLE, WEBSITE: HYPROLINE; https://cordis.europa.eu/project/id/314685/pl	
Brief description	The general objective of Hyproline is to strengthen the competitiveness of the European industry by introducing manufacturing methods, which will allow companies to 1) reduce time-to-market and number of rejects, 2) make more customized and innovative products with a higher market value, and 3) make products > 20% more accurate with considerable savings (>30%) in consumption of waste metal, fluids and services, with an equivalent reduction of CO2 emission. By further developing the manufacturing process itself as well as by research and application work on materials, pre and post treatment of the parts produced and supporting software Hyproline adds capabilities to commercially available manufacturing systems, in terms of speed, product quality and versatility. By keeping focus on the entire process from conceptual outline of the product via product design, engineering and production planning to actual manufacturing and control of quality, the project contributes to the development of a versatile manufacturing process, suited for industrial production by SMEs of complex custom made metal (meso scale = order 10 mm) parts in small batches or even in one-of-a-kind production mode. The Hyproline manufacturing concept will be demonstrated by its pilot implementation for serial production of customized high quality meso parts for two different industrial sectors of (1) electronics and (2) aerospace.
Main activities and results	3D printing is a relatively recent technology that is ideally suited to this type of task. Part of the complex 3D geometry consists of details provided as a CAD file. However, reducing production costs requires improvements in precision and post-processing. As part of the EU-funded HYPROLINE (High-performance production line for small series metal parts) project, scientists have built a high-performance production line for 3D printing a series of small, high-quality, customised metal parts. It works in conjunction with a high-speed finishing line using laser polishing. The project partners also developed the production process itself and conducted research on materials, pre- and post-processing of parts and the relevant software. This has improved the production systems available on the market in terms of speed, product quality and variety. The complex HYPROLINE machine consists of a carousel with space for 100 pallets and a robot that picks up and places unfinished components, selects finished products and adds specific modules. Pallets move under a patented metal 3D printer (Digital Metal) on a fixed Z-axis. A key element of the machine is a laser scanner that compares finished 3D prints to the 3D models used to produce them, while a laser ablation module polishes parts and removes excess material. The added monitoring and measurement processes are expected to result in benefits such as reduced time to market, reduced rejects and waste, and improved product quality and

	market value. The HYPROLINE machine can produce parts from three different metals: 316L stainless steel, titanium and copper. The pilot implementation was demonstrated by the mass production of high-quality, custom-made parts in the 10 mm range for companies producing jewellery, dental instruments and microwave electronics. The automated, high-speed HYPROLINE system for producing small, high-precision metal parts promises to significantly increase the competitiveness of European SMEs. It will also enable the production of innovative components that consumers have not had access to before due to their cost.
Partners	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO
Relevance for Addcircles	Metal printing solutions

3.2. Other identified stakeholders

1. NAME, WEBSITE: HIGH-TECH FACILITIES FOR ALL, https://www.nlr.org/article/high-tech-facilities-for-all/	
Brief description and references	The Netherlands Aerospace Centre (NLR) has renamed and repositioned its modernized ACM3 Field Lab (pronounced as ‘ACM Cubic’), with the aim of attracting more Small- and Medium-sized Enterprises (SMEs). This well-equipped, state-of-the-art field laboratory makes high-tech equipment available for the development of light-weight products. In this way, ACM3 enables everyone to pursue successful innovation. The purpose of ACM3 (Field Lab for Automated Composites, Metal Manufacturing and Maintenance) is to support companies in the development of light-weight systems made of composite materials and/or metal. This support can be provided in nearly all phases of product development: from concept studies and material screening to preparing detailed designs and creating concepts. Repairs and full-scale prototyping are also carried out in the centre.
Relevance for Addcircles	supporting companies in the development of light-weight systems
2. NAME, WEBSITE: CFAM, https://ceadgroup.com/; https://cordis.europa.eu/project/id/830468	
Brief description and references	Composite materials find innumerable applications and they are manufactured in most cases via the open-mold process. However, when the object to manufacture is large in size, complex in shape, and to be produced in a few units only (e.g. for prototyping purposes or small production batches) the open-mold process becomes very expensive because of the cost of the mold, so the production is moved to Asia to save at least on the labor costs. This introduces though long lead times (up to 8 weeks). This situation is common in the maritime and industry sectors, in which small batches of complex and large composite-made parts are used very often. These industries need a solution to manufacture locally (in order to reduce the lead time) and inexpensively custom-made parts.

	Our innovation addresses exactly this need. We offer the largest (1.5 m × 4 m × 2 m) Additive Manufacturing machine capable of producing carbon- and glass-fiber parts with a high throughput (up to 15 kg/h) and low costs (about 50 €/h, including material, personnel, and depreciation). Our Continuous-Fiber Additive Manufacturing (CFAM) machine exists as a TRL 6 prototype, which is a small-scale version of the final product but in which all critical technologies have been thoroughly tested. The main goal of this project is to take the CFAM machine to TRL 9, manufacture and test it, and finally bring it to the European market. We have already two launching customers (Dutch SMEs working in the maritime and industrial sectors) and we have planned business development activities Europe-wide that will guarantee to our company a turnover of over €17 million in 2022. During the project, we will also build an Experience Center in which our CFAM machine will be available for demonstrations and for 'manufacture as a service' purposes for clients that want to test it or use it for prototyping purposes. Cead group is a company implementing the project and continuing the results of the project in their own manufacturing business. Specifically, CEAD Group implements pilotprojects, technology components, robot based solutions, gantry based solutions.
Relevance for Addcircles	continuous fiber additive manufacturing, large scale solutions, tailored advice for companies, prototyping and piloting.

3. NAME, WEBSITE: Fraunhofer IAPT, <https://www.synera.io/news/additive-design-toolkit-fraunhofer-iapt>

Brief description and references	Designing parts for additive manufacturing (AM) can be complex and time-consuming. Engineers and decision-makers need access to expert know-how and design guidelines specific to AM to ensure optimal part designs and improve efficiency. This is where the Fraunhofer IAPT Additive Design Toolkit for Synera comes in. The Additive Design Toolkit (ADT) by Fraunhofer IAPT is yet another powerful tool part of Synera's marketplace for engineers, product designers, and scientists in additive manufacturing looking to use the full potential the process. By simplifying design evaluations and providing valuable manufacturing insights, the ADT accelerates the adoption of additive manufacturing and paves the way for innovative and sustainable parts. Synera's commitment to create an open ecosystem for engineers continues to propel the industry forward, providing the solutions and connectivity needed to meet and exceed the demands of modern design, engineering, and manufacturing teams.
Relevance for Addcircles	Testing the Toolkit. Bulding on this solution for our toolkit.

4. NAME, WEBSITE: AM PLATFORM, <https://rm-platform.com/am-related-projects/projects-list>

Brief description and references	The AM-platform is the largest and oldest community of stakeholders for all subject related to Additive Manufacturing (hereafter named AM) in Europe. Currently, more than 700 members from more than 25 countries are part of this network. The AM-platform is active since 2007 (formerly as the RM-platform). The objective of the AM-platform is to contribute to a coherent strategy, understanding, development, dissemination and exploitation of AM. A point of networking, reference and coordination. AM is still fragmented. Many organizations and initiatives are working or doing research and innovation in this area but there is no coherent strategy and several interpret the subject differently. There is no central organization or place for people to, for instance, get directions on Am trends and current activities, get to know the existing ecosystem, ask questions, to start a discussion, to find expertise, or to up- or download an interesting paper or article. This platform helps to achieve the Lisbon & Gothenburg objectives as defined by the EC (to become the most dynamic and most competitive knowledge-based economy by 2010 and achieving sustainability by 2030).
Relevance for Addcircles	Overarching platform combining resources in AM, free membership, overview of companies and projects.

5. NAME, WEBSITE: VANGUARD INITIATIVE, https://www.s3vanguardinitiative.eu/	
Brief description and references	The Vanguard Initiative offers a platform for businesses, clusters and knowledge institutes to meet and join forces in finding new innovative solutions. Together, we aim to increase the competitiveness of companies and scale-up regional businesses in Europe-wide value-chains. The Vanguard Initiative's Pilot Projects offer unique possibilities for businesses, clusters, and knowledge centres to connect with like-minded partners across European regions that share a joint goal; to strengthen industrial innovation in Europe. The benefits of interregional partnerships, established through the Pilot Projects, include exploiting complementarities, project development at the demonstration and piloting stage towards upgrading and business exploitation (beyond TRL 5), opening and sharing specialised infrastructure, access to a larger community of end-users, pooling good practices as well as jointly addressing non-technological issues, etc. The participating stakeholders in the Pilot Projects get access to exclusive networks of pilot plants, demo-sites, and partners, working together to accelerate the market uptake of advanced technologies and methodologies in areas of strategic importance to Europe's industry.
Relevance for Addcircles	EU wide network of stakeholders, good starting point for collaboration and knowledge access.

6. STRATEGIC OUTLOOKS IN INVOLVED REGIONS AND WIDER

On the EU level it has been long recognized that research and innovation are a key for sustainable and smart economic transformation. The process of recognizing the importance of innovation and innovation diffusion as well as research has materialized starting in 2010 in Smart specialization strategies of regions and countries. In the current programming period it is reflected in the Objective 1 of the ERDF – **“A smarter Europe by promoting innovative and smart economic transformation”**. To achieve the objective, the Smart specialization strategies are obliged to respect three main principles:

1. Localisation: smart specialization is a place based approach, it builds on the assets and resources available.
2. Prioritisation: S3s have to identify and concentrate resources on a limited set of areas, the so-called S3 investment priorities.
3. Participation: S3s require stakeholders from the quadruple helix (public sector, research, private sector and civil society) to engage throughout the strategy-cycle. Local actors need to support the definition, review, monitoring and implementation of S3 investment priorities.¹

S3 quotation in EC Communication on a New European Innovation Agenda

[...] over the new programming period 2021-2027, smart specialisation strategies will continue to “play a central role in strengthening regional innovation ecosystems so that they are better equipped to stimulate and sustain economic growth. They provide the framework for ERDF support for research and innovation to the tune of an estimated EUR 56 billion. Thematic Smart Specialisation Platforms and partnerships have also become key tools for connecting innovators with similar or complementary strengths and priorities in all Member States and regions, including in technology areas that are key for the twin green and digital transition.

In Austria² on the national level, the ERDF has been allocated 741,1 million EUR in total.

In **Carinthia**³, S3 focuses on:

1. Strengthen of academia EDUCATION
2. Deepen the cooperation between science and economy RESEARCH
3. Broaden of the innovation active entities INNOVATION

From the available documentation Carinthias' S3 builds upon the first-class tech-companies, research basis and technology/innovation ecosystem. From the S3platform⁴ Carinthias' priorities are:

- Control technology and module switching technology
- Information and communication Technologies

¹ https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/about_en

² <https://www.oerok.gv.at/eu-fonds-2021-2027>

³ <https://era.gv.at/policies/regional-dimension/knowledge-innovation-driven-regional-growth-and-smart-specialisation/smart-specialisation-in-austria/>

⁴ <https://s3platform.jrc.ec.europa.eu/map/-/eye3/y/2014-2020>

- Sustainability technologies and materials
- Production technologies at the interfaces of IT.

In **Styria** the guiding themes and markets are:

- Mobility
- Green technology
- Health technology.

With the core technological competencies being:

- Materials and materials technologies
- Production technologies, machinery and plant engineering
- Digital technologies and microelectronics.

For Styria, we can find some more guidance on the importance of various questions when preparing or seeking support from the state, as listed below⁵:

“In order to ensure that the above-mentioned activities are carried out in line with the S3 strategy and its objectives and that success- and result-oriented projects receive an LOI (Letter of Intent) or LOC (Letter of Commitment) from the State of Styria, it is important that the applicants or the S3 projects meet certain criteria.

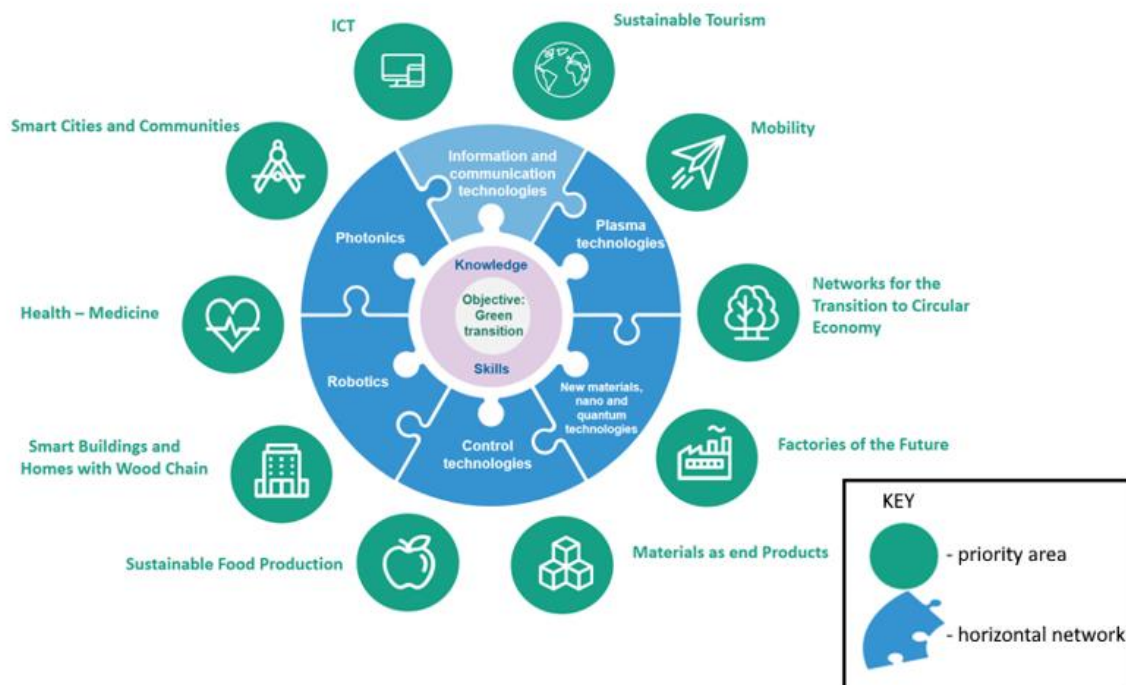
The following points or questions serve as a guide and must be considered and answered before or when submitting the application:

- *Which lead markets (mobility, green tech, health tech) does the project address?*
- *Which Styrian core competencies are addressed (materials, plant engineering, digital technologies, etc.)?*
- *Will the know-how generated during the project be retained in Styria after the project ends? If so, to what extent?*
- *What cross-cutting themes does the project address (digitalization, education, creativity as a raw material for intelligent change, etc.)?*
- *How should the innovative content of the project be assessed and what added value does it bring for Styria?*
- *Which project partner is taking the lead in this project?*
- *Are spin-offs/start-ups generated/are these planned after the end of the project (especially in Styria)?*
- *Are climate and environmental issues addressed?”*

For **Slovenia**, there is only one national Smart specialization strategy, named S5⁶ (Slovenian sustainable smart specialization strategy). The strategy has identified ten priority pillars. The abovementioned objective 1 of ERDF consists of 727,1 million EUR, with the division between both regions (Eastern Slovenia as less developed region eligible for 485,8 million EUR, and Western Slovenia as developed region eligible for 241,3 million EUR).

⁵ <https://www.wirtschaft.steiermark.at/cms/ziel/174367847/DE/>

⁶ <https://evropskasredstva.si/en/slovenias-cohesion-policy-programme-2021-2027/slovenias-smart-specialisation-strategy/>



The relevant ones, for the application of AddCircles objectives are:

- Factories of the future - through key enabling technologies
- Materials as end products – integrated in the focus areas and technologies identified in the entrepreneurial discovery process.

7. CONCLUSIONS AND NEXT STEPS

Additive manufacturing sector in EU has been fast developing. From micro, small and medium sized companies, to institutes and various institutions, all the way to wide ranging funding support (on the EU level but also on national levels in some countries and regions). The Initiatives such as Vanguard, AM Platform, Smart regions serve various purposes:

- Mapping and collaboration opportunities
- Leverage for funding
- Promotion and marketing, as well as establishing stakeholders in the EU map.

The AM Platform amongst other offers the best overview of the AM ongoing in EU, and is also serving as the interface to European commission, whereas Vanguard initiative on the other hand joins various pilots (not just Additive manufacturing) and is also supported by regional policy makers, thus has a better political stake.

Supported projects in EU are numerous. In this report we only highlight the most important/relevant ones for Addcircles project, as otherwise the list would be non-exhaustive. If other relevant projects come to our attention we will update the report accordingly.

Regarding the strategic outlooks across Europe Additive manufacturing is rarely clearly mentioned, even though new technologies, 3D techniques and new materials are made reference too. This could be attributed to the fact that many of the companies and organizations involved in AM are relatively dispersed on one hand, specialized, or perhaps the knowledge is even consolidated in enclosed institutions. The competence map of AddCircles will enable us to get a better understanding of this and bring AM to the forefront of Strategic outlooks.

The competence map, which is an additional deliverable of Addcircles will on the other hand complement this report with relevant references of stakeholders in Austria and Slovenia.