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## Preview
# JEC World 2023
# Innovation

## Business
Global trends

## Manufacturing
Industry 4.0, aerospace

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## Feature Innovations

# Process and eco-responsabilty lead innovation



## Business



## Manufacturing



## Technology

## process

# Additive manufacturing: the default manufacturing technology of the future

**After a slow start in the 1980s, 3D printing of polymers as well as metals has spread very rapidly over the last 10 years in many industrial sectors. It is so booming that over the next decade, the 3D printing market is expected to grow exponentially from $2.5 bn to about $20 bn (+560%) [1]. The highest growth percentage is expected to be in end-use parts. The annual sale of 3D printers is expanding accordingly.**

Born for prototyping, present additive manufacturing technologies, with their materials and ancillary services, are increasingly chosen as a solution to manufacture end-use parts. These technologies are now used to some extent by almost all major industrial players.

Additive manufacturing (AM) - or 3D printing - is the process of producing objects by depositing layers of material on top of each other instead of traditional subtractive methods, such as CNC milling which is used for industrial manufacturing. A digital 3D model of the object to be produced is cut into hundreds of thin layers by a dedicated software to be exported in 3D printing format. This format is then read by the printer to know exactly when and where to deposit the material. The layers are 3D printed one at a time until the complete object is obtained. The most frequently used 3D printing technologies are FFF (fused filament fabrication) or FDM (fused deposition modeling), which use coils of filament, SLA (stereolithography) and PBF (powder bed fusion).

Flying-Cam's discovery during the flight. CRP Technology collaborated with Flying-Cam to create functional 3D printed tail rotor actuator guard for "super drone" Discovery. © Flying-Cam

### 3D printing allows a versatile typology of materials to be used

In fact, it is possible to 3D print with almost any material. The most common 3D printing materials are polymer-based, from standard PLA to advanced and highly resistant polymers such as PEEK or PEI, and thermoplastics reinforced with carbon or glass fibres. Prototyping, moulds and tools have always been the main applications of additive manufacturing and will always continue to grow. To benefit from the various advantages that different types of materials offer, it is possible to 3D print composite materials. Composite materials can include basic elements such as wood filled PLA, or very strong and durable materials such as nylon or carbon fibre filled PEEK. It is even possible to deposit long strands of fibre directly during the 3D printing process, with the right equipment.

The main interest of 3D printing applied to composite materials is to combine the desirable properties of two different materials. Customisation, the ability to easily produce complex geometries, product consolidation, and - in some cases - cost reductions are also the most obvious benefits of 3D printing. Nevertheless, the additive manufacturing of composites shows some weaknesses such as optimisation of workability, which changes according to the materials and the resulting properties associated with the adhesion between layers as well as between reinforcing fillers and matrices.

If recycled fibres are used as reinforcement, the availability of waste composite materials with different compositions and geometries, and the consequent variability of the properties of the filler introduce other variables to control in the process. Therefore, it is necessary to validate the opportunity to develop a specific additive manufacturing process for composites reinforced with recycled glass fibres (GFs) and carbon fibres (CFs). 3D printing is used not only in traditional industrial sectors such as aerospace, automotive, marine, construction, oil and gas, medical, etc. but also for bioprinting, food printing as well as building and construction industry (3D printing of concrete).

### A means to deal with the issue of EoL composites

The quantity of composite products that reach the end-of-life (EoL), is continuously increasing. We must find a way to recycle and remanufacture. In 2019, the Department of Chemistry, Materials and Chemical Engineering "Giulio Natta" of Politecnico

On Dubai's Jumeirah beach stands a unique Dior installation composed of two circular modules. crafted from natural materials–combining clay, sand and raw fibres using an exceptional 3D printing system designed by WASP ©Wasp

di Milano [2], investigated the potential of 3D printing for EoL composites and demonstrate that an additive regeneration process starting from recycled glass and carbon fibres allows to obtain a new thermally light-curing composite. In their paper, researchers concluded: "*The results of this work show for the first time that a low-cost UV-assisted three-dimensional printing technology can be used for the remanufacturing of GFRCs and some complex structures were printed as a proof-of-concept. This study opens the way towards the reintroduction of GFRC waste from various application fields (e.g. wind turbine blades and construction components) to the production cycle of high-performance composites.*"

Car manufacturers were among the first together with the aerospace industries to be interested in the possibility of directly producing even complex parts in a short time. Currently, both the automotive and aeronautical industries are developing additive manufacturing technologies to improve the production process because they have understood that it allows the creation of very complex geometries, significantly reducing production times and costs. It also makes it easier to increase the part strength and resistance and reduce weight. Weight optimisation is of the utmost importance particularly in the aerospace sector. The creation of the mould is always an essential and expensive step that is usually made with subtractive technology and CNC machines. Till recently, the success of 3D printing was linked to the fact that it allows manufacturers to do away with the costs of industrial moulds. Yet, up to now it has not been a sustainable technology for large-scale production.

To conclude, 3D printing is a great option for traditional manufacturing methods like injection moulding. It can be used to print a specific part, prototypes or small series in a quick and cost-effective way. It is increasingly being applied to the production of parts, moulds, tools or other one-off parts.
3D printing also revolutionised the automotive industry by offering the opportunity to produce in a more environmentally friendly manner and also on-demand. The maritime industry for example, will also be able to rapidly produce hollow, watertight and corrosion resistant parts. The same is true for manufacturers of railway carriages, Industry 4.0, telecommunications, etc. According to a recent research by Lux Research, the forecast is more than brilliant. 3D printing is set to grow to $51 bn by 2030, rising at a 15% compound annual growth rate.

## Making the most of 3D printing: the examples of Massivit, Novation Tech, Moi Composites and Roboze

Thanks to its new exclusive materials and all innovative "Cast in motion" technology, the Israeli company Massivit 3D has developed a large 3D printer (Massivit 10000) with an additive manufacturing system capable of producing industrial moulds. It reduces production times and costs with the thermal and mechanical resistance necessary for mass production.

In practice, the Massivit 10000 creates a type of empty "shell" in a special water breakable gel, inside which a thermosetting epoxy resin is poured. The result is then immersed in water, where the shell crumbles leaving a mould that does not present the structural criticalities of a traditional 3D printing due to the lack of molecular bonds between the layers. This technology reduces the production time of a mould by 80% and the manual labour required by 90%. Currently, the company is developing a completely new capability for the 3D printed isotropic moulds to be able to withstand autoclaves, results are expected in mid-February. The first Massivit 10000 in Europe has been installed in Italy by Novation Tech, one of the European leaders in carbon processing, specialized in the production of high-quality carbon components. For cars alone, the company produces over 20,000 carbon seats every year and thousands of interior and exterior components for the custom-built cars of major international brands. The printer will be used first for the creation of moulds and projects dedicated to carbon modeling. According to Luca Businaro, CEO of Novation Tech, the new Massivit 10000 will allow his company to make a further leap in quality in its production and in services to their customers, who have always been keen on high technology and precision manufacturing. "*The automotive world, like the other industrial sectors we work for, is constantly accelerating the time-to-market of new products. This technology allows us to reduce mould creation times for the production of fast carbon prototypes, in compliance with the technical drawings of the products,*" says the manager.

Furthermore, the time needed to create moulds is significantly reduced. Related prototypes allow for more room to experiment. It also paves the way for successful innovations and products. "*The goal is to quickly get to exploit the full potential of the machine in order to produce two to three moulds per week. We also want to make the service available to external companies, as we already do with the other machines in our 3D printing department. We are facing a new phase of additive printing, bound to profoundly change in a few years' time the entire prototyping and industrial production phase,*" he adds.

"*In the future, I think we will come to have more and more integrated solutions, able to streamline cycle times and finishes,*" says Gabriele Natale, CEO and founder of Moi Composites.

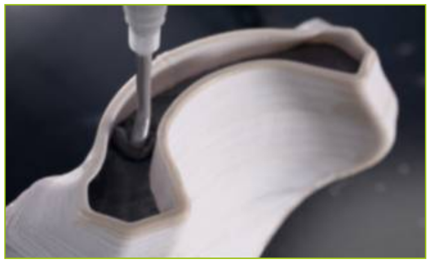
The Massivit 10000 introduces to market the first true isotropic 3D-printed mould for composite manufacturing

Massivit 10000 Automated Tooling for Composite Materials

Born as spin-off of the 3D printing laboratory of the Politecnico di Milano university and winner of the 2017 JEC innovation award, Moi Composites is a company offering solutions for tailor-made parts for the composite market. Next April, the company is going to present the beta version of Sistema, a framework for the manufacture of advanced composites based on Moi's proprietary Continuous Fibre Manufacturing (CFM) technology.
Sistema provides end-users with the ability to 3D print parts with highly optimized fibre orientations according to both planar and non-planar deposition strategies. This results in substantial weight savings and improved performances ; it uses a wide range of thermosetting polymers matched with continuous fibres such as carbon fibre reinforced epoxy and glass reinforced vinylester. An innovative dedicated line of hardware is used for the deposition of continuous unidirectional fibres, impregnated with proprietary blends, supporting layer-by-layer deposition of a range of different tow sizes.

Nowadays, state-of-the-art sees carbon composites offering extreme mechanical performances, but at the cost of sacrificing

The Massivit 10000 3D's Cast In Motion (CIM) technology combines ultra-fast, additive manufacturing technology with high-performance, thermoset materials to enable automated tooling for composites



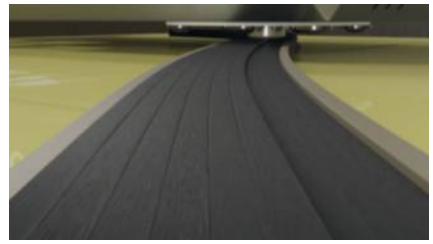
A detail of the "cast in motion" technology for the mould of a car roof

production flexibility and cost efficiency. On the other hand, polymer-based additive manufacturing offers extreme design and production flexibility coupled with a cost-efficient production, but with comparably inferior mechanical performances.

For Alessio Lorusso, CEO & & founder of Roboze, a company which is specialised in 3D printing technology for super polymers and composites, the experience the company gained in the additive manufacturing of parts with high-performance thermoplastic materials has demonstrated its ability to integrate into traditional production processes, offering the reduction of production costs and delivery times as the first tangible short-term advantage. According to him, the next 10 years will be crucial in increasing end-user awareness of the benefits of industrial additive manufacturing. "*This will lead to new challenges which, in our opinion, will be played out on two distinct levels: sustainability and the integration of technology in all stages of production. Roboze is already working on both fronts, proposing not only innovative technologies and materials, favored by our strong nature in the R&D of completely new and competitive ecosystems, but also more sustainable commercial and financial models*," he declares.

Roboze decided to build upon this status quo, to offer a porosity-free Continuously Carbon Fibre (CCF) additive manufacturing solution by developing a new patent pending process

3D-printed truss made in continuous carbon fibre and epoxy resin



Close-up of Roboze's UFO-extruder depositing a porosity-free composite layer. An automated casting system dispenses the A&B components according to the required ratio

that the company called "UFO technology". It delivers mechanical performances comparable with state-of-the-art carbon composites, while embracing the inherent flexibility of additive manufacturing. This is made possible by depositing and compacting high temperatures thermoplastic filaments (PEEK, PEKK, ULTEM™ AM9085F and PA) with a 50% plus CCF reinforcement. The said fibres are steered along the part's envisioned load-path, a process known as "fibre steering". It exploits the high-performance orthotropic behaviour of the carbon fibres while obtaining fully dense components. Roboze's industrial printers ensure the production of components with reliable and repeatable mechanical performances and high-quality surface finishing, without any post-consolidation needed. This patent pending technology will equip Roboze's high-performance 3D printers with heated chambers. ☐

**More information:**
www.roboze.com/en/
www.moi.am
www.novationtech.com
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