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formnext magazine



Lynxter
innovates
while living
the high life
» Page 16

Concrete and
philosophy come
together at
Constructions-3D
» Page 22

VLM Robotics
combines fine
vintages with
Industry 4.0
» Page 30

by **formnext**

The perfect is the enemy of the good

Le mieux est l'ennemi du bien

[French aphorism]

Cover: feedbackmedia.de, iStock/Waidelotte

EDITORIAL

There's a French saying that goes »Quand le vin est tiré, il faut le boire« – once the wine has been opened, it has to be drunk. Of course, it means much more than not allowing a good vintage to spoil; after starting something, one should generally see it through.

In the French AM industry, the cork was drawn from the bottle very early on. Ask an expert in Paris or one of the country's many regions about where 3D printing began and you won't hear a name like Chuck Hall. Instead, they're sure to tell you about Jean-Claude André, Olivier de Witte, and Alain le Méhauté. Back in 1984, it was these three inventors who developed and patented a process for stereolithography, but evidently lacked the business acumen Hall demonstrated on the other side of the Atlantic.

After that, the technology developed somewhat less rapidly than in places like the United States, but Formnext's partner country for 2022 has since cultivated a very broad and highly innovative AM industry that covers solutions all along the process chain and boasts an array of companies with very exclusive expertise in printing everything from concrete to silicone. Our editor-in-chief, Thomas Masuch, took it upon himself to visit many of them this summer to bring you a different kind of travel report and the latest news in AM from France.

France is the home of many corporations and brands that are renowned the world over. Their products range from submarines and nuclear power stations to trains, planes, perfume, wine, cars, clothing, and winter sports equipment. These companies are constantly striving to come up with further innovations, as well. Whether it's in developing new products or manufacturing them – particularly in small and medium quantities – they are increasingly making use of additive manufacturing, and the number of applications is practically guaranteed to keep growing apace.

Meanwhile, the French government has set up a variety of funding programs to support the country's additive future. Among other aims, 3D printing is to help drive a process of reindustrialization in France, where the proverbial wine has been left on the table in some sectors of industry in recent decades. This presents tremendous potential for providers and users alike in the world of AM. As the world's most important platform for additive innovation and networking, Formnext will help ensure that this potential is realized.

I'm already looking forward to getting the »grande fAMille« back together in Frankfurt!

À bientôt,



Sincerely, Sascha F. Wenzler
Vice President Formnext



CONTENTS



05 FORMNEXT NEWS
» Another year, another level up

06 FROM MANUFACTURERS TO USERS
» An overview of the French AM market

08 PARTNERS
» The Carnot network, the Nouvelle-Aquitaine region, Initiative 3D

10 SIGHTS SET ON THE INTERNATIONAL STAGE
» AddUp

13 FLOATING MICROTOOLS
» Binc Industries

14 WHEN LOKI AND THOR PRINT PROTOTYPES
» Fabulous

16 PRINTING SILICONE, CATCHING WAVES
» Lynxter

20 PRINTING PELLETS IN PARIS
» Pollen AM

22 CONCRETE, PHILOSOPHY, AND NAPOLEON'S ELEPHANT
» Constructions-3D

27 ALUMINUM IS IN OUR DNA
» Constellium

30 FROM WINE BARRELS TO TRAIN PARTS
» VLM Robotics, Wine & Tools

34 OUTSIDE THE BOX
» Small tables, big joie de vivre

FORMNEXT NEWS



STILL ON THE RISE, FORMNEXT ADDS MORE EXHIBITORS AND FLOOR SPACE

After its successful return to hosting in-person events last year, Formnext is set to continue its positive development in 2022. In August, the world's leading trade fair for additive manufacturing and modern industrial production already reported more than 630 exhibitors and around 45,000 square meters of reserved floor space.

This means that months before the start of this year's trade fair, Formnext has almost achieved its total number of exhibitors and exceeded its gross area in 2021 by more than 30%, all while drawing an impressive 57% of its attendees from outside of Germany.

The exhibitors that have already registered represent the global elite in additive manufacturing, including companies such as 3D Systems, Additive Industries, AddUp, Arburg, BigRep, Carbon, Desktop Metal, DMG Mori, DyeMansion, EOS, Evonik, Farsoon, Formlabs, GE Additive, HP, Keyence, Markforged, Materialise, Renishaw, Ricoh, Siemens, Sisma, SLM Solutions Group, Stratasys, Trumpf, Voxeljet, Xerox, XJet, and Zeiss.

»This successful development underscores the fact that for many companies in the AM industry, face-to-face meetings are essential to successfully conduct business, advance developments, and find partners and investors,« says Sascha F. Wenzler, Vice President for Formnext at event organizer Mesago Messe Frankfurt GmbH.

FRANCE: A VERSATILE, INNOVATIVE, AND BROAD-BASED PARTNER COUNTRY

France is one of the most important European countries in AM and has had a strong presence at Formnext for years. In 2022, more than 30 French companies, associations, and research institutes will be exhibiting at Formnext and presenting their range of services. The French AM industry will be showing off a very diverse portfolio of offerings along the entire process chain.

The exhibitors from France are broadly positioned and include internationally established AM companies such as AddUp; numerous highly innovative young companies such as Lynxter, Pollen AM, SAS Cosmyx, and Fabulous; as well as other renowned industrial companies such as Arkema, Constellium, and Granges. With France Additive, Cimes, CCI Nouvelle-Aquitaine, and the CNRS Institut Carnot MICA, important AM associations, regions, research

institutions, and other French partners will also be represented at the trade fair.

The event's second day, 16 November 2022, will be dedicated to this year's partner country. A further taste of Formnext will also be provided by Journée Initiative 3D, an industry event hosted by Cimes on 22 September 2022 in Grenoble, where Formnext will be a partner and invite its attendees to a networking reception afterwards. And finally, only Formnext will offer a special edition of its AM Field Guide in French.

A DIVERSE SUPPORTING PROGRAM

In Formnext's diverse supporting program, established events will be continued and expanded. The Start-up Challenge, for example, will honor innovative and viable business ideas from young companies for the eighth time. On the AM4U stage, the exhibitors in the Start-up Area will introduce themselves in short rounds of presentations. And of course, there's the purmundus challenge idea competition, which will celebrate its 10th anniversary with a festive reception and a special »Best of 10 Years« show.

In addition to Discover3Dprinting seminars (in German and English), which are in high demand in the industry, visitors to Formnext 2022 will be able to find out about the wide range of career opportunities in the AM industry on the AM4U platform.

Meanwhile, the high-quality conference program organized by content partner TCT will again address current trends and developments in AM, as well as bring together AM thought leaders and users from various industries. The VDMA will present a special show featuring valuable AM applications from the world of mechanical engineering.

Finally, the BE-AM special show will demonstrate advanced developments in the increasingly important area of 3D printing in the construction industry. The topic of standards will again be discussed by experts and decision-makers from around the world at the renowned ASTM Standards Forum.

+ FURTHER INFORMATION:
» formnext.com

AN IMPORTANT TOOL FOR REINDUSTRIALIZATION

From printer manufacturers to users – an overview of the French AM market

For France, it all started in 1984 when three French pioneers – Jean-Claude André, Olivier de Witte, and Alain le Méhauté – invented stereolithography. From that moment on, research centers, training laboratories, industrial companies, and end users believed in 3D printing, and a revolution was underway. Some 38 years later, this idea has spread worldwide, and additive manufacturing has also developed very successfully in France, including on both the manufacturer and the user side. In terms of figures, the French AM market has a volume of around €500 million and is showing double-digit growth rates. This puts it among the top six markets worldwide.

To get a more detailed overview of the players in French AM, they can be divided into the following six categories:

- National research centers working on fundamentals, such as CEA and CNRS
- Laboratories and educational institutions, which are mainly associated with universities and engineering schools
- Technical centers and regional platforms such as France Eclat, Cetim, INORI, Cimes, and NAE
- Solution providers for the entire process chain, including software, materials, hardware, energy, and services

- Industrial and service companies that are able to manufacture with quality and efficiency
- End users in many sectors, from start-ups and SMEs to large corporations

Most of these stakeholders work together in the France Additive – 3D Printing Cluster, a non-profit organization open to players based in France or abroad that share a common aim: driving the French market forward and creating added value with additive manufacturing in social, environmental, and economic terms. We've even seen AM solutions being used to support France's ambitions for the 2024 Olympic Games in Paris.

DYNAMICS WITHIN THE REGIONS

There are 18 regions in France that are very active in the fields of research, education, and economic growth. Two of them will participate in Formnext 2022: Auvergne-Rhône-Alpes and Nouvelle-Aquitaine. In these regions, a network of technical centers is working closely with end users to identify business needs, find potential solutions, solve difficulties, and test benefits before proceeding to industrialization. Most of them will be present at Formnext under the collective name »Institut Carnot«.

19 INDUSTRIAL SECTORS

The French government has defined 19 strategic industrial sectors. Each of them has finalized a framework agreement with a roadmap that specifies where they are going, what they need, how they will meet these needs, and what they will deliver in terms of value creation in the future.

Five of these sectors have officially identified 3D printing as key to achieving their goals: Aerospace, Fashion and Luxury, Nuclear, Rail, and Marine. For AM companies, this is a promising opportunity to lay the corresponding groundwork and, in the long term, develop new applications in batteries, hydrogen, packaging, and more.

Under the new France 2030 program that was launched by President Emmanuel Macron, a substantial €54 billion national fund will be made available (in part for AM) and managed by the French public investment bank BPI. France Additive was one of the players selected to define and implement these AM ambitions.

Additive manufacturing is seen by the French authorities as a »game changer« for the industry and as an efficient tool for meeting sustainability commitments. In addition, AM is viewed as means of supporting the reindustrialization of France's regions thanks to its decentralized manufacturing capabilities.

Text: Christophe Eschenbrenner

Photos: France Additive



Christophe Eschenbrenner,
President of France Additive

A BROAD BASE OF AM COMPANIES

French AM companies are world leaders in various segments, such as aligners (Prodways), ceramics (3DCeram), concrete (XTree), biomaterials (Arkema), design-to-manufacturing software (Dassault Systèmes), and gas (Air Liquide).

Pioneering companies such as AddUp (PBF and DED), Volumic (FDM), Aubert & Duval (metal), Kimya (polymers), and others are growing rapidly. In addition, more and more start-ups are emerging, such as Lynxter (silicone), Pollen AM (pellets), Poietis (human tissue), Cosmyx3D (FDM), Nanovia (material), Vistry (security), Batiprint (construction), Handddle (equipment), VLM Robotics (automation), Cirtes (Strato), and Cognitive Design (software). New entrants are also joining forces, such as Viaccess Orca (security) and Vallourec (WAAM).

Meanwhile, various service providers are developing at a fast pace and producing high-volume products, including Erpro, Volum-E, 3DProd, Demgy, Bombyx, Lisi, NES, Sculpteo, and THI. Engineering companies have also discovered additive manufacturing (such as Caggemini, Sopra-Sterea, and Segula). Furthermore, it's equally important that educational players train young talent, and engineering schools (Polytechnique, Centrale, CESI), universities (Belfort, Lille, Lyon, Nancy, Nantes, Picar-

die, Saclay, Toulouse) and others (Lycée Loritz, AFPA, AFPMA) are doing precisely that.

Users range from start-ups to corporations. The French economy is known for its large, world-leading corporations, many of which use AM and have developed exciting applications. These include Chanel and L'Oréal (luxury goods); Lafarge and Holcim (construction); Alstom and SNCF (railroads); Naval Group (shipping); Thales (defense); Renault, Stellantis, Michelin, and Valeo (automotive); Airbus, Ariane, Dassault Aviation, and Safran (aerospace); EDF and Total (energy); and many more. Highly proactive retail companies such as Decathlon, Salomon, and SEB are also successfully using AM.

At the same time, France is a nation of start-ups, as well. Many new AM companies are emerging, including in the medical sector with XFeet (orthopedics) and Lattice Medical (implants), and in the consumer sector with Syos (music), Yuyo (surfing), and La Patisserie Numerique (food).

The French start-up scene – also known as »La French Tech« – brings together start-ups, investors, policymakers, and community builders with the goal of making France an excellent place to start and grow international companies.

»La French Fab«, meanwhile, is the collective term for the industrial ecosystem across

France. It is joining forces with »La French Tech« to rapidly move to Industry 4.0, and international AM players can get involved through the »Choose France« program. More information will be available at Formnext 2022, where France Additive will also be actively involved through animations, the conference, and delegation tours.



+ FURTHER INFORMATION:
»franceadditive.tech

PARTNERS

INDUSTRY-RELATED PARTNERSHIP RESEARCH



Created in 2006, the Carnot network aims to develop research conducted by French public research laboratories and technical centers in partnership with companies ranging from SMEs to large groups. The Carnot label is awarded to French public research structures that carry out upstream research activities to renew their scientific and technological skills while also following a proactive policy of partnership research that

benefits companies. In additive manufacturing, eight Carnot institutes operate as a network that seeks to support companies in their R&D projects along the entire value chain in all business sectors, from early-stage research to industrial application. These laboratories and technical centers are capable of supporting companies in designing new parts and developing tailor-made materials, adapted processes in additive manufacturing and post-processing, and control tools, as well as in characterization and performance tests for these materials to ensure that manufactured parts comply with customers' specifications. The Carnot network's specialists offer their expertise to industrial projects. The complementary nature of their skills enables them to work on everything from the development of a micrometric clamp weighing just a few micrograms for polymer 4D additive manufacturing to the manufacturing of a stainless-steel mold several meters in diame-

ter that weighs hundreds of kilograms. At the Carnot network booth in the French pavilion, about 30 demonstrators will be exhibited to highlight the recent developments and knowledge accrued through French research, particularly in material diversity.



+ FURTHER INFORMATION:
» carnot-mica.fr

TRANSFORMING THE INDUSTRY BY MINIMIZING RISK

France's Nouvelle-Aquitaine region supports industrial companies' transitions within the framework of the major program «Factory of the Future». Because tomorrow is taking shape today, it is necessary – even fundamental – to give industrial actors, CEOs, production managers, engineers, and other stakeholders access to all the possible solutions to promote the improvement of manufacturing as a tool and bolster competitiveness through innovation and technological developments.

Each company is a laboratory of value creation that has intangible heritage talents it can take advantage of. The regional authority, along with the Chamber of Commerce and Industry of Nouvelle-Aquitaine, provides a tailor-made path to accelerating the integration and/or use of 3D printing technologies by manufacturing companies. The «Additive Manufacturing Journey» allows for more rapid and

targeted use of such technologies by industrial SMEs by securing their projects under the individual guidance of a certified on-site expert, and also by providing managers and employees with the training they need to understand the technologies and grasp their advantages and uses. In just a few weeks, a company can proceed from an idea to a corresponding project thanks to this «de-risking» process.

The Additive Manufacturing Journey is also designed to reach a combination of objectives that support productive competitiveness at the regional level. These include disseminating up-to-date information on the issues, limits, and maturity of these technologies according to applications and uses; providing ways to train and improve skills; and connecting people with the available results of R&D. The Nouvelle-Aquitaine region is also investing in rese-

arch, studies, and demonstration tools to help all the relevant players find their way to appropriate additive manufacturing technologies.



The following companies will be present at the Nouvelle-Aquitaine booth: VLM Robotics, 3D Minerals, Axis, Toyal Europe, 3D Distrib, CDFI 3D, Handddle, Compositadour, Namma, and 3D Iconic.

+ FURTHER INFORMATION:
» nouvelle-aquitaine.fr

Photos: Région Nouvelle-Aquitaine/Thierry Martrou, Institut Carnot

PARTNERS

THE METAL ADDITIVE MANUFACTURING NETWORK IN AUVERGNE-RHÔNE-ALPES

Initiative 3D is a network of skills and resources related to metal additive manufacturing in the Auvergne-Rhône-Alpes region of France. With the support of its region, it brings together more than 120 full-time employees from technical centers and technological platforms (CETIM, CEA, IPC, CTIF, Manutech, ID Pro, AFPMA) and higher-education and research establishments (Mines Saint-Étienne, École Centrale de Lyon, ENISE, Grenoble INP, INSA Lyon, SIGMA Clermont, ECAM Lyon) under the aegis of the competitiveness cluster CIMES.

Initiative 3D is preparing the future of additive manufacturing by carrying out R&D and investing in new equipment. It shares technological platforms that cover the entire value chain in metal additive manufacturing. Meanwhile, Initiative 3D also provides manufacturers with a unique set of AM processes (powder fusion, wire fusion, non-melting technologies) that are supported by design plat-

forms dedicated to additive manufacturing, the capacity to produce powders or wire by design, finishing techniques, and metallurgical and property characterisation resources. In particular, it has significant expertise in 3D characterisation (e.g. X-ray microtomography).

In addition, Initiative 3D offers ongoing training courses either by catalogue or in formats customised for companies. It also contributes to the development of training courses focused on additive manufacturing at both the technical and engineering levels. Initiative 3D develops scientific strategies around priority areas (e.g. process optimisation, alloy and shape design) that are defined in consultation with industry groups (aeronautics, health, energy, tools, luxury goods, additive manufacturing machines). In this context, its technical centers play an essential role as interfaces between the needs expressed by industry and the research activities conducted in academic laboratories. Finally, the CIMES cluster acts as

a catalyst to initiate research projects that bring industrial entities, academic laboratories, and technical centers together.

In 2021, Initiative 3D joined forces with two other regional structures (AFH for the Île-de-France region and AddimAlliance for Occitanie and Nouvelle-Aquitaine), CETIM, and the GIS head of the CNRS to coordinate France's national efforts in metal additive manufacturing. The objectives of this coordination are to ensure that the links in the technical readiness level (TRL) chain extend from the user to the laboratory, and that knowledge and tools are transferred from laboratories to production workshops without neglecting the standardization aspect. The overarching aim is to promote the development of a strong network involving both research and platforms through the sharing of equipment and skills, and thus to facilitate the dissemination and support of SMEs and large groups towards the adoption of additive manufacturing technologies.

+ FURTHER INFORMATION:
» initiative3d.com
» cimes-hub.com



SIGHTS SET ON AN INTERNATIONAL SCALE



CEO Frank Moreau (left) and Mathieu Roche, marketing and technology manager at AddUp

In 2016, the French industrial groups Michelin and Fives launched the AM company AddUp. Through organic growth and several acquisitions, this manufacturer of metal 3D printers has become one of the most important additive companies in France and is now looking to capture additional market share around the world.

Black sets the tone in Clermont-Ferrand in the geographic center of France. The heart of this city of around 400,000 inhabitants is dominated by a cathedral made of black volcanic stone, and just one kilometer away, millions of black tires are designed and tested every year in the workshops of the Michelin Group. The fact that the AM company AddUp has its headquarters just a few kilometers north of Clermont-Ferrand in Cébazat is no coincidence, as the industrial giant Michelin was one of the two founding fathers

of the up-and-coming manufacturer of industrial metal 3D printers.

Founded in 2016, AddUp is now one of the largest AM companies in France, with more than 300 employees worldwide and four major sites in Europe and the USA, as well as a few additional offices. The young company isn't content to rest on its laurels, however, and plans to continue its ambitious development in the coming years. In doing so, it will have strong support from Michelin and its other owner, Fives. »Our shareholders expect us to

Text: Thomas Masuch

continue to grow significantly, and have also invested considerably in us to make it happen,« says Franck Moreau, CEO of AddUp.

The growth that AddUp has shown in recent years has been based on its own organic development and its acquisition of various companies. In 2018, for example, it purchased the French service provider Poly-Shape, which employs around 50 people and has a production site in Salon-de-Provence. Picking up the conventional machining company Serm-Meca that same year enabled AddUp to add industrial finishing solutions to its portfolio. And the acquisition of Beam, a Strasbourg-based manufacturer of direct energy deposition (DED) machines, was a strategic means of introducing this new technology to the market.

MACHINE OEM AND SERVICE PROVIDER IN ONE

AddUp's corporate headquarters are located in an industrial area of Cébazat on a well-secured Michelin site. In addition to administration and marketing, various departments are located here, including research and development. 3D printing equipment is delivered and electronically checked in the production hall, all of which is designed to meet the needs of AM machine production. Currently, AddUp's Saint-Céré site (near Toulouse) assembles all the components of its machines. A few rooms away, tests with powder are carried out before the machines are prepared for shipping.

Behind heavy doors that only open to a few authorized people, AddUp also operates a fleet of its own machines to produce additive metal parts on behalf of customers. Of these machines, 35 run at its Cébazat site, and 10 more are in operation at sites in Salon-de-Provence and in the USA. In another area of the hall, there is also capacity for post-processing – including saws to separate build jobs from the build plate and ovens for heat treatment.

»With our large machine park, we're not only one of the largest service providers worldwide, but also one of the few manufacturers of AM metal equipment that also officially acts as a service provider on the market,« says Mathieu Roche, marketing and technology manager at AddUp.

PART PRODUCTION AN IMPORTANT SALES PILLAR

Producing parts on its own machines benefits AddUp in three ways: First, it creates confidence in the company's technology, and sooner

or later, that also supports sales. »After all, customers won't buy machines if you can't supply them with the parts,« explains Moreau.

In addition, the service provider business has developed into an important component of the company's revenue, having accounted for around half of AddUp's total sales in recent years. For 2022, Moreau expects more very stable figures in the production of AM parts, including a volume of around €10 million. At the same time, machine sales have picked up even more strongly; AddUp is predicting that it will contribute another €20 million to its total sales.

»Another important advantage for us comes from the fact that we as a company understand the technology and applications even better and gain more experience, which ultimately flows into the development of new machine generations later on,« explains Moreau in an interview with Formnext Magazine.

In its activities as a service provider, AddUp almost exclusively uses the powder bed fusion (PBF) process – and thus the FormUp 350 machine, which is currently AddUp's only PBF model. »The percentage here is 99 percent,« reports Mathieu Roche. »In contrast, DED technology doesn't currently play such a strong role for us as a service provider.« This may be due in part to the fact that this even younger technology is often used for component repair. Plus, companies are more likely to buy DED machines and integrate them into production to develop their own processes. In machine sales, on the other hand, AddUp can



benefit strongly from DED technology, which it says is more on a level similar to PBF.

SEVERAL MILLION PARTS FOR VULCANIZATION MOLDS

In addition to the 45 production machines running in its own factory halls, AddUp has sold around 60 machines worldwide. One of its most important customers in recent years has been the Michelin Group, which has been involved in additive manufacturing since the early 2000s and has produced parts for tire vulcanization molds on AM systems. Having produced several million AM parts, Michelin is probably one of the largest additive users worldwide. One of the latest developments in tires was also created with the help of 3D printing. »The current Premier (US) and CrossClimate (EU) tires have been decisively improved with additive mold inserts,« explains Mathieu Roche. »They are designed in such a way that when a tread wears out, a new one practically forms underneath.«

Another prominent customer is the aircraft manufacturer Dassault Aviation, which already has two FormUp 350 machines in operation. AddUp is also building an automated production line for the company that is scheduled to be finished by 2024. »At the same time, Dassault wants to respond very flexibly to demand and is needing more and more additive parts, so it's also ordering more and more parts from us, which we then produce in Cébazat,« Roche is pleased to report. »

Photos: Thomas Masuch (1), AddUp (2)

SOFTWARE AND HARDWARE DEVELOPMENT TO DRIVE FURTHER GROWTH

With its PBF machines, AddUp is laser-focused on series production and has optimized the entire FormUp 350 system in this direction. This includes a powder recycling system that is a standard component of every machine. AddUp also aims to gain additional market share with strong software that is being developed further by several dozen software engineers. Among other things, this software makes it possible to monitor key process values during builds. It not only includes macro sensors (e.g. for oxygen, temperature, and humidity percentages), but also covers torque for many components, along with events, gas consumption, and much more for a total of over 80 variables. AddUp also offers advanced melt pool monitoring that is capable of generating digital twins of produced parts in real time. By using multiple sensors that collect data at high frequencies, the system can detect power drifts and unexpected

melting variations. »This monitoring is crucial for many AM users, including those in the aerospace and medical sectors, where non-destructive evaluation (NDE) represents up to 50% of the cost of parts,« says Mathieu Roche. AddUp has also developed a recoating solution that photographs each individual layer and repairs powder anomalies when necessary.

Meanwhile, AddUp has some development work ahead of it in the DED sector, as well: The company is constantly improving the different versions of its Modulo machines, and according to Franck Moreau, it will also soon bring a larger DED machine to market. AddUp's CEO, who headed the aerospace division at Michelin before taking up his current post two years ago, says that these steps are meant to help the company achieve market leadership by 2030. This would also be in the national interest of France, which Moreau says would then be able to strengthen the country's industry and supply chains further.

In its growth strategy in the highly competitive PBF market, AddUp is focusing primarily on Central Europe and the USA, where it also wants to gain an edge as a »very open and transparent company,« as Moreau explains. He adds that this applies to both the machinery's open platform and the open-source materials used. »At the same time, we are, of course, adapting our strategy to succeed in other countries.« While AddUp counts large industrial groups such as Michelin, Airbus, Dassault, and Safran among its customers in France, the company wants to focus more on SMEs in Germany, for example, and has entered into partnerships with the likes of Fraunhofer ILT in Aachen for this purpose.

+ FURTHER INFORMATION:
» addupsolutions.com



Powder Bed Fusion
For further information on this procedure, check out the AM Field Guide at
» formnext.com/amfieldguide



Direct Energy Deposition
For further information on this procedure, check out the AM Field Guide at
» formnext.com/amfieldguide



AddUp isn't »just« a manufacturer; its 45 production machines make it one of the world's largest AM service providers, as well

Text: Thomas Masuch

FLOATING MICROTOOLS PROVIDE MIRROR-SMOOTH SURFACES

Before 3D-printed turbine blades, gas turbine engine components, injection-molded plastic inserts, or artificial knee joints are usable, they often first make a trip to St. Priest near Lyon, France. Here, Binc Industries ensures that the surfaces become as smooth as required by their customers.

The Binc Industries group specializes in post-processing and surface finishing. Its French subsidiary, Binc Industries France SAS, employs around 20 people at its site in St. Priest. At the core of the company is its proprietary Micro-Machining Process (MMP), which uses »microtools« that float in a liquid and are aggregated by a catalyst. The workpiece is firmly anchored in the machine, and the tank is filled with the solution and the microtools. High-energy movements along three axes then cause the aggregates to scrape past the surface and remove only the »targeted range of roughness frequencies.« »Typically, 3D-printed parts have a surface roughness of 15–30 microns. With this process, surface finishes of 0.8 microns or less can be achieved, which is very close to a mirror,« explains Christophe Jacobs, Commercial Director Europe at Binc Industries. In addition, the emulsion reaches virtually every angle of the component, including some internal channels.

SURFACE ENGINEERING TO IMPROVE PERFORMANCE

This sophisticated process, which Binc Industries offers only as a service (the company does not sell machines), is more than just surface machining according to Jacobs. »It's surface engineering we use to improve the performance of components,« he explains. »When our customers send us a component for technical validation, we first analyze the full roughness profile and study the frequency ranges present.

We then use this as a basis for determining the appropriate MMP to be applied – that is, the composition of the microtools, the movement program, and the positioning of the part.« In total, Binc Industries has around 650 recipes.

The MMP technology is already 20 years old and was originally developed in Switzerland as an alternative to manual polishing to produce high-quality surfaces on watches and jewelry. At the time, the innovation gave rise to the Swiss company Binc Industries SA, which today has around 125 employees and branches and subsidiaries in France, Germany, the USA, India, China, and Japan. The company's current location in St. Priest was chosen because it is both quite close to Switzerland and lies within the second-largest economic area in France, as Jacobs explains.

It was around 17 years ago that MMP was then also discovered by the additive community through the European project RC2. »Manufacturers of AM equipment approached us at that time because they wanted to finish the surfaces of 3D-printed products to show what was possible with additive manufacturing, and that there was a service chain for it,« says Jacobs.

NOT JUST FOR PROTOTYPING ANYMORE

For Binc Industries, which was also one of the first exhibitors at Formnext, the additive manufacturing industry has now developed into an important business segment. Around 15 percent of its sales are now generated with 3D-printed components, as Jacobs reveals. »And this

sector is growing by far the fastest – at a rate of 100% from 2021 to 2022, in fact. AM is really booming.« The reason for this, he says, is that additive manufacturing is increasingly extending beyond prototyping and being used in more and more industrial applications.

The objects that undergo surface engineering in St. Priest range from knee and hip joints made of a wide variety of materials (stainless steel, ceramics, zirconium, etc.) to components for the aerospace sector, gas turbines, stamping and cold forging tools, high-performance transmissions, and the pharmaceutical industry.

+ FURTHER INFORMATION:
» mmptechnology.com

WHEN LOKI AND THOR PRINT PROTOTYPES



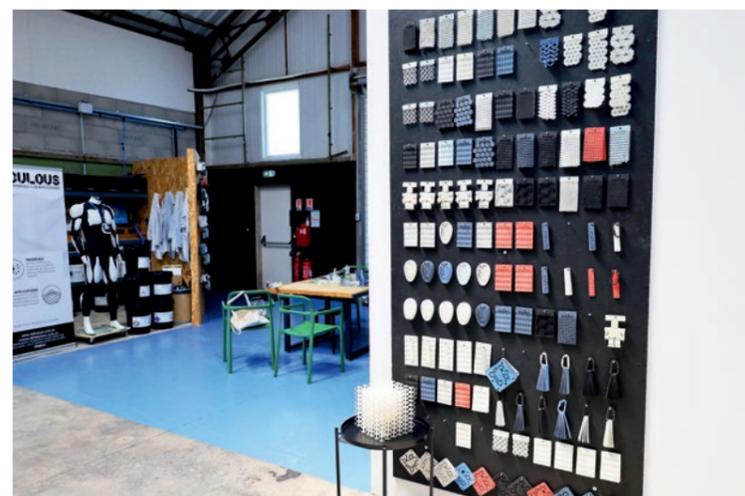
The young company Fabulous was actually founded as a design office, but has since developed more and more into a specialist in plastic powder. It hasn't lost any of its creativity in the process.

Fabulous's tech center, which is located in a sober industrial area of Vaulx-en-Velin just outside Lyon, »is my playground,« says Olivier Coulet. His toys? White and blue powders made of plastic. In the company's 250-square-meter hall, the engineer tinkers with new material formulations on his PC and produces test components or prototypes with his own powders on two ProMaker P1000s (SLS machines from Prodways). The machines' official designation doesn't really fit into Coulet's creative universe, though, which is why they go by the names Loki and Thor at the company.

The tech center simultaneously serves Fabulous and its four employees as a showroom, office, and production facility, and also has equipment for powder removal and sandblasting. 3D-printed, internally illuminated artwork hangs on the walls, and next to the SLS machines stands a two-meter-high doll with 3D-printed body shields that were developed for Disneyland Paris.

Olivier Coulet is a developer through and through, and one who's enthusiastic about his work in additive manufacturing. A conversation with him never stops: His passion for his cho-

Text & Photos: Thomas Masuch



sen field is evident as he reports on his projects, and he casually pulls a prototype out of a drawer every now and then to tell a related story. At the same time, however, he rarely reveals the names of Fabulous's customers and development partners; much remains a secret.

Coulet and his brother Arnault actually founded Fabulous as a design office for AM components in 2014. »At that time, there were some AM 'masterminds' who promised that everything could be 3D-printed in the future,« Olivier says. He goes on to describe this as counterproductive for the industry because it promised too much and ultimately delivered too little. »We set out to develop concrete designs and deliver a proof of concept.«

FEELING THE REALITY OF THE MARKET THROUGH DESIGN WORK

At the time, Coulet was still running Exceltec, a company he had founded in 2004 that distributed its own PA11 and PA12 plastics. In 2015, he sold Exceltec to a French AM industry giant – the aforementioned Prodways – and eventually began devoting 100 percent of his time to his new company in 2019. Since then, Fabulous has been transforming itself more and more into a specialist in plastic powders, but not forgetting its founding idea in the process. »It's true that the materials sector is now Fabulous's main revenue generator, but we'll continue to offer our expertise in AM design because it's where we see and feel the reality of the market,« Coulet explains. For Fabulous, this reality entails things like bringing its technical expertise into its work with

other service bureaus or creating a file for 3D printing for a major luxury corporation based on a hand-drawn sketch.

While Fabulous's powder division has enjoyed a good deal of success in recent years, Coulet still describes the company as »a small player with an annual volume of less than 25 tons«. And yet the engineer, who also worked as an application engineer for EOS for nine years at the beginning of his career, has managed to develop a material portfolio that now includes 11 plastics (PA 11s, PA 12s, and a TPU) in a fairly short time. The powders are produced through dry blending, which involves incorporating aggregates, plasticizers, or other additives into a plastic powder compound. According to Coulet, they are compatible with the systems of all the main manufacturers.

Coulet is particularly proud of PA 11 Bluecare, a patented food plastic for which Fabulous obtained the FDA CFR 21 and EU 10/2011 food contact certifications within 18 months. Its development was initiated by a well-known pasta manufacturer. Another patented material, PA 11 Detect, is an extension of PA 11 Bluecare that opens the door to additional applications thanks to its magnetic property. Fabulous purposely makes both materials in blue because it's a color considered quite unnatural in food, which makes it easy to identify.

APPLICATION-DRIVEN MATERIAL DEVELOPMENT

Most of Fabulous's material developments are based on customer requests and requirements. »Our goal is to support specific applica-

tions for which no 100-percent suitable material is available,« Coulet explains. »There are a variety of materials on the market that call themselves PA 11, but that's what's causing the market to lose confidence in the designation. There are very big differences among the materials, after all.«

Olivier and Arnault Coulet have invested a six-figure sum in the development of their new plastics. »We're working on finding more customers for them and ensuring that the investment pays off,« says Olivier. The numerous AM industry contacts he's been able to make in his career so far have also helped along the way. It thus comes as little surprise that Fabulous sells even more in Germany than in France – especially in the food industry, where grippers, nozzles, and numerous plant components are 3D-printed for production lines from Fabulous's blue plastic.

The company's development has been so successful that Fabulous is now looking for a partner in the USA. In addition, Olivier Coulet has set his sights on developing ceramic materials and tell us that he has already decided to join forces with an important French partner for this purpose. Fabulous's further growth is also to be fueled by the new investors who came on board in 2021. At Formnext, the company plans to present further details and developments, as well as many other innovations.

Meanwhile, the tech center's machine park will also continue to grow: In late summer 2022, the two Prodways machines will be joined by two more: a Gravity 3D-printing system from the young Swedish manufacturer Wematter and a new Fuse 1 Nitrogen from Formlabs. And don't worry – Coulet and his team are sure to come up with creative names for these machines, as well.

PRINTING SILICONE, CATCHING WAVES



In the southwest corner of France, Lynxter is an emerging 3D printer manufacturer that is about to take the next big leap.

Only about five kilometers from swanky Biarritz, where the Atlantic crashes against the rocks of the city, tourists walk in the footsteps of Ernest Hemingway, and sun-tanned surfers bob in the water waiting for the next perfect wave, Thomas Batigne stands in front of the Lynxter factory gate and points to a fallow area on the other side of the road. The 27-year-old entrepreneur has a lot of plans for the plot: »We've already secured the 3,500-square-meter property; we want to build a new company headquarters there with space for up to 100 employees.«

In the French part of the Basque Country, a region known throughout Europe for its wide beaches, high waves, and half-timbered houses painted red and white, Lynxter's founder and CEO has joined his friends and co-founders Julien Duhalde and Karim Sinno in building a company that now has 30 employees and continues to grow rapidly. At the center of its development is the S600D, a modular 3D printer whose strength lies primarily in its flexibility according to Batigne. It can also be used, for example, to print industrial-quality silicone on a large scale. »In this area of materials, we're the

Text: Thomas Masuch

Photos: Lynxter (4), Thomas Masuch (4)



The co-founders and managers of Lynxter (from left): Julien Duhalde, Thomas Batigne, and Karim Sinno

company that has sold the most machines worldwide,« Batigne states.

In the hall behind him, around a dozen S600D units operate in two rows. Inside each printer, nozzles attached to three columns deposit silicones, ceramics or other plastics (thermoplastics) on the print bed and form various test bodies. These are intended to convince potential customers of the printer's performance. At the same time, Lynxter is also testing new ideas and applications. »We sell printers first and foremost, but we also need to provide customers with ideas for new applications so that the market continues to grow,« Batigne says.

Lynxter's development is going so well that space in its previous premises, which are located in a modern industrial area on the outskirts of Bayonne, has become quite tight. The company is thus set for another major leap.

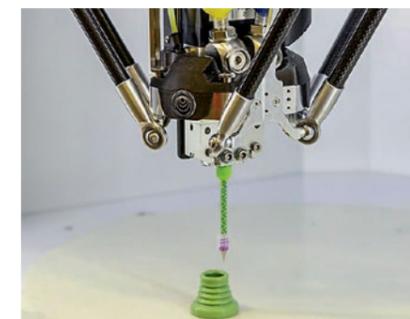
FIRST PRINTER DELIVERED TO AIRBUS

Around seven years ago, there was little sign of such ambitious developments taking place. Batigne, Duhalde, and Sinno knew each other from the ENIT engineering school in Tarbes. Batigne had already started his own business developing 3D printers, but then »we had the idea to start a company because there were no open industrial 3D printers at the

time,« the CEO recalls. Coincidentally, a start-up competition was taking place in the region and the three entered »just for fun«. They ended up winning first prize and being discovered by Airbus. »The company approached us and said if we could deliver our printer – which existed only as a model at the time – within six months, they would buy it,« Batigne says. From then on, the three friends worked day and night on the printer and delivered it on time. That was in September 2016.

After this exciting start, the company's further development was quite unspectacular for a start-up – especially because the three founders initially refused to take on investors. »We didn't want to be eaten by a big player and preferred to do everything ourselves. We wrote the programs, assembled and installed the printers on-site with customers, and took the calls when customers had questions,« Batigne continues. At the same time, they also continued to develop the printer and in 2018 introduced Liquid Dispensing Technology – their solution for printing silicone. »

Lynxter also sees major potential in using silicone for medical applications



INVESTORS AFTER ALL

In the meantime, the three friends came to the realization that external investors would, in fact, be a better way to continue growing. In 2019, the company thus received an influx of €1.5 million. »This allowed us to hire more staff, work with sales partners, drive our growth in France, and take on a more professional structure,« Batigne explains. The S600D is now distributed by the online store IGo3D, for example, and initial pilot projects with distribution partners have already been launched in the United States.

To further its international growth, Lynxter – whose name was inspired by the Sphinx that guards the Egyptian temple of Giza – is currently preparing another investment round. It hopes that this will enable it to replicate its success in France in other markets. While Batigne did not want to reveal the details in a personal conversation in July 2022, he did say that it »will probably be one of the largest investment rounds in the French AM industry.«

The fact that Lynxter is now so successful in financing is also due to Batigne keeping his eyes open and maintaining contacts in the field

worldwide. »In France, the financing options are far less developed than in Germany or the UK, for example – not to mention in the USA,« he points out. »That's why we'll also be talking to investors from the UK and the US in further rounds. They're much more willing to take risks, and to invest larger sums.«

»MAINTAINING A HUMAN TOUCH IN THE COMPANY«

Lynxter's growth has, however, come with a whole new set of challenges. »In our industry, there are very few people with experience, so we've had to train our employees from scratch and pass on everything we know,« says Batigne. In the process, the CEO – who previously served as a software developer, process R&D engineer, and service worker all at once – has become strictly a manager. »We have a different structure now, with specialists and people responsible for sales and finance. Nevertheless, we want to maintain our human touch in the company, and that's probably one of our biggest challenges for the future,« says Batigne, who is occasionally drawn to the workshop in the summer, when most employees are on vaca-

tion. Here, the 27-year-old once again tinkers with the technology and software himself, just like in the old days.

The number of Lynxter printers that are already up and running on the market is not something the company wants to disclose officially, but it is »very well represented in France,« as Batigne puts it. Among other large groups, Airbus, Schneider Elektrik, Sanofi, and Total have acquired an S600D – the company's only model to date, which has been updated several times – and also use it in production. According to Batigne, numerous research institutes (including CNRS and ESILV) and well-known French service providers such as Erpro Group or Third also have the S600D in use.

EXCELLENT MATERIAL COMPATIBILITY

According to Lynxter, the secret of the S600D's success is its versatility and the wide range of materials it can process: silicones, polyurethanes, various pastes (metals and ceramics), and thermoplastic filaments, among others. It sells a range of specially certified materials that the printer can handle. At the same time, the company supplies a development kit to that enables clients to come up with their own custom modules, materials, and software.

Thanks to the wide variety of printable materials, Lynxter has an immense potential market in which it has focused on a number of key areas, including tooling and prototyping, medical applications (Lynxter offers a silicone certified in line with ISO 10993-5 for skin contact), and research and development. The latter area is of particular importance to Batigne, as »research institutes manage to bring to light the often greater-than-expected potential of printers.«



A GOOD ENVIRONMENT FOR GROWTH IN THE AM SECTOR

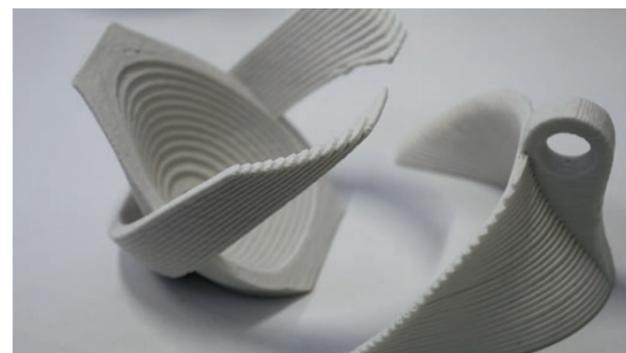
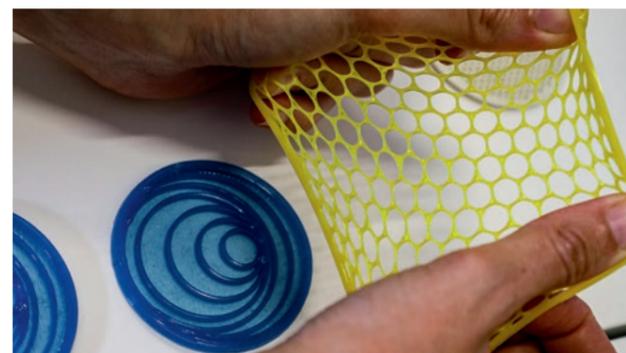
With its strategy to date, Lynxter has been able to »consistently achieve triple-digit growth – 106% on average in the last six years,« Batigne explains proudly. »And that's despite the fact that the French industry has tended to shrink in recent years. In this respect, conditions in the AM industry in France are not bad.« In addition, he says, a lot of innovation is taking place due to the numerous training opportunities and research facilities in the field. There's also the »Choose France« campaign, which is aimed at foreign investors and meant to further strengthen the domestic economy. »I therefore assume that the next few years will actually be very promising for us as well,« Batigne says.

Just how strongly the AM industry is developing, even in the far southwest of France, can also be seen when looking across the land reserved by Lynxter in the Bayonne industrial park. To the right of it, the technology institute ESTIA has built two huge halls for the Addimadour and Compositadour research platforms. »Here, something like an AM cluster has emerged more or less by chance, which helps us a lot,« Batigne explains. »We can tackle projects together, and it's also easier to get funding support for joint development projects. And we just speak the same language.«

When it comes to finding additional staff to fuel its further growth, Lynxter has more than an exciting company history and the charm of being part of building something special to win potential employees over. »We actually have some colleagues who come to us from the north of France or other regions because we can offer a very good work-life balance and a very attractive environment here,« says Thomas Batigne. »Most of our team likes to go surfing; we often do that together, and sometimes we go hiking in the mountains.«

+ FURTHER INFORMATION:

» lynxter.fr



Innovation and diversity under the same roof (from top): workshop employees, Thomas Batigne in Lynxter's test lab, and applications of silicon and ceramic

PELLET PRINTING FROM THE METROPOLIS ON THE SEINE

On the outskirts of Paris, Pollen AM develops and produces pellet 3D printers with a clear focus on further growth



Situated among a school, a residential building, and an industrial hall in the Paris suburb of Ivry-sur-Seine, Pollen AM's headquarters is a place that used to house a design company. Even today, the artistic flair can still be clearly felt on the premises of this French manufacturer of 3D printers. On seven floors, each of which comprises a single space, its 13 employees work on new technical solutions, marketing activities, or demonstrations of the various pos-

sible applications of Pollen AM's 3D printing solutions in the company's showroom.

The common theme of these wide-ranging activities is the 3D printing of pellets. »Pellets are the most commonly used materials in industry – from pens to smartphones, basically everything was made from pellets at some point,« explains Didier Fonta, the general manager responsible for sales and marketing at Pollen AM. »Even the filaments used in 3D printing were once pellets.«

When Pollen AM was founded in Paris in 2013, it was based on the idea of using classic industrial materials for 3D printing. Today, the company offers three series of 3D printers that can additively process a wide variety of materials, from plastics to ceramics to metals. »The big advantage here is that you can use materials that are already certified, and they're also usually much cheaper than dedicated 3D printing materials,« Fonta says, adding that doing so also offers a material advantage in the area of plastics: »We save one heating process and thus achieve the same quality as injection molding.«

CONNECTED TO THE CAPITAL

In typical Paris bistros two streets away, people are chatting; the street here is also filled with the mixture of hustle and bustle, style, and diversity that is typical of the French capital. However, the proximity to the center of metropolis on the Seine is also reflected in the rent prices and rather cramped spaces available. Still, Fonta can't imagine leaving. »We're Parisians, and we don't want to go anywhere else.« Why not? »Hard to say – I was born here and I have my environment here. The rest of France is good for vacations,« he explains with a smile.

Text & Photos: Thomas Masuch



Didier Fonta in Pollen AM's showroom

When it was founded, Pollen AM occupied premises at Place de la République in the heart of the city. Later, the company moved to Ivry because the rents here were economically feasible, at least by Parisian standards. Across the street from its winding seven-story headquarters, Pollen AM has rented two more rooms in a kind of shared factory; it uses them for assembling its 3D printers, and also for storage. Next door, a former employee has started his own business as a 3D printing service provider and now supplies Pollen AM with components, including several that are installed in its pellet printers.

Pollen AM's portfolio includes one printer series each for plastic, ceramic, and metal pellets. The company deliberately forgoes offering hardware for post-processing (e.g. ovens or debinding units). »That's because each material requires a specific solution, and sometimes this even varies depending on the manufacturer,« Fonta explains. In most cases, he adds, customers have the required technology available anyway, as many partners come from the metal injection molding sector and have many years of experience in this area. »Otherwise, we also work with partners who can provide the right solutions.«

The situation is similar when it comes to materials: customers obtain them from familiar sources, while Pollen AM »operates purely as a machine manufacturer; we don't even think about selling materials,« Fonta affirms. »We're like the suppliers of CNC or injection molding machines: First and foremost, we take care of the calibration of the machines so we can give our customers the right recommendations to produce in the best possible way.«

CLEAR FOCUS ON FURTHER GROWTH

According to Fonta, Pollen AM's printers are used for things like for prototyping or after-market activities. When it comes to providing spare parts even after many years have passed, 3D printing can often be the more cost-effective solution compared to long storage periods. The technology from Paris is also used in the tooling sector, and its customers include both corporations and small and medium-sized businesses. If a customer needs so few parts that buying a printer isn't worth it, Pollen AM occasionally produces them as a service provider, as well. According to Fonta, however, this is only a very small part of its business. »Above all, we want to sell machines,« he states.

The increased demand for Pollen AM's 3D printing technology is also reflected in the company's growth. In the past two years, its workforce has doubled, and it expects to hire another four employees by the end of 2022. This is partly because during the Covid-19 pandemic, Pollen AM focused on developing digital services. »We've also been able to add important customers in the aerospace sector, and we've been awarded two important funding projects from Île-de-France,« Fonta reports.

According to Pollen AM's general director, the fact that 3D printing currently has such good prospects in France is also due to a change in attitude in politics and industry. »A few years ago, there was still a belief in the need to become 'fables' – in other words, to get by without manufacturing and production,« Fonta explains. »Now that people have realized it was the wrong direction, they're trying to get an industry going again.«

In the future, the company plans to remain focused on further growth. »To that end, we invest around 20 percent of our sales in technical development,« says Fonta, who points out that leveraging its business success to position itself even better for the future is important to Pollen AM's owners and investors.

Meanwhile, Pollen AM's growth has been largely organic in recent years because it is operated like an independent family business. Shortly after the company was founded, a number of private individuals invested in the company, including members of the founders' families and individuals with industrial experience »who helped us a great deal in making the right decisions as the company continued to develop,« Fonta explains. »The fact that no traditional funds or large corporations have joined us has allowed us to remain very independent.«

Fonta has a lot of ambitious plans for Pollen AM's ongoing growth, especially in the field of ceramics. In January 2020, the company presented its PAM series MC printer specifically for this material. By the end of 2022, it also plans to open a branch dedicated to the ceramics sector near an important partner in Mons, Belgium.

+ FURTHER INFORMATION:
» pollen.am

CONCRETE, PHILOSOPHY, AND THE ELEPHANT OF THE BASTILLE

Constructions-3D, a young company from the north of France, is creating concrete 3D printers and developing its (partially additively manufactured) headquarters into a center of creativity and sustainable ideas.

Nikola Tesla, Albert Einstein, and Marie Curie are there to greet me: 3D-printed plastic busts of the three luminaries are enthroned on charging stations for electric vehicles in the parking lot of Constructions-3D in the northern French city of Valenciennes. The stations themselves are also 3D-printed, as is the entrance portal to the production and

office building. And when I enter the building, the journey through the world of AM continues: at the reception counter printed from concrete; the replica of the city of Minas Tirith (from The Lord of the Rings) that passes on my left; and the Indian busts, jungle palace, and pantheon of Greek gods I encounter – all of which came from a 3D printer.



Photos: Constructions-3D (2), Thomas Masuch (6)

Text: Thomas Masuch



Constructions-3D's co-founders – from left: Didier Malbranque, Antoine Urquizar, Antoine Motte, and Axel Théry – present their MaxiPrinter

The roughly 10-meter-high exterior walls of Constructions-3D's corporate headquarters are adorned with the name «Citadelle des Savoires-Faire», meaning «fortress of knowledge and making». Inside, Antoine Motte, Axel Théry, and their team are standing next to a concrete 3D printer measuring around two-by-two meters, which is performing a test print around one meter high. Its precisely controlled nozzle repeatedly travels along the contours, each time placing another length of thick concrete slurry on top of the one before. After about 15 minutes, the work – the front of which features the carved-out name «Constructions-3D» – is completed, and two colleagues carefully pull out the pallet bearing the still-unstable structure. «Such tests are immensely important for us, as they allow us to improve our own development while documenting the stability of 3D-printed objects,» explains Théry, co-founder and engineering manager at Constructions-3D. He's controlling the printing parameters and construction process from his laptop, and urges me to hurry along. «The cement in the system's hoses dries very quickly, so we have to continue with the next test print right away,» he explains.

FROM CRANES TO 3D PRINTERS

A few meters further on, a steel spider spanning around five meters and weighing several tons occupies the hall. The MaxiPrinter is a flexible concrete 3D printer which can be trans-

ported entirely in a container. It's Constructions-3D's main product, and one with which the French company wants to shake up the construction industry.

The technology is based on a chain-driven crane. «However, this is pneumatically driven and actually quite inaccurate,» explains Théry. «Our task over the past few years has been to make the pneumatics precise. That's a big challenge because this kind of technology is made to be strong, robust, and able to withstand the weather on jobsites.» In addition to the necessary technical modifications, Constructions-3D also developed its own control software. Just how big a challenge it was to turn such a heavy-lifting roughneck into a precise 3D printer was also demonstrated by the reaction of the Japanese manufacturer of the crane in question. «At first, the Japanese thought we were crazy,» recalls Antoine Motte, co-founder and CEO of Constructions-3D, «but now they appreciate us because we've bought quite a few of their cranes in the meantime.»

Meanwhile, Antoine Motte and his team have brought the MaxiPrinter to market maturity and delivered a number of units. In a fairly young but already competitive space, Motte cites the MaxiPrinter's quick assembly (it takes no more than two hours) and compact design as advantages. «Assembled, it fits through a hinged door and can also print indoors,» he points out. In addition, the company offers smaller concrete printers: the MiniPrinter PRO, »



These days, you can print more than just buildings with concrete; segments of interior architecture are also possible (left), and rebar can be incorporated for additional stability (right)

which is suitable for things like furniture or medium-sized concrete parts, and the MiniPrinter EDU, which is used primarily in vocational schools.

FROM RESELLING PRINTERS TO 3D-PRINTING HOUSES

In the beginning, Constructions-3D's ambitious and very determined development was also shaped by chance: Antoine Motte had already founded Machines-3D, a reseller of desktop 3D printers, in Belgium in 2013. After moving to Valenciennes, the company grew rapidly and reached around 10 employees in three years. To date, the company – which is also housed in the Citadelle des Savoir-Faire – has maintained that size. For a trade show appearance, the team built a concrete 3D printer for demonstration purposes using many 3D-printed components. »It wasn't so much to show our involvement in the construction industry, but to show what you can do with our 3D printers,« Motte reveals. This small 3D printer, which still stands as a model not far from the assembly station of the giant MaxiPrinter, was the unexpected prelude to entering a whole new business field. Initial contacts were made with the construction industry, the original model was developed further, and 2017 saw the official founding of

Constructions-3D. Motte holds a majority stake in the company, but with Axel Théry, civil engineer Antoine Urquizar, and senior sales manager Didier Malbranque, the founding team is also involved. Constructions-3D now employs 15 people and plans to have 20 by the end of 2022.

In 2019, the company's first 3D-printed building was created. »The Pavillon« now stands just a few meters away from the production hall and can be reached via a small path bordered by 3D-printed curved curbstones. Along the way, you pass a narrow garden where employees each cultivate a small plot of flowers, fruit, or vegetables. A small corner with tables and benches – also 3D-printed from concrete, of course – invites you to linger.

The circular pavilion, which consists of a 3D-printed wall and a wooden roof, was a project fraught with some uncertainty three years ago. »There was no concrete optimized for 3D printing yet,« says Antoine Motte, »but if you don't take risks, you won't be the first.« For its next 3D-printed buildings, such as the entrance hall of the Citadelle, the Constructions-3D team had already developed the necessary manufacturing expertise: For the walls, three vertical layers are printed to form two hollow segments. These are each filled with concrete and flax, which provide a good

combination of stability and insulation. Flax is a material that has been used in the Hauts-de-France region »as far back as the Middle Ages, and doesn't get eaten by rodents and insects,« says Motte. Additional stability can be achieved by reinforcing the concrete segments with structural steel.

NO PROBLEMS WITH BUILDING PERMITS

For Antoine Motte, 3D-printing concrete was a return to familiar territory, as the 38-year-old trained civil engineer had already worked in the construction industry for eight years before founding Machines-3D. In the process, the father of three was also able to put his extensive experience in dealing with the authorities to good use, which helped him obtain permits for his 3D-printed buildings without any major problems. »The city mainly checks things like wall thickness, fire safety, and the number of parking spaces,« Motte said. »In France, you don't really have to specify the technology that will be used in construction.«

However, the relative ease of planning of 3D-printed buildings currently only applies to self-financed properties in France. According to Motte, the situation is different for externally financed projects: »Here, banks will probably demand proof that the technology to be used is mature and reliable enough.« To remove the

3D-printed charging stations graced by the likes of Tesla, Curie, and Einstein welcome visitors to Constructions-3D. The image below offers a look at the »Citadelle des Savoir-Faire«, some 3D-printed stone edging, and »The Pavillon« in the background



bottleneck in AM's further development in the construction industry, Constructions-3D creates test prints and tests them for strength in its laboratory on a regular basis.

For these tests, Antoine Urquizar has specifically designed a test machine called Constructimeter that repeatedly examines the strength of a freshly printed »concrete cake« at intervals of a few minutes. This can then be used to predict not only stability, but the optimum printing speed, as well. Constructions-3D has now also brought the machine to market as a quality assurance product for customers like concrete manufacturers, which use it to test their materials. »For us, it's not about making profits at all, but about growing the market. That's the only way we'll be successful as a company and fulfill the goals we've set ourselves,« says Antoine Motte.

A FUTURE BEYOND THE TRADITIONAL CONSTRUCTION INDUSTRY

In addition to the technical challenges at hand, Antoine Motte sees a lot of other work ahead, especially in the construction industry and the field of potential applications. The conventional construction industry, he says, has a very traditional attitude and is very difficult to win over with new technologies. »The market isn't yet well developed, and its development is currently dominated by somewhat crazy masterminds – those who bought a Tesla five years ago,« Motte smiles. »So in the future, most of our customers will probably come from other industries that are more open to innovation and shaking up the construction industry.« The OVH Group, for example – Europe's largest cloud provider – has ordered a MaxiPrinter to build a new data center itself.

Constructions-3D also wants prospective users to get more ideas at the Citadelle des Savoir-Faire. Around the current production and office hall, the company has purchased a 2,500-square-meter area that will be filled with 3D-printed buildings for offices, production, and development over the next few years. The next of these will be an 11-meter office tower, the foundation of which was already unveiled in June 2022. This is set to become the world's tallest 3D-printed building according to Constructions-3D, which is financing its ambitious growth itself. Ultimately, however, the success of its products is what will enable the company's further development. »Through the sale of our small machines, we finance the development of the large ones, and through the sale of

the large ones, the development of the Citadelle,« explains Motte. In general, however, it's not the availability of money that's the challenge, but »getting the right people.«

As a home for talent, the rather tranquil Hauts-de-France has been a good address. »We have good universities here and good transport routes, including via the river Scheldt, which enables us to ship our machines and materials.« In addition, France offers excellent research facilities and a strong cement industry, thus providing ideal conditions for growth.

MUCH MORE THAN TECHNOLOGY AND BUSINESS

To tell the story of Constructions-3D in technical and business terms alone would leave it far from complete; it's also a story of ideas, historical references, and philosophies. This isn't meant to give the impression that the company is a hive of unbridled creativity, though. On the contrary, its halls and offices are among the tidiest and cleanest I have visited.

»Our long-term goal is to offer a solution for 3D-printing affordable homes to people all around the world,« explains Antoine Motte. While slogans like these are often meant more as a marketing approach in the industry, this

one has a deeper meaning for Motte. His wife of more than 20 years is originally from the Philippines; he has been to the southeast Asian country many times and seen a lot of misery and poverty there. »That's where I want to eventually provide a roof over the heads of the homeless. However, 3D-printing such houses only makes sense if you can also use local materials.«

To move one step closer to sustainable 3D printing, this year Constructions-3D developed a recipe for a material (Thermix 3D) that primarily comprises locally available products such as clay, straw, and residual materials from the company's foundry that would otherwise be disposed of as waste.

In addition to sustainability, Motte is bubbling over with other ideas. They include resurrecting the Elephant of the Bastille, which Napoleon actually wanted to erect as a monument on the Place de la Bastille in Paris around 200 years ago. Later, only a plaster model about 10 meters high was created and eventually immortalized in Victor Hugo's *Les Misérables* as a home for the ragamuffin Gavroche. As a metaphor for Constructions-3D's corporate goal, the elephant is to be recreated in 3D-printed form in the Citadelle des Savoir-Faire.

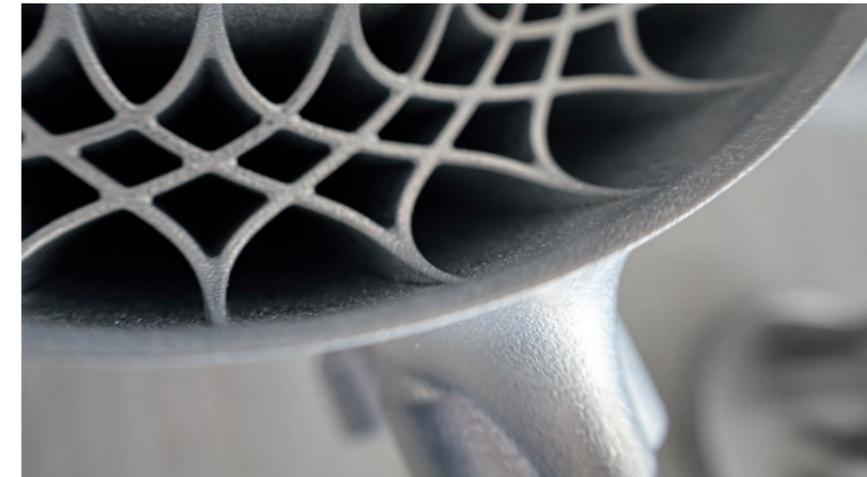
A vision of AM's future at the »Citadelle des Savoir-Faire«: The entrance area next to the parking lot and »The Pavillon« (right-center in image below) have already been 3D-printed. Next up is a 11-meter-high office tower (below the production hall)



+ FURTHER INFORMATION:
» constructions-3d.com

Text: Thomas Masuch

»ALUMINUM IS IN OUR DNA«



The aluminum group Constellium has set up an AM team at the heart of its technology center in Voreppe (near Grenoble, France) to develop and market special aluminum materials for additive manufacturing.

When you walk through the halls of Constellium in Voreppe, you find various machines lined up along a length of more than one hundred meters. Relatively little is produced here, however; the armada of casting equipment, rolling mills, heat treatment furnaces, surface treatment baths, welding systems, mechanical testing machines, spectrometers, and microscopes is used mainly for the development of products and processes at the aluminum group, which operates its international Constellium Technology Center (C-TEC) here on the edge of the French Alps. Constellium's young additive manufacturing team also benefits from the almost limitless test capacity available.

The fact that the NYSE-listed group, which employs around 12,000 people, has an AM team at all is due to demand from an aerospace industry consortium. »In 2015, a team from various aerospace OEMs approached Constellium because the aluminum powders used in additive manufacturing weren't meeting their needs,« recalls Dr. Alireza Arbab, who heads Constellium's AM activities. He goes on to explain: »The aluminum alloys available for additive manufacturing at the time – and many of those available today – often come from a conventional era and are optimized for other manufacturing processes, but not necessarily for additive manufacturing.«

Photos: Constellium (1), Thomas Masuch (3)

A total of eight employees make up the core team at Constellium AM, and the team can also access experts and resources at C-TEC. This means that a total of around 20 employees are directly involved in the development and sale of the company's new AM powders. The AM team focuses on developing specialized aluminum alloys for additive manufacturing because »aluminum is in our DNA,« as Arbab puts it. Besides that, the company supports customers with its decades of metallurgical knowledge and assists them in developing specialized heat treatments and surface protection methods such as anodization.

The fact that Constellium's AM team is located in Voreppe, about 20 kilometers north-west of Grenoble, is no coincidence. »Here, the team, which is set up like an internal start-up, can access the entire technical infrastructure of a global company, including state-of-the-art testing machines and equipment for material analysis,« explains Syam Unnikrishnan, business development manager for AM at Constellium. »C-TEC has more than 240 people focused on aluminum and gives us everything we need while also being something of an incubator for material innovation.«

WORKING TOWARD A VERSATILE, EASY-TO-PROCESS MATERIAL

If aluminum alloys are not optimized for 3D printing, this can lead to a number of disadvantages according to Alireza Arbab. »Using conventional alloys designed for traditional manufacturing, certain components evaporate which can affect component properties, and the formation of smoke can perturb the lasers of the printer. Furthermore, the post-processing of standard alloys usually requires quenching (Ed: heat treatment and abrupt cooling in cold water), which can distort the complex geometries we're printing.« The composition of individual alloys also presents further limitations, he says; additions of rare materials such as scandium make alloys very expensive. »Our customers wanted us to develop a material that would be easy to process, suitable for numerous applications, and sustainable as a solution for scaling up,« Arbab continues.

According to the engineer, the initial aerospace consortium continues to work together today in a large collaboration for which Constellium is the only material manufacturer. Cooperative efforts have since developed in other industries, as well. »For us, this is about working

with other companies to find out what material options meet their needs, and then implementing and validating them for the respective industry,« adds Dr. Alexandre Vassa, AM sales engineer at Constellium. »Ultimately, we want to enable our customers to scale their AM production.«

HIGHER PRINTING SPEEDS, SMOOTHER SURFACES

In 2020, Constellium launched its first AM powders, Ahead CP1 and Ahead HT1. From then on, basically any company could purchase these new aluminum alloys – but the partners that developed them had an advantage in that they already had a lot of related experience. Particularly in the production of end-use parts in safety-critical industries such as aviation, this is a decisive edge: »The use of new materials usually has a long learning curve,« says Arbab.

With Ahead CP1, Constellium says it has been able to meet development targets particularly well: the new alloy offers high strength without the need for abrupt cooling in a water bath. Without volatile elements such as magnesium, it also allows for higher printing speeds



The Constellium Technology Center (middle of photo) is located at the foot of the French Alps



Constellium's AM team (from left): Dr. Alireza Arbab, Dr. Bechir Chehab, Dr. Alexandre Vassa, and Syam Unnikrishnan. Their Ahead CP1 material is already being used in a variety of applications



and smoother surfaces according to the Constellium team. »The molten bath created by the laser in the 3D printer is also comparatively stable, so no material components escape and no smoke is produced,« explains Dr. Bechir Chehab, technical project leader in additive manufacturing.

»BIG COMMITMENT FROM CUSTOMERS«

While new metal powders for additive manufacturing are not particularly spectacular from a purely visual point of view, developing them and bringing them to market is a major challenge. For one thing, the development

process involves several stages. »At the beginning, you're still quite flexible, but later on it becomes increasingly difficult and costly to make further improvements,« explains Syam Unnikrishnan. »Therefore, the further you progress in development, the smaller the fine-tuning steps become. From stage four of Constellium's innovation process, all the parameters are fixed, and it's all about testing and qualifying the material.«

At the same time, even for users – and especially larger corporations – the decision to use a material is about more than just buying powder. »Once introduced, materials are

Constellium

Headquartered in Paris, Constellium has approximately 12,000 employees around the world and operates 27 manufacturing sites in Europe, North America, and China. Its capabilities include extrusions and rolled products, structural automotive components, and recycling. The Constellium Technology Center (C-TEC) in Voreppe, France – along with the company's U.S. hub in Plymouth, Michigan, and its university technology center at Brunel University London – continue to produce many advanced aluminum alloys and solutions.

usually used for many years. That's a big commitment from customers,« says Unnikrishnan. »And that's exactly why we need to deliver world-class solutions. After all, the reputation of a publicly traded company is also at stake.«

MORE AND MORE APPLICATIONS, STRONG GROWTH IN SALES

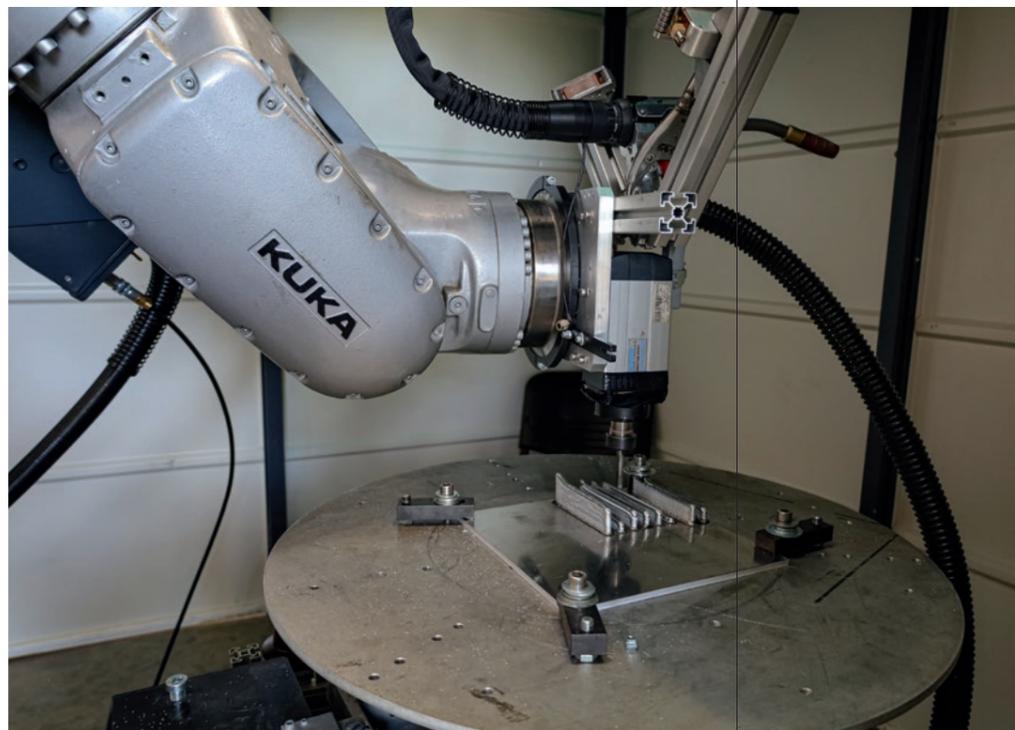
Since Constellium presented Ahead CP1 at Formnext 2021, the material's properties have won over a number of users. Components are now being made from CP1 in various industries – for luxury automobiles or heat exchangers, for example – and »numerous other applications are also about to be realized,« Alireza Arbab is pleased to report. It's precisely the versatility of Ahead CP1 that makes the engineer proud. »A good AM material proves itself first and foremost by succeeding in numerous markets and applications,« he points out.

The increasing number of applications is also reflected in the sales of the material. The company doesn't disclose official figures, but indicates that the order of magnitude has already changed significantly. »In terms of sales figures, we started out talking about kilograms, and this year we'll deliver several tons,« says Arbab, adding that this means Constellium's overall sales of AM powder are growing at around 300 to 400 percent a year.

+ FURTHER INFORMATION:
» constellium.com

FROM WINE BARRELS TO SPARE PARTS FOR TRAINS

VLM Robotics specializes in additive manufacturing with robots and has also developed customizable industrial manufacturing cells for this purpose. In this way, the family-owned company based near Bordeaux focuses primarily on producing the largest possible components in small quantities, or even batches of one.



Text & Photos: Thomas Masuch

Left:
Philippe Verlet, founder
and CEO of VLM Robotics,
and Béatrice Rivalier,
head of R&D and market
development
Right:
Integrated post-processing

The fact that a company from the world of 3D printing is also active in wine production is certainly possible in the first place in the country of sommeliers – and here, the proximity to the wine mecca of Bordeaux plays an important role. The headquarters of the family-run technology company VLM Robotics is located in an industrial area of Le Barp, about 30 kilometers from the capital of Gironde and halfway to Arcachon on the Atlantic coast.

At Formnext 2021, the 25-employee company presented its prototype of a 3D-printed mold for a wine barrel around two meters high. It was developed in cooperation with Siemens, the Strasbourg research institute Irepa Laser, and the Bordeaux wine barrel manufacturer Wine & Tools. The mold (and possible successor models) are to be used to produce new types of wine barrels that also make high-quality wine aging possible without barrique barrels (see article on page 33).

At the heart of VLM Robotics' manufacturing cells is direct energy deposition (DED) technology. Using a robot, wire (the preferred material, although powder is also possible) is deposited to form a component. »Our goal here is to 3D-print the largest possible parts – up to several meters in diameter – in very small quantities according to industrial standards,« explains Philippe Verlet, founder and CEO of VLM Robotics. »This is less about productivity and more about agility and creating added value.«

»A PIONEER IN THE INDUSTRIALIZATION OF 3D PRINTING«

»In addition to engineering, software and machine control play a particularly important role in the development of AM cells,« explains Béatrice Rivalier, who is responsible for R&D and competitive intelligence at VLM Robotics. That's why the company works closely with Siemens and is the only robotic Machine Tool System (MTS) solution partner in France. »This makes us a pioneer in the industrialization of 3D printing in France,« Rivalier proudly explains. The company's partnership with Siemens also goes beyond just using Siemens components (CNC, Drive, NX, and others): »For example, we also exchange technical knowledge, work together on research projects, and develop special additive production solutions for our customers and partners,« Rivalier continues.

The fact that the company from the south of France is currently working with Siemens has, among other things, a purely technical background. »For industrial 3D printing, you need more than just software; you also need a controller, solutions for integration into the production process, and much more,« explains Verlet. In this way, VLM Robotics achieves numerical continuity – the prerequisite of providing turn-key solutions to its customers, which are predominantly end users from the aviation, rail transport, and energy sectors.

In addition to its standardized cells, VLM Robotics offers individual solutions; complementary functions for pre- and post-processing can be integrated, for example. To ensure that this works smoothly, VLM Robotics has tested things like how to mill several 3D-printed layers of steel 0.3 to 0.8 millimeters wide. This isn't as easy as it might seem: »We can't use any coolant in the cell, and therefore have to fine-tune the parameters so as not to overheat the tools and still be able to work productively,« Verlet reveals.

VLM Robotics' industrial solution for 3D printing with robots also makes it possible to monitor the printing process. For this purpose, for example, a second robot can be equipped with process-monitoring sensors to document the setup at hand. »With this patented solution, we're pursuing our philosophy of having everything take place around the workpiece without moving the workpiece,« says Verlet. »For this type of agile manufacturing, we're also experiencing an ever-increasing demand from industry.«

RESEARCH AND PRODUCTION

The production cells are used in research projects and at research institutes, for example, as well as in production by customers such as aeronautics subcontractors, Poly-Shape (in Aix-en-Provence), and SNCF. The French rail giant uses them to manufacture spare parts for its trains.

So far, VLM Robotics has focused heavily on the French market, but CEO Verlet wants to significantly expand its business radius with the help of machines like the Comp@qt, Solo, and Gemini. They range from approximately one to several cubic meters, and the Gemini includes two robots. »We have many large groups in France in areas like shipbuilding, aircraft construction, or nuclear power, but unfortunately, there are no large machine manufacturers »



anymore. That's why cooperating with Germany is all the more important,« explains Verlet, who worked for a German company for several years before founding VLM Robotics and is fluent in the language.

In exchanges with existing and new business partners, Philippe Verlet's experience has been that DED technology in particular »is finding more and more applications at companies that need concrete DED components, but the quantity required is often so small that buying a machine doesn't make economic sense.« However, no service provider in France offers appropriately sized DED components according to Verlet, who says this is partly because unlike SLM technology, DED is quite new and less established. For this reason, VLM Robotics manufactures such components itself

on request and thus acts not only as a machine manufacturer, but also as a parts producer. In the long term, Verlet also expects this demand to increase among users and gradually result in machine sales.

The CEO sees opportunities for his technology in other areas, as well, such as large molds, spare parts, and space applications. »We can build molds for rocket tanks just like we do for wine barrels,« he points out. Another thing Verlet sees as crucial here, however, is that users recognize the potential of additive manufacturing and decide to make it work for them. VLM Robotics wants to showcase this potential at Formnext 2022, where it will be participating in the joint booth of the Nouvelle-Aquitaine region and presenting part of its new extra-large manufacturing cell.

+ FURTHER INFORMATION:

» vlm-robotics.fr

Left: Several 3D-printed layers of steel 0.3 to 0.8 mm thick are used to test how the steel can be milled without coolant
Right: Béatrice Rivalier next to a prototype of a two-meter-high 3D-printed mold for wine barrels, which VLM Robotics presented at Formnext 2021

White polymer instead of barrique

Even though Frédéric Planchon works in an industry that is several thousand years old, he is far from just following the established procedures in traditional winemaking. »We've developed a new system for aging wine,« says the managing director of Bordeaux-based Wine & Tools. »We produce barrels made of polyethylene that have a special shape and a special design that put the lees of the wine in contact with the right amount of oxygen to let it mature,« Planchon explains. »Our technology makes wines softer, rounder, and fruitier.«

Wine & Tools manufactures these special plastic barrels in the French wine region of Aquitaine. The barrels are used for wines from Cahors, Bordeaux, Narbonne, Côte du Rhone, and other regions of France, but also for wines from Spain and even white wines from Germany.

Special molds are needed to produce these egg-shaped polyethylene barrels. These molds are painstakingly handcrafted or milled from large blocks of aluminum. In the latter case, only about 10 percent of the aluminum is utilized. »Ultimately, both methods are very

cost-intensive,« says Planchon, who has been developing products related to wine production for more than 20 years.

Wine & Tools first got in touch with VLM Robotics five years ago. After the first test 3D prints (of egg cups), the idea was born to also use »robotic 3D printing to advance our business,« says Planchon. »I was thinking mainly about reducing the cost of our barrel molds, making our manufacturing more flexible, and enabling new designs more quickly.« In the meantime, this has resulted in concrete small-scale molds for barrel production, along with an exhibit at Formnext 2021. »The challenge after that was to increase the size of the molds from a diameter of around 20 centimeters to more than a meter while making them strong enough to fit rotational molding requisites, but not too heavy in order to reduce the amount of material required,« Planchon explains.

For development partner VLM Robotics, this meant experimenting with different wall thicknesses and using reinforcements in the right places. The two companies now seem to have found the right combinations. »We've now

reached the stage of development where we'll be able to use the first 3D-printed molds in production in the late summer of 2022,« Planchon reports.



With or without oxygen and tannins?

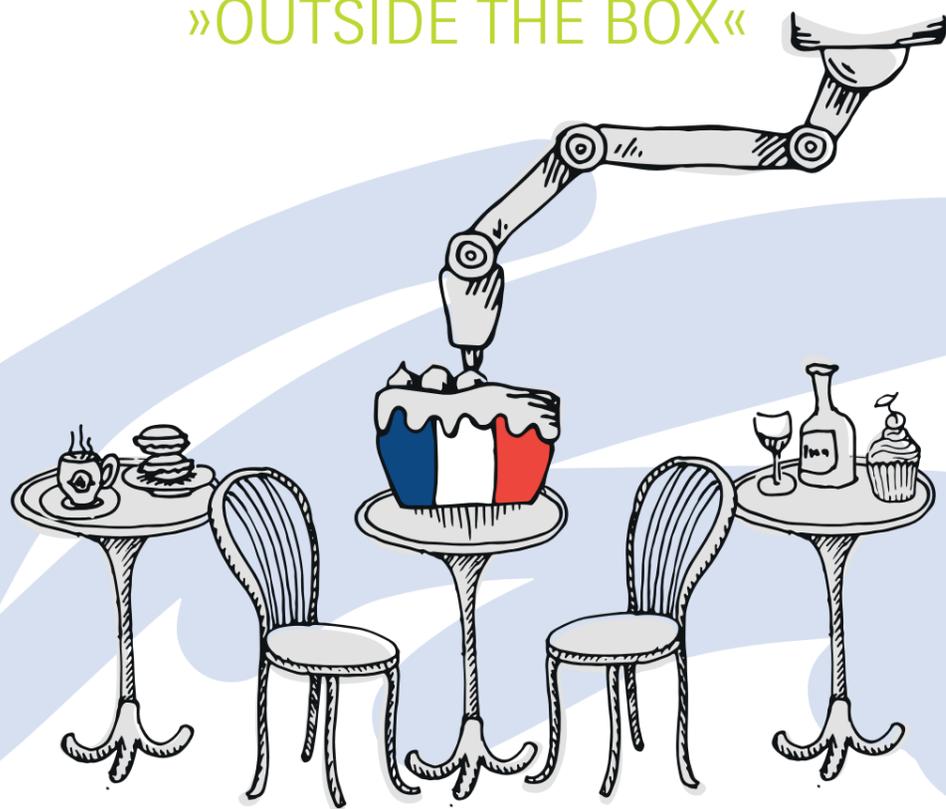
Traditionally, high-quality red wines in particular are stored for a certain time in barrique barrels, where they not only gain additional tannins, but are also supplied with a minimal amount of oxygen via the wood. These 225-liter barrels, which are made of oak and charred from the inside, were once primarily used for transporting wine to England.

The fact that the oxygen supply, which actually spoils the wine, is also important for the aging process in the right measure was only discovered in the 1960s. According to Wine & Tools CEO Frédéric Planchon, however, barrel aging brings with it two problems: oak is

becoming increasingly rare and expensive, and even more importantly, the high tannin content (the tannins already present in red wine are intensified by barrel aging) is proving to be less and less to the taste of customers. According to Planchon, an aging process that adds no further tannins and involves the right amount of oxygen is thus the right way to go.

Another type of aging takes place in stainless steel tanks, where wine neither receives additional tannins nor comes into contact with oxygen. Here, the aging is done via a technique called »pumping over«, or providing oxygen with a special apparatus Planchon says is difficult to dose adequately.

»OUTSIDE THE BOX«



Text: Thomas Masuch

Small Tables, Big Joie de Vivre

I recently had an interview scheduled for an early afternoon in a city in the south of France, but when the time came, my counterpart was nowhere to be found. After spending a little while waiting and writing a message, I was just about to leave when he finally appeared, evidently in no hurry despite being more than half an hour late. »Pardon, I was meeting some people for lunch. We're in France, you know – sometimes these things run a bit long!« he said.

Based on the nonchalance with which he explained his late arrival, I could tell how much importance French people attach to a nice lunch with good company. In fact, restaurants seem to generally have a much greater significance as places where people gather to enjoy themselves than they do in, say, Germany. It's not for nothing that we Germans use the phrase »living like God in France« to refer to time spent in the lap of luxury. In 2010, French

cuisine was even recognized by UNESCO as intangible cultural heritage. This is understood to include not only elite chefs like Paul Bocuse, but also the very friendly and professional service one encounters in restaurants and bakeries across the country – which you wouldn't call the general standard in Germany, for example.

There are plenty of differences like these that you notice when you cross our western border to France. The cars on the roads all seem to be more affordable models, for instance, and some of them appear to have more dents. An amateur sociologist might assume that the people here take the money they save on buying and maintaining their vehicles and invest it more or less directly in pleasures of the palate.

After my four-week tour of the country, there's only one slight drawback to the French penchant for enjoying meals in social settings: In the center of larger cities like Toulouse and Lyon, the tables at restaurants aren't much

bigger than the chairs, and they're packed in so tight that you have to be careful not to pick up your neighbor's silverware by mistake. That said, you could think of this as a form of social interaction, as well.

French cuisine has also felt the influence of 3D printing, of course. While decentralized manufacturing hasn't been identified as a way to solve the issue of crowded restaurants, AM methods have been leveraged for things like adding charming decorations to birthday cakes (as provided by pâtisserie numérique).

This certainly hasn't posed a real threat to haute or nouvelle cuisine thus far, and no one is seriously worried about being served boeuf bourguignon, coq au vin, or crème brûlée that was made in a 3D printer. You never know, though: Formnext is just over two months away, and it has certainly astonished us before...

Illustration: feedbackmedia.de, iStock / Natasha_Pankina

AM4U

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CONTACT:

- » Hotline: +49 711 61946-810
- » formnext@mesago.com
- » formnext.com/fonmag
- » Further information: formnext.com



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EDITED BY
ZIKOMM – Thomas Masuch
thomas.masuch@zikomm.de

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