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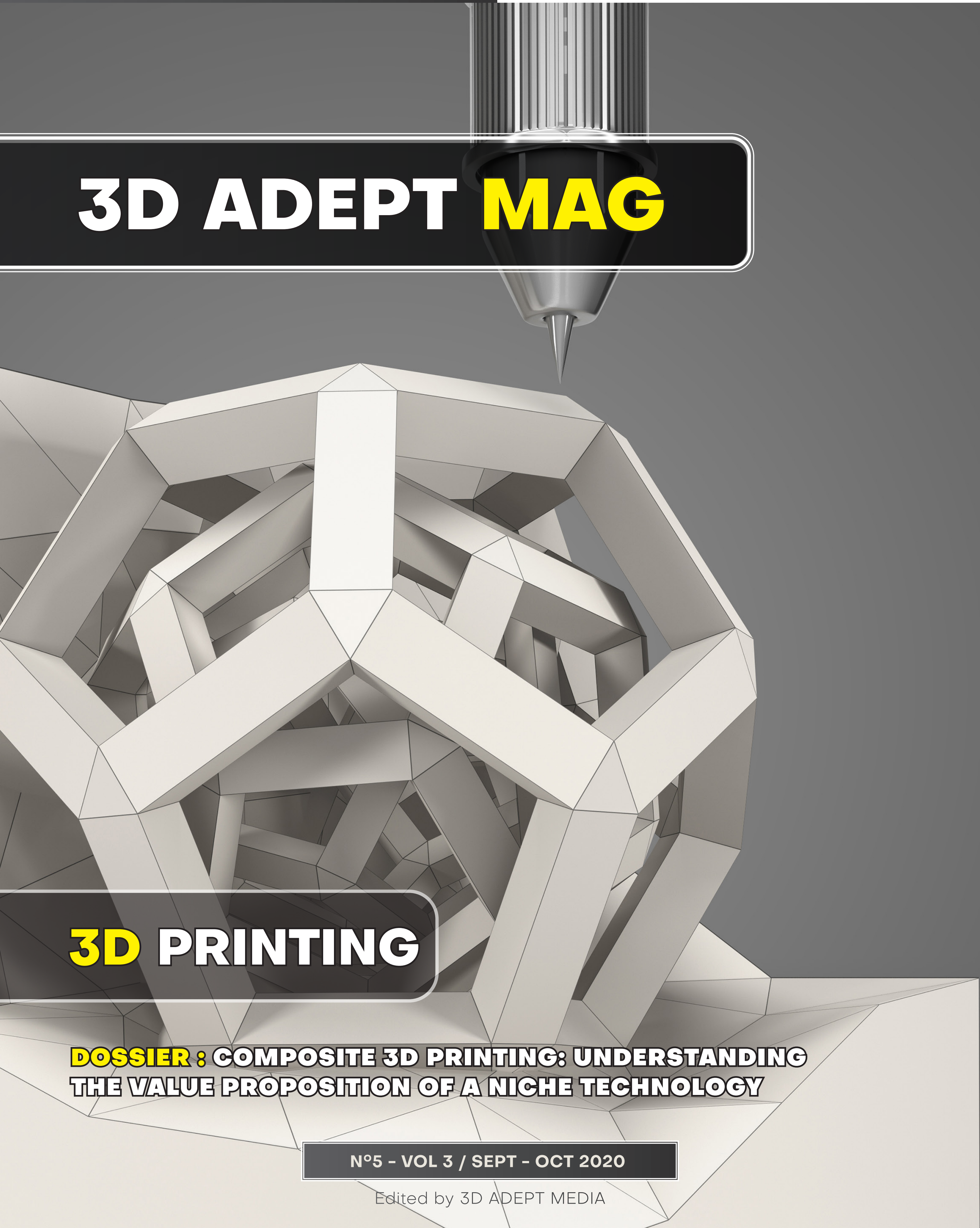

3D PRINTING

DOSSIER : COMPOSITE 3D PRINTING: UNDERSTANDING THE VALUE PROPOSITION OF A NICHE TECHNOLOGY

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3D ADEPT MEDIA
All about Additive Manufacturing

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Hello & Welcome

The end of the summer vacations marks the beginning of the Back-to-school season for children and students. In the additive manufacturing industry, this period started with Additive Talks, a series of panels that brought together suppliers of additive manufacturing technologies and users of these technologies around various key topics. It was an enriching experience made possible by the contribution of participating companies and professionals from all industries. Thanks again to all of you for your participation.

The back-to-school period is also the peak season for industry events. Companies are willing to invest extra miles to end the year on a positive note.

It's also the time of year when our minds are focused on Formnext. Between logistical preparation and strategic communication preparation, every action usually counts. This year, as you already know, things will be done differently. There will be no logistical preparation for Formnext but there will be a crucial digital preparation. The "Event" segment of this issue highlights our exchange with **Sascha F. Wenzler**, Vice President of Formnext, who shared key insights into Formnext Connect.

At a time when all companies are rethinking their business strategy, virtual meetings may be the only possible way to exchange right now, but they are more crucial than ever. It's a chance to bring an idea to life, to rethink a strategy, or to win a prospect. They are a chance to find the solution to move forward.

Kety SINDZE
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Editorial

DOSSIER

COMPOSITE 3D PRINTING : UNDERSTANDING THE VALUE PROPOSITION OF A NICHE TECHNOLOGY

When Additive Manufacturing comes to composites fabrication, we did not expect this combination to work and lead to the development of some niche yet interesting applications for the industry. In their latest report, ***SmarTech Analysis*** *announced this market segment would surpass $9 Billion in 2028. What explains the host of new opportunities for the composites industry? More importantly, what drives this market segment?*

This article aims to give a state of the art of composites additive manufacturing and highlights key takeaways companies should keep in mind while taking their first steps into this market segment. To address this issue, we've invited two experts: Anisoprint and SABIC.

Anisoprint is one of the pioneers in Continuous fiber 3D printing. The Russian manufacturer develops composite fiber co-extrusion 3D printers that can fabricate high-strength reinforced parts. With a decade of academic and industrial experience in design and optimization of composite materials and structures, **Fedor Antonov**, the company's founder and CEO, shared his thoughts on this niche technology.

Next to Anisoprint, is **SABIC**. This expert in the chemical industry delivers value by providing materials at various points throughout the global additive manufacturing value chain. **Kim Ly**, Lead Scientist, Application Technology at SABIC's Specialties Business answered our questions as part of this feature.

Seven years ago, when we witnessed the launch of Markforged's 3D printer that could process polymer structures with continuous carbon fiber reinforcement, any article on the topic would have taken one or two pages. Today, with the development of new materials and the entrance of new comers, this same topic can fill an entire magazine.

Legend: © Anisoprint – 3D printed parts produced with their composite 3D printing technology

Antonov

For **Antonov**, Composite 3D Printing is less widespread compared to other AM technologies because *"it is one of the youngest branches of AM technologies. New players are entering the market every year and the number of applications and use cases is growing rapidly". "I'm pretty sure that in 5-10 years composite 3D printing will be one of the biggest things in AM"*, **Antonov** said.

Why does composites additive manufacturing make sense today ?

We tend to believe that the *"virtuous cycle of the 3D Printing industry" drives this change. As per the words of Shane Fox, Founder of Link3D, "the more designers design products, the more applications we will have. The more applications there are, the more materials will be developed, and the more printers will evolve or be introduced to the market".*

This virtuous cycle is a first response to the evolution of composites additive manufacturing. If we dig a little bit deeper, we realize that this virtuous cycle also draws attention on **the challenges of traditional composite-manufacturing processes** and how additive manufacturing might be uniquely positioned to address them.

Indeed, traditional composite-manufacturing technologies often require **hand lay-ups and post-processing stages** such as autoclaving and vacuum-molding. Not only these stages are expensive with standard plastics or metals, but they should be performed by a higher-skilled workforce.

Furthermore, as designers need stronger materials that can be processed via AM, there is a need to explore other manufacturing opportunities. **Composites materials might therefore become an interesting alternative where metals are not always sufficiently lightweight enough.**

Speaking of the way the use of composites differs from conventional manufacturing processes & additive manufacturing processes, Antonov stated:

"There is not just one conventional composite manufacturing process. And most of them are additive by definition (the materials are added to create an object, not removed). Moreover, Automated Fiber Placement (AFP) or Tape Laying (ATL) technologies, that are successfully used for decades to produce high performance composite parts, could be called 3D printing. Some of the new composite 3D-printing companies are offering technologies that are very similar to AFP or ATL, and some of the old AFP/ATL providers now start calling their machines 3D printers. There are other composite manufacturing technologies, such as hand layup, filament winding, pultrusion, resin transfer molding and many others, that are quite different one from another, but all of them are additive. What really makes the difference, is not the fact that these technologies are additive, but rather higher level of automation, digitalization and customization of the manufacturing process. Most of the conventional technologies are multi-stage processes that require lot of hand and paper work, and have many limitations. The ideal

composite manufacturing technology of the future (anisoprinting) is a fully automated, single-stage, digital manufacturing process that imposes no limitations on the shape and internal structure of the part".

This need for hand lay-ups, the expensive curing equipment and the need for stronger materials are a few areas where AM brings tangible solutions.

The use of composite materials in Additive Manufacturing

First, composite materials are the combination of two or more materials with different physical and chemical properties. To develop most composites, material experts usually take one material (the matrix) and surround it with fibres or fragments of a stronger material (the reinforcement).

Composite materials are meant to perform a certain job, for instance to deliver stronger or lighter parts, to deliver parts that can withstand electricity or to improve strength and stiffness. In a nutshell, they always improve the properties of their base materials and are leveraged in various applications.

Composite materials can be found in various forms. Taking SABIC's materials as an example, **Kim Ly** explained that *"glass- and carbon-reinforced polymer pelletized compounds can be used in Large Format Additive Manufacturing (LFAM), also known as Fused Granular Fabrication or pellet extrusion Additive Manufacturing"*. However, these materials can be found in many different forms as the way they are utilized also depends on the type of AM technology that processes them. Speaking of LFAM for instance, Ly explained that this technology is commonly associated with print envelopes of 1 cubic meter and larger and pellet feed rates ranging from 5-250 kg/hr.

Anyway, SABIC's *"primary base polymers include ABS (Acrylonitrile-Butadiene-Styrene), PC (general purpose and high-heat polycarbonate), PPE (NORYL™ polyphenylene ether resin), and PEI (ULTEM™ polyetherimide resin), as well as a new compound based on our FST PC for enhanced performance with respect to low flame, smoke and toxicity".*

Speaking of challenges operators can encounter at the materials level, Ly continued:

"We have learned that many early LFAM

adopters have less experience processing polymers than our traditional customer base in injection moulding, particularly in the areas of material selection and Design for Additive Manufacturing. In addition, understanding best practices in material handling, drying, and processing are critical since there may be differences in the behaviour of grades, even within the same polymer family. For that reason, SABIC also provides support including fundamental polymer education when needed. Further, since we use our Large Format printer to screen compounds under development, we are very aware of the potential design and processing challenges that can arise, so we offer to review proposed print configurations and can be present either in person or online during first prints to help diagnose any issues. This can help accelerate the learning curve for our customers".

Chopped vs Continuous fibres

As mentioned before, most composites are formed with one main material (the matrix) which is strengthened with fibres of fragments of a stronger material. It should be noted that two reinforcement types of fibre are compatible with AM technology: **chopped** and **continuous**.

With chopped fibre, small strands (< 1 mm in length) are embedded into the polymer material. The percentage of fibre used and the base thermoplastic will influence the strength of the final part.

Continuous fibre on the other hand, requires a mix of long strands of fibre and a thermoplastic during the printing process. This thermoplastic can be PLA, ABS, Nylon, PETG and PEEK. Such type of parts is usually very light and strong as metal.

It's easy to appreciate the capabilities of those two types of fibres when they are processed on a specific AM technology.

"Printers built for LFAM utilize compounds based on chopped fibre to take advantage of the strength properties along with widespread availability and lower cost of pellets as compared to filaments. Use of chopped fibre provides distributed reinforcement throughout the matrix of the print. Printers that incorporate continuous fibre into a matrix of molten polymer have more recently been introduced and offer additional functional capabilities; however, use of continuous fibre may have some limitations on design and full incorporation into the matrix, particularly in gantry-based AM systems" SABIC's speaker pointed out.

In the industry, additive manufacturing of chopped fibre composites would find more applications than continuous fibre due to this length of strands, which is less complex to process than AM of continuous fibre.

The key focus on Carbon fibre

Carbon fibre is one of the most widely used type of fibre used on the 3D printing market, alongside fibreglass and Kevlar. For the two experts, two main arguments explain this excessive and growing use of carbon fibre: **performance** and **applications.**

For Anisoprint's CEO, it is a matter of performance. *"As the main UVP (Unique Value Proposition) of composite 3D printing is high performance (high strength, stiffness and low weight) it is logical to use the most high performance components. When the price topics will become more important with the maturity of the technology, probably, other types of fibers (such as glass, basalt, aramid or natural fibers) will become more popular, but everyone will find its own niche"*, **Antonov** notes.

Even though she recognizes that the primary use cases to date, are seen with carbon-fibre and glass-fibre, Ly also lays emphasis on the expensive cost of carbon-fibre-reinforced compounds as compared to glass-fibre compounds. However, despite this expensive cost, operators are attracted by the high strength, modulus, thermal conductivity and the lower coefficient of thermal expansion that carbon fibre delivers, properties that are *"all highly critical for tooling applications"*. Not to mention that carbon fibre compounds are also less prone to warpage, a key advantage for robust manufacturing.

Distinct differences remain, between printing carbon fiber and printing carbon fiber-filled thermoplastics, as well as continuously laying carbon fiber as part of a 3D printed geometry. This brings us to our next question: what type of AM technologies can process composite materials?

Legend: Image via SABIC – Olli shuttle – SABIC provided materials to 3D print components of this electric vehicle.

Materials vs AM technologies

A few number of manufacturers position themselves on the composites 3D printing market. Some of them have made this technology their core business while others provide this technology as part of a large production technologies portfolio. There are for instance:

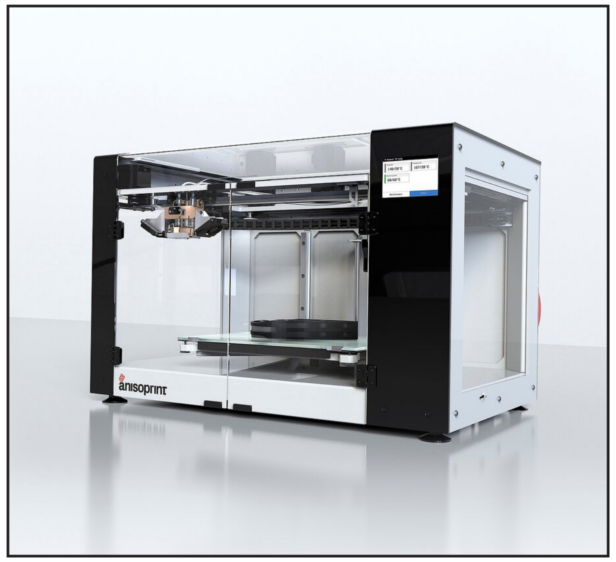
Anisoprint, +Lab/moi composites, 3D Fortify, 3DXTech, Advanc3D Materials, Arevo Labs, CEAD Group, Cincinnati Inc., Continuous Composites 3D, CRP Group, EOS, Impossible Objects, Ingersoll, Markforged, Roboze, Ricoh, Stratasys, Thermwood, Desktop Metal and Fortify.

As composite materials are available in various forms, their AM technologies can be based on a **liquid or filament process**.

Furthermore, as composite materials require a dedicated approach, existing technologies that were not developed with the goal of processing composites, cannot process them. Antonov did not take into account short fibre reinforce composites here, as *"they do not offer a different value proposition"*.

Nevertheless, *"most of the composite AM are material extrusion based, or lamination based. At the moment it's quite hard to categorize them, as every vendor has its own process, each of which has its pros and cons"* Anisoprint's CEO completed.

Anisoprint's continuous fibre 3D printing technology stands out from the crowd thanks to two inputs: the first one is designed for reinforcing material (fibre) and the other one is meant for the matrix material (plastic). The two materials are mixed inside the print head and are extruded through a single nozzle.



Legend: Anisoprint' 3D printer, Composer – © Anisoprint

To comment on what makes their technology outstanding, Antonov states: *"in most of the other extrusion-based continuous fiber 3D printing processes, the fiber is preliminary impregnated with plastic, and the print head has one input (for fiber, impregnated with plastic) and one output (for the same, but plastic molten inside). The co-extrusion approach allows us to use different types of plastics as a matrix (binder) material, and this choice is made at the customer side, which is not possible with the pre-impregnation approach. And more important, with co-extrusion you can locally change the volume fraction of the fiber that allows for printing more complex structures such as lattices or using layers with variable thicknesses"*.

Concluding Thoughts

As the AM market shifts away from the stereotype of rapid prototyping, an increasing focus is made on functionality and materials are not exempt from such scrutiny. As far as composites 3D printing is concerned, this niche technology enables a multitude of applications in every field that requires high performance and lightweight parts.

The value proposition in creating large parts and tools in days rather than months includes speed-to-market, reduced development costs, and often increased revenue from faster sales.

"However, from the perspective of the material supplier, improvements in material quality and consistency continue to be a primary focus. Because prints can span hours or even days of run time, errors that may occur well into the printing cycle can result in material waste and highlights the need to minimize process fluctuation". This is therefore the next area for improvement of AM specialists.

formnext

What to expect from Formnext Connect and most importantly, how should AM companies prepare for it?

Key Insights from Sascha F. Wenzler Vice President of Formnext

Formnext Connect will take place virtually from 10-12 November 2020

With 852 exhibitors split into four halls and over 34 000 visitors, last year, Formnext established itself as one of a kind show in the entire AM world. It usually takes months before companies announce their participation at events, but last year, at the end of the 2019 edition, most exhibiting companies had already arranged to come back for the 2020 edition and even announced it through their social networks.

Then, Covid-19 came into play. From outbreak to pandemic, the sanitary crisis has had a proportion and an impact that nobody would have expected. You are certainly well aware of this point, as wherever you are in the world, it has changed so many aspects of life.

For the global events industry, this impact was even more important as in addition to building community and driving innovation, workforce development and education, this field represents over 26 million professionals. It was valued at more than $1.1B in 2018 and was expected to grow at a CAGR of 10.3% to reach $2.3B in 2026.

Needless to say today, these projections have clearly changed. Events' organizers across the world including **Mesago**, Formnext' organizer, are rethinking their strategy.

At the time we are writing, China is currently the only country that is back on track with regards to the organization of trade fairs.

As far as Mesago is concerned, this "new normal" led to the creation of ***Formnext Connect,*** a virtual platform where, as per the words of ***Sascha F. Wenzler, Vice President of Formnext, the*** *"AM community will finally have the opportunity to showcase their latest innovations and [where] attendees will be able to discover the entire world of additive manufacturing enabling them to incorporate the benefits of [this technology] into their production."*

Speaking of the goals they set themselves and how these goals have been adapted and have evolved, in light of current circumstances, Wenzler states:

"To be perfectly honest, very few of our original goals were able to withstand the outbreak of the Corona pandemic. Surely, many of your readers will agree that adapting your goals and strategies was and still is daily business and may well stay with us for the foreseeable future. Only in early September we had to shift our goals once again from a hybrid approach for Formnext 2020 to a now fully virtual event. Rising infection rates with COVID-19 all over the world and Europe and as a result tightened travel restrictions both from the authorities as well as from companies of exhibitors and visitors alike ruled out a physical event with satisfying attendance figures.

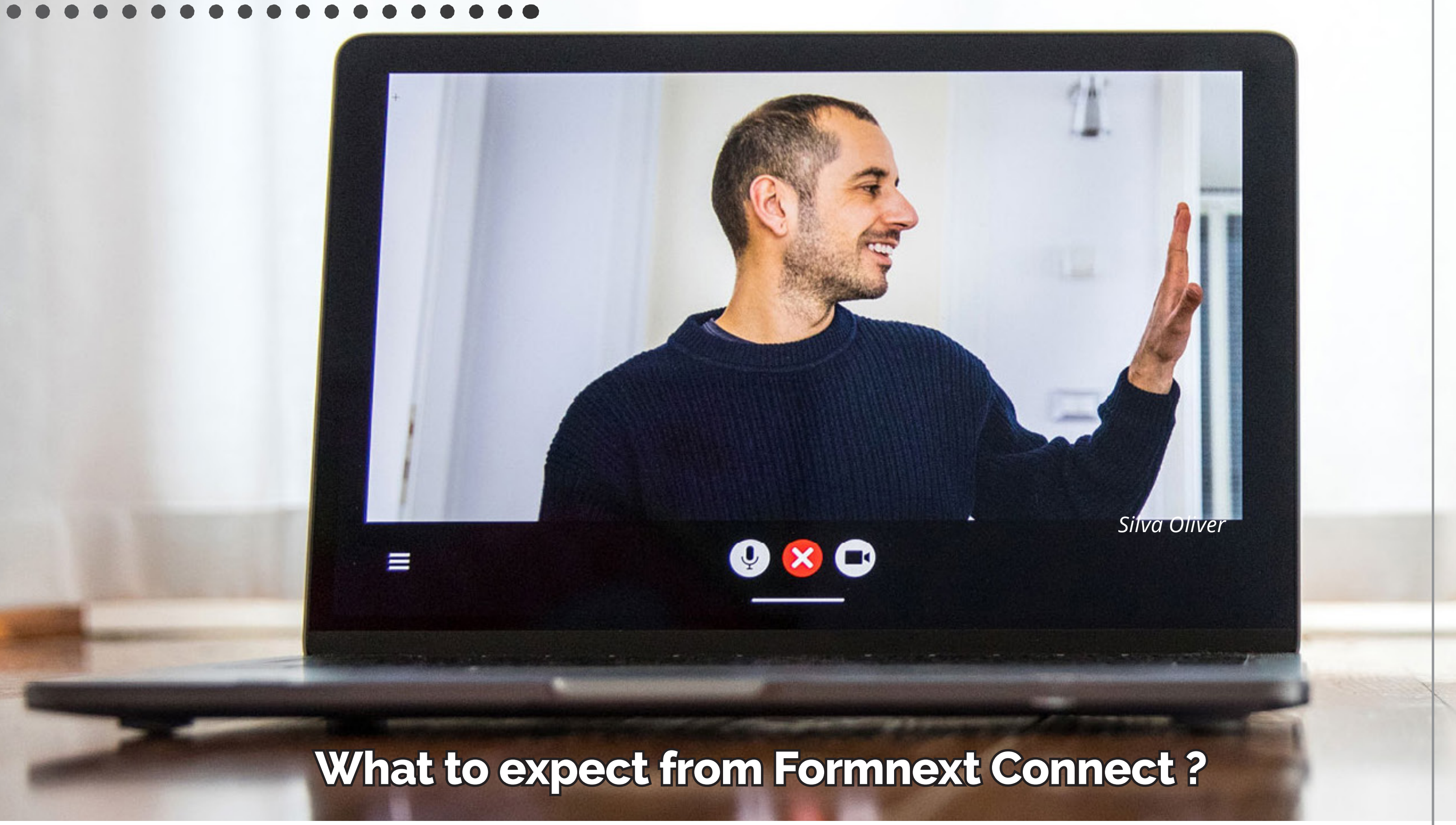
However, since we are convinced that the additive manufacturing community still requires a platform for exchange in the autumn of 2020, we are now shifting all our efforts towards the launch of our virtual event "Formnext Connect."

The reality is that countries around the world are setting new guiding principles to follow to organize small and large gatherings. With the goal of enhancing protection of all attendees – and to a certain extent, preventing the spread of the virus, event planners and officials can determine, in collaboration with local authorities, whether and how to make adjustments to meet the unique needs and circumstances of each situation.

Formnext is no exception, as it needs to comply with the current restrictions. *"As a highly international trade fair with global importance Formnext is not immune to the current restrictions for personal encounters. Once the volatile infection rates stabilize and a sense of security returns, at least we [will already be ready] to organize a Formnext that meets the required health and safety measures"*, the spokesperson explains.

Sascha F. Wenzler, Vice President of Formnext

FROM 10 TO 12 NOVEMBER 2020



What to expect from Formnext Connect ?

Organizations and companies have been organizing a lot of virtual events in the past months. These events aimed at enabling companies to exchange ideas, therefore they did not always replicate all the feature of a physical event.

As an event planner that has built extensive experience in the organization of gatherings, Mesago brings a vision that is necessary to organize a virtual event that will keep "this human touch" we all seek to maintain.

However, **the challenge with a virtual event lies in the choice of the platform and its ability to enable a user-friendly experience for both tech-savvy people and beginners in the use of digital tools**. With that in mind, Wenzler ensures that their aim is to make participation as convenient and efficient as possible.

"At a physical event it makes perfect sense to stroll down aisles and be inspired by the solutions on display. However, in the digital space this approach is not necessarily desired. Here, attendees wish to find the best solution possible through good filtering options and a clearly structured user interface. Performance issues and buffering times for CPU-consuming graphic elements are not acceptable and would spoil the experience.

Additionally, events such as Formnext are made by the random, inspiring encounters, which we try to transfer to the digital world and encourage through the AI-based matchmaking engine.

Lastly, content. Presentations, expert talks, round tables, showcases and additional formats such as Formnext. TV, which cover all aspects of additive manufacturing processes as well as the industries using them is an integral part of Formnext and will of course be included through live and on-demand streams.

By focusing on these three key elements, we believe our attendees and exhibitors will have a successful Formnext and be able to generate real value from their participation", the spokesperson points out.

How should AM companies & visitors prepare themselves ?

On the other hand, exhibitors will observe a different form of preparation. The physical event of Formnext was one of the rare additive manufacturing events where companies could first distinguish themselves from others of the same range with their booth.

At Formnext Connect, exhibitors will also be able to make a real splash in the way they will exhibit. Basic requirements will consist in completing their company profile, uploading their product information and appointing their representatives.

"If exhibitors wish to go a little further, Formnext Connect enables them to include bespoke content. From links to their individually branded VR-show room to an integrated live stream with Q&As in a branded studio, options are limitless. We are simply providing the platform, where exhibitors will be able to make that all important connection resulting in meetings with their team members", the Vice President of Formnext notes.

What's interesting in this preparation is that, the way exhibitors will complete their profile and upload their information will attract their leads. Thanks to a state-of-the-art matchmaking tool, participants will be suggested products and exhibitors that are in line with their interests.

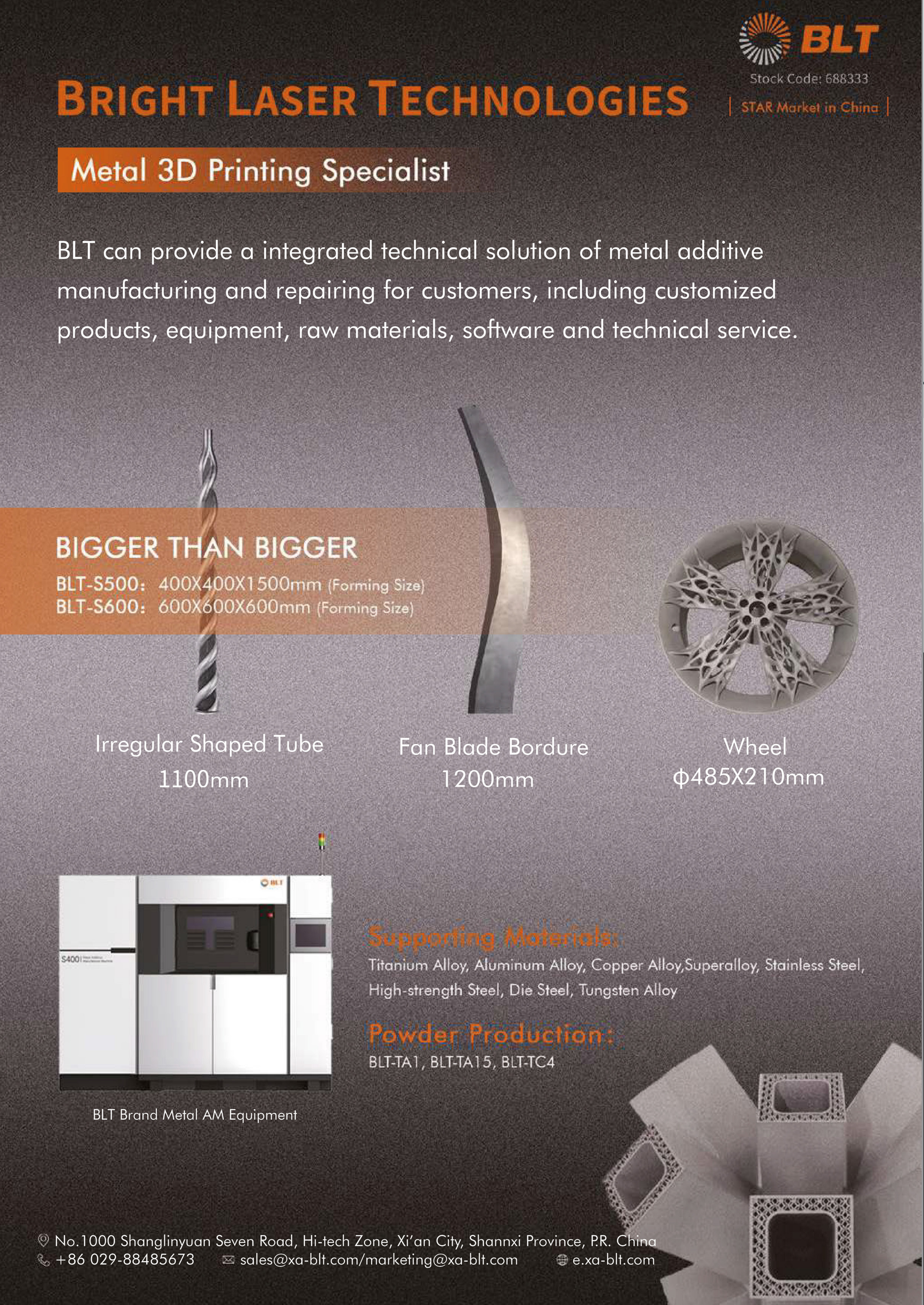
According to Wenzler, that's the strength of Formnext Connect. *"Matches will be determined by an algorithm based on users' input and behavior. If both parties agree, video calls or in-person meetings at Formnext can be arranged. This offers a new dimension of coming into contact with potential customers"*, Wenzler continues.

Formnext' DNA remains intrinsically the same

Over the past years, Formnext has also been acknowledged for the wide range of sub-events to convey AM resources. Formnext Connect will also feature these popular events and numerous other live events to ensure a diverse and informative event program.

Formnext Connect is made possible thanks to the support of both the event's exhibitor advisory board and AM companies that need to exchange and foster the advancements of this much-needed technology. As a matter of fact, this additional digital brand does not change the event's DNA that remains intrinsically the same.

At different levels, the unprecedented times have taught us several lessons and have changed many things. We couldn't agree more with Wenzler when he says: *"social contacts and face-to-face-meetings are without a doubt the element [we] miss the most in this crisis". "And like every crisis we have chances in it and it will come to an end"*, **Sascha F. Wenzler** concludes.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INTERVIEW

What can we learn from an Additive Manufacturing consulting firm?

3D ADEPT MEDIA Matthias Schmidt-Lehr

AMPOWER gives key tips to companies that are taking their first steps in Additive Manufacturing & insights into the current market situation

A quick Google search for "additive manufacturing/3D printing & Consultancy" reveals hundreds of companies that provide their expertise to companies that are willing to take the right first steps into additive manufacturing. These consultancy firms are either independent or are part of well-established companies. Given the intriguing and sometimes complex nature of additive manufacturing technologies, all these companies certainly have their place on the market. However, while most of them usually operate in their region, very few actually manage to have a seat on the international stage as AMPOWER does.

The Germany-based startup opened its doors three years ago, with the mission to helping companies integrate AM into their activities.

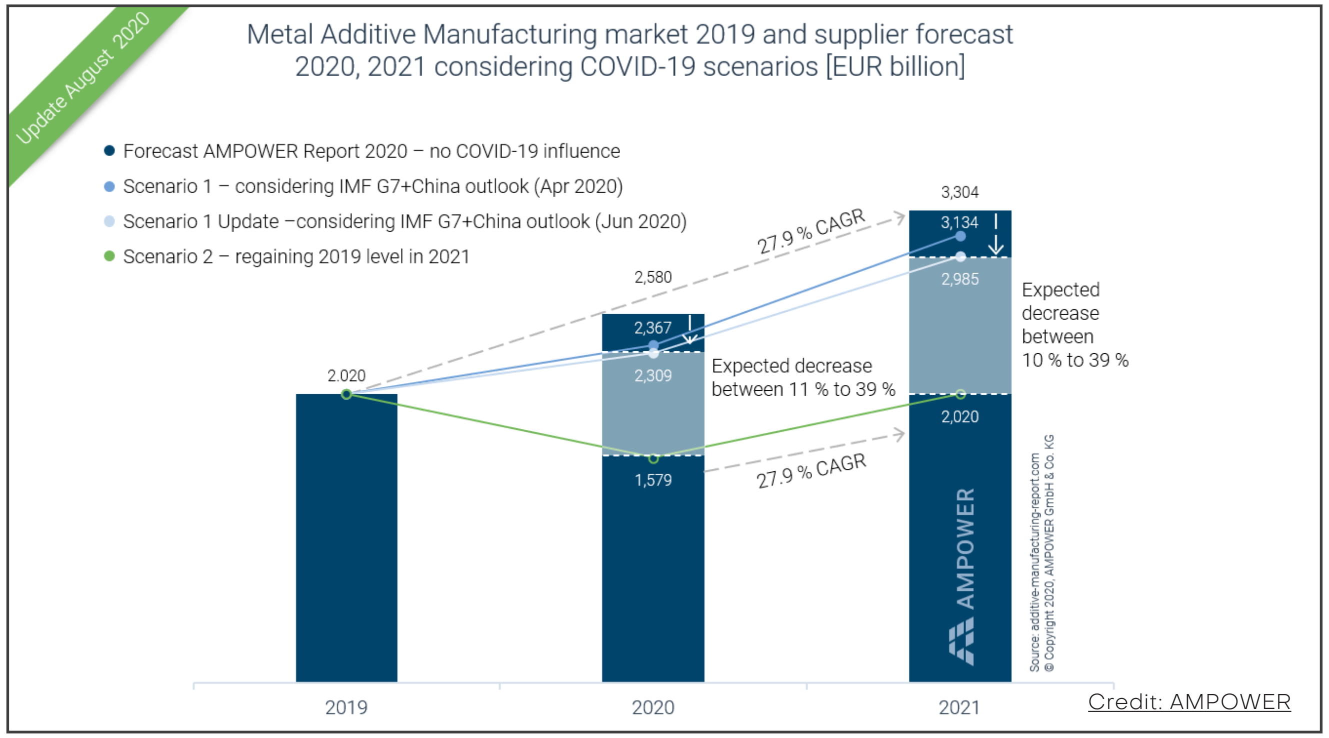
At this point, AM consultancy which is AMPOWER's core business should not be confused with 3D printing consultancy. Indeed, while 3D printing is utilized to refer to a technology used for the creation of prototypes, AM on the other hand, lays emphasis on a more in-depth use of the technology by industrials. The term usually implies the production of consistent, quality and repeatable parts by operators.

"We saw many companies on user and supplier side struggle to find support with go to market strategies and qualification issues related to Additive Manufacturing. AMPOWER is closing the gap between technology-focused support from research institutes and high level management consultancy", **Matthias Schmidt-Lehr**, Managing Partner tells 3D ADEPT Media.

At that time, companies needed to acquire a deep knowledge about Additive Manufacturing. However, the learning phase of AM usually varies from one company to another. Depending on a company's investment in the project, it can take several years and might require expensive means. To mitigate these risks and to a certain extent, to reduce this integration time, Schmidt-Lehr and his two partners decided to rely on their experience.

The company then develops key reports and technology studies that encompass key questions companies ask themselves before leveraging AM. These reports give key insights into the various players that operate on this market and their technologies as well as key statistics on the market evolution. With the goal of filling the gap between machine manufacturers and end users, the company quickly expands its offering to reach out the main stakeholders of the supply chain:

"For Additive Manufacturing users, we offer guidance along the implementation process from technology scouting and strategy, training and design to qualification and supply chain setup. For suppliers of Additive Manufacturing systems, materials, and services, we offer market analytics, go to market strategies and support in qualification programs" **Schmidt-Lehr** completes.



Credit: AMPOWER

Moreover, just like AM companies greatly rely upon collaborations to develop both their technologies and the market, it should be noted that, a consulting firm like AMPOWER is also uniquely positioned to initiate these partnerships through their technology studies.

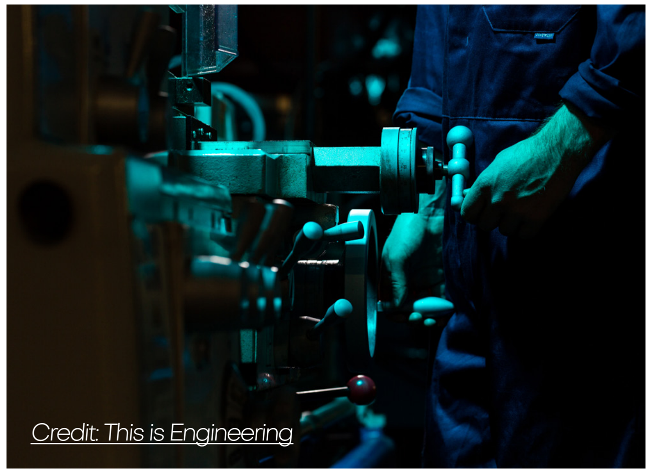
Indeed, the company conducts 2-3 highly dedicated technology studies per year (currently Binder Jetting and HIP), and covering these topics is only possible with the support of a solid network.

Key tips to introduce AM within a company and current market situation

As we are moving forward to an Industry 4.0 era that encourages the integration of intelligent production systems and advanced information technologies, companies can easily feel overwhelmed. Added to this, AM is considered to be an essential ingredient in this new movement. This might raise several questions in the management team, questions in terms of workforce competences and even new way of working.

To those companies that are introducing AM into their activities, AMPOWER's expert first tells that they should keep in mind that this technology is application driven.

"The first step is always to learn about the variety of technologies, the potential but also limitations and match the AM technology portfolio with the internal part portfolio. It is very important to create the right mindset for new designs, but also develop a realistic understanding of cost and challenges. Internal communication is a major skill for the technology introduction. Communication towards management, but also towards engineering and production is important to create a stimulating culture", recommends the expert.


Credit: This is Engineering

However, with the Covid-19 pandemic, things can change. Consumers' habits have changed. As countries have reopened part of their economies, individuals and corporations are trying to live with the Covid-19 reality and are settling into a new normal. For the manufacturing industry, efforts and concerns are directed towards other objectives: **minimizing the financial impact**, the **effects on operations** and on their **workforce**.

As far as the metal AM market is concerned, AMPOWER has analysed the pandemic's impact scenarios in 2020 and realized that *"the first scenario is based on transferring the expected impact from the International Monetary Fund (IMF) market forecast to the AM market. This leads to a reduced growth of the AM market in 2020. The second scenario is based on the assumption, that we will regain the 2019 market volume in 2021 and 2020 can be marked as a « lost year ». In our 2021 market report, we will find out about the actual impact. Today, we assume, that it will be somewhere between those two scenarios. The AM industry is currently in a situation, where it must prove, that it really adds value. This means that companies must evaluate, if they can earn money with AM technology. It is important, that the supply chain now focusses more on the real value proposition of AM besides nice lattice structures and bionic bottle openers. AMPOWER wants to support companies on this journey and invites everyone to join us on this path."*

What does "openness" truly mean in a metal AM system?

Needless to recall the monumental changes that helped many industries appreciate and consider the potential of additive manufacturing. With over 300 metal additive manufacturing (AM) systems available on today's market, most of them being closed and proprietary systems, we cannot help but think to the long road ahead and the challenges that still need to be addressed. How can operators access knowledge about additive manufacturing processes? How can they address the limitations in terms of materials and achieve more applications? How can they have greater control over the manufacturing process? For a niche of experts on the AM market, the answer to these questions is to: ***"rely on open additive manufacturing platforms"****.*

This feature discusses the rise and the reasons that led companies to consider "Open Manufacturing". Most importantly, it aims to give manufacturers in various industries another option to consider when it comes to investing in metal additive manufacturing technologies.

The concept of "open manufacturing" is not new. On the contrary, it is relatively simple to understand. The term is linked to the idea of democratizing technology as embodied in the maker culture and other areas for grassroot innovation such as hackerspaces. It consists in combining new production tools, processes (3D printers) and protocols for manufacturing.

As far as AM is concerned, manufacturers struggle to understand and apply it to the current industrial environment. WHY? To answer this question, we invited two of the "must know" companies that are currently paving the way to more "openness" in additive manufacturing: Dyndrite and Open Additive.

Dyndrite™ is on a mission to delivering advanced technology for the future of digital manufacturing. Founded in 2016, the company has developed the **Dyndrite Kernel**, an accelerated geometry kernel that enables companies to build next generation software or additive manufacturing hardware easier and faster than ever before. Next to this flagship product, the company has been acknowledged for its Dyndrite Developer Council, central component to the Dyndrite Developer Program which provides tools, resources and community for original equipment manufacturers (OEMs), independent software vendors (ISVs), service providers and educators.

Open Additive is another one to watch when it comes to open additive manufacturing systems. With the goal of providing affordable metal AM systems, Open Additive stands out from the crowd by providing customizable solutions to the additive manufacturing industry.

Harshil Goel, founder and CEO of Dyndrite™ and **Ty Pollak**, President and CEO of Open Additive share key insights into this topic.

Legend: Americans wind manufacturing – Nordex USA manufacturing facility – Jonesboro, Arkansas.

How should we recognize an "open" additive manufacturing platform?

First, there is not yet a standard definition of "open additive manufacturing platforms". 3D printer manufacturers that are currently developing and providing open additive manufacturing platforms first aim **to meet the demand for better quality materials, more applications**, thus customisation. This issue has become inherent for many manufacturers including Origin, Arburg or even Freemelt.

Let's take the example of polymer 3D printing. 3D printer manufacturers Origin and Arburg have opened the doors to material companies that are now adapting a wide range of materials usually leveraged in injection moulding. Operators can for instance, choose between different amorphous injection-molding granulates to produce not just mockups, but real functional components.

In the same vein, to broaden the Electron Beam Powder Bed Fusion (PBF-EB) material portfolio and application areas, Sweden-based manufacturer Freemelt AB develops an open source material development system that enables operators to try new materials and innovative beam scanning strategies. That's a wise strategy, especially in PBF-EB where the biggest hurdle that slows down the wider adoption of this process is material development.

The reality is that, unlike polymer-based 3D printers, which essentially require the development a whole range of materials, metal 3D printers are known for the use of wire (metal powders) and feedstocks from industries that already existed. As a matter of fact, the rule says, if a metal welds or casts well, then it should also be amenable to additive manufacturing. However, what this rule does not take into account is the virtuous cycle of the AM industry. This virtuous cycle states that *"the more designers design products, the more applications we will have. The more applications there are, the more materials will be developed, and the more printers will evolve or be introduced to the market."* **Ultimately, this cycle reinforces the growth of the industry but it also raises many of its challenges.**

While looking at the development of metal AM systems, part of these challenges shows that materials cannot be the only factor that should be taken into account to qualify an open additive manufacturing system.

Other key characteristics of an open additive manufacturing platform

In addition to "open materials", other elements should be kept in mind while looking for an open AM platform, elements that have strong counterarguments raised by manufacturers of well-established Industrial 3D printers.

Open Architecture VS Closed Architecture.

Closed systems have been the standard across industrial additive manufacturing. The only thing is that such option often locks manufacturers into one vendors' hardware, processes and materials. Simply put, open architecture and closed architecture can be seen as two faces of the same coin.

Credit: Tom Claes – Image: Ultimaker

Understandably, companies that have been at the forefront of AM technology are protecting the intellectual property they've developed over the past years. They are also uniquely positioned to capitalize on this market.

"The intellectual proprietary argument" makes perfect sense; not to mention that proprietary systems are known for their ability to provide stability, repeatability and traceability that give industrial manufacturers confidence in the choices they perform.

The argument of companies that develop an open architecture system is to provide ***"a tool for more than just making parts, but also for making advances in the industry."***

This argument might certainly be more appealing not only for manufacturers but also for researchers, as such system enables more **flexibility**. Operators that use these systems have more freedom to modify, develop, and/or integrate hardware or software components.

"Ideally, the platform should be designed with openness in mind from the outset, with adequate physical space, available information about the configuration, and ability to access system data", Open Additive explains. Furthermore, truly open additive manufacturing systems enable users to integrate their own proprietary technology, which has nothing to do with "open materials or parameters".

Open configuration vs Closed configuration?

Let's focus on powder-bed systems for example. Depending on the project that is being achieved, operators might need to achieve a certain performance with the laser(s), optics, build plate, powder deposition or sensors.

These features are usually configured prior to the sale and they cannot always be changed in AM systems with a closed architecture. To optimize the industrial manufacturing process, operators often tune machine settings **by relying on simulation** – which in the end, leads to greater control of the manufacturing process.

Legend: Design engineer tests virtual reality software

Truth is, be it in open AM systems or closed AM systems, the list of factors that can impact the quality of a final part is lengthy and these process variables must be strictly defined and controlled to enable a successful print each and every time, no matter the machine is.

However, one thing that anyone should appreciate in open AM systems is **flexibility**. Indeed, one cannot predict all the types of project that could be performed with a machine and the ability to adapt the machine before or after sale is definitely valuable.

This list of pros and cons is certainly not exhaustive as the debate is just emerging. However, the key stakeholder that is driving the conversation is the customer.

What does the customer want?

The client wants options. In a 2018 survey carried out by 3D printer manufacturer Essentium, 162 managers and executives from manufacturing companies across the world shared their current experiences, challenges and trends with 3D printing for production manufacturing.

The survey reveals that despite the optimism regarding the use of AM technology, some companies still face obstacles including the high cost of 3D printing materials (51%); expensive 3D printing hardware (38%); and current 3D printing technology does not scale (31%).

To overcome system inflexibility and to use the materials of their choice, manufacturers demand open ecosystems. 50% of respondents state they need high quality and affordable materials to meet the growing demand for industrial 3D printed parts. On the other hand, for 85% of manufacturers, industrial-scale additive manufacturing has the potential to increase revenue for their business, 22% said vendor lock-in has hampered needed flexibility.

Harshil Goel and **Ty Pollak** could not agree more as they strongly believe this is the time to accelerate the shift towards "Open" Metal Additive Systems.

Why are open systems and advanced software the future for the industry? – Insights from Harshil Goel and Ty Pollak

While legacy business models have driven the growth of the industry to its current state, they are not suitable to propel and sustain the industry in today's environment, in which dozens of vendors now compete, offering hundreds of hardware and software options to be optimized for a dizzying array of applications by a much more sophisticated user base. In this new climate, the model of closed, highly proprietary metal AM solutions limits the ultimate promise of AM to its end users—greater design freedom, lower costs, and better part quality. Thus, more open hardware and software solutions are key to the future growth of the industry.

The Primacy of Toolpath

At its most basic level, 3D printing comes down to tracing a path (e.g., a line or area) with an active tool (e.g., print head, laser, etc.) to join bits of matter into a solid piece. Today, the metal AM industry currently has more than 300 metal systems available, and most are closed and proprietary systems, with their own unique toolpath strategies which are generally difficult to understand, let alone control. This means that even if you can run the same process parameters across different vendors' machines, it will too often produce markedly different parts from both a metallurgical and geometric standpoint, making standards and process control difficult and costly. Compare that to traditional machining tools that can run the same toolpath on different machines, resulting in similar parts. More open hardware/software systems which allow understanding and control of toolpath are thus critical to the acceleration of AM to improve quality and reduce costs.

Metal Additive Parts are way beyond "Lawn Mower Brackets"

We are stuck in a catch-22 situation: Machine systems vendors are developing new materials, and process parameters on a yearly basis while tying this development to their core intellectual property strategy. Machine systems manufacturers and their software/engineering teams are being pushed to the limit for developing these parameters. But they are using generic/representative parts to test and validate. However, end users are pushing the limits of these printers by producing ever more complex and sophisticated geometry harnessing the true mandate of 3D printing:- with geometry significantly more exotic than generic parts. End users view these new advanced parts as a core part of their intellectual property strategy, and thus are unwilling to share this geometry

Harshil Goel, founder and CEO of Dyndrite™

with anyone.

So now, the metal additive industry is stuck in a scenario where the intentions of the system vendors and their customers are at odds. Quite frankly, something has to give. ***The systems manufacturer needs better tools to develop better machines. The end user needs solutions that meet their evolving needs.*** An open-architecture is one of the key ways to get out of this predicament

Reducing Risk of Obsolescence

While open systems have been mostly beneficial to the R&D community thus far, they also enable producers, from major suppliers to the small machine shop, the opportunity to modify their system configuration as needs and technology evolve. As a result, risk of obsolescence decreases, and a wider range of future applications may be supported. ***This may spur organizations to commit to getting in the game sooner, knowing they can get started on developing expertise and use cases, but not get locked into existing capabilities.*** Thus, open-architecture systems can reduce one of the key barriers to entry in metal AM—the fear of making a major capital investment which locks down future capabilities in an industry that is rapidly evolving.

Towards Smarter Systems

A key element in the development of AM standards and improved process control strategies is the integration of various sensors and analytics to monitor, and even modify, the build process. To develop and make the most use of such capabilities, users must be able to access the raw and processed sensor data, understand any available analytics or create their own. This delivers the capability to inform the operator and control the machine to take actions based on this resulting information. Closed architectures place barriers to each of these steps, resulting in the dearth of useful process information available on today's metal AM machines. On the contrary, open hardware and software systems are key to realizing the future state of the industry, in which metal AM platforms become smarter production tools.

Connecting the Digital Ecosystem

Today, metal AM machines are increasingly part of a digital ecosystem, which will only become ever more connected. While the machine's software controls everything about the build process – parameters, process controls, resolution, speed, feeds, etc. – it needs to be integrated with other tools that allow pre-build setup and optimization, efficient utilization of available assets, collection and analysis of real-time and post-build data, etc. The machine thus needs to be able to accept and output a variety of format standards, compatible with different software tools used across this digital landscape. Software frameworks are thus needed which accept both open standards in addition to proprietary standards, and deliver greater flexibility for the user to control the machine through custom software plug-ins and APIs as needed. Open software frameworks with APIs that are accessible to people beyond in-house software developers are key to future growth.

Building Bridges Through Standards and new geometry kernels

"*We can't possibly have 30, 40 or 100 separate printer companies all with different competing standards.*" **Harshil Goel**, at the Dyndrite Developer Council 2020 event in April.

All the participants agreed. Standards are a topic central to the future growth of the metal AM industry. Without standards working across the industry, the industry's collective growth is held back, affecting each OEM individually. Dyndrite is working to address the issue of standards through the development of the core geometry kernel aimed to power the AM industry forward and develop critical integrated ecosystems that power digital manufacturing. In addition, it has also launched the Dyndrite Developer Council to work with industry vendors to develop standards that all can work to and help develop the Dyndrite kernel to meet collective needs. A key, critical task being handled by the Developer Council right now ***is the development of a standard toolpathing API to help solve the toolpathing issues described earlier.*** Members span the industry, from established companies

Ty Pollak, CEO of Open Additive

such as 3D Systems, EOS, SLM, Renishaw and ANSYS, to newer players on the market including Open Additive, Aconity3D, and Impossible Objects. Interest in having more open systems is growing throughout the council, including SLM and EOS.

The Council is now up to 20 members and still growing as vendors take notice of the need for collaboration even while in competition. Alongside Dyndrite, Open Additive is a champion for accelerating innovation through more open solutions, and seeks to expand the development and application of AM standards to its metal AM machine control strategies as well as its multi-sensor data collection and analytics tools.

Concluding thoughts

Some AM companies have started acknowledging the need for open and independent machines. However, despite the predictions, the market does not seem ready to drop the intellectual proprietary paradigm. Right now, several factors play to open systems' strengths. If **Harshil Goel** and **Ty Pollak** are correct, it's only a matter of time before industries follow this move.

The use of Inconel 718 in Additive Manufacturing

Credit: Hermus&OEM – Inconel 718

Among the wide range of applications that Additive Manufacturing allows, a key interest is devoted to processing superalloys for aerospace, automotive and even nuclear; industries in a nutshell, that require outstanding combination of superior mechanical properties and wear resistance. In this context, Inconel 718 receives increasing interest.

Quick reminder: superalloys are a type of materials that can retain high strength at elevated temperatures. Such materials become of utmost importance for industries that need to manufacture components out of high-performance metals. Nickel-based superalloys are the type of alloys that are compatible with additive manufacturing. One of these superalloys is **Inconel 718**.

To date, many operators do not know the type of AM technologies that can process this alloy as well as its main applications and features. This article aims to shed light on this material and its use in the AM industry.

Introducing Inconel 718

Inconel 718 (IN718) is a low cost nickel-based superalloy which is mostly used as a turbine disk material. The superalloy was first used to overcome the poor weldability of superalloys in 1960s. As AM and welding processes are quite similar, operators have been using IN718 with metal AM processes since then, to facilitate the understanding of **process-microstructure-property relationships.** This might explain the reasons why IN718 is mainly associated with 3D printing/AM technology.

In terms of mechanical properties, IN718 provides an exceptional thermal resistance - up to 700°C and high resistance to oxidation and corrosion. It is also acknowledged for its excellent strength, high yield, tensile and creep-rupture properties. When additively manufactured, Inconel delivers strength over a wide temperature range, which makes it **a good candidate for high-temperature applications or low-temperature applications.**

With a melting point of 1430°C for instance, the material demonstrates effective resistance to heat and high temperatures, therefore suits well in cryogenic conditions. At room temperature on the other hand, it exhibits a minimum of 725 MPa yield strength and 1035 MPa tensile strength. When it undergoes solution and precipitation treatment, these numbers rise to 1035 MPa and 1240 MPa, respectively.

IN718's composition includes about 50-55 % nickel, 17-21% chromium, 4.75-5.5 % niobium and tantalum, and trace amounts of molybdenum, titanium, cobalt, aluminium, manganese, copper, silicon and other elements.

It should be noted that Inconel 718 often raises confusion with another popular nickel-based superalloy, Inconel 625. The addition of iron in IN625, coupled with a lower nickel content allows the price point of Inconel 718 to be lower than that of **Inconel 625**. These elements mainly constitute the differences between the two materials. Let us see now how it functions when it is processed.

Processing Inconel 718

Inconel 718 is mainly processed by powder-bed processes. Metal AM technologies that can process this material include **Electron Beam Melting (EBM), Selective Laser Sintering** and recently Binder Jetting.

As each metal AM process is unique, the way it will process Inconel 718 will undoubtedly alter the structure – property – processing – performance of the part that is being manufactured.

We've asked Kyle Myers, ExOne's R&D Manager, a number of questions about this material and the way they tune it before it is used by any customers. As a reminder, the recent qualification of Inconel 718 brings the total number of materials ExOne's binder jetting can process to 22.

Credit: ExOne

With several decades of expertise in binder jetting and the industry in general, it's safe to say ExOne knows a thing or two about the market and the way companies across vertical industries adopt these new technologies.

The manufacturer of binder jetting systems does not develop their own unique chemistries and powders. As per the words of Myers, they *"mostly develop processing parameters that work for traditional materials and commonly used powders". "These traditional materials are qualified to known standards which most of our customers are familiar with, which alloys them to adopt our manufacturing process for their application quicker.*

Therefore, any customer that already designs a part, for their application with the inherent physical and mechanical properties to that specification, can insert binder jetting into their manufacturing process.

Other customers may want to take advantage of AM, but work with a similar alloy to In718. They will need to do their homework to make sure the specifications of In718 can fit their specific application", Myers told 3D ADEPT Media.

For researchers, the microstructure of additively manufactured IN718 is largely dependent on the specific process history. With different process parameters, such as scanning strategy and component geometry, quite different as-manufactured IN718 microstructures can be obtained even under the same manufacturing method, let alone different manufacturing methods.

Therefore, the heat treatment for AM IN718 should be customized with regards to its specific process history. Standard specification ASTM F3055 recommends a heat treatment for powder-bed-fusion additively manufactured IN718.

However, this standard only provides a guideline for stress relief and hot isostatic pressing treatments. Establishing the actual heat treatment should be as agreed between the component supplier and purchaser.

Applications of Inconel 718

Inconel 718 is a natural fit for extreme heat applications such as metal die casting.

As mentioned before, IN718 is mostly used as a turbine disk material. Due to its efficient weldability and heat resistance, it has become an integral component of gas turbine engines and turbojet engine parts such as compressor casings, discs and fan blades.

A recent study from The Pennsylvania State University highlights the degradation of turbine blade tips in aerospace today: *"after degradation surpasses a definite point, the entire blade must be taken out of service and replaced with a new blade. The material taken out of service is regarded as scrap and thrown out. This wasteful procedure causes serious financial impact to the aircraft industry as well as being a nuisance in the attempt for a more sustainable earth".*

Combining additive manufacturing (AM) and Inconel 718 for the manufacturing of these turbine blades would provide a possible solution to this problem by allowing for the incremental replacement or repair of the worn or broken part.

The superalloy has also found its way into the production of rocket engines and into the nuclear industry.

At the end of the Winter season, Westinghouse Electric Company installed a 3D-printed thimble plugging device in Exelon's Byron Unit 1 nuclear plant. The installation was made during their spring refueling outage.

Westinghouse Electric Company provides a wide range of nuclear power plant products and services to utilities throughout the world. The company's products and services include advanced nuclear plant designs, nuclear fuel, service and maintenance as well as instrumentation and control systems. Exelon on the other hand is a US-based energy provider.

The collaboration between both companies is the result of three years of development work. According to our colleagues from Nuclear Engineering, when Westinghouse embarked on this mission, the nuclear industry did not have any direct radiation experience with additively manufactured materials. Westinghouse was therefore one of the first to take these first steps in the production of a 3D printed component intended for a commercial nuclear reactor. The company had mini-tensile specimens of Stainless-Steel Alloy 316L and Inconel Alloy A718 additively manufactured for testing. Those alloys were the ideal material for crossover to nuclear applications.

A laser powder-bed system has been leveraged for the production, as it fuses layers of powdered metal together.

Over time, the company designed and additively manufactured other fuel components such as a bottom nozzle and an advanced tubular grid. The designs fully take advantage of additive manufacturing. It also affects the freedom component designers have in applying the advantages of the process to think out of the box. This technology has allowed them to better address flow, pressure and other issues to fuel performance with improved designs; issues in the end, that they have not been able to address using traditional manufacturing methods.

Image: Protolabs – Part produced with Inconel 718

POST-PROCESSING

From eBikes to automated post-processing of SLS 3D Printed Parts: the story of PULVERMEISTER

Solutions to industry challenges usually come from unexpected experiences. To eliminate the speed restriction of 25 km/h for electric bikes, Luigi Monaco came up with an ingenious idea: contactless chip tuning.

Developed by Monaco's company, Badass eBikes, this solution consists in *„a hack where a coil induces a magnetic field with which the sensor of the eBike motor is brought to believe that the actual speed is different - lower - than the real speed, [hence the elmination of] speed restriction"*.

At the beginning, to manufacture this chip tuning device, Monaco used injection moulding but he rapidly turned to additive manufacturing as it enabled a total control over each production. Furthermore, mass producing these devices using injection moulding became difficult to handle as eBikes manufacturers started changing their sensors, to limit the sale of these chip tuning devices.

At the manufacturing level, choosing among the variety of AM technologies was not an easy task as each technology offers ist advantages and disadvantages for the fabrication of chip tuning devices.

Luigi Monaco

„We compared all the different additive manufacturing methods and we immediately saw that everything requiring a support structure of any kind would not be feasible for our little casings, mainly because of surface finish and the added labour. SLA could have been interesting but a mechanical device fixed on an eBike that would have been exposed to sunlight – not to mention the rough environmental conditions – made it difficult to find available materials that could fit our requirements. So we went to powder based systems and then decided to produce in PA11 (mechanical, chemical properties) and black to save us even another production step (colouring)", Monaco told us.

Once they began production with their powder-bed based machine, Monaco came to realize how much they struggled to achieve the post-processing steps that enabled them to have the desired finished 3D printed components. Those post-processing stages included **depowdering, sand blasting and powder mixing**, to name a few of them.

„It had been 8 hard months of 3 time a week 4,5 hours of depowdering, sand blasting, powder mixing etc.", he recalled. But he was also a reflection time as he was determined to find a solution that would have facilitated these important, time-consuming yet underestimated steps. These are times that led to the creation of **PULVERMEISTER**.

The people behind PULVERMEIRSTER

Truly self-taught, he mostly learned by himsled what he knows about IT and mechanical engineering. He is backed in the management and development of PULVERMEISTER, by his cofounder & friend Harald Schreck. Schreck is also the founder of a company, Schreck GmbH & Co. KG, that produces machines for the automotive industry.

„The speciality of Schreck is high precision, where the standard deviation in producing parts is 5/1000mm. Him and I we grew up together and when Badass had to place a laser sintering machine with compressor and blasting machinery I asked if he would have some space available. He had, we installed the machines there and he saw the problem. When I asked him if we can finally end this powder pooling malaise he gladly agreed. PULVERMEISTER was born", Monaco enthused.

PULVERMEISTER: specifications and functioning

At Formnext 2018, they officially unveiled the first prototype of the 3D print post-processing device that they have been improving during the past two years.

A YouTube Video of the first prototype shows the rapid process of the depowdering machine. In approximately 10 minutes, the upper chamber slowly rotates in different directions and shakes any powder. Removed powder flows back to a recovery bin, but is not exposed during the process.

„We depowder in an air tight under pressure compartment with tumbling and an air jet. The under pressure guarantees that the powder is transported in the storage container. Handover to the second compartment is done by bringing the doors of the containers to each other, opening them and then the parts fall from the upper compartment to the lower one. In there blasting is done. Basically the same device as the upper one, to save cost and to have a modular and reliable - tested - system. Handover is contamination free, the used powder can be taken out of the storage container for refreshing and usage" Monaco explained, speaking of the post-printing process.

Today, the latest machine of the Germany-based startup is an automated depowdering and blasting solution, designed for every industrial production of bulk plastic parts – in a nutshell, every bulk part that survives a 1 meter drop - . Monaco can pride himself on having Badass eBikes, a company that has become a real proof-of-concept of what is possible to achieve with Additive Manufacturing and PULVERMEISTER's depowdering system.

PULVERMEISTER at Formnext 2018

„The growth of Badass eBikes as an international market leader in this brief time would never ever have been possible without AM“, he told us.

Recently there have been some developments in the post-printing space, as the number of companies using industrial AM – and powder-based solutions especially – continues to rise due to price drops and demand. This has created a greater need to automate the traditional manual post-processing steps, and PULVERMEISTER is part of those companies that are willing to bridge this gap.

At the time we are writing (September 2020), PULVERMEISTER has certainly already started the commercialization of its solution. The company did not share any information about pricing, but they are currently looking for sales professionals who can work on a provision basis.

GUEST Column

The "new normal" of flexible and decentralized production

By Filipe Coutinho

Image via Gartner

Today we are living uncertain times, adapting to what we now refer to as the "new normal", co-existing with the difficulties imposed by COVID-19.

We are challenged both personally and professionally, adapting the way we interact with each other. This is also true for organizations and the way we do business. Given the difficulties that we've been facing with the generalized slowdown brought by the pandemic, we must be efficient and aware of opportunities. Some of these will surely come up with Additive Manufacturing and I'd like to focus on a specific one, which can greatly support us when addressing the currently strained supply chain: Decentralized Production.

Today we see AM as an increasingly common tool for the production industry, not only as a high-end technology for specific applications. This is especially valid if we look at the consumer goods industry, where large series are now far from impossible. Who doesn't remember the Adidas Futurecraft sneakers? Or maybe we can think of BMW's use of 3D printing for vehicle customization (Mini ID) or Invisalign as an example of mass production of customized 3D Printed orthodontics. The examples of serial production are fortunately transversal to all industries.

As AM serves the production industry, it enables not only new products but also revolutionary business models, based on **flexibility** it creates. **This also applies to supply chain**. More and more, we are required to fulfill the request for on-demand delivery: we want convenience, speed and freedom of choice, while maintaining a low cost. These demanding market requirements of today can be answered with the support of Additive technologies.

AM provides the flexibility of Digital Manufacturing, by easily enabling the move from 3D design to reality; it also enables the flexibility of Digital Supply chain, which uses the same manufacturing concept directing it towards optimizing the supply chain.

Today, we need to further reduce the distance between supply and demand, in order to be competitive and answer the requests from the customer, i.e. we need to reduce the required time for moving goods. Digital media and streaming services are a great example of the success of substituting physical goods (for example, CDs and other physical media) by data which we can access almost instantly. Ultimately this is the most extreme example of shortening this distance and the time it takes to access new content.

However, for most goods, we are unable to consume them in a digital format. This is where Digital Supply comes in, which is based on the concept of Decentralized Production. Instead of moving goods from A to B, we can transfer them in a digital format and produce them closer to the end-user, shortening the required time for distribution and, in turn, delivering them faster. Of course, 3D Printing is the perfect candidate for quickly producing these remote series of goods, as it doesn't require complicated industrial setups. We could eventually produce goods overnight and ship them across a shorter distance the next day.

Digital Supply can be summarized as the delivery of digital information pertaining to physical goods to a decentralized production facility. Instead of physically moving goods, we are transferring the required data to produce them close to their destination.

It is easy to understand that digitally supplying goods is an instant process. Moreover, it doesn't occupy any space, which ultimately enables us to reduce both waste from transportation and the need to stock physical items. However, this concept is only as good as the network of production centers that we can put together, which defines a combined production capability. Fortunately, great advances have taken place during the past few years with online platforms from companies such as 3D Hubs, which today provide instant quoting of a digital item and its complete fulfilment via a decentralized production network. Not less relevant is the fact that combining capacity will contribute for reducing shortages in supply and level the overall stress on the supply chain, optimizing it towards delivering the most demanded products on-time.

We've also seen interest from large players in the market, replicating this concept. I'd like to highlight that some of these players include large third-party logistics operators, such as **DHL, UPS** or **DB Schenker**, who started to adapt their business models and creating platform solutions for decentralized production.

Once again, this is done via Decentralized Production, which can strategically take place closer to distribution hubs for easier transportation of items towards their destination. As an example,

the so-called end-of-runway services would enable the production of time-critical goods right next to the runway, shipping them via air mail in the shortest possible time. We've seen these concepts being implemented by UPS in collaboration with Fast Radius (Louisville, Kentucky) or promoted by airport infrastructures like the Neighborhood 91 concept in Pittsburgh. Proximity to these critical hubs is a major factor to enable overnight supply of critical components, such as spare parts, which often are required on-demand and in smaller, variable series.

As these new concepts become the "new normal", **it is likely that we start purchasing digital licenses to physical items, ordering them to be printed closed to us,** maybe personalized to our taste, if possible. The on-demand nature of this production is made possible with AM, which is not tied down to the need of setting up a complex value chain to serve our needs. On the other hand, we may witness a shift in demand patterns towards smaller series and the reduction of stock requirements as we gradually increase the movement of "digital goods" as opposed to only physical items.

More recently, the high potential of AM for decentralized production was put to the test during the COVID pandemic. We've started seeing different initiatives all over the world for the creation of platforms to produce protective equipment for healthcare professionals, where everyone with a 3D printer could participate. Small collaborative networks of makers provided extensive support to the global COVID response. I've personally participated in one of these networks with a small domestic 3D printer and it was very rewarding to see it being put to good use by contributing to this fight. Components were produced close to the local hospitals and clinics, being quickly delivered according to their needs.

On a more industrial note, we can also highlight more extensive efforts, such as the COVID Response Network created by 3YOURMIND, enabling connected AM production capacity in Europe, US and Latin America. Common to all these initiatives was the quick setup and evident flexibility that 3D Printing brought forward for an agile worldwide response, not possible otherwise.

The market is changing, and this brings opportunities together with challenges. In fact, if we think about it, customers didn't become less demanding with the pandemic. With most of us having to stay at home and increasingly ordering items online, the stress on the supply chain increased, while our distance was larger than ever.

From now on, we need to shorten the distance between supply and demand, which increased with the generalized confinement created by the COVID-19 pandemic. This will be necessarily part of the "new normal" of production.

Although we can foresee technologically exciting times, some challenges await us. We're still cracking the value behind decentralized production, as **certification of produced parts is still a big concern.** Although we've seen several valid business cases, the real large-scale success is yet to be found.

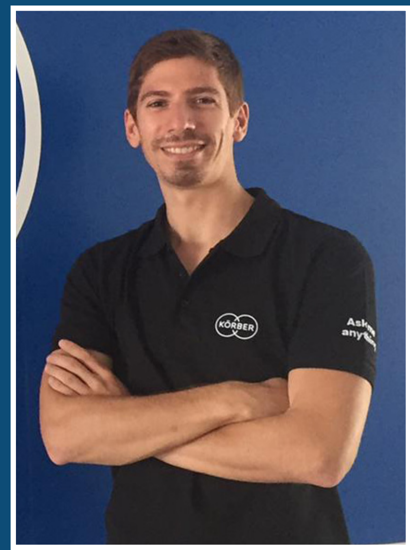
On the other hand, as we start discussing Digital Supply, we need to ensure that effective IP protection and legislation are in place, as it becomes easier to replicate proprietary designs and know-how. Here, several companies, such as Identify3D or LEO Lane are fully focused in creating the means to ensure safe and fair digital distribution of goods.

I truly believe that the next big business idea will come up soon and there is a real chance that 3D Printing will play a major part in it. It will surely be part of a "new normal" leading to more flexible and efficient supply chains, which in turn will enable new opportunities to come up in the most difficult of times. After all, our resilience is being tested now more than ever and the surprisingly positive answer from our society in general should be reason enough to stay optimistic. Let's make the most of AM to shorten the distance and print together for a brighter future!

Filipe Coutinho currently works at Körber Supply Chain, previously taking the role of Additive Manufacturing Technology Coordinator.

He has a master's degree in Mechanical Engineering and an additional 3 years of acquired experience in the technical development and research of Industrial Metal Additive Manufacturing machinery for the Portuguese OEM ADIRA S.A.

Later, as AM Technology Coordinator for Körber Supply Chain, Filipe supported and ramped-up the implementation of Additive Manufacturing at different group companies, while coordinating the AM expert group for Körber. Currently, he maintains a close connection with the topic and the industry, providing support to the group companies and promoting new AM applications internally.



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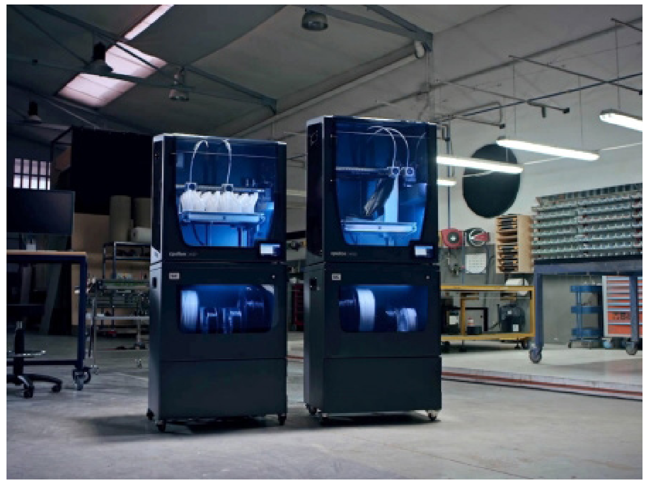
NEWS ROUND UP

The past two months have been marked by so many interesting applications, product launches and fundings. We have summarized on these pages some of the announcements that raised the most our online visitors' attention. You just need to click on each title to access the article on the online media!



BCN3D takes a major step forward with Epsilon and Sigma 3D Printer Series

After securing €2.8 million in its last funding round, BCN3D is now making a real splash with the launch of its next-Generation 3D Printers: Epsilon W27, Smart Cabinet, and Sigma D25.

WASP launches a large-format 3D printer and a PEEK 3D printing service

WASP's new 3D printer has a build chamber that can reach temperatures up to 300°c. It is launched alongside a PEEK 3D printing service to support its commercialisation.

Wayland Additive reveals launch date for new metal AM process

NeuBeam overcomes the inherent instabilities of traditional eBeam processes and the internal residual stresses typically associated with laser powder bed fusion (PBF) processes to offer a truly stable and flexible process: Calibur 3, set to be launched on January 27th, 2021.

Luxexcel says its technology is mature enough to 3D print smart prescription lenses in volume

Luxexcel's technology can meet airgap requirements by embedding a wide range of smart devices into the lens. The company's volume manufacturing solution is ready to be used by other high-tech companies.

Dutch company Vertico opens its 3D concrete printing facility

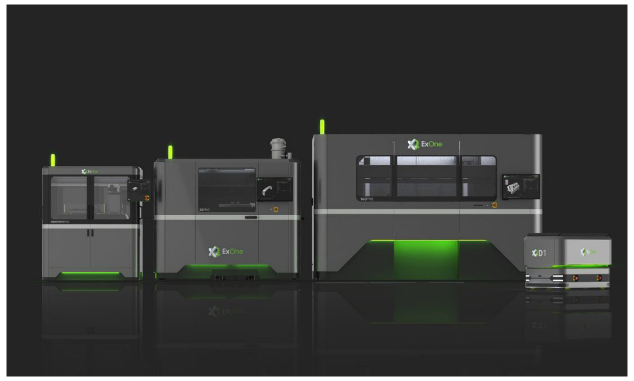
"We decided to set up shop in Eindhoven as it is the tech capital of the Netherlands and, with two other local printing facilities, perhaps the concrete printing capital of the world."

Guinness World Records: 3D printing is part of the recipe of the world's lightest e-bike

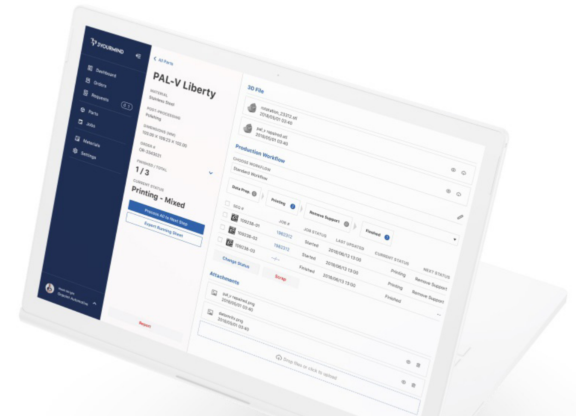
Dennis Freiburg, a mechanical engineer based in Germany, now has his name in the Guinness Book of World Records for achieving the world's lightest electric bicycle prototype. Here is the recipe for this record.

ExOne is raising the bar with new advanced metal binder jetting system

"Affordable does not mean less efficient". The InnoventPro is described as the most advanced entry-level binder jetting system for printing metals, ceramics and composites.



3YOURMIND secures $5.5M USD to further develop smarter manufacturing infrastructures



Renewable energies will be part of this next step.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