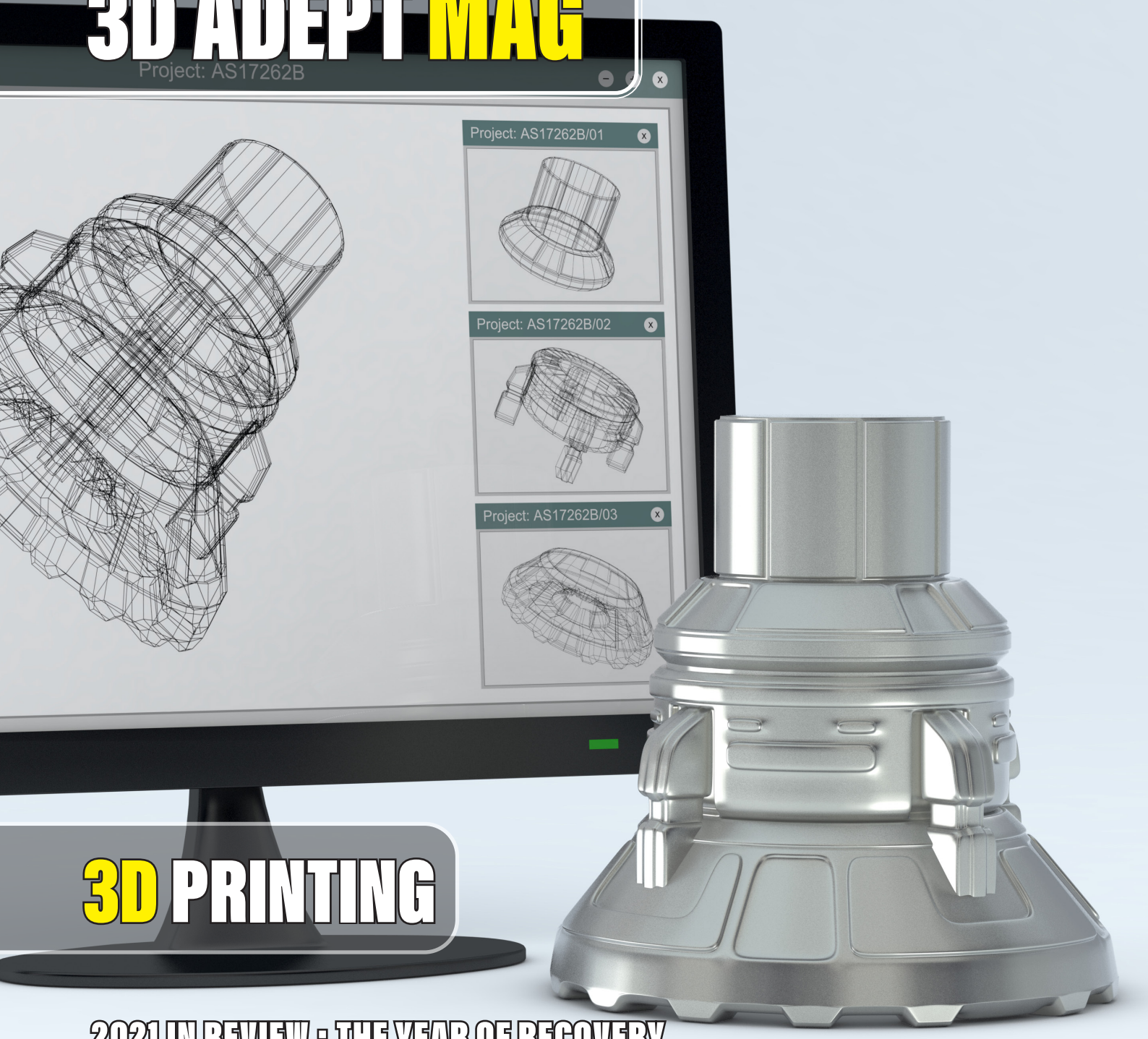
MANUFACTURING

additive

3D ADEPT MAG



3D PRINTING

2021 IN REVIEW : THE YEAR OF RECOVERY

BUSINESS - MANUFACTURING - VERTICAL INDUSTRIES

N°6 - Vol 4 / November - December 2021

Edited by 3D ADEPT MEDIA - ISSN : 2736-6634

Edited by 3D ADEPT Media

Graphic Designer
Charles Ernest K.

Editorial team
Luca van der Heide, Kety S., Yosra K., Martial Y.

Proofreaders
Jeanne Geraldine N.N.

Advertising
Laura Depret
Laura.d@3dadept.com

Periodicity & Accessibility:
3D ADEPT Mag is published on a bimonthly basis as either a free digital publication or a print subscription.

Questions and feedback:
3D ADEPT SPRL (3DA)
VAT: BE0681.599.796
Belgium –Rue Borrens 51 – 1050 Brussels
Phone: +32 (0)4 86 74 58 87
Email: contact@3dadept.com
Online: www.3dadept.com

3D ADEPT MEDIA
All about Additive Manufacturing

Table of Contents

Editorial 04

2021 in Review: The Year of Recovery 07

BUSINESS – MANUFACTURING – VERTICAL INDUSTRIES.

Materials 11

WHAT ARE THE MICRO-TRENDS IN MAJOR MATERIALS ?

Guest Column | Software 13

THE INCREASING RELEVANCE OF SMART DATA IN 3D PRINTING

Post-processing 19

- DOWNFALLS AND OPPORTUNITIES IN POST-PRINTING

- SOLUKON CONTINUES TO ENHANCE DEPOWDERING PHASE OF METAL 3D PRINTED PARTS WITH NEW AUTOMATED DEPOWDERING SYSTEM

START-UP AREA 25

12 3D PRINTING START-UPS THAT HAVE BEEN FOUNDED IN THE MIDST OF THE PANDEMIC

Interview of the Month 33

HOW RECYCLABLE AND 3D PRINTABLE ARE METALS ? **F3NICE TOLD US.**

Focus 35

3D PRINTING IN THE SERVICE OF UNDERPRIVILEGED COMMUNITIES

Event 37

PEOPLE, PRODUCTION & COSTS: HIGHLIGHTS OF FORMNEXT 2021 & MORE

Hello & Welcome

What a year !

So, Formnext took place. Finally. And it somehow helped the whole industry to wrap up this extraordinary year on a positive note. Yes, I said “extraordinary”. The year 2020 was extraordinary because of the Covid-19 pandemic and all the changes it brought to our life. And 2021 has also been one of its kind; it has been a year of adaptation. Had Formnext been scheduled for a week later, I am not sure it would have taken place given the growing number of Covid-19 cases that dominated the mainstream news in Germany a few days prior to its grand opening. The wrap up would have been different and I don’t think 2021 would have had the same positive endnote.

And here we are, trying to navigate the key highlights of 2021, the sad and happy peaks, the lessons learned and the areas of improvements we will focus on in 2022 – both for personal and professional matters.

In the AM industry, a lot (has) happened and a lot still needs to be done. While many of us agree with the fact that 2021 is the year of recovery across all industries, Formnext reminded us of something more important: we need to be humble to do business in this industry and we need to be well surrounded.

So cheers to those people with whom you invest the extra mile to advance AM to the next level, cheers to those who remain in the shadow – our invisible strength –, cheers to you, simply.

Season’s greetings from the 3D ADEPT Media Team.
Stay healthy.

Kety SINDZE
Managing Editor at 3D ADEPT Media
ketys@3dadept.com

Editorial

Edited by 3D ADEPT MEDIA

2021 IN REVIEW: THE YEAR OF RECOVERY

Business – Manufacturing – Vertical Industries

From a personal standpoint, reviewing an ending year always makes people go through the lens of experiences – sad or happy - peaks, and trials in their life. That is the reason why, we never or rarely have a unanimous answer. From a professional standpoint and in science (technology) especially, there is often a set of trends that the majority of professionals agree on.

Like most industries, the Additive Manufacturing industry has been no exception to the changes and disruptions caused by the pandemic. While the trends we predicted at the end of 2020 were mostly spot on, there are other trends that stood out from the crowd, making us envision other growth routes for 3D printing/Additive Manufacturing.

In this column, we have categorized the main trends that marked 2021 into three: **Business, Manufacturing** and **Vertical Industries**.

Business: Career Moves, Mergers & Acquisitions, IPOs vs SPACs

First thing we should note is that 2021 saw a **lot of career moves** within Additive Manufacturing companies that were trying to find the right balance on the heels of the pandemic. As explained in the Interview of the Month (préciser la page), the pandemic urged AM companies to create a new environment and modus operandi for their employees, an environment that requires to take into account DEI objectives and remote work. For other companies, it was about establishing a new management team that would help them get through this pandemic without too much damage.

That being said, ***"mergers & acquisitions"*** (M&A) that were the last trend in our review of 2020 happened to be the first trend that we noticed early at the beginning of 2021. ***With 53 acquisitions (including SPACs) recorded throughout the year – the biggest number ever reported since AM has been recognized as a true industry –, it's fair to say 2021 was a year of consolidation.*** Yet, acquisitions and mergers are nothing new in the additive manufacturing arena. Remember, mergers really propelled the industry's initial boom in the first place.

The thing is, ten years ago, mergers were driven by the potential consumer 3D printing inspired to companies like Stratasys and 3D Systems (these were the leading companies that acquired others to secure a leading place in the industry at the time). This year on the other hand, consolidations have been marked by companies that were initially looking for more financial resources to thrive. These mergers also stressed out the potential of AM to advance industrial production needs. From 3D printer manufacturers to material producers and AM applications companies, some acquisitions were expected, others were quite surprising. Stratasys, 3D Systems, and Desktop Metal are the organizations that led the M&A game this year – with the highest number of acquisitions reported. Interestingly, unlike other companies that have only acquired other SMEs, 3D Systems gave with one hand and took away with the other. Beside this, one of the most surprising acquisitions we witnessed is the acquisition of ExOne by Desktop Metal– yet it's one that could constitute a real powerhouse marriage for binder jetting.

On another note, the business perspective also reveals that a great number of companies went public this year through SPACs or IPOs. Interestingly, going public via a SPAC has been more appealing for AM companies than going public via the conventional IPO process. **9 companies went public via a SPAC process against 7 for the traditional IPO process** (Statistics of September 2021). We attempted to understand the world of stock markets that AM companies are entering and this preference for SPAC processes. We found out that the attraction goes both ways: tech companies are currently the preferred target for most SPACs and high growth AM technology companies are also looking for a way to go public. Not to mention that, AM being from the very beginning a disruptive technology, founders and executives who are at the heart of such companies are likely to be attracted by unusual yet disruptive mechanisms like SPAC mergers, to go public.

We have dedicated an exclusive feature to this process, its advantages, disadvantages and the call to remain cautious.

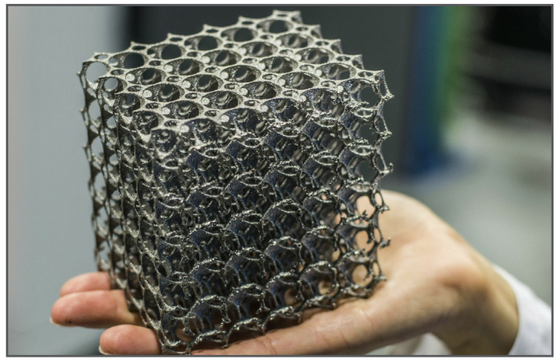
Manufacturing

Metal 3D printing has always been the category that has driven the growth of the additive manufacturing market. It's hard to confirm it in this review when we know that this year was really tough on metal 3D printing companies. The truth is, aerospace is one of the key vertical industries that leverage metal AM technologies the most and this is the vertical industry that has been severely impacted by the Covid-19 pandemic. As a matter of fact, since December 2020, there has been a wide open debate about how this long-standing revenue-generating industry will completely get back on track when looking at aircraft manufacturing, the supply chain and aftermarket support businesses.

It eventually managed to find a way out of this mess, but it was not enough to remain at the top of manufacturing processes that have been leveraged in AM applications, at the top of manufacturing processes that have been sold this year.

However, we should recognize the **steadiness of polymer AM** and the ability of players in this field to make strides where we do not expect.

Apart from leading companies like 3D Systems,



Sintratec and Sinterit are often the first names that come to professionals' mind when it comes to exploring SLS technology. We should recognize other players' efforts here to secure a booster seat around the international table. Here, our thoughts go to the Sweden-based company Wematter that secured a financial round, enhanced its SLS 3D printing package at the software and manufacturing levels, and continuously expands to new markets.

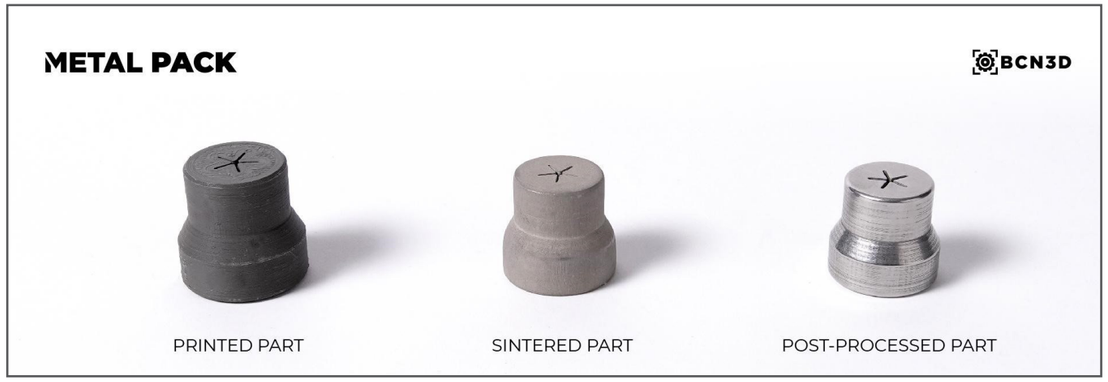
Nexa3D has not been left behind. While the hype has been made on the company's first desktop 3D printer based on its proprietary lubricant sublayer photo-curing (LSPc) technology, it should be noted that the 3D printer manufacturer has developed a QLS 350 selective laser sintering (SLS) system that can achieve a speed of eight liters per hour at 20 percent job density.

As we mentioned Nexa3D's LSPc technology, we can't dwell on this topic without highlighting the need to watch players that ambition to **make photopolymer AM an ideal candidate production for end-use applications**. With Carbon, we saw some really cool examples in the sports industry, but I would say Azul3D, Axtra 3D, dp polar and Cubicure are other companies to watch in the field.

Surprisingly, the manufacturing area also saw the **rise of Wire-Arc Additive Manufacturing (WAAM)**. Let's remember that the first patent for this technology was granted in the 1920s, which means it is one of the oldest AM processes that exist. Yet, the technology is the least known among recognized AM processes. We conducted a thorough investigation on the reason for this slow adoption, and it turns out that the key to success may lie in the gap that still needs to be fulfilled in the supply-chain. However, apart from these areas for improvement, this year WAAM has demonstrated its ability to deliver efficiency in industries that are likely to propel the growth of AM. With interesting and real case applications shared in the heavy industries, oil, gas & maritime sectors as well as energy, WAAM can hold its own in the aforementioned segments and deliver a real business value proposition to any manufacturer that wants to make it its core business.

On another note, just as it is impossible to talk about manufacturing without talking about metal 3D printing, it is quite impossible to talk about manufacturing without a word for FDM 3D printing.

The most widely-used AM process across industries has been marked by the increasing interest of FDM 3D printer manufacturers in **metal FDM 3D printing**. That's a trend that will continue to gain momentum throughout 2022. Forward AM, the AM brand of BASF, may have created a real hype around metal FFF printing when it released its first metal filament two years ago, and another one last year, but let us not forget that it's been over 6 years that companies like Virtual Foundry have been exploring and developing solutions to make metal 3D printing accessible through metal FFF.



Other companies debuted in metal FFF printing this year: 3D printer manufacturer BCN3D that announced a "Metal Pack" that can be attached to their Epsilon line of printers to enable extrusion of BASF's Ultrafuse metal filament and 3DGence that launched their ELEMENT line of BME printers, alongside their own metal filaments.

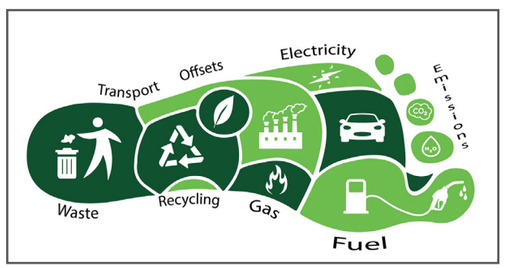
Speaking of materials, apart from metal filaments that will expand in 2022, the materials segment is a category that will always evolve as the growth is driven by customers who want to achieve specific applications. An exclusive feature has been dedicated to the micro-trends in this segment (page11).

As for software, the market is currently advocating open software platforms that will help manage the entire range of AM operations engineers have to conduct for parts manufacturing. While Stratasys latest developments with its GrabCAD® AM platform is not a surprise, there is a bunch of startups that provide solutions that are worth following in the field: Oqton, Authentise, or Additive Flow are a few names we will keep in mind here.

Vertical Industries

As we close the manufacturing segment to focus on verticals that stood out in 2021, it is hard not to highlight the **growing importance of sustainability** in all aspects of manufacturing. The truth is, sustainability on its own constitutes an entire "category" or "segment" of this industry since it can be tackled on multiple fronts.

We have dedicated an entire edition of 3D ADEPT Mag to this segment. The topic was already a key trend in 2020 as companies are increasingly aware of the need to rethink their business model or manufacturing journeys to meet climate goals. The subject was on the agenda this year and will continue to impact on business actions next year. In the meantime, let's recognize **Sherry Handel's** efforts to encourage companies to take action in this journey as part of AMGTA. The Additive Manufacturer Green Trade Association has welcomed 22 organizations this year, has granted a $100,000 gift to Yale to fund AM life-cycle assessment research and has announced its first Life-Cycle Assessment Research Project for Additive Manufacturing.



It has not only been a busy year for AMGTA. Other companies have achieved applications that take into account sustainability and circular economy needs, but the hardest part so far is being able to quantify them. We believe this is the road we will be heading down most next year: **discovering data that reveal how sustainable technologies and applications are.**

As far as vertical industries are concerned, for some reason, we were sure that automotive, medical & healthcare would have been the verticals that we will talk about the most in this review. It turns out that despite the advancements in these verticals – especially in terms of battery cells and electric vehicles in the automotive area –, the verticals that made the greatest strides this year are **food 3D printing** and **construction 3D printing**.

With the many projects that are being held across the world right now, be it in the USA, Germany or UAE, the global 3D printing construction market could be on the right path to grow from USD 3 million in 2019 to USD 1,575 million by 2024, at a CAGR of 245.9 % between 2019 and 2024.

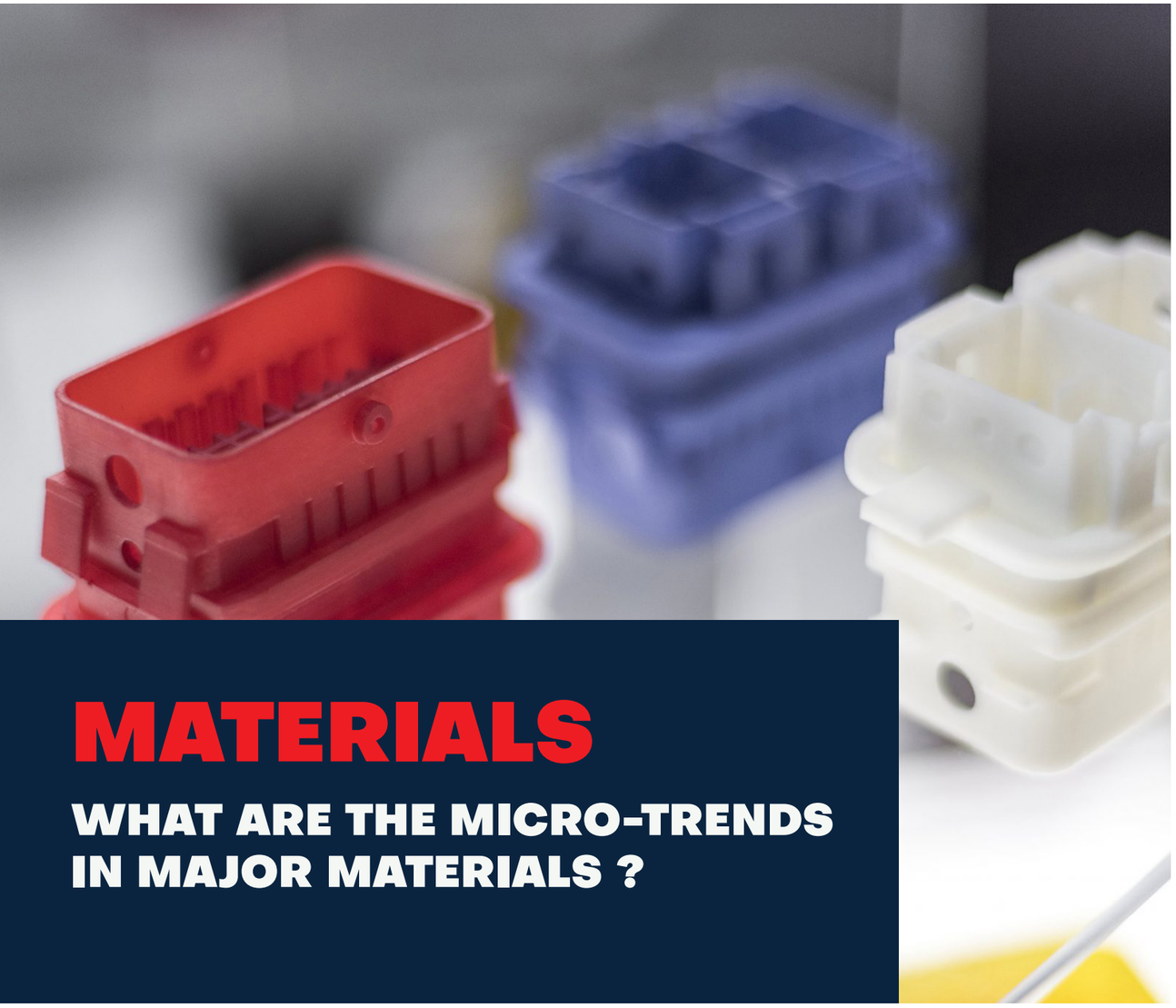
Several companies have decided to specialize in the field, both companies that are coming from the conventional building industry and technology companies that have been providing construction 3D printing services since day one. No matter what background they have, these companies have decided to address a challenge common to all regions (Africa, USA, Europe, Asia): the **housing shortage**.

As for **food 3D printing**, the segment is undertaking a real change as there is a growing use of 3D printing for applications that go beyond the aesthetic purpose. In 2021, this vertical saw the development of alternative meat 3D printed products – some of them already available in select restaurants –, vitamins, and 3D printed fish. Sales of plant-based meat for example, grew 45 per cent over 2020 and this niche is now worth $7 billion. Names that we will remember here include Redefine Meat, MeaTech, byFlow, and SavorEat to name a few.

And now...?

It can be overwhelming to reflect on a year that is ending, trying to bring out the key highlights and to determine what will shape the coming year. There may have been some developments or sectors of activity that were not mentioned, and this is not necessarily because they have not evolved...In the end, the degree to which these trends have affected the industry varies from one geographical region to another or from one vertical to another...

Until now, for the entire 3D ADEPT Media Team, heading to Formnext 2021 in Frankfurt - after almost two years of virtual events, and what seemed to be endless lockdowns – to connect and reconnect with new and old faces of this industry will remain the highlight of year 2021 for us.



MATERIALS

WHAT ARE THE MICRO-TRENDS IN MAJOR MATERIALS ?

30 years on from the invention of the first 3D printer, the 3D printing market has proven to be disruptive for so many industries. Within what she describes as a year of recovery, IDTechEx Technology Analyst ***Sona Dadhania*** *shares a few thoughts on the development and/or continuation of* ***micro-trends within each major 3D printing subspecialty****: polymer, ceramic, composite, and metal additive manufacturing. She identifies and explains the micro-trends that are worth keeping an eye on going into 2022.*

Plastics : Sustainable 3D Printing Polymers Come To Market

3D printing has always claimed to be sustainable due to its reduced wastage in manufacturing compared to other forms of manufacturing like machining. However, the most popular materials have always been carbon-based polymers, which are inherently not sustainable since they are derived from non-renewable resources. With more awareness of this reality, more 3D printing materials suppliers and companies are releasing polymers for 3D printing with green characteristics, like recyclability and reusability; this trend came into full force in 2021 as a different approach to sustainability in 3D Printing.

For example, chemical company **Braskem** teamed up with materials recycling company **Vartega** to create a polypropylene filament that includes 100% recycled carbon fiber. This filament release is part of a novel carbon fiber filament recycling program that Braskem and Vartega are launching, which will encourage users of these filaments to appropriately recycle them. Another company releasing a «green» filament is **Fillamentum**, who recently launched NonOilen, a 100% biodegradable polymer filament. NonOilen, which is composed of polylactic acid (PLA) and polyhydroxybutyrate (PHB), is also made from bio-based polymers (meaning polymers derived from renewable resources).

However, filament manufacturers are not the only type of 3D printing feedstock that is getting the sustainable treatment. In 2021, **Materialise** launched Bluesint PA 12, a 3D printing powder made from 100% re-used powder. The goal of Bluesint PA 12 is to decrease the wastage of powder in selective laser sintering, which turns up to 50% of the powder in the bed into waste. With companies reiterating their commitment to sustainability, IDTechEx will be closely watching whether more biodegradable or recyclable 3D printing polymers come to market in 2022.

Ceramics: New Materials Releases Foreshadow An Expanding Market ?

The overarching trend for ceramic 3D printing in 2021 was the launch of a variety of new materials through different technologies. **These materials from 3 main places**, the first of which is ***3D printing companies entering into ceramic 3D printing*** for the first time. For example, Boston Micro Fabrication, who focuses on micro 3D printing with their projection micro-stereolithography technology, released a high-temperature alumina resin for micro-ceramic components.

The other source of new ceramic materials for 3D printing came from ***chemical or material companies***; notably, these companies were minimally involved in 3D printing before the release of these materials. For example, American company Emery Oleochemical's Green Polymer Additives division released a polymer binder system that can be used for metal or ceramic filament extrusion printing. In addition, GC Advanced Materials Solutions, who are based out of Hong Kong, have qualified silica and mullite powders that can be used with a polymer binder (like the one Emery developed) to create ceramic filaments for extrusion printing.

The last source of new materials came through ***strategic partnerships***. The first was between AGC Chemicals and binder jetting printer manufacturer voxeljet. AGC had previously produced a silica additive for 3D printing, but this was their first technical ceramic developed for 3D printing. The two companies worked together to create Brightorb, a high-performance ceramic powder specifically for investment casting molds and shells.

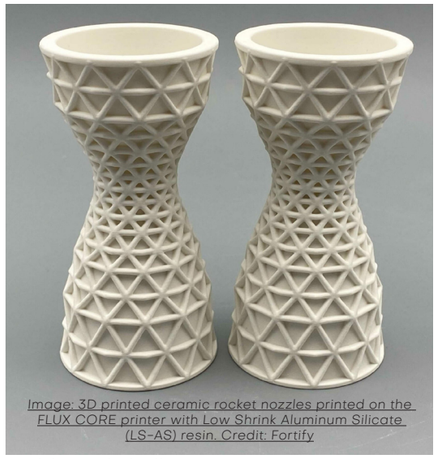


Image: 3D printed ceramic rocket nozzles printed on the FLUX CORE printer with Low Shrink Aluminum Silicate (LS-AS) resin. Credit: Fortify

The second partnership was between composites start-up Fortify and Tethon 3D, a company specializing in ceramic 3D printing materials. They developed high purity alumina and aluminum silicate resins for Fortify's FLUX CORE printers, which are made to handle filled photopolymer resins. The two companies intend to develop more technical ceramic resins in the future.

What is particularly notable about these materials releases are the companies releasing them. Other than voxeljet and Tethon 3D, **none of the companies mentioned have dabbled in ceramic 3D printing before**. This could foreshadow an expansion of the ceramic 3D printing field in the near future, something IDTechEx will look out for in 2022.

Composites: Notable Partnerships Pushing Composite 3D Printing Forward

In recent years, there has been a number of partnerships formed to push forward technology development, material development, and adoption of composite 3D printing. Partnership formation continued unabated in 2021, mostly with an emphasis on materials development collaborations.

As mentioned previously, the Braskem and Vartega partnership is just one of these major composite 3D printing partnerships for materials development.

First, materials supplier Solvay has partnered with Swiss start-up **9T Labs**. 9T Labs has created a hybrid composite printing system that combines 3D printing with molding, and the Solvay partnership aims to develop Solvay's materials portfolio like CF-PEEK, CF-reinforced PA, and CF-PPS for 9T Labs printers.

The second partnership is between Japanese multinational company, Ricoh, and Impossible Objects, which is a start-up making composites through sheet lamination. Sheet lamination is a very niche AM technology that very few companies operate in. Some of those that used to have now discontinued their sheet lamination products, like EnvisionTEC, or have closed, like Solido.

Impossible Objects is hoping to revive the technology through their Composite-Based AM (CBAM) technology, which they are expanding in Europe through Ricoh Europe's AM service bureau, which will now include the technology. The Ricoh/Impossible Objects partnership was not the only one formed in 2021 for the CBAM start-up. In May 2021, Impossible Objects announced a collaboration with Owens Corning to develop fiberglass composites for 3D printing. The goal of the partnership is to scale CBAM technology for high-strength, high-volume applications.

One notable similarity is that all partnerships mentioned involve established materials or technology companies like Solvay, Ricoh, and Owens Corning partnering with upcoming start-ups. As more large companies continue to explore the potential for expansion into 3D printing, it is likely to see the formation of more of these types of partnerships, which IDTechEx will be tracking in 2022.

Image: 9T Labs

Metals: Increasing Momentum for Bound Metal Extrusion ?

Bound metal extrusion (BME) (also known as metal-polymer filament extrusion, or MPFE) has received plenty of 3D printing press in the last few years, as market leaders Desktop Metal and Markforged accelerate their expansion with SPAC mergers and acquisitions abound. BME refers to the extrusion of polymer filaments loaded with metal powders; after printing, BME parts undergo debinding (to remove the polymer binding the metal powder into a filament) and sintering (to fully densify the metal part). From a technology standpoint, 2021 saw not only continued support and development for BME systems from the key players but also newer companies entering the space with their own BME systems.

In early 2021, Desktop Metal launched the Studio System 2, an upgraded version of its original desktop-level BME printer, the Studio System. The Studio System 2 has notably eliminated the solvent debinding step normally required for BME through the development of new material formulations for the Studio System 2. This significantly reduces the post-processing time needed for parts made by BME, thus increasing the potential efficiency of the technology. Markforged also announced the release of their next-generation BME system, the Metal X Gen 2, though the major innovation with this release is software-related.

However, while the market leaders have made notable moves, what is especially interesting for the technology are the number of companies releasing BME printers in 2021, with most launching them at Formnext 2021. For example, Spanish printer manufacturer BCN3D announced a «Metal Pack» that can be attached to their Epison line of printers to enable extrusion of BASF's Ultrafuse metal filament. Additionally,

Image: BCN3D

3DGence announced their ELEMENT line of BME printers, which will not use BASF's Ultrafuse filament in favor of their own metal filaments. Belgium-based start-up FuseLab debuted their own BME printer capable of printing both metals and polymers, featuring dual extruders, an open filament system, and a heated chamber. With all these new entrants to BME in 2021, IDTechEx will be monitoring if the field picks up even more steam in 2022.

Image:Data respons

THE INCREASING RELEVANCE OF SMART DATA IN 3D PRINTING

Today, 3D printing continues to transform factory floors as companies adopt 3D printing for large-scale production across multiple sites. Historically, a lot of 3D printing production happened in isolation – separated from the conventional manufacturing process. But as the walls between these two manufacturing environments disappear, these two eco-systems now start to connect and create a more integrated production environment.

Such a unified, increasingly digital production environment enables greater efficiency, repeatability, scale and control, but it requires a common resource - a common language, and that is data. Moving forward, we believe the role of data in additive manufacturing (AM) will become increasingly important in many ways.

In our round table, we bring together some of the finest minds at Materialise to discuss the relevance and ownership of smart data in AM and its impact on the need for human expertise.

How relevant is data in AM ?

We call 3D printing "Smart Manufacturing" but the terminology originated from traditional manufacturing. AM, however, is probably more complex than its conventional counterpart because with AM, the material and the product are created simultaneously. So the role of data is probably more important in 3D printing than in traditional manufacturing.

"Smart data holds the key to transform industrial 3D printing production", says **Tim Van den Bogaert**, Sr. Market Director at Materialise Software. "As manufacturers scale up production, smart data will allow them to reduce scrap rates, predict failures even before they start printing, and meet stringent quality requirements."

Our ability to make manufacturing "smart", depends on our ability to collect data. But while access to data is crucial, it is certainly not enough. Manufacturing becomes smart when we are able to analyze the data to create 'actionable insights'. This allows us to improve the process, scale up production and, ultimately, make better products.

Or as a customer recently stated: "we believe in a world where the next part that we print is always a better version of the previous part". This will require a software platform that is capable of connecting to all of the systems and datasets found in the production environment and beyond.

"For medical AM applications, we need to distinguish between two types of data", says Materialise Innovation Manager for Medical, **Pieter Slagmolen**. *"On one hand, smarter data allows medical companies to upscale the production process of personalized and increasingly complex medical devices. On the other hand, there is also 'patient data'. Incorporating this personalized data into the planning and production process allows us to improve patient treatment, but it also introduces additional concerns about privacy and data security."*

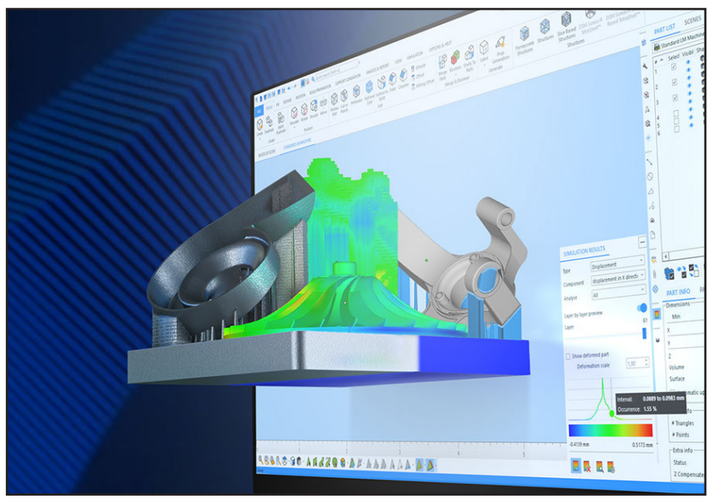
According to **Kristel Van den Bergh**, Director of Innovation for Materialise Mindware, these concerns also apply in an industrial production context. *"3D printing gives us the freedom to manufacture wherever and whenever we want. But in an increasingly distributed and cloud-based manufacturing environment, people are also concerned about the protection of proprietary data, such as prototypes or new designs."*

Who owns the data in AM ?

The question: "who owns the data?" certainly isn't new. But for **Peter Leys**, Executive Chairman, this is not the most important question. Data allows manufacturers to create better designs and processes. So, the real question is: "who owns your designs and processes?".

"Most manufacturers will not only claim ownership of designs and processes, but also express the desire to control them", Leys explains. *"They may decide to share some of these insights in order to empower other users, but manufacturers should retain ownership and control. This will enable them to create smarter production processes that allow them to leap ahead of the competition."*

"By anonymizing data, manufacturers can share data with greater confidence, allowing them to empower others and fuel industry innovation without disclosing their competitive advantage", adds **Bart Van der Schueren**, Materialise CTO.



In an industrial context, data ownership – whether it's process expertise or intellectual property – also comes with responsibility. Now, the transition from centralized production, where liability resides with one centralized manufacturer, to distributed production, which includes multiple stakeholders, opens up new conversations about responsibility and liability. And the legal framework that surrounds distributed production, is still being developed.

For medical AM applications, the process data clearly belongs to the hospitals and medical device manufacturers. As they create AM workflows, they need access to and control of the data for quality assurance. Ownership of patient data, on the other hand, remains a heavily debated topic. But delivering the most optimal care to patients, will require access to patient data, regardless of who owns it.

Will human expertise still be important in AM ?

Smart data leads to optimized workflows, which may decrease the need for human intervention. At the same time, creating better production processes still requires human expertise. So, what impact will smart data have on the need for human intervention in 3D printing?

"The role and relevance of human intervention depends on the operational context", says **Kristel Van den Bergh**. In the predictable context of standard operations, where lots of data is available, machines can play a dominant role and the human role can be reduced to supervision. However, when there is a lot of uncertainty or ambiguity, which is typically the case in the context of innovation, more human skills are required, like creativity, imagination and intuition. These are two extreme ends of the spectrum and in most cases automation and human intervention will go hand in hand.

"True, but even when an abundant amount of data is available, as is the case with AM, data alone is not sufficient to automate production flows", adds **Bart Van der Schueren**. *"Because even in such a data-rich context, the domain-specific knowledge of human experts is required to optimize the process before it makes sense to automate it. In other words, if you use a lot of data to automate and scale up a bad production process, you still end up with a bad process"*.

Peter Leys sees additional opportunities: *"Smart manufacturing, based on data, also creates an opportunity for smart people to make a difference."* He explains: *"A smart medical surgeon will use his or her experience, personal insights and interpretation to add an additional layer of intelligence to improve patient treatment. Similarly, in an AM context, adding an additional, personal layer of intelligence to the process allows a company to make a difference and create a competitive advantage."*

The third ingredient

"Breakthrough innovation depends on the ability to create a link between things that seem unrelatable", says **Van den Bergh**. *"And while computers might process connections faster than humans, the human brain is able to create associations that wouldn't naturally appear in a given dataset. That's what distinguishes us from computers"*.

"So, to answer the main question: will more smart data replace or reduce human expertise? The answer is no!"

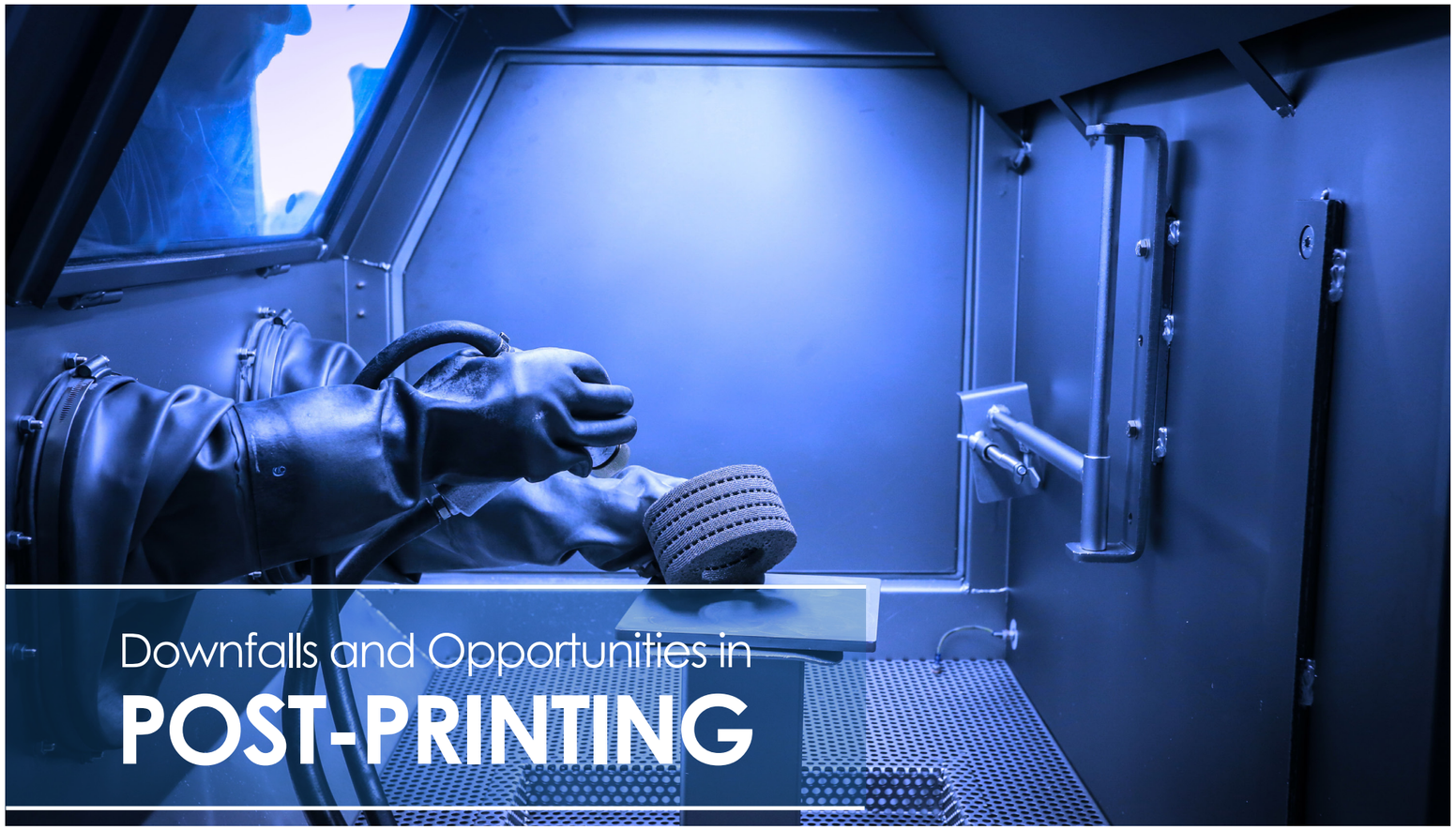
She concludes: *"Companies need to invest in human expertise as well as in machine intelligence. But they will still fail if they don't invest in the third ingredient: a process to make those two successfully work together."*

Conclusion

It's clear that smart data will play an increasingly crucial role in 3D printing. As part of that, we need to think about the ownership of data, but also ask ourselves: who controls the data? In the end, the success of 3D printing depends on having the right hardware and software, but also on our ability to capture, use and apply data to create actionable insights.

And then there's the human aspect. As data leads to smarter and more automated manufacturing, this reduces the need for operational human intervention. This frees up time for skilled engineers to do what they do best: defining and finetuning unique production processes. One of the challenges that lie ahead is to establish a workable process of how these two – machine intelligence and human expertise – can successfully work together and enhance each other at every stage of the 3D printing journey.

Edited by 3D ADEPT MEDIA



Downfalls and Opportunities in POST-PRINTING

By expediting the use of AM across industries, the Covid-19 pandemic has also expedited the need for appropriate post-processing solutions per application. As a reminder, post-processing is an umbrella term that covers a variety of stages that 3D printed parts have to undergo before being used for the final purpose.

Ever since the industry has become aware that this stage of the manufacturing process is often the most time-consuming & expensive one in producing a part, experts in the field have continuously invested extra miles to facilitate its implementation in applications.

Many prefer to leverage internal resources to continue tuning or developing (new) machines as we saw with Solukon, DyeMansion or AM Solutions – post-processing experts as well as Nexa3D, XJET or Ultimaker – 3D printer manufacturers that develop solutions directly compatible with their 3D printers. Others on the other hand focus on collaborations to help advance and develop dedicated post-processing solution per technology. Mimaki, ExOne and Carbon® are some examples that directly come to my mind to illustrate such collaborations.

No matter which route you follow, the speed at which post-printing advances greatly depends on the market needs. It depends on the most widely used AM technologies on the market, on the reasons why AM technologies are used and obviously, on budget.

Indeed, there might only be 7 recognized AM technology processes, but the market is filled with at least 20 types of AM processes. This means that if material extrusion is for instance, the most widely used process on the market, experts in the field are likely to focus the improvements of post-processing on this technology. In the same vein, industrials that leverage AM for prototyping or production purposes will definitely not use post-processing the same way.

As a matter of fact, the 2021 report from Additive Post-Printing Survey from Post-Process Technologies revealed that **Material Extrusion, Vat Photopolymerization, and Powder Bed Fusion** remain in the top three of widely used AM technologies. Surprisingly, binder-jetting users – especially the ones that use polymer materials – are the group that faces the most challenges in this process.

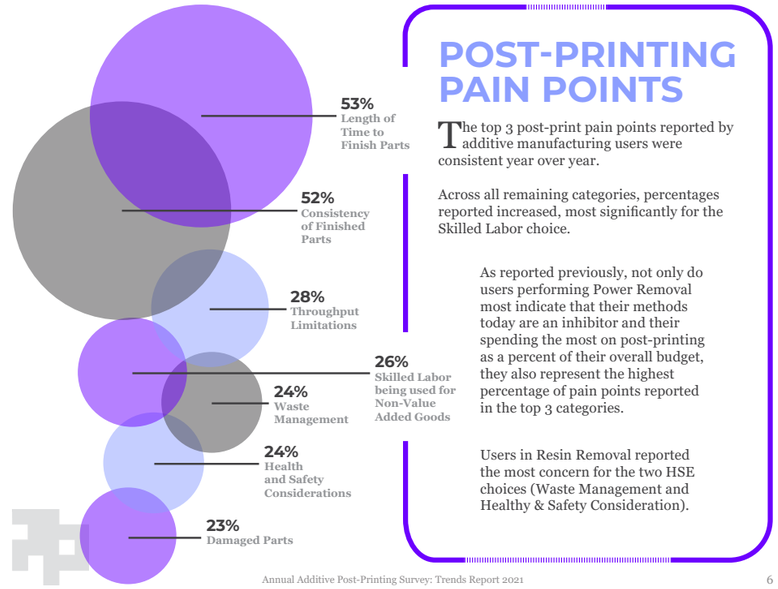
Directed Energy Deposition users on the other hand, are the minority group in the AM landscape yet they spend *"the most on post-printing as a percent of their overall AM budget vs. any other print technology. Material Extrusion users are spending the least"*.

In the same vein, as material extrusion is in the top three of the most widely used AM technologies, it makes sense to see support removal as the most widely used post-printing technique in 2021, followed respectively by surface finishing, resin removal, and powder removal.

"Users performing Powder Removal and Dyeing most indicate that their methods used today are an inhibitor to achieving their AM goals. Of the top 5 methods being used, respondents who must perform Powder Removal processes are spending the most on post-printing as a percent of their overall AM budget", the report reads.

So how can we envision expenditures or trends at the post-processing level in 2022 ?

Envisioning how industries will enhance their post-printing operations require to take into account existing challenges that still need to be addressed. The latter includes for instance the **skilled workforce, the length of time to finish parts as well as Health and Safety Considerations.**



"The top 3 areas where AM users would like to invest in to improve their post-printing operations were consistent year over year. The choices centered on investment for the purposes of reduction of or redirection of labor increased the most over last year, as echoed by the data collected on pain points reported previously. This sentiment is likely correlated to the tight labour market experienced in 2021", the report explains.

Furthermore, health and safety considerations which were already a priority last year remained at the forefront this year and these concerns are only going to increase moving forward, especially because sustainability is increasingly being tackled on multiple fronts.

Lastly, 2022 will see an increasing focus on automated and reliable solutions that can deliver industrial quality parts to cope with the length of time to finish parts. Needless to say, the more AM post-printing solutions will be automated, the less companies will need human intervention. While existing jobs will be reoriented to new jobs, one thing is certain, this will help increase the use of post-processing for end-use production.

POST-PROCESSING

Solukon continues to enhance depowdering phase of metal 3D printed parts with new automated depowdering system

The new machine completes a portfolio that already includes four systems designed for metal parts, each of them optimized for different part sizes and applications.

Any space engineer will tell you that removing the remaining powder on rocket engines, or heat exchangers is one of the most complex tasks to conduct in a manufacturing process. Fortunately, it's been a few years that machine manufacturer Solukon is investing extra miles to address this issue by developing dedicated automated machines based on its **Smart Powder Recuperation technology SPR®**.

The latest baby to join the Solukon family is named **SFM-AT350**. Designed for medium-sized components, the new machine features a more compact design and comes to replace the previous model **SFM-AT300**, that we discovered as an ideal fit for medical 3D printed parts.

As we may expect, the new family member comes with the Digital Facotry Tool in option – just like the SFM-AT800/-S and SFM-AT1000-S, the Solukon systems designed for large parts.

With increased freedom of motion and further flexibility in programmability, the Solukon SFM-AT350 enables endless rotation, while the horizontal axis can pivot up to 250 degrees. It can process metal 3D printed parts with a **maximum total weight of 60 kg** (incl. build platform) & a **maximum height of 420 mm**; and would be a great fit to process parts made with reactive materials such as aluminum or titanium.

Operators could handle the machine using an integrated software that will easily draw paths according to part geometry, waiting times, knocking procedures, or even variable moving speed.

Installing the machine can be done faster on the building plate using a clamping system not to mention that the interface for the powder outlet is now compatible with standard containers.

"The SFM-AT350 can now be inerted much faster and more cost-effectively. [It] is the new standard for the depowdering of medium-sized components. Medium-sized components can now be automatically freed from powder even faster and easier. The fact that complex rotation patterns can be programmed effortlessly is a great advantage for depowdering even the most challenging geometries," states **Andreas Hartmann**, CEO and CTO of Solukon.

Be it through new features or new machines, Solukon does not rest on its laurels, and is on the right path to maintain a leading position in the depowdering of 3D printed parts.

Image: Solukon

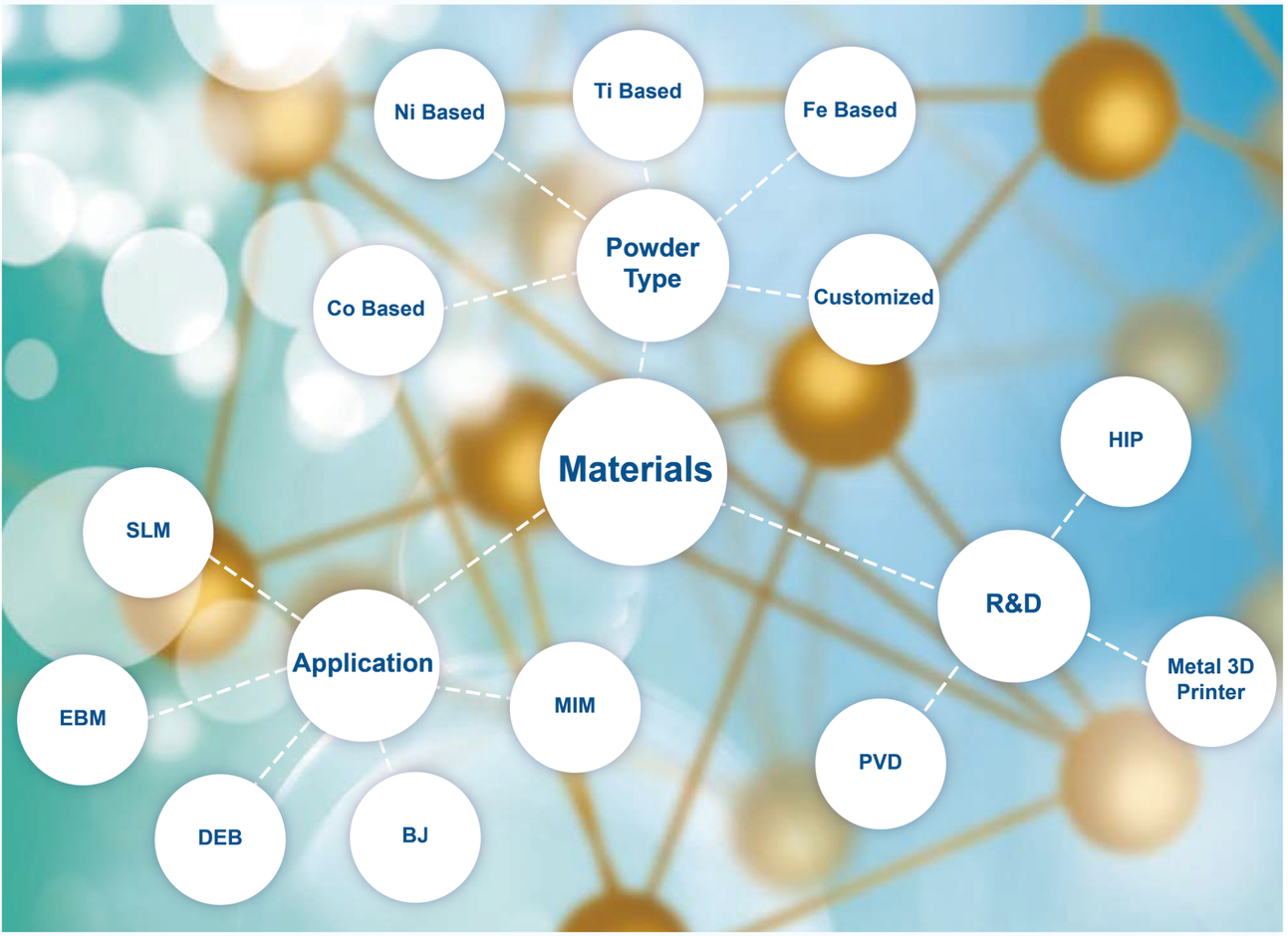
Andreas Hartmann
CEO and CTO of Solukon

悦安微特 UNIFINE

Material Technology Innovations Co., Ltd. 纳 联 材 料

MTI

Specialized in AM metal materials



HIPER | 恒普

Full Series Debinding and Sintering Furnace

for Additive Manufacturing(AM)

- Debinding and sintering for Metal **Binder Jet** and **FDM**
- Heat treatment for Laser Printing
- Graphite hot zone and Moly hot zone available
- High vacuum acceptable

FOR MORE INFORMATION, CONTACT

MTI: (MTI is a Yuean group company)
Materials Technology Innovations Co., Ltd.
info@mt-innov.com
Tel: +86 (0)20 3104 0619 www.mt-innov.com

Hiper is the leading AM furnace manufacturer in the world

- Graphite/Metal hot zone debinding and sintering furnace
- Tailormade furnace acceptable

E : xiangwei.zou@hiper.cn/W: www.hiper.cn
NO.521,Haitong Road,Cixi City,Zhejiang,China

12 3D PRINTING START-UPS THAT HAVE BEEN FOUNDED IN THE MIDST OF THE PANDEMIC

How many times have you heard that start-ups are the propeller of the Additive Manufacturing industry? Enough to know that we need to keep an eye out for those entrepreneurs who can become the next unicorn in the industry. While we understand the need for start-ups to remain in stealth mode until their technology is ready enough to be officially introduced in the industry, we can't help but give kudos to these start-ups that have been created in the midst of the Covid-19 pandemic. Cheers to these twelve startups that, as per Winston Churchill's words, did not let "a good crisis go to waste".

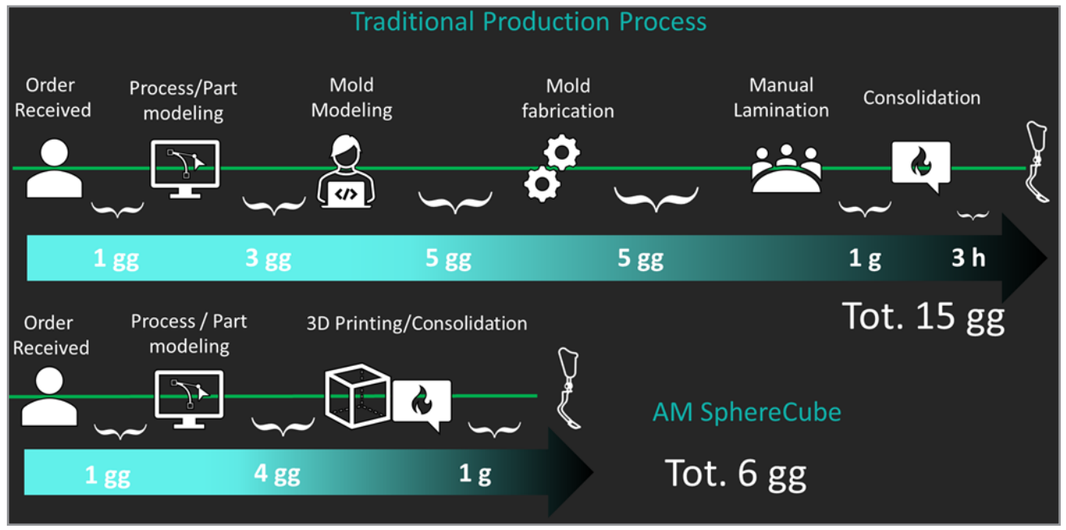
1. F3nice

Founded in May 2020, in one of the countries most affected by the pandemic, F3nice is the idea of **Luisa Elena Mondora** and **Matteo Vanazzi**. Both cofounders came up with the idea of F3nice in 2019, on the heels of an analysis in the Oil & Gas industries. With the decommissioning of offshore assets for the oldest oil fields in the North Sea, and the digital inventory for on-demand and "just in time" production of spare parts, they investigated the possibilities to use the high value scrap metal from offshore decom to power a circular economy project.

F3nice – whose pronunciation is similar to the Italian word for Phoenix, "Fenice" (the bird that obtains new life by arising from the ashes of its predecessor) – ambitions to live up to its name by sourcing metal scrap and disused parts and transforming them into metal 3D printable powder.

The company's project has gained traction over time and has raised the interest of Equinor Ventures who signed a Letter of Intent with the team. As part of this contract, the materials producer will process Equinor's scrap, and the feedstock made with it will be used to print parts for the commissioning of the **Johan Castberg field**, near Hammerfest, by Fieldmade – in a true Circular Economy Ecosystem.

The start-up told 3D ADEPT Media in an interview that its powder *"is identical to any other high-quality powder produced with VIGA technology and can be re-used during the printing process just as many times [as the alloy allows]. The added value is that, once the powder is deemed 'exhausted', the OEM can contact F3nice and ask for it to be recycled instead of having the hassle of disposing it (at high cost) as hazardous waste. F3nice can provide this service not only for its products but also for any powder."*



2. SphereCube

Remember we told you that start-ups have the opportunity to think about a business model that takes environmental concerns into account from the very beginning of their venture? Well, **SphereCube** has decided to play its part in these environmental concerns at the manufacturing level, by getting rid of composite processing scraps and molds, in order to reduce the environmental impact of composite production.

This 3D printing start-up is a spinoff of the Marche Polytechnic University (UNIVPM, Ancona – Italy) which develops 3D printers capable of fabricating composite objects using thermosetting resins and continuous fiber reinforcement.

"Through the interaction of a heat source with the raw materials involved in the process, SphereCube's system enables the production of components in composite material with continuous fiber reinforcement and thermosetting matrix. This innovative production process is able to automatically create products using high-performance composite materials, without geometrical limitations", the company told 3D ADEPT Media.

The manufacture of connected composite 3D printers that are less energy-consuming and that can process biocompatible materials is according to the company, a key step in helping industries build a 100% sustainable supply chain.

SphereCube has filed its first patent "Method and system for composite material 3D printing" (Italian patent n. n. 102021000006800) and has registered its European trademark.

2022 will see a key focus on the development of the design and fabrication of the Minimum Viable Product and customers' feedback will help to further validate the company's technological solution.

3. Replique

Replique, a Mannheim-based venture of the BASF business incubator Chemovator received some media hype when it announced a partnership with Miele, a German home appliance manufacturer. Under the terms of the partnership, the company receives the exclusive right to produce and ship high-quality 3D printed accessories from Miele using its decentralized production network.

Founded in 2020 by **János Váradi**, **Dr. Henrike Wonneberger**, and **Dr. Max Siebert**, the company provides an industrial 3D printing platform that enables OEMs to provide parts on demand to their customers through a global, decentralized and secured 3D printing network. It is entering a market that is worth more than 500 billion USD and which enables revenue potentials with significantly higher margins compared to the sale of new services.

From **qualification of 3D printable parts**, to **digital inventory** and **production network**, the company provides a solution broader than what is usually seen on the market.

For industrial production, Replique uses their global network of quality-approved industrial manufacturing service bureaus. With this solution, OEMs are reducing their total costs of ownership while increasing flexibility. Not to mention that they can provide better aftermarket services to their customers, with parts always being available, even at the end of the product lifecycle; thus gaining competitive advantages.

Amid the companies that have already benefitted from Replique's services, one counts OEMs in the automotive industry, and recently Siena Garden, an expert in the category of garden tools and garden furniture.

4. Marklix

Still in the field of spare parts, another start-up has been founded last year in France – in February 2020 precisely, with the mission of making "obsolescence obsolete". This original baseline makes any expert in the AM industry rapidly understand that Marklix enables manufacturers to qualify and distribute spare parts by producing on-demand and locally using 3D printing.

Their journey started with the development of a «marketplace», where the idea was to be able to find all the parts of all the manufacturers, for example a hoover part, and thus allow individuals to repair their hoover without having to change the entire appliance. Two challenges popped up during this project: the price of parts was too expensive – it was often cheaper to buy a new appliance than to order a part –, the parts were not digitized which means one could not 3D print them with just a simple click.

To overcome these hurdles, the Marklix team decided to develop new software solutions:

The first software solution addresses the price issue of the spare parts by enabling manufacturers to be more competitive and to save time.

"It is an ERP/MES that allows them to manage their machine park, to edit invoices and delivery notes, to take orders online while letting the manufacturer choose whether to let the customer pay directly or not, by securing the files, etc. The feedback we have received indicates an average time saving of 40 minutes/order and a better visibility and efficiency for their company. Our partners are therefore more competitive, making the prices more attractive", the company explains.

The second solution consists of the digitalization of stocks, which is of crucial importance for some companies because of the high cost of spare parts stocks. In this vein, this software solution heps engineers achieve five main tasks: identification of 3D printable parts thanks to AI, qualification of the parts with the right materials and production technology, calculation of ROI (from an economic and ecological standpoints), transfer the parts that have passed the 3 first steps on an online catalogue and printing. The last task can be done internally or externally if the company does not have the production means.

Following the positive response they receive on the launch of their first software, the Marklix team led by **Pierre-Jacques LYON** and **Thomas BOULLIER**, respectively CEO and CTO, does not intend to rest on their laurels. They will continue to serve the needs of 3D printer manufacturers and part producers, with their dog **Reynolds**, a young White Swiss Shepherd that has the heavy responsibility to create and maintain an atmosphere conducive to work.

5. Addiblast

It's not every day that we talk about AM in Slovenia…and the start-up that is making us envision more than just a touristic journey in the country with stunning caves is **Addiblast**. This team makes us explore the field of the manufacturing process that every operator fears: post-processing. Founded in 2020, the start-up is part of FerroECOBlast® Europe, a family company that has established a strong reputation for solving the most demanding surface treatment problems. The parent company's portfolio includes a wide range of solutions such as air blasting, shot peening, enamelling & coating solutions, dry ice & dry snow cleaning, as well as UHP water jetting.

Addiblast therefore leverages over five decades of experience from its parent company to provide the AM industry with a portfolio that comprises **blasting, depowdering** and **recycling**.

The company debuted at Formnext this year by showcasing the capabilities of its three main products:

– The BAM station, a solution for surface treatment designed for various processes such as smoothing, roughing, unifying, and polishing surfaces, removing support structures, and precise removal of powder from extremely complex structures. It is made of stainless steel and is suitable for all types of shot blasting media.

– The set of MARS (Metal Additive Removal System)

Available in three options, these machines enable the de-powdering of parts that are complex or large. Each machine features a communication and exchange data system with other machines from the manufacturer. The main difference between MARS01, MARS02 and MARS03 is that the latter is a fully automated solution that is explosion-proof and that complies with the ATES directive. Furthermore, by enabling a closed-loop inert atmosphere workflow, the machine can maintain oxygen level below 2%. This prevents contamination and oxydation of the powder during de-powdering and conditioning, and brings powder reusability to new levels.

– The latest in this portfolio is the STAR (Station for Transfer and Additive Recycling). Designed as a central station that continuously and automatically controls the pneumatic transfer, recycling, and conditioning of powder, this machine enables a direct connection with the 3D printer and other equipment. That is its main advantage compared to other solutions from the manufacturer. It can also be used to purify the virgin powder and like, the MARS series, it prevents contamination and oxydation of the powder during de-powdering and conditioning, and brings powder reusability to new levels.

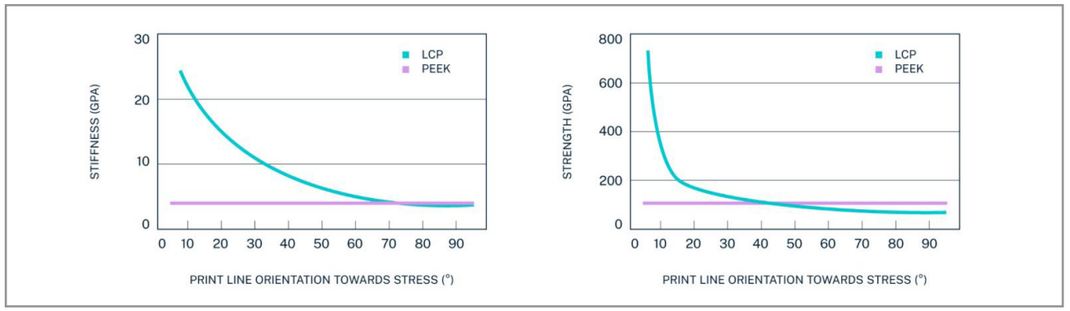
6. NematX AG

The next startup in this list is a spin-off of ETH Zurich founded by **Raphael Heeb** and **Silvan Gantenbein**. With the ambition of ushering in the next generation of 3D printing with high-performance polymers and significantly surpassing the current benchmarks in corresponding end-use components, the Swiss start-up targets all vertical industries whose parts manufacturing has to withstand harsh environmental conditions.

NematX AG that was one of the winners of the 2020 Formnext start-up challenge is developing what it calls a **"Nematic 3D Printing"** technology that aims to help industries make their low-volume business more profitable and sustainable.

"Liquid crystal polymers – short LCPs – belong to the family of high-performance plastic materials. In comparison to conventional thermoplastics such as PEEK or PEI, LCP molecules are comparably short and stiff and possess unique properties that makes their use in 3D printing highly attractive. In the molten state, LCPs adopt a short range order, similar to packages of tree logs floating on a river", the company explains.

The Nematic 3D Printing technology is therefore based on material extrusion (FFF 3D printing). "During printing, we can align these individual packages LCPs along the print direction to produce parts with unmatched mechanical and thermal properties from polymer additive manufacturing", the NematX AG explains on their website.

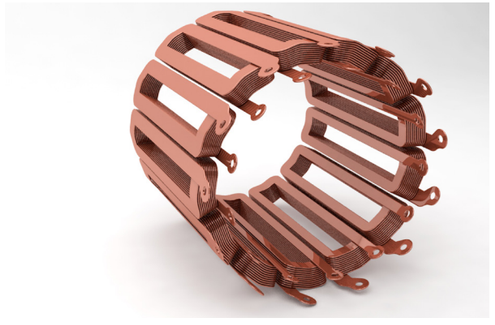


"By controlling the molecular alignment of our LCP 3D printing materials, we achieve superior stiffness and strength from polymer 3D printing. In printing direction, we can achieve Young's moduli of up to 25 GPa and ultimate tensile strengths of 650 MPa. In transverse direction, stiffness and strength values of other thermoplatics such as PEEK or PLA are achieved", they outline.

7. Additive Drives GmbH

Not many companies can pride themselves on raising money during the first three months of their existence, **Additive Drives GmbH** can and the best part is, the company did so during the first peak of the Covid-19 pandemic last year, when the economy was not at its best.

Founded by **Philipp Arnold**, **Jakob Jung** and **Axel Helm**, Additive Drives GmbH develops and manufactures additively manufactured electric motor components. With a **$1.5 million seed investment** from AM Ventures Holding GmbH, Additive Drives GmbH ambitions to drive the electric drives market with new applications.



"Jakob and I, both come from the applications side of the industry. We have been developing electronic robots in the former automotive company we worked for. Engineers by training, we built up extensive experience with copper and additive manufacturing machines. After a deep research, we came to realize that the combination of AM and copper might lead to not only shorter development and test cycles for electric motors but also more performant applications. After a few successful trials, we reached out to Axel Helm who has a solid expertise in manufacturing processes and industrialization. His experience in copper processing and optimization of AM processes is pivotal to define the type of applications we could work on. We have therefore decided to combine our respective strengths to make Additive Drives GmbH a viable business" Arnold told 3D ADEPT Media in an interview.

With 13 employees on board, Additive Drives GmbH ambitions to enhance performance of electric motors by up to 45% by focusing on copper windings, the main component of an electric motor. AM is definitely part of this game as the direct manufacturing from the CAD data allows for shorter development and test cycles. Moreover, it does not jeopardize material parameters and offers instead an electrical conductivity at the same level as conventional production.

While the Additive Drives GmbH team is up to new adventures in this applications field, it should be noted that they have won the Gründerpreis Sachsen/ Award for the most innovative young company of Saxony, a free State on the south east corner of Germany.

What the Start-up area had in store for this year 2021 …

8. Axtra 3D

We will rarely find a start-up that has made a real splash on its debuts on the International Scene of the AM industry. Axtra 3D did it at Formnext 2021, with the launch of a unique 3D printer. We recently learned more about this company's innovation and two things really marked us: the **product development time** that only takes 9 months as well as the **technology.** This technological solution is the result of a collaboration between on-demand manufacturing platform **Xometry** and **Axtra3D**, a developer of advanced Additive Manufacturing solutions using Optoelectronics.

Together they have created a 3D printer based on a patented Hybrid PhotoSynthesis (HPS) technology, which could combine the benefits of SLA, DLP, and LCD. The stake is even higher when we know that, when it comes to resin 3D printing, operators are often hesitant between the advantages and disadvantages of SLA, DLP and LCD. According to Xometry, choosing between these three solutions requires compromises, either on print speed and resolution (DLP/LCD) or on surface quality and print area (SLA).

So, what makes Hybrid PhotoSynthesis (HPS) outstanding?

HPS enables a printing process with fine resolution and delivers high print speeds and excellent surface quality even with large print areas. The process combines two light sources in a custom assembly (DLP & Laser) in order to create a harmonized light engine that efficiently harnesses the power of the two sources.

"In our HPS technology, the Laser defines the resolution and as a result, HPS offers higher resolution and fine feature reproducibility than a standard DLP," explains **Gianni Zitelli**, one of the founders of Axtra3D.

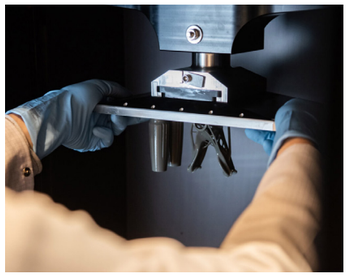
The new process therefore delivers the speed of DLP/LCD with the surface quality and scalability of SLA, along with ultra-fine resolution, continuous printing and isotropic part performance capabilities.

"Users often have high surface finish costs," states **Praveen Tummala**, the other cofounder of the company, *"but with the fine surface quality and resolution offered by HPS, they can save time and money as the 3D printed parts don't require any post-print surface finishing"*.

Where does Xometry come into play?

As the story goes, the project started at the beginning of 2021 with the objective of launching their 3D printer during Formnext 2021 edition . *"We thought it would take us about 18 months to complete a project like this,"* explains Tummala. *"Thanks to the team and our partners in Europe, it only took us 9 months"*.

In August, the Italian team launched the first simulation of the complex optical system which was a resounding success. This breakthrough then accelerated the whole production process. *"A lot of the credit goes to Xometry, as they were able to deliver about 2,000 parts in 6 weeks, an extremely demanding timeline,"* states Zitelli.



"We have access to CNC providers in Italy, but it wouldn't have been a strategic move for our company. Working with Xometry gives us access to thousands of providers worldwide—this is the real value of our collaboration".

In order to finish the project in time for the forum, Axtra3D called on Xometry to produce every single aluminium CNC machined part used to assemble the printer, from very small components for the light system to elements for the printer's base. "We can't imagine any other partner who could have been able to deliver the parts in time to allow us to launch the product and exhibit it at Formnext," says Tummala. "

The Axtra3D team worked very closely with Liana Zedginidze of Xometry during the entire production process. "We are highly indebted to Liana for her support of our project. She was available for us round the clock and ensured that the ordered parts were produced and delivered on time," said Zitelli.

The next step for both partners is now to produce 10 beta 3D printers by June 2022 in order to launch their product on the industrial market.

9. Additive Appliances

Thereafter comes **Additive Appliances**, a start-up that was incorporated in April 2021, with the goal of developing the next generation of household appliances such as coffee brewers, and personal care products. From the very beginning, the company has received the support of angel investors, including a university spin-off company that specializes in Computational Fluid Dynamics and Topology Optimization.

Together with **Kilometro Rosso**, a private innovation hub in Italy, Additive Appliances has secured an EU Grant via the ***Digital Innovation Hub World's First Open Call***. The funding will accelerate Additive Appliances development for its « *3D Printed Heat-Exchanger for Household Coffee Machines* » project.

The Italian start-up comes with decades of experience in 3D printing applications such as heat-exchangers. In this case, it explains controlling water's temperature and pressure is key to extracting the best out of coffee and the solution allows for a more efficient and sustainable beverage preparation.

Electro-thermic household equipment controls the process' variables by embedding several (hardly recyclable) components, while traditional thermo-mechanic devices do not directly control them, showing quality and repeatability issues. Currently, consumers have to trade-off between quality and sustainability, a press communication from the company reports.

Interestingly, to enhance performance, explore new features and functional personalization, AM could be utilized at different stages of product development, including end-use production. As we saw in an application shared by Additive Drives Gmbh, combining AM and conventional manufacturing processes enables a better control of temperature, pressure through embedded, conformal, high-efficiency yet ultra-compact heat exchangers.

This means that small batches can for instance be engineered to exalt specialty coffee varieties, down to individual consumer preferences. On the other hand, a single piece of mechanic can replace auxiliary electronic components, significantly reducing the carbon footprint of the equipment's lifecycle from production to recycling. In a nutshell, an ecological experience of coffee.

USA Tech, the Living Space for Additive Technologies of Kilometro Rosso, will be a crucial partner during the DIHWorld's experiment. Its 3D printing infrastructure will help the company quickly leverage the technology hands-on and perform in-depth process assessments through real-time monitoring systems -speeding up manufacturing optimization, the company concludes.

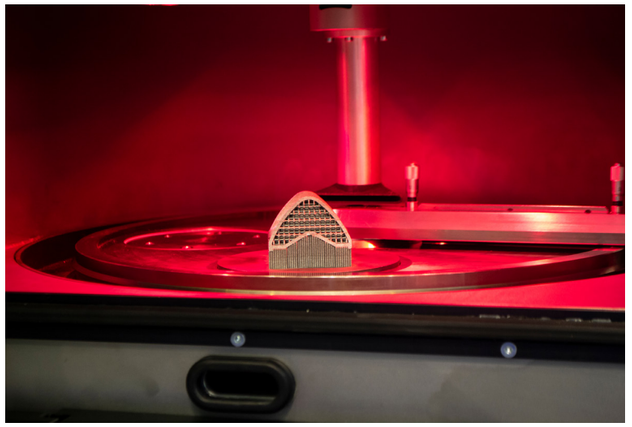


Image: Additive Appliances – 3D coffee post (conceptual picture)

10. Vispala Technologies

This India-based company impacts the lives of disabled people with its 3D printed hand prosthesis **iGrip**. The company that develops customized 3D printed orthotics, 3D printed artificial limbs and prosthetics, has made an official entrance on the International Stage of the AM industry by taking part in the 2021 Formnext Start-up challenge.

The company stood out from the crowd by winning the AM Ventures Impact Award, which recognizes the winner's approach to sustainability, an approach that takes into account the 17 sustainable development goals of the United Nations; environmental considerations (such as green energy and resource conservation) and social aspects (for example, education and equality).

Vispala's iGrip is an affordable, lightweight body-powered hand prosthesis that helps patients perform work related to their daily living.

«We at Vispala are taking on the challenge to modernize the prosthetics sector through technology and innovation and restore 50% or more livelihood capability to users with comfortable and aesthetically pleasing solutions,» said **Dipak Basu**, CEO of Vispala Technologies. «*Simultaneously, we are building a sustainable social enterprise to scale up our work.*»

11. Nobula

Another startup that the 2021 Formnext startup challenge brought to limelight is **Nobula**. This glass 3D printing startup is a spin off from KTH in Sweden that brings a lot of diversity in the range of AM technologies already available on the market.

Their innovation? A **Nobula™ glass 3D printer** based on **Direct Glass Laser Deposition (DGLD™)** that can produce complex 3D structures in glass.

The company has filed for two patents, one for the glass 3D printer and one for the printing material technology, which will enable them to provide custom glass 3D printing for science, development and production.

Moving forward, we may expect the company to finalize its prototype printer and to launch the first model before summer 2022.

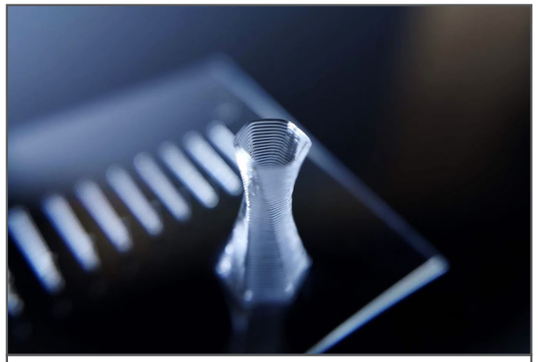


Image: Vase mode

12. AM Entrepreneur

Last but not least, this Germany-based start-up aims to "standardize the implementation of AM technological value within profitable and sustainable business models." Behind this ambitious vision is **Gregor Reischle**, who launched and pushed the AM roadmap at TÜV SÜD forward.

AM Entrepreneur's creation was founded based on one observation:

"Distributed manufacturing within Business models will help to reach our CO2 emission goals as well as open complete new digital business models and strategical positioning potentials. In today's corporate "business unit" structure, we quite often realize a lack of cross-disciplinary, entrepreneurial TEAM DNA which often results in projects stagnation. The complexity of the business design within Additive Manufacturing strictly requires the collaboration between all operational units and minds", which is an ability AM Entrepreneur wants to establish within industry companies.

Within AM Entrepreneur, Reischle therefore aims to provide an entrepreneurial mindset incubation for all AM Start UP and intrapreneurial TEAMs, provides digital assets that will enable scalable implementation of AM processes while assuring predictability on return on investment. Lastly, he will also deliver consulting, training, coaching, and hands-on support to overcome the quality, approval, and business design challenges industries often face.

So far, AM Entrepreneur has already delivered workshop and assessment result reports?, supplier assessments and GAP Reports based on AM quality and health & safety standards like ISO/ASTM 52901, 52920; AM Innovation TEAM coaching during the "business design phase (multiple weeks program). It has already supported the installation of AM systems in regulated environments, in compliance with CE, or quality assurance requirements - assessments based on the ISO/ASTM 52930 and others.

"After around 20 years at corporate career, I finally managed to spin off and start up. The freedom to be able to travel again, after being vaccinated and be part of the FormNext exhibition reunion with AM industry friends. My consulting and business incubator start-up leads to new profitable business models and software solutions. My "hands-on creator mindset" empowers executives and operational teams to build new successful business models, while incubating AM values", Reischle told 3D ADEPT Media.

Closing remarks

This "Start-up" area shows that there is a greater number of start-ups that have been founded in 2020 than in 2021. This reveals the industry's resilience and its ability to find the good in any crisis and most importantly, this attests to AM's readiness to create a business model exclusively based on applications.

INTERVIEW OF THE MONTH

ADDITAE DIGITAL ON THE 2021 AM LABOUR MARKET : IT'S ALL ABOUT "PEOPLE, PLACE AND PROGRESSION"

As we currently go through 2021 and its highlights, we came to realize that there is one specific vertical industry that we did not talk about much: **recruitment**. The Covid-19 pandemic drastically changed talent acquisition teams, heaped new demand on others, and marked a milestone for this field of activity as virtually recruiting and onboarding a remote workforce became the norm for several organizations.

These hurdles eventually led to a new modus operandi in 2021 which meant sometimes considering internal talent pools. Furthermore, they highlighted the gap that needs to be fulfilled to create "multi-talented" teams, a gap that absolutely needs to be fulfilled by focusing on diversity, equity and inclusion (DEI).

In my opinion, this struggle is even harder for an industry like AM that already suffers from a gender gap; now imagine how high the stakes are when we involve minorities. That's the reason why I believe that recruiters who will thrive in this sector are the ones who will go beyond "this perception problem" to add new skills, and for that they should have the highest degree of integrity and honesty, treating others as they like to be treated.

These are exceptional qualities that I discovered in **Greg Waters**, Founder and Managing Director of **Additae Digital** (previously known as Additae Global), a recruitment company that focuses on attracting and hiring the most sought-after talents across the world that will help companies design and implement their Advanced and Digital Manufacturing strategies. The company's journey started in 2017 and this year saw the addition of another Director: **Anthony Hickey**.

And before you wonder, I do not intend to change my job. I officially met this recruitment entrepreneur last year, in the storm of the pandemic and all of the questions it raised with regards to DEI. In November 2021, formnext gave us the opportunity to chat a little bit more, during a walking dinner organized by **AM Ventures** and during a **Women in 3D Printing** panel on "Diversity & Careers in AM" he moderated.

ADDITAE DIGITAL
EMPOWERING 4.0

For this last edition of 3D ADEPT Mag of the year 2021, Waters and I caught up to discuss the key takeaways we should keep in mind from the 2021 Additive Manufacturing job market. A discussion that required us to turn the clock back to 2020, another tough year for recruiters.

"Recruitment was hugely affected by the Covid-19 pandemic in 2020. It was a complete mess for everyone. People were worrying about losing their jobs while companies were struggling to justify hiring new talent. 2020 saw the suspension of almost all recruitment activities. Fortunately, during 2021, companies started recovering, and the positive impact of that recovery has been felt across multiple industry sectors."

As far as applications are concerned, Waters notes that machine manufacturers are one of the groups that have hired the most consistently throughout 2021. *"In our experience, the main hiring organizations were not necessarily those who have been developing Additive Manufacturing systems from the beginning. We've worked with several companies who have been developing new products and new applications using AM technologies. Within those projects, we found the most-in-demand roles to be sales, business development and application engineering positions. And of course software engineers. Everyone's looking for software engineers! "*, he adds.

It should be noted that these roles were already among the most sought-after skills before the pandemic. While the pandemic may have expedited the need for these talents, it has also partially addressed the issue of **lack of technical skills**.

In Waters' opinion, certain areas like software still require more technically qualified professionals but, in general, one should acknowledge the fact that the candidates the additive manufacturing industry needs are out there. *"The main challenge consists of getting the right skills set in the right geography. For each open vacancy, we can always find suitable candidates, but he or she may not necessarily be based in the required location, and that's one of the key challenges that many companies still face. It's true that more and more roles can be carried out remotely, but that's not always possible"*, Additae Digital's founder outlines.

So, how should companies attract and retain talents?

Every company must answer this million-dollar question, no matter which industry it operates in. Here is the thing, AM remains a niche market where it is relatively easy to network with other people, but to successfully navigate this industry, "you have to be humble", Waters states.

"You have to be humble to do business in this industry", he repeats. *"It's important to understand that good candidates always have options. Companies should realize that people in the industry are hugely informed about Additive Manufacturing, so attracting or retaining them will depend on factors that go beyond the wage argument. Their ability to join or stay in a company often depends on their ability to progress both personally and professionally, to have the right balance between their personal and professional life, to recognize themselves in an organization's values, or [to identify themselves with people who look like them]."*

The focus on this latest point emphasizes another mission that is close to Water's heart, and his company play its part in helping minorities thrive by putting on an equal footing all professionals no matter their gender, ethnicity, religion, or skin colour. A point that is further reinforced in the company's rebranding this year – **from Additae Global** to **Additae Digital**:

"First and foremost, we needed to update what the company represents. The change to using the word "Digital" enables us to reflect the wide range of services we provide to the industry. As the Additive Manufacturing industry evolves, so do we. The market and new technologies are evolving to embrace the requirements of Industry 4.0. Adopting AM today, necessarily goes hand in hand with integrating software solutions, smart factories, IoT solutions and all other technologies related to industry 4.0, and all these digital manufacturing solutions have to be reflected in the services we can provide companies.

Furthermore, we felt like changing the colour scheme of the company logo will help more people to feel included in our mission, and the conversation that we want to foster about diversity. Taking into account that people are at the core of what we do, we really wanted to highlight that."

What will the 3D printing labour market look like in 2022?

According to Waters, *"organizations will increasingly look for people with software experience. This is something that grew exponentially in 2021, and we believe that demand will only continue to grow. The other key focus area is where companies in the AM industry now start to focus on volume production, the requirement for manufacturing engineers will only grow, and there will be a trend towards trying to attract more people with hands-on aerospace, automotive and medical experience."*

Additae Digital will continue to go the extra mile to support organizations with their staffing requirements, and I have no doubt their efforts will pay off as they stay true to their vision that, "together we enable the makers of today to build a better tomorrow".

3D PRINTING IN THE SERVICE OF UNDERPRIVILEGED COMMUNITIES

Jason Szolomayer (on the right)

Over the past decade, we have seen 3D printing growing in popularity and moving from its first experimental and private uses to more widespread industrial applications. However, as the potential of the technology became increasingly apparent and big companies around the world began to take advantage of the technology's capabilities of design freedom, customization, rapidity of production, and sustainability, it was inevitable that the question would also arise: what else can we accomplish with 3D printing technology?

Recently, a steadily increasing number of NGOs and initiatives from AM-focused companies have been conceived and put into action for the specific purpose of using 3D printing for ethical and social purposes. Among these, many are focusing on getting healthcare services to countries where they are most needed.

Starting with a pilot to bring hearing aids to 50 kids in Jordan, 3DP4ME's long-term goal is to work alongside the many nonprofits that are providing lower-limb prostheses in Syria.

"In the past, if they worked very hard they could make maybe 5-10 hear moulds a day using plaster. Now we can scan someone's ear and can 3D print up to 20 moulds in one sitting and on a small bed", says **Jason Szolomayer**, CEO of **3DP4ME**. *"Like this we can scan someone's ear on the field and that information will go into the cloud in real time, ready to be downloaded into the CAD software, printed into a mould, and sent back to the field in a day or two."*

Nevertheless, this is not without challenges. Besides **difficulties related to funding and supply chain** to deliver materials and consumables to their base in Jordan, Szolomayer points out how one ongoing battle is the lack of specialist know-how and the need to bring together collaborators with different competences, to tackle such a new and complex technology and the complications that come with it.

Due to 3D printing being still a relatively new technology, the awareness of its potentialities and possible applications is often lacking and is bound to be an obstacle, especially in developing countries. **Shweta Thapa**, founder of The Art of Making Foundation, a school to empower girls and women through STEAM (Science, Technology, Engineering, Art, and Mathematics) education and, in particular, learning to design and make things with 3D printers, outlines two of her greatest daily challenges: **accessibility and mindset**.

"The good part about digital manufacturing is you can make designs online, from wherever you are in the world. But in countries like India they rarely have WiFi or internet access, so you have to make sure either to install that in their homes or get them the necessary facilities. And even if that is sorted, there is the mindset. Girls in India have a pressure to get married. Parents who come here want to know: if she learns 3D printing and design thinking, will she have a job? And we say yes, we are creating the avenues, we're getting them jobs, this education will help her feed her family. Understanding one another is possible, but only through real, tangible examples."

Thapa stresses how 3D printing innovates education by making learning more engaging and hands-on and preparing learners to acquire skills for which there is an actual demand on the market. *"We want women to have a livelihood. The whole idea of using 3D printing is: look at it as an industry, so you can learn an art, and tomorrow you can start your business."*

This year, The Art of Making Foundation is launching their **first MAKE IT 2021 conference**, with the purpose of spreading awareness on the benefits of 3D printing-driven education.

As big companies began to discover and promote Additive Manufacturing for industrial purposes, their involvement with NGOs and supporting underprivileged communities also intensified. The role of the industry, in fact, is paramount for providing socially-involved projects with funding and technical support, but also for changing the way people, and the industry itself, view 3D printing.

Companies like **EOS**, involved in a number of both local and global socially-oriented projects, most recently focused on furthering STEM education and providing components for the fight against COVID-19 (see their "3D Printing Against Corona" initiative), recognize the necessity of leveraging their technology and resources not only to generate profit, but to further the idea of 3D printing within a framework of positive social change.

"It all depends on the vision of the company", says **Lea Stegemann**, Sustainability Manager at EOS. *"At EOS we think a lot about what kind of role we play as a company within society. Our goal is to accelerate the transition through 3D printing towards more responsible manufacturing. Today if you are dealing with a new technology it does not only need to be cost-effective, it also needs to be legitimate and to be serving the global community. If we pursue responsible manufacturing, it makes sense that the way we do things, and what we do it for, also needs to change."*

Jason Szolomayer, who currently has a commitment from EOS to cooperate in the making of lower-limb prostheses, commented: *"It's true, businesses are profit-driven. However, it is often a win-win situation, where they can have a strong impact and tell the story, while adding credibility and the technical know-how an NGO needs in terms of higher-end materials and production systems. That is why it is important to build a 3D printing ecosystems. We can't do it alone."*

Image: Girls learning the basic steps in 3D printing through Shweta Thapa's organization

For those who are trying to make the difference, the future of 3D printing carries a lot of hope and a few concerns. The need is to keep building strong collaborations to put together means, knowledge, and good intentions. The main concern remains that people, in Lea Stegemann's words, **"won't walk the talk"**. But the take-home message is a hopeful one, and the consensus the same: as 3D printing shows its real potential, more and more people show real motivation to be part of the solution.

Image: EOS

EVENT

People, Production & Costs: Highlights of Formnext 2021 & More

The 2021 edition of **Formnext** marks the seventh year of the International Gathering of the world of Additive Manufacturing in Frankfurt, Germany. Held every year during the second or the third week of November – with one skipped year in 2020 – Formnext has made it a priority to feature a series of world premieres throughout the entire chain process and to demonstrate the ever-growing fields of application of Additive Manufacturing.

This 2021 in-person edition of Formnext, held from November 16th to 19th, was long-awaited and has been organized with all the uncertainty surrounding the Covid-19 landscape – the uncertainty of being cancelled at the last minute. The event finally took place under the highest '2G' safety conditions, meaning that only those fully vaccinated against or recovered from COVID-19 were allowed to attend.

Most importantly, this edition was long-awaited as the entire industry came to realize that virtual events are not enough to do business.

That's the reason why, one of the first highlights of this edition was ***"People".***

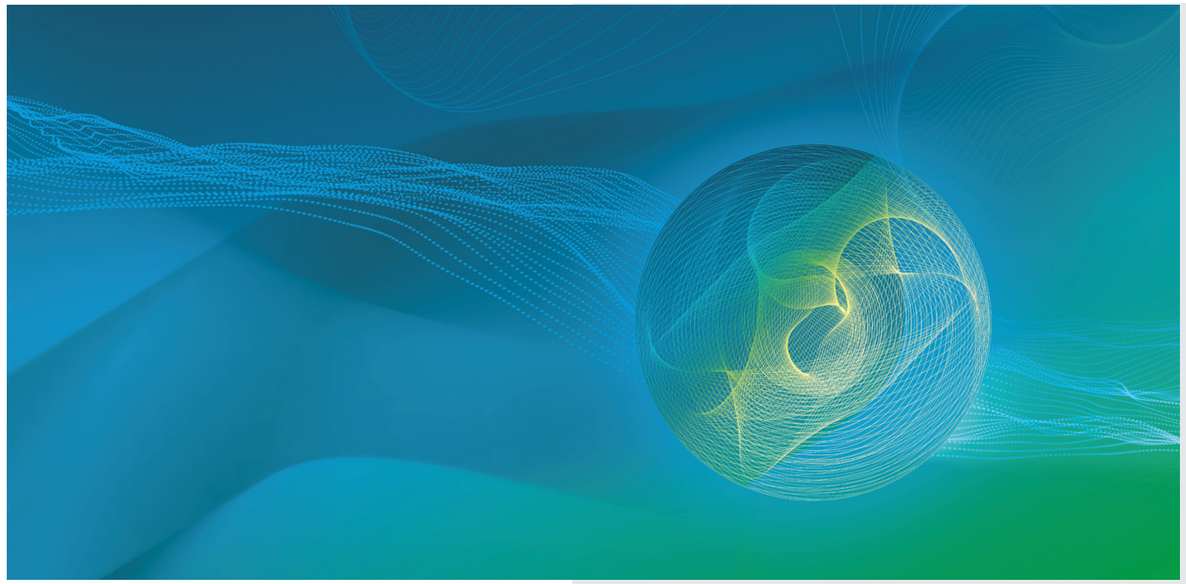
People: "See or Be Seen"

With over 600 exhibitors from 36 countries, covering a total floor space of 30,000 square meters, Formnext 2021 welcomed 17,859 specialists and executives from 76 nations.

This number is perhaps equivalent to half of the visitors who attended the show in 2019, but this remains one of the highest levels of attendance observed in AM-dedicated industry events. As a matter of fact, most exhibitors told **3D ADEPT Media**, that they didn't expect to have such a crowd giving the increasing number of Covid-19 cases in Germany.

"Formnext has once again shown itself to be the highlight of the year for the AM industry. After the significant challenges we faced last year, this year both the number of exhibitors and visitors in attendance surpassed our expectations," commented **Sascha F. Wenzler**, Formnext Vice President at organizer Mesago Messe Frankfurt GmbH. *"It has shown once again just how important Formnext and face-to-face meetings are for this innovative industry, which develops technologies at a rapid pace and is keen to share these with investors, partners, and customers. It was clear that Formnext had been eagerly awaited by the entire industry."*

While this reemphasizes the sense of belonging to a community the event creates within the industry, be it from an exhibitor or a visitor's standpoint, the various activities held in Frankfurt, also highlight the need for people to



network and to further know other industry professionals through a very sophisticated range of experiences. This year, these activities included for instance, the very selected AM Ventures' walking dinner held on Tuesday, the AMT party, or even, the Formnext happy hour that was held on Thursday. And these are just the cherries on the cake…Added to this the various booth parties exhibitors held where they were located, other marketing attractions to draw crowds' attention, and sub-events of Formnext , you obtain another form of immersive experience into the event.

Production before, today, and tomorrow

From a manufacturing perspective, ready-to-use production parts have always been the ultimate goal of industrials. Over time, companies came to realize that addressing this issue necessarily requires to involve other stakeholders of the AM ecosystem, stakeholders that are not only and always 3D printer manufacturers.

The in-person 2019 edition for instance, laid emphasis on several items including post-processing, to address this issue. This edition of Formnext first reveals that the most urgent needs at the production level require to take into account **supply chain discrepancies, distributed manufacturing** or **localized production** as well as sustainability concerns.

Unlike "3D printers" that can easily be displayed and seen, these are topics one can only discuss with stakeholders of the industry. As a matter of fact, a few 3D printer manufacturers and material producers told 3D ADEPT Media that they exhibited to meet new companies that could meet distribution challenges in regions they are not present yet.

Furthermore, the manufacturing standpoint highlights how **Polymer AM is increasingly heading towards mass production**. HP for instance, has cemented a leading position in this area, and does not intend to stop now (given its partnership with L'Oréal). Indeed, on the path to the makeover for the cosmetics industry, HP and L'Oréal signed a partnership to increase production flexibility and to create innovative new packaging and customer experiences using AM. Both companies showcased examples of the custom packs at Formnext, as well as unique textures for luxury cosmetics only possible with HP's 3D printing solutions.

Other companies that are worth watching in this field include Stratasys and voxeljet. Stratasys has always been a company to watch, even more so now that it has expanded the portfolio of its companies and has unveiled its SAF technology.

What I like about voxeljet's proposition in this field, is that they are focusing on the economics of manufacturing. The company is looking to enhance the use of its VX1000 system (a machine that combines the benefits of selective laser sintering and binder jetting) by developing a material-machine combination with materials producer Covestro. Both companies have previously developed a Thermoplastic Polyurethane (TPU) powder for HSS (High Speed Sintering) and now they are looking to enable volume manufacturing thanks to a dedicated material-process solution.

Moreover, we will keep a keen interest in AM startups as they are uniquely positioned to disrupt the industry and in machine manufacturers that ambition to bring affordable solutions to the market. At the end of the day, the latter makes it possible for a wide range of industries to take their first steps in AM, especially metal AM which remains the most extensive process of the market. Xact Metal is a very good example in this category. The machine manufacturer has showcased the XM200G metal 3D printer series at Formnext. With a build volume of 150 x 150 x 150 mm, the new 3D printer enables faster print time thanks to a high-performance galvanometer system. With a multi laser configuration, the machine would offer a 66% overlapping area at 50µm spot size, and a 100% overlapping area at 100µm spot size. Faithful to its mission of making metal powder bed fusion (PBF) more accessible; Xact has lowered the price point of its XM200C printer from **$90,000** (€79786) to **$65,000** (€57623).

However, powder-bed fusion might be the widely known AM technology in the polymer AM niche, but let us not forget that this field's growth is also due to the rise of other AM processes. I am thinking here to the **well-known alternative SLS**, the **extrusion processes**, as well as other technologies in the *photopolymerization* niche.

While manufacturers like Nexa3D want to make it easy for companies to explore applications in a commercial environment, we should recognize Anisoprint's efforts to enhance composites AM. Anisoprint's newest continuous fiber 3D printer is one of the machines we saw on the last day of the show. Its development does not only highlight Bosch's expertise in automation technology, but it also marks Anisoprint's entry point into IoT, which is a path most hardware producers are striving to achieve.

On the other hand, I also learned that a lot still needs to be done in industrial 3D inkjet printing applications. It took a collaboration between **Altana and dp polar** for me to

realize that multi-material 3D printing has often been hindered by non-end-use applications, and that's an area I hope to see evolve over the next months or years.

In the same vein, it might be easy to set aside what's happening in the software side of the manufacturing industry, yet it is the software that makes AM machines dance on the production floor.

The thing is, there are so many considerations to take into account at the software level, but for some reason, part identification and **simulation** remain one of the most important ones in my eyes. While the first one helps you determine the right part to produce for AM, simulation is pivotal to ensure or reach a "First Time Right", or at least early in the design and production stage. This is particularly important in metal 3D printing applications where parameters are often complex to set for every material and part, and where operators are struggling to avoid material waste, and to save time.

One example that I have kept from the show is the **Amp cloud-based**, process management software platform from GE Additive. With limited release of the first two modules (**Print Model** and **Simulation & Compensation**), the software is designed for Concept Laser M2 machine users.

"Amp is the fourth pillar in GE Additive's full solution along with machines, materials and services," said **Igal Kaptsan**, general manager – software at GE Additive.

Amp breaks down the silos between CAD, build prep, simulation, compensation and inspection data to help improve part production. With centralized data, users can access tools that simulate how the manufacturing process unfolds in real time and see the estimates for cost and time for a part throughout the process. Amp streamlines the process. It uses a single database that supports seamless data transition between one task and another. In addition to the database, Amp also incorporates the industrial knowledge, best practices and workflows, and time/cost analyses that GE has pioneered over the past decade, the company explains.

The Cost conversation

Let's admit it. Talking about money is not sexy and it's a conversation nobody likes to have. We are super glad that our conversations with AM companies like AMCM GmbH highlight the need to bring down the final cost per part as one of the key challenges to address, in all vertical industries.

Indeed, in order to reach full commercialization at scale, industrials or parts manufacturers will continue to evaluate AM versus other manufacturing methods, trends in material pricing, as well as software paradigm that comes into play.

One thing I have observed in the AM industry is that 3D printer manufacturers do not often take the lead at this level. To say the least, very few comparisons are revealed at this stage. I strongly believe it will only serve more vertical industries if they are shown the benefits in terms of costs by investing in AM technologies in advance, rather than just the benefits of the technology.

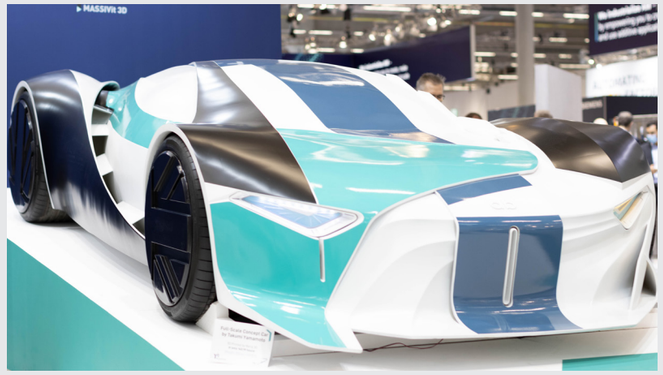
Applications that were well worth a visit at Formnext

Lastly, what would be Additive Manufacturing without applications? We may be talking about 3D printers, materials, software and any other form of related technologies the whole day, if we do not talk about applications, it's like we have been talking in the void. At the end of the day, applications are the entrance door to AM, for whoever trying to understand how this world works – be it with or without any experience. I had to wait until the last day of the show to remember this undeniable truth.

By walking from booth to booth, without the usual too much commercial talk we are given by companies' representatives, we took time to appreciate what AM technologies can do. Unfortunately, for this review, and for the sake of word count we were told to pick only five of them. And here they are:

1. The First Ever Full-Scale 3D Printed Concept Car at Massivit's Booth

There were so many cool applications on the show but this 3D printed concept car is one of the reasons why we decided to feature a few applications in the mag. We've witnessed a lot of applications of AM in the automotive industry but this one is quite unusual as it is an entirely new approach to producing concept prototypes which happens to be in this specific case, a tribute to David Bowie, leading figure in the music industry. When **Pieter Machtelinckx**, EMEA Marketing Specialist at Massivit, told me about this project, I immediately remembered that we wrote a story about that and Formnext 2021 gave us the possibility to see it in real life.



Known for their massive industrial 3D printers, Massivit 3D Printing Technologies Ltd. collaborated with **Marie 3D** – large format 3D printing specialists – and renowned car designer, **Takumi Yamamoto** for this project.

The car embodies **Yamamoto**'s life-long passions for car design and David Bowie. **Philippe Marie**, Managing Director at Marie 3D brought his expertise in prototyping to the table and achieved the fabrication on the Massivit 1800 large format 3D printer.

This new concept prototype production method has provided the perfect expression of Yamamoto's imaginative and emotive dream to build a David Bowie-inspired concept car that embodies Bowie's key personal and physical traits. The design incorporates a core body that represents and 'protects' the inner Bowie while the intricate, outer body is designed with different looks from various perspectives in homage to the singer's chameleon-like personality. Crystals were chosen to reflect the purity of Bowie's lyrical and musical message, the Massivit team states.

2. A 3D printed bike prototype at Flam3D's booth

Bikes are certainly in the top three of commercial applications that can be made for end-users. So why did we pick this one, a prototype, when we knew that other companies like Oerlikon also showcased ready-to-use 3D printed bikes at their booth? Certainly, because of the challenges they faced and the in-house capabilities they created and leveraged to make it happen. (There is an even greater satisfaction in learning from the challenges on the road and succeeding in overcoming them).

Furthermore, as an end-user, you never really question the way the 3D printed object you use, has been manufactured – sometimes, you do not even know that that object has been 3D printed. As an editor, unless you dig a little more, you are usually told the end of the story.

In this case, this 3D printed bike prototype emerged as a research project at Windesheim, University of Applied Sciences. It was built on a large scale FFF (or FDM) printer the research team developed in-house (basically a modified CNC router) in order to find the do's and don'ts around creating larger products/assemblies with AM and to inspire local companies.

For the frame and the seat that have been 3D-printed, **Tommie Stobbe**, Researcher in AM said, the most challenging part in creating

this bicycle frame was to build it up out of components that are easy and efficient to print. [By "efficient", understand aspects such as using more expensive high-end materials only where needed, using a larger nozzle where possible to reduce printing time and to avoid the use of support material].

For example, *"high-load parts (such as the crank casing and the steering headtube) are printed out of polycarbonate (on our Stratasys FDM Titan), parts of the seat and the rear axle hubs are printed out of PA12 (using our EOS P100) and the topologically optimized seat holder was printed out of AlSi10Mg using our EOS M400. The main structure of the frame was built up out of larger, flat pieces (a sandwich structure with PLA on the inside, and PETG with carbon fibre for the black outsides of the frame) that do not require any support material during printing. The rear swing arms had to be positioned at an angle, which was realized with separate spacers, instead of using (a lot of) support material. The vertical/arched slits in the rear swing arms are positioned in such a way that they add strength and stiffness to the part, while it also adds to the aesthetics of the design"*, Stobbe explains.

There are no plans for commercialization but what's even more interesting is how far they can go to play with AM technologies. And that's something they plan to do– assuming that their research program gives them that possibility – by adding new 3D printed features to it, as new materials/technologies become available.

3. A Titanium diffusor at Velo3D's booth

This part is in this list as it is the proof that "impossible" is not part of AM's technical terminology. This part is the chef d'oeuvre of KW Micro Power, a company that designs and manufactures high power density Auxiliary Power Units (APUs) for commercial aviation and **military applications.**

Enrique Enriquez, President of KW Micro Power, has always wanted to develop a microturbine generator roughly the size of a microwave oven that can crank out more power than systems ten times as large. He ran into some major roadblocks while attempting to manufacture one of the device's key components and considered scrapping its design and starting all over. The SupportFree metal powder-bed 3D-printing technology from VELO3D turned out to be the ideal production candidate that led him

to a commercial launch.

What raised our attention in this part is the design that looked like a small "spaceship". Yet it is described as *"an unassuming titanium disc roughly 10-inches in diameter and 4-inches tall, whose interior contains a complex labyrinth that channels exhaust gases far more efficiently than conventional systems. It is the heart of KW Micro Power's turbine technology"*.

If you are an engineer, you probably already know that one of the biggest challenges in the manufacturing of this part lied in the internal channels. The truth is, most additive manufacturing technologies, and especially those that print metal, require a series of scaffold-like supports to keep the workpiece from drooping and warping during the build process. Though expensive and time-consuming, it's accepted industry practice to machine or grind these supports away post-build. And that's something that can't be done with these small internal structures.

What's interesting with Velo3D is its use of **feature-specific processing**. Where most machines use the same laser power, traverse rates, and other build parameters across an entire part layer—and often for the whole build—Sapphire can apply more than 20 geometry-dependent "recipes" to specific sections within each layer. The result is less metallurgical stress, greater part accuracy and faster build times. And to make sure that all is going according to plan, Sapphire comes standard with advanced metrology to assure quality and reduce variability, the company explains.

4. Component rocket built by toolcraft

Showcased on Trumpf's booth, this beautiful 3D printed component rocket reveals exceptional quality that Trumpf's technology

can deliver. This component rocket has been 3D printed by toolcraft, a parts producer that has been levering AM technologies for 10 years. One of the advantages in working with Trumpf's machines is that the TRUMPF team develops the laser themselves, and they have the expertise to handle the medium.

The production of this part required the use of several machines from Trumpf and a wide range of materials. However, the TruPrint 1000 (green laser) is the 3D printer that fabricated the greatest number of parts as the manufacturing required a stable process window and a technology that could process materials that deliver good thermal and electrical conductivity and thereafter withstand heat treatment.

5. "From digital to real life"

When you are walking through booths to admire 3D printed pieces, you do not expect to be attracted by parts showcased on software providers' booth. Yet my eyes fell out on this beautiful metal 3D printed part that was on Oqton's booth.

I don't know if engineers feel the same… but as an editor, there is a weird feeling of pride that consumes me every time I see and touch a print edition of 3D ADEPT Mag after working on screens with my colleagues for months. I believe, this feeling might be the same for engineers who finally get to see real manufactured parts after working on them and seeing them on screens for a long time.

Seeing this part makes Oqton's capabilities more tangible as a closer look reveals three layers of part embedded in the complex print job.

Of course, there is certainly more than that…Engineers would have probably asked records of all statistics for each layer, or any topology optimization information, but I myself was too busy admiring the beauty of it.

Last but not least…

You do understand that with over 600 companies on the exhibition floor, it becomes more and more difficult to share the key highlights of Formnext. That's the reason why, we diversified our review this year by recording a general video report that you can watch on our online media.

MAKE SURE YOU SUBSCRIBE TO OUR NEWSLETTER

TO RECEIVE THE LATEST INDUSTRY NEWS AND ADVANCES IN ADDITIVE MANUFACTURING.

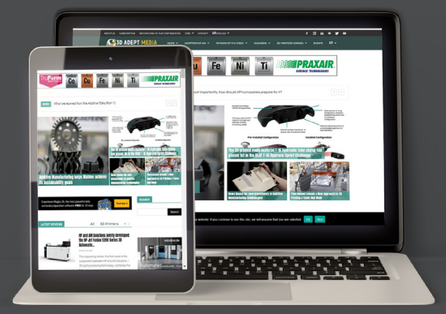
3D Adept is a Communication Company dedicated to the 3D printing industry. Our Media provide the latest trends and analysis in the 3D printing industry in English & French. 3D Adept Media includes an online media and a bimonthly magazine, 3D Adept Mag. All issues of 3D Adept Mag are available to download free of charge. Our mission is to help any company develop its services and activities in the 3D printing industry.

3D ADEPT MAG

All about Additive Manufacturing

GET IT!!!

6 issues per year



www.3dadept.com

Contact us !!!

contact@3dadept.com
www.3dadept.com
+32 (0)4 89 82 46 19
Rue Borrens 51,1050 Brussels - BELGIUM

Ready for the 2022 International Catalogue of Additive Manufacturing Solutions ?