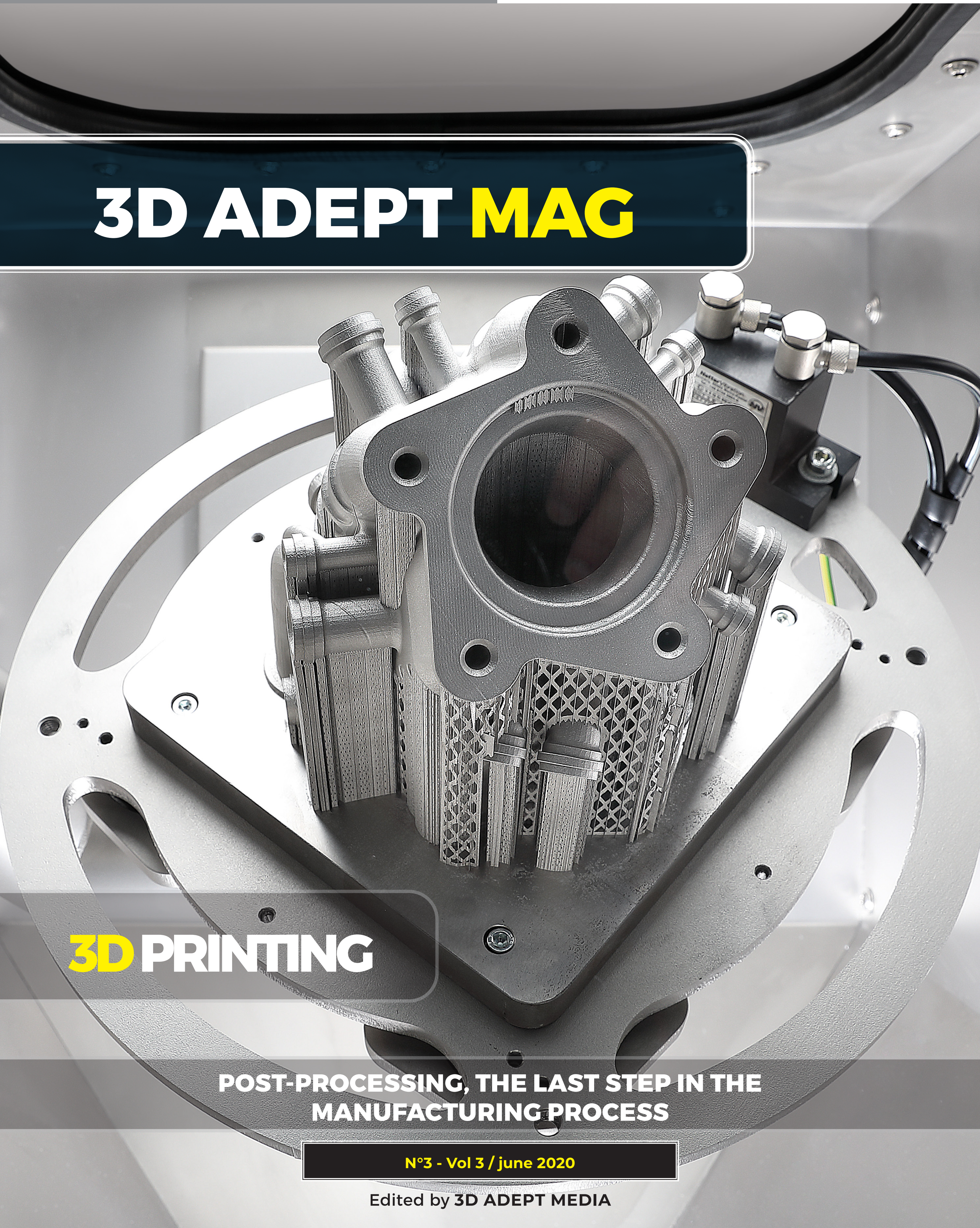
MANUFACTURING

additive



3D ADEPT MAG

3D PRINTING

POST-PROCESSING, THE LAST STEP IN THE MANUFACTURING PROCESS

N°3 - Vol 3 / june 2020

Edited by 3D ADEPT MEDIA

3D Adept Mag

ADDITIVE MANUFACTURING/ RAPID PROTOTYPING/ TECHNOLOGICAL INNOVATIONS

Edited by
3DA Solutions

Creative Director
Benell Delano

Graphic Designer
Martial Y. , Charles Ernest K.

Editorial team
Laura Depret, Yosra K.

Proofreaders
Jeanne Geraldine N.N.

Advertising
Kety Sindze
ketys@3dadept.com
Phone: +32 (0) 4 89 82 46 19

Cover image – credit: Solukon

Questions and feedback:
Belgium / Rue Borrens 51 - 1050 Brussels
Phone: +32 (0) 4 89 82 46 19
Email: contact@3dadept.com
Online: www.3da-solutions.com
www.3dadept.com
3D ADEPT SPRL
VAT: BE / 0681.599.796

Editorial

As an editor, it is hard, very hard to share with you what happened in the industry without any words for the Coronavirus pandemic.

Unexpected urgent needs have come to light through this Coronavirus pandemic. Sadly, another spectrum of existing challenges, yet vital have been left apart and aren't going to solve themselves. These challenges include for instance, poverty, climate change, mental health issues or even racism.

In light of the recent events, that gradually take away any desire to follow the news, I couldn't help but ask myself: **what does the world need right now?** A friend of mine told me: kindness, acceptance, inclusion and solidarity, words that are emotionally charged, but no longer reverberated within me. It was no longer enough. From then on, I remembered the initiatives for gender equality launched by Women in 3D Printing, in our industry, the fight for diversity within companies, solidarity among Additive Manufacturing companies during the Covid-19 pandemic to support frontline workers, and I realized that the common thread of this chain of actions and reactions is that it is always triggered by one single action. That's what the world needs right now. It needs active participants. It needs us, it needs YOU.

If this works for some of the major challenges the world encountered, there is no reason it does not work for our industry. This new issue of 3D ADEPT Mag sheds light on some of these active companies that are investing extra miles, to provide the industry what it truly needs.

Kety SINDZE

Contents

N°3 - Vol 3 / june 2020


solukon

POST-PROCESSING, THE LAST STEP IN THE MANUFACTURING PROCESS

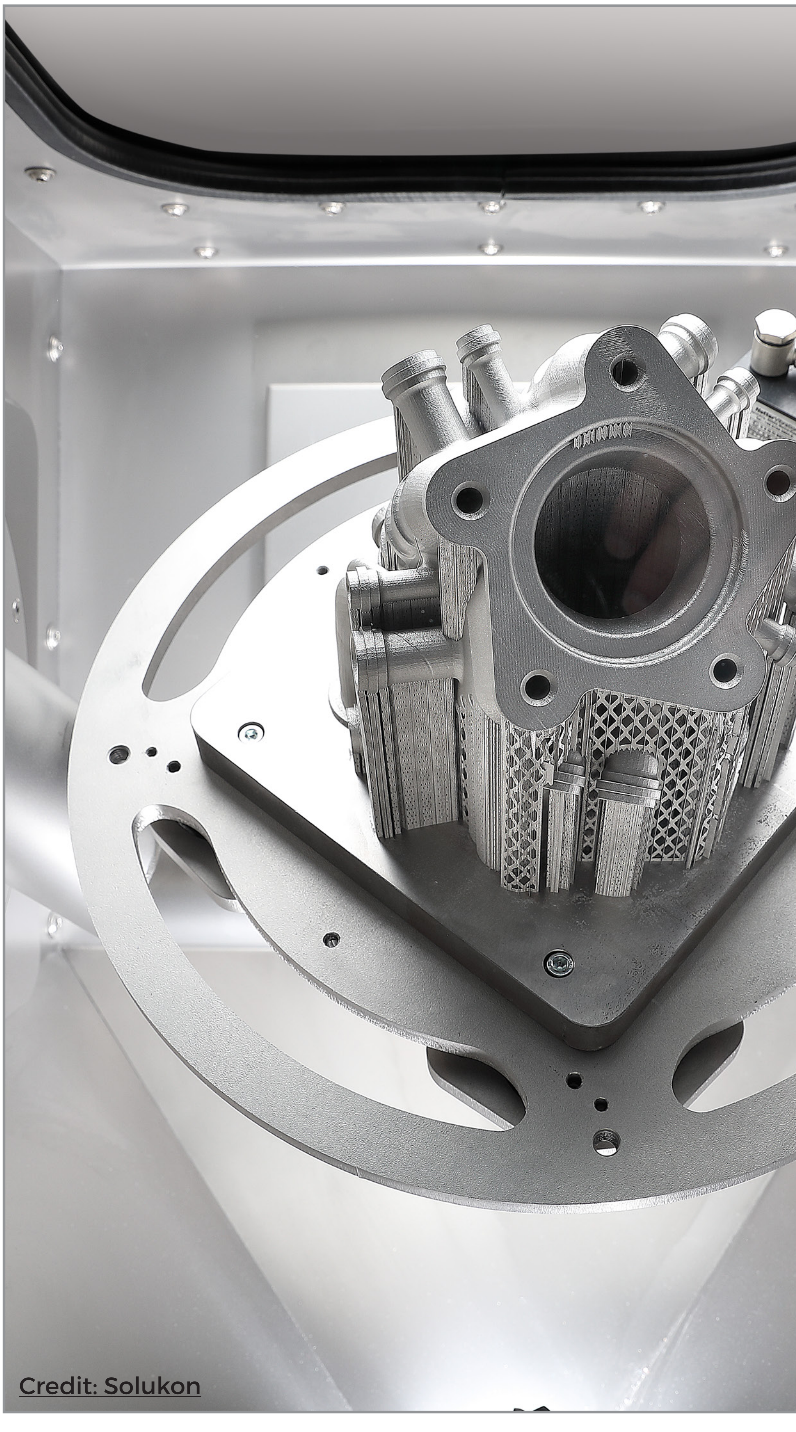
Industrials have spent the last twenty years singing the praises of additive manufacturing but reality shows that if there is one thing that truly enables to appreciate the benefits and the results of this technology, it is post-processing. The only thing is that post-processing is a complex, confusing and sometimes disturbing stage of the manufacturing process.

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. No matter what post-processing stage the AM part needs to go through, the goal remains the same: removing the undesired properties that have been built-in the final product during the additive manufacturing process.

Furthermore, as the name suggests, it takes place at the end of the manufacturing process, and the type of post-processing actions leveraged as well as the amount of work at this stage of the manufacturing depends on many variables including applications.

Post-processing jobs might, therefore, include and are not limited to Heat Treatment, UV Curing, Support Removal, Cleaning & Depowdering, Machining, Coating or Infiltration, Surface Finish Processes, Inspection and Dyeing.

This dossier aims at giving industrials key insights into post-processing, its different segments and its importance in AM serial production. To address this issue, AMT's CEO, **Joseph Crabtree** and **Manuel Laux**, Head of **AM Solutions** will mainly take the floor to share their opinion on several key points. We also thank **FIT AG**, **Solukon**, **Protolabs** and **Girbau**, for the examples provided.



Credit: Solukon

A post-processing stage can bring many improvements such as better aesthetics, geometric accuracy, mechanical functionalities and properties, desired surface characteristics, to name a few. However, to get the product in its "ready-to-use" form, operators face two main challenges:

- The first one is that a large proportion of the tasks carried out after the printing process are manual.

According to AMT's CEO, **Joseph Crabtree**, *"currently, up to sixty percent of the manufacturing costs of a 3D printed part are attributed to the highly manual steps of post-processing, the part after it has been printed. By automating the post-processing workflow, manufacturers will reduce costs by producing end-use parts with a technology that is reliable, repeatable, and reproducible."*

AMT's CEO, Joseph Crabtree

- The second issue is that be it resin, filament or metal, each AM process poses its challenges when it comes to post-processing. In this case, operators should first know the desired results they expect their part to have in order to determine the post-processing step that best suits their project. Furthermore, some post-processing tasks are mandatory for certain applications, others are not.

"Apart from powder-based SLS, HP MJF and binder jetting techniques for plastic components practically all 3D printing systems require support structures for components with overhangs. As part of the post processing process, these support structures must be removed. Also, depending on the printing method, residual resin and powder must be removed. And, finally, the surface of the printed components must be refined by edge radiusing, surface smoothing and, frequently, polishing. On average the removal processes (support structure, resin, powder) and surface finishing account for about 75% of the post-processing work. Other post-processing activities may involve vacuum drying and dyeing of the printed components.

To be cost-effective, these jobs can no longer be handled by manual labour like pliers or old-fashioned immersion tanks for support removal, or hand sanding. This is too time-consuming, produces inconsistent results and is too costly. Preferably, the manual labor and traditional tanks must be completely replaced by fully automated chemical and mechanical systems", explains **Manuel Laux**, Head of **AM Solutions**.

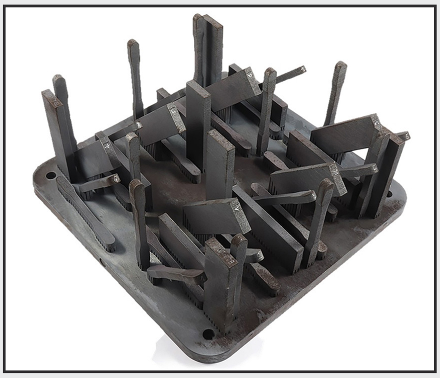
Manuel Laux - Head of AM Solutions

A look at the various post-processing steps

1- Heat Treatment

Several Additively Manufactured metal parts require a heat-treatment solution with precise temperature uniformity. This ensures the printed parts adhere to the metallurgical properties of the selected metal alloy. To avoid major distortion, metal 3D printed parts are usually stress relieved together with the build platform and heat-treated after being cut off from the build platform. This solution is often selected by companies because of the complexity of materials used in the AM process. For aerospace and medical applications, for instance, the AM process has to comply with very strict rules, therefore the benefits of heat treatment lie in its ability to reduce surface contamination and to maximize mechanical properties.

High-Pressure Heat Treatment (HPHT) is a new form of technology used for the consolidation and densification of metal, ceramic, and plastic parts. According to contract manufacturer FIT AG, typical pressures of 15,000 - 30,000 psi, temperatures of up to 4,000 °F, as well as cooling rates of up to 4,500 K/min allow for a maximum theoretical density, ductility, and fatigue resistance of high-performance materials.



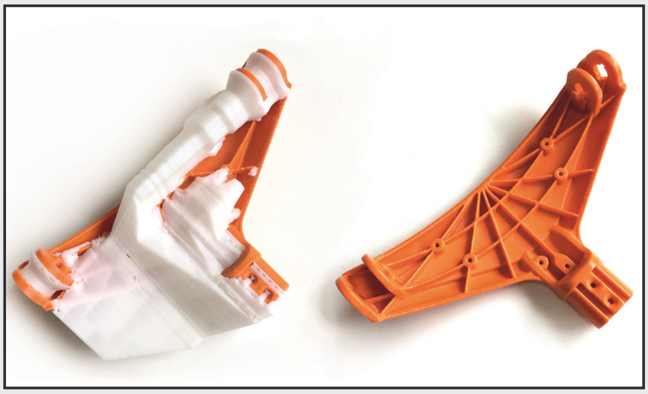
Legend: Heat treated 20MnCr5 on the build platform © GKN Powder Metallurgy

2- UV Curing

This post-processing step is usually compatible with components that have been produced with photopolymerisation processes/resin 3D printing technologies such as Carbon's Continuous Liquid Interface Production (CLIP™), and SLA. Components are exposed to UV light to fully cure to improve the physical quality of the part and enhance the aesthetic characteristics.

3- Support removal

Support removal is necessary with parts that have been produced with resin or filament 3D Printing technology. Put simply, 3D printed components are usually attached to the build plates by scaffolding and support structures which enable the creation of overhanging structures, therefore reduce the degree of warping. These support structures can be made from soluble and insoluble materials. If the material is insoluble, then several accessories can be used (blades) to remove these support structures. However, a soluble support material offers a lower risk of damaging the model as the support structures can be dissolved in water or with a chemical called Limonene. Furthermore, those who would like to reduce the manual work can opt for a more automated solution. PostProcess Technologies, for instance, a partner of AM Solutions, provides various solutions that meet the requirements of these different AM technologies: "With the "Submersed Vortex Cavitation (SVC)" technology the PostProcess systems DEMI and FORTI reliably remove supports and excess resin. For support removal of products made from filaments (FDM/FFF) PostProcess offers the DECI and BASE units using the "Volumetric Velocity Dispersion (VVD)" process", states **Manuel Laux.**



Legend: Post-processing stage achieved by Rösler – AM Solutions

4- Cleaning & depowdering

The term "depowdering" is often used interchangeably with "cleaning". However, if cleaning can refer to the ability to remove support structures for FDM, resin or material jetting technologies, depowdering remains the most explicit word to outline the ability to remove residues of powder that remain in AM parts.

"Depowdering" comes into play when components have been produced with powder-based metal additive manufacturing technologies. It is the first step and current bottleneck of the post-processing chain after the printing process. A wide range of other post-processing steps are often required after this task, that's why some experts prefer to call this stage "pre-processing".

Let's take the example of a complex part produced on a Powder-Bed Fusion system. Depowdering this part will usually require a brush and vacuum cleaner. Thereafter, this part will have to be destressed, sawed-off and tumbled. Depending on the application, further tasks such as CNC and precipitation hardening can be performed. The reflection cost put asunder; these manual processes might take several days before getting the desired end-result. To remedy this situation, some machine manufacturers integrate post-processing steps into their AM systems, other manufacturers and AM users who already have a fleet of AM systems simply opt for an automated powder removal solution.

"A unique trait about AMT's automated post-processing solutions is that all AMT's technologies are safe and sustainable, and specifically designed for

additive manufacturing, unlike other post-processing technologies on the market. Both AMT's depowdering, PostProDP, and surface finishing, PostPro3D, technology gently finish parts on an industrial scale. Not only do AMT's technologies improve the parts aesthetics, they also improve the part's mechanical properties, such as elongation at break (EAB), and eliminate water and gas intake. Using smart algorithms and machine learning, AMT's technologies are equipped with programmed recipes for each common material combination, therefore offering a truly plug and play solution", **Crabtree** told **3D ADEPT Media**.

Another manufacturer that also stands out from the crowd is Solukon. To address issues related to the complexity of parts with channels and voids that retain powder, Solukon has developed a series of automated and programmable depowdering machines that remove powder from finished 3D printed metal parts. German company systems do not only rotate and vibrate in spatial direction to remove the remaining powder, but they also ensure a high degree of protection from hazardous dust build-up, and inert gas infusion to prevent an explosive atmosphere.

Credit: Solukon – Powder removal system

5- Surface finish processes

Depending on the application, 3D printed components may require a further surface refinement by edge radiusing, surface smoothing and, possibly, polishing.

In a surface refinement process that combines blasting and finishing systems, Laux from Head of AM Solutions explains: *"the initial surface of 3D printed parts can sometimes be quite rough with Ra readings of up to 1,000 micro inches. In such cases, it can be beneficial running the workpieces through a blasting process for an initial reduction of the surface roughness before processing them in the actual finishing system. This allows reducing the Ra values down to < 20 micro inches."*

If the operator is looking for extra smooth surfaces on metal components, AM Solutions can offer a *"finishing system producing extremely fine surface finishes with Ra values of < 5 micro inches on 3D printed metal components. This is achieved with the patented DRYLITE® dry electro-polishing technology, which does not require any liquid electrolytes."*

Moreover, the term finishing designates a range of post-processing activities such as priming, filling, grinding, preparing ready for painting, deburring, etc. They are generally used as the basis for further post-processing, such as metal coating.

6- Machining

Parts may require additional machining to remove further support structures. This post-processing task can be done after almost any AM processes. It is required for metal processes that do not deliver geometries close to the final contour.

7- Coating or Infiltration

Coating consists of the infiltration of microporous components with polymers. The goal of this activity is to produce components that are completely gas-tight or liquid-tight.

8- Dyeing

If the visual appearance of your powder-based polymer parts needs to be improved, then you probably need a dyeing post-processing step. Dyeing can be performed, either manually in pots of hot water or using automated dyeing equipment. This post-processing technique is mostly leveraged by HP MJF users. The results are most visible on parts that are subject to wear (glasses for instance), as the color penetrates the surface of the part. **Girbau**, for instance, is one of the specialists of the dyeing equipment industry that designed its equipment for HP MJF.

9- Inspection

This post-processing step allows for the validation of a part's dimensional accuracy and mechanical properties. It is usually seen as a benefit in on-demand manufacturing situations. One Industrial manufacturing services supplier that integrates detailed measurement and inspection reporting services to its offering is **Protolabs**. The company explained that the *"inspection process verifies that final parts comply with the original drawing, purchase order, and other specifications. Dimensional inspection uses CMM equipment to ensure part dimensions are within tolerance and align with measurements provided in the original drawing.*

Final report details location on the build plate, how the geometry was oriented, support structure placement, and a build log file detailing the entire build process from the machine."

Taking the example of parts that have been manufactured through Direct Metal Laser Sintering (DMLS), the manufacturer of parts explains that computed tomography (CT) scanning is often the ideal inspection method for these parts. Indeed, it offers a non-destructive means to part validation. According to Protolabs, the process can be used to inspect and validate hollowed-out features or internal channels. It can measure any variances in wall thickness, or detect warping and cracking. Lastly, it can verify that no residual powder remains within the part.

Can the same post-processing technology be compatible with several types of additive manufacturing technologies?

First, it should be noted that specialists of post-processing technologies usually develop their solutions to respond to specific demand of the additive manufacturing industry. Over time, applications tend to extend their area of expertise to other technologies.

Moreover, choosing among the array of AM technologies the ideal process for one's project is quite complicated. However, despite the numerous aforementioned post-processing techniques, the choice can quickly be made for a post-processing solution.

"A small number of post processing equipment, be it for removal of supports and residual resin, de-powdering & cleaning or surface finishing, can be used for whole groups of additive manufacturing technologies. For example, for de-powdering, cleaning and initial surface smoothing the AM Solutions S-Line equipment can be used for plastic components and in terms of metal for initial surface smoothing.

When it comes to surface finishing of the same plastic or metal components the AM Solutions M-Line equipment line is suitable", says AM Solutions' **Manuel Laux**.

Furthermore, experience in various applications might easily enable operators to determine the ideal post-processing technique for their project.

In tooling applications, for instance, the texture of parts at the end of the printing process is similar to corduroy. That's why those parts need to be machined after the printing and cooling processes.

Lastly, **similarities and disparities between additive manufacturing technologies must absolutely be taken into account**. Binder jetting, for instance, presents postprocessing requirements similar to Fused filament fabrication (FFF). Metal FFF parts, on the other hand, might require further investments in post-processing. Indeed, with this AM technology, the raw material is made up of a filament with a plastic or wax binder heavily loaded with metal powder. The binder must be removed once the part is right out of the machine. Thereafter follow a debinding with heat or an acid bath and a sintering step.

"It's not just about making parts look good, it's about improving the mechanical properties of the parts for high performance."

Additive manufacturing itself has proven its capability to cut down production times to just a few days. However, its viability for volume and serial production is not yet unanimous.

For **AM Solutions**, *"to a large extent, this is due to laborious post processing methods characterized by a preponderance of manual labour, use of old-style methods and lack of automation. The outcome is extremely time-consuming post-processing, inconsistent results with low throughput and very costly. Only with automated, intelligent post-processing solutions can additive manufacturing be truly integrated into industrial production lines. But automated post-processing will achieve a lot more: It will allow full usage of the printer capacities resulting in significantly reduced cycle times, an overall higher throughput and a drastically improved cost-efficiency. It will produce a consistently high quality of the post-processed components, thus significantly reducing the reject rate (less warpage & swelling due to water absorption, less breakage, etc.).*

Welcome side effects of integrating automated post-processing treatments are lower work-in-process inventories, better workpiece traceability and higher workplace safety (manual de-powdering can be hazardous)."

"To scale post-processing safely and sustainably, new technology development and automation are key. It's not just about making parts look good, it's about improving the mechanical properties of the

parts for high performance", adds **AMT**.

Collaborations between 3D printer manufacturers and post-processing systems suppliers on the one hand, as well as collaborations between AM users and post-processing specialists, will certainly foster the integration of more automated postprocessing solutions in AM productions, but understanding these concerns, and disparities is a crucial key to serial production.

Note to the readers:

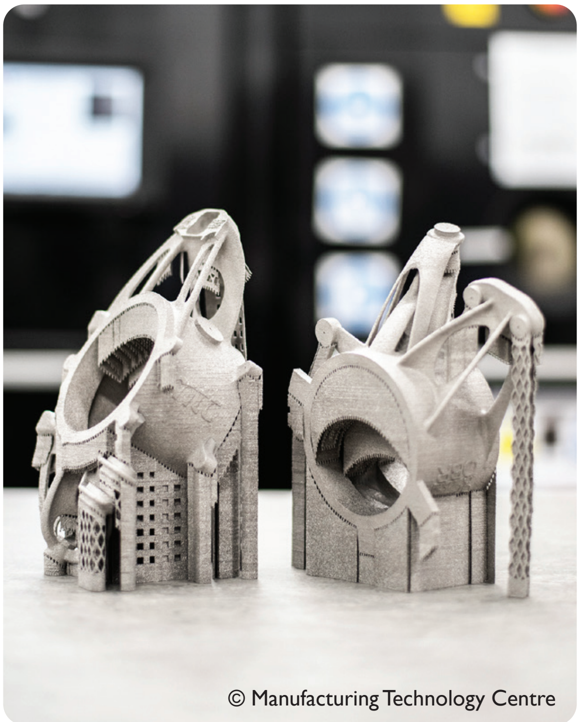
Rösler provides a wide range of solutions in the field of surface treatment across many industries. The company bundled all its activities around additive manufacturing under the brand name "AM Solutions". Under AM Solutions - 3D post processing, they develop customer specific post processing solutions and furnish suitable equipment for AM technologies; and under AM Solutions - 3D printing services, they provide a broad spectrum of services ranging from design support for 3D printed components, over sub-contract 3D printing to machining and surface finishing.

AMT, short for Additive Manufacturing Technologies Ltd, offers a range of depowdering and surface finishing solutions designed specifically for additive manufacturing applications. All of AMT's technologies are 3D printer material agonistic and works with all powder-based printer platforms including HP Multi Jet Fusion, EOS, and 3D Systems, as well as a range of thermoplastic polymers such as polyamides and elastomeric materials.

PM *Life*

LIFELONG LEARNING IN POWDER METALLURGY

ADDITIVE MANUFACTURING



© Manufacturing Technology Centre

24-28 August 2020 | Dresden, Germany

For those wishing to gain profound insights into the current state of Additive Manufacturing technologies for metal and ceramic parts, including non-beam methods like binder jetting and fused filament fabrication, this is the perfect place to be.

The unique abundance of dedicated AM labs of four Fraunhofer institutes, as well as the strong industry presence, ensures that this intense course is up-to-date and of practical relevance. The program includes plant and lab visits as well as practical hands-on exercises.

REGISTRATION DEADLINE	10 August 2020	LOCATION	Dresden, Germany

Email: dn@epma.com | **Registration forms and prices at:** www.pmlifetraining.com/additive-manufacturing

eit RawMaterials ACADEMY

EPMA european powder metallurgy association

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

A MATTER OF LIABILITY

*If there is one area where health and medical 3D Printing differ from general 3D Printing, it is **liability**. The term has never been so controversial than in this field. Indeed, 3D printed medical and health-related models can result in various forms of liability issues, and surprisingly, one way to avoid liability issue with 3D Printing/Additive Manufacturing is to ensure that **post-processing has been completed properly.***

Most of the times, we usually talk about post-processing challenges in demanding industries such as aerospace, space or even automotive. Reality shows that any fabrication utilizing additive manufacturing can require a form of post-processing stage, or "pre-post-processing", as per the words of Solukon's CEO **Andreas Hartmann**.

In the medical 3D Printing industry, this stage is even more complex as professionals manufacture complex parts that are often inserted in the human body. The risks that might occur in such a vital environment often lead to more challenges than expected, as told by French company **Coulot Décolletage**.

Founded in 1985, Coulot Décolletage provides aerospace companies with various components it manufactured using conventional manufacturing processes. A decade later, in 1996, the company reaches a fundamental milestone and decides to gear product offering towards the medical industry. Several certifications and various collaborations with international medical distribution groups in hand, Coulot Décolletage is acknowledged today for its ability to manufacture complex products including medical prostheses or implants for the spine, orthopedics and neurology fields.

In 2016, the company begins to leverage additive manufacturing in its production workflow. Satisfied with the results, it gradually constitutes its additive manufacturing production portfolio. At present, with two metal additive manufacturing systems and one polymer 3D Printing system, the medical parts manufacturer can produce complex parts, improve osseointegration and save production time and costs.

"This technology has opened up new avenues for product development. Indeed, the designs are more optimized and the material is used only for its strict utility", states **Saby Eric,** AM Manager at Coulot Décolletage.

What the team at Coulot Décolletage did not know, it is the challenges they were about to encounter after the printing process.

COMPLIANCE WITH REGULATIONS BUT NOT ONLY…

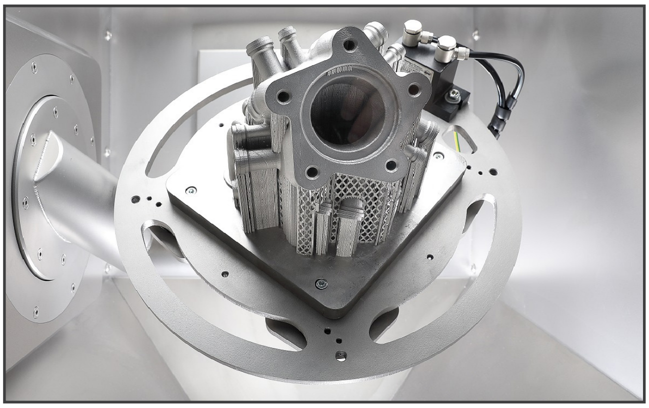
First, as discussed in the March/April issue of 3D ADEPT Mag, several considerations should be taken into account prior to investing in additive manufacturing technologies. As a reminder, these considerations fall into four main key areas which include **machine and tooling costs, production environment, design for additive manufacturing, and the stages that follow the printing process (better known as post-processing).**

In the case of our French company, the production environment and the postprocessing stage were even more crucial as the company handles complex materials.

Due to handling of complex powders in their working environment, and to comply with the French governmental decree of 05 December 2016, the *"first challenge was to put in place a building that meets all the regulatory requirements related to powders"*, explains the company.

Once it was done, the next challenge occurred: the removal of powder residues in the internal structures of additively manufactured parts. *"The parts produced by additive manufacturing always contain powder residues that we cannot remove manually. In addition, the complex geometries do not facilitate the "depowdering process". We therefore need to "de-powder" our part before the heat treatment, otherwise the powder will be sintered in the part and the part will be thrown away. [Not to mention that with regard to] medical requirements, we must work on clean, powder-free parts. That's the reason why we turned to Solukon, a company which offers depowdering machines"*, adds the AM Manager at **Coulot Decolletage**.

What the company appreciates the most is *"the vibration system coupled with the rotation of the platform under inerting"*.



THE UNIQUENESS OF MEDICAL APPLICATIONS

Unlike other industries, applications of additive manufacturing in the medical industry have to meet the most stringent requirements. Parts accuracy, cleanliness and even compliance with regulations and medical standards per country are just some of the key features that enable the manufacturing process in this field to stand out from the crowd.

Interestingly, additive manufacturing turns to be the ideal candidate for the production of some parts. Parts that should be customized to fit the body of a patient for instance, parts that integrate complex geometries or parts with bionic forms and structures are best produced via AM.

"AN EFFECTIVE DEPOWDERING MUST BE APPLIED"

Solukon has gained extensive experience in various powder removal applications across industries. Through its automated powder removal technology, the manufacturer aims to close the gap between manufacturing and post processing.

The company is using the SFM-AT-300 to remove the remaining powder on the part. However, removing that powder manually was really time-consuming for Coulot Decolletage.

Indeed, before the integration of Solukon's technology into its production portfolio, Coulot Decolletage used to leverage manual powder coating for such tasks. Not only this method is *"obviously insufficient"*, but it "cannot be repeated on 1000 parts", explains **Saby Eric**.

Imagine a scenario where a 3D printed intervertebral cage still contains a lot of powder after the fabrication stage and the damages it can cause into a human body if this postprocessing stage is not met properly. Therefore, to prevent this powder from sintering in the lattice structure, it is crucial to entirely remove the powder.

One advantage brought by Solukon in this regard, is automation. *"The machine is easy to use, efficient for depowdering the parts and safe [for] ATEX materials such as titanium"*, completes the operator.

The only thing is that, *"the more complex the structures of the components are, the more complex is the task of meeting the demands for fast and reliable cleaning. The materials used, such as Titanium, meet all requirements but are expensive and difficult to handle due to their flammability"*, explains **Hartmann**, Co-founder and technical director.

Solukon's cleaning method addresses these issues with its systems. By using the company's system, the operator collects the powder released during cleaning for reuse.

Furthermore, Solukon has also been able to address another peculiarity of medical 3D Printing: the **size of components.**

As parts produced for the medical industry are usually small, it is possible to arrange several parts on the build tray. The only thing is that, the production of several parts this way, is usually performed with a small Z-dimension, which might lead to short production times but might increase the need for quick unpacking and cleaning.

To address this limitation, Solukon has developed the SFM-AT200 system. The system which is a particular good fit for medical applications, *"is characterized by a geometrically optimized process chamber, which is flooded with protective gas in a very short time. Thus, the cleaning time including non-productive times such as loading and chamber inerting can be reduced to a few minutes. Serial cleaning processes are now easily possible"*, says **Hartmann**.

"The simple and compact design saves installation space, inert gas and acquisition costs at the same time. Due to the good accessibility for cleaning and filter change, a material change can also be carried out in a short time. Considering the requirements of the medical-AM production, the SFM-AT200 is the right choice", adds **Michael Sattler**, Global Sales Director.

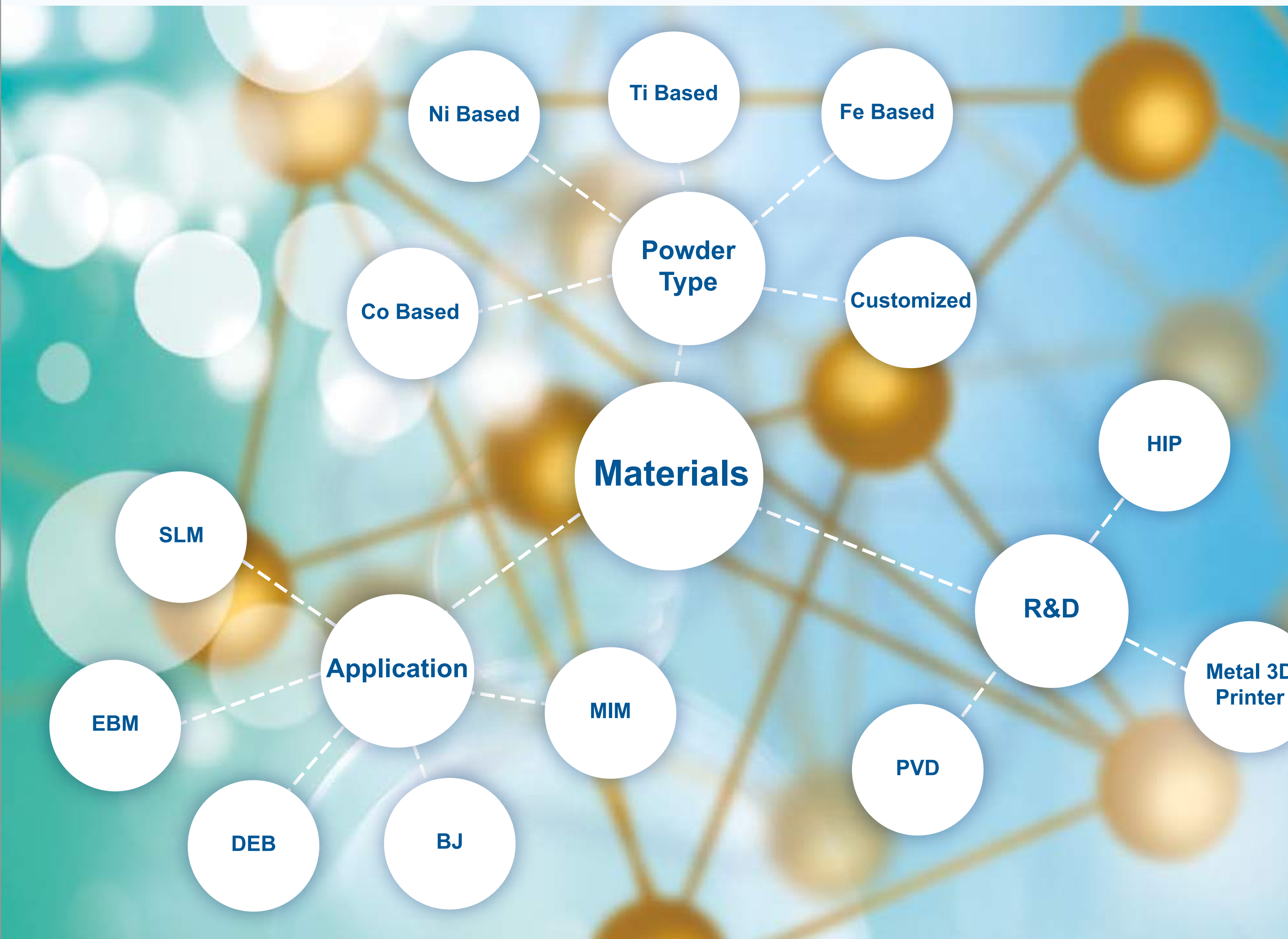
Solving a depowdering and cleaning issue is not an easy task. A constant manufacturing environment will be pointless if scaling and automating post-processing operations remain a hurdle. Ultimately, the appropriate post-processing solution in place opens the door to a high degree of repeatability and productivity. More importantly, for a vital industry such as medical, it somehow leads to the development of medical devices that are safe enough to be inserted in the human body, and that becomes a matter of liability.

悦安微特
UNIFINE

Material Technology
Innovations Co., Ltd.
纳联材料

MTI

Specialized in AM metal materials



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

“Air treatment is to production environment what materials are to 3D Printers”

Over the past 40 years since the introduction of 3D Printing, 3D Printer manufacturers have been looking for various solutions to improve technology and achieve the right first-time additive manufacturing process. They have been addressing issues at various levels: software, hardware, materials but they rarely considered the production environment.

As we write these lines, we cannot help but think about what we learned during this trip we took to Sweden to visit an additive manufacturing (AM) plant: part of building a great company is having the right facilities and the right tools for the teams, customers and suppliers to work with, and developing the best possible products. In industries that require a production environment, this means understanding how external elements can impact the manufacturing process and the working environment and learning how to “manage what seems to be out of control”: dusts, fumes, odours, gases and vapours.

The issue might seem trivial yet is crucial and addressing it the right way can literally help any manufacturer save money. Companies that are uniquely positioned to understand such a situation are air technologies providers, and an exchange with **ULT AG** tells us how.

“THREE DECADES LATER, AN ENTREPRENEURIAL MINDSET AND A MULTIFACETED PORTFOLIO”

Put simply, ULT AG, short for Umwelt-Lufttechnik (environmental air technologies), specializes in extraction, filtration, and air-drying technology. The company’s journey started 26 years ago in Löbau (Germany) with the single goal of removing hazardous particles in various manufacturing processes including laser processes, soldering operations or welding processes, to name a few.

More than two decades later, a well-established international customer base and distribution network, and a 130 certified staff in DIN EN ISO 9001, we rediscover a company whose entrepreneurial mindset has led to the development of a multifaceted portfolio.

Alexander Jakschik, Managing Director/CTO at ULT AG

"The company's solution portfolio ranges from mobile extraction units for manual workstations and tasks under limited space, stationary systems that can also be integrated into production lines, to complete hall extraction or support of large systems.

In addition to turnkey solutions, ULT AG develops and produces special devices for particular applications. That happens in close cooperation with the customers. ULT does not sell systems but provides solutions that fit best with the respective application. If required ULT develops customer-specific fume extraction systems, also certified according to ATEX and W3 and tested to meet H requirements.

In support of capturing efficiency, ULT provides extraction elements and suction arms, designed for specific working situations and applications", states **Alexander Jakschik**, Managing Director/CTO at ULT AG.

Over time, research shows that every plant is unique and needs to meet many specific requirements for optimal comfort to be obtained. Manufacturing facilities for instance, are high-bay buildings, which sometimes require both heating and ventilation systems. Such constraints mark the beginning of ULT's collaborative efforts with engineering offices to develop complete air handling systems.

More importantly, as there is always room for improvement, the air technologies specialist has made cooperation with research institutes and universities a top priority. At present, the company has created a global network for research and development issues, especially in the fields of future technologies and processes.

Very early, the first tangible AM applications unconsciously marked the importance of gas cleaning to process argon and nitrogen, inert gases which are usually present in the production environment. Interestingly, as the market is still considered a nascent one, it is crucial to develop a dedicated product offering whose focus would be advice and product assessment on everything related to air pollution control, occupational safety, air drying in plastic and metal AM processes.

"ADVICE & PRODUCT ASSESSMENT"

"ULT has always been a company that was very early on adapting to technological changes and innovations. We have always been one step ahead in technology. It was the same 20 years ago when the first AM applications appeared, and we needed gas cleaning to process argon and nitrogen. Since then, we have consistently developed our product portfolio in this area", explains **Boris Fruehauf**, Key Account AMF with ULT.

In this vein, the additive manufacturing industry can benefit from inter gas cleaning in laser sintering, laser melting, laser applications as well as in similar processes. It can also take advantage of process air drying for powder handling which ensures good process quality of the powder. Furthermore, ULT can advise and provide fume extraction solutions for powder handling, at post-processing workplaces, as well as industrial vacuum cleaner for cleaning construction chambers and the entire ventilation technology concepts for sites using additive manufacturing.

THE DEVIL IS IN THE DETAIL

ULTs aforementioned commitment to the additive manufacturing industry is clearly stated: advise, assess and customize when possible. In theory, ULT AG has understood the needs of the market and has developed a wide range of services that this market can take advantage of, but in practice, the market is very far from having understood where the issue is.

It's already been three years that we ask additive manufacturing experts what they expect for every new year, and the common thread of all responses is to be able to move AM to series or mass production. We are almost there but not yet. Laudable improvements have been made at every level (material, hardware and software) but not at this one. In the end, reality shows that it's a matter of awareness. Air treatment is to production environment what materials are to 3D Printers.

"It does not work without it. Gas cleaning is essential for a functioning process. The difficulties lie in the details and, hence, it shows that many companies with 3D printers after the initial «gimmicks» and gaining experience are now reaching their limits with large construction jobs or series production. Some still have this learning curve in front of them and try to improve it. ULT can help and provide solutions based on many years of know-how in industrial extraction and filtration technologies.

But one thing should be said, there are no standard systems that fit all types of 3D printers in the PBF or SLM process, these are always special adaptations. However, the ULT has advantages in this area because it uses standard components from modular systems. These are constantly being further developed and this also includes extraction accessories, e.g. for post-processing, or on topics such as air drying that play a major role in preventing corrosion of steel powders. The world of extraction in the AM plastics area is still at the very beginning. The industry has just started to take air cleaning or the filtration of harmful substances and smells more seriously" continues Fruehauf.

Boris Fruehauf, Key Account AMF with ULT

Luckily, this is just the beginning. Metal additive manufacturing users and machine manufacturers of powder-bed fusion technologies and Selective Laser Meting technologies are leading the learning curve but there is still a long road to go as plastic SLS, FDM and SLA 3D printers' users increasingly face issues related to gas cleaning.

Harnessing gas cleaning solutions is a big move, but one which will enable any large manufacturer to bring safety, quality, turnaround time and costs into its direct focus. The issue took a certain amount of time before it comes through the pipeline, but it has now and ULT AG is looking forward to contributing on this field with its air technologies solutions.

This content has been written in collaboration with ULT AG.

BRIGHT LASER TECHNOLOGIES

BLT
Stock Code: 688333
STAR Market in China

Metal 3D Printing Specialist

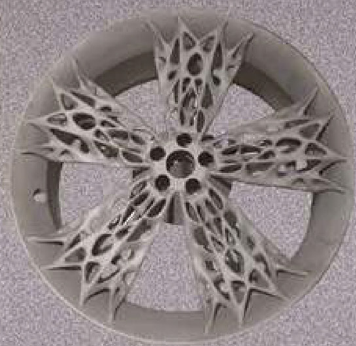
BLT can provide a integrated technical solution of metal additive manufacturing and repairing for customers, including customized products, equipment, raw materials, software and technical service.

BIGGER THAN BIGGER

BLT-S500： 400X400X1500mm (Forming Size)
BLT-S600： 600X600X600mm (Forming Size)

Irregular Shaped Tube
1100mm

Fan Blade Bordure
1200mm



Wheel
Φ485X210mm

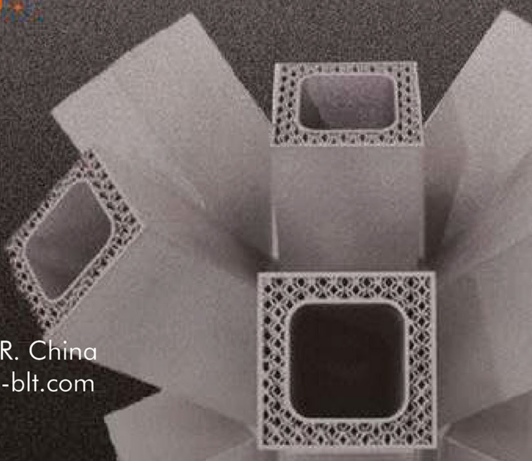
BLT Brand Metal AM Equipment

Supporting Materials:

Titanium Alloy, Aluminum Alloy, Copper Alloy,Superalloy, Stainless Steel, High-strength Steel, Die Steel, Tungsten Alloy

Powder Production:

BLT-TA1, BLT-TA15, BLT-TC4



No.1000 Shanglinyuan Seven Road, Hi-tech Zone, Xi'an City, Shannxi Province, P.R. China
+86 029-88485673 sales@xa-blt.com/marketing@xa-blt.com e.xa-blt.com

FOCUS ON COVID-19

ENVISIONING A POST-COVID-19 WORLD FOR OUR INDUSTRY

NORA TOURE

As most European countries and states in the US are initiating a post-COVID-19 phase and lifting some of their restrictions, I can't help but think about what's next for our industry.

We probably can all agree that the COVID-19 crisis got 3D printing "on the map". I hate to think about this pandemic in any positive way at all, but I got to say, as an industry, it triggered the best in us. We started working together, towards a same goal, organizing ourselves on an individual, but also on a corporate level, forcing us sometimes to refocus on our core business and technology.

In just a couple of months, over a hundred of 3D printing COVID-19 responses, and probably millions of 3D printed personal protective equipment pieces later, here we are, trying to get back to business as usual.

But what does business as usual mean in a post-COVID-19 world?

Have priorities changed for our customers? Is there still room for additive manufacturing?

How do we make our small, and sometimes not so small, 3D printing business to survive all this? Grow and thrive from this unprecedented crisis?

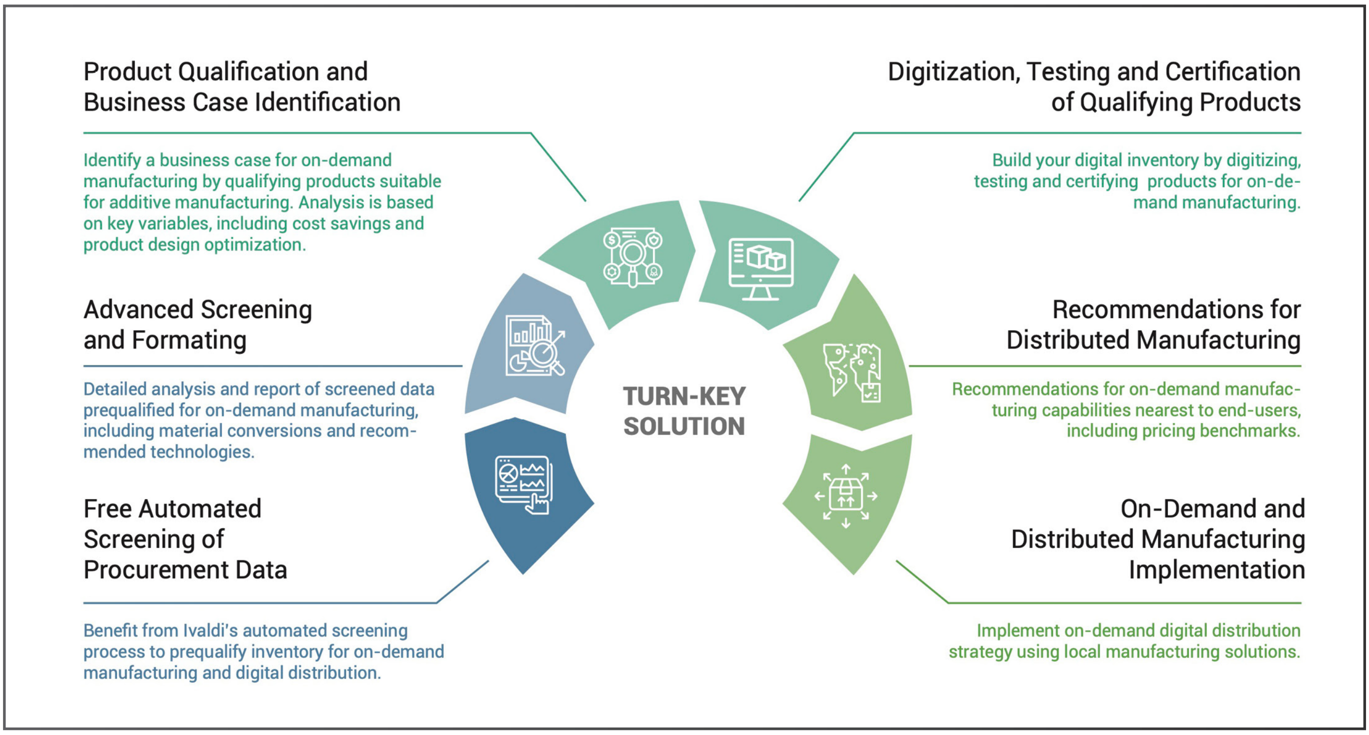
What does business as usual mean in a post-COVID-19 world?

As we step away from manufacturing free parts for first-respondents, let's maintain some of the maker spirit we all went back into during this crisis.

A few weeks ago, I wrote about organizing 3D printing for emergency responses, covering some of the technical challenges of the 3D printing responses to COVID-19 and the need for a global and coordinated answer. Having a global and quickly deployable emergency manufacturing response solution to face catastrophes, sanitary, economic or political crisis has to be a top priority. And additive manufacturing has a role to play in being one of the tools in this global toolkit. We've proved it a million times the last couple of months.

With that being said, getting back into business as usual means getting back into the habit of charging customers for products and services we are providing. Catching up with our internal roadmap. Meeting our 2020 KPIs if we still can. Re-hiring our talents we had to let go. Growing. Thriving. Surviving COVID-19.

As we're re-shifting back into business as usual, though, we might have to adapt our businesses to our customers' new priorities in light of the worldwide recession. I can't talk for all 3D printing companies obviously, but from my experience with Ivaldi Group, we have found a new business as usual. We have gone from providing distributed manufacturing solutions to a select number of customers to opening up our expertise by offering consultancy services and automated tools to heavy industries and first-necessity industries who are lacking the flexibility of a rapidly deployable distributed manufacturing solution. The problem we elected to answer is that most companies don't have a clear and organized view of their procurement data enabling them to quickly assess rapid-manufacturing solutions. We believe it is fundamental to know what we're dealing with as a starting point before implementing drastic changes into the supply chain. And we've decided to help by doing just that.



Whatever your niche expertise in 3D printing is, think about how you can adapt it to these industries who have been hit the hardest by the COVID-19 crisis.

Is there still room for additive manufacturing in light of new top priorities?

Chances are, at least a few of your major clients have been impacted by COVID-19, or are about to be impacted the longer the crisis goes.

Will their business priorities and decisions change? Probably.

Is it a good thing for you? Maybe.

I bet meeting 2020 KPIs is the #1 priority for you and, guess what, for your customers too. KPIs vary from one business to another, but signing customers while reducing production costs is probably not too far from the top of the list for everyone.

With that in mind, what role is there for additive manufacturing in helping our customers meet their KPIs?

The usual shebang is still valid: faster production, cost-effectiveness, easy operator training, no minimum quantity, variety of available materials...

And then, there is more:

As we've witnessed the world going crazy over ill-managed stocks of essential goods (I am definitely not talking about your toilet paper but rather essential PPE items), and the 3D printing community, among other unrelated industries, stepping up to fix failing supply chains, we need to look into the root-cause: no country is self-sufficient anymore. Not even China.

There is room for new business models. It is becoming critical to have, even just as a back-up, but ideally for every-day production as well, a global distributed manufacturing solution in place.

And that is definitely something additive manufacturing can help with. But it's probably not something we can do alone. We will need to work with public institutions and our customers towards this objective.

So, the short answer is: yes, there is still room for additive manufacturing. Probably more than ever actually. It's up to us to find the right angle for everyone else to see what's obvious to us.

How do we survive this crisis, and even thrive from this situation?

Whatever the size of our businesses, we've all been impacted at various degrees. Our industry is not a stand-alone industry. We are a technology; we exist thanks to our end-users. End-users who are not robots, but human beings, who are already busy refocusing their own business, dealing with remote-working, the ton of online webinars and digital events they're either attending or presenting to, their kids, the dog and the pile of dishes to be washed, in addition to being scared as hell from catching this disease from their last trip to the grocery store.

So, how do we survive this crisis and bounce back?

As stated above, here is an opportunity to refocus on our core businesses too.

Customers who didn't know anything about additive manufacturing before COVID-19 won't come out of this crisis as experts in 3D printing. There will still be, maybe even more than before actually, a need to educate our customers, at various levels, from beginner, early-stage to advanced and in-depth work.

For the most advanced clients, those who are already aware of the benefits of an additive manufacturing strategy for their core business, it will be fundamental to secure the position of 3D printing based on their new priorities.

Let's also utilize this time to continue our worldwide reconnections with other 3D printing professionals, thanks to online conferences, webinars, meetups etc...

Even as countries open up their borders, travel restrictions initiated by companies will be extended for the next few months, some might even say, until the end of the year. We need to think of a way to still conduct business while missing a good handshake that closes a deal.

Let's also reflect on how 3D printers can be more autonomous and more remote-work friendly. I, for one, would like to see more 3D printer manufacturers / software providers collaborations in the future.

I am sure we can come out of this crisis stronger, more focused, and with an actual plan to, maybe not save the world, but at least making it a step closer to being efficiently connected and collaborative.

About Nora Toure

Founder @Women in 3D Printing | VP, Strategy @Ivaldi Group | TEDx Speaker | 40Under40 Bay Area

With 10+ years' experience in additive manufacturing, Nora Toure has a deep understanding and experience of the manufacturing ecosystem.

Her latest publication, «Organizing Additive Manufacturing For Rapid-Emergency-Responses», covers some of the technical challenges of the 3D printing responses to COVID-19 and the need for a global & coordinated answer.

RECYCLED MATERIALS FOR 3D PRINTING: CAN WE EFFECTIVELY FILL THE GAP BETWEEN PLASTIC WASTE AND AM?

Legend: 3D Printed pavilion made from recycled plastic bottles – Credit NAARO

A team of researchers from the University of California (Santa Barbara) recently discovered that more than 9 billion tons of plastic have been made since the 1950s, and the great majority of it has been thrown in the trash. Plastics are used everywhere, including in the 3D printing industry. Logic would have it then that, since this technology is considered as a sustainable manufacturing process, it would enable less waste, especially at the materials level, hence the increasing use of recycled materials as an alternative. The only thing is that this alternative raises several questions regarding its viability, and effective use for leveraging AM as a mass production tool or a series production tool.

What is special about recycled materials for 3D printing? What are the differences between recycled and non-recycled materials for 3D printing? Speaking of plastic materials, can all types of plastic be recycled for 3D printing? Or is there a specific type of plastic that can be recycled? Can the recycled and printed filament be recycled again? What about the quality and characteristics of these filaments compared to non-recycled filaments? Do recyclable materials present any advantages for mass production in AM?

By answering these questions, we aim to give industrials that leverage 3D printing, key insights that will help them to determine, whether or not, they can consider the use of recycled materials in their series production or mass production workflows.

Mogens Hinge will join us in this discussion. Mogens is associate professor at the Department of Engineering at Aarhus University. He's leading the research group called Plastic and Polymer Engineering. Together with his team, they are currently involved in a research project that consists in transforming recycle plastic waste into a standardised filament product for the AM industry.

Legend: 3D Printed pavilion made from recycled plastic bottles – Credit NAARO

RECYCLED VS NON-RECYCLED MATERIALS FOR 3D PRINTING

According to Hinge, in terms of usage, apart from the fact that the material is recycled, there is not a great difference between recycled and non-recycled materials for 3D printing. However, doubts remain regarding the properties they are supposed to deliver.

Indeed, be it grinded, melted and extruded, filaments that have been recycled and 3D printed should have the same material properties than other forms of filament. For makers, producing their own filament at home might be cost-efficient if they do it properly as they could save up to 80% on filament costs. The only thing is that while they sacrifice quality, they often end up with a lower grade of plastic, which did not always integrate the properties of the desired material.

When asked about the quality and characteristics of recycled materials for 3D printing and non-recycled materials, the Associate Professor at Aarhus University (Denmark) explains: "there is so much (maybe even all) undocumented, good and bad filament on the market today. In most cases, you only know the material type (e.g. PLA, ABS, PETG) and the thickness (1.75 or 3 mm Ø). In some few cases, there is also a printing and bed temperatures (often generic). Thus, no quality or characteristics are supplied for 3D printing filament today, why should this be different for recycled materials? It is a common mindset we face all the time that now that it is recycled then we need documentation. Most consumers have never looked at the documentation for virgin material and most cases do not have it at all. Thus, what will the knowledge of, e.g. Tg and melt-flow-index for a recycled 3D printing material be compared to [non-recycled materials]? If you ask, does it print - Yes to a very high quality, good bridging, minimal stringing, low oozing, good bed adhesion, etc."

On the other hand, material producers or researchers that often leverage more technical expertise develop proprietary methods to produce recycled filaments that meet the desired production properties.

Reflow, for instance, is a Dutch company that develops an approach to recycle discarded plastic into a range of sustainable materials for 3D printing. The company utilizes "monomer recycling" to chemically break down plastics, removing therefore this issue of degraded performance in recycled filament.

What type of material can be recycled for 3D printing?

"In theory, all plastics can be recycled, but there are plastic types (e.g. PVC) that degrade heavily during processing and thus would be less suitable for recycling. It is clear that some types of plastic will not make sense to recycle as 3D printing filament, as not all plastics are suitable for 3D printing", said Hinge.

Let's take for instance the two most-commonly used filaments in the 3D printing industry: PLA & ABS.

ABS on the other hand is acknowledged for its electrical properties and its flame retardancy capability. Heat and chemical resistance make it a suitable option for many applications. However, studies have not yet found if such type of plastic can be recycled for 3D printing.

To avoid plastic waste, researchers and companies have been studying what kind of materials can be recycled for 3D printing. The goal is to avoid plastic waste while developing a filament that can enable many 3D printing applications.

In this vein, Hinge is currently collaborating with the largest plastic recycling company in Scandinavia, Aage Vestergaard Larsen A/S, as part of a new research and development project. The project consists in developing a standardised, documentable 3D printing filament of high and stable quality from recycled plastics.

Speaking of the situation in Denmark, Gitte Buk Larsen, business developer and marketing manager at Aage Vestergaard Larsen A/S, said three reasons explain the raison d'être of this project: "firstly, it hasn't yet been possible to produce filament from 100% recycled plastic. Secondly, no one has cracked the **code for producing filament based on** a data sheet in order to ensure uniform quality. And thirdly, there are currently no filament producers in Denmark."

It did not reveal its recycling method but Dutch company Reflow has decided to bet on PETG for recycling, a material that is gaining momentum in the industry and which combines the functionality of ABS and the easy printing of PLA.

Furthermore, it is also developing a filament made from polyethylene furanoate (PEF), a "bio-based" plastic. Russia-based researchers have developed and tested the material using an Ultimaker 2 3D Printer. Although it is not yet globally available, PEF integrates desirable thermal and mechanical characteristics and demonstrates its efficiency because it's biodegradable to a higher degree than PLA.

Can the recycled and printed filament be recycled again?

In the case that the original printed filament was not a recycled material in the first place, this question would have had a twofold answer: Yes & No. Indeed, according to Trinota, a medical 3D printing company, to know if a material is recyclable, one should ask ""if there will be an end user of the recycled material?". If there is somebody willing to buy the end product, then the material is recyclable – generally any material is recyclable, as long as there is somebody willing to pay for it."

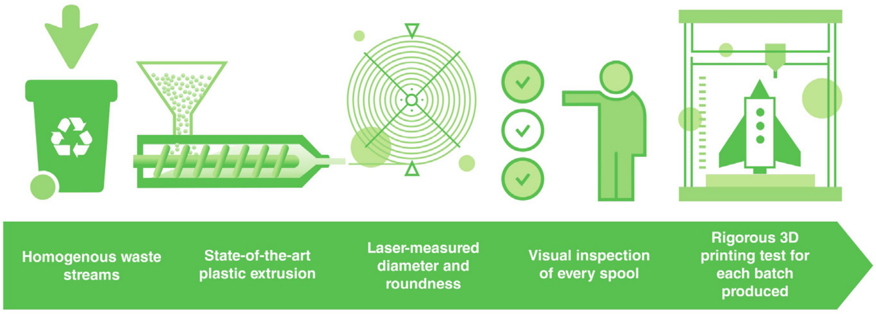
In the case where the recycled filament is already used, the question becomes difficult to answer. "We do not know. It is known that all plastics degrade (to different degree) during processing (recycling normally includes shredding, extrusion, and sometimes compounding). Thus, plastic recycling (when implemented) will face the challenge of 4th, 5th, 6th etc. generation material that would be somehow degraded. In some cases, unrealistic to reach 4th gen. and in other cases no problem at all. This is strongly depending on plastic type and added stabilizers (additives). This needs to be investigated further", stated Hinge.

Any specific advantages for mass production?

From the very beginning of this article, the goal has been clearly defined: exploring if recycled 3D printing materials can be a viable option in the use of 3D printing as a mass production tool.

The topic has raised awareness on the methods used by the 3D printing community to reduce plastic waste in the environment. It also shows a crucial lack of documentation on the topic despite the little number of companies which address this issue on the market. Moreover, it shows a small palette of recycled materials available for series productions leveraging 3D Printing

Although these actions are laudable, applications of recycled materials for the 3D printing industry show a predominant use of these filaments in Do-It-Yourself projects by makers. Although the topic is of paramount importance, a number of solutions still needs to be determined to make the use of recycled materials for 3D printing a viable alternative for mass production or series production workflows.



Credit: Filamentive

Legend: Gitte Buk Larsen from Aage Vestergaard Larsen A/S and associate professor Mogens Hinge browsing through plastics. Credit: Aage Vestergaard Larsen A/S

©Fraunhofer ILT, Aachen / Volker Lannert

Metal Additive Manufacturing Conference

Industrial Perspectives in Additive Technologies

September 30 - October 2, 2020
Vienna, Austria

Do not miss the opportunity to become a part of the Metal Additive Manufacturing Community!

www.mamc2020.org

ARTIFICIAL INTELLIGENCE & ADDITIVE MANUFACTURING, WHERE ARE WE?

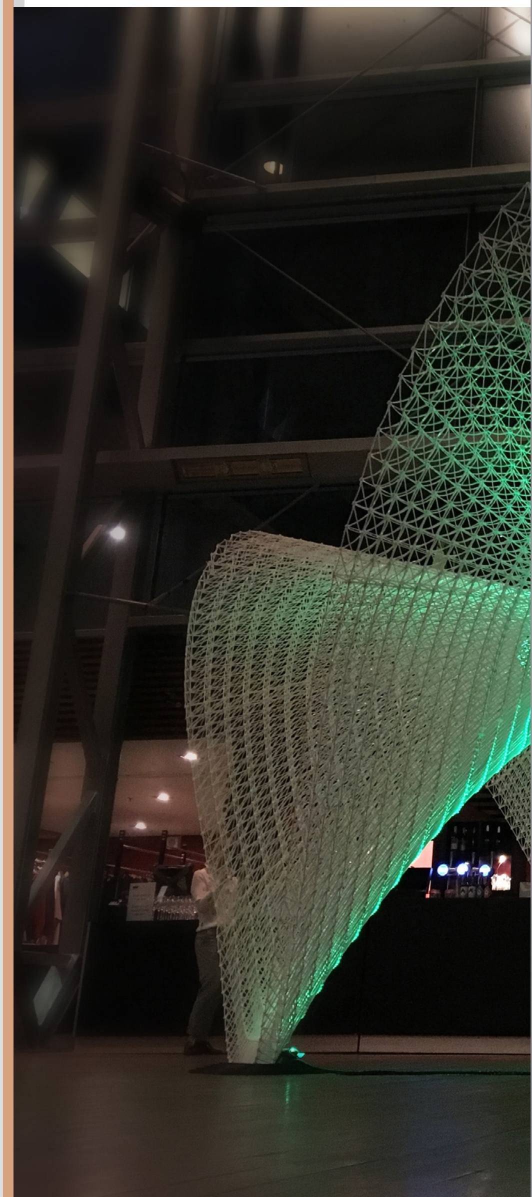
Artificial Intelligence (AI) is part of these advanced technologies that promise massive leaps forward in productivity, environmental friendliness and quality of life, yet confusion around the technology is stronger than ever and dampens its effective integration in manufacturing. Where is therefore the place of AI in a manufacturing sector covered by Additive Manufacturing technologies?

The current artificial intelligence market is difficult to quantify. Although the term is generally understood as the simulation of human intelligence in machines, it should be noted that the term raises confusion with a variety of other segments, including machine learning. Furthermore, experts on the field do not agree with a single definition.

"AI can be seen as an umbrella term, and its scope is incredibly vast. At AMFG, we see AI as a technology that will enable AM machines and systems to be 'smart' enough to carry out core operational tasks both effectively and efficiently.

But achieving this requires machine learning. Machine learning is a form of AI and, as the name suggests, it is the idea that machines can learn from data to solve problems and execute tasks - without manual intervention" states **Keyvan Karimi**, the CEO & Founder of AMFG, that we invited in this segment alongside Additive Flow's CEO & Co-founder **Alexander Pluke** as well as Ai Build's CEO and co-founder **Daghan Cam**.

If Pluke agrees with the fact that machine learning



is a subset of AI inspired by scientific understanding of how humans learn, he outlines that he prefers "a broader definition of AI (and in this sense 'narrow' as opposed to a 'general' AI as depicted in sci-fi) – where a computational approach can deliver results or recommendations normally completed by human intelligence. In this sense, smart algorithms written by humans that can act 'intelligently' - for example evolutionary algorithms and generative approaches, as well as complex classical algorithms that pass the likely subjective threshold of 'intelligence', and substitute human activity, could be labelled 'AI'".

Nonetheless, AI's nascent stage of development makes it difficult to understand and to define all the contours of the integration of this technology but also to determine all its applications.

This article serves as an overview of existing efforts by companies which have attempted to discuss the use of AI in AM.

Adapting to process changes

First and foremost, even though AI promises to disrupt the manufacturing environment as we know it, the main issue is that organizations don't appear to be on the same page about how they want to implement AI. Until today, statistics are not clear about the number of companies that regularly use AI in their production environment.

For Ai Build's Daghan Cam, the problem with this uncertainty in the manufacturing landscape is that not only AI is misinterpreted but companies do not answer the right questions:

"AI is sometimes misinterpreted as a black box software that learns and solves any given problem. That is the definition of Artificial General Intelligence which doesn't exist today, and most probably won't exist in the next 10 years. What we have very commonly available instead is narrow forms of artificial intelligence which are extremely powerful in solving specific sets of problems.

In order to leverage these scientific breakthroughs, application developers in manufacturing like in any other industry must be crystal clear about two questions:

1. What exactly are we trying to solve with AI?

2. How are we going to source the specific type of data that is required to solve that problem?"

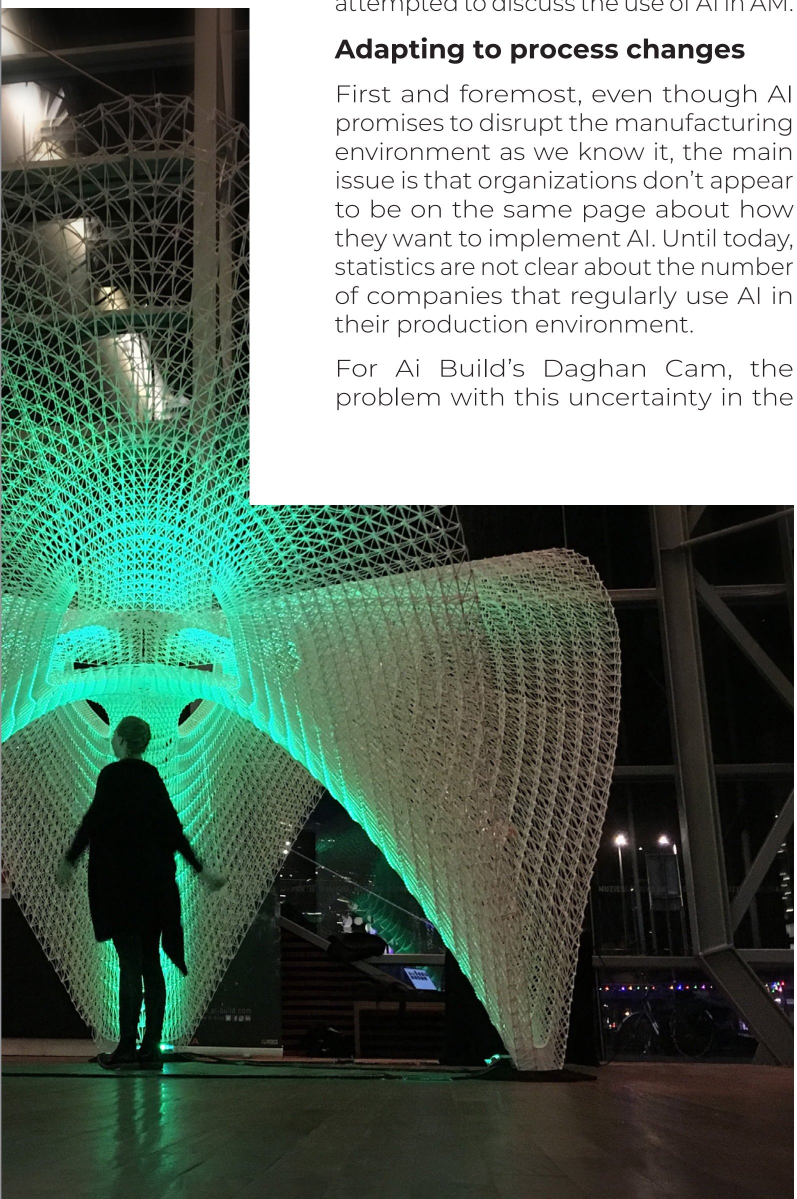
It makes sense. How can we address a challenge if that challenge itself is not well defined? In other words, AI will remain a buzzword if there is no upstream strategy.

Research shows that manufacturers that have been able to define a clear strategy have leveraged AI for quality checks, management in smart factories, creation of more reliable designs, reduction of environmental impact to name a few examples.

Is AI a Must in AM?

Despite the media hype and advantages of 3D Printing, there are still a number of reasons that prevent companies from using the technology: financial considerations, speed and the quality of the final part that (does not always match) or requires further investments to match the quality of traditional manufacturing processes like injection moulding.

Interestingly, AI greater potential lies in opening new doors in manufacturing and when it comes to AM, a wide range of cases can be explored.



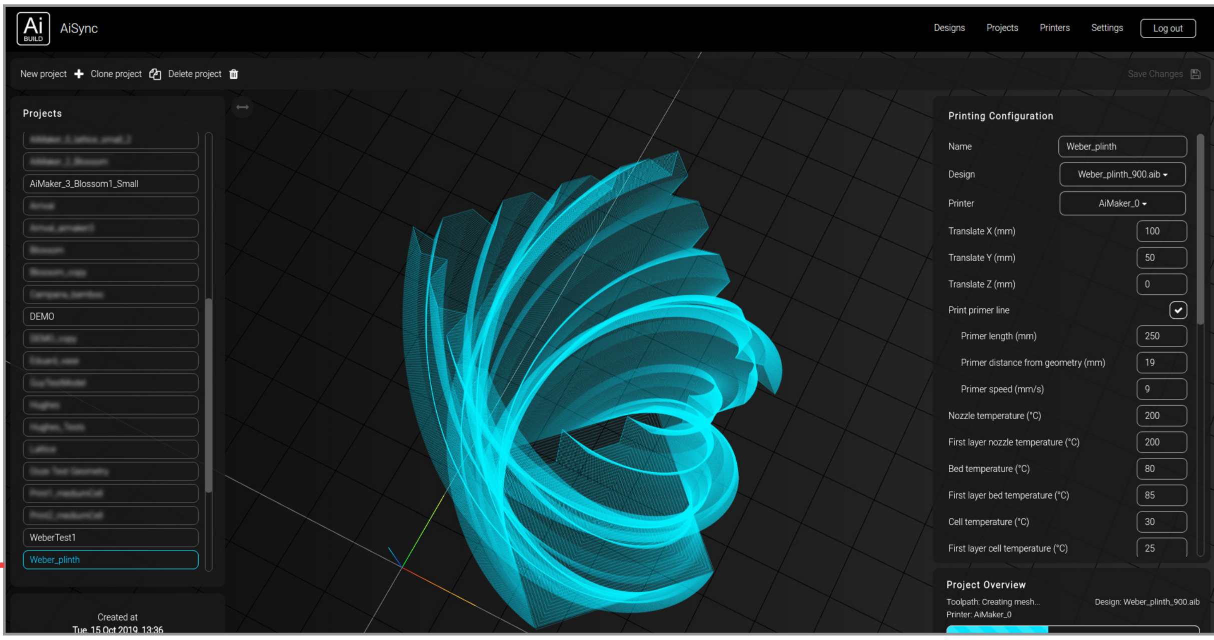


*Image: **Ai Build***

First, AI allows for a new way of thinking about software

"Any software driven technology that doesn't use AI is doomed to fail and will be replaced sooner or later. There is a big responsibility on the machine manufacturers and software developers to work together on redefining the boundaries of additive manufacturing with new releases of their products in order to stay relevant. If a machine is able to bring practical or commercial value to its customers by using AI, it is highly unlikely that other competing products will be able to survive in the market without taking advantage of a similar feature within the next 5 to 10 years depending on the novelty of the process.

For example, Ai Build introduced computer vision into 3D printing in 2016 for autonomous path planning. At that time 3D printers didn't have cameras embedded so we built a solution from scratch to develop our machine learning algorithms. Nowadays most industrial 3D printers are shipping with built in cameras because of the increasing demand from the market. This is great news because now we are able to work with innovative partners to develop computer vision solutions for different platforms and use cases. If we project 5 years forward, we don't think any major industrial 3D printers will exist without basic computer vision capabilities like automatic fault detection, because the technology is too useful to be left out, Ai Build's CEO comments.

Opportunities across the workflow, from design, to production and Quality Assurance (QA).

According to Additive Flow's Alexander Pluke, a number of opportunities for AM in AM can be observed across the **workflow, from design, to production and Quality Assurance (QA)**.

"The complexity of the 'design domain' (the possible combinations of design outcomes within a set of variables) is both extremely large, and interdependent. Material quality will affect part performance, which will influence design decisions; and production parameters will affect quality assurance - and quality assurance requirements will (or should!) be reflected in those design decisions... and so on.

Bring in concepts like geometric freedom, and an Additive Flow speciality 'multi-property' - where material properties can be tailored within different regions of a geometry - and this complexity gets greater still.

In light of this - rather than asking the question 'How can AI be leveraged in AM?', the question should be 'How can AM be leveraged without AI?'. This is more of a rhetorical question. Without deploying AI-driven tools (in design, in production, in QA, across the workflow), industrial use of AM will not be fully leveraging the opportunity (cost savings, performance, innovation

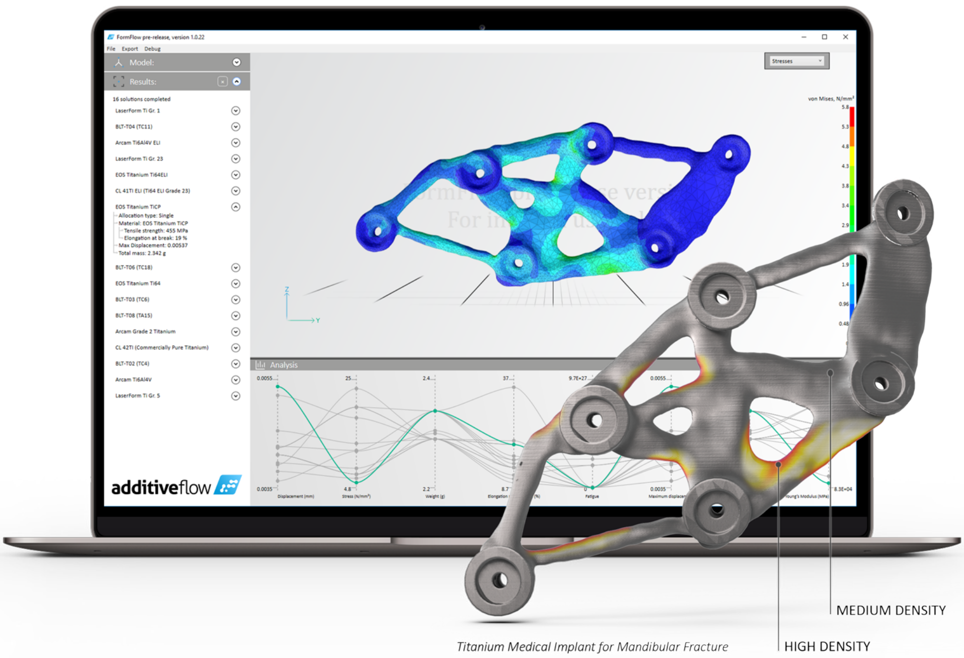
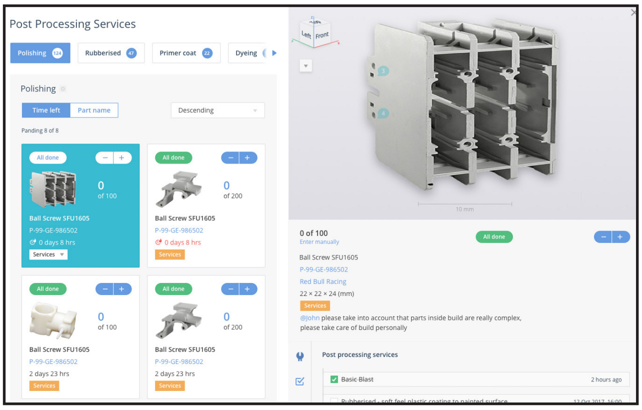


*Image: **Additive Flow***

acceleration) we have all heard about."

Defect Detection

To avoid repeatable errors, AI could be included in 3D modelling programs through CAD software. Combining AI & 3D Printing to achieve this specific goal would enable the development of tools that will easily find defects and turn the model non-printable into a 3D model.



"This enables humans to spend much less time on repetitive, manual tasks and more time on value-adding processes.

Machine learning is one step in this direction. For example, our software is able to provide intelligent material and technology recommendations based on previous data inputs. Our software can also predict part quality and allow users to control the 3D printing process so as to reduce the risk of printing errors. This saves both time and costs.

Additionally, as AM moves to the production of end-use parts, a vast amount of data will be needed to optimise processes. AI will play a role in leveraging this data to achieve faster production and optimal results, so that companies can manage the 3D printing process more effectively", says **Keyvan Karimi** from AMFG.

Creating new materials with new properties

The aforementioned examples show an intelligent use of AI before and during the printing process. It should be noted that not only a real-time control by an AI-driven tool can reduce time and material waste, but the technology can also enable the creation of materials that are stronger, lighter, more flexible, and less expensive to produce.

In this specific case, machine learning is often harness to discover these new forms of materials. Materials scientists just need to enter the desired properties they are looking for into a program and algorithms will predict which chemical building blocks can be combined at a micro level to create a structure with the desired functions and properties.

"Data, data, & data!"

In light of these examples, there is no doubt AI and AM must work together. Even though, there are still a few numbers of companies that actually leverage AI for AM. It is hard to say that the market still suffers from a lack of awareness when improvements are seen across the most important fields of the production chain (software, 3D printers and materials).

However, for the three companies that take part in this segment, the most important challenge that slows down the integration of AI in AM is data.

"The best optimisations need the best data sets, and open access to data within this sector is not (yet) prevalent", explains **Pluke**.

"One of the biggest challenges is the high level of complexity required to develop AI specifically for 3D printing. Large volumes of data are needed and extensive testing and experimentation done to ensure that the machine is 'learning' correctly.

Additionally, AM as an industry is still very much in the early days of integrating 3D printing and AI. Developments for these two technologies are largely happening separately", adds **Karimi**.

Keyvan Karimi from AMFG

How do the participating companies approach AI and AM?

As you may have noted, we have invited three UK-based companies to discuss this topic: AMFG, Additive Flow and Ai Build.

AMFG is a software company that provides an end-to-end workflow management solution for autonomous AM. **Keyvan Karimi**, the CEO & Founder of the company was the main spokesperson in this segment.

The company develops an MES software that integrates elements of machine learning and AI at three levels:

- The ability to analyse the printability of 3D files. AMFG's software allows for the verification of the 3D printability of a file. As mentioned earlier, the integration of AI in a software might easily find defects (therefore remove the risk of printing errors) and turn the model non-printable into a 3D model. AMFG's software can also estimate production times.

- The second area covers predictive maintenance - i.e., being able to predict the quality of 3D-printed parts prior to production. AMFG's software makes it possible to ensure quality throughout the production process. By predicting part orientation for instance, it is possible to determine how the part will be produced.

- Finally, *"the third way in which we aim to use AI is through the automation of key process steps across the entire 3D printing workflow"*, declares the company.

Additive Flow is another UK-based software company that aims to solve digital workflow issues that currently prevent AM users from unlocking the potential of manufacturing technologies during the pre-production stages of the process chain. **Alexander Pluke**, CEO and co-founder has shared the company's expertise on this topic.

To demystify complexity about AI and AM, Additive Flow bets on a system wide approach. The company develops a software named Formflow, which can take in data from across the workflow to put the right material, with the property in the right place.

Alexander Pluke

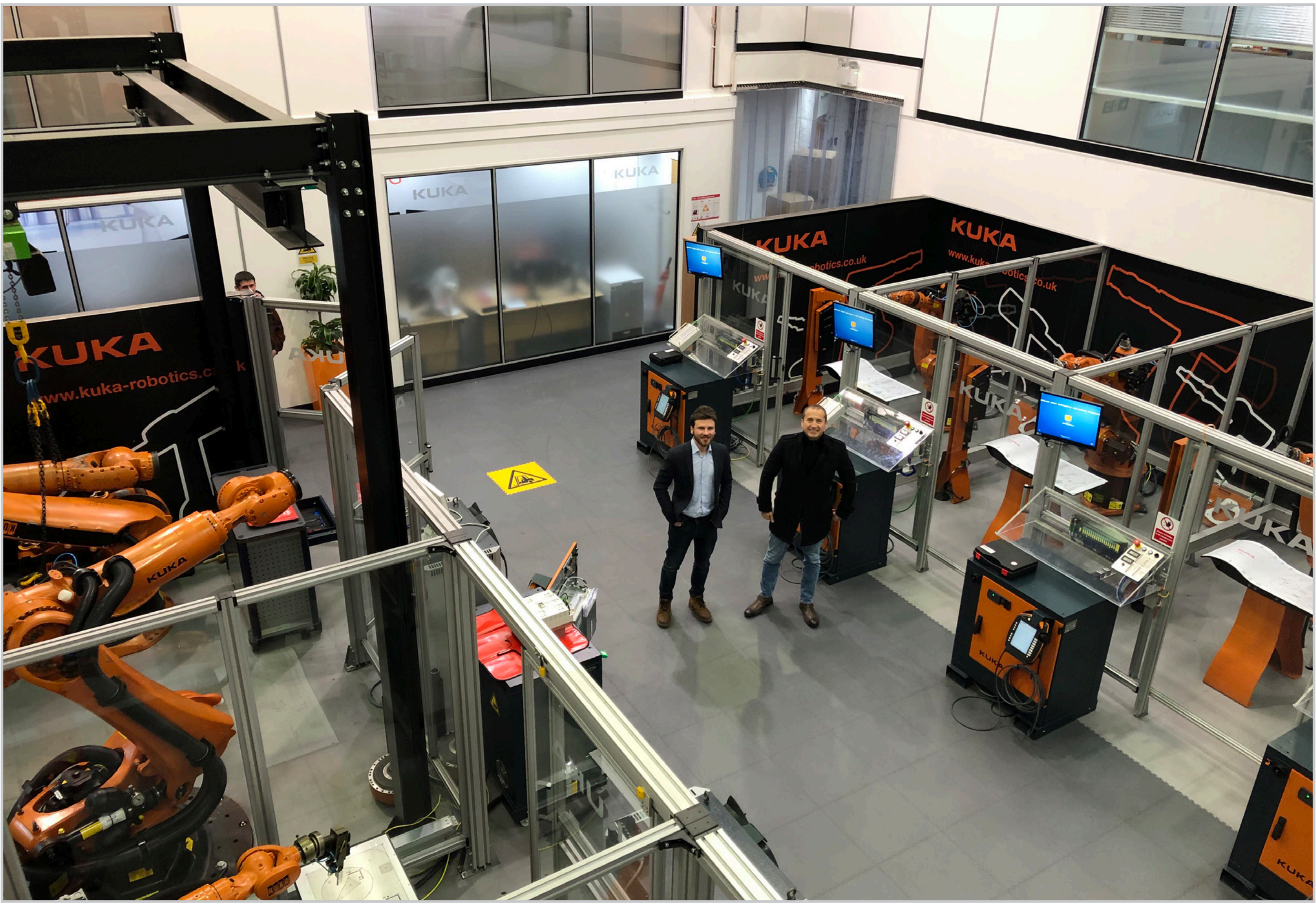
"Some aspects of the design spaces we are presented with are best suited to neural network approaches, while others are best met with more classical algorithmic techniques. For example, using generative algorithms to optimise exponential variables and allows our users discover new high performing results by revealing solutions that would have otherwise been hidden. Neural networks have provided us some powerful results computationally, and have been useful when considering optimisations that rely on data-structures less digestible by classical algorithms.

We are careful not to 'do AI for AI's sake', but with it, Additive Flow's software is able to allocate materials, processing parameters, and localised structures simultaneously with geometry - unlocking value in AM in ways that would otherwise be possible", emphasizes the company.

Lastly, Ai Build develops additive manufacturing software & hardware for factories of the future. The 3D printer manufacturer's real-time inspection technology helps to detect and prevent 3D printing errors thanks to artificial intelligence. Daghan Cam, the company's CEO and co-founder was our guest in this dossier.

The company first came to our radar two years ago when its technology was displayed in the Sculpture gallery of the Victoria and Albert Museum. Over time, we realized it also stands out from the crowd thanks to its AiSync software.

"One of the foundational decisions we made in AiSync software to enable an AI driven additive manufacturing process is to deliberately avoid using gcode files to describe a toolpath. This was very counterintuitive because all 3D printers and CNC machines on the market that we are aware of use gcode or a brand specific gcode-like language to drive the motions of machines. Gcode would work fine in a perfectly deterministic



world where the whole process could be predicted with high accuracy, but unfortunately the additive manufacturing process in real life is far from perfect. We are not able to predict the physical form of 3D printed parts precisely because even the tiniest change in the build volume during production can lead to catastrophic deviations in the additive process. Even if we could fully control the environment and if there was a powerful simulation engine to precisely predict material behaviour 99.9% of the time in one layer, the success rate of the overall prediction on a typical part with thousands of layers that support each other would still be less than 30% for statistical reasons.

This was the key insight for us to abandon gcode and develop a completely new machine control process from scratch that is more resilient. In AiSync software we use a combination of offline and online optimization methods to control the actions of 3D printers. Instead of slicing a design and uploading static gcode files onto machines, AiSync analyzes a design with powerful computers on the cloud and sends optimized directives to the machines in an abstract format. These directives are then interpreted and turned into machine level instructions bit by bit on the fly by another computer that is located on the edge which has real-time access to sensor data from the machine. This double optimisation infrastructure enables us to take full advantage of AI algorithms by combining the strengths of cloud supercomputing for high level tasks like path planning and edge computing for time critical tasks like fault detection and quality assurance", describes the company.

To sum up…

This dossier shows that despite the perfect match between AI and AM, we are still very far from a perfect integration of both processes in manufacturing. Indeed, the biggest strength of AI is also its major weakness: data. To overcome this challenge, both standardization and collaborations between stakeholders are necessary to enable the right integration of AI in AM processes.

HOW TO MITIGATE SUPPLY CHAIN RISKS

>> *Shane Fox - Link3D's CEO & Co-founder*

When considering Additive Manufacturing for its speed, flexibility, and efficiency, it's crucial to understand supply chain and operational optimization. That's something we have learned from our conversation with **Link3D**'s CEO & Co-founder, Shane Fox.

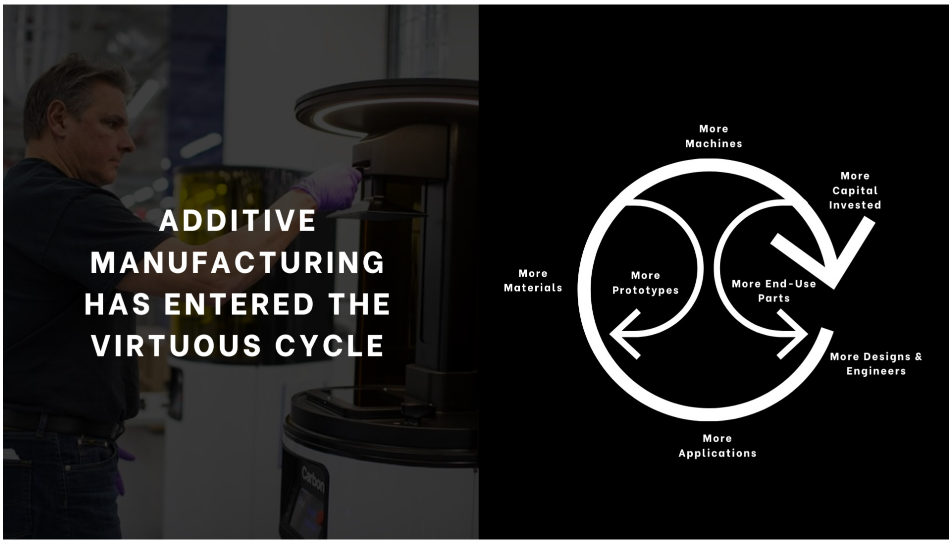
Fox worked for a couple of technology companies in the past, but the one that marked a significant turning point in his career is Within technologies, a topology optimization software company. That's how he got exposed to 3D Printing. "We were really on the cutting-edge of topology optimization and DfAM," Fox recalls.

In 2014, Within Technologies was acquired by Autodesk. Fox continued at Autodesk as an additive manufacturing evangelist traveling the globe meeting with some of the most advanced Autodesk clients across key industries, including aerospace/defense, energy, automotive, medical, and consumer products. Industry agnostic challenges included operational efficiency tools, manufacturing execution systems, and quality management systems.

"What became apparent was introducing, and scaling AM was critical to the success of these industries. In these industries, a solution was needed to drive the success of this new supply chain.", said Fox.

Link3D, founded by Vishal Singh & Shane Fox, debuted in the additive manufacturing industry in 2016 as a success enabler to the industry.

The company is acknowledged for its suite of modular solutions that are essential to organisations scaling up their AM ecosystems. Put simply, *"the solution that we provide helps them to plan, manage, and optimize their AM supply chain,"* explains the CEO. Simply put, *"our solution* *is the operating system enabling the optimization of their AM supply chain.”*



The «virtuous circle» of the 3D Printing industry

From an economic perspective, Fox notes, the industry is evolving in a «virtuous cycle,» a positive chain of events reinforcing the growth of the industry, meaning *«the more designers design products, the more applications we will have. The more applications there are, the more materials will be developed, and the more printers will evolve or be introduced to the market». «We are starting to see a shift in Manufacturing to mitigate our reliance on global supply chains that can be disrupted in times like these. Some of the lessons learned as a result of the COVID-19 pandemic will reinforce the growing drive across the manufacturing community for digital distributed manufacturing models enabling R&D and ultimately production to be done close to the customer and on-demand.*

Manufacturing companies are emphasizing agility and resilience as strategic supply chain priorities. Achieving these characteristics requires constant and real-time visibility of an organization’s manufacturing assets. Link3D is paving the way by leveraging machine connectivity. *«By integrating the real-time feedback of both build progress and build heath into our operating system, organizations can maximize their production and manage production quality, even in a decentralized production environment.»*

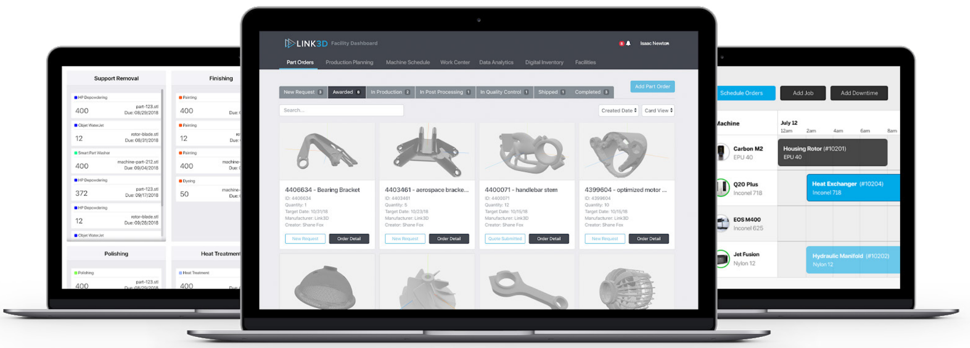
Even though the majority of Link3D’s customers are large OEMs or service bureaus, their process maturity covers the spectrum from reactive to managed, but none have crossed over to automated. One of the most significant challenges in evolving to fully automated processes is the lack of a unified data model. For companies harnessing AM for tooling, jigs and fixtures, and prototyping as well as series production, Link3D’s operating system is a valuable solution within their ecosystem. Fox notes, *«As an organization’s AM maturity develops, customers grow beyond our simpler tools - order capture, costing simulation and quoting. Their ability to leverage our advanced platform, including dynamic production planning, scheduling, and quality management enabled with IoT, and our machine connectivity becomes game-changing relative to maximizing their return on investment (ROI) and effectively managing production risk.»*

«The collaboration between material producers, machine manufacturers, standards organizations and Link3D is critical», **Shane Fox**.

To help facilitate the industry’s rapid transformation, we are starting to see an unprecedented level of collaboration between machine manufacturers, materiel producers, standards organizations, and users. This collaboration will accelerate the broader adoption of AM. Improved quality, risk reduction, and reduced cost are extended positive effects of this collaboration as companies look to expand the reach of AM to mitigate supply chain risks.

The rate of innovation will continue to accelerate. This can quickly be seen in the number of new printer OEMs and printers entering the market, the evolution of machine/material combinations, and the integration and automation of post-processing. It’s not practical to expect internal IT teams to build and maintain systems to manage this pace of innovation.

To explain their role in such a situation, Fox takes the example of their collaboration with EOS. The industrial 3D printing systems manufacturer uses Link3D’s technology globally inclusive of Asia, Germany, and North America. Link3D’s use also extends to EOS’ sales and service partners.



“EOS is leveraging our software to manage the global production of benchmark parts for their customers

as well as their R&D efforts. Our collaboration with EOS also extends to printer connectivity facilitating dynamic production scheduling and manufacturing quality management. Key goals of our partnership include:

- *Providing EOS with a global operating system to ensure production quality and the capability to effectively manage their R&D, benchmark, and internal production programs.*
- *Providing an industry-leading solution to EOS and Link3D customers looking for proven, digital distributed Manufacturing operating and quality systems required to scale production.*

We have a very strategic approach to our collaborations with EOS and other machine OEMs, enabling ongoing collaboration to find solutions that leverage technology advancements enabling AM industry evolution and advancement. The same strategic partnership is applied to material producers, given the increasing demand for digital material traceability. Our operating system can connect to the material management ecosystems providing digital production and testing data management during new material development and production, inclusive of batch management from virgin powder through the qualification of blended material lots.

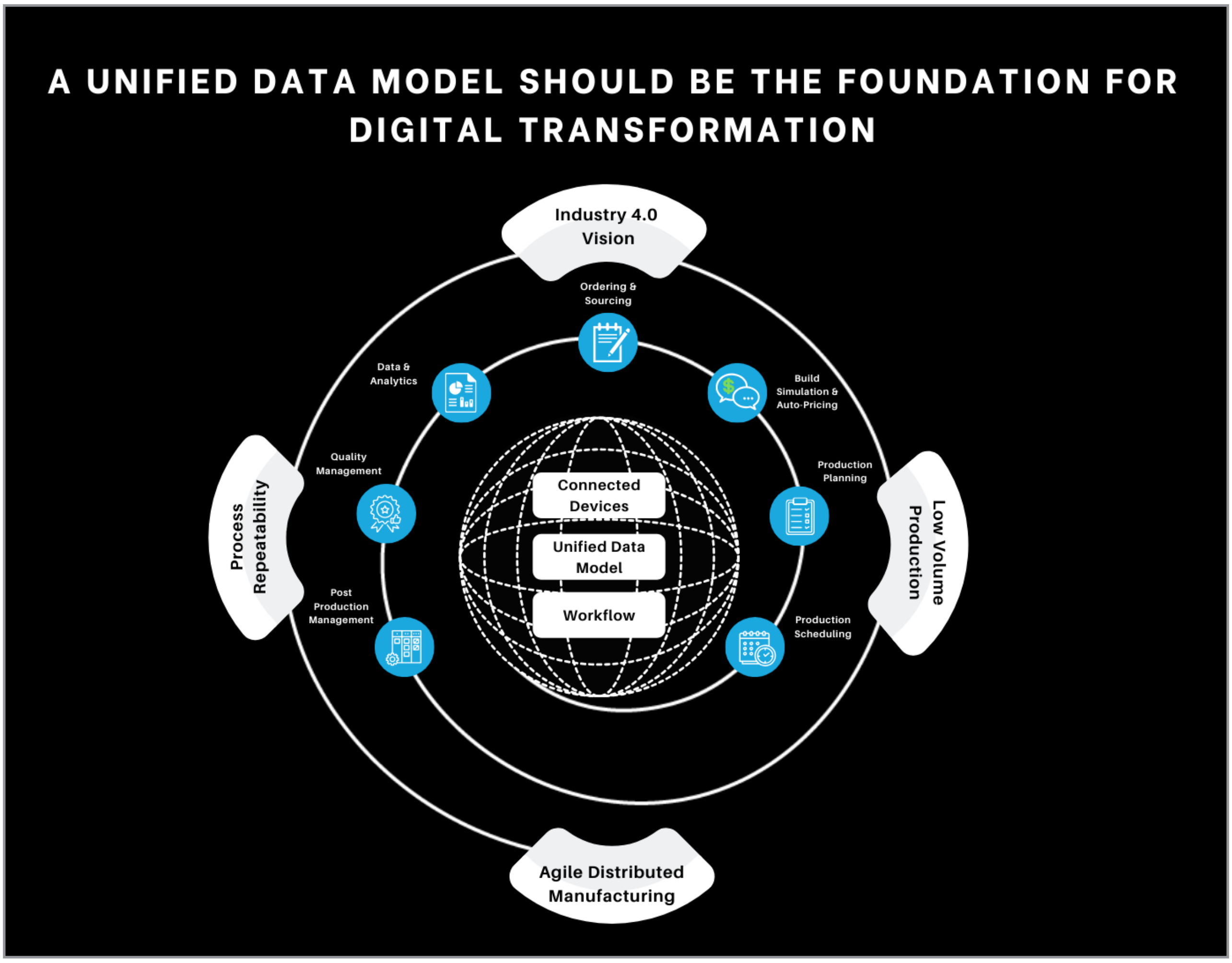
The quality requirements driven by complexities of the AM ecosystem highlight the increasing importance of the partnership or marriage between the machine and material manufacturers, standards and quality organizations, and Link3D,» the CEO states.

Primetime for Additive Manufacturing?

Link3D provides the manufacturing industry with smart solutions that respond to market needs. However, it was hard not to raise the Covid-19 pandemic. Will manufacturing needs remain the same?

Manufacturing needs were evolving to more capital-intensive automated processes with less reliance on people, and the Covid-19 pandemic accelerated this trend. This can be seen with the rapid global expansion of AM over the course of the pandemic given the strain and, in some cases, the collapse of the supply chain. Not only has there been solidarity in support of the front-line workers and small businesses but also across the AM industry as barriers to entry for engineers are being broken, enabling AM solutions to be envisioned and ultimately driving the use of printers and materials to be leveraged in uncommon ways. The Covid-19 pandemic also highlighted our dependence on disparate and disconnected global supply chains.

"I think in the years ahead, digital transformation and successful industry partnerships will be critical enablers to the rapid expansion and adoption of additive manufacturing as the technology continues to advance and mature», Fox concludes.



HIPER | 恒普

Full Series Debinding and Sintering Furnace

for Additive Manufacturing(AM)

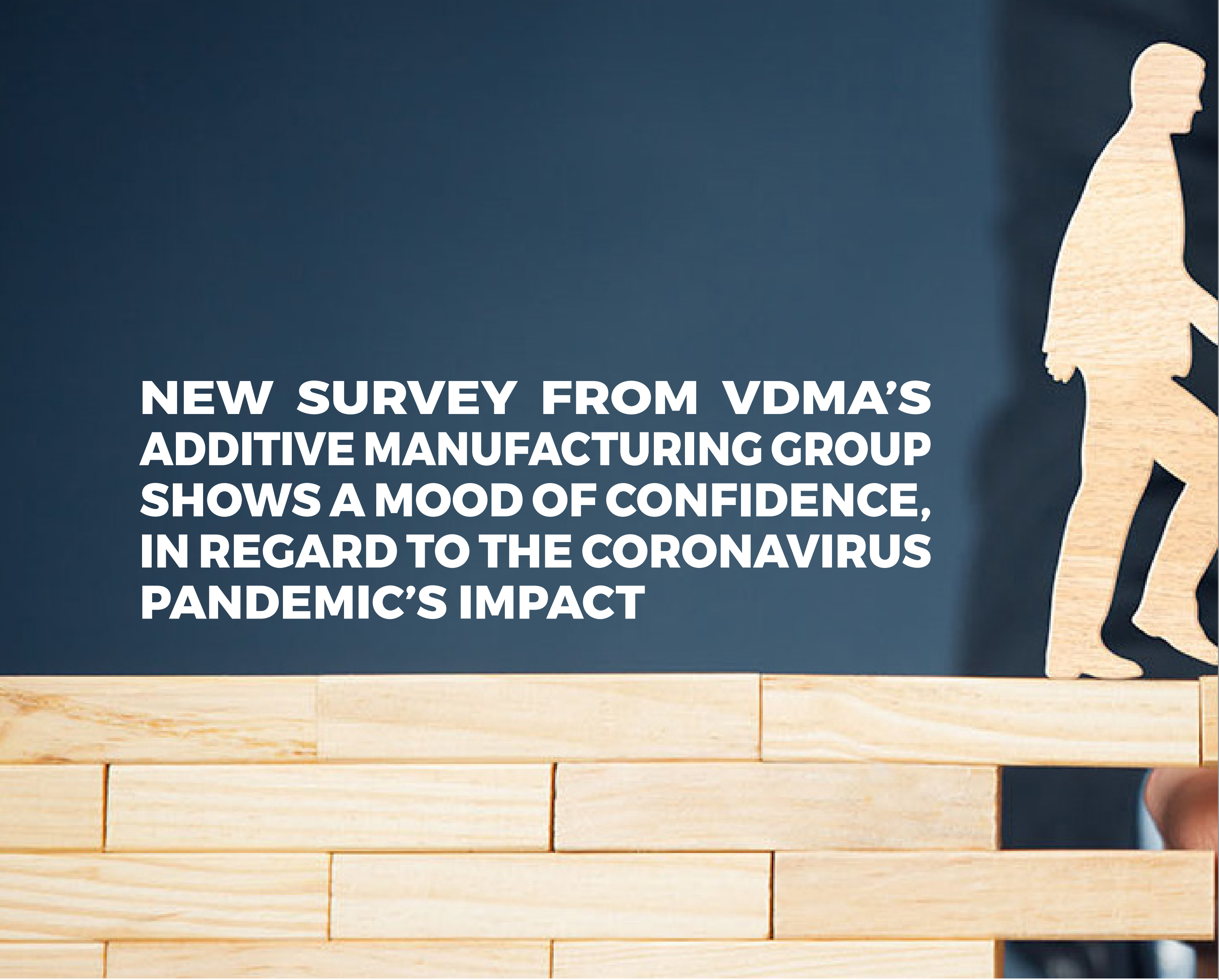
- **Debinding and sintering for Metal Binder Jet and FDM**
- **Heat treatment for Laser Printing**
- **Graphite hot zone and Moly hot zone available**
- **High vacuum acceptable**

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



NEW SURVEY FROM VDMA'S ADDITIVE MANUFACTURING GROUP SHOWS A MOOD OF CONFIDENCE, IN REGARD TO THE CORONAVIRUS PANDEMIC'S IMPACT

"Despite the currently noticeable effects of the Corona crisis, the mood in our industry remains one of confidence." This is how **Dr. Markus Heering**, Managing Director of the VDMA's Additive Manufacturing Working Group, summarizes the results of a recent member survey.

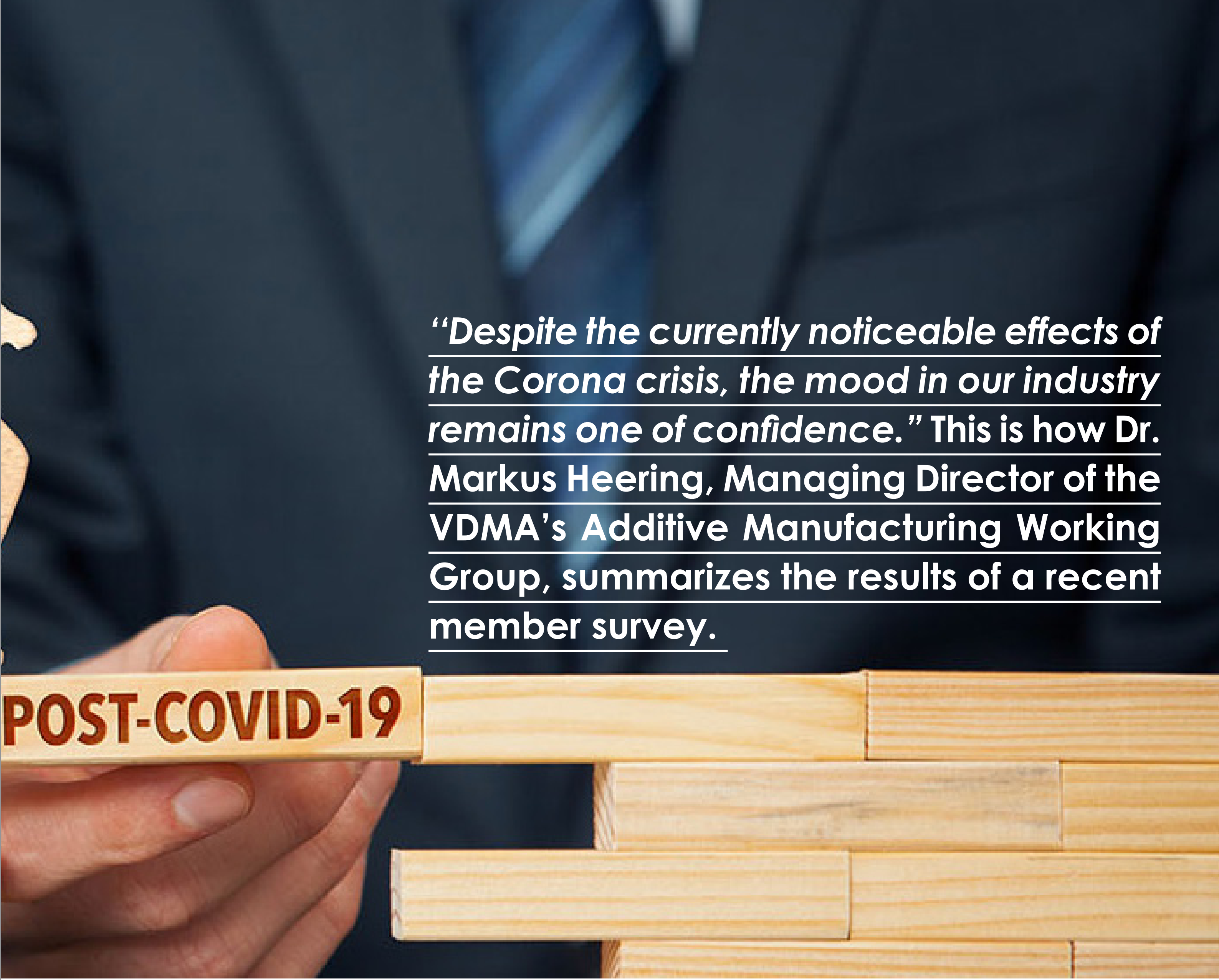
The **Mechanical Engineering Industry Association** (in German: Verband Deutscher Maschinen- und Anlagenbau – VDMA) represents around 3,200 members, making it the largest industry association in Europe. The Association represents the interests of the predominantly medium-sized companies in the mechanical engineering industry towards policymakers and society, as well as towards business, the scientific community, public authorities and the media.

In April, in the middle of multiple national lockdowns due to the Covid-19 pandemic, almost 80 members of the Additive Manufacturing group of VDMA, took part in a survey. Its aim? **Determine the impact of the pandemic on the industry.** Production service providers, users and machine manufacturers were particularly well represented.

It is striking that 75 percent of those surveyed assess their business prospects for the next 24 months as positive, while only 6 percent expect their business situation to deteriorate. Even the short-term forecast for the next twelve months is positive or at least unchanged at 39 percent each. Only one-fifth (22 percent) of those surveyed fear a negative development. *«Compared to our last member survey in September 2019, optimism remains almost unbroken,»* explains **Heering**. At the time, 77 percent of members had a positive assessment of the outlook for the next 24 months - only 2 percent more than now. What has changed are primarily the short-term expectations.

Companies are pursuing their investment plans despite the crisis

Heering is surprised by the positive mood, but considers it to be consistent in itself. After all, the members surveyed underscore their optimism through entrepreneurial action. *«One in four companies says it plans to increase its investments and another 44 percent plan to invest at the same level,»* he explains. Compared to the survey in September, the investment plans are surprisingly stable, he says. That now 32 percent instead of at that time 16 percent of those surveyed want to cut back on their investments is understandable in view of the crisis, he said. *«Conversely,*



***"Despite the currently noticeable effects of the Corona crisis, the mood in our industry remains one of confidence."* This is how Dr. Markus Heering, Managing Director of the VDMA's Additive Manufacturing Working Group, summarizes the results of a recent member survey.**

this means that two-thirds of those surveyed want to maintain or even increase their investment level,» says Heering. He sees this as proof of the motivation and determination of the young industry.

AM gains a foothold in series production - and defuses supply bottlenecks

Heering sees another reason for the confidence of the member companies in the growing technological maturity. For example, 41 percent of those surveyed say that they intend to use additive processes mainly in series production over the next 12 months. In contrast, the use of prototypes, samples and additive tools and spare parts is declining slightly. *«With the increasing use of series production, the requirements are shifting,»* he reports. The attention of the members shifted towards costs, stability and speed of AM processes. According to the survey, the topics of standardization, automation and quality assurance are also gaining in relevance. Heering interprets this as a clear indication of the maturing process in the industry.

A third of the respondents have benefited from this technological progress in additive manufacturing during the Corona crisis. For example, 34 percent stated that they were able to circumvent corona-related supply bottlenecks with the help of additive-manufactured components. Also, against this background, the companies see the pandemic more as a driver for the use of additive manufacturing processes than as an obstacle. More than half believe that the importance of AM will increase as a result of the Corona crisis. In contrast, only 5 percent fear a loss of importance.

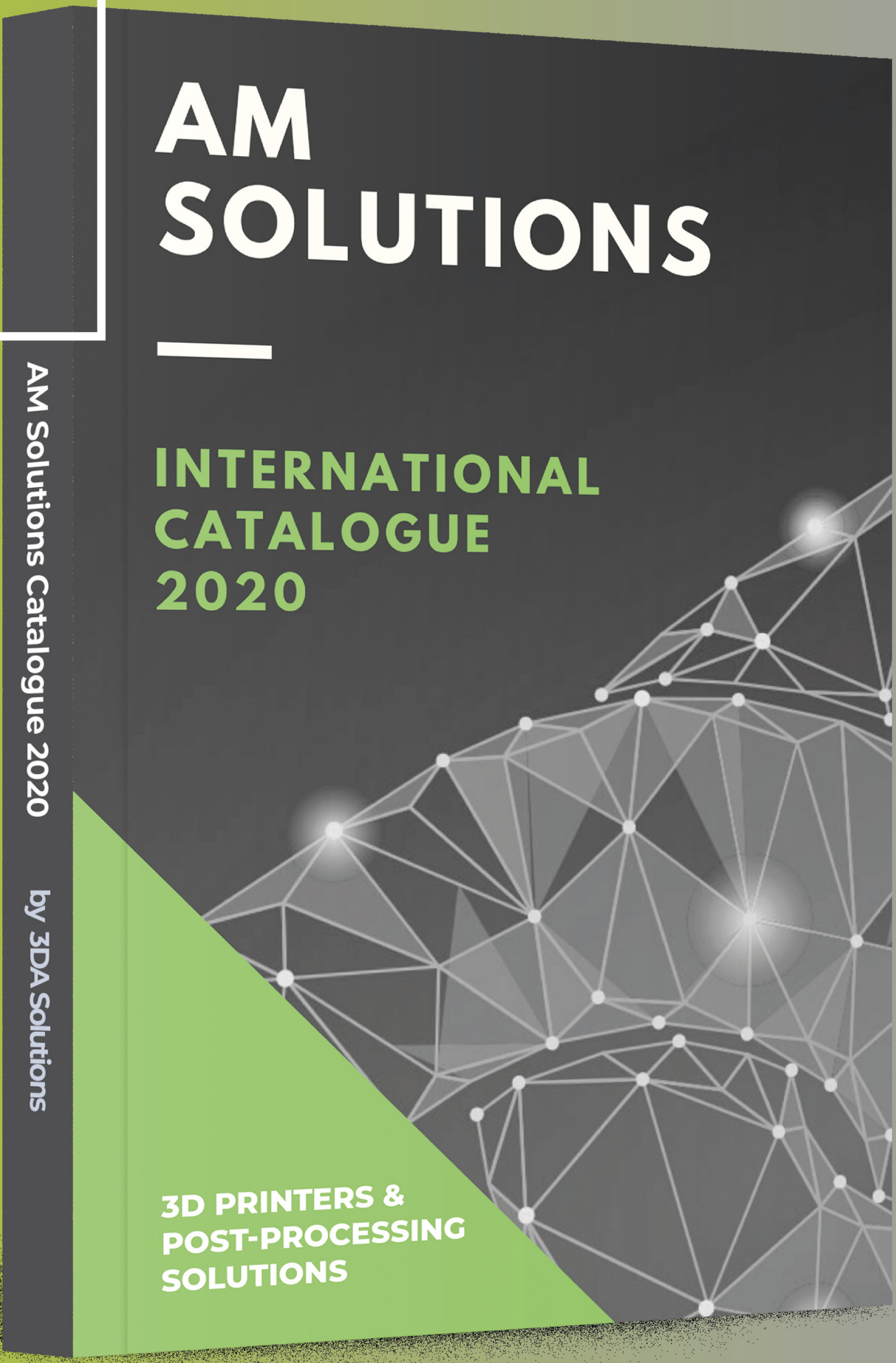
«During the crisis, additive manufacturing is perceived as a flexible and quickly adaptable enabler technology,» says Heering. Platforms have come together around the world in a very short space of time to respond quickly to acute needs for protective equipment, auxiliary devices and components for medical devices with additive processes. «Although this was not always possible straight away because of the regulations in this field, public awareness has grown that additive manufacturing is ideal for emergency situations and unusual requirements,» he explains. This should also contribute to the overall positive mood in the industry.

VDMA Additive Manufacturing Group

VDMA

Working Group
Additive Manufacturing

MAKE SURE YOU SUBSCRIBE TO OUR NEWSLETTER TO RECEIVE THE LATEST INDUSTRY NEWS AND ADVANCES IN ADDITIVE MANUFACTURING.


AM Solutions Catalogue 2020
by 3DA Solutions
AM SOLUTIONS
INTERNATIONAL CATALOGUE 2020
3D PRINTERS & POST-PROCESSING SOLUTIONS