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3D ADEPT MAG

3D PRINTING

DOSSIER: EXPLORING ADDITIVE MANUFACTURING IN THE OIL, GAS AND MARITIME INDUSTRIES

N°4 - Vol 3 / july - August 2020

Edited by 3D ADEPT MEDIA

Editorial

"Additive-Talks"

Since Summer goes hand in hand with outdoor activities, most people usually go for a while in another state or another region of their country. This time, it's different. This time, Summer activities should go hand in hand with social distancing measures to flatten the curve of Covid-19.

But it is not that easy, especially now that some countries are dealing with the second wave of contamination.

For the additive manufacturing industry, this raises several uncertainties regarding the organization of events and the opportunity for professionals to come together and exchange ideas in person again.

For 3D ADEPT Media, this means finding another way to interact with AM players and our audience. Indeed, those who are familiar with our digital and print magazine, 3D ADEPT Mag know that to address most of our dossiers, we confront different ideas, experiences and expertises.

In this vein, 3D ADEPT Media has imagined another way to give the industry access to 3D printing/AM resources. This way is Additive-Talks. On September 10th, AM players and AM users (beginners or advanced users in the aerospace, the automotive and the manufacturing industries in general), will discuss a series of topics through a digital and interactive platform.

As you may know, 3D ADEPT Media does not charge for access to any of its contents including the upcoming Additive-Talks day. We are completely supported by our advertisers and this page is another opportunity to thank them for their support, on behalf of the 3D ADEPT Team.

I look forward to our debates and discussions with leading and well-established players of the industry, to discovering new entrants' expertise and networking with other industry peers. In the meantime, I will let you enjoy this new issue of 3D ADEPT Mag.

Kety SINDZE

3D Adept Mag
ADDITIVE MANUFACTURING/ RAPID PROTOTYPING/ TECHNOLOGICAL INNOVATIONS

Edited by
3DA Solutions

Graphic Designer
Martial Y. , Charles Ernest K.

Editorial team
Kety S., Yosra K.

Proofreaders
Jeanne Geraldine N.N.

Advertising
Laura Depret
Laura.d@3dadept.com
Phone: +32 (0) 4 89 82 46 19

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

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DOSSIER:
EXPLORING ADDITIVE MANUFACTURING IN THE OIL, GAS AND MARITIME INDUSTRIES

Professionals of the Maritime, Oil and Gas (MOG) industries take major risks to gain valuable global opportunities. Some of these risks involve adopting new regulations and laws, climate change, as well as production of parts, hence the importance of continuous monitoring on a number of daily operations.

As far as production of components is concerned, DNV GL's global network that specializes in failure investigation carried out a report that revealed that tubes and piping are the most failure-prone components in the oil, gas and maritime industries; fatigue and corrosion being the most common failure types.

The research was based on over 1 000 failure cases studied across the United States, Europe and Asia.

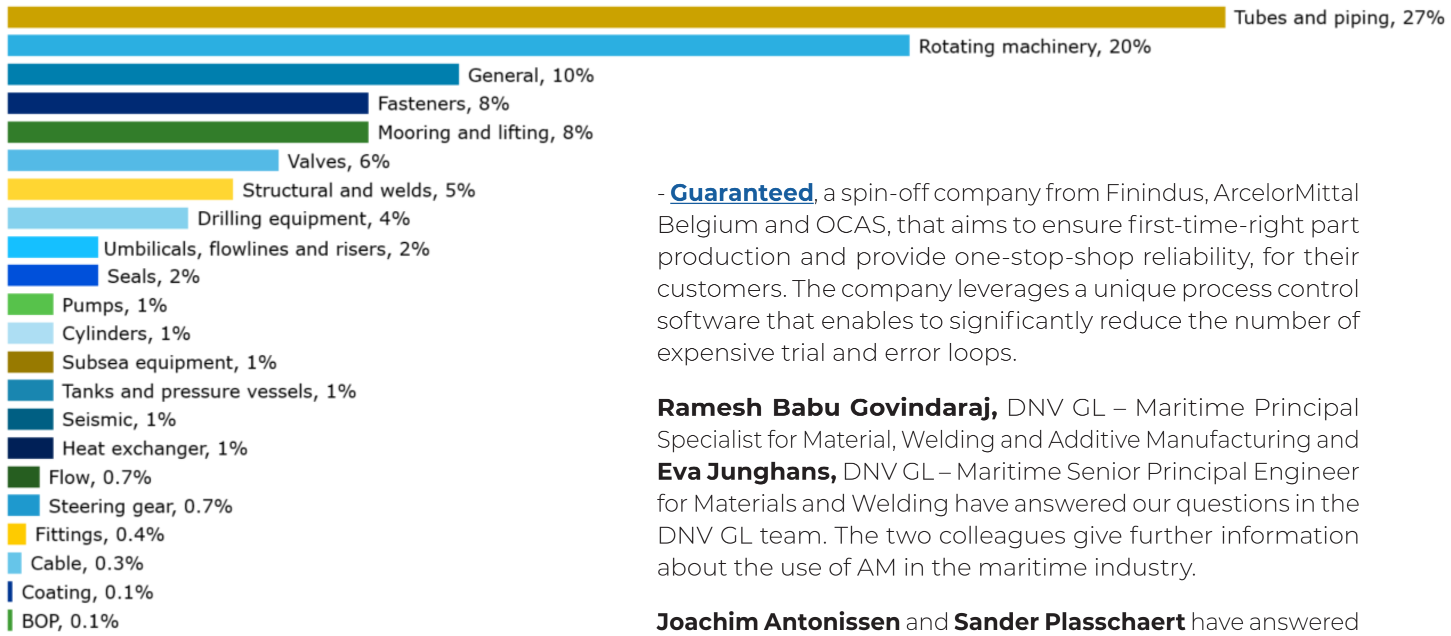
"The cost of prevention, monitoring, repair or replacement as a result of these forms of component degradation can run into billions of dollars. Potentially, financial penalties can occur if major incidents and loss of life result from such a failure", explained Koheila Molazemi, Technology and Innovation Director, DNV GL – Oil & Gas.

To avoid or minimize these common failure types, professionals have been considering digital solutions and digital manufacturing technologies that deliver better sustainability. One of these technologies is Additive Manufacturing. However, while AM has been widely adopted in aerospace, automotive, and medical industries, the MOG industry remains a nascent adopter of the technology.

This article aims at highlighting the main outlines & commercial opportunities to take into account while considering AM in this sector of activity.

To discuss this topic, we have called for the expertise of two main companies:

- **DNV GL**, an international accredited registrar and classification company that provides services for several industries including maritime, renewable energy, oil & gas, electrification, food & beverage and healthcare.



- **Guaranteed**, a spin-off company from Finindus, ArcelorMittal Belgium and OCAS, that aims to ensure first-time-right part production and provide one-stop-shop reliability, for their customers. The company leverages a unique process control software that enables to significantly reduce the number of expensive trial and error loops.

Ramesh Babu Govindaraj, DNV GL – Maritime Principal Specialist for Material, Welding and Additive Manufacturing and **Eva Junghans,** DNV GL – Maritime Senior Principal Engineer for Materials and Welding have answered our questions in the DNV GL team. The two colleagues give further information about the use of AM in the maritime industry.

Joachim Antonissen and **Sander Plasschaert** have answered our questions in regard to the use of AM in the oil & gas industries.

Anticipating the risks in the oil, gas and maritime sectors

SmarTech Publishing's latest report on additive manufacturing for the oil and gas sector predicts that the oil and gas sector will generate $2 billion (USD) in revenues by 2027. This future seems even more promising for the 3D Printing industry, as according to Research and Markets, the use of 3D Printing in Oil & Gas sector is estimated to **be worth $32 Billion by 2025.**

Based on experiences in rapid prototyping and tooling within other industries, several oil and gas operators and suppliers, ambition now to use additive manufacturing to gain a key competitive edge in the production of advanced and complex final parts.

DNV GL is one of the companies that early anticipated this growth but also the challenges and risks adopters of AM in this sector would face. That is why, in 2017, it released **a classification guideline for the use of additive manufacturing (AM) in the maritime and oil & gas industries.**

For manufacturers, sub-suppliers of materials, parts and components, service suppliers and end-users adopting AM technologies, this guideline would serve as a tool that will ensure the parts or components created by an AM process and the materials from which they are created have the same level of quality assurance as traditionally manufactured products.

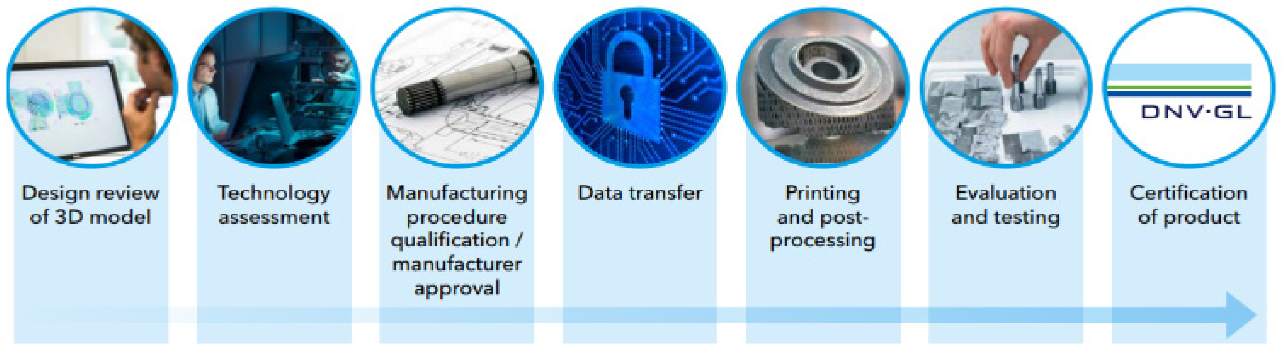
Two years ago, an Oil & Gas Consortium launched **two Joint Innovation Projects (JIPs)** which aimed at defining a guideline and a business model for the use of additive manufacturing in the Oil, Gas and Maritime industries. 11 companies started the project in 2018 and they were joined by 9 other companies at the end of 2019.

"The approach by the DNVGL JIP programme was based on the FMEA (Failure Mode and Effects Analysis) workshop which was attended by all participants. There the failure mitigation process was established and the testing to capture the weakest zone in applications was considered.

As part of this project, operators are the end-users, and provide their expectations for quality, functionality and service durability for their assets.

Contractors do the design, specify the detailed requirements for the components and optimize the design to achieve the full benefit from Additive Manufacturing.

Fabricators: They provide information related to the printing process and establish the essential variables which are important in order to obtain material properties meeting the requirements" commented **Ramesh Babu Govindaraj** & **Eva Junghans.**



Certification process flow – Credit: DNV GL

The completion of these projects led to tangible applications of AM in this segment and a deeper understanding of challenges a manufacturer can encounter to produce a 3D printed part for this segment. We've asked Guaranteed, one of the companies involved in these projects what these challenges can be and how is the manufacturing process different from what operators used to see with conventional manufacturing processes.

A question of price

Joachim Antonissen and Sander Plasschaert explained that, *"the oil & gas industry often uses cast or forged components made out of rather expensive specialty alloys such as e.g. Inconel. On the one hand, the forging process itself results in significant material waste, while also being characterized by extended lead times and non-negligible failure rates which potentially impact the future operations. Although this clearly emphasizes the opportunity for AM in the sector, the severe operating conditions call for a clear quality assurance framework, while also often imposing components to be large and heavy.*

At the same time as the technology shifts from lab to fab, the business case really needs to be there in order for industry to adopt AM. The combination of component size and functional complexity makes a compelling case for wire based DED-processes such as the WAAM-process offered by Guaranteed B.V. as it allows parts of several meters to be produced within hours at a competitive cost. The wide choice of available wire materials which come at a considerably lower cost as their powder counterparts, combined with the fact that quasi 100% dense parts are produced, omitting the need for hipping, further contributes to the economic attractivity of the technology for the segment. As the WAAM-technology furthermore allows to deposit on top of an existing component (e.g. plate or cylinder) or even repair an existing part, the business case can be further enhanced even without taking into account logistic savings such as reduced lead times or stock keeping costs. Besides the resulting economic benefits localized repair or on-demand near net shape production furthermore also contributes to sustainability as it significantly reduces the need for raw materials and transport logistics.

Simultaneously the strict certification requirements imposed by the severe operating conditions in oil & gas industry also need to be considered when assessing the business case. Depending on the criticality level of the component, certification might impose a substantial amount of destructive test samples to be produced alongside the actual part."

DNV GL's experts laid emphasis on the **important costs production required to utilize AM** in the maritime industry, as compared to well established manufacturing processes such as rolling, casting and forging.

The aviation and automobile industries for instance, mainly deal with closed circle production (mass production) which includes the use of thin materials such as aluminum and titanium while *"customized parts made of thick steel with big dimensions are more typical in the maritime industry"*.

This question of price had already been raised in a former conversation we had with voestalpine Additive Manufacturing's Managing Director.

For **Armin Wiedenegger**, the Managing Director (MD) of the 3D Printing Research and Production group voestalpine Additive Manufacturing Center GmbH, the oil & gas industry has its own guidelines. Quality assurance for the manufacturing of components is not the same than in other industries. **The continuous search for lightweight parts that we observe in aerospace and automotive applications for example, cannot be applied in the oil & gas industry. The main challenge here is to produce parts cheaper & faster than with conventionally process routes.**

Parts manufacturing in the oil & gas industry

Hundreds of intricate parts are regularly used by professionals of this area of activity. They include for instance, **turbine plates**, **turbo-expanders** as well as **compressor parts** such as pistons, rings, valve seats, seals or cylinder side plates.

Our research shows that most manufacturers of parts for this segment see a demand for components made from very large forgings up to five feet in diameter and weighing nearly 4,000 lbs., and with machining tolerances within .005 required. However, 2019 saw the return of more autonomy to Oil-production parts, that's why companies are increasingly looking for production applications which include fabrication of spare parts on site, testing new product designs, and simplifying inventory management to save costs; demands that are usually met by 3D Printing technologies.

"With oil and gas assets being deployed in increasingly isolated regions for longer durations, there is a correspondingly larger likelihood of essential parts breaking down, becoming obsolete due to technological changes or changes to standards or going out of production before the asset is decommissioned. The small numbers and short life-cycles of these parts relative to the component present a unique challenge in inventory management and further strengthen the case for the deployment of AM. Obsolete parts can be reverse-engineered digitally and additively manufactured on demand, leading to greater asset longevity in cases where the faulty part of a critical component can simply be 3D printed and replaced like-for-like", Guaranteed's spokesperson stated.

Furthermore, there might be a need for more automation in parts production, but it should be noted that companies cannot decide on their own of the parts they can produce via AM, given the screening of components in facilities and the stringent testing and certification requirements, they need to meet. For Guaranteed, companies that are exploring the opportunity of AM in the Oil & Gas industry should also take into account other advantages.

"We therefore believe that on short term, the opportunity in the oil and gas industry is not just in parts production, but also in the products that support oil and gas

operations, which have lower critical importance, and hence lower quality requirements.

Product groups that hold promises for large scale application of AM for components are for instance valves, piping systems, hydraulic systems, nozzles and tooling. Various downhole and topside components have also indicated to show possibilities and benefits for using AM", our experts point out.

Technology & materials

A wide range of manufacturing methods within the AM landscape can be deployed, depending on the technical requirements of the components and the environment in which they operate.

Until the recent years, **polymer 3D Printing** was predominantly used in additive productions for the MOG industry. However, the launch of the JIP by DNV GL has publicized the use of **metal additive manufacturing technologies** in this segment.

As a reminder, the scope of the project was to provide a framework to ensure that metal parts produced via **SLM technology** and **wire arc additive manufacturing** meet the oil, gas, and maritime industry specifications.

As far as materials are concerned, experts at Guaranteed told 3D ADEPT Media that candidate materials for AM applications in the oil & gas industry should meet four main criteria:

– *"high strength and ductility within a broad range of operating temperatures (from cryogenic up to 400°C) to withstand the working conditions*

– corrosion resistance induced by the presence of water, C02 and/or H2S

– chloride induced pitting resistance

– economic sourcing possibility (availability within short time and limited cost)"

That is why, duplex stainless steel or nickel-based alloys such as Inconel 718 are usually a great fit for applications in this field.

What's next in the pipeline for oil, gas and maritime companies?

At the manufacturing level, AM is proving its essential role as an enabler of several new applications and opportunities in the Oil, Gas & Maritime industries. However, given the stringent requirements to meet, it takes time to make the use of 3D Printed parts effective.

"In the maritime industry, material manufacturers for significant components must first be approved by a Classification society like DNV GL. DNV GL has developed an approval programme - DNVGL-CP-0267 - specifically for Additive Manufacturing as well as DNVGL-CP-0291 for Feedstock Approval. The first manufacturer for Additive Manufacturing was approved in 2019. For critical components, the maritime industry requires a sacrificial test coupon for each batch. DNV GL rules and offshore standards have been revised, too, to accept Additive Manufacturing as a manufacturing method similar to rolling, casting and forging", DNV GL's experts said.

Even though these sectors are set to become one of the major adopters of additive manufacturing, the current environment is subjected to volatility. In fact, volatility has always been a challenging element of the oil and gas market but it has rarely been more extreme than it is today. Disruptions in demands, due to the pandemic, as well as the impact on financial markets have led to rapid price swings.

It's hard to tell now what will be the impact in the additive manufacturing market, however one thing is certain, the complex environmental norms, volatile oil prices and growing competition will make oil and gas companies to consider AM to achieve operational efficiency.

Notable applications of Additive Manufacturing in the Oil, Gas & Maritime industries

As mentioned before, several applications can highlight the possibilities of AM in the MOG industry.The Maritime, Oil and Gas (MOG) industry includes drilling rigs, refineries and supertankers both on- and offshore. The maritime industry especially, which should not be confused with marine applications, includes for instance, shipping companies, ships manufacturing, and port authorities.

While many agreements are still in progress, a small number of applications have already been highlighted by companies of the industry. The lines below describe the latest highlights in 2019 that are worth mentioning in terms of applications.

The maritime industry

As far as participating companies to this dossier are concerned, it should be noted that DNV GL has joined other development projects in Korea with KOSWIRE; projects that involve feedstock approval and that are carried out in collaboration with SY Metal Co and HHI, the ultimate goal being to develop **a ship propeller**.

"Conventional production requires high effort and cost for preparation, manufacturing and shipping of the replacement propeller. Furthermore, the ship is subject to an enforced lay time. Producing the propeller by Additive Manufacturing reduces the lead time significantly. Another appealing asset is to unlock new design opportunities, e.g. combine a convenient steel with good structural properties and geometry in any order, with an expensive corrosion-resistant steel", said DNV GL.

"Furthermore, we are working with SHI, INSSTEK, KOSWIRE, PK VALVE, KIMS and KAERI to manufacture a cryogenic valve. In the Netherlands, a project is ongoing to develop an offshore crane hook with Huisman and Ramlab. In Germany, DNV GL is participating in the Maritime Network for 3D printing (MN3D network consortium). More projects with reputable stakeholders in the maritime industry are under negotiation", **Ramesh Babu Govindaraj** and **Eva Junghans** added, speaking of DNV GL's current projects in the maritime industry.

In 2018, French defense contractor **Naval Group** and French engineering school **Centrale Nantes** worked together on the development of a 3D Printed military propeller. Last year, that same collaboration resulted in the **world's first 3D printed hollow propeller blade**.

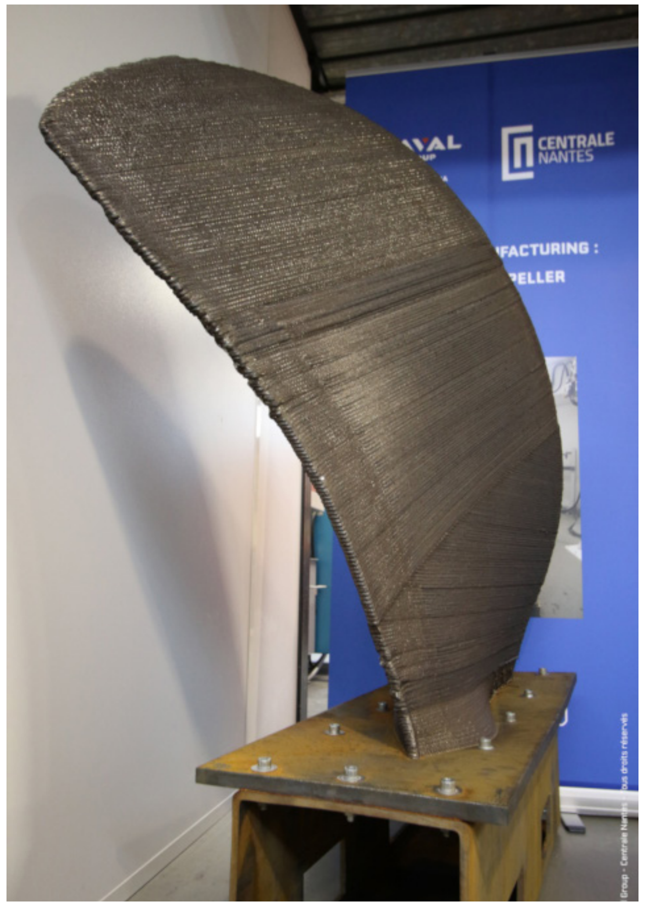
Funded by the European Commission, as part of the European H2020 project, the goal of the project was to leverage new technologies such as AM to decrease the environmental footprint in the manufacturing of large naval vessels.

As DNV GL's experts explains, *"additive manufacturing helps to scale down carbon emissions by reducing the amount of raw material - and material which is discarded in the manufacturing process - and by shortening transportation journeys."*

Using **Wire Arc for Additive Manufacturing (WAAM)**, the team 3D printed steel propellers with six meters in diameter, but they produced a prototype at one-third scale. With approximately 300kg, the blade required less than 100 hours of print time.

According to the team of the project, AM of the blades at full scale led to a wight reduction of 40%, which means less material and less load on the engines. The new production further reduces fuel consumption, therefore, the environmental impact on the ship. Furthermore, an improved blade design results in further efficiency and durability while reducing radiated noise and vibrations that have negative effects on marine animals.

Legend : 181003-N-N2201-0001 NEWPORT NEWS, Va. (Oct. 3, 2018) This drain strainer orifice system, a prototype, is a steam system component that permits drainage and removal of water from a steam line while in use. A version of this is approved as the first metal part created by additive manufacturing for shipboard installation and will be installed aboard the aircraft carrier USS Harry S. Truman (CVN 75) in fiscal year 2019. (U.S. Navy photo courtesy of Newport News Shipbuilding by Ricky Thompson)



Credit: Naval Group

At Guaranteed, earlier this year, the Belgian company has commissioned the first of two production lines.

"On these lines, metal parts from heavy industry, oil & gas, offshore, shipping, … are repaired or produced with WAAM technology. The Guaranteed production cell can process workpieces up to ten by six by five meters, with a maximum weight of 20 tons. Currently the material database is already well populated (steel, stainless, Inconel, Titanium, aluminum, bronze, …), but can easily be expanded at the request of customers. With its dual value proposition, Guaranteed offers potential customers the opportunity to either directly save costs by repairing parts or to realize logistical cost savings by producing complete replacement parts on demand and quickly. To enable and support this, Guaranteed is actively involved in Joint Industry Projects managed by DNV to facilitate the uptake of AM in sectors such as oil & gas where certification is important", Joachim Antonissen and Sander Plasschaert said, speaking of their current projects.

Concluding thoughts

To conclude, additive manufacturing in the Oil, Gas & Maritime industries is still nascent. Even though technology promises a lot of advantages, yet remains quite expensive in terms of applications. Companies that debut on this segment should focus on advantages that are not provided by conventional manufacturing processes such as: production of spare parts, production on site, freedom of design and an environmental-friendly approach due to reduction of carbon emissions.

HOW TO DEFINE AM CANDIDACY FOR PRODUCTION APPLICATIONS ?

A wide range of rules has been established to implement conventional manufacturing processes. AM breaks many of these rules since it introduces new capabilities that are not compatible with conventional manufacturing. Therefore, to properly apply AM, one basic step consists in determining if the fabrication of a part is suitable for the technology. In the lines below, Julien Cohen, Application Engineer at 3DEO Inc., metal 3D Printer manufacturer and service bureau, answers 3 questions that are worth taking into consideration before selecting a metal AM production process for industrial production.

Let's make things clear now: this topic could have been addressed from the polymer 3D Printing perspective, or from the liquid 3D Printing perspective. Fascination for AM also lies in its strangeness. Even while discussing this topic, Julien Cohen makes it clear from the very beginning: "there are many ways to address this issue". His answers are based on his experience at 3DEO Inc. and in large corporations with tens or hundreds of thousands of SKUs (stock-keeping unit). They will be combined with industry researches and application examples shared by companies.

Frameworks to define AM candidacy

We have outlined three different frameworks that can be assessed before going down the AM route for series production.

1- A database of components and assemblies

Despite the significant advantages of AM, all parts are not suited for AM processes. The most logical step would consist in listing the criteria that should be taken into account to define candidate products for AM applications.

In theory, conventional manufacturing metrics which are usually compared with AM metrics and related experience are first filtered by design engineers to determine the first criteria selection. Secondly, a database of components and assemblies is used to assess AM potential and label according to the pre-determined criteria. The same selection criteria are usually applied for every new part of assembly and result in a model decision for AM candidacy.

Julien Cohen, Application Engineer, 3DEO

In practice, *"there is no central library containing all the necessary data and metadata to make this decision. For example, how do I go search for parts in a specific size range, made via investment cast aluminum, at a certain annual quantity range? The first hurdle for many corporations is to make these data accessible in a searchable database.*

Once that access is available, the problem can be addressed from multiple angles. In my opinion, rather than starting with a list of parts and identifying which AM process could be used for each, it's more effective to identify a potential AM process and then filter out parts based on the known process limitations. This workflow can be roughly split into four steps:

1) Choose an AM process to focus on (L-PBF, 3DEO's Intelligent Layering®, DED, Cold Spray, etc.)

2) Disqualify parts using absolute process limitations (i.e. maximum build volume, available materials, feature size capability, annual quantity)

3) Rank the remaining parts using some kind of business case metric (which application would make the biggest impact to the business with a 20% cost reduction, 20% weight reduction, or faster time-to-market?)

4) Pare this ranked list down to a manageable number of top opportunities, and examine these in-depth to determine which is worth pursuing", Cohen explains.

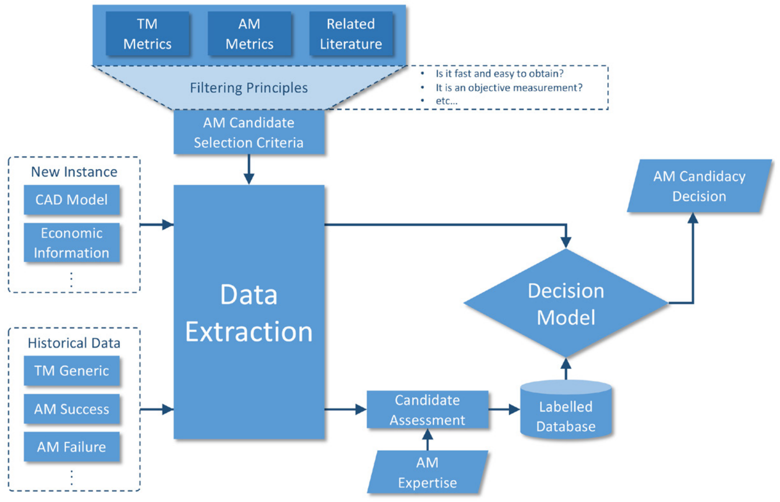


Figure 1. Framework to define AM candidacy (in theory) – Credit: McGill University – (Automated Candidate Detection for Additive Manufacturing).

2- The design analysis approach

Another methodology applied by companies is the **design analysis**. This approach consists in identifying parts where AM could be applied efficiently by leveraging DfAM capabilities. Four criteria are often taken into consideration in this process: **functions integration, customization, lightweight design as well as operation efficiency**.

Functions integration can be understood as the way the design will be integrated in the whole structure. This criterion aims to determine if a group of parts can be redesigned into one single part, if a product size can be reduced while achieving the same function, or if it will require less time for its production. Complex assemblies made of single-function parts often meet this criterion as each of them can be produced separately to reduce design and fabrication complexity.

From a technological perspective, the "customization" criterion involves multiple design variations and smaller lot sizes at the manufacturing level. This criterion is the most-acknowledged benefit of AM – it satisfies the requirements of consumer products end-users.

Lightweight design on the other hand, usually goes hand in hand with weight and materials costs savings. The challenge of the design engineer here is to improve parts performance with weight-reduction and ultimately less materials & costs savings. To tackle this issue, engineers usually leverage topology optimisation software, as such tools increase the part's geometric complexity by placing the material in locations required by the function.

Lastly, the operation efficiency consists in exploring all the innovative solutions that can improve the part efficiency once it will be used. This criterion often leads the engineers to explore ways the product life expectancy can be improved, ways to lower operational costs, ways to improve energy conversion and many more.

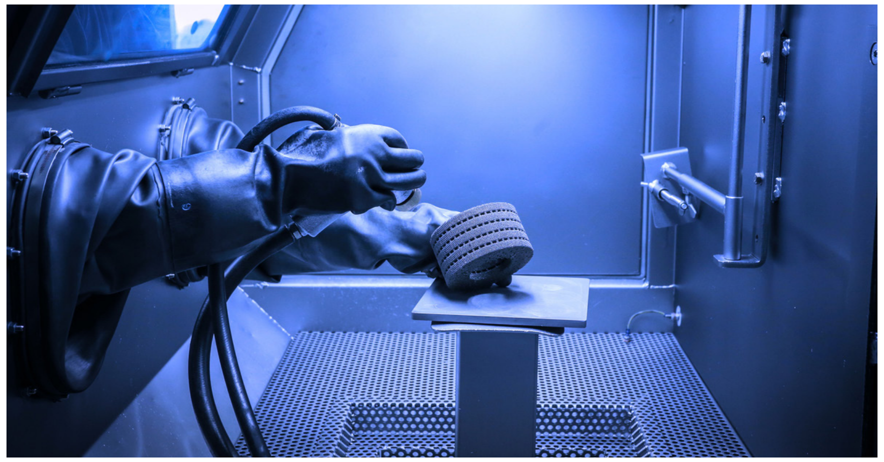
In general, this approach looks at the various technological and economic advantages of AM. Moreover, depending on the ultimate goal of the manufacturer, **the part might not always need to be redesigned**.

"People that work in the AM industry constantly get asked "can we 3D print this part?", and the answer is almost always yes... but this is not the right question. What you need to ask is "should we 3D print this part?"

It's possible that without redesign an organization can still reap benefits from switching to an AM process: shorter lead times, no tooling cost, decreased risk, etc. But without redesign, they will miss out on the incredible potential for optimization which AM design freedom offers. We have an incredible array of generative design, implicit modelling, and topology optimization software tools now at our fingertips, and it's a shame to leave their capabilities on the table.

My strong opinion is that AM experience should be injected as far upstream in the design process as possible, and that AM can have a much greater effect on new product development and clean sheet design projects vs. existing products which are already tooled up and in production", 3DEO's application engineer points out.

Unfortunately, this method of criteria analysis also presents its limitations as it only focuses on areas where AM will succeed, and does not address what makes AM a bad choice for a specific part. In this sense, it does not reject parts with obvious limitations. Furthermore, it does not take into account all the operational factors of the production process which includes the **supply chain**.



3- "The supply chain scenarios"

Supply chain has become an integrated part of the AM process. That's why, Senvol, a company that provides data to help companies implement AM, has defined seven supply chain scenarios where AM can be cost-effective. These scenarios take into account manufacturing expense, lead time, inventory costs, sourcing, remote operations, import/export costs, and functionality.

Checking AM candidacy through this approach is pretty simple: if a component meets the requirements of one or more scenarios, then AM should be explored further. However, if none of these scenarios is met, therefore AM is likely not the ideal technology process to leverage.

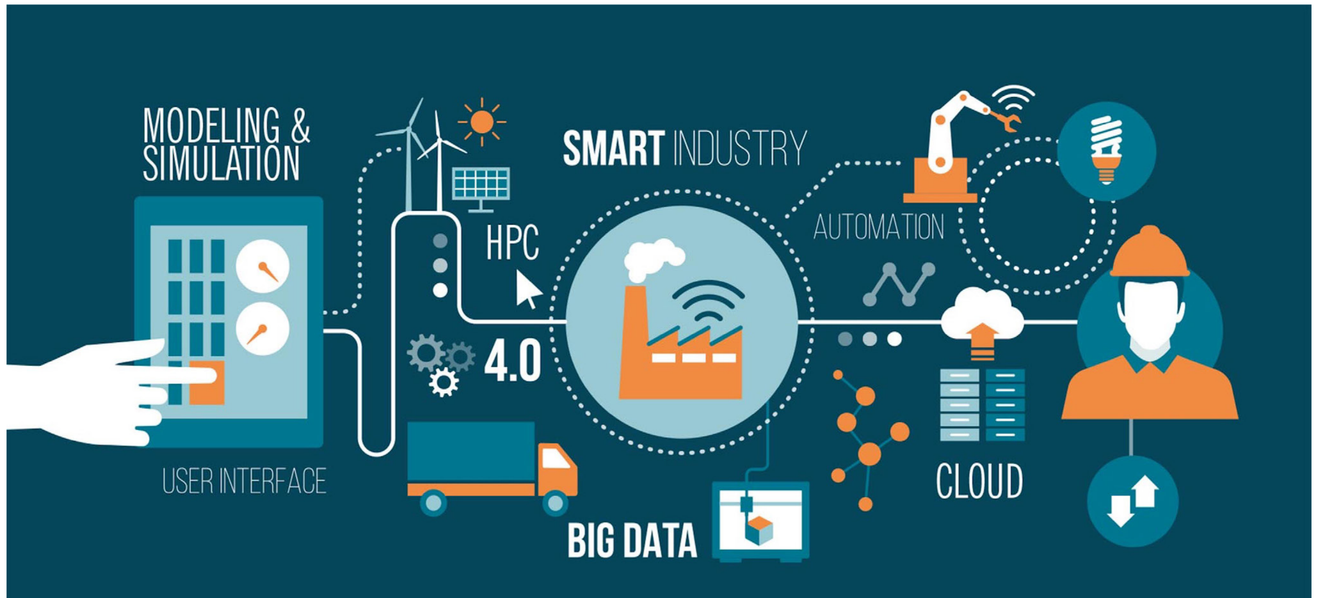


Image: Cloud Manufacturing

Scenario	Description
Expensive to manufacture	Do you have parts that are expensive because they are complex, have high fixed costs (e.g. tooling), or are produced in low volumes? AM may be more cost-effective.
Long lead times	Does it take too long to obtain certain parts? Are your downtime costs extremely high? Do you want to increase speed to market? Using AM, you can often get parts more quickly.
High inventory costs	Do you overstock or understock? Do you struggle with long-tail or obsolete parts? AM can allow for on-demand production, thus reducing inventory.
Sole-sourced from suppliers	Are any of your critical parts sole-sourced? This poses a supply chain risk. By qualifying a part for AM, you will no longer by completely reliant on one supplier.
Remote locations	Do you operate in remote locations where it is difficult, time consuming or expensive to ship parts? AM may allow you to manufacture certain parts onsite.
High import/export costs	Do you pay substantial import/export costs on parts simply because of the location of your business unit and/or your supplier? Onsite production by AM can eliminate these costs.
Improved functionality	With AM, it is possible to redesign a part to improve performance beyond what was previously possible.

Credit: Senvol

The main advantage of this approach is that the questions are easy to understand and can be quickly assessed. However, it is not always considered as an objective method.

Do these criteria differ from one AM technology to another?

Sometimes, each of these methods is assessed with the type of production (low-volume production or high-volume production) to achieve in mind. Cohen draws attention to the fact that these terms can easily raise confusion among industrials from various industries.

"High-volume production parts in the aerospace industry might mean a few hundred parts annually. Low-volume production in the industrial and automotive industries might mean tens of thousands of parts annually" the expert states.

Furthermore, one common limitation all these methods share is the fact that they do not take into account the uniqueness of each AM technology.

"For example— while powder bed processes like L-PBF and EBM can enable significant optimization of strength-to-weight ratio, heat transfer capability, and internal fluid flow efficiency, the process is still extremely expensive and comes with a laundry list of limitations and considerations, especially in serial production. These processes can be fantastic tools for low-volume, high-cost parts, but with the right support design and process control can also be cost-effective for small parts which nest efficiently on the build plate.

Similarly, 3DEO's Intelligent Layering® process was developed specifically for high-volume, low-cost applications— I'm talking 100k+ annual quantities and <$5 per part. Our process is unique in the metal AM space and overcomes many limitations inherent to emergent processes like binder jetting, as well as traditional processes like MIM and CNC machining. The types of applications that fit our process are completely different than those which fit many of the other processes on the market.

In the absence of widespread industry standards and technology maturity, making the correct choice of application requires deep knowledge of available AM processes, their pros and cons, and experience using them in the past. At 3DEO we maintain long-term production partnerships with our customers and offer our knowledge base to accelerate these types of decisions" 3DEO's spokesperson comments.

In a nutshell

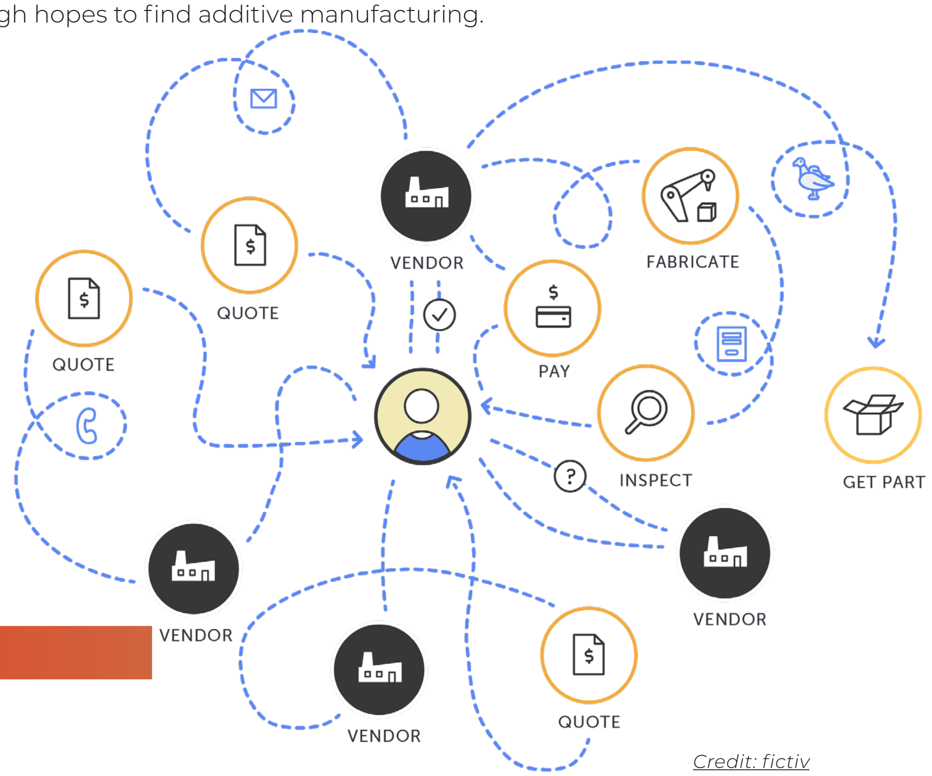
We have described three AM candidate selection criteria methods that are often utilized within organizations. Each of these AM technologies has its pros and cons. However, the more the market advances, the more companies will be able to standardize a guide that will help verify AM candidacy for production applications.

Additive Manufacturing

Is Distributed Manufacturing a form of Sharing Economy in the AM industry?

"Distributed Manufacturing" (DM) is primarily the ability create value at geographically dispersed locations via manufacturing. Over time, the concept has evolved and has taken different shapes in the additive manufacturing industry. It's time to understand what it means in the AM industry, why customers want it and what infrastructures should be implemented to this end.

Let's take the primary attribute of DM. DM has gained popularity with inefficiencies of *"offshore manufacturing"* with large volume producers. Those challenges, sometimes include, language barriers, time zones, and several issues between the various sales and logistics teams. DM has therefore positioned itself an alternative enabled by digital technologies. Unsurprisingly, where digital technologies lie, there are high hopes to find additive manufacturing.



Credit: fictiv

What does DM mean in the AM industry?

In reality, the terminology around DM is not precise. A myriad of terms is used interchangeably, to designate "distributed manufacturing". They include for instance, *"distributed production", "redistributed manufacturing", "local manufacturing"* and *"decentralised manufacturing"*.

Local manufacturing refers to a strategy implemented to support local communities while *"redistributed manufacturing" "captures the anticipated reshoring and localisation of production from large scale mass manufacturing plants to smaller-scale localised, customisable production units, largely driven by new digital production technologies."*

In the AM industry, the most widely-accepted definition refers to the integration of local production in manufacturing behaviours. Depending on the person who is speaking, the term might mean, production "within the neighbourhood", "within the region", or simply "in the country".

Italian manufacturer of 3D Printers **WASP** for instance, believes that a *"distributed manufacturing network consists in sharing knowledge, materials and processes between teams that are not necessarily based in the same country. It calls it shared fabrication."*

Two years ago, the company launched a network of WASP Hubs, operating units that innovate by sharing discoveries, projects, processes, materials and job opportunities. Today there are 13 of them: In Italy they are in Milan, Venice, Macerata, Mantua, Naples and worldwide in New York, Berlin, Barcelona, London, Paris, Madrid, Umea and Beirut.

Why would a company be interested in local production?

The reasons why companies might opt for a local production seem obvious, as they generally tend to **focus on environmental**, **socio-cultural** and **economic** aspects.

An environmentally-friendly production necessarily implies reduction of emissions from transportation and implies giving a chance to a circular economy approach. A company that is driven by socio-cultural decisions is one that would like to enhance the capabilities and potential of local manufacturers and their willingness to create new cultural values within the society. Economic reasons on the other hand, encourage the development of the local industry and to a certain extent, the creation of jobs.

Furthermore, **from a technological perspective**, DM operations require the use of different technologies that need to be mature enough, to ensure a certain level of production and customization.

A study entitled "Distributed Manufacturing, scope and challenges", carried out by different universities in the UK and published in the International Journal Production of Research, demonstrates that not only 3D Printing has been a key enabler of DM but as an enabler, it has created new business models whose impact is not completely understood and mastered by stakeholders.

From the manufacturer's perspective

From this perspective, a DM business approach involves the input of **different stakeholders** as well as a **well-established infrastructure**.

Various stakeholders

Even though, manufacturing aims at producing a product, it is first and foremost, a collaborative activity where several professionals with different expertise can come together, and work in a codified way across various locations.

In a company that applies a DM business model using, these stakeholders can include but are not limited to the designer, the manufacturer, the material producer, the various software providers, the post-processing specialist and sometimes the end-user.

WASP illustrates this production approach with **WASP Hub**, its 3D Printing service network. The WASP Hubs are advanced digital fabrication laboratories located around the world and equipped with various technologies including large 3D printers. To manufacture the large architectural installation Conifera - COS realized by Arthur Mamou-Mani (WASP Hub London) during the Milan Design Week 2019, several experts from the various WASP Hubs and the architects shared their knowledge and worked together through the web platform.

The challenge of this project was to achieve a structure of 700 modules in bioplastic and recycled plastic of about half a cubic meter each. The Milan, Venice and Macerata's Italian WASP Hubs, connected to the London's one and worked together from the design to the production stages. It took two months to achieve the whole structure which was 3D Printed on the Delta **WASP 3MT Industrial 4.0**.

"WASP Hubs are a great resource for all the production systems. It is a group of designers and architects, that can see and foresee the future due to digital fabrication. They work in a network with innovative processes and tools. Advanced plastic polymers, recycled plastics, mortar and geopolymers: materials and dimensions are no longer a limit. Their minds are connected through the web, and that allows them to materialize projects by sharing information about materials and processes. It's like the perfect scene of a science fiction series, but WASP Hubs are a reality", **Tiziana Teghini** from the marketing department said.

A new infrastructure

DM is only possible with digitized resources and absolute control. Companies that provide this service have to find a way to make this infrastructure work. It is about mastering the technology, ensuring material control, understanding of material properties, monitoring (e.g., remote monitoring), sensors, and connection to the customer base, supplier base, consumer base, and many more.

"These requirements are increasingly being met by advancements in areas such as additive manufacturing. Two-sided platforms have been created, linking customers wanting to access 3D printing capability with owners of 3D printers. The range/library of materials conducive to 3D printing/additive manufacturing is constantly expanding, and the software that enable 3D printing files to be created, modified and distributed is inexorably improving", researchers from the study "Distributed Manufacturing (…)" explained.

In the same vein, since connectivity has become an integral part of this production approach, it requires advancements in digital infrastructure including process analytical technologies, IoT, management systems; and on the other hand, data, data analytics and Big data.

As part of its SAP Leonardo portfolio for the Internet of Things (IoT), the enterprise software company SAP has launched a **SAP Distributed Manufacturing** which works through integration with the SAP S/4HANA cloud that delivers **business process automation as a service. The SAP DM** is an application that enables collaborative business network where manufacturers can work with a variety of 3D printing companies, service and material providers as well as OEMs.

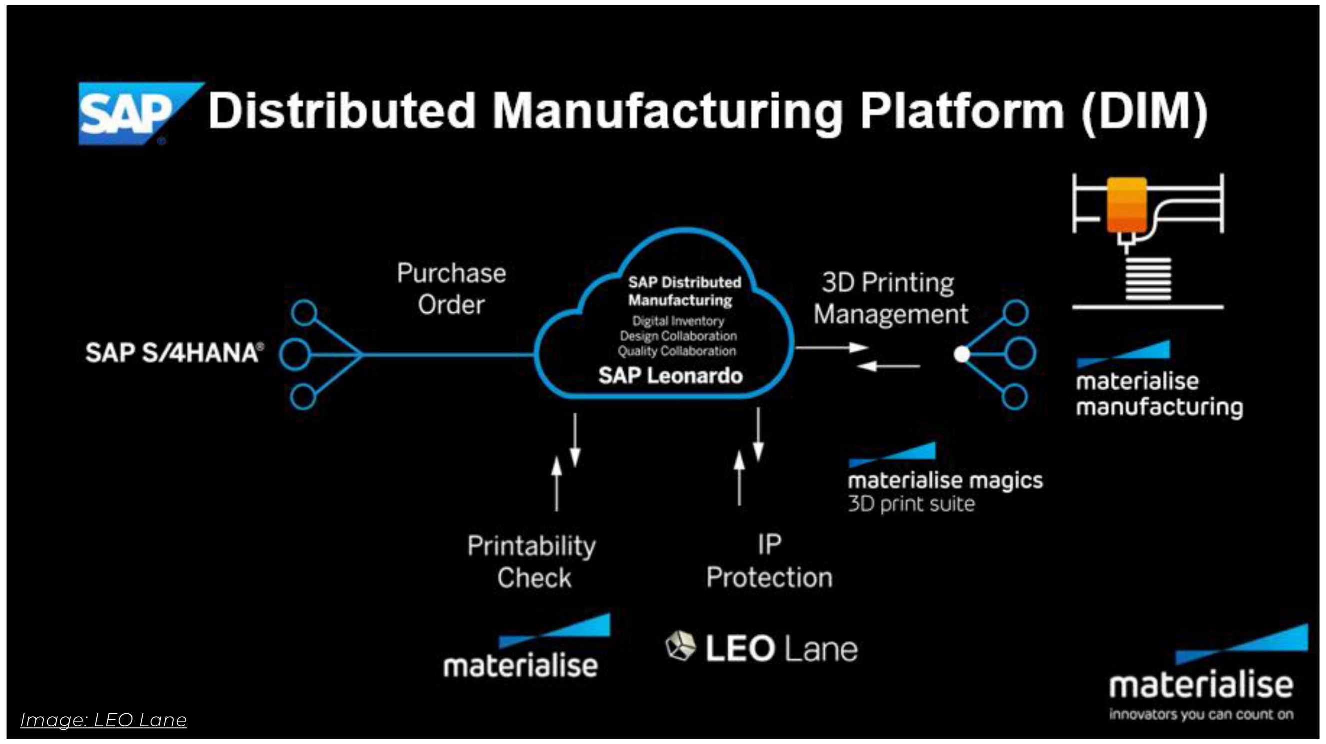


Image: LEO Lane

"Beyond the prototype it brings 3D printing into repair, spare parts and production," Lackey said. "Customers want lot sizes of one. They want to buy products that are made for them and with 3D printing you don't have to have things in inventory. You can make it on demand", Mike Lackey, SAP's global vice president of solutions management for IoT and digital manufacturing, said during the launch.

Companies that have understood this process, are now looking for ways to overcome the challenges they can encounter.

Challenges

Challenges in a DM business model come at three levels:

- **IP implications in terms of ownership**.

In its DNA, a DM approach might include multiple inputs in design. Scientists from the study "DM: scope & challenges" believe it might have implications on the product's robustness, and maybe compromise the product integrity. However, the most glaring consequence remains the question of ownership: who is the approved designer? And how to avoid copyright infringement?

"IP Protection will be necessary for the prevention of copyright infringement for design and development work. Business-to-business and business-to-consumer data sharing, governance, ownership and security are key potential barriers to DM's adoption".

- This makes "**regulatory and governance issues**" the next challenge on the list.

A framework is of the utmost importance to ensure regulation is in line with technology advancements otherwise a number of institutional factors can become a barrier to the wider adoption of DM.

"There is further demand for regulatory and commercial pathways that challenge current funding, and commissioning models. Standards, compatibility and certification are other outstanding topics while

DM will also navigate different layers of governance."

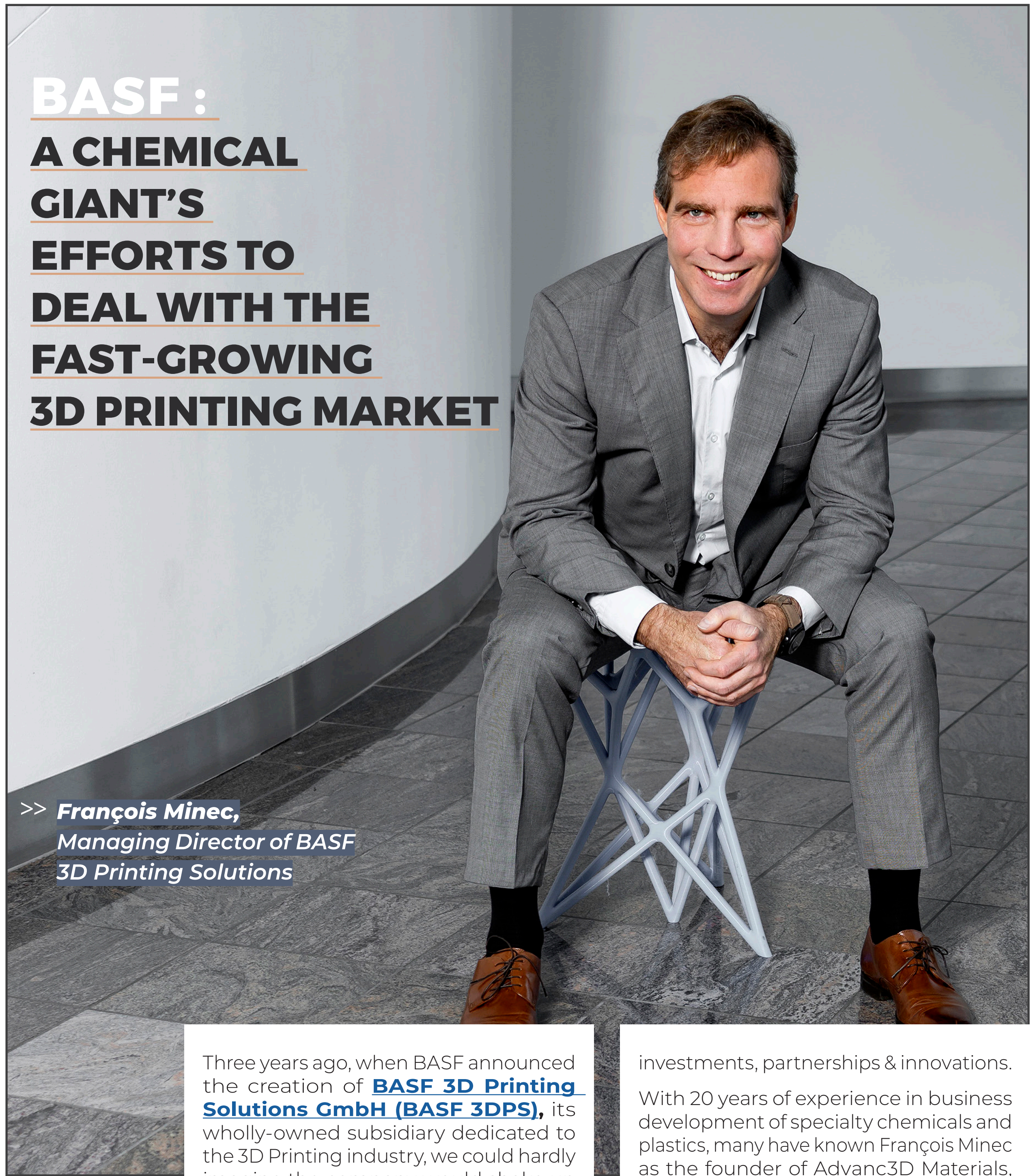
From the consumer's perspective

The launch of a new service always aims to respond to a certain market's demand. For some companies of the industry such as **Arevo**, the Covid-19 has validated the manufacturing-on demand business model while it has encouraged others including **Roboze** to launch a new service with a similar model.

The only thing is that, nothing is certain yet about the current market and how the economy will evolve. If consumers can benefit from "just-in-time delivery", a number of questions remains unanswered. What will be the demand in terms of manufacturing? Are we going to achieve the same applications? What will be the price of new products manufactured at the local level? And will a DM approach take into account an ethical context that seeks to minimize social exclusion?

These are uncertainties that need to be addressed in the long term.

BASF : A CHEMICAL GIANT'S EFFORTS TO DEAL WITH THE FAST-GROWING 3D PRINTING MARKET



>> ***François Minec,***
Managing Director of BASF 3D Printing Solutions

Three years ago, when BASF announced the creation of **BASF 3D Printing Solutions GmbH (BASF 3DPS),** its wholly-owned subsidiary dedicated to the 3D Printing industry, we could hardly imagine the company would shake up the 3D Printing industry so intensely.

As a chemical giant, the company's efforts during the past three years could be seen as signals of a company trying to set its marks in the 3D Printing world. In hindsight, while looking at the bigger picture, we reminded ourselves this statement from Rüdiger Theobald, Senior Manager Sales & Marketing 3D Powder Solutions, to 3D ADEPT Media: "one year in AM is 10 years in traditional chemistry". A statement that might finally explain the company's continuous astute moves to stay in everyone's radar.

In this interview, François Minec, Managing Director of BASF 3D Printing Solutions, discusses the company's acquisitions, investments, partnerships & innovations.

With 20 years of experience in business development of specialty chemicals and plastics, many have known François Minec as the founder of Advanc3D Materials, a company that developed 3D printing materials, such as FDM/FFF filaments and SLS powders, and which was acquired by BASF in July 2018.

He was also a shareholder of Setup Performance, a partner company of Advanc3D Materials that was also acquired by BASF. As a Managing Director of BASF 3D Printing Solutions, the 3D Printing specialist is in charge of the company's strategic direction as well as the business performances of its different product lines.

Since the launch of BASF 3D Printing Solutions, the German company has quickly broadened its levels of expertise about additive manufacturing, and this is mainly due to its acquisitions and investments.

Acquisitions and investments

Indeed, before the acquisition of Advanc3D materials and Setup Performance, it should be noted that BASF firstly expanded into 3D Printing materials with acquisition of Innofil3D. Other investments in Essentium, Prismlab, Materialise, as well as high-profile partnerships in AM with made even clearer the company's seriousness about 3D Printing.

However, among these acquisitions, one that remains a big surprise for the industry was Sculpteo's acquisition. For several years, the French 3D Printing Service has worked hard to keep a seat on the international scene alongside fellow companies such as Materialise and Shapeways.

This decisive turning point in Sculpteo's existence, gives more strength and a polymer expertise to Clement Moreau's company; on the other hand, it gives BASF a new profile: the one of parts producer.

"For us, the acquisition of Sculpteo in November 2019 was a logical step to bring AM forward. We as Forward AM offer high-performance materials and solutions, Sculpteo offers printing services. By bringing these two complementing aspects together, we create synergies that our customers benefit from. With Sculpteo we are able to accelerate the introduction of innovative materials and solutions. And, of course, we can demonstrate a proof of concept by printing our solutions – offering our end customers solutions that really work", **François Minec** explains.

Furthermore, this acquisition's announcement happened at the same time the company launched its new corporate brand, Forward AM.

Forward AM, BASF's new corporate brand

Last year, in November 2019, when the German company announced its new communication orientation with Forward AM new brand, it was obvious that the combination of the words *"Forward"* & *"AM"* was meant for *"future-oriented, leading-edge materials and technology"*.

But to be honest, it was also a bit confusing with regards to BASF 3D Printing Solutions GmbH. Is it a new brand which is part of BASF 3DPS? Or is it the new name of BASF 3DPS?

The MD removes the uncertainty regarding this topic: *"'BASF 3D Printing Solutions GmbH' is the name of our legal entity while Forward AM is the name under which we market our AM solutions and materials globally. The term 'Forward' in our brand name and logo symbolizes our objective of bringing AM to the next level by industrializing it; and thereby support our customers with our end-to-end solutions from first idea to printed product. Looking at the positioning of our company within the BASF framework, we are clearly defined as subsidiary, purely focusing on 3D printing solutions and materials. This is also the reason we are organized in start-up like structures – to act fast in the dynamic AM industry."*

Moving forward with partnerships and innovations

As far as ongoing developments are concerned, the materials specialist announced last year that, it was working on a "third-party certified materials program" as part of its partnership with HP. First fruits of this project saw the launch of the certified material Ultrasint® TPU, which is leveraged for several applications across industries (footwear, protective gears, auto seats and interiors as well as jigs and fixtures).

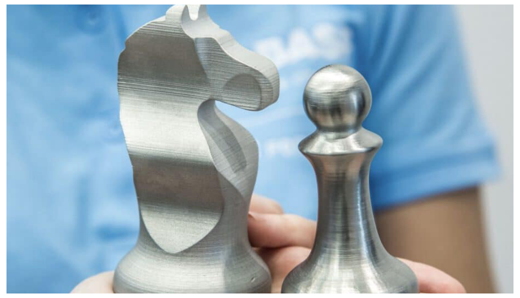
A month and a half ago, the companies released a High Reusability Polypropylene (PP) material for HP's Jet Fusion 5200 Series. Suitable for applications where an optimal balance between performance and cost is desired, it helps reduce waste by enabling up to 100% reusability of surplus powder.

Door defroster vent used in the ventilation system of automobiles. Printed with HP 3D HighReusability PP enabled by BASF

Furthermore, first opportunity that resulted from Sculpteo's acquisition by BASF was the launch of Sculpteo's digital platform, where customers could upload 3D files and order 3D printed parts – that will be produced with a wide range of BASF's materials amongst others.

Speaking of these materials, the MD enthuses about a specific metal filament: *"It is a cost-competitive filament, based on the BASF Catamold® material, which works on any FFF printer. It's the perfect material for tooling, jigs and fixtures, but also for spare parts for industrial machines and agriculture. We commercialized this material last year, and since now it is also available for direct part printing via the Sculpteo platform I mentioned before. We really see an acceleration for this product."*

Moreover, in Asia, the company is expanding its 3D Printing business with the support of Prismlab, a 3D Printer manufacturer that is now an official distributor of Forward AM's high performance Ultracur3D® photopolymer products. This new range of materials will be distributed under a specific portfolio "Ultracur3D® for Prismlab".



Credit: Forward AM by BASF – Part produced with a metal filament for FFF

"This partnership is one element in our strategy for the Asian region. Since we started with Forward AM in Europe, we now have the clear objective of establishing an infrastructure in North America as well as Asia. By Q1, 2021, we plan to have 3D Printing Centers of Excellence in both regions to serve customers with our solutions globally", the MD adds.

Credit: Forward AM – Dental molds produced with Ultracur3D® RG

The 3D Printing market today: materials and opportunities

It takes so much time to develop a 3D printing material that producers must seize market opportunities when they saw one. That's what BASF did. Three years ago, when the company debuted on this market, there was a high demand for more functional plastics and powders. Today, there is a fairer distribution of materials opportunities for the four major technologies (PBF, VAT Polymerization, Filaments and Metal), "with each technology accounting for approx. 25 percent", according to some market reports.

These technologies "all show similar growth rates of around 25%– so there is no 'clear winner', even if VAT polymerization is still a bit ahead. For us at Forward AM, this development underlines our strategy to be present in all technologies and offer solutions across the different technologies", the MD concludes.

It took several years to many companies to position themselves as leading players in the AM industry. BASF only needed three years to reach an outstanding position, and we have not heard the last of the company.

RE-IMAGINING PRODUCT DESIGN : 3D PRINTING AND THE CMF OPPORTUNITY

The latest J55 3D printer provides designers access to an office-friendly, compact, ultra-quiet and affordable prototyping technology

Words of Yariv Sade, Director of Applications Engineering at Stratasys

In the 21st century, product design is central to driving revenue for many businesses – it provides an opportunity to connect to consumers, increase sales, personify and build a brand. The CMF design process – color, material, finishing– is an essential part of product design, but for various reasons, remains a challenge for designers to easily integrate into the design process.

Over the past decades, the way businesses and consumers look at design has changed. While a product's engineering has historically taken center stage when it comes to bringing it to market, the 21st century takes engineering excellence and product performance for granted. Today, if something is to stand any chance of enjoying the all-important successful launch and subsequent positive reception among target audiences, then it is product design that's king.

In a recent McKinsey study looking at the correlation of product design to business success, it was found that design-led companies have 32% more revenue and 56% total returns of shareholders than companies that place less focus on design. The results clearly demonstrate that companies that monitor consumer behaviour and understand a product's look and feel – from color choice to surface finish – are ahead of the competition. This holds true for nearly every industry, from automotive to consumer goods, and from healthcare and medical devices to consumer electronics.

The designers behind product concepts are therefore under more pressure to deliver the winning design; the next bestseller. The processes and tools at their disposal are numerous. However, there are still several barriers for designers to easily create realistic representations of their ideas during the design process, and accurately convey them to potential stakeholders and decision makers. A crucial challenge for designers is the CMF process.

Understanding the way we design products

In design, CMF refers to the process in which color, material and finishing is determined and selected for a product. Color can refer to hues, saturation, shading and color combinations within the design; materials reflect the feel and character; while finishing is the texture and surface appearance – pattern, matte, smooth, shiny etc. These elements create the finished 'look' of a product. The challenge many designers often face is that CMF is not integrated enough into the product development process – it is often only reflected perfectly in the finished product's look. This is largely because – if they are using it at all – design facilities in enterprises, design studios or SME's often rely on, or are restricted to, single-color 3D printing to create physical representations of their digital designs. These prototypes are built to reflect the geometry and functionality of the design, yet they cannot represent more than one color, nor reflect textures or finishes. The absence of an easy, fast and affordable solution to create full color concept models or high-fidelity prototypes to test and present a product's geometry, functionality, and look and feel is an inherent issue

3D printing gives designers the tool to fully integrate CMF into the ongoing design process (prototypes printed on the Stratasys J55 3D Printer)

Design concepts are therefore split over several mediums. Designers utilize textile samples and PANTONE™ color charts, as well as printed and online images to determine CMF for new product designs. In addition, the product's measurements, geometry and build is reflected in a 3D file that can result in a basic single color physical 3D-printed prototype – which can be painted or 'dressed up' to more realistically reflect the design idea. This not only makes it difficult to translate the design idea quickly and uphold faith in the product design when presenting it to stakeholders, but it also denies easy design iterations and accurate testing among focus groups or potential buyers.

In order to have a prototype final product at the end of the design process, some design studios outsource the creation of full-color prototypes to global suppliers. This is in fact a US$ 5.3 billion market , yet the delivery time for models is lengthy and usually takes several weeks. Furthermore, the associated cost can be several thousand dollars (for a 10-15cm long model). An added challenge comes in communicating the exact CMF look to the external supplier – as the geometric shape is kept in a 3D file, yet the CMF information is carried in other mediums (images, slides, PPT, notes etc). Relaying design information from one person to another is therefore difficult, and leaves room for error. With such huge cost and long waiting times, designers typically only leverage this high-end outsourcing option to create a model of the finalised product for marketing purposes at the end of the design process.

Introducing full color 3D printing

The answer – full-color multi-material 3D printing is straightforward, yet still not that widely used within the design world. In fact, only a few leading corporations have leveraged the potential of this technology for their in-house design requirements. Those that have are granted the means to create ultra-realistic 3D printed design prototypes in little time, which can be iterated and adapted to deliver visually impactful designs. One such technology is Stratasys' J-Series PolyJet 3D printing, which enables PANTONE™ validated full color capabilities and a choice of up to seven different polymer materials - all united in a single print.

Providing up to 500,000 distinguishable color combinations, the J-Series technology not only opens up unparalleled design freedom but gives designers the tool to fully integrate CMF prototypes into the ongoing design process. This saves both time and money, thanks to quicker decisions, improved CMF design iterations, and no external lead times for models.

Designers can use ultra-realistic 3D printed prototypes as a tool to convey and sell their design ideas to prospective customers and stakeholders. This can also raise confidence in the design idea, without dependence on different digital mediums to present a design – or rely on other people's imagination to envisage the final product's look.

Providing up to 500,000 distinguishable color combinations with PANTONE™ validation, the J-Series 3D printing technology opens up unparalleled design freedom

A material world

This capability to combine different materials in a single print pushes the boundaries of design realization much further. This opens up the possibility for improved design representation, as textures and different material surfaces can accurately be represented – from wooden textures, marble effects to glass. Combining this with PANTONE™ validated color spectrums brings CMF directly into the prototyping process and enables designers to create 3D printed prototypes with such true-to-life accuracy that they are indistinguishable from the final product.

In terms of consumer behaviour and designing a successful product, full color 3D printed prototypes also open up the opportunity of AB testing - the process in which consumers are presented with visually different versions of the same product before both response and sales are measured for each. The ability to undertake this market research with 3D printed prototypes (in focus groups for example) gives designers or stakeholders the opportunity to decide on the most popular CMF design for the new product.

Providing up to 500,000 distinguishable color combinations with PANTONE™ validation, the J-Series 3D printing technology opens up unparalleled design freedom

Looking ahead

For designers, full color, multi-material 3D printing is the tool that enables designers to overcome existing CMF design barriers and realize product designs exactly as they envisaged.

One such technology that can unlock CMF and endless design possibilities for designers is the new J55 3D printer. Allowing ownership of designs from start to finish and cost-efficient model development in-house, the J55 provides designers access to an office-friendly, compact, ultra-quiet and affordable prototyping technology.

McKinsey's 2018 study highlights that 'research, early-stage prototyping and iterations' are some of the key pillars to driving business success through design. In markets where competition is fierce and true-to-life design even more vital, it is essential that the final go-to-market products have the best color, material and finish, in addition to faultless engineering.

As an Additive Manufacturing Company, when do I need an air technology solution? More importantly, which one fits my needs?

In the May/June Issue of 3D ADEPT Mag, we shared some insights into ULT AG's activities, a global company that aims at removing hazardous particles in various manufacturing processes. The company provides the AM industry with advice and product assessment on everything related to air pollution control, occupational safety as well as air drying in plastic and metal AM processes. The first step towards appropriate use of air technologies solutions consists in understanding their specifications and how each of these technologies should be leveraged.

In this feature, Alexander Jakschik, Managing Director/CTO at ULT AG helps industrials to understand when they should rely on air technologies solutions. He also reveals key tips to know which air technology solution fits best a company's needs.

Why do I need an air technology solution?

First of all, let's keep in mind that this article will focus on three main solutions provided by ULT AG to the AM industry: extraction, filtration, and air-drying technology. These technologies can be utilized either in the workplace or more specifically alongside the 3D Printer.

Air's ability to contain and to convey liquids, solids and living particles is quite overlooked. The reason sometimes is simple: as we do not see these particles, we can't properly assess their impact on the end part or the operator health.

Yet, research demonstrates that 3D Printed parts often suffer from the impact of impurities in the construction chamber. Even once purged, those impurities can have a damaging impact on the 3D Printed part or alter the desired mechanical properties of the part, especially when sensitive materials are utilized during the production.

Seven forms of impurities can influence the AM process, machines and products. They can also cause significant health risks for operators: macro dust, nano dust, solvent vapors, noxious gases, foreign particles, oxygen in inert gases and air humidity.
"The extraction and filtration process starts with pollutant or air capturing, as you can only filter what has been captured before. Contaminants or air streams are captured using specially designed capturing elements. This highly important step requires strong

Alexander Jakschik,
Managing Director/CTO at ULT AG

expertise. Particularly contaminants in AM are nanoscale and almost do not sink to the bottom. Plenty of know-how is required to capture these airborne pollutants", **Alexander Jakschik** points out.

Indeed, these pollutants occur at different stages of the production process, therefore, have a different impact on operators, the manufactured product or even the 3D Printer's functioning.

Nano dust for instance, is usually seen in melting processes, during a production that requires the use of powder materials.

Solvent vapors can be released during outgassing of liquid synthetic resin and cleaning of products. These solvent vapors can be a nerve poison, can cause eye damage or can even be a risk for the operator's breathing.

ULT AG
FOCUS ON You Series

Noxious gases pollutants can be released when melting powder materials during production processes. Due to contamination of powder materials and liquid synthetic resins, these pollutants can have a detrimental effect on the manufactured part. Furthermore, in the workplace, dust particles that remain in the air can contaminate the materials and have a similar impact on the manufactured part.

These examples show that air pollutants can have an impact at different stages of the AM process. That's why, to tackle them, they require different types of air technologies solutions.

In this vein, Alexander underlines the different stages of the AM process that require dedicated solutions:

"[There are] solutions for AM process preparation. Drying technology is utilized during the handling of powder under defined dry conditions for better material and process quality. Air cleaning technology comes into play when operating with powders under safe and health conditions.

[Next in the line are] solutions for the AM process. Inert gas cleaning technologies (e.g. Argon, Nitrogen) are required for safe and stable processes. ULT offers solutions for powder bed fusion, material extrusion, and more. They are implemented either as an integrated solution or as retro-fit.

[And] solutions for post-processing which include vacuum cleaners such as process chamber cleaning, as well as air cleaning at manual workplaces (required when removing printing support material or smoothing phases). Not to mention that air cleaning is also used at unpacking stations or depowdering stations."

Very often, additive manufacturing outlines are only assessed from the prism of the printing process. By highlighting these different stages, ULT AG's Managing Director also highlights the need to address the issue at both the pre- and post-processing stages of the manufacturing.

Interestingly, the use of each air technology solution also depends on the AM technologies leveraged, hence the need to know which solution fits best each manufacturer.

Credit: ULT AG - Extraction technology for post-processing

Which solution fits your organization?

Air handling jobs can be performed both on the processing of metal, plastic, and ceramics powders as well as on the processing of plastic fibers and liquid synthetic resins.

Based on the aforementioned description of air pollutants impact, one notes that air technologies solutions mostly fit with selective laser melting and stereolithography technologies. However, further applications of these technologies can be explored for FDM processes and other forms of metal AM technologies including electron beam melting and laser deposition welding.

Air drying technologies, as well as extraction and filtration technologies, can be used for each of these AM technologies.

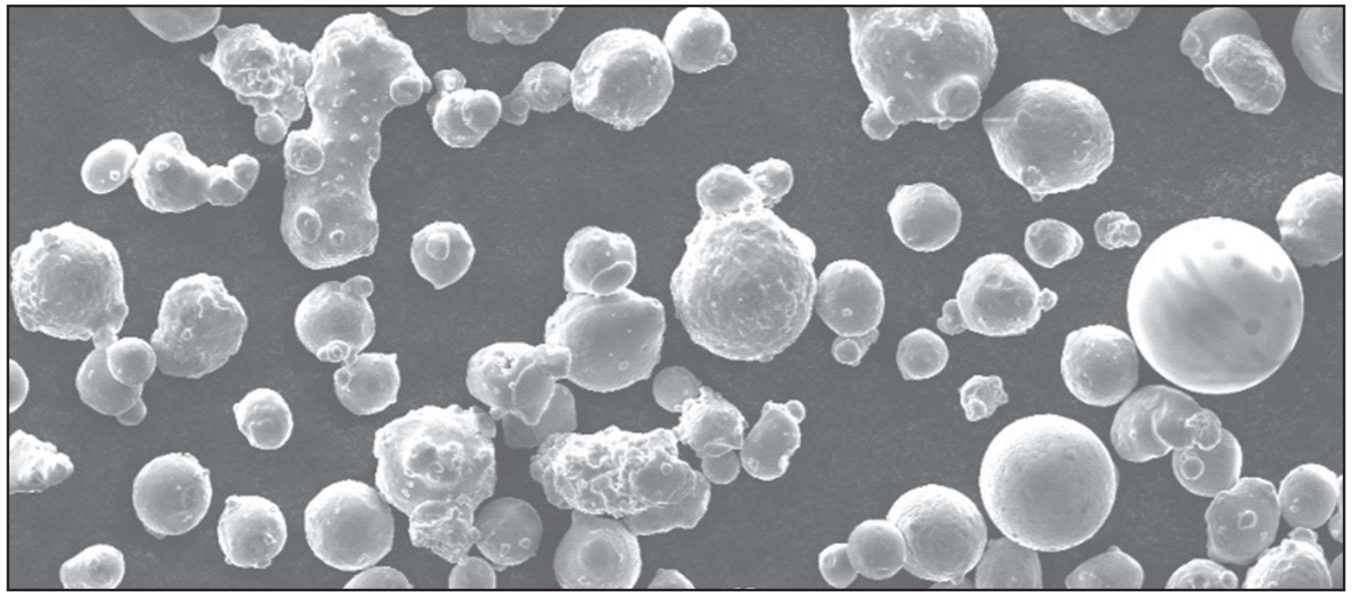
Air drying technologies come into play when the operator must process powders while meeting safety and quality requirements. In this regard, *«it is important to ensure constant air humidity in the powder storage or production rooms. It helps prevent water from attaching to the powder and negatively influencing the process quality of the selective laser melting process or leading to corrosion»*, Alexander states.

As for extraction technologies, they require the use of unpacking stations as well as post-processing systems for metal 3D Printing processes. As their name implies, they help remove powders that are downstream from the AM process into an optimized system.

"The powder itself is in the micrometer range. The particles that are created during processing are nanoscale. This particle size hardly sinks to the bottom and remains in the air. It can, therefore, be distributed anywhere in the room or dragged into the home. Such particles overcome the lung-blood barrier and are distributed throughout the body and the brain, where they may cause irreversible damage.

Also, it is advisable to subject the entire production area to air purification in order to ensure cleanliness in the production process and to prevent the particles from being carried over into the home.

Furthermore, ULT AG also provides industrial vacuum cleaners. Thus, the excess powder can be safely removed from the machines and in the production environment", **Alexander Jakschik** explains.



Legend: Analysis from a powder material management – Credit ULT AG

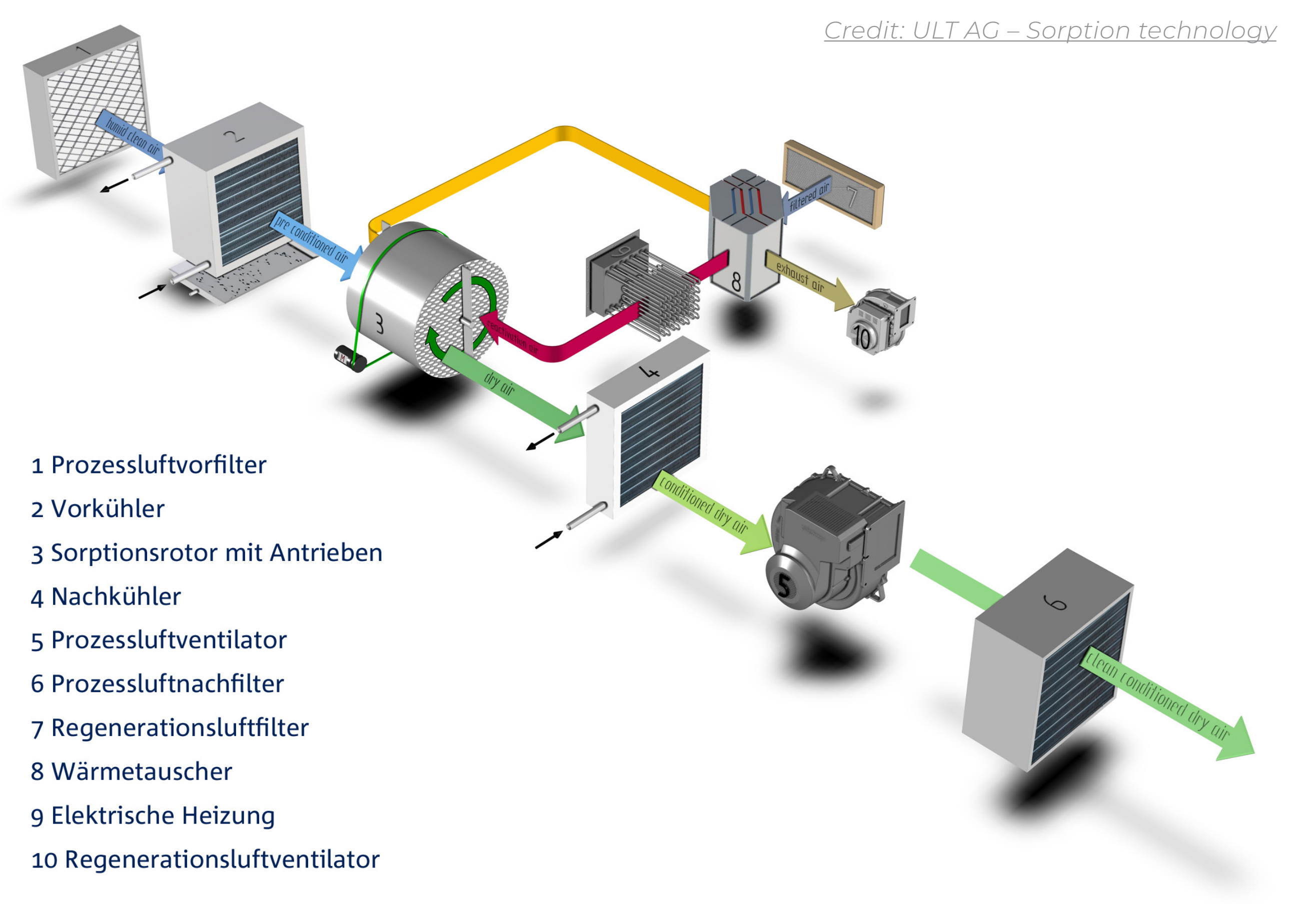
Unpacking stations are a further step towards the flexible use and industrialization of AM. They are integrated into the AM material management system and help to establish a seamless powder processing chain. The good news is, they can be used no matter what the number of production machines is.

Application of air-drying technologies with Selective Laser Melting

SLM-based technologies always require the use of extraction technologies. Used in the form of gas cleaning, these technologies enable operators to maintain a stable and safe process.

ULT has built up extensive experience in applications with this AM process and has conducted further research in the field to explore new possibilities to improve the production environment.

"Based on experience and intensive research, [they] have defined a multi-level filter concept, for [different processes including] selective laser melting processes. Coarse and fine particles are filtered through several stages. The filters must be designed in the way they can handle flammable or explosive substances safely. In terms of air-drying systems, we have developed a sorption technology which aims to achieve extremely low dew point temperatures. The most important component of such a system is the specially coated sorption wheel/rotor. It rotates at a speed adapted to the process and absorbs the moisture from the process airflow. In countercurrent, warm air is led through the sorption rotor, which removes the moisture from it. The water-laden exhaust air is then released into the environment outside the process area", the MD states.



Credit: ULT AG – Sorption technology

Concluding thoughts

The integration of air-drying technologies requires to pay attention to several parameters, from AM systems specifications to the use of materials leveraged and the workplace. In this case, personalized advice is often best as it can determine how efficient a company's air treatment solution can be.

Several issues regarding this topic still need to be addressed, in light of the current development of automated AM solutions. However, the biggest issue today, is to raise awareness on the impact of harmful substances in 3D printing. As they are an invisible danger, their effects are only likely to be seen in a few years.

"The particles and gaseous substances are not visible (because they are nanoscale) and often cannot be smelled. Therefore, there is hardly any problem awareness. The effects are often visible years after application [and at that moment], they are no longer reversible. Particles cross the lung-blood barrier and are distributed in the body and brain.

I wish for the future that the understanding for it grows more and more and that we can all guarantee safe and clean production processes in the future", **Alexander Jakschik** concludes.

This content has been written in collaboration with ULT AG.

THE CHINESE ADDITIVE MANUFACTURING MARKET THROUGH THE EYES OF JSJW

TCT Asia took place from 8-10 July 2020 at the Shanghai New International Expo Centre (SNIEC). The event was the first 3D Printing/AM event to be held in-person after a long period of events' cancellation due to the Covid-19 pandemic. The decision to hold the event was in light of the improving COVID-19 situation in China. Furthermore, the Chinese Government had announced that exhibitions in China would gradually resume from May onwards.

Over 220 exhibitors across the entire additive manufacturing ecosystem attended the event. The organizer's mission was to develop a 360-degree understanding of the potential of additive manufacturing and 3D printing technology to increase utilisation at all stages of design, engineering and manufacturing.

Market players such as Farsoon, Z-RAPID, Raise3D, FlashForge, Polymaker, EOS, Stratasys, 3D Systems, Formlabs, SLM Solutions as well as Jiangsu Jinwu New Material Co., Ltd were present on the show floor.

We've reached out to Dr. Wang Haiying, General Manager at JSJW New Materials Co., Ltd, to have an overview of the current Chinese Additive Manufacturing market.

JiangSu JinWu New Material Co., Ltd. aka JSJW specializes in the development of spherical metal powders. With a decade of experience in the manufacturing of high-quality metal powders, the advanced R&D and manufacturing company supplies companies in the aerospace, energy, biomedical and automobile industries.

The company is currently taking its first steps in the USA through Kuzma Industrial Corp, a metal powders distributor based in Brooklyn, New York, USA. Their unique IPCA technology enables the material producer to develop "high-quality spherical metal powders, especially titanium alloy, with the most beautiful appearance and high fluidity", as per the words of the general manager.

Dr. Wang Haiying, General Manager at JSJW New Materials Co., Ltd

Images: JSJW

On the road to "Made in China 2025"?

Thanks to the support of its central-government policies, China has quickly embraced 3D Printing. Since 2015, the Ministry of Industry and Information Technology defined 3D Printing as a strategic national goal of the manufacturing country. A vision that took several proportions over the years, and attracted the interest of several international companies.

Needless to say, this year was an unusual one for the country. With the Covid-19 pandemic, the country was one of the first to implement lockdown policies, and one of the first to return to some normalcy.

"We were allowed to go back to the offices around mid-March. In our opinion, the AM market is recovering quickly", states Dr. Wang Haiying. "TCT Asia was the first 3D Printing show to be held in the industry, since the peak of the pandemic. It was really over our expectations, despite the consequences of the pandemic. All overseas brands did not attend the show but most companies that have a China-based office were present. Given the current climate, there were a lot of visitors this year, that's why we are quite satisfied with the results."

Now that companies are getting back on track, they have to deal with new trends created by the pandemic. For the additive manufacturing industry, the pandemic emphasizes the needs of local production. Even though, many China-based companies already rely on local production, those that eye the international market had to rethink their strategy.

"The global pandemic really affected the overall business cycle and forced some manufacturing companies to focus on local production. However, we still envision a bright future and the creation of new opportunities for the global business. As a material producer, we have obviously adjusted our business model and we have increased our production capacity in China. However, we keep introducing our best products to overseas customers. [As a matter of fact, the recently signed partnership with US-based distributor is a proof that not only does JSJW still ambition to position itself on the international scene but there is always an interest in international products]. We strongly believe the market will find its balance and a healthy way to move forward", the General Manager explains.

In the meantime, the food industry, the construction industry, the medical science and research, the manufacturing industry in general as well as education are the main sectors where we can witness breakthroughs of 3D Printing in China. Applications of the technology in the space industry are quite nascent. A few programs are currently being in progress to allow astronauts to print items with a 3D printer directly in space with no freight difficulties.

What's next for JSJW?

JSJW debuted on the international market last year at Formnext 2019. The materials producer plans to continue its expansion in Europe.

"We hope to explore new market opportunities with powder manufacturers that are based in Europe and who are looking for establishing a business operation in China. By sharing our resources, I believe we can learn from them as much as they can learn a lot from us and the business market in China, which is the most active one in the world. It's all about establishing a win-win strategy", Dr. Haiying points out.

"In the meantime, we have started our Phase II facility in China. Our production capacity will reach 150t per year for Titanium alloy. It will meet the current increasing demand and requirements of the AM industry, especially in China. We hope to come back to Europe as soon as possible and we are already looking forward to meeting the industry in-person at the Formnext 2020 show", she concludes.

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The only catalogue that describes each AM/3D printing technology and post-processing technology while underlining the main players that provide them.