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3D ADEPT MAG

3D PRINTING

DOSSIER : LASER POWDER-BED FUSION OR MATERIAL JETTING, WHAT TECHNOLOGY BEST SUITS THE PRODUCTION OF CUSTOM MOULD INSERTS ?

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3D ADEPT MEDIA
All about Additive Manufacturing

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Hello & Welcome

Passing trend or genuine interest?

"Do you really need it?" I was once told that this simple question, when applied, can have a direct effect on any bank account. Sometimes, this seems to work well for those who like shopping, or who envy what others have. Here is the thing, in industrial manufacturing, once a company is the first to announce a new product, a new service, or a new modus operandi, there is a great chance that several others will follow suit…and make similar announcements for their business. This theory could be highlighted to explain the steady wind of acquisitions, SPACs and IPOs that is increasingly embracing all sectors across the additive manufacturing value chain.

Is it just a passing trend or is there any real interest for additive manufacturing companies? An exclusive feature of this new issue provides an attempt to understand the world of stock markets that additive manufacturing companies are entering.

In any case, no matter what reasons led to a SPAC, an IPO or an acquisition, one thing is certain, this "wind" will lead to significant growth across all AM technologies. If you asked us what AM technologies will shine first, and will easily reach an advanced level of production readiness, we will give you a "one-size-fits-all" response – yet incredibly true: "it all depends on applications." However, our biggest bet right now goes for AM technologies like material jetting, laser powder bed fusion or the newly developed hybrid bound metal printing, that can provide the ability to create custom tools for traditional manufacturing processes, an ability that also extends into the realm of injection moulding. These are some of the technologies we extensively discussed in this issue.

Furthermore, this significant growth across all AM technologies cannot be effective without material producers. As you will discover either in one of the key segments or in the news round-up of this issue, they provide required solutions to ramp up production capacity and help the machines materialise what the engineer has thoroughly thought and designed using various AM-dedicated software.

Lastly, as AM continues to expand across various segments, we come to realize that some sub-segments in the post-processing stage are often more highlighted than others. Different sub-segments of this field have started to occupy a more important place in the AM landscape. 3D ADEPT Mag has explored the importance of one of them in this issue and we can't wait to see what the others have in store for us.

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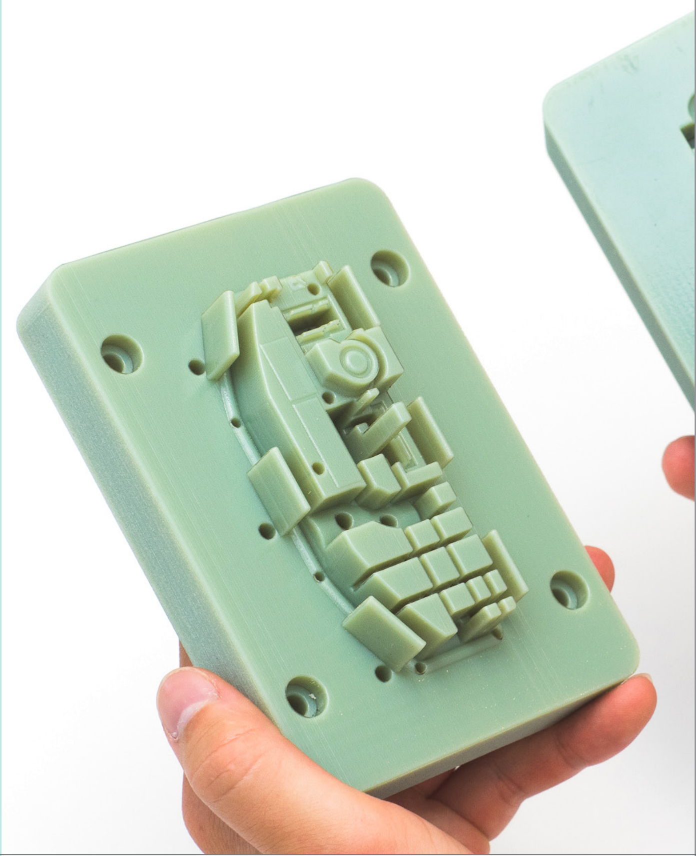
Editorial

LASER POWDER-BED FUSION OR MATERIAL JETTING, WHAT TECHNOLOGY BEST SUITS THE PRODUCTION OF CUSTOM MOULD INSERTS?



Insert moulding services are one of the main services offered by digital manufacturers. Such a service helps accelerate the development cycle of products across the medical, automotive, consumer products and electronic components industries. The fact is, although operators no longer question the ability of Additive Manufacturing technologies to produce a much-more cost-effective result than conventional tooling and die making, they are still cross-examining what AM technology best suits the production of prototype mould inserts.

The rise of 3D printing has had impacts not solely on the production of end-used parts as a direct manufacturing technology, but also as an indirect manufacturing technology. For example, Additive Manufacturing is sometimes used to create moulds for the purpose of urethane or silicone casting. In other circumstances, it is used to create tools such as jigs or fixtures that enhance the performance of machining cells. This ability to create custom tools for traditional manufacturing processes also extends into the realm of injection moulding, where 3D printing technology is used to create custom injection mold inserts. But when it comes to creating a custom mould insert, which technology is best? We spoke with a couple of digital manufacturing experts to learn more about two of the most popular 3D printing technologies used for this application, material jetting and laser powder bed fusion.

The use of Additive Manufacturing technologies for the production of custom mould inserts

With the goal of addressing the needs of mass customization, AM companies have been exploring their manufacturing processes to produce the tooling used in injection moulding with varied levels of success.

Image: 3DHubs - A 3D printed injection mold made from Digital ABS

Cullen Hilkene, CEO at 3Diligent

"Theoretically, any AM technology can be used. One might immediately think of extrusion 3D printing which is probably the most widely used technology for prototypes but that's probably because it is the technology people know the most. There are no reasons why SLS, other powder-bed processes like Electron Beam, or even binder jetting can't be used. At the end of the day, it's the results obtained, that matter the most", Cullen Hilkene, CEO at 3Diligent told 3D ADEPT Media from the outset.

So far, most applications that have been shared by companies were achieved using DLP, SLA, Freeform Injection Moulding, SLS, DMLS / SLM, as well as PolyJet. However, DMLS and PolyJet are the most widely mentioned technologies for such applications, which is why we will only focus on these two technologies as part of this dossier.

That being said, no matter what AM technology is used, the manufacturing perspective reveals that *"traditionally, the moulding with metal inserts is carried out with the aim of reinforcing the mechanical properties of the inserts, reducing the cycle time and obtaining moulded articles with a better aesthetic / dimensional quality."*

Furthermore, still according to ZARE's experts, another manufacturing goal would consist in integrating an item with specific thermal properties, in a mould done with a different material.

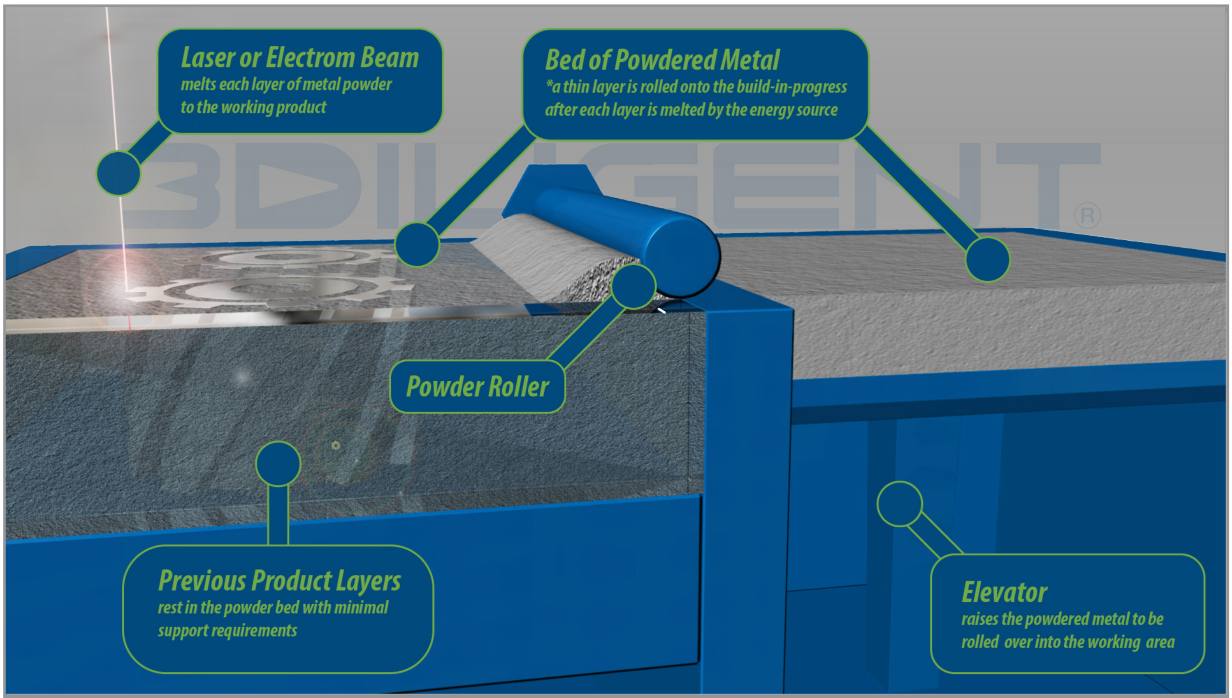
Moreover, *"another use, more critical, concerns the creation of particular and equidistant cooling channels from the surface. Such cooling channels allow a greater heat dissipation in the unit of time with the consequent reduction of the duration of the moulding cycle and a reduction of the deformations on the finished product, increasing the quality of the final product"*, they said.

Brief description of DMLS/ Laser powder-bed fusion (LPBF).

First of all, let's note that, although DMLS is often used interchangeably with SLM or LPBF, it should be noted that DMLS is a trademark of EOS, SLM, a term introduced by the Fraunhofer Institute in 1995, while LPBF is the generic name given to the manufacturing process. That's why the name "laser powder-bed fusion" will be the one used in this feature.

Let's erase any confusion that may arise here: DMLS which is meant for Direct Metal Laser Sintering, features the word "Sintering" when in reality, it works by melting. In the same vein, LPBF uses the word "Fusion" while one cannot melt a plastic; it needs to be sintered.

In any case, for those who are not familiar with it, this manufacturing process enables the production of "net and near-net shape parts directly from a digital drawing file with dimensional tolerances of less than 0.1 mm" through an interaction between a high-energy laser and a metal powder feedstock.



Legend: Image via 3Diligent – Powder-bed fusion process explained

During the manufacturing process, the machine fills its build chamber with an inert gas and thereafter, heats it to the ideal printing temperature. Based on the layer thickness defined upfront (typically 0.1mm thick of material), a thin layer of powder is applied to the build platform. Once the fiber optic laser (200/400 W) scans the cross-section of the part, it allows for the melting of the metal particles together. A new layer of powder is spread across the previous layer using a roller. More layers or cross sections are fused and added. The process is repeated until the 3D printed part is completely built.

Brief description of PolyJet/ Material Jetting

PolyJet is a manufacturing process that works either on a **continuous or a Drop on Demand (DOD)** approach. With a process similar to a two-dimensional ink jet printer, it fabricates parts by jetting thousands of photopolymer droplets onto a build platform and solidifying them with a UV light.

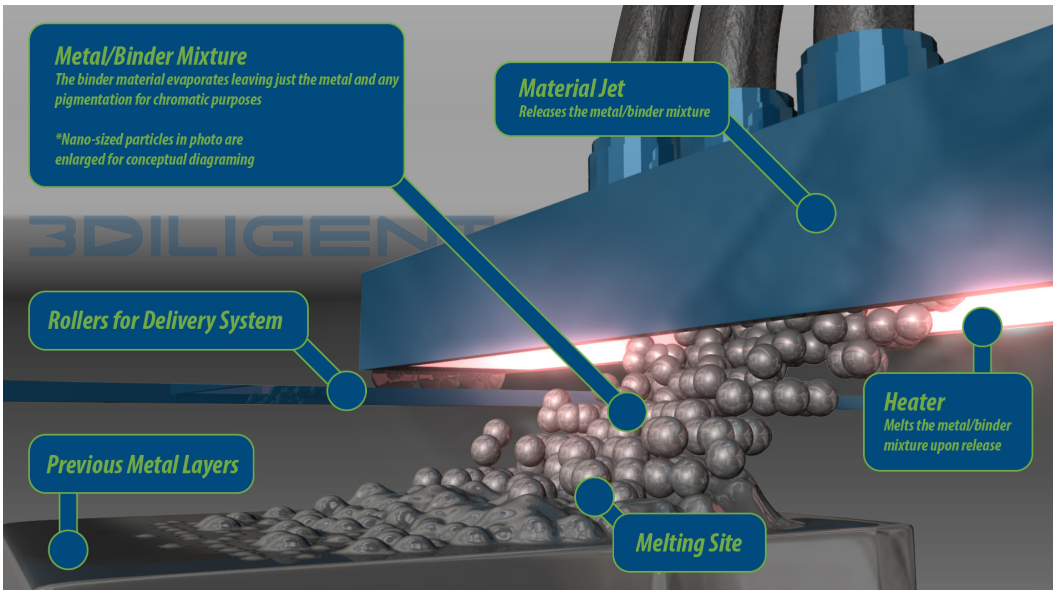
In the 2000s, Objet-Geometries was the first company that developed a 3D printer with that process, patented it under the name PolyJet. Eleven years later, in 2011, Stratasys acquired Objet, and since then, has been expanding its range of products to **Material Jetting (MJ)** solutions.

Today, the name PolyJet remains associated to Stratasys 3D printers. However, Stratasys is not the only company that develops industrial 3D printers based on this process, which is why ***"Material Jetting"*** will be the term used in this process, as it refers to the general name of this manufacturing process.

The printing process begins with pouring the photopolymer resin into the material container. That resin must be heated (to between 30 and 60 °C) in order to reach the appropriate viscosity.

As the X-axis carriage starts to move across the build plate, the print heads begin selectively jetting hundreds of tiny resin droplets. As the UV light sources follow the print heads' trajectory and instantly cure the sprayed resin. Once an entire layer is completed, the build platform drops one layer in height and the process is repeated until the part is entirely formed.

With technology advancements, machine manufacturers have developed 3D printers with multiple print heads in order to achieve multi-material printing. Depending on the machine used, multi-material 3D printers can enable dissolvable support material or multiple varieties or colours of functional material.



Legend: Image via 3Diligent - Material Jetting process explained

Furthermore, over time, several types of Material Jetting technologies have been developed in order to meet the diverse needs of industries. They include for instance material jetting processes that work with resin and cartridge; material jetting processes that work with ink; material jetting processes that work with wax and cartridge or even material jetting processes that work with metal and cartridge.

"While it is important to distinguish between material jetting with metals and plastics, it should be noted that mould inserts are usually made out of metals", Hilkene notes.

However, this does not mean that, one cannot produce a mould insert in plastic. As a matter of fact, the aforementioned AM technologies that can be used to produce mould inserts include FFF which processes plastic materials. Here is the thing, we need to understand what explains the move from traditional manufacturing processes to additive manufacturing processes; and thereafter the choice for one specific AM technology over another.

In this case, many of the traditional struggles with design for injection moulding in metal presented themselves in the design of plastic tooling. However, most of these issues are often amplified due to the poorer surface finish of a 3D printed mould when compared to a similar metal mould, hence the choice for a metal AM process for such production.

In addition, research shows that 3D printed plastic mould inserts have revolutionized mould manufacturing in the plastics processing sector. The low mould costs as well as the rapid implementation of design changes were very appealing to users at the beginning, until they realized the results were not always durable. Furthermore, due to higher temperatures of the materials and high injection pressures, the operating cycles of the 3D printed plastic moulds often decrease. The search for more stable solutions for small series and medium quantities has led many manufacturers to consider metal AM alternatives.

For the production of mould inserts, what will tip the balance in favour of LPBF or MJ?

Image via ZARE – Mould inserts

In order to assess which technology best suits the production of mould inserts, we've compared these two technologies based on **five** main criteria: **complexity of the geometry, post-processing, timing, production volume** and **costs**.

This analysis is mainly based on our interview with **Cullen Hilkene**, CEO of 3Diligent, a company that brings Distributed Digital Manufacturing to fruition. External contributions from other companies as well as research have also helped to bring the most accurate evaluation of these processes.

Complexity of the geometry

It goes without saying that there are some products that are easy to manufacture using injection moulding because of their simple single cavity design and their size. However, it is no secret that AM is appealing because of its ability to produce complex geometries, especially complex cooling channels.

According to **Hilkene**, LPBF earns a point here, as the technology is suitable for cooling parts with complex shapes. According to the expert, the challenge at the manufacturing level consists in keeping a uniform temperature on the surface of the mould to cool the hot molten material inside the cavity. Not only does this cooling process take time, but it often leads to high costs of production. To dissipate heat in a very short period of time during the manufacturing process, engineers have to reconstruct the cooling channel near the surface of the part. Compared to traditional milling, LPBF brings significant improvements at this level as it gives engineers the possibility to design free geometries, melting layer on layer metallic powders, while ensuring a steady dissipation of heat across the chamber.

Post-processing

Certain AM technologies do not require post-processing once the manufacturing stage is over. In this specific case, LPBF loses a point as the technology *"does not always print as smooth as the other manufacturing processes, hence the need for a post-processing step at the end of the printing process"*, 3Diligent's CEO notes.

On the other hand, for applications where wear resistance is no longer the most critical factor, Material Jetting is acknowledged for delivering 3D printed parts with high accuracy and excellent surface finish.

Time, costs and volume production

Compared to conventional manufacturing processes that often take several weeks, both AM processes enable operators to save time. Nevertheless, when comparing those LPBF and MJ processes, one notes that **LPBF is more costly and requires more production time than MJ**.

Not only does the manufacturing process with LPBF require an extra post-processing stage – which is already considered as the most expensive stage of the overall production process -, but sometimes, the production of mould inserts should meet customer-specific solutions that can't be defined upfront.

As far as volume is concerned, one of the first steps at the production level usually consists in considering whether a mould is going to be used to make 30 or 30 000 parts. Once the prototypes have been approved, conventional manufacturing processes usually become the ideal option for mass production. Nonetheless, between the two manufacturing processes that we analyse today, one notes that **Material Jetting best suits the production of low-run moulding**.

So, what should we keep in mind?

The table below provides a quick look at the items that have been assessed to compare LPBF and MJ for the production of mould inserts.

Technologies/ Analysis criteria	Main competitive process in the traditional range	Complexity of the geometry	Post-processing	Time	Costs	Volume production
Laser powder-bed fusion	Traditional milling	Ideal for complex shapes	Additional post-processing stage	More production time	Costly compared to MJ	Big volume production
Material Jetting		Excellent accurate results	No intensive post-processing stage	Reduced production time compared to LPBF	Less expensive than LPBF	Ideal for low-run moulding

And now?

We can't say for sure that the challenges surrounding tool design within injection moulding industries will all be addressed anytime soon. However, one can testify to the various manufacturing processes that can now produce a tool having complex geometries, "with accurate dimensions, feeding of material into cavity, cooling channels and easy ejection of solidified part".

Two of these technologies have been assessed today. What we will keep in mind is that 3D printed mould inserts can be produced in fast turnaround times (1-2 weeks as opposed to 5+ weeks with traditional milling). Most importantly, AM technologies are ideal for mould designs where changes or iterations are probable, for parts that are relatively small (less than 150 mm), and for low production quantities.

Despite these advancements at the production level, one should note that we do not always know whether or not, these 3D printed parts are brought to the market as a standalone product or as part of a bigger structure. Not to mention that, there is no clear indication of the lifecycle of a 3D printed mould.

Contributions and resources

3Diligent is the main contributor that has been invited in this exclusive feature. Headquartered in California (USA), the company is a network-driven digital manufacturing services provider whose technology portfolio includes, among other things, 3D printing, machining, casting and injection moulding. We find it interesting to rely on its expertise in a wide range of production processes, to understand the production of mould inserts with Material Jetting and LPBF. Interestingly, when asked what manufacturing technology their operators use the most for the production of mould inserts, Cullen Hilkene, CEO, replied that they are "driven by the circumstances of the manufacture. However, for most use cases, machining remains the most interesting option economically, to produce massive volume." Last but not least, 3Diligent is also known for its ProdEX's proprietary software, that allows industrials to submit an RFQ through a cloud-based, secure portal in order to receive project bids from pre-qualified 3D printing, CNC machining, casting, and injection-moulding manufacturers.

Other resources include:

- Contribution from ZARE's experts.

- "Using Additive Manufacturing to Produce Injection Moulds Suitable for Short Series Production", a report from **Conor Whleana & Dr. Con Sheahanb** from the School of Engineering, University of Limerick, Limerick, Ireland.

- Media coverage on www.3dadept.com

SPACS AND IPOS: ARE THEY A PASSING TREND OR IS THERE ANY REAL INTEREST FOR ADDITIVE MANUFACTURING COMPANIES?

Image via Inc42

An attempt to understand the world of stock markets that additive manufacturing companies are entering

Even though the Covid-19 pandemic has expedited the use of AM across various manufacturing fields, it should be noted that beyond these industries, there are financial markets that are often vitally linked to economic performance. Indeed, the influence of financial development on economic growth is one of the most challenging research questions that macroeconomists and financial economists had and still have to discuss. Yet the reality of our industry reveals that the number of AM companies going public via mergers with Special Purpose Acquisition Companies (SPACs) rather than conventional Initial Public Offerings (IPOs) is increasingly growing.

- How do SPACs work?

- Why do AM companies prefer SPACs mergers over IPOs?

- And the call to remain cautious…

August 27th, 2020. Additive Manufacturing Company **Desktop Metal** became the first company of this niche industry to announce to agree to a reverse merger with special purpose acquisition company (SPAC) **Trine Acquisition Corp** and global credit investment firm **HPS Investment Partners**; an announcement that has officially been sealed and confirmed on December 2020.

On the heels of Desktop Metal, other AM companies follow the "SPAC" merger route to access the stock market. The first observation, one can all make, is that, beyond the SPAC IPO trend, such mechanisms happen to be a funding opportunity for AM companies that are going down these routes.

AM Companies	SPAC Company	Projected Post-SPAC Value	Expected Funding Raised
Desktop Metal	Trine Acquisition Corp	$2.5 billion	$575 million (raised)
Markforged	one	$2.1 billion	$425 million
VELO3D	JAWS Spitfire Acquisition Corp.	$1.6 billion	$500 million
Shapeways	Galileo Acquisition Corp.	$410 million	$195 million from Galileo and $75 million from a private investment in public equity (PIPE)
Rocket Lab To go public in H2 2021	Vector Acquisition Corporation	$4.1 billion	$320 million from Vector Acquisition and $470 million from a PIPE
Fathom	Altimar Acquisition Corp.	$1.5 billion	$80 million
Bright Machines (Software company)- to go public in H2 2021	SCVX Corp. (NYSE: SCVX)	$1.6 billion	Up to $435 million
Redwire Space – to go public in H2 2021	Genesis Park (NYSE: GNPK)	$615 million	N/A
Fast Radius – To go public in Q4 2021	ECP Environmental Growth Opportunities Corp.	$1.4 billion	$345 million

However, apart from the SPAC-IPO trend, one should give kudos to those AM companies that went public without any fusion with a third-party company.

AM Companies	IPO Market	IPO Share Price	Valuation at IPO	Expertise
Massivit 3D (MSVT)	Tel Aviv Stock Exchange (TASE)	$870	$203.6 million	Manufacturer of large-volume 3D printing systems
MeaTech 3D (MITC)	NASDAQ	$10.30	$1.1 billion	Food-tech start-up that specializes in 3D printed cultured meat production
Norsk Titanium (NTI)	Euronext Growth Oslo Exchange	$1.19	$326.3 million	Producer of aerospace-grade, 3D printed structural titanium parts
Xometry (XMTR)	NASDAQ	$44	$2 billion	Online AI-enabled marketplace for on-demand manufacturing
Freemelt (FREEM)	Nasdaq Stockholm AB.	$1.15	$ 9 806 569	Metal 3D Printer Manufacturer
Rokit Healthcare (expected for H2 2021)	Korean Stock Exchange	To be announced	To be announced	Bioprinting company

But what is a SPAC and how does it work?

"Generally, a SPAC is formed by an experienced management team or a sponsor with nominal invested capital, typically translating into a ~20% interest in the SPAC (commonly known as founder shares). The remaining ~80% interest is held by public shareholders through "units" offered in an IPO of the SPAC's shares. Each unit consists of a share of common stock and a fraction of a warrant (e.g., ½or ⅓of a warrant)", a PwC report reads.

This means that **those companies have no operations or business plan other than to acquire a private company using the money raised through an IPO, thereby enabling the latter to go public quickly.**

As far as shares are concerned, it should be noted that founder shares and public shares present similar voting rights. However, founder shares have the exclusive right to elect SPAC directors. Warrant holders generally do not have voting rights and only whole warrants are exercisable.

Furthermore, as mentioned earlier, private companies that are going down the SPAC merger route often benefit from a funding opportunity.

Helen Boyle & **William Samengo-Turner**, senior associates at law firm **Allen & Overy LLP** explain: "SPACs offer young and fast-growing tech businesses seeking a listing an alternative to the traditional IPO. Many will not have the credentials of a traditional IPO candidate, possibly being unable to deliver the kind of long-term financial and operating track record traditionally expected of a successful IPO. They may be in the very early stages of development, looking for ways to finance the research and development programmes that their future success depends on, and are certainly likely to be pre-profit and in some cases pre-revenue (unusual on a traditional IPO)".

Why do AM companies prefer SPACs mergers over IPO?

According to financial experts, tech companies are currently the preferred target for most SPACs. Interestingly, one could say the attraction goes both ways as high growth AM technology companies are also looking for a way to go public.

Another way to explain this attraction can be the fact that AM being from the very beginning a disruptive technology, founders and executives who are at the heart of such companies are likely to be attracted by unusual yet disruptive mechanisms like SPAC mergers, to go public.

Just like conventional manufacturing processes are described as time-consuming and expensive in certain cases, AM companies might see in SPACs mechanisms a rapid and cost-saving process.

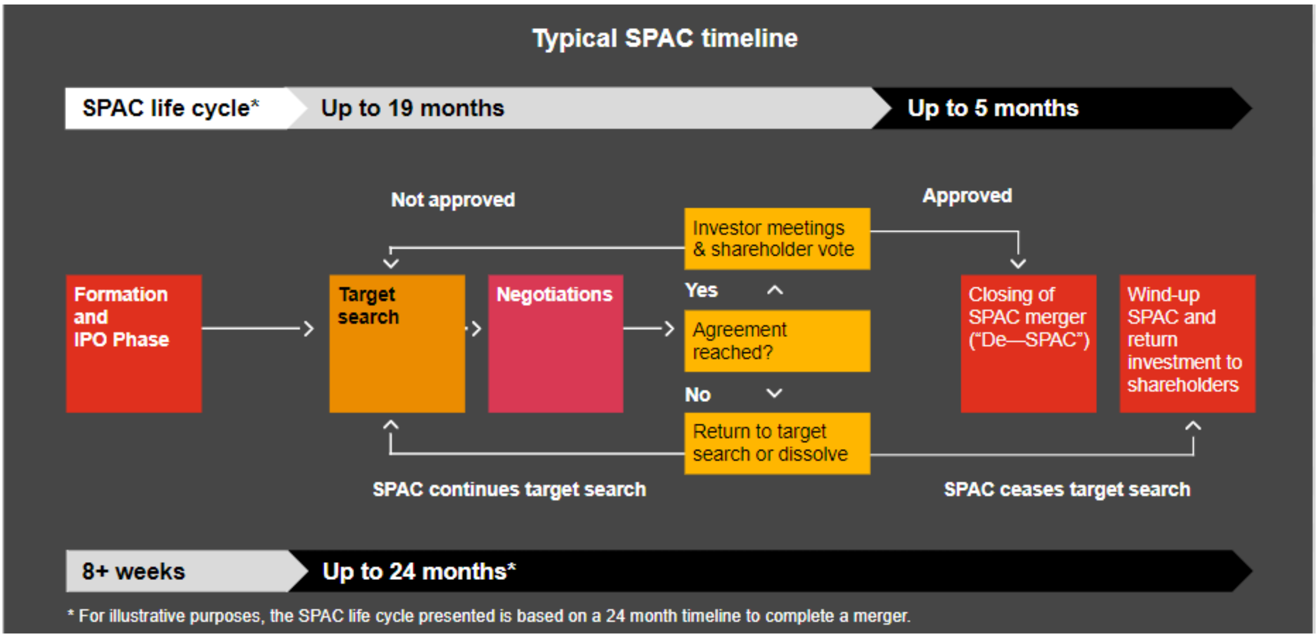
Experts from PwC explain that a SPAC lifecycle can occur **on a 24-month timeline to complete a merger**.

"Following the IPO, proceeds are placed into a trust account and the SPAC typically has 18-24 months to identify and complete a merger with a target company, sometimes referred to as de-SPACing. If the SPAC does not complete a merger within that time frame, the SPAC liquidates and

the IPO proceeds are returned to the public shareholders.

Once a target company is identified and a merger is announced, the SPAC's public shareholders may alternatively vote against the transaction and elect to redeem their shares. If the SPAC requires additional funds to complete a merger, the SPAC may issue debt or issue additional shares, such as a private investment in public equity (PIPE) deal", they point out.

For this reason, "*under the rules governing them [see the table below], SPACs must identify firms they can merge with within 24 months after they have raised their funds or they will be wound up and the IPO proceeds returned to investors*", **Ivana Naumovska**, lecturer at INSEAD, a business school with campuses in France, Abu Dhabi and Singapore notes.



Source: PWC – Typical SPAC timeline

While the advantages seem very appealing for private companies, it should be noted that such process also raises its share of disadvantages. The table below features a list of pros and cons that companies should be aware of – a list of items that has been established in comparison with IPO's advantages and disadvantages:

Going public with a SPAC – advantages	Going public with a SPAC—disadvantages
Faster execution than an IPO "A SPAC merger usually occurs in 3–6 months on average, while an IPO usually takes 12–18 months."	Shareholding dilution: "SPAC sponsors usually own a 20 percent stake in the SPAC through founder shares or "promote," as well as warrants to purchase more shares. SPAC sponsors also benefit from an earnout component, allowing them to receive more shares when the stock price achieves a specified target over a certain timeframe which could lead to further dilution."
Upfront price discovery: Your IPO price depends on market conditions at the time of listing, whereas you negotiate the pricing with the SPAC before the transaction closes—which is much more advantageous in a volatile market.	Capital shortfall from potential redemption: Initial SPAC investors may redeem their shares. If redemptions exceed expectations, then cash availability becomes uncertain and forces SPACs to raise PIPE financing to fill the resulting shortfall.
Funding opportunity	Compressed timeline for public company readiness: Although the SPAC sponsor may offer help during the merger process, the target company usually takes the brunt of preparing for required financials in the SEC filings and establishing public company functions, such as investor relations and internal controls, under a much shorter deadline than in an IPO.
Less marketing resources: "A SPAC merger doesn't need to generate interest from investors in public exchanges with an extensive roadshow (although raising PIPE involves targeted roadshows)."	Financial diligence performed at narrower scope: The SPAC process does not require the rigorous due diligence of a traditional IPO, which could lead to potential restatements, incorrectly valued businesses or even lawsuits.
Access to operational expertise: (AM) private companies can benefit from their SPAC sponsors' experience in finances and management	Lack of underwriting and comfort letter: In a traditional IPO, the underwriter makes sure all regulatory requirements are met but because a SPAC is already public, the target company doesn't have an underwriter.

*Source: Why so many companies are choosing SPACs over IPOs? – Insights from **John Lambert**, Partner, Accounting Advisory Services, KPMG.*

Image via Investmattallen

We are just halfway through the year…be cautious.

We are just halfway through the year and 2021 has already seen some massive valuations of newly public companies, companies that do not only operate in the AM arena. No matter what route (SPAC or IPO) they take, the primary advantage to go public for AM companies is the potential to grow their company exponentially with much-needed cash.

While we cheer with AM companies that have embraced this route, we can't help but fear an "IPO crisis". Far be it from us to be birds of ill omen but the fact is, there was a time when interest in technologies has spiked and fallen during the mid-2010s.

When asked if this might happen with AM technologies, **Arno Held**, Managing Partner at AM Ventures Management GmbH, did not and could not provide a definite response, yet remains encouraging:

"Our planet and our society are faced with massive challenges. If we want to make the transition to a sustainable civilization, we must adapt our ecologic and economic behavior. Changing our consumption means that products must change which means that production must change. We must avoid waste, increase the lifespan of products and reduce the distances that products have to travel as physical goods. All these challenges are addressed by digital manufacturing in general and Additive Manufacturing technologies very specifically.

On AM Ventures' tech radar which identified more than 600 AM startups in 2021 alone, we can see that half of the AM companies founded this year are applications companies. This is an entirely new trend since we have started monitoring startup activities more than 7 years ago and means that we have finally learned how to use AM technologies and apply it in order to revolutionize how products are developed, produced and distributed.

Of course, markets are performing in cycles which are sometimes bearish and sometimes bullish. The overall trend, though is very encouraging and we are only just at the beginning of the digital manufacturing age".

Furthermore, another key point we will keep in mind is that, although these publicly-listed companies benefit from "enough" cash to fund operations and ensure their future growth, one cannot legitimately say that SPAC acquisitions guarantee profitability or the success of a company.

As per the words of Held, *"profitability and success are never granted in business. They are much rather the result of extremely hard work in the right market, at the right point in time, with a sound business model and done by the right team of individuals. Still, all these factors can only increase the likelihood for success but will never give a 100% guarantee."*

Moving forward, AM just starts to be the talk of the markets. This newfound interest will not fade anytime soon. So, if you are a publicly-listed company, do not lose track of your vision and use the cash wisely, if you are not a publicly-listed company, take advantage of the media hype it continuously provides to AM technology in general, and make your best deal out of it. In any case, the progression from early-prototyping applications to end-use (mass) production becomes more and more tangible.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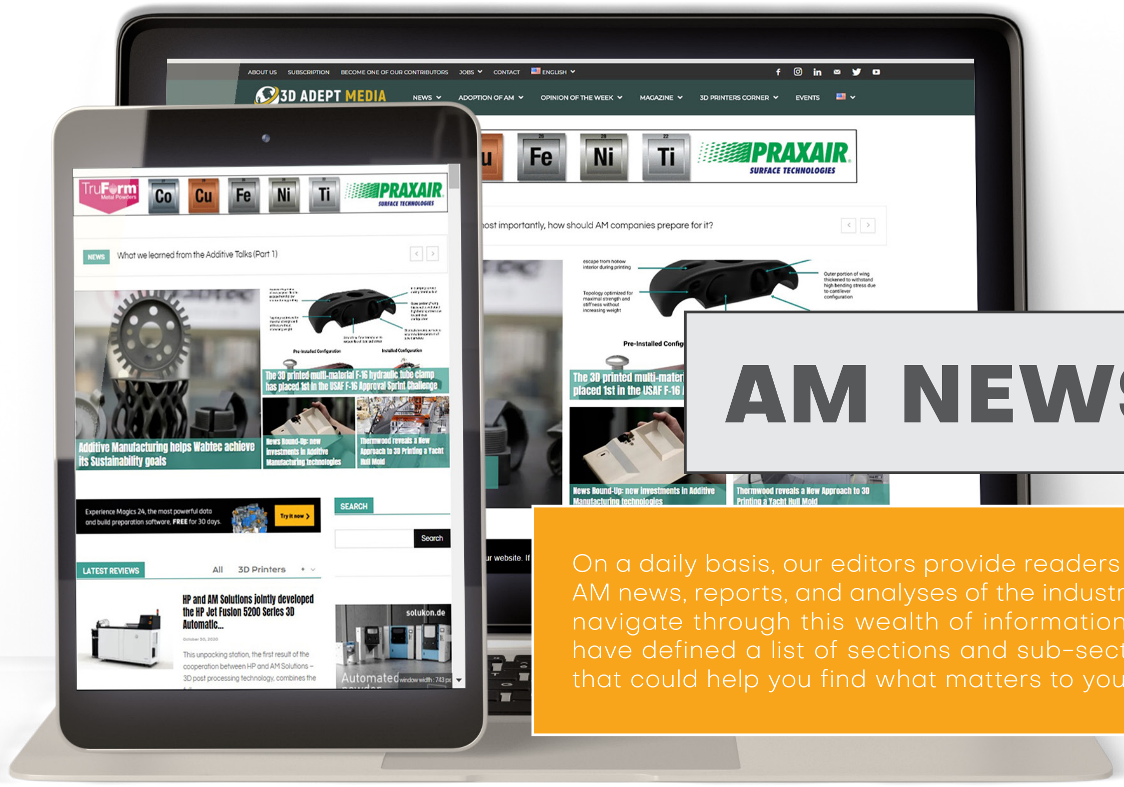

AM NEWS

On a daily basis, our editors provide readers with AM news, reports, and analyses of the industry. To navigate through this wealth of information, we have defined a list of sections and sub-sections that could help you find what matters to you.

Do you have any current information related to 3D printing or a press release that needs to be published ?

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HOW & WHY DOES DESKTOP METAL BUILD A PORTFOLIO OF "AM 2.0" PRINT PLATFORMS?

Arjun Aggarwal,
Chief Product Officer, Desktop Metal

The Desktop Metal journey is highlighted by big ambitions: a solid materials strategy, key process performance targets and an intriguing plan to become more than just a general service bureau.

In 2020, Desktop Metal (DM) announced its intent to go public through a special purpose acquisition company (SPAC) with Trine Acquisition Corp and global credit investment firm HPS Investment Partners, and confirmed it just before we bid goodbye to that extraordinary year. Nobody would have thought then that this single action from the Additive Manufacturing unicorn would lead to a wave of SPAC-IPO transactions in the industry. Yet, since this IPO, Desktop Metal's journey has evolved in terms of structural organization, manufacturing processes & applications, and overall vision. For this Interview of the Month, 3D ADEPT Media caught up with Arjun Aggarwal, Chief Product Officer, to discuss the journey of the "Pure-Play Additive Manufacturing 2.0 Company".

Desktop Metal was founded in 2015 with a single goal: making 3D printing an essential tool for engineers and manufacturers around the world. With solutions for every stage of the manufacturing process - from prototyping and pilot runs to mass production and aftermarket parts – Desktop Metal has invested extra miles to transform the way engineering teams work within the same organization or across different organizations, and fabricate metal and composite components across a wide range of applications and industries.

Here is the thing, at some point in its journey, every company undergoes a transition or change in order to remain viable and scalable. Whether it onboards new employees, opens a new department, or merges with another company…these changes can have a significant impact on the trajectory of one's business.

In Desktop Metal's case, the company has made great strides since it turned stealth mode off in April 2017. From being the highest ever funded company of the industry - with a total of $438 Million, all funding rounds combined prior to its SPAC merger – to the number of products it develops for the industry and the partnerships it signed to advance key areas of the technology, it is fair to say Desktop Metal has had several reasons to rejoice.

Nevertheless, the turning point of this journey occurred last year when the company officially became a publicly-listed company. The **initial public offering** has marked the beginning of a new era: ***Additive Manufacturing 2.0***, that Desktop Metal coined. As we all know, the term "2.0" is always used to denote a superior or more advanced version of an original concept, product, service, etc. And our guest company today, wanted the industry to be aware of that inflection point.

As a matter of fact, **Aggarwal** defines the company today as an Additive Manufacturing 2.0 organization which focuses *"on solutions that enable the volume production of parts through additive that compete cost-effectively with conventional manufacturing".*

"That focus is agnostic to material and to print process as well - rather the focus is on developing the right platforms solutions and capabilities for our customers that enable high-performance parts with competitive economics, regardless of the application. That's really the next frontier of additive manufacturing and that's 100% of our focus. We're doing that through a variety of technology platforms, leveraging a range of technologies, including binder jetting on the metal side and great DLP technology through our acquisition of EnvisionTEC on the polymer side. We support sand and wood 3D printing through several of these platforms as well, the bulk of which enable superior price performance relative to our peers to help our customers produce parts through AM economically and in larger volumes previously only supported by conventional manufacturing. Across

these platforms, we've qualified more than 225 materials across metals, composites, polymers, elastomers, ceramics, wood, sand, and biocompatible materials. We're really trying to build a portfolio of AM 2.0 print platforms with an array of materials to push through these platforms so we can address a broad spectrum of applications", he adds.

So, how did Desktop Metal build a portfolio of AM 2.0 print platforms?

The Desktop Metal journey

This journey starts with Ric Fulop, a man who is approximately 46 and (based on the last time we hear him) comes from a country in South America. Together with a bunch of experts in materials science, engineering, and 3D printing (**Jonah Myerberg, Ely Sachs, Rick Chin, John Hart, Christopher A. Schuh, and Yet-Ming Chiang**), their first step in remaking manufacturing was to develop a Desktop metal 3D printing system we all know: the **Studio System**.

Designed to produce low-volume runs of metal 3D printed parts, first shipments of this $ 120,000 occurred in 2018, alongside the introduction and first commercialization of **the Production System**, one of the first binder jet systems to be equipped with an industrial inert environment that integrates gas recycling and solvent recovery for the safe printing of reactive metals. With a build volume of 750 x 330 x 250 mm, and a bi-directional system that enables high-resolution printing at up to 12 000 cm3/hr – which means the ability to produce over 60 kg of metal parts per hour - this industrial 3D printer has been so far the fastest binder jetting 3D printer we've seen on the market.

With these flagship products, they cemented their positioning in the global manufacturing

Credit: Desktop Metal

industry, selling their products to the military, the automotive and other industries ranging from medical devices to apparel.

However, the company's advancement in the 3D metal printing market is taking place in a context where companies are becoming increasingly aware of the potential of digital manufacturing and are rushing to the most promising sectors. For savvy machine manufacturers, it is no longer enough to build expertise in one single field; it becomes crucial to be able to diversify one's offer as much as possible in order to maintain a leading position in a market where 3D printing startups abound. Not to mention that AM companies are trying their best to evolve in industries that continuously compare AM companies with conventional manufacturing processes.

While the area of rapid prototyping and the 3D printing production of simple jigs and fixtures was coming to its end, competition came and made the game more interesting. Players like GE and HP, were coming with other serious yet intriguing AM processes while at the regulation level, ASTM was standardizing seven AM processes. And this was just the machines' side of the iceberg. Across the value chain, companies were demonstrating the need to pay attention to materials, software, and post-processing areas to make the entire AM production worthy.

"Broadly speaking, our growth strategy revolves around building

out three key pillars of the business – printers, materials and parts. With respect to printers or print platforms, we want to have a broad set of technologies that enable us to compete cost-effectively with conventional manufacturing across a range of applications", the CPO states.

Here is the thing, while one should recognize the ability to this unicorn to pull in money, it should be noted that to build these three pillars, more cash and time were necessary. When the Coronavirus pandemic hit, many businesses filed bankruptcy but Desktop Metal has not only been able to survive this crisis, but secure a well-funded yet super-secret stealth operation ($575 million) through its SPAC merger with Trine Acquisition Corp.

Luckily for the American organization, the IPO has not changed much of its leadership team. It did help save time as the first step in building these pillars consisted in increasing its technologies portfolio and refocusing its vision on key segments.

Scaling one's business with other businesses

To increase its technologies portfolio, **Desktop Metal** has successively acquired **EnvisionTEC**, **Adaptive3D**, **Aerosint** and most recently **ExOne**.

Apart from the polymer resin supplier Adaptive3D, and the soon-to-be confirmed acquisition of ExOne, each of these companies helps Desktop Metal debut on a new field of the additive manufacturing industry.

"*We brought on* ***Al Siblani*** *through the acquisition of EnvisionTEC, who oversees* ***our photopolymer product roadmap*** *and development efforts. Al works very closely with* ***Mike Jafar****, who we brought on to lead our new* ***Desktop Health business*** *– that's a group within Desktop Metal focused on developing and commercializing solutions targeted specifically towards the healthcare and dental markets. Segmenting this business is allowing the rest of the company to focus on consumer and industrial end markets such as automotive, consumer products, oil and gas, industrial machinery, aerospace and defense. Additional changes to our organization have largely been bolting on a few* ***new R&D stage start-ups*** *that we continue to integrate from a back-end M&A perspective, while we let the entrepreneurs operate pretty independently. A great example is Aerosint, which we acquired very recently. They have developed a unique* ***multi-material printing technology*** *with initial applications in powder bed fusion, so we want to make sure they can operate relatively independently and retain the ability to commercialize this solution into that market with third parties. At the same time, we will also work with the team to mature the technology and look to integrate it into Desktop Metal products in the future*", Aggarwal points out.

However, amid these M&A transactions, ExOne – if confirmed – has been the most surprising one.

Not only would we have suspected that, if there was to be an acquisition, it would have to be ExOne buying Desktop Metal, but beyond that, Desktop Metal decides to bring into its portfolio a company that has always been considered as its biggest competitor.

The announcement states that, ExOne shareholders will receive $8.50 in cash and $17.00 in shares of Desktop Metal common stock for each share of ExOne common stock, for a total consideration of $25.50 per share. All of this represents a transaction value of **$575 million**, subject to a collar mechanism and implying a 47.6% premium to the closing price of ExOne's common stock on August 11, 2021 and a 43.9% premium based on the 30-day average closing price of ExOne common stock. The transaction value also implies an acquisition multiple of 6.4x 2021 consensus revenue estimates for ExOne.

Furthermore, let's remind that ExOne, founded in 2005, is one of the first players that started the commercialization of metal binder jetting systems. Over time, the company launched several metal binder jetting systems, with each being an evolution on the previous one.

There are so many questions about this acquisition, questions that ExOne may not have all the answers to in the short-run. However, apart from this potential real powerhouse marriage for binder jetting, the ExOne team also believes in the complementary potential of two main fields of activities:

- Their material expertise in metals and ceramics, made possible through the company's patented Triple ACT system and the work of their R&D and engineering teams, combined with the speeds of Desktop Metal's Single Pass system;
- The combination of ExOne's sand 3D printing platforms with DM's low-cost Viridis3D robotic sand 3D printing technology.

Manufacturing processes & applications

Even though several actions are being implemented to drive the growth of each pillar – printers, materials, and parts –, at the end of the day, they are interrelated as they are part of a "big puzzle".

As far as 3D printers are concerned, Desktop does not intend to release new products anytime soon, but rather to improve existing manufacturing processes. Be it for its in-house metals and composites processes, or photopolymer 3D printing and multi-material AM technologies it acquired through EnvisionTec and Aerosint, the main goal will be to enhance performance of the processes by working on how to achieve better material properties, surface finish, tolerances, and most critically, speed and cost.

With the acquisition of ExOne, all eyes will be on the binder jetting technology, which is the main technology that both companies have independently developed in this industry. According to the CPO's explanation, we can probably expect more development at the materials level:

"Binder jetting is a technology that can enable materials that you wouldn't necessarily manufacture via conventional manufacturing like CNC machining because the material is too hard or it takes too long, or via powder bed fusion in the case of non-weldable alloys. There's a whole set of materials that you can manufacture with powder metallurgy and that binder jetting makes possible. So again, it's not so much that 3D printing requires complex materials as it enables high performance, complex materials that you can't manufacture with other processes. That's one of the reasons that we're really excited about it. But, at the same time our platforms, including the Shop System and Production System, support workhorse or commodity materials like stainless steels and enable customers to manufacture parts with these metals cost-effectively and at scale. And we continue to invest in materials not just on the metals side, but across our polymer platforms as well – our Adaptive3D elastomers offer best-in-class performance for industrial applications, and we also recently launched two new photopolymer materials for the dental market, Flexcera Base and Flexcera Smile, that enable high-performance functional dentures."

Still on the materials' side of its business, this year saw the release of a number of materials including the **sinterable 6061 aluminum** and later on the **4140 low alloy steel**, all of which can be processed by its metal binder jetting systems.

Linar pneumatic piston – produced with 4140 low alloy steel – Image: courtesy of DM

Image: Surgical nozzle produced with 316L Stainless Steel – Credit: DM

Those material developments predict a new era of competition in the metallurgy industry, an era that metalcasting experts should watch closely. Indeed, demands from industries have become more stringent as they no longer limit their manufacturing goals to design and production. They are going one step further by challenging metallurgy, as it was the preserve of foundries and die casters.

Indeed, one used to say that the higher the strength of aluminum, the more difficult it is to form with traditional manufacturing. "We're getting properties with Al 6061 that are better than wrought, and with binder jetting you can produce more complex geometries than with traditional CNC machining" Aggarwal affirms. Add to that the fact that, Al 6061 is one of the rare lightweight metals that can finally be processed by metal binder jetting, you obtain a wide variety of thermal and structural applications across industries.

"Materials are really what unlock applications, and so we're focused on bringing to market materials that we think are going to unlock the widest variety of applications. 4140 and Al 6061 are two of those key materials. We have also qualified 17-4PH and 316L stainless steels, and our roadmap also includes carbon steels, super alloys, titanium, copper, and other materials for which we see key that either already exist or are emerging in the market", he completes.

Although materials will enhance the performance of its various platforms, Desktop Metal strongly believes they will also help their customers remove some of the margin stack-up that would otherwise take place.

Although its subsidiary is relatively new, **Forust** which enables wood 3D printing via binder jet, might help deliver this economic advantage to customers in the architecture and construction industries. This material strategy is just as important here as it's about taking waste byproducts from traditional wood manufacturing, like sawdust and lignin, and recombining them using 3D printing.

Image: A glimpse of the manufacturing process – Forust. Courtesy: Desktop Metal

However, while with Forust, the environmental benefit in this material strategy was clearly understandable, we can't help but ask ourselves if the other materials developed for the metal binder jetting systems also provide any environmental benefit as compared to other materials this technology can process.

Image: The Forust process combines two waste streams from traditional wood production, sawdust and lignin, to sustainably produce isotropic, high-strength, wood parts. Courtesy: Desktop Metal

"I think it's twofold. First, binder jetting is inherently a green process. All of the powder that does not end up in parts at the end of a print can be recycled and reused in future prints. There's not a huge amount of waste that's generated as a result of this process, which is in contrast to CNC machining where you're basically starting from a billet of material, and you have to cut your part out. The more intricate the part is, the longer machining takes, and the more waste you actually generate. Binder jetting is also different from powder bed fusion, where there are actually some constraints on the re-use of the material as it can degrade with each print. With binder jetting, by contrast, the material is almost reusable endlessly – in fact, we are still running prints in our lab using powder that has been recycled many times over. From that perspective, binder jetting is a very green process compared to some other additive and conventional manufacturing methods. Second, by using binder jetting in combination with high-performance materials, some of which have high strength and stiffness, you can produce highly optimized structures, which may have been difficult to produce via conventional manufacturing. As a result, with our platforms, you can create products that use less material and there are positive downstream effects, too. For example, if you are able to lightweight components for a vehicle, it can reduce the fuel consumption of that vehicle, and the same goes for an aerospace component. So, while the materials themselves may not provide an environmental benefit today, the core binder jetting process is green. Through more complex, optimized geometries, you can reduce material usage and take advantage of downstream benefits, like reduced fuel consumption. Our new Forust process for binder jetting wood has been designed to upcycle traditional wood manufacturing byproducts - sawdust and lignin - so that new material and cradle-to-cradle process is enabling a totally new, more environmentally friendly way to manufacture functional, wood parts", the company's representative replied.

As for applications? It's easy to predict that DM will focus on those vertical industries that foster the adoption of AM technologies. As we saw from the very beginning, the company has already indicated a firm interest in focusing on the healthcare through a dedicated line – Desktop Health.

However, whether it is in the automotive, consumer products or other industrial sectors, today more than ever it is crucial for the machine manufacturer to focus on applications that make sense. As per the words of Aggarwal, there's a real benefit to metal 3D printing, where one can improve sustainability by creating products that can be re-used multiple times versus those created in plastic. In the automotive sector especially, manufacturing should deliver a tangible environmental benefit by light weighting and optimizing components, by taking into consideration fewer material usage, fewer material costs, and by improving the fuel consumption economics of vehicles.

Furthermore, in heavy industries like oil & gas where applications are often highlighted with other types of metal AM technologies, the expert refocuses the debate on the capability of Single Pass Jetting to scale a production (in-situ) while removing many of the shipping and logistics burdens associated with conventional manufacturing.

More than just a general service bureau

Moreover, as it moves forward, this focus on applications that make sense will lead DM to further implement and develop an online manufacturing platform where parts to manufacture will be selected wisely.

Courtesy of Desktop Metal – 3D printed with Flexcera, a proprietary resin for use in 3D fabrication of high-quality dental prosthetics.

“We see a huge opportunity to actually own the entire value chain, not just the technology and materials but also the supply of parts to the end customer. We want to be selective about building a parts’ offering to address from of these killer applications for AM as they hit inflection points. An example of us starting to organically go there is with Forust – in addition to selling the technology platform and materials, we are offering parts produced by Desktop Metal and Forust through an eCommerce platform. The parts focus area is one where you’ll see us play a little bit more in the future. We don’t intend to be just a general service bureau, but we may continue to evaluate opportunities to provide parts in specific verticals and applications where AM enables really unique products and high value, high margin offerings. We believe these three pillars –– print platforms, materials and parts –– are all synergistic and will reinforce each other as Desktop Metal continues to grow” the CPO told 3D ADEPT Media.

What’s next in the pipeline…

Even though the company remains super-secret about what expertise they will add to their companies’ portfolio, Aggarwal ensures that we may expect DM will pursue its acquisitions strategy. However, after this incredible first half of the year, we can legitimately say metal AM will remain at the heart of its next phase of growth.

“While we have broadened our strategy to focus on providing cost-effective AM solutions at-scale across materials, metal remains one of the core foundations of the Desktop Metal business. In fact, we have more employees focused on metal 3D printing today than we have had at any point in the past. I think because we were a metal company from the start, some of the announcements that we’ve made more recently have been related to investments outside of metal, but we continue to invest heavily in metals organically and inorganically. We’ve had a number of new metal material releases over the past few months, and we’ve had several new products that we’ve launched just in the last year – in binder jetting, our Shop System and P-1 in Q4 last year, and the P-50, scheduled for later this year. The Studio System 2 also launched in the first quarter of the year – so we’ve had considerable new developments from a print platform perspective, as well as an extensive material roadmap we are working towards. We announced Aluminum 6061, 4140 low-alloy steel, and 316L stainless steel for our binder jet platforms, and we have a couple of exciting announcements on the horizon there as well.

Success for Desktop Metal is capturing double digit market share in the overall AM market over the next decade, and metal is a key ingredient to that success along with broadening our AM 2.0 portfolio to address a growing set of applications through additional materials, including polymers, elastomers, sand, wood, and biocompatible materials”, Aggarwal concludes.

SOFTWARE AUTOMATION IN ADDITIVE MANUFACTURING : WHERE ARE YOU ?

When early users of Additive Manufacturing technologies started leveraging these technologies, the most important aspect, if not the only one, was to determine if those technologies could effectively achieve rapid prototyping. As users' needs have evolved towards series production or even mass production, technologies' capabilities also need to be adapted. Automation comes into play and becomes a pivotal goal to reach, to truly enable series production of 3D printed parts, but the route towards true automated additive manufacturing production is often strewn with pitfalls.

Needless to say, automation is a vast topic. In the manufacturing field, where most of the tasks were historically done by hand, automated manufacturing has helped operators to rely on a number of computerized control systems to run equipment in a facility. In an industrial additive manufacturing setting especially, one quickly observes that depending on their needs, facilities can implement automation strategies at various levels of production – no matter what AM technology is harnessed – : software, pre-processing, manufacturing or even post-processing.

Despite its crucial role in manufacturing, software automation in additive manufacturing is often the part that is least understood by users of additive manufacturing, which is why we've decided to explore it in this exclusive feature.

What drives software automation in additive manufacturing? What are the key stages that are taken into account to advance Additive Manufacturing Software Automation? Where are the current needs/challenges? This article aims to address these questions with examples taken on various types of AM technologies.

Benjamin Schrauwen, CEO of software company Oqton has also been invited to share key insights into this topic.

What drives software automation in Additive Manufacturing?

In traditional manufacturing, automation is used to increase efficiency and speed. Not only do machine manufacturers and software developers want to bring those advantages to additive manufacturing, but they need to bring them at a more advanced level in order to justify the use of AM technologies in production. This explains the increasing number of collaborations between machine manufacturers and software developers, software developers and material producers, or even between software companies with various expertise.

Benjamin Schrauwen, CEO of Oqton

As you will have understood, software is the backbone for any attempt at automation. To understand the various levels that often require the attention of software companies, it's important to categorize the different types of software solutions that can be leveraged in additive manufacturing.

We've identified six main types of software in the Additive Manufacturing industry: Design (CAD), Part identification, Simulation (CAE); Processing (CAM), Workflow (ERP/MES), and QA & Security.

When asked what are the areas that would require automation the most, Benjamin Schrauwen, CEO of Oqton, a software company that is solving manufacturing challenges with an AI-driven factory operating system, explains:

"Any manual, repetitive task that is currently performed by manufacturing engineers should and can be automated. This way, we can increase efficiency and productivity while freeing up their time to focus on value-adding work. This is also known as 'end-to-end automation' of the workflow.

We see this as very important, for example, dental and polymer AM service providers who produce high quantities of mass customized and personalized parts. Manufacturing Execution Systems (MES) is a big area for automation, too: we believe an intelligent way of scheduling is the way to go. This would be completely automated based on printer, material, and people capacity.

In general, we see that advanced manufacturing industries are maturing, and production quantities are increasing – so, in turn, they need automation. If they don't, it will be a challenge to scale up while producing in an economically feasible way."

While it highlights some of the key stages that are currently taken into account to advance software automation strategies, Schrauwen's explanations also reveal that what currently drives software automation in AM has moved beyond the reach of the software that operates the equipment.

Indeed, industrials have no choice but to consider an automation strategy at the software level, if they want to achieve mass production – therefore, save time, costs and design resources –.

Although that's a concern tackled by machine manufacturers, an automation strategy at the software level is prevalent, when we know mass production with AM inevitably requires to achieve **consistent and repeatable parts**.

Most importantly, as Schrauwen's notes, *"any manual, repetitive task that is currently performed by manufacturing engineers should and can be automated"*. This means that, the first step in deciding where one should focus their automation strategy consists in identifying those tasks and assessing the stage that will require an immediate action.

The different levels where value and complexity can be enhanced through software automation

Not surprisingly, manual tasks can start way before the manufacturing process itself. They consist in but are not limited to entering data into systems, replying to customer requests, calculating and providing cost estimates or even bringing USB sticks to AM systems to have files 3D printed.

To make their job easier, most companies often use simple tools like Microsoft Excel to examine data or apps like Zapier to relay data from one machine to another. This stage is often referred to as native automation.

As it requires a combination of manual tasks and simple tools, engineers can still encounter issues when it comes to processing information such as 3D printing requests, file conversions/repair, or project status update.

To address this issue, they often move to "basic or simple automation" and integrate a software tool that can handle multiple steps and applications. In this vein, on the market, one can find AM workflow software that can help engineers to automatically handle ordering, customer requests, rule-based automation for production scheduling, or even

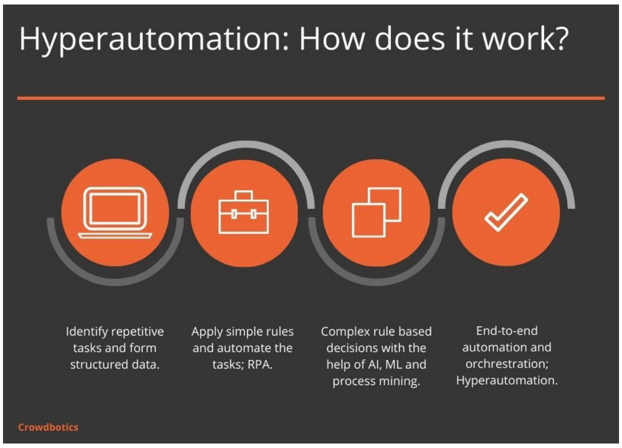
distribution of files to specific 3D printers for production.

Beyond these single steps, it is possible to integrate a software solution that automates the whole process from the beginning to the end while enhancing processes over time. Such software tools often require the use of artificial intelligence, and consists in the creation of a seamless digital thread (smart automation) to facilitate visibility and decision-making. This stage of smart automation also brings a certain connectivity and helps create a unified environment for AM with better production planning, traceability and standardisation.

The fourth stage in software automation is certainly the most mature one as it combines the two previous phases with Machine Learning (ML): **hyperautomation.**

As you may know, once you've got a software tool that is based on AI and ML, not only can tasks automatically be optimized, but the software tool utilized here automatically enhances its technology with the increasing amount of data processed.

This stage necessarily involves the question of interoperability that we addressed in a previous issue of 3D ADEPT Mag, Moreover, it should be noted that its integration within a factory is often highly individualised and based on the company's manufacturing strategy. At this level, the first advice one can give companies is to go for a software platform that is scalable and that is compatible or can easily be adapted with all their platforms and systems.



What are therefore the challenges manufacturers want to address through dedicated automation strategies?

It goes without saying that, each of the aforementioned stages comes with a number of benefits once the appropriate software automation strategy is implemented. As most manufacturers are currently trying to achieve series or mass production with their AM systems, they often try to implement a seamless digital thread or a hyper automation strategy within their production environment.

The fact is, they often mention "investment costs" as one of the hurdles that slow down the integration of an automation strategy but **reality shows that they do not often know the digital capabilities they aim to reach.**

The first step in understanding what these digital capabilities are, often comes down to recognizing the typical constituent components of additive manufacturing:

· Design & simulation stages;

· Print properties selection;

· Print preparation and orientation;

· Managing in-print queue;

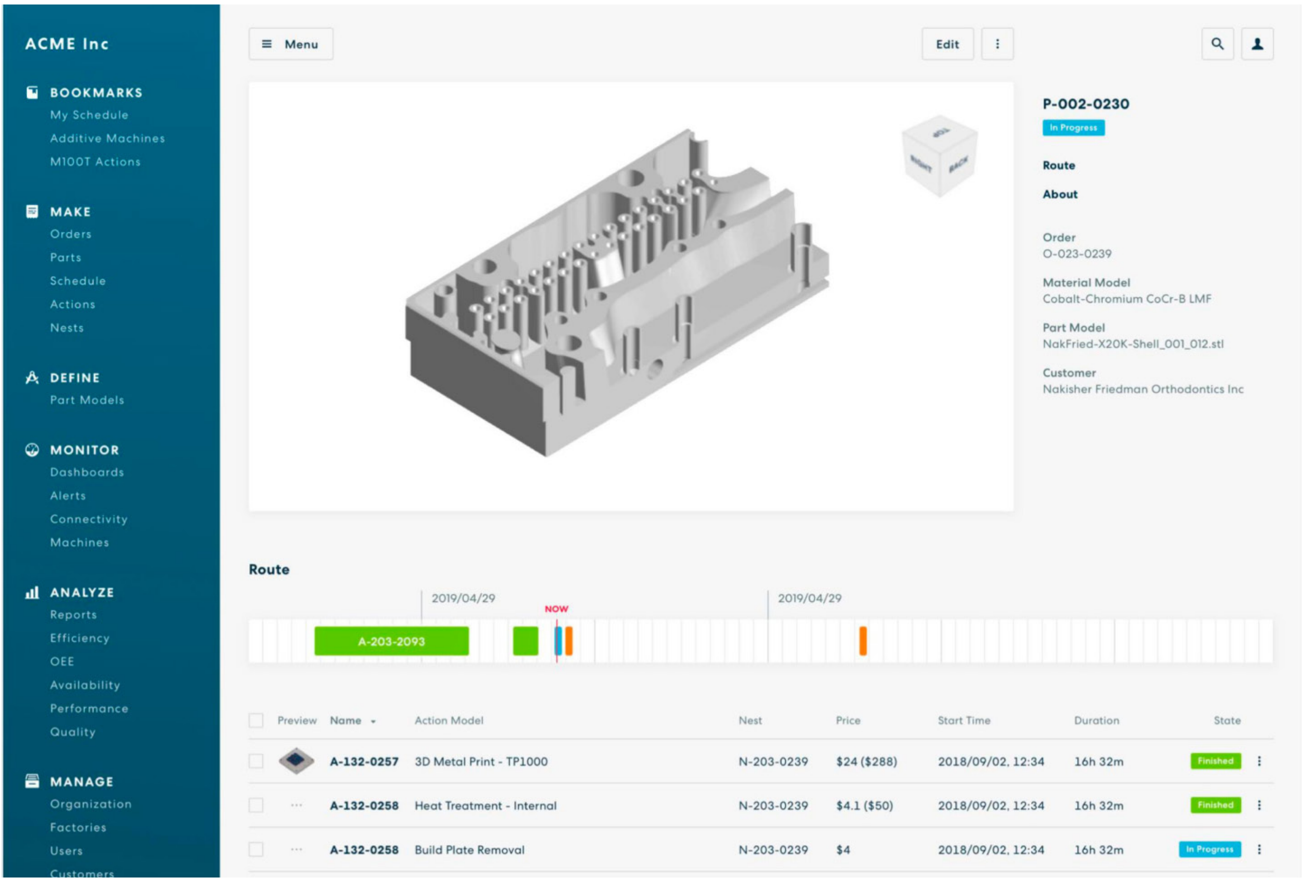
· Initiating printing;

· Removing parts from the 3D printer;

· Post-processing; and

· Finished part retrieval.

"A good example of a specific use case is build preparation for laser powder bed fusion. There are many important factors like part orientation, support generation, and parameter assignment. A mistake can easily be made, and a failed print job can cost tens of thousands of dollars. Oqton [for instance], provides customers with the opportunity to create build preparation templates. We capture their knowledge and experience and couple it with our AI algorithms to automate the complete process. In this way, we speed up the process and lower costs while substantially decreasing human error and improve reproducibility. When you reduce dependency on key operators, this also means that more people can program autonomously. You are no longer at the mercy of one key person's holiday schedule or them falling sick. This also enables full end-to-end traceability, especially in regulated industries where full documentation is vital, such as medical and aerospace. Ultimately, we see clients increase machine efficiency by faster programming and using advanced manufacturing equipment like welding robots and industrial 3D printers", **Schrauwen** notes.



Platform UI – Courtesy of Oqton

Apart from determining the right digital capabilities one aspires to, it is important to take into account the implementation of an automation strategy with regards to closed AM systems. Although it requires a dedicated article, that's something we have partially addressed in the exclusive feature "**What does "openness" truly mean in a metal AM system?**".

Taking the example of the Oqton platform, **Schrauwen** explains that the biggest challenge they see in adapting existing processes for an automation strategy, is often replacing systems in an active production environment. *"We often use a phased approach where companies, for example, start with MES, add IIoT, and then add our integrated build preparation. This way, we can provide a lot of value right from the start without interrupting or slowing down production"*, he points out.

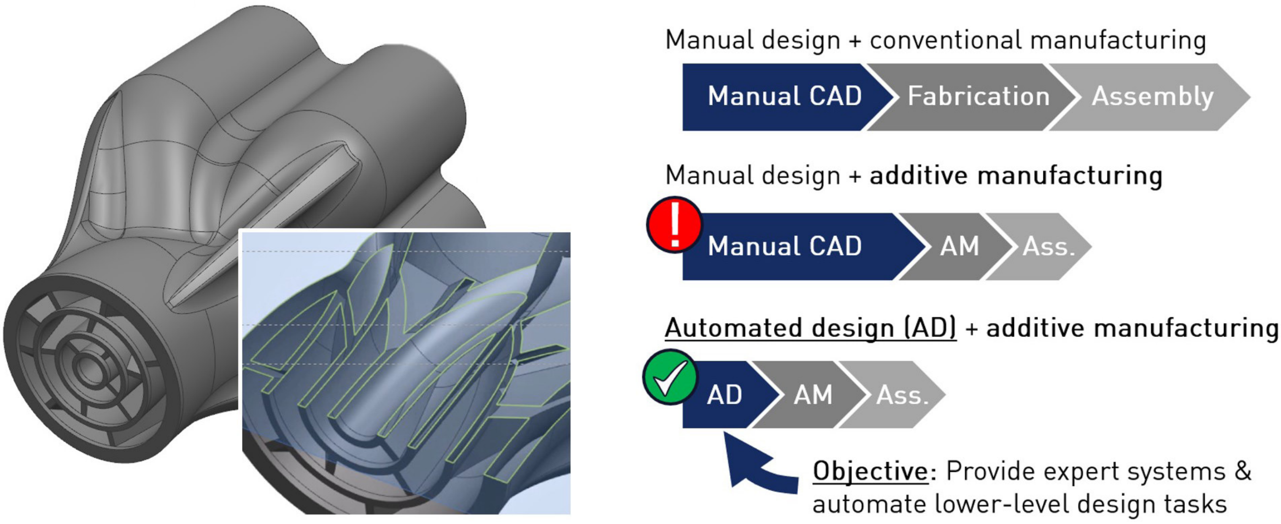
What does the future hold for software automation?

As additive manufacturing advances, it becomes difficult to discuss automation strategies at the software level without any word for its influence on machines. In this vein, let's note that exploring strategies for advancing automation in post-production processes, as well as automation in 3D printing order and production management should currently be on top of manufacturers' agenda.

At the software level, which is the heart of this feature, design automation and AM data sharing automation are often mentioned as the key trends that will drive the development of automation solutions.

Design automation for AM

It is no secret that AM helps to reinvent the design of parts and products in different application fields. Despite the design freedom that AM allows, most of the time, AM parts are designed manually. This can be explained by the fact that designing requires a lot of expert knowledge. Complex-shaped parts in particular, can often be an effortful process, both for novice CAD users and experienced designers, hence the need for design automation as an enabler for AM.

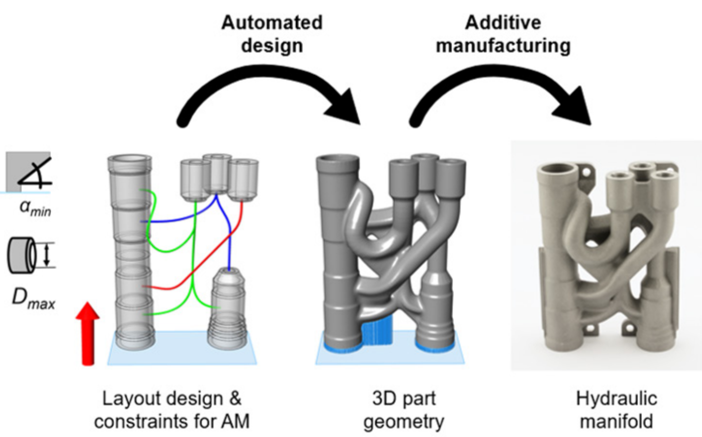


Legend: Process chains with complex additive manufactured parts can be made cost-efficient by employing an automated design approach as a technology enabler.

Let's mention an example shared by researchers from ETH Zurich as an illustration. As part of a project, researchers from the Swiss university demonstrate the potential of design automation by implementing applications in different areas.

"The basic idea is to simplify and accelerate the design phase by providing expert systems that automate lower-level design tasks. Design intent and goals are specified on a high level of abstraction and automatically translated into optimized geometries while taking into account manufacturability restrictions of AM", they said, speaking of the above image.

Another interesting example saw the development of computational procedures to automate the design of additive manufactured flow components such as hydraulic manifolds. *"A designer specifies pathways of flow channels and manufacturing restrictions for AM. Based on these user inputs, algorithms automatically generate a production-ready 3D part geometry that can be used to fabricate prototypes or to conduct numerical simulations. Benefits for the product development include the shortening of iteration loops, the comparison of different production scenarios, and the cost-efficient customization of parts for small lot sizes"*, the report reads .



Legend: Novel design algorithms helps to generate complex-shaped, additive manufactured manifold designs that are automatically adapted to comply with manufacturing restrictions of AM.

While these examples may be theoretical, it should be noted that, to create digital end-to-end workflow in AM, AM users across vertical industries currently partner with software companies that can help them reduce the time to design tools from hours to minutes.

On the other hand, one notes the increasing number of collaborations between machine manufacturers and software providers to advance this specific area of manufacturing.

AM data sharing automation

The more technology providers create integrated, interoperable 3D printing workflows, the more open Application Programming Interfaces (APIs) are being used to enable connectivity between systems. This increasing use of APIs is a key trend that currently drives AM data sharing automation.

Simply put, an API is a software intermediary that allows two applications to talk to each other. For those who do not know, each time you use an app like Facebook, send an instant message, or check the weather on your phone for instance, you're using an API.

3DControl Systems, AMFG, or even Dyndrite have been collaborating with machine manufacturers such as HP to enhance such connectivity between systems and expand the use of data. The more APIs-based collaborations will be formed, the more the gap between hardware capability and software enablement will be filled.

"Admittedly, data preparation – build and process data is notoriously difficult to extract, analyse, visualize and share. Every machine manufacturer has its own standards and protocols. End users and the industry would benefit a lot if all manufacturers would openly share data through common protocols and APIs", our expert notes.

A big shift in focus from hardware to software

However, moving forward the *"trends coming around the corner include,* ***a big shift in focus from hardware to software****, which includes the move to cloud-based platforms, and the use of AI to automate that process.*

IoT connected machines produce lots of data, which in turn requires machine learning AI as the only way to process all that information. Operations will therefore rely more and more on automation to manage their workflows. How to upskill their current workforce to take on new work responsibilities and work with automation is, therefore, both a coming trend and a challenge for the industry at large.

We also see a shift in manufacturing from using 3D printing just for prototyping towards its use within actual production.

Another trend we see is in areas of integration. All the bigger software companies are working on developing end-to-end solutions, consisting mainly of acquired and connected point solutions. Oqton, on the other hand, has architected, developed, and built our end-to-end platform from scratch. In doing so, we have solved a lot of difficult problems and combined powerful data processing and management with a clean and intuitive interface - Something that has never been done before", Oqton's CEO lays emphasis on.

Nevertheless, no matter what trend is driving the development of automation solutions in AM right now, the first step for industrials consists in determining at what stage of the journey they are.

Notes for the readers

Several resources have been gathered to produce this exclusive feature dedicated to software automation in AM.

The main contributing resources have been based on Oqton's insights & ETZ Zürich's report led by Manuel Biedermann & Patrick Beutler.

ETZ Zürich is a Switzerland-based University whereas Oqton is a Belgian software company that develops an agnostic manufacturing operating platform which automates the end-to-end workflow across and beyond the production floor.

Oqton combines order tracking, latticing, build preparation, slicing, all relevant to Additive Manufacturing. On the CAM side of the process are order tracking, scheduling, traceability and data insights.

This is all done in one cloud-based platform that leverages Artificial Intelligence to automate every repetitive task and utilizes intelligent IoT capabilities to connect all of the equipment on the factory floor. This includes everything from plastic 3D printers, metal additive manufacturing machines, and even post-processing equipment.

As far as this topic is concerned, Oqton currently defines itself as a company that empowers humans and machines to work seamlessly together. That is increasingly becoming the key difference between manufacturing success and manufacturing failure.

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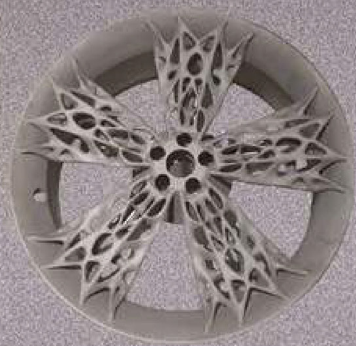

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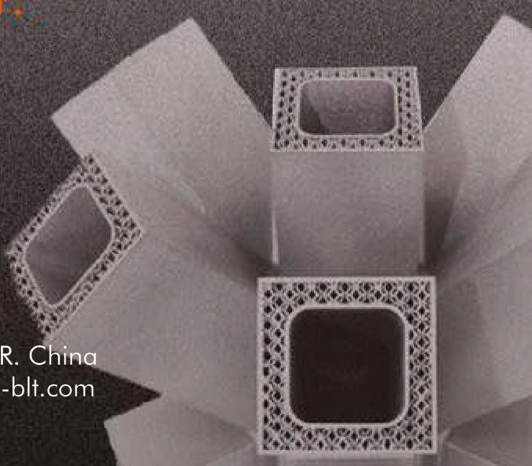

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A GLIMPSE OF THE USE OF FURNACES IN ADDITIVE MANUFACTURING

Whether it is for homes or for industrial settings, a furnace remains a device that produces heat. In industrial environments, those devices were first used in metallurgy to heat and melt metal or to remove gangue, primarily in iron and steel production. Over time, the use of furnaces has expanded so much that it requires a dedicated trade press to speak about all its ins-and-outs. However, it turns out that when it comes to additive manufacturing, the use of furnaces remains quite limited, yet of paramount importance to achieve the desired finished 3D printed part.

Industrial furnaces may have been used since the beginning of the industrial revolution, but the 20th century came with its share of innovations, not to mention that it expanded the use of these technologies to new applications that were previously not considered in the field. The story does not tell us when exactly occurred the first uses of furnaces with Additive Manufacturing. However, it does reveal that most companies that deliver furnaces to additive manufacturing technologies providers or users are mostly companies that have a solid expertise in the development and commercialization of furnaces for conventional manufacturing processes and other industries such as foundry, forging, thermal process technology, to name a few.

So, **why & where are furnaces used in the AM process? What type of 3D printed parts require furnaces? How do we use furnaces? And what are the main features of these machines?**

This article aims to provide a glimpse of the use of furnaces for additively manufactured parts.

Why & where are furnaces used?

First and foremost, given their primary nature, furnaces are used for applications that require high processing temperatures.

In the AM industry especially, although applications achieved through metal AM technologies will generally require the use of furnaces, it should be noted that two main reasons may explain the use of furnaces. These reasons also help catalogue the 2 main types of furnaces that are used in the field:

Parts that require **sintering (and often debinding)** and parts that require **heat treatment**. To this end, *"ceramics and composite 3D printed parts may require to be treated in a vacuum furnace, as do most metal 3D printed parts"*, **Andrea Cassani**, Sales Director at TAV VACUUM FURNACES SPA notes from the outset.

This means that, basically, all types of 3D printed parts may require the use of a furnace at some point of the production.

Debinding and Sintering

For those who are not familiar with these terms, please note that debinding and sintering occur both after the manufacturing process.

Debinding is a process that consists in removing the primary binding material in a very short time and with the least amount of damage.

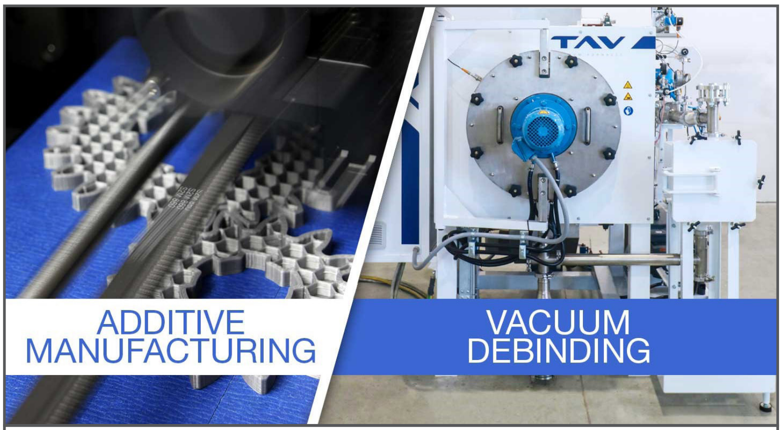


Image: TAV VACUUM FURNACES SPA

Sintering is often considered as the final step of all powder metallurgy processes, including some metal 3D printing processes. During this stage, *"green parts (a combination of metal powder and binder) are first heated to a temperature where the binder evolves and is removed from the parts. The furnace then ramps up to the sintering temperature of the metal which is just below the melting temperature of the material, fusing together the metal particles. After sintering is complete there is little or no evidence of the original powder particles, fabrication process and parts have very low porosity".*

However, the operator does not automatically always perform both processes. Even though it is faster to debind and then sinter the parts, the operator can also decide to (skip the debinding step and) directly sinter the part. On the other hand, one should note that there might be several steps to the debinding process, and more than one cycle before the binding material is completely removed before that part goes through sintering.

No matter what cycles are performed, sintering helps get a better density of the part. According to experts from **Desktop Metal**, during the final stage of sintering, pores continue to shrink, and the part further densifies. To optimize part density, sintering temperatures and holds are closely monitored to control and avoid grain growth, which can occur if parts are left at elevated temperatures.

In general, the following three steps are often observed:

1. Removal of binder – either by degradation (chemical interaction with furnace gas) and/or evaporation (vaporized binder)

2. Densification and pore removal take place as metal particles migrate and fuse

3. Cooling of furnace so that parts can be safely removed.


Image: Nabertherm

As the name implies, heat treatment consists in heating material to a specific temperature and then cooling it to improve its mechanical properties. This material is usually a metal or an alloy. In some manufacturing processes, this part is of paramount importance as it enhances the fabricated part to better withstand wear and tear.

To make it happen, what better way than using a furnace which can maintain heat at a desired temperature for a defined amount of time, before cooling.

"While it's hot, the metal's physical structure, also called the ***microstructure*** *changes, ultimately resulting in its physical properties being changed. The length of time the metal is heated for is called the 'soak time.' Knowing what temperatures to heat and cool metals at, as well as how long each step of the process should take for a specific metal or alloy is extremely complicated. Because of that, material scientists known as metallurgists, study the effects of heat on metal and alloys and provide precise information on how to perform these processes correctly"*, an expert from General Kinematics explains.

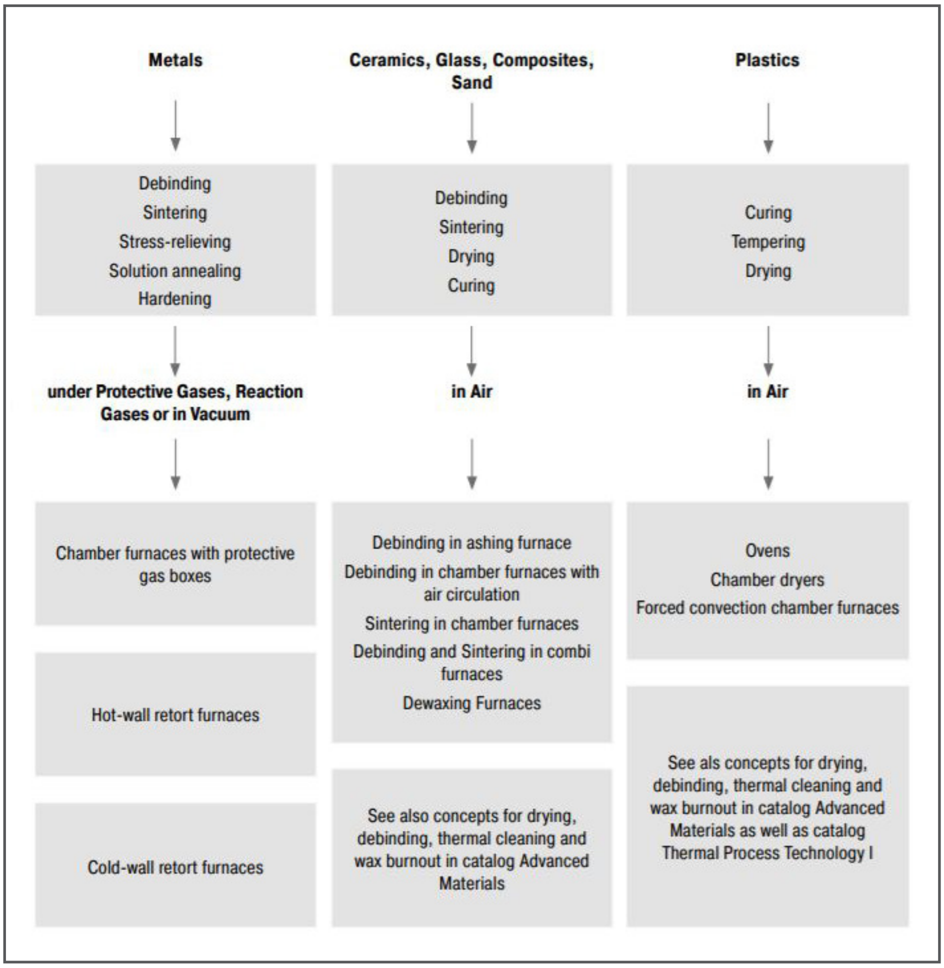
Taking the example of parts that have been manufactured using SLM technology, TAV VACUUM FURNACES SPA explains that most materials that are printed with SLM technology **need a heat treatment**.

"This heat treatment can be de-tensioning (to release most of the internal tensions accumulated in the material during the printing phase) or of another type (to try to optimize the mechanical properties of the component according to its specific application). Usually these treatments are carried out in air or in controlled atmosphere", the expert highlights. Furthermore, materials such as stainless steel, titanium superalloys, superalloys of nickel and CoCr alloys, could require the use of vacuum.

What type of 3D printed parts require furnaces?

As mentioned earlier, all types of 3D printed parts may require the use of furnaces at some point of their production. The thing is, there are so many furnaces that a metal 3D printed part will not require the same furnace as a ceramics or a polymer 3D printed part. In the same vein, they will not necessarily go through the same stages after the debinding or sintering phases.

Please note that, 3D printed parts produced in ceramics, glass, composites or sand can be treated in vacuum furnaces or in air.



Source: Nabertherm – Heat Treatment of Additive Manufactured Parts

How do we use furnaces? And what are the main features of these machines?

We started this article with the assumption that we could draw a general use of furnaces for 3D printed parts. We were wrong. Contributors and resources we relied on to write this article reveal that with the many types of furnace that exist, it would not be possible to catalogue the main features of furnaces – at least not here.

So, how can we help AM users to make a decision? **Cassani** attempts to provide a useful answer:

"We cannot make a generic statement valid for all kind of vacuum furnaces. We can say that today the temperature range required for 3D printing parts is approx. between 500 and 1400°C for sintering and heat treatment or below 900°C for debinding/presintering. In the case, a part has to be sintered often; we split the process and the furnaces in 2 steps: first step a debinding furnace to take out parts from the binder and second step (at higher temperature) a sintering furnace.

In the case of parts to have to be heat-treated the furnace is very close to a classic vacuum heat treatment furnace, with some specific features/characteristics. You often need to consider that whoever buys a furnace for the heat treatment of 3D printed parts uses the furnace only for these parts, so [an optimised design is generally justified]."

In the same vein, one can take note of the following recommendations from **TAV VACUUM FURNACES SPA & SECO/WARWICK S.A**. to companies looking for a new furnace:

- Usually, when using the same technology for 3D printing processes and materials, it is not needed to adapt/change the furnace.

- However, the furnace size needs to be adjusted to match estimated production capacity.

- After the use of furnaces, the part often requires finishing and in some cases some small machining.

TAV VACUUM FURNACES – vacuum furnace for Metal 3D Printed parts

- If the furnace is correctly customized, the furnace itself only represents a small percentage of the investment required for 3D printers and it can generally work with something between 4 to 16 printers

- One technology may require sintering, while another would need stress relieving. Thus, taking into consideration the manufacturer's future goals – such as standardization of a furnace, mass production, or constant flow of orders – helps invest in the right industrial furnace and helps companies avoid most of the obstacles before they even occur.

Moving forward…

The truth is, as AM expands, the need for better technological capabilities continue to rise and it's only recently that heat treatment processes have started to occupy a more important place in the AM landscape.

It is no longer a great achievement to have an industrial (metal/polymer) 3D printer. As a matter of fact, several reports including PostProcess' 'Additive Post-Printing Survey' reveal that over 50% of 3D printer users have two or three different types of technologies within their facility.

This means that the disadvantages of one manufacturing process will ultimately be compensated by the advantages of others and, in this production scheme; furnaces will have to accommodate both.

That's the reason why collaborations between developers of furnaces and 3D printer manufacturers or private and public research centres/universities are also prevalent here. As is the case with TAV VACUUM FURNACES SPA, such collaborations help producers of 3D printers and research centres/universities define post-processing standards and constantly improve the furnace features in terms of performance, productivity and quality on the 3D printed parts.

Resources:

Main contribution: Interview with Andrea Cassani, Sales Director at TAV VACUUM FURNACES SPA.

External contributions: SECO/WARWICK S.A. – Desktop Metal – Nabertherm - General Kinematics

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TIME-SAVING IN PRODUCT DEVELOPMENT: WHY MANTLE'S HYBRID METAL 3D PRINTING IS AN INTERESTING BET

In an industry where one of the major issues consists in reducing "product-time-to-market" cycles, additive manufacturing is often directly categorised as a technology that enables faster production compared to conventional manufacturing processes. Yet, for certain applications such as mould tooling – which is pivotal for the development of many products –, certain AM processes are not only costly, but are as long as conventional machining, not to mention that they will still require the operator to perform some machining before obtaining the final 3D printed part.

Interestingly, another alternative recently came onto the market, an alternative that would provide a more interesting bet in terms of tool lead times and product-time-to-market; an alternative that is based on metal pastes.

Mantle, a San-Francisco based-startup that recently turned stealth mode off, following a secret fundraising of $13 M, brings this intriguing concept onto the market. With a technology solution named TrueShape, the company decided to solely focus on the tooling market (for now); a specific interest, that is perfectly understandable when one knows the background and expertise of the founders. At the end of the day, your experience often determines how you will shape the future, right?

Well, Mantle has been founded by Ted Sorom (CEO) & Steve Connor who are respectively mechanical design engineer and chemist by training. Although the company officially made entered the market on February 2021, it should be noted that Sorom and Connor have founded it over five years ago.

Ted Sorom (right) & Steve Connor (left)

Their respective professional experiences led to the development of TrueShape to the extent that from the very beginning of his career, Connor built up expertise and decided to specialize in nanoparticles and metal pastes. He has even developed a successful "lower-cost replacement for the expensive silver metal pastes used in the solar industry." "He then shifted gears to see if similar technology could be used for additive manufacturing", Sorom told 3D ADEPT Media.

The focus on the tooling market can be explained by the fact that its size was valued at $212,500.0 million in 2020, and is projected to reach $439,994.9 million by 2030, registering a CAGR of 7.5% from 2021 to 2030. Beyond these figures, it should be noted that Sorom has also gained extensive experience in the field. Indeed, right after he obtained his degree, he "joined a vertically integrated company that made high-end equipment using CNC machined metal and injection molded plastic parts."

"I designed the parts and molds upstairs and then went downstairs and made the molds before putting them into full production. I saw first-hand how time-consuming and expensive the toolmaking process was for even a simple plastic part. Our new product launch schedules were gated by tooling. Unfortunately, my experience is not unique; almost every manufacturing company struggles with these same challenges. At Mantle, we've focused our efforts on addressing these challenges", he recalls.

Understanding the backbone of the manufacturing industry

Often considered as the backbone of the manufacturing industry, tooling involves the designing and manufacturing of tools required for bulk production of parts, parts that may involve the fabrication of moulds and dies (presses), forging, gauging, jigs & fixtures, and cutting tools, all of which are useful to produce other parts for cars, turbines, propellers, to name a few.

As the design and fabrication of these tools directly affects the production quality of the end-user industry, the choice of the manufacturing process leveraged here is of paramount importance. "Tooling applications require outstanding surface finish and a high degree of accuracy", Sorom points out. To deliver such rendering, Mantle decided to combine the best of both worlds: traditional machining and additive manufacturing.

Most importantly, as far as AM is concerned, the founders see an opportunity here for this technology to make a big impact on high-volume production of products.

TrueShape

Historically, fabricating tools using a traditional manufacturing method often requires a multi-step process that includes programming, cutting, and finishing the tools – a process in the end that can take several months rather than just a few days with the dedicated AM technology.

Mantle's hybrid bound metal printing works by extruding a proprietary metal paste before refining the part surface via traditional subtractive machining. For those who are not familiar with them, please note that metal pastes are often used to fill the dent over any metallic and solid surface and also for fixations of granites and other allied industries. Usually, a resin and hardener are combined to create a durable, high-strength bond that dries in minutes and can be used for repairing, filling, and rebuilding all metal and concrete surfaces.

Legend: Metal Paste – Credit: Mantle

In Mantle's case, the paste consists of metal particles and liquid carriers, which one extrudes to build up the parts layer-by-layer.

"Then we heat and dry the paste inside the printer, which removes the liquid carrier and leaves a "green body" that is relatively soft and can be machined quickly and easily. The machining creates the accuracy, surface finish, and fine features needed for precision parts like moulds. The final step is a sintering step, which is important because it fuses the metal particles and establishes the final material properties. We sinter in a high-temperature furnace that brings the parts' temperature to just below the material's melting point, and then cools it off. When the parts come out of the furnace, they are high-hardness tool steels with extraordinarily smooth surfaces that can go directly into injection mould tooling applications with no post-processing of the mould surfaces", the CEO told 3D ADEPT.

Based on the company's explanations, the main difference with other AM processes lies in the post-processing stage. It is no secret that this stage of the production cycle often takes more time than the manufacturing stage itself, and is even more expensive than manufacturing a part. TrueShape ambitions to drastically reduce or even remove this stage, when necessary.

There is not much to say if we compare it to conventional manufacturing processes. However, we do know that this technique seems advantageous to some AM processes which highlight design advantages such as conformal cooling. Indeed, Mantle's process seems to go beyond these advantages, as it can also provide some sort of material uniformity during the process which is pivotal to achieve reproducibility of parts.

This is mainly due to the way the Flowable Metal Paste is distributed, to create stronger microstructures directly in the end-3D printed part. So far, Mantle has developed two steel materials that are comparable to very common tool steels, P20 and H13, for the specific needs of the tooling industry.

To illustrate the capabilities of their technology, Sorom mentioned the example of a global medical device manufacturer that used TrueShape to fabricate cavity and core tool-steel mould inserts. Using the hybrid metal printing process, this company successfully moved its production from 7 weeks to 8 days, and reduced costs by over 50%.

The next step in the pipeline

Mantle's first goal is to demonstrate how TrueShape is capable of making precision components with a key focus on tooling as first application. Moving forward, the company expects their customers to find all sorts of uses for this technology.

"Other application areas include precision jigs and fixtures and low volume / spare parts for industrial applications", the CEO notes. "We also anticipate that, several years from now, our technology will be qualified for end-use medical, aerospace, and automotive applications", he completes.

Lastly, as a young machine manufacturer, we might expect Mantle to develop new materials, faster printing processes, and larger build envelopes but what we can't wait to see right now, is the shipment of their first systems, as it often marks a real positioning on the international stage of the industry.

Medical device mould insert – Image: Mantle

NEWS ROUND UP

During summer, it is hard to always stay abreast of what's happening in the industry. If you have had some time off during the months of July and August, then don't worry. We've got your back. This news-round provides a summary of the announcements you shouldn't have missed this summer. It includes new developments at the business level, and in the 3D printers, post-processing and materials segments. It does not include the development of new products in key vertical industries that leverage AM technologies as well as current collaborations between AM solutions' providers and industrial companies to develop new products.

Business

First of all, as money is the nerve of war, a **$60 million venture capital fund** has been announced to support the development of simulation and AI startups. The company that will handle this venture capital fund is **Parkway Venture Capital**, a generalist venture firm with an emphasis on technology companies that are using artificial intelligence (AI), complex engineering, and data science to enable the advanced simulations that power tomorrow's industry. As simulation and AI also play a key role in advancing the adoption of AM technologies, this capital fund – the second announced by Parkway –, is of paramount importance for companies of the industry, that are looking to raising money. Parkway currently has eight investments in its portfolio, and is operating on a rolling close through 2021.

new products using Additive Manufacturing, establishes a new subsidiary in Finland. ExOne opens **a Metal 3D Printing Adoption Center in Germany** whereas **BASF increases its footprint in China** by opening an Additive Manufacturing Technical Center. The Shanghai-based centre is open in collaboration with Xuberance, a Chinese 3D printing design and service company, where BASF Venture Capital invested. This venture investment is strengthening BASF's strategy in Additive Manufacturing and will enable Xuberance to further accelerate its growth in the Asia-Pacific region. This marks BASF's second biggest investment in China, the first one being its investment in 3D printing company Prismlab.

New ventures also made a quiet start into the 3D printing industry:

– Early at the beginning of July, **AM Global GmbH** and **RANDERATH GmbH** created a joint-venture named "The Aviation AM Centre". Based in Germany, the start-up aims to provide to provide AM Turnkey Solutions for the aviation Industry. For those who do not know, AM Global is part of the LANGER GROUP and works with EOS to jointly develop and industrialise additive manufacturing applications. RANDERATH on the other hand, is a project delivery company leverages additive manufacturing as part of its activities.

– **Prototek Holdings LLC ("Prototek")**, a company known for providing rapid prototyping and low volume production services for precision machined and sheet metal fabricated parts, also made its entrance into the AM industry. These first steps have been made through the acquisition of **Midwest Prototyping LLC**, a large independent additive manufacturing services provider. Following a transaction which closed on July 15, 2021, the combined company will be able to provide a full suite of sheet metal, CNC, and additive manufacturing capabilities with a fleet of more than 140 machines.

– **Precision Additive**, a Colorado-based company opened its doors for business in June 2021 and **made the official announcement in July**. The Colorado-based company has been founded based on one observation: many industries are outsourcing work to other countries, making people speculate that the future of 'American Made' may not be so prolific. Due to AM's ability to manufacture locally, the new 3D printing service bureau therefore, comes with the vision of "revitalizing American manufacturing".

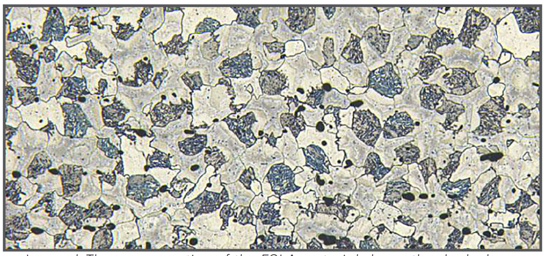
– **Gelato**, a Norwegian-born platform that enables creators around the globe to produce and ship customized products on demand in the end-customer's market, has **secured a total of USD $240**

million in new funding. The current business model of the company enables users to achieve achieving fast order-to-delivery times with little to no inventory or investment. In the 3D printing world, this business model is already applied by a great number of companies, like i.materialise or Shapeways. The capital injection will accelerate Gelato's market penetration and growth in the US and Asia, and its expansion of new local production hubs and products, including 3D printing. In the mainstream end-customers' market, the company plays a role in the production and distribution of customized products such as wall art, clothing, books, and home décor through its hyper-local network of worldwide production partners and software. However, let's note that the company's key strength relies in a software that connects to idle production capacity using an API module.

Materials

This segment saw a lot of interesting developments during the past two months

GKN Additive's new metal powder materials



Legend: The cross-section of the FSLA material shows the dual-phase microstructure after heat treatment. Image: GKN Aerospace

Digital manufacturer of advanced AM parts and materials for prototypes, **GKN Additive**, has improved one of the widely used **low alloy dual-phase steel in the automotive industry**. The material would be similar to DP600, which means, it could serve manufacturers' efforts to reduce vehicle weight and improve crash performance.

Named [DPLA (Dual Phase Low Alloy) and FSLA (Free Sintering Low Alloy)](), the new metal powder materials developed by GKN Additive, deliver higher ultimate tensile strength (UTS) and low yield strength (YS) to UTS ratio, just like the DP600 (HCT600X/C).

While many could see the new materials as the transformation of the traditional automotive material DP600 (HCT600X/C) into two AM powders, GKN Additive goes beyond this simple adaptation by improving spreadability, laser absorption (Laser AM) and sinterability (Binder Jetting).

"Traditional DP600 offers specific standardized mechanical properties achieved by heat treatment. The dual-phase steel AM materials developed by GKN Additive on the other hand are very flexible in their characteristics, as their mechanical properties can be tuned more widely by the heat treatment after the laser or binder jetting process", **Christopher Schaak**, Technology Manager for Binder Jetting at GKN Additive notes.

Designed to be processed by Laser Powder Bed Fusion (DPLA) and Binder Jetting (FSLA), the materials are ideal for applications that require to adapt the design of sheet metal parts, or to develop completely new structural components. However, while automotive customers are primarily targeted, it should be noted that other industrial sectors might also benefit from the new materials' capabilities. Furthermore, those who are looking to achieve weight reduction of their parts, or to create new designs such as bionic structures might also see in these developments a great fit for their applications.

BEAMIT Group's newly-developed 2024 RAM2C Aluminium alloy

In Italy, Additive Manufacturing company **BEAMIT Group** qualifies aluminium alloy Al2024 RAM2C for Additive Manufacturing applications in the Motorsport Sector. The demand for 3D printed parts in the Motorsport sector requires parts that could achieve high-performance levels no matter what the temperature is, while remaining extremely light. The newly-developed 2024 RAM2C Aluminium alloy performs better at both room temperature and high temperatures than other alloys currently in use, plus it is exceedingly tough as well as extremely lightweight.

These characteristics make it perfect for applications in the Motorsport and Automotive sectors for components like the suspension, parts of the chassis and structural parts of the powertrain – so basically any part near the engine.

The alloy processed with conventional technologies is commonly used for the structural parts of aircraft, but Additive Manufacturing opens up new horizons for the future of Aerospace design, enabling the production of much lighter and higher performing structural parts which would bring down energy consumption and costs.

Until now, 2000 series Aluminium alloys, including 2024, were known in the AM world for their inability to be processed via Additive Manufacturing due to their composition. The elements in alloys (such as Copper, Zinc and Magnesium) solidify at completely different temperatures and it becomes very difficult to melt them with a laser to create solid elements. The first step of the project was in collaboration with Elementum 3D: choosing to print with Elementum 3D's Al2024-RAM2C material, a 2000 series Aluminium alloy composition modified with their patented RAM additions. The toughest challenge was discovering the ideal process window for the alloy. BEAMIT Group's R&D team benefits immensely from the integrated processes offered by a fully integrated value chain and took a multidisciplinary approach that resolved the problem.

The Metal AM segment also saw the qualification of Titanium alloy Ti-6Al-4V (Ti64)

Desktop Metal has announced the qualification of titanium alloy Ti-6Al-4V (Ti64) for the Studio System 2TM, the company's metal 3D printing platform that enables the production of high-performance metal parts in low volumes for pre-production and end-use applications. Titanium alloy Ti-6Al-4V (Ti64) is therefore the third material that is qualified for use on Desktop Metal, following 4140 low-alloy steel, as well as the development of sinterable 6061 aluminum. With plans to begin shipping Ti64 next month, Desktop Metal would be the first and only company to make the material commercially available for extrusion-based bound metal additive manufacturing technologies. Main applications for this material include, but are not limited to Machine Bracket, Telescope Focus Ring, Drone Coupling or even Fuel Injector Nozzle.

Image: Desktop Metal – Machine bracket.

A production-grade acrylate resin in 3D Systems' portfolio

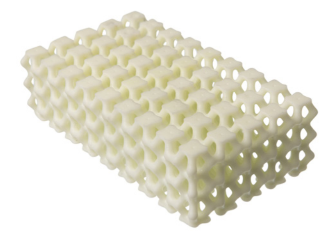
3D Systems also unveils a new production-grade acrylate resin for its SLA 3D printing technology. Named **Accura® AMX™ Rigid Black**, the tough material would producelarge-scale additively manufactured parts that can withstand the rigors of long-term mechanical use.

TOYOTA Gazoo Racing manufactured this automotive grill CNC fixture using 3D Systems' new Accura AMX Rigid Black – Image: 3D Systems.

The announcement follows the release of **Accura Composite PIV**, a material that has been co-developed with Alpine F1 Team for Industrial SLA 3D printing. The development of 3D Systems' new material has been inspired in part by the advanced production application requirements of TOYOTA Gazoo Racing (TGR). TGR and 3D Systems have been working together since 2019 to enhance automotive design and production. Their shared vision for a CNC fixture that would be larger than the build size of the Figure 4 printers, played a key role in this development. Designed to enable long-lasting mechanical performance and stability in any environment, the Accura® AMX™ Rigid Black has been tested for up to eight years of indoor and one and a half years of outdoor mechanical performance, enabling significantly improved part performance and stability.

Nexa3D and Henkel followed with a new photo-elastic material for polymer 3D printing

The partners Nexa3D & Henkel have announced the availability of a new photo-elastic material for polymer 3D printing: **the xFLEX 475**. The soft rubber material has been designed to be used with Nexa3D' resin 3D printers in mind. It can achieve AM applications in the industrial and consumer products industries, applications that require resilience, snap back and tear resistance. Those applications include for instance, pipes and manifolds, handles, and grips, seals, and gaskets or sportswear and footwear midsoles. This material also boasts an impressive up to 150 per cent elongation at failure and an excellent energy return of up to 50 per cent.



This material follows the development of **Nexa3D's "ultrafast" NXD 200 dental polymer 3D printer** in collaboration with BASF Forward AM.

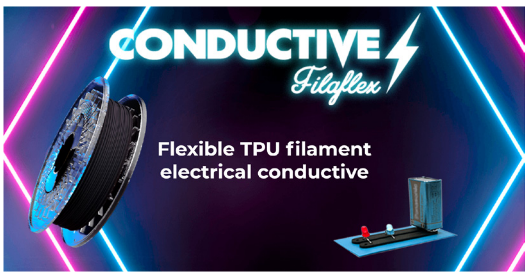
Still on the resin's side of the business, new high-precision Dental Model Pro resin materials

Liqcreate announces the launch of two new dental-oriented photopolymer resins. Dental Model Pro Grey and Beige have been developed and validated in collaboration with dental professionals for this specific sector.

According to the company that discussed the different forms of toxicity and solutions explored to reduce it in resin 3D Printing, Liqcreate Dental Model Pro is a matte, opaque colored photopolymer available in the colors grey and beige. Its matte surface finish accentuates depth and detail in dental models, which accommodates a perfect view on undercuts and the surface is ideal for scan impressions. 3D printed parts from these materials have exceptional dimensional stability and low shrinkage during printing. Liqcreate Dental Model Pro resins are easy to use on all open source SLA, MSLA and DLP 3D-printers in the range of 385 – 420nm. This material has excellent properties like low shrinkage and low odor, accuracy and dimensional stability, making it perfect for the production of dental models, C&B, Implant models, thermoforming and removable dies.

An electrically conductive TPU flexible material in the filaments' side

In Spain, material producer Recreus has decided to to address the requirements of electrically conductive parts by developing a new material named **Conductive Filaflex**. Recreus' new 3D printing filament is an electrically conductive TPU flexible material. It is a flexible filament with a 92A Shore hardness and an electrical resistance of approximately 3.9 Ω-cm. It is a TPU filament with a lot of potential designed for the manufacture of electrically conductive parts and components and ideal for the creation of wearable devices. In addition, it can also be used for printing electrically conductive circuits used in flexible electronics, such as electromagnetic signal isolators, pressure-sensitive buttons, or for interfacing computers, joysticks, arduinos, digital keyboards, trackpads, or even surface electrodes, among many other applications. From a manufacturing standpoint, it should be noted that Conductive Filaflex melts at a printing temperature of between 245 and 250ºC and must be printed very slowly at a speed of 20 mm/s.



3D Printers & Post-processing equipment

The ARGO 1000

Known for the ability to deliver extreme end-use applications that can be used as metal replacement, **Roboze** is going one step further with the release of its new machine: the ARGO 1000. Described as the largest 3D printer to date in the manufacturer's portfolio and in the world, the new machine is equipped with a heated chamber designed to produce large-scale parts with super polymers and composites for industrial applications.

Roboze – the ARGO 1000

The Italian machine manufacturer explains that the ARGO 1000 can produce parts up to one cubic meter, nearly 40 inches by 40 inches by 40 inches ***(101 cm by 101 cm)***, radically transforming the way industries, including aerospace, energy, transportation, MedTech and automotive, can fabricate lighter, higher-quality components. Using more sustainable and high-performing super polymers and composites such as PEEK, Carbon PEEK and ULTEM ™ AM9085F, Roboze is reducing the current strain on global supply chains.

xWASH, a post-processing machine for photopolymer 3D printed parts

Nexa3D's xWASH

Nexa3D has released a new automated washer that works exclusively with its sustainable **xCLEAN washing detergent**. The announcement follows the **recent financing round** the manufacturer of polymer 3D printers secured to propel its machines.

xWASH would only work with the company's sustainable xCLEAN washing detergent to help manufacturers streamline, optimize, and scale their 3D printing and post-processing operations. Designed to accept a full build plate from the company's NXE400 3D printer at volumes of up to 16 litters per print job, the smart cleaning washer would enable operators to save as much as 75% in post-processing costs as compared with other post processing units. The company said that operators could also realize orders of magnitude throughput gains by producing consistent high-quality parts.

The company explains in a press communication that to provide washing flexibility, xWASH is equipped with bidirectional agitation and variable speeds, helping the user achieve efficient and consistent cleaning for a variety of different parts. The machine also features an adjustable cleaning cycle and saturation timers, complete with preprogrammed cleaning recipes, meaning the user can optimize the cleaning cycle based on geometry and resin type. To facilitate maximum throughput, the xWASH can accept two NXE400 build plates simultaneously and it comes standard with a basket option for smaller loose parts.

amace has developed its first ALM 400 PBF metal 3D printer

Founded in 2018 with the goal of making Additive Manufacturing more accessible, amace is part of the Ace Micromatic Group (AMG), one of the largest machine tool conglomerates in India. Known for their design consulting and training programs, as well as other 3D printing services, the company officially adds another string to its bow: the one of machine manufacturer. The **official release of ALM-400**, a high productivity metal additive manufacturing machine makes this expertise a reality. This machine is even more important for the Indian market as it is the second "made-in-India" metal 3D printer unveiled for this market; the first one being the metal 3D printer from Intech Additive Solutions.

ALM-400 – metal 3D printer

Key features of the ALM-400

With a build volume of 410mm x 410mm x 450mm, the ALM-400 is powered by 2 x 1000W lasers with full scan field, functioning independently of each other. It is said to enable high productivity. The machine controller provides smart notifications about the performance status. Its predictive interface helps users gauge potential failures and take necessary actions. With the Internet installation, the industrial 3D printer can be controlled from any remote location. Other features include a powder management and control, and a multi-blade re-coater that ensures a uniform distribution of powder during the build as well as minimum downtime in the event of a part defect requiring a changeover of the blade.

BigRep releases Large-Format Dry Cabinet for Industrial 3D printing filament

"Smart cabinets" are gaining momentum across the industry as 3D printer manufacturers are increasingly looking to ensure optimal storage conditions for 3D printing materials. The latest company that unveiled a solution to address this issue is **BigRep**. The German machine manufacturer is bringing to the market the [BigRep SHIELD] which maintains 0.1% humidity by looping airthrough a controlled desiccant chamber without the use of heat, therefore avoiding the risk of over-dryingfilaments from long-term heat exposure. The new cabinet also reducesmisprints and material waste by 20% and saves up to 50% on repair costs caused by clogging andextruder damage.

The industrial-sized storage chamber holds up to 60 kg of filament, enough material for one month continuous 24/7 printing.

- **Interior dimensions: W x D x H: 480 x 480 x 1200 mm, 276 liters**

- **Storage capacity: Minimum of 12x 2.5 kg spools, 12x 4.5 kg spools, or 6x 8-10 kg spools The SHIELD maintains constant overpressure for an airtight storage volume.**

This prevents new moisture from entering its chamber during regular operation and ensures the system can quickly remove any and all airborne humidity with 100% air recirculation. The SHIELD provides ample space for safe, long-term storage of highly-sensitive additive manufacturing materials to maintain their ideal condition.

Digital Metal® unveils Automated depowdering for metal binder jetting

Named **DPS 1000**, Digital Metal®'s automated depowdering machine is described as a cost-saving option "that removes the human factor from the equation."

Fraunhofer IAPT has been impressed with Digital Metal® DPS 1000's ability to precisely remove metal powder from most geometries of any parts. The added manual cleaning option makes it possible to clean even tricky geometries after the initial program has removed most of the powder. The institution is also pleased with the whole Digital Metal printing system, and how well it fits with their mission to industrialize the additive manufacturing of metals.

Dr. Philipp Imgrund, Head of AM Processes Department at Fraunhofer testifies to the capabilities of the machine: *"To date manual depowdering and cleaning have taken up most of the work hours in the binder jetting process. Automating this step makes the whole AM process cost efficient while ensuring more consistent part quality."*

Please note that this is only a recap of the news you shouldn't have missed during the past two months. There is a lot more information that is covered on a daily basis through our online media www.3dadept.com. To stay informed about all our news, make sure you follow us on LinkedIn, Twitter and Facebook.

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