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formnext magazine

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USA special

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There has never been a more exciting time to be in additive manufacturing.

[Avi Reichental, CEO XponentialWorks and former CEO of 3D Systems (2003 – 2015)]

EDITORIAL

When you take a look at how additive technologies have evolved, it's sometimes difficult to keep your own euphoria in check. The number of applications is rapidly increasing in line with the double-digit growth rates the entire industry has been witnessing for years. The outstanding success story of Formnext reflects this unique rise, as well.

Meanwhile, the advancement of AM over the past decades has been due in no small part to key players on both sides of the Atlantic. Those leading the charge with this technology can be found in the United States, Germany, and elsewhere in Europe. In fact, the U.S. is set to serve as Formnext's first partner country in 2019, and we couldn't be more excited.

Along with USCS we've put together a comprehensive action program that includes a U.S. pavilion, a panel of experts, a U.S. theme day, and the special edition of Formnext Magazine that you're reading right now.

In the coming years, we plan to continue these cooperations and keep building bridges in the international AM industry. I hope you'll be a part of it!

Sincerely,
Sascha F. Wenzler
Vice President Formnext

The designation of the United States as Partner Country at this year's Formnext is an incredible honor. The U.S. Commercial Service has developed a great relationship with the show's management – and for good reason.

Formnext has developed into a highlight for the global additive manufacturing industry. This technology is changing the way we manufacture products and completely upending traditional business models.

It is essential that U.S. firms work closely with their European counterparts to develop these new technologies and business models in a way that is cooperative and collaborative. We are interested in fostering an industry structure, based on common, globally recognized standards, that allow the best technologies to lead the way.

We look forward to hosting a large delegation of U.S. firms at Formnext in November – including participants on a Trade Mission to France, Formnext in Germany, and Poland. I hope to introduce you to these great U.S. companies that are looking to do business with you.

Ken Walsh
Principal Commercial Officer/
Commercial Consul
U.S. Commercial Service
U.S. Consulate Düsseldorf

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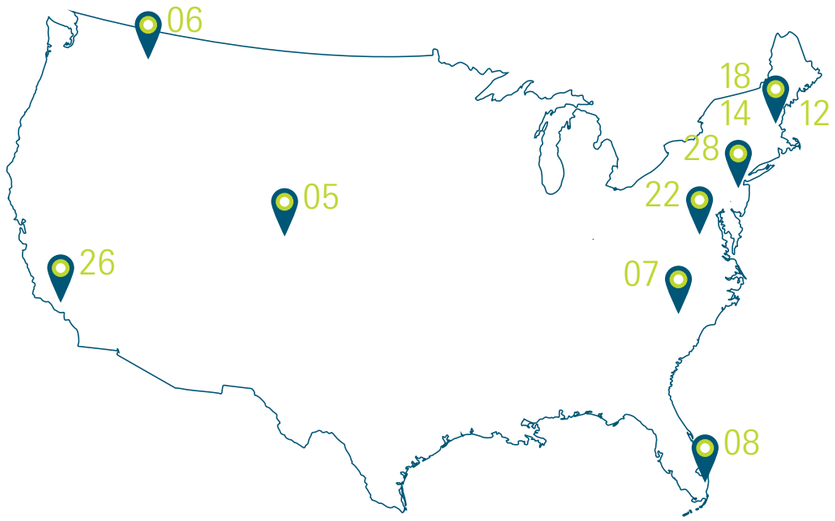

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NEWS

CONTINUING AT RECORD SPEED

Having taken off to become the world's leading exhibition for additive manufacturing and modern industrial production in recent years, Formnext continues this development at a record pace in 2019. In March, 518 exhibitors have already registered for Formnext this year. This is another significant increase compared to the same time the year before. As such, the amount of space that Formnext 2019 will cover has already exceeded the final size of Formnext 2018.

In 2019, the USA will become the first partner country to be represented at Formnext. During the event, there will be special highlights for American guests. A diverse program awaits Formnext's visitors on the partner country stage of the U.S. pavilion, including a discussion panel of renowned speakers. Following a successful launch in 2018, the »AM Standards Forum« is scheduled again this year, organized in cooperation with the U.S. Commercial Service.

Formnext, from November 19 – 22, 2019, in Frankfurt am Main, has recorded strong growth along the entire process chain. The post-processing area has developed considerably, which is key to the continued industrial development of additive manufacturing. »Here, many companies from traditional industrial sectors have seized market opportunities and developed very exciting products and technologies,« says Sascha F. Wenzler, Vice President for Formnext, Mesago Messe Frankfurt GmbH.

Due to the huge growth, Formnext 2019 will take place in Halls 11 and 12 for the first time, the most modern part of the Frankfurt exhibition grounds.

»FORMNEXT START-UP CHALLENGE«

The international Formnext Start-up Challenge, now in its fifth year, aims to recognize young companies are shaking up the additive manufacturing (AM) market with novel and sustainable business ideas. Applications are now being invited from companies that are no more than five years old.

+ FURTHER INFORMATION:
» formnext.com

STILL TREMENDOUS UNTAPPED POTENTIAL

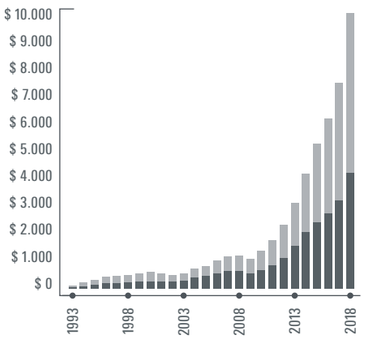
No sign of a cool-down: In 2018, the AM industry further accelerated its already high speed of growth. Worldwide sales of products and services grew 33.5 percent to $9.795 billion, according to Wohlers Report 2019, which was published in March. With a growth rate of over 40 percent, the materials sector is an indicator that AM is gaining considerable momentum for series production, with an increasing utilization rate of systems. Revenues from parts sold by service providers grew by an impressive 38.7 percent to a $4.1 billion, according to the report.

The 369-page Wohlers Report 2019 includes wide-ranging data on growth, development, and the future of materials, applications, systems, services, and design. It also reveals the latest in AM software, patents, startup companies, standards, investment, and research. Wohlers Associates has tracked growth and sales of 177 producers of industrial AM systems. The number of these companies grew by a surprising 50% in the USA in 2018. While industrial system manufacturers grew notably, desktop 3D printing systems (those that sell for under $5,000) saw significant decline. The overall AM market continues to trend upward, with many new players, hundreds of millions of dollars invested, and innovative new products designed for AM that few envisioned years ago.

The figures are all-the-more astonishing because the AM industry has been in a continuous upward trend for 30 years, with an average annual growth rate of 26.9 percent. The impact of AM worldwide is even greater because internal investments at large companies such as Airbus, Adidas, Ford and Toyota have been excluded in the statistics. Also, Wohlers Associates, a consulting firm that produced the report, estimates that a large number of medium-sized companies with sales of $1-5 billion are investing, some greatly, in AM research and development. This is expected to favorably impact the long-term prospects of the industry.

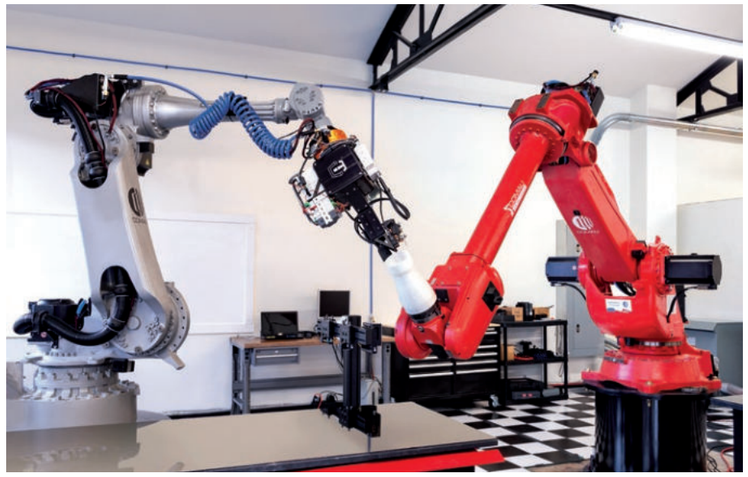
Historically, the USA is a global heavyweight in industrial 3D printing, which Wohlers Associates defines as systems priced at more than $5,000. According to Wohlers Report 2019, 35.5 percent of the world's industrial AM systems are installed there. China (10.6), Japan (9.2), Germany (8.3), and Great Britain (4.0) follow by some distance.

According to the report, the fastest growing and arguably most interesting application of AM is final part manufacturing. Wohlers Associates sees »tremendous untapped potential« for increased use of AM for many series production applications. Among them are custom products in quantities of one, spare part manufacturing, and a broad and interesting range of tooling applications. The company is witnessing organizations of all sizes push very hard in these areas, led mostly by users and customers of AM. This is one area in which Wohlers Associates finds tremendously exciting.



Worldwide sales of all AM products (dark segments) and services (gray segments). Figures are in millions of dollars. Source: Wohlers Report 2019

NEWS



By employing an interfactor on a robotic arm Sintavia reaches a tremendous amount of scalabilit

THE ABILITY TO PRINT WINGS

Even though Continuous Composites has developed somewhat under the international radar, CEO Tyler Alvarado sees future opportunities that are in no way inferior to those of the large American AM companies. Based in Idaho (northwestern United States), the company and its 20 employees have developed an additive technology that uses robotics to print in free space. It makes it possible to 3D-print large-format components made of composite materials – wings for aircraft, for example.

The fact that Continuous Composites, located in the tranquil community of Coeur d'Alene at the foot of the Rocky Mountains, developed its technology more or less unchallenged was due to what Alvarado calls its »very solid patents position«. Since the beginning in 2012, the company's strategy has focused on intellectual property, which was why an in-house IP attorney was its first hire. »We own the earliest granted patents in the world on 3D printing with continuous fibers. We have 13 granted patents, eight international patents, and another 250 concepts covered provisionally.«

This probably also explains why Continuous Composites is purposefully developing its technology with a manageable team instead of seeking rapid growth. Today, the company is bringing its technology to market maturity with regard to the hardware, software, and materials involved. It is hoping to achieve its first sales by 2020.

»We don't want to be another tech start-up with a massive burn rate and a $350 million valuation; we wanted to de-risk the business to make sure we were developing our technology and creating a strong business foundation,« says Alvarado. Recently, the company raised $5 million to continue to invest in the evolution of its technology from a hardware, software, and materials standpoint. It will also need to expand its team to meet demand. »That $5 million takes us a couple of years down the road to the next inflection point,« Alvarado explains. More important for the company than raising money is creating collaborations with strategic partners that can add value to its overall technology readiness level.

No wonder, then, that representatives of major aviation companies such as Airbus and Boeing have also considered Continuous Composites' technology. The company is also already working on a project with Lockheed Martin for the U.S. Department of Defense. Alvarado sees early adopters in Formula 1, motorsports in general, and wind energy, as well.

The range of applications seems endless: By employing an end effector on a robotic arm, the technology offers a tremendous amount of scalability. Alvarado sees a big advantage in the much cheaper production of composite materials, which were once rather cost-intensive. »Today, companies face high barriers to entry with costly molds and autoclaves and extensive manual labor,« he says. »Our disruptive CF3D technology has the ability to remove traditional manufacturing barriers. Printing wings today, supporting structures tomorrow – it's extremely agile and scalable.«

Photo: Continuous Composites

TALKING ABOUT

»SPIRIT OF INNOVATION AND CURIOSITY«

With over 30 years of history, 3D Systems is one of the most experienced and largest 3D printing companies in the world. Over that lengthy period, it has helped determine the development rhythm of the industry. New technologies and applications, as well as the high pace of innovation throughout the industry, pose challenges, even for a global player. We talked to Scott Turner, director of advanced R&D at 3D Systems, about how this company continues to have a strong hand in shaping new developments.

Right now, the 3D printing industry is probably the most agile industry worldwide. What are the main directions in which 3D Systems' research and development are heading?

TURNER 3D Systems has a diverse technology portfolio, with systems and products that range from sintering thermoplastics and metals to photopolymers. When it comes to innovation, we take a customer-centric approach – looking at how they want to transform their application workflows and how 3D Systems' solutions can enable them. Innovation is always in high demand, and our approach to meeting that demand is leveraging our deep experience and expertise. We are also very fortunate that our founder and current chief technology officer, Chuck Hull, is still part of the company. His spirit of innovation and curiosity fueled the invention of stereolithography, and that same spirit continues to drive 3D Systems' innovation to this day.

3D Systems has one of the market's broadest product portfolios. In light of your efforts to come up with new technologies every year, is it still possible to lead in terms of that wide coverage?

TURNER Vyomesh Joshi, our president and CEO, joined 3D Systems in 2016. He brought best practices and structure to 3D Systems that really allow us to analyze the market and determine how we can best leverage our expertise not only to meet the market's needs, but to bring new innovation that enables 3D Systems to differentiate itself as a solution provider, as well. Our ultimate goal is to provide customers with end-to-end solutions that include materials, hardware, software, and services they can use to transform their manufacturing workflows.

Photo: 3D Systems

Sounds like 3D Systems is undergoing a shift from providing printers (and a surrounding ecosystem) to offering applications …

TURNER While 3D Systems was founded as a 3D printing technology provider, the company has evolved to providing end-to-end solutions. We are at the point where manufacturers are continuing to adopt and utilize these additive technologies to meet demand and pave the way for better products that only additive can deliver now and in the years to come. You see everything from eyewear and footwear to components in airplanes and automobiles. More and more production sequences are being converted to additive processes, so this digital future is quite bright.

If you had to choose between creative inventions that create new products and more routine ones that reduce costs in the automotive industry, which would you take?

TURNER It's not a matter of choosing one versus the other. Additive solutions have the power to transform routine manufacturing processes, deal with complex geometries, and spark the creation of products that wouldn't be possible with traditional manufacturing technologies. I think for me, the most rewarding part is leveraging technology to the point that it can deliver the most to the end users of the resulting products. Right now, material innovation and material science are just exploding. 3D Systems has been servicing various industries for more than 30 years. During this long history, we have always been able to meet the needs of our customers. So now, as we advance additive material properties, we can go back to both our long-term and new customers and fulfill their application needs with new materials and processes that weren't available before. This includes new ways to produce complex geometries that aren't possible with traditional manufacturing – in light-weighting parts and reducing part counts, for example.

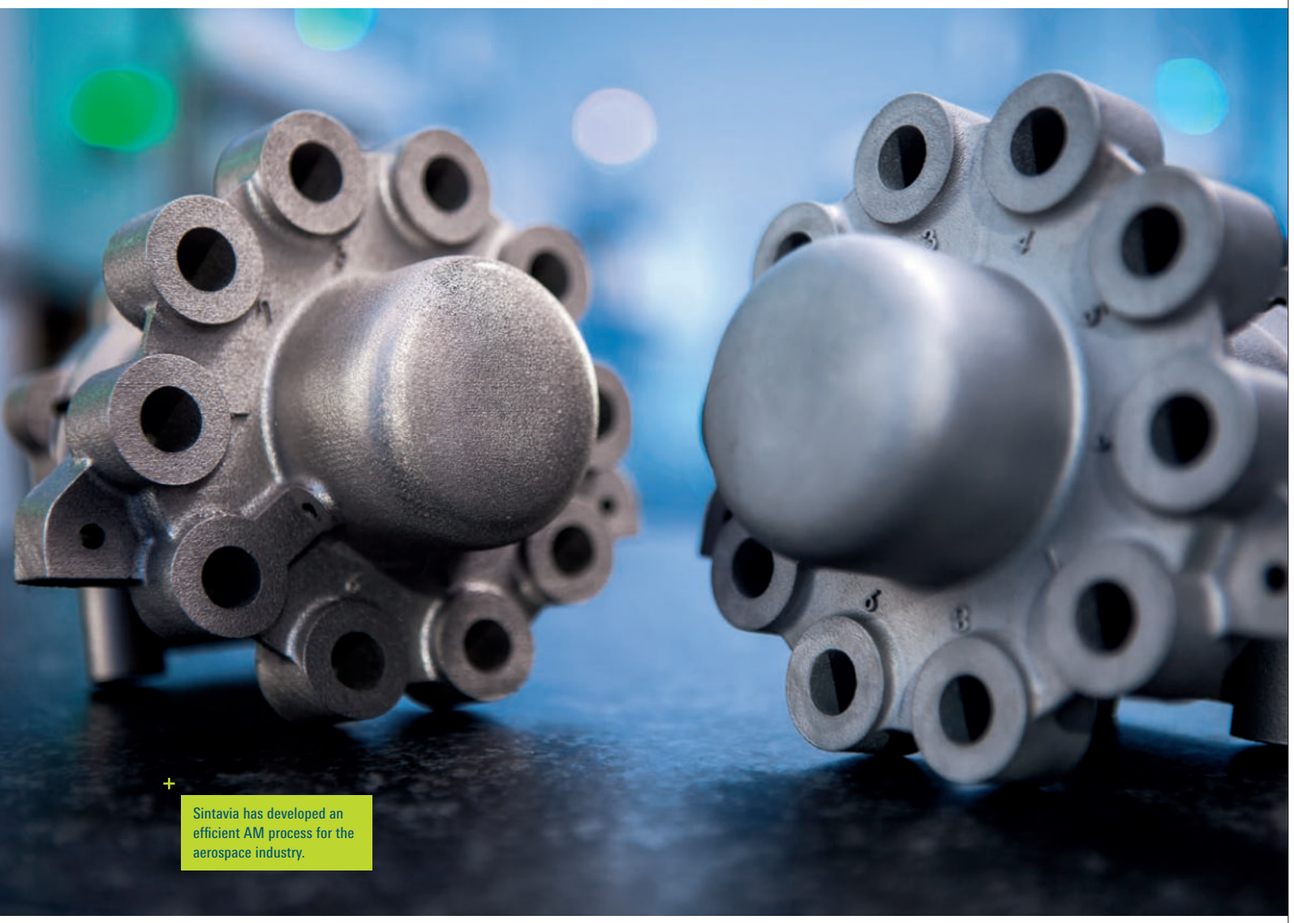
To get into these markets, do you think inventing these technologies on your own or investing in or buying start-ups is the more effective approach?

TURNER 3D Systems' growth strategy has been multi-pronged through the years. Part of this growth has occurred organically through our own inventions, and some has come from acquisitions of companies. We also value strategic partnerships – »standing on the shoulders of giants«, as it were – to collaborate with leaders in their respective fields and complement our solutions. Working with other companies, developing technologies using their innovations combined with ours – that's what helps deliver the best solutions to our customers today rather than tomorrow.

Scott, thank you very much for this interesting conversation.

NEW SUPPLY CHAIN FOR A $100 BILLION MARKET

Text: Thomas Masuch



Sintavia has developed an efficient AM process for the aerospace industry.

In the aviation industry, the development of additive manufacturing has so far progressed rather in small steps. According to Brian Neff's plans, however, this will change in the next few years: The founder and CEO of Sintavia LLC wants to build a completely new supply chain and thus challenge established suppliers: »With additive manufacturing, we will beat the big casting houses«.

Photos: Sintavia

I know that AM will replace high-end precision casting in the long run.

Even in the United States, where great visions and plans are heard much more often than in Europe, Brian Neff's announcement sounds extraordinary. But unlike many ambitious start-ups, Neff and Sintavia already have a lot to show for their efforts: at its site in Davie near Fort Lauderdale, in the Sunshine State of Florida, the company with around 45 employees additively manufactures components for the aviation industry – including valve bodies, ducts, chassis, and heat exchangers. The company has become the first AM supplier approved to produce flightworthy parts for Honeywell Aerospace, one of the largest early adopters of AM in the commercial aerospace industry.

The company has grown strongly since it was spun off from Neff's other aviation company, CTS Engines, in 2015. In Davie, 18 powderbed units, a materials laboratory equipped with extensive equipment, and a hall with heat treatment furnaces (incl. HIP and vacuum furnaces) are all under one roof, alongside machining and eroding machines for post-processing.

In May, the company's new production plant will open just a few miles away. Here, Sintavia will house over $30mm of new machinery, including a larger, automated powder handling system, an enhanced aerospace quality inspection system for production parts, an uninterruptable power supply, and an increased post-processing footprint. The expansion is anticipated to bring more than 135 new jobs to South Florida. The additive machinery is also expected to grow significantly. Four new large machines are planned during the remainder of 2019, and eight to nine next year. »By 2022 or 2023 we will level our plan with 55 to 60 printers,« explains Brian Neff in an interview with Formnext magazine.

»WILL DUPLICATE THIS FACILITY«

But the real growth story planned by Neff and his team goes one step further: »We will duplicate this facility in other parts of the US and Canada closer to our customers. We are in the process of building a second production facility in Houston which will primarily service oil and gas. Then it is our intention to build one in Phoenix, Arizona, and Seattle, Washington to support respectively Honeywell and Boeing.«

With the help of additive manufacturing, Neff intends to turn the entire supply chain of the aviation industry upside down: »We are committed in establishing an alternative and parallel supply chain for precision cast parts within the aerospace industry. We are going right after the casting houses, because it's a huge $100 plus billion global industry every year. There are great opportunities within that market.« And thanks to the advantages of additive manufacturing, Neff sees very good chances in this competition. »I know that AM will replace high-end precision casting in the long run. Additive manufacturing for precision commercial aviation components kills that technology.«

Neff's figures sound ambitious, but they are not out of thin air. Precision Castparts Corporation alone, the largest foundry in the United States, has an annual turnover of around $10 billion, 70% of which is in aircraft construction.

»AH-HA MOMENT« AS A STARTING POINT

Neff is also CEO of CTS Engines, a jet engine overhaul facility for the commercial aerospace industry, and is therefore very familiar with the industry's networks and needs. »For example Honeywell and Boeing are traditionally supported by big casting houses. It is no secret that this relationship is strained across the industry. They argue about capacity, price increases, tooling, repair tooling of casting beds. The relationship is quite difficult, and the casting houses have become so large that they have real leverage over the OEMs.«

Because of this »strained relationship« Neff saw and sees »the opportunity for a new parallel supply chain to be built up that the OEMs favour because it is not the current one«. The prerequisite for this was an »ah-ha moment« during a visit to the engine manufacturer MTU in 2011: »During that visit, I was introduced to additive manufacturing technology for the first time and realized that this was the technology that I wanted to focus on for the rest of my career.«

Neff brought the idea back to CTS and developed it in-house until early 2015 when he and his partner Doug Hedges, Sintavia's Presi- »

Photo on top:
Brian Neff
Photo below:
At Sintavia, each batch of powder supplied (1) is checked by the Tibor Csakvary (2) and his colleagues. With 3D printed components Sintavia wants to beat precision casting (3+4)

dent, spun it out of CTS and started printing by late 2015. »After the famous GE fuel nozzle announcement in 2014 we realized it was time to spin it out.«

CORE MATERIAL LABORATORY

Even though Neff already had contacts in the aviation industry, setting up the current production facility required a lot of stamina. »If you have half a million dollars you can buy pretty much buy any machine you want, but what do you do with that? You print toys or you use it for production. If you use it for production you have to have an accredited testing facility, have to be able to do your inspections, to show that you have documented control, process control over and over and over. That is far more expensive than the printers«

Sintavia's production runs on 18 AM systems from multiple OEMs (SLM Solutions, EOS, Concept Laser, Arcam, and Trumpf). Only one specific powder is processed on individual plants – for example Ti64, F357 or Inconel 625. In addition, the materials laboratory is one of Sintavia's core facilities. Here, each batch of powder is checked again – partly with an ICP (Optical Emission Spectrometer), in which a powder emulsion is burned in a trap and the elements contained in the powder are evaluated. »Here we can see exactly whether the powder is contaminated,« explains Tibor Csakvary, metallurgist at Sintavia. Particularly for parts for the aerospace industry, »we carry out double or triple tests, depending on the customer's wishes«.

»UNIQUE QUALITY ASSURANCE«

Sintavia provides a very efficient process as it has more than a dozen different test apparatuses (including CT) and therefore the parts and samples do not need to be sent to external laboratories. »There is no other company in the country with such equipment for AM powder quality assurance,« explains Csakvary. For Sintavia, this is of crucial importance, »and the demand is growing«.

»We invested in a quality control system«, Neff reports. »Having an aerospace background like we do, you know that the hard part is understanding the requirements for final inspection, dimensional inspection, and the sophisticated controls that have to be in place for production. You have to qualify and qualify and qualify.« Neff's conclusion from the first four years of aerospace production with AM is not really surprising anymore: »The expensive part is not the machine, the expensive part is the quality system.« That's why in 2016, Sintavia achieved AS9100 and ISO17025 accreditation and 2018 added NADCAP accreditation.

FROM PROTOTYPING TO SERIES PRODUCTION

The fact that customers in the aerospace industry have more confidence in additively manufactured parts is also shown by the fact that Sintavia's serial production has now largely replaced the production of prototypes. »When we started out is was zero production and 100 percent prototyping,« recalls Neff. »Now we have been able to qualify 50 percent of our production for end use parts. And I'm seeing to go that to 99,9 percent.«

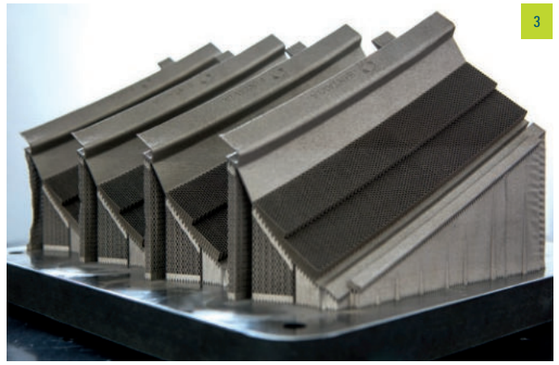
The newly opened factory in Hollywood, Florida is intended to convince customers even more. On two levels and with a total of 55,000 square feet of production, post processing and office space, the individual processes are efficiently networked and, according to Neff, customers can see for themselves here: »Come and see how we print your parts, see how we conform your parts, how we qualify your parts, see our quality systems and get comfortable that we are going to be able to produce the parts and adopt the technology faster.«

Neff sees the driving force behind Sintavia's success in the fact that the management floors of the large aerospace OEMs need to take advantage of the benefits of additive manufacturing. »Something like our new facility, where we want to have 55 to 60 printers operating in an aerospace quality environment, is missing in the industry. Adoption of AM is limited now because there are no independent large tier one AM companies out there.« That's why Neff and his team are building the company's extensions so fast even if Sintavia is not a huge company right now. »We see the need in the industry for major suppliers to exist.«

This is where the difference in the European market lies at the moment. »There is probably more pressure in the US with the senior leadership at the OEMs who want to introduce this technology into their supply chains. The traditional supply chain in the US is very much hated.« The missing link as Neff explains is that you have a superior technology from cost, design, speed on one hand, and you have the chief technology officers and the procurement officers of the OEMs on the other who want to use that technology in their supply chains. »Between them is a grey zone that Sintavia is trying to fill.«

+ FURTHER INFORMATION:

» fon-mag.com
» sintavia.com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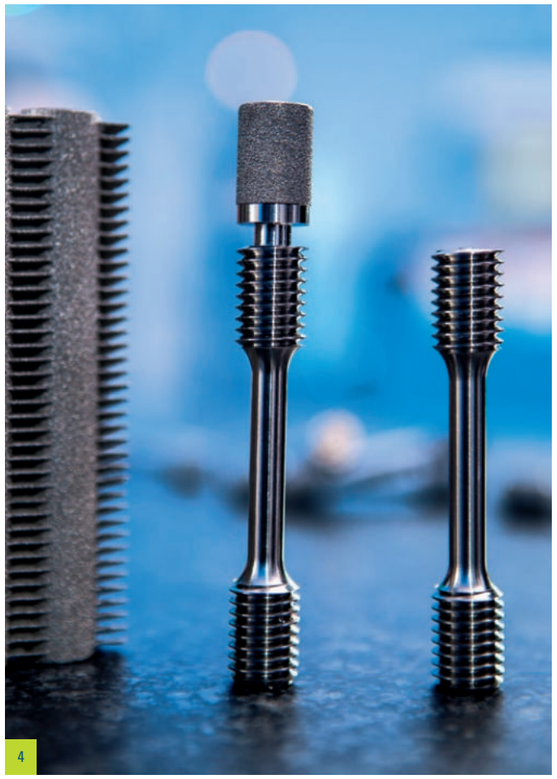
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»HYPERGROWTH« BEHIND BRICK WALLS

Chief Marketing Officer Brian Semple (left), Jon Reilly, VP of Product (right).

In just six years, Markforged has become a big player in the AM world with its technology for 3D-printing carbon reinforced fibers. An investment round of $82 million is now fueling further growth – but time is the decisive factor.

If you drive from Boston along the banks of the Charles River for about 10 miles upstream to the suburb of Watertown, you don't suspect to find one of the young, but already big players in additive manufacturing. The area resembles a typical American film set, with rows of wood-clad, single-family houses framed by rose bushes and neatly cut grass, and of course, American flags waving above the front lawns.

Riverworks, a riverbank brick complex that was home to a wool textile mill in the 19th century, now houses the headquarters of Markforged. Visitors are first greeted by an online registration process that includes an automatic photo and a touchpad signature.

The mixture of brick walls and high-tech also reflects the development the company has undergone in the six years since its foundation. On the one hand, Markforged has established itself internationally with its 3D printers for carbon fiber-reinforced plastic and already »more than 10,000 users worldwide,« as chief marketing officer Brian Semple explains. »And we broke profitability last year,« adds Jon Reilly, VP of products.

»THE DIFFERENCE IS TIME«

At the same time, Markforged continues to pursue a high growth rate. Its »hypergrowth«, as company founder and CEO Greg Mark calls it, is being fueled further by a $82 million financing round announced by the company at the end of March. »We saw the opportunity in the metal space to aggressively go after end use parts – so, we can bring the technology to market faster,« Reilly says. In 2017, Markforged launched the Metal X system, which uses metal powder contained in plastic filaments.

Text: Thomas Masuch

Photos: Thomas Masuch

Riverworks is home to the headquarters of Markforged, as well as other young companies and research institutes.

The dynamic AM world is now all about being fast, as Reilly explains. »The only difference is time. If we want to sell large-scale without investment capital, it will take longer,« he points out. »Young companies that are looking to grow and make a big impact on the world need to move quickly to do that.«

FROM COTTON TO 21ST-CENTURY FILAMENT

The interview with Reilly and Semple takes place in the Markforged cafeteria. The large glass doors offer a view of the open-plan office. Other corridors bordered by brick walls lead to meeting rooms or a demonstration chamber with 3D printers and components. Neither engineers nor managers have their own offices. You don't see anyone in a suit; most employees wear a black corporate sweater. Today, the spirit of young entrepreneurship that wants to put products on the street quickly and practically flows through the old cotton factory. It's now an atmosphere more suited to a new type of fine thread.

Since its founding in March 2013, Markforged has grown to 270 employees. In addition to its headquarters at Riverworks, the company operates a facility around two miles away where printers and materials are manufactured. The company buys powders and then blends them before they are extruded into filament. As the demand for material grows, its production will soon have to be expanded, as Reilly explains. »This is a good sign because it shows that customers are producing with our machines.«

It is essential for the company to have the development of all its product areas (software, hardware, materials) under one roof. In the beginning, this was practically inevitable because »there was no one who produced carbon-reinforced continuous fibers we could buy,« Reilly recalls. »That drove us to do it ourselves. There was no software package to lay them out, so we had to hire software engineers who could do that.« This also helps to further optimize the entire production process. »This is the only way to ensure, for example, that the same part comes out of the printer during digital production in Munich as it does in Boston,« Reilly says.

STOCKS AND COOL PRODUCTS

In addition to materials, Markforged's hardware sales have witnessed strong growth. »We shipped over 2,500 industrial printers last year, which places us behind Stratasys on the top,« explains Brian Semple. The sale of Metal X has also gotten off to a successful start: More than 200 have now been delivered, with a strong upward trend. Meanwhile, in order to keep its delivery time to a few weeks, the company must scale up its production capacity. According to Reilly, Markforged »is now the largest supplier of sintering furnaces in the world because they are always paired with our printers.«

Semple, who has been responsible for marketing at Markforged for 10 months, explains that despite the abundance of universities and graduates in Boston, it's usually not easy to recruit new staff. »But even people from MIT come to us because we simply have cool products and they want to be part of our story,« he reports. Stock ownership is also meant to bind employees to the company for the long term and provide additional motivation. »Everyone has stock, so everybody succeeds when the company grows,« Semple adds.

TEN TIMES CHEAPER AND FASTER

The success of Markforged is based on a technology that produces very hard plastic parts capable of replacing machined metal (above all, aluminum) components. Such parts can be used in tools, fixtures, jigs, work holdings, or end effectors on robot arms. The big advantages are the price and the speed: »3D printers are 10 times cheaper and 10 times faster than sending it to the job shop,« Jon Reilly affirms. Further applications are expected in the aerospace industry. There are already a lot of applications in military and space projects, where certifications are not needed. The company just announced a flame-resistant material for general aviation, as well.

In addition to the development of new materials and technologies, Jon Reilly sees other challenges, including in hiring and scaling up very quickly or building up all the infrastructure needed. »It's about keeping the innovation pace fast with value at the end of it so the customers can adopt it quickly, which then feeds back into growth,« he says. For Reilly, it's kind of a virtuous cycle: »As our installed base grows, we'll be able to invest in new technologies more aggressively and bring them to market faster.«

+ FURTHER INFORMATION:

» fon-mag.com

» markforged.com

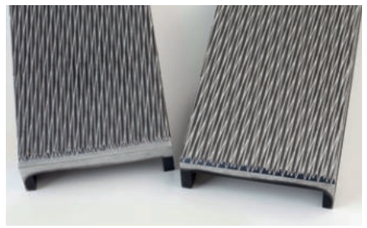
THE HENRY FORDS OF METAL POWDER FOR 3D PRINTING

Text: Thomas Masuch

These days, the heart of engineer Dr. Harald Lemke belongs to two places: A native of western Germany's Rhineland region, he has been living in the United States for 27 years and flying from Boston to Düsseldorf practically every month for the past five. The 50-year-old describes himself as »50% American and 50% German« and is intimately familiar with both the American business mindset and the meticulousness for which Germans are known. Lemke does his best to leverage the advantages of these two worlds, which remain similar in spite of their differences. »The combination of Germany's solid technological developments and the ability to bring them to market quickly in the U.S. is simply ideal,« he says.

His love for Düsseldorf's renowned Altbier and Sauerbraten isn't the only reason why Harald Lemke clocks so many frequent-flyer miles. For his company, Formetrix – a young provider of metal powder for specific applications in additive manufacturing – he also visits customers, service providers, and research institutes in his home region. »Germany offers an excellent and broad basis of technology, along with a strong sense of industry solidarity thanks in part to the efficient collaboration of the corresponding associations. There's nothing quite like it anywhere else in the world,« Lemke says, adding that the country also makes it possible to engage in industry-related developments where »people don't immediately start asking about the ROI«.

That said, the fact that Formetrix exists at all (with Lemke as its chief commercial officer) also has something to do with the American mentality for making things happen. Lemke and two colleagues from the powder manufacturer Nanosteel in Providence (around 50 kilometers southwest of Boston) had spent four years researching metal powders for additive manufacturing. »The goal was to come up with a way to print alloys and hard production components directly using laser powder-bed fusion,« he says.

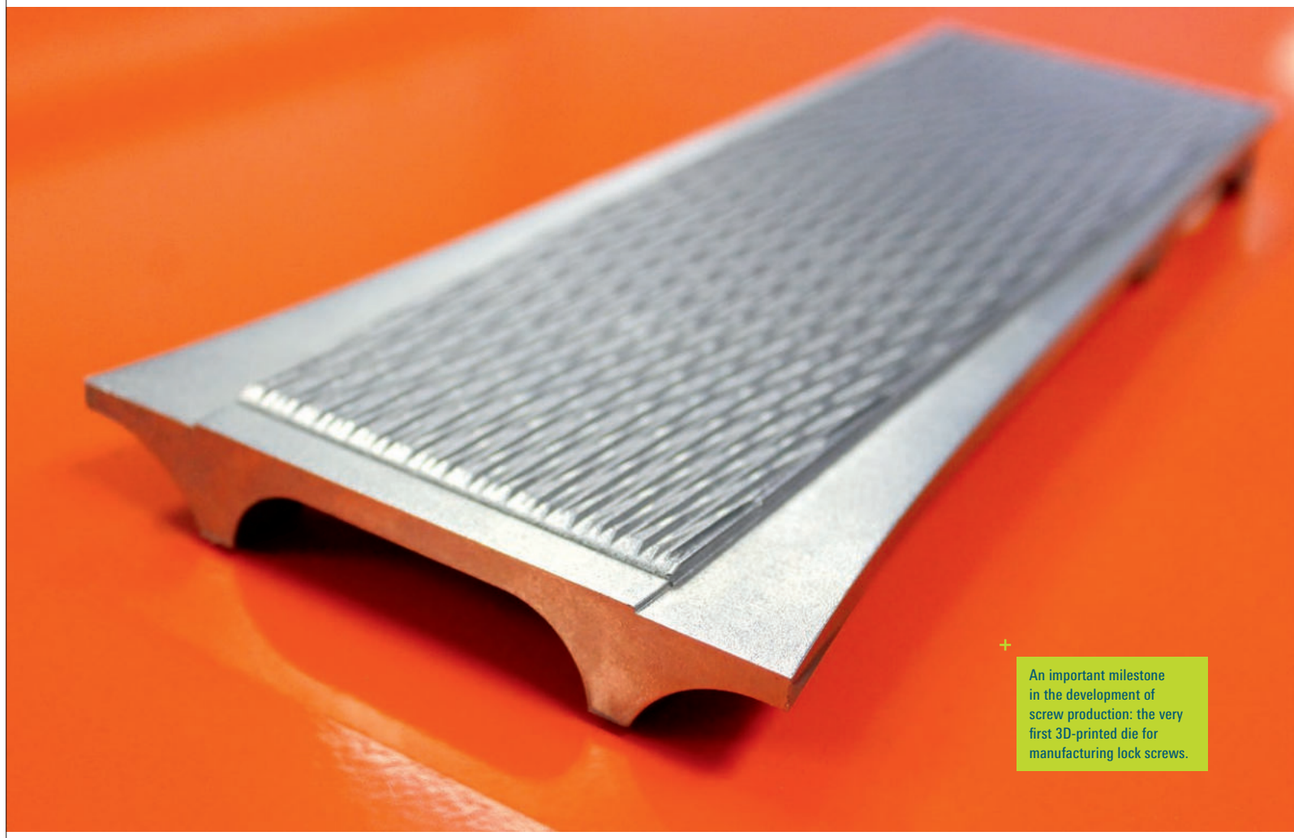


»HARDER AND MORE IMPACT-RESISTANT THAN EVER BEFORE«

This resulted in the material »L-40«, which became the first product of the spin-off Formetrix. The patent, which belongs to Nanosteel and is now licensed exclusively to Formetrix all around the world, cites Dr. Harald Lemke as one of the inventors. L-40 is finding a niche in the market because it enables users to »3D-print components and production tools that are harder and more impact-resistant than ever before directly and at room temperature«, as Lemke asserts with American self-confidence.

This is made possible by the alloy's special composition. Unlike traditional types of tool steel, L-40 isn't based on a high level of carbon content. »That much carbon leads to more cracks in laser printing because the molten metal cools so quickly,« explains Lemke, who says that L-40 avoids this problem. Following an approach he calls »new materials for new processes«, Lemke and Formetrix are opening the door to various advances, including the

Photos: Formetrix (left), Thomas Masuch (rigth)



An important milestone in the development of screw production: the very first 3D-printed die for manufacturing lock screws.

chance to »eliminate inefficient preheating of the build area to 500 degrees Celsius or more«.

Formetrix got off the ground in the summer of 2018 with a round of series-A funding that has involved both financial investors and strategic partners focused on the long term. Lemke sees this as a good mix, as it favors sustainable development and a solid return, as well. »That kind of funding is one of the strengths of the American market; it makes rapid growth possible for young companies,« he points out. While people in Germany often consider all the eventualities and try to plan everything down to the last detail, »Americans have that 'let's do it' mindset about new technologies. Risks are seen as opportunities,« Lemke adds. He also says that it's easier to access venture capital than it is in Europe, with investors willing to take risks as long as the expected return is substantial enough.

»FOCUSED ON LESS 'SEXY' MARKETS EARLY ON«

Halfway between Boston and Providence in the town of Mansfield, Lemke and seven colleagues moved into a modern low-rise building in an industrial park surrounded by old oak and beech trees in March 2019. The rent is quite affordable here, and Boston and its many universities are not far away. Formetrix has 580 square meters where it can print test components for customers or trials of new alloys. The company has several software packages for developing new alloys, a FormUp 350 powder-bed fusion machine from AddUp, and a laboratory for examining the quality and other properties of metals.

It was back in 1992 that Lemke and his two suitcases first arrived in the U.S., where he got his start in the Texas oil industry. He began exploring industrial applications of additive manufacturing at a time when many were barely aware of the technology and was already printing tool components for the American manufacturer Kennametal by 2006. »I wasn't as successful as I'd hoped back then, but I gained insights not many had,« Lemke recalls. »I also focused on less 'sexy' markets very early on, »

Americans have that ›let's do it‹ mindset about new technologies. Risks are seen as opportunities.

Photo on top:
Dr. Harald Lemke in front of the recently installed Formup 350 Powder-Bed-Fusion machine from Addup.
Photo below:
In addition to L-40, Formetrix is already developing other new materials.

meaning those outside of the aerospace and medical sectors.«

Here, Lemke is talking about areas like the tool-making, mechanical engineering, die-casting, and automotive industries. There are opportunities to sell large quantities of 3D-printed tool steel in these fields, where the calculations are a lot tighter than in aerospace or medical technology. »That's why prices are the most important factor,« he explains. Lemke is well-versed in this regard, having experienced the particularities of such industries himself over the years. »Some years ago, when the price of powder was less than $5 per kilogram for typical high-volume, non-additive applications in the automotive industry, we raised our price by 8% and it nearly ruined our business relationships,« Lemke says. »In today's additive manufacturing, we're talking about $50 or more per kilogram, which isn't sustainable for high-volume applications in such industries.« This is the challenge the German-American transplant is taking on. »The price of powder has to come down to less than $10 per kilogram in the long term, and steel alloys can make that possible,« he affirms. »For me, every penny counts.« Some initial successful attempts at 3D printing with water-atomized powder have been a step in the right direction.

»DEMAND CONTINUES TO GROW«

Meanwhile, Formetrix wants to enter the mass market. »We're the Henry Fords of metal powder for 3D printing,« declares Lemke, who is sensing a constant rise in demand from the industrial realm in general. »A year ago, there were a lot of companies – mainly SMEs – that were worried about missing out,« he continues. »We're now getting inquiries from more and more groups that are treating additive manufacturing as a primary concern.« He considers this important, as »even the best material means nothing« without the necessary expertise. Lemke also says that using the right printing parameters for the machine at hand plays a significant role in achieving quality results. This is why Formetrix not only sells powder, but maintains a strong focus on service and consulting, as well. »In the beginning, you can't leave customers to their own devices,« Lemke points out. »Otherwise, it's always the material's fault when something goes wrong.«

To tap into the mass market, Lemke – a technician, product developer, and entrepreneur rolled into one – has put a great deal of time and effort into numerous reference projects in recent months. Successful applications for the tool-making, oil, and automotive industries have been the result. Lemke is particularly proud of one tool, which happens to be the very first 3D-printed die for manufacturing lock screws. In addition, a 3D-printed, internally cooled machine press rated at 900 tons of pressure has already produced untold thousands of parts – another »major accomplishment« in Lemke's eyes. The components in question see use as side collision protection in the mass production of American trucks.

MATERIAL AS A PROBLEM-SOLVER

»The word 'material' is taking on a whole new meaning in additive manufacturing, where lots of problems can be solved by choosing the right one,« reveals Lemke, who views this as an opportunity for the entire industry to come up with innovative uses.

Formetrix's initial reference projects have been so successful that the company is already sending out shipments measured in tons. Its commercial orders typically range between 100 and 500 kilograms. These quantities are expected to increase further going forward due to additional applications and larger lot sizes. Lemke sees considerable potential in tools for forming and aluminum die-casting, for example, as well as in the oil industry and the design of functional automotive prototypes. »Right now, we're focusing in particular on increasingly large, internally cooled forms for aluminum die-casting,« he reports. »Our initial results with L-40 are exhibiting fewer cracks due to thermal shocks, which makes the material more durable.«

To identify further uses, Lemke is working closely with select service providers. Customers located near these providers can obtain high-quality sample components stemming from these efforts. Meanwhile, the new materials Formetrix has in development are set to make things even more dynamic. Although Formetrix will be concentrating on powder for powder bed fusion machines for the time being, materials for other additive manufacturing techniques may be on the way in the future.

FURTHER INFORMATION:

» fon-mag.com
» formetrixmetals.com

»IT'S ALL ABOUT ENGINEERING«

Consistently built up as a »tech company«, Desktop Metal combines the additive world with the modern entrepreneurial spirit of Silicon Valley.

Ric Fulop in one of the development departments at Desktop Metal.

Thirty kilometers north of Boston, $438 million seems to have disrupted the usual flow of time in the business world: Just three years old, Desktop Metal already employs around 270 highly qualified engineers at its enormous single-floor facility. »You can develop a lot of technology this way,« explains co-founder and CEO Ric Fulop. When you listen to Fulop's ambitious plans with Desktop Metal, it seems that a tech giant is set to leave childhood behind, skip its teenage years, and make big strides in shaking up the market for industrial metal production.

Desktop Metal's headquarters are located in a young industrial area of Burlington, Massachusetts. The 80,000-square-foot building is packed with numerous departments for the development of printers and furnace and debinding units. Here, laboratories and material testing facilities operate in close proximity to an area only accessible to select employees, behind whose doors the concepts for the company's next product lines are created.

In an open-plan office of remarkable size, engineers work almost elbow-to-elbow, many of them with electrical components, circuit boards, or other components right there on their desks. A collection of innovation trophies and technical journals adorns one wall, but attracts little notice from the employees here – probably because their PCs or laboratories have more exciting tasks to offer. Somewhere, a foosball table serves as a reminder that a little more than three years ago, Desktop Metal was a start-up with just 11 employees.

HUNDREDS OF RESERVATIONS

About 40 months and several investment rounds totaling $438 million after its foundation, Desktop Metal can boast of hundreds of reservations for its two systems in both the United States and the rest of the world. The company has been shipping its Studio System to large numbers of customers in the U.S. since late 2018 (the first was shipped to Google's ATAP in December 2017). »The Production System for mass manufacturing will see broader shipments in 2020,« reports Lynda McKinney, Head of Global Communications.

While Desktop Metal does not reveal its exact sales figures, CEO Fulop is proud to announce that the company has now caught up with the world's leading manufacturers of metal 3D printers in terms of delivery figures and is setting its sights on becoming number one.

»IT'S ALL ABOUT ENGINEERING«

Desktop Metal's ability to become a global player in the AM world in just three years has also been due to investments that are currently only being made in the U.S. From the outset, Fulop has thus formed an organization that is »

Text: Thomas Masuch

Photos: Thomas Masuch (left), Desktop Metal (right)

At Desktop Metal's headquarters in Burlington, several systems are in operation to further develop its technology.

Everything is product development, engineering and R&D. We outsource as much as we can.

Photos above and at right: The 80,000-square-foot building is packed with numerous departments for the development of printers and furnace and debinding units.

closely aligned with technology companies from Silicon Valley. »That $438 million has allowed us to engage in product development that very few players can do,« Fulop adds.

Of Desktop Metal's 300 employees, some 270 are engineers. All its internal departments apart from product development – including marketing, manufacturing, HR, and accounting – have either been boiled down to the required minimum or outsourced entirely. »Everything is about product development, engineering, and R&D; we outsource as much as we can,« Fulop explains. The company's service providers and outsourced areas are overseen by channel managers.

THE CHANNEL PHILOSOPHY

These channel managers also coordinate Desktop Metal's sales efforts, all of which are handled by 90 sales partners in 48 countries. According to Fulop, this is a big advantage compared to having a conventional sales department because a very small team ensures »that we have 1,400 sales people on the streets, selling our products«. In Germany, for example, Desktop Metal is represented by the AM specialists Solidpro, Alphacam, and Encee. Fulop explains that channel sales are the better solution in the long term while citing the CNC industry, where this form of sales and service is becoming more and more popular. The manufacturers of plastic 3D printers have also gradually switched to this technology in order to achieve higher quantities. In the metal sector, Fulop sees Desktop Metal as the first company to have built a channel. »All AM laser manufacturers manufacture and sell directly,« he points out.

»WE'RE A TECH COMPANY«

According to co-founder Fulop, its strategic organization clearly distinguishes Desktop Metal from traditional industrial companies. »For a tech company, the key differentiator in the U.S. is that you just focus on your core competency and outsource everything else,« he says. »Our core competency is developing products and making things easier to use. That's the main difference to the European model, where companies are used to doing everything.«

When Ric Fulop talks about Desktop Metal's strategy, he often makes comparisons

Photos: Thomas Masuch (right), Desktop Metal (left)

to Apple or Google. The Boston entrepreneur only mentions the company's competitors in additive manufacturing to point out differences – as if the other established AM companies out there were already old-fashioned. Fulop is convinced that »his« business model will prevail in the long run. «It's superior to the traditional approach,« he asserts.

For the production of its equipment, Desktop Metal cooperates with companies like Jabil, a contract manufacturer with $20 billion in annual turnover. Jabil produces according to Desktop Metal's specifications and delivers directly to its channel partners. Desktop Metal employees are embedded in the supply chain to monitor the corresponding production quality. »We do all our manufacturing the same way that Apple, HP, or similar companies are doing it,« Fulop reports, who goes on to describe its manufacturing partners as »best in class« and capable of raising Desktop Metal to another »level of excellence«. It's clear that this is the right path for modern companies. »With the traditional model, you do everything, but don't excel at anything – and you're very slow,« Fulop reveals.

»IT'S A DIFFERENT TECHNOLOGY«

»Additive manufacturing in the metal sector is currently too slow, too inaccessible, and too complex for mass production,« Fulop continues. When he talks about current additive metal production, he means the powder bed process. By comparison, a binder jetting process like the one used by Desktop Metal is many times faster. When this is combined with material costs that are 80 percent lower, Fulop says that additively produced components become significantly cheaper; in fact, he anticipates manufacturing costs of less than $50 per kilogram, while powder bed components would cost 10 to 20 times as much. »It's a different technology,« he says, one that is giving rise to new areas of application – in the automotive industry, for example, where »seven of the top 10 car makers are using our technology«. For this price-conscious sector, cheaper AM production is obviously a future field, as BMW and Ford's investments in Desktop Metal indicate.

According to Fulop, another advantage of binder jetting relates to the experience the industry already has with MIM technology. This process is used in automotive and electronics applications, and ASTM standards for binder jetting already exist. »We're standing on the shoulders of giants,« Fulop admits. »Big customers are familiar with the microstructures that come out of our machines, so there's an immediate sense of understanding from the customer base.«

Fulop is certain that Desktop Metal's technology will be broadly adopted. »I think our technology will outsell laser powder-bed fusion in terms of units in 2019,« he affirms.

FOUNDERS AND EMPLOYEES WORKING SIDE-BY-SIDE

At Desktop Metal's open-plan office in Burlington, co-founders like Ric Fulop and Jonah Myerberg can be found working among the rows of PC workstations. The company's founding team of MIT professors and material and engineering experts knew Fulop from other projects or from his studies in Boston. Myerberg, for example, had already worked with him at the nearby battery company A123 Systems.

As an investor and »tech entrepreneur«, Fulop spent many years building up young technology companies. »We invested over $130 million in various companies,« he says. Fulop was also one of the first investors in the AM company Protolabs. »The company is now worth $3 billion, so that was a good investment,« he concedes with a smile.

It was in 2011 that Fulop – whom Forbes magazine describes as a »charismatic serial entrepreneur« – first came into contact with metal AM, at which point he decided to »make the complex process and technology cost-effective«. From 2012 to 2015, he brainstormed with contacts he had made over the years. The result: »We developed a fast new approach to binder jetting that we call single-pass jetting,« Fulop explains.

While Fulop's old contacts have »certainly not hurt our search for investors, the product does the talking in the end«. In addition to strategic investors such as BMW, Google, and Ford, Desktop Metal has received support from major venture capital firms like NEA and Kleiner Perkins. »We all share the same vision of where we want to take the company,« emphasizes Fulop.

For Ric Fulop, Desktop Metal is different from his previous investment projects. He has no exit strategy this time, either. »The plan is to stay here for the next 20 years. That's long-term – none of us have other plans,« he adds. To underscore his commitment, Fulop also describes how he withdrew from all his previous positions upon getting involved with Desktop Metal. He feels comfortable in additive manufacturing, and like in his previous investments, he remains active in advanced production. »That's kind of the area I enjoy,« he offers in summary

+ FURTHER INFORMATION:

» fon-mag.com

» desktopmetal.com

IM INTERVIEW

»Recycling is the key«

Text: Thomas Masuch

In its history, NASA has successfully realized some of humankind's most technologically demanding projects. With its missions to the Moon and Mars and numerous other activities in space, the agency operates at the forefront of technological developments and opportunities. For over 30 years, NASA scientists and engineers have also been working with 3D printing. We had the opportunity to talk to John Vickers – Principal Technologist for Nanotechnology, Advanced Manufacturing, and Lightweight Materials within NASA's Space Technology Mission Directorate – about the role additive manufacturing plays at NASA in both its current and future missions.

John Vickers

Numerous missions and projects are prepared and implemented at the 10 NASA Centers. Can you give us an overview of how additive manufacturing has developed within the agency and where the technology is used today?

VICKERS We have been involved in 3D printing since its inception in the late '80s and we have some of the first Beta machines for stereo lithography. We continue to follow that industry because we see the great benefits for what we do at NASA. We have continued to be right on the cutting edge of the machines, trying to acquire the latest different machines as they come out. We work in partnership with the global community. If you want to do something big and new you must have diverse partners. Our team of global industry and academia is the ecosystem of partners that allows us to accelerate this technology for NASA applications.

It sounds like AM already plays a very important role …

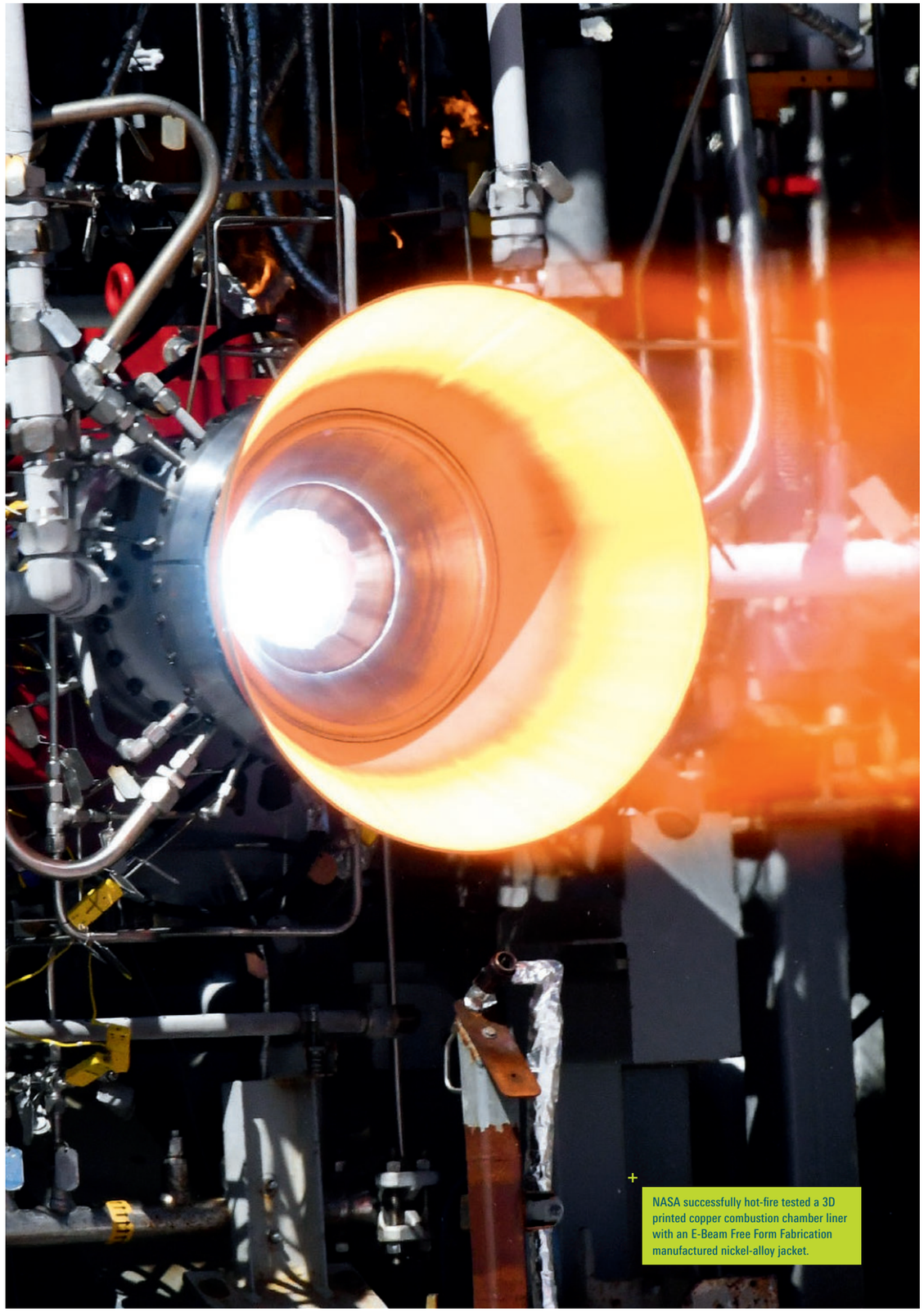
VICKERS Additive manufacturing is certainly one of the most important elements of advanced manufacturing processes. We have hundreds of additive manufacturing activities going on within the agency, at all 10 NASA centers. They span many technology readiness levels (TRL) – a NASA measurement system used to assess the maturity level of a particular technology – all the way from basic research to testing a system in a relevant environment, or TRL 6.

There are nine TRL levels at NASA. What are the next steps at level six?

VICKERS For NASA technology development that we intend to share immediately with industry, development generally stops at TRL 6. The production parts would generally come from our NASA industry suppliers. We work continuously and closely with them, but we are generally not doing that work internally.

Can you give us some examples of applications in which you use additive manufacturing?

VICKERS We cover the entire technology spectrum. NASA missions are complex and 3D printed parts might be critical to the performance of a mission. It's important to understand all the requirements of parts that we are working within R&D or for a particular vehicle. That can be a propulsion system, launch vehicle, satellite or a rover on Mars. We are using additive parts for all of those. But, we are still early in the »



NASA successfully hot-fire tested a 3D printed copper combustion chamber liner with an E-Beam Free Form Fabrication manufactured nickel-alloy jacket.

Photos: NASA/MSFC/David Olive

About
John Vickers serves as the principal technologist within the area of advanced materials and manufacturing in the Space Technology Mission Directorate at NASA Headquarters. He also serves as the associate director of the Materials and Processes Laboratory at NASA's Marshall Space Flight Center and as the manager of the NASA National Center for Advanced Manufacturing with operations in Huntsville, Alabama and New Orleans, Louisiana. He has over 35 years of experience in materials and manufacturing. As principal technologist, he leads the nationwide NASA team to develop advanced manufacturing technology strategies to accomplish the goals of NASA's space exploration-focused missions.

Photo on top:
In this artist's rendering, the Dragonfly technology enables satellite self-assembly in orbit.
Photo below:
The »Refabricator« is a recycler and 3D printer in one unit about the size of a dorm room refrigerator.

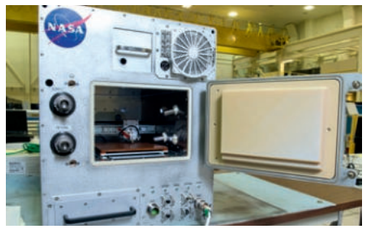
adoption of additively manufacturing specific critical parts.

How are things going in the current space projects that employ 3D printing?

VICKERS We have three 3D printers on board the International Space Station. We just installed the Refabricator – that's the name of the newest 3D printer in space. Once operational, it will recycle materials as well as 3D print. All these machines are polymer based.
We also do a lot of work in the propulsion arena. I would say NASA is a leader for rocket engine propulsion components. And those require even more rigorous qualification and certification processes. Here, we spend a lot of time understanding these processes and making sure the parts are safe.

With polymer parts already being produced in space, is there also a plan to produce metal parts?

VICKERS There are plans to produce metal parts. We awarded contracts to three companies for a first-generation, in-space, multi-material fabrication laboratory, or FabLab, for space missions. That's likely the next equipment beyond the Refabricator that will be installed on the space station. The minimum requirement for FabLab is to produce metal parts. Another requirement is to produce multi-material parts combining electronics, composites and polymers.



How is the experience gained on the International Space Station helping to further improve the usage of AM?

VICKERS The International Space Station is a great proving ground for us to operate in, giving us access to test these technologies in microgravity. Beyond that, we are looking at in orbit assembly, servicing and manufacturing capabilities. NASA plans to build the Gateway, which is essentially a small space station in orbit around the moon. One of the first pieces of equipment on Gateway will likely be a 3D printer.

You mentioned the Refabricator that is already on board the ISS. What have the experiences with it been like so far?

VICKERS When you have a long-term sustainable presence in space, recycling is key. This is the first step. There is a lot of plastic material, all kinds of packaging for food and other products, that would all be waste and we would have to bring it back to Earth. The farther you go in space, the harder it is to return waste back to Earth.

NASA has a extensive experience with 3D printing. For example, you've been using EBF3 (Electron-beam freeform fabrication) for a long time, including in testing during parabolic flights. Is this a technological approach that NASA is concentrating on?

Photos: NASA/Space Systems Loral (on top), NASA/MSFC/Emmett Given (below)

We have lots of concepts for in-space additive metal manufacturing

VICKERS That's a label that refers to a certain system and a process. You can also buy this commercially, but there are half a dozen similar processes. I don't think that the three companies involved in the FabLab project are using electron beam as a power source. There are unique processes that they are proposing for the FabLab. We have lots of concepts for in-space additive metal manufacturing. Electron Beams is just one of them.

Here on Earth, one of the biggest challenges in AM is post-processing. Does the same apply in space as well, or do you focus on parts that can be used right out of the printer?

VICKERS You are exactly right. Post-processing, especially heat treating, is a research area for all of us in the community. There are still a lot of unknowns. We are not even sure if we need that heat treatment at all. We would like to have fewer operational constraints when we get into space, and heat treatment would be very difficult to accomplish.

And let's not forget steps like milling or drilling …

VICKERS We are looking at all of that. There are machines that can perform the additive process and some post processes, machining surface finishing all in one machine.

There are also projects about printing habitats. Is there already a timeline for building the first 3D printed habitats in space or is that too far away now?

VICKERS Just a couple of weeks ago, we announced the winners of our 3D-printed habitat competition. The idea is to develop a 3D printed structure for a habitat on the Moon or Mars. It's a hardware approach of using materials that are applied from Earth along with on-site resources. So, we use what can be easily found on the Moon or Mars as a building constituent as you would use concrete for an Earth-based construction. These structures can be used for a habitat, but for different infrastructure as well.

And how far off is that?

VICKERS If you see the results of that competition you can see how fast we can make that happen. We are not that far away. I think we have the engineering understanding and the technical capability to do that as fast as the program will allow us. We are certainly capable to do it within the next 10 years.

Mr. Vickers, thank you very much for these interesting insights.

+ FURTHER INFORMATION:
» fon-mag.com
» nasa.gov

A »COLLIDING AREA« ON THE PACIFIC COAST

Text: Thomas Masuch

On the Pacific coast of California, Xponentialworks brings together promising start-ups from all over the world under one roof. A mixture of venture capital, guidance, domain experts, and state-of-the-art innovation labs – all underpinned by a global ecosystem of industry contacts – ensures that new products are brought to market quickly.

Jakub Graczyk (on top) und Tomasz Cieszyński.

When Jakub Graczyk and Tomasz Cieszyński left their home in Krakow, Poland, at the end of 2017 and moved to California, they put all their trust in Avi Reichental. The two young entrepreneurs had not only left their families far behind; they had also put aside their further plans for a nascent start-up named Sand Made.

The decision to move to Ventura, a coastal city about 100 kilometers northwest of Los Angeles between Santa Monica and Santa Barbara, was not made for its beloved Pacific surf. It was the prospect of a successful future in additive manufacturing that led the two to found a new start-up with the potential to change the industry. »At Formnext 2017, we talked to many people from the industry about our plans,« Jakub Graczyk remembers. »The massive feedback we got convinced us that there was no time to waste. One week later, we moved to California.«

Reichental, who was CEO of the AM heavyweight 3D Systems from 2003 to 2015, has created an environment in which young tech companies can develop quickly and successfully in Ventura. It's based on a company he founded in 2015 called Xponentialworks – a blend of venture capital, expert advisors, innovation labs, and a powerful ecosystem that is fast becoming a force multiplier for tomorrow's players in additive manufacturing and generative design.

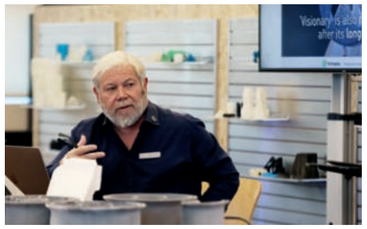
The young companies that Xponentialworks has assembled under its umbrella come from fields like these, as well as from medical technology, applied AI, and robotics. Through his involvement as a co-founder, investor, and shareholder, Reichental has very strong relationships with the start-ups.

»THE MOVE WAS WELL WORTH IT«

Graczyk and Cieszyński confirm that the move to California has been »well worth it, as we're seeing in how our project and company are growing«. In November 2017, they launched NXT Factory and started working on their new »Quantum Laser Sintering« technology (QLS), which aims to speed up the SLS production of plastic parts by projecting layers at once. »Our proprietary projection system can split the beam of a single three-kilowatt laser into millions of microlasers capable of sintering the entire powder bed all at once,« explains Tomasz Cieszyński, now the CTO of NXF Factory. »This technology is in the making, but it's going to compete with the fast, state-of-the-art technologies out there.«

In the QLS 250 and QLS 350 systems that the company is currently fast-tracking to market, however, those millions of microlasers are not yet in use. Instead, NXT Factory is deploying a novel »Quad Laser Sintering« system consisting of four lasers. At Formnext 2019,

Photos: Xponentialworks



NXT Factory's technology will compete with the fast state-of-the-art innovations out there. Avi Reichental offers advice, investment, and guidance in avoiding mistakes.

NXT Factory will present a fully automated system that includes an autonomous powder cart. The materials it can process range from the polyamides PA6, PA11, and PA12 to TPU and high-temperature substances.

According to Cieszyński, the prospect of a new sintering technology from Ventura revolutionizing the AM market has also drawn the attention of many investors. »Nearly every other day, we have people who are interested to see what we're doing,« Graczyk adds. »Obtaining venture capital is much easier here than it is in Europe.«

In Ventura, NXT Factory has a growing team of five employees that is expected to double in size before the year ends. Graczyk and Cieszyński have also maintained a core R&D team in Krakow, where another five employees are engaged in software development, CAD design, and mechanical engineering.

Operating in California comes with numerous other advantages, as well. »One great thing is our direct access to the Xponentialworks community: When you're working at your desk, you'll have experts in engineering, AI, marketing, intellectual property, go-to-market strategy, and competitive analysis just a few steps away with whom you can discuss your ideas,« says Graczyk .

At Xponentialworks, a full-time team of 12 experts from fields such as AM printing engines, material science, applied AI, and robotics is available to the young partners. »We follow and guide the companies every day,« Reichental explains. »Like we tell the CEOs, there's no need to repeat the mistakes we've already made – teach us how to make new ones!« In addition, the start-ups have at their disposal rapid prototyping and design expertise; solid branding, marketing, and PR resources; and daily access to innovation laboratories and technical services that »normally only bigger companies can afford«.

At the same time, Reichental makes it easier for the start-ups at Xponentialworks to engage with companies larger in size. »Here, we leverage our global ecosystem of contacts to provide immediate access to key industrial players so that our start-ups can get feedback and validate their technologies more quickly,« he says. Reichental calls this the »colliding area«, which is meant to forge partnerships that can speed up time-to-market for everyone involved.

MENTORING A KEY BENEFIT

It was precisely the right guidance that the young entrepreneurs from Krakow lacked at their first start-up, Sand Made. »In 2014, we started together on SLS printers for foundries and assembled a team in Krakow. By 2016, we were already going to shows and had sold some printers,« Jakub Graczyk recounts. »We wanted to do something, but we didn't have proper guidance on market opportunities or the rest of the business side. We were paying for our mistakes. Then we met Avi.«

Reichental knew that the world didn't need another low-cost SLS system. He traveled to Krakow for a whole week to brainstorm with the young entrepreneurs on what they wanted to do. »Mentoring was one of the biggest benefits we got,« Graczyk reports. »With the help of Avi's experience and knowledge, we came to the conclusion that there was a bigger market to address: medium- and high-volume production, where injection molding is struggling right now.«

Avi Reichental and his team continue to keep an eye out for companies that have the potential to change the industry. The most important criterion, however, is the people involved. »Are they resourceful and resilient? Have they had any successful exits?« As a further basis for investing in a young company, Xponentialworks relies on its »own assessment of the current state of additive manufacturing and whether we believe the new company has the ability to be a category leader – if it really can disrupt« Reichental continues.

In Xponentialworks' concept Reichental also sees an advantage over conventional investment models. »Keeping all the companies in one place with a lot of authoritative experience and resources can substantially de-risk the entire investment and make the cycle more cost-effective,« he reveals.

As Reichental reports, Xponentialworks usually conducts rounds of seed financing for start-ups itself. »If it comes to subsequent rounds, we typically invite other partners to co-invest with us,« he explains. As to whether he would like to remain invested in the young companies for the long term or has an exit strategy in mind, Reichental is non-committal. »You have to be responsible and create options for every company because we live in a very dynamic and fast-moving space. I think the job of people like me is to create the maximum options for each company.«

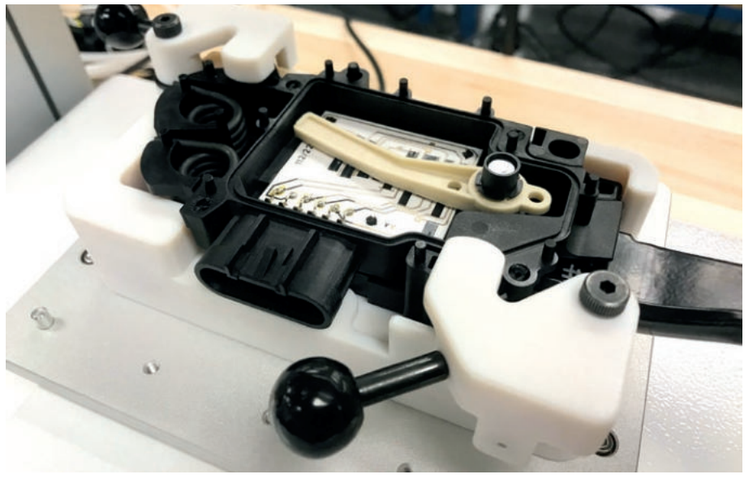
THE GATEKEEPER OF THE TECHNOLOGY

Text: Thomas Masuch

When you discuss additive manufacturing with Gianluca Mattaroccia, you can't fail to notice the fire in his eyes. AM inspires the 39-year-old. He speaks about the technology and the many opportunities it offers with all the enthusiasm of a car mechanic talking about a Ferrari or a violin maker about a Stradivarius.

According to Mattaroccia, AM changes everything. »There's no end to how deep it will transform the manufacturing industry.« If Mattaroccia lacked this enthusiasm, he would probably still be one of 70 engineers in the development department of a major automotive component supplier in New York, creating design drawings of production equipment and managing orders with suppliers experienced in conventional machining processes.

But Mattaroccia pursued a career in additive manufacturing. At the outset, he was something of a lone wolf in a large, traditional company. Over the years, he overcame many obstacles and cleared the hurdles of skepticism. And perhaps it was no coincidence that his story was set in New York – a city that offers opportunities to those who dare to challenge the status-quo.



Gianluca Mattaroccia (photo at right) sees enormous savings potential for the entire manufacturing industry through the additive production of production equipment and components.

Photos: Mattaroccia

STARTING AT THE BOTTOM

Mattaroccia had already experienced bumpy starts. After studying mechanical engineering in Cassino, Italy, he explains, »I wanted to learn English and so I came to New York.« But during his first job interviews, the response was: »I don't know you. Why should I hire you?« So, to gain initial experience, Mattaroccia started at the very bottom. For the first three months, the then 26-year-old accepted to work without a salary. An evening job in a pizzeria enabled him to make ends meet. »What's more, I spent more than an hour each day on the subway and then on the bus on the way to work,« he recalls.

His road to additive manufacturing was also paved with many attempts and failures. These days, he works as an equipment design engineer at Standard Motor Products, an international manufacturer of automotive spare parts headquartered in New York. »From 2015 onward, I followed the 3D-printing industry and asked myself as an engineer how I could make use of the technology.« He familiarized himself with the subject, consulted guides, and designed his first components for production use. »You simply have to try it out for yourself. After all, there's no one around to tell you that if you want such and such a part with such and such properties, you have to make it from this material and using this manufacturing method.« After working hours, he honed his expertise with additional training in design for Additive Manufacturing at the MIT in Boston.

UNREALISTIC EXPECTATIONS

The introduction of AM was smoothed by the fact that the 3D-printed parts were used exclusively in production and development and therefore did not require certification. »Nevertheless, many managers often imagine that, if you have a 3D printer, all you have to do is push a button and the right part will come out.«

»The greatest challenge for me was convincing the skeptics.« Mattaroccia developed his own strategy to achieve this: On the one hand, he painstakingly noted all the savings and other benefits his company reaped by using additive manufacturing. »It's more persuasive shifting the talk about the inefficiency and the waste of capital of an existing manufacturing process than it is to convince the executive team to invest in this game-changing technology.« And that's why he believes it's important for engineers to learn how to perform cost analysis.

This is especially true in the automotive sector: »It's all about costs. This is the toughest industry. It's characterized by low margins and high volumes.« And to paint a more complete picture, Mattaroccia didn't just look at component costs when analyzing »waste eliminated« but, rather, at the process as whole – from design right through to using the parts on the production floor. He recorded the detailed results, created implementation road maps, outlined cost-saving strategies and presented his work at many conferences. The largest savings were generated by improvements such as shorter delivery times, reduced production downtimes, and a lower procurement cost. One electrical connector for testing stations saw production costs plummet from USD 1,300 to USD 280. »We save over $50k annually on this part alone,« says Mattaroccia. As he walks through SMP's development department, he can show dozens of examples of this kind.

MERELY THE TIP OF THE ICEBERG

But there were also other favorable side effects. Thanks to the lighter weight of the additive components, shipping costs could be cut by 30%. »My engineering team develops, orders, and ships thousands of parts every year, and that soon adds up.« In light of this, the engineer comes to an amazing conclusion. If you add up all the savings, says Mattaroccia, »at our current implementation stage, every dollar invested in designing and making a part via additive saves the company five dollars in conventional manufacturing and another 3 dollars in the simplification of the supply chain.« And most companies are totally unaware of this. The use of AM in traditional production environments is still very low in many industries, but the potential is vast. »So far, we're only seeing the tip of the iceberg.«

The engineer illustrates the scale of this iceberg with a simple calculation, showing that manufacturers could save big on costs by deploying AM on the manufacturing floor.

»The global manufacturing sector generates about $12 trillion in annual revenue, according to the UN. The industrial machinery manufacturing market alone, is expected to reach a value of nearly $2.7 trillion by 2022.«

»If only 10% of the manufacturing companies would use AM to replace 10% of the components on their manufacturing equipment, that alone would save 27 billion dollars per annum.« But considerable efforts are still required to tap this potential. For example, Mattaroccia, sees training as a major hurdle: »There is still very little knowledge of additive manufacturing within companies, and it usually exists only in niches.« Additive applications are, therefore still limited by whether the right people with the right knowledge are present in the specific project meetings. »The engineers are the gatekeepers of the technology in every company, they are meant to bring innovation to the table, but without proper training and a vision from the executive leadership, often time they tend to ignore what is not conventional and not proven long enough. A dangerous overall slowdown.«

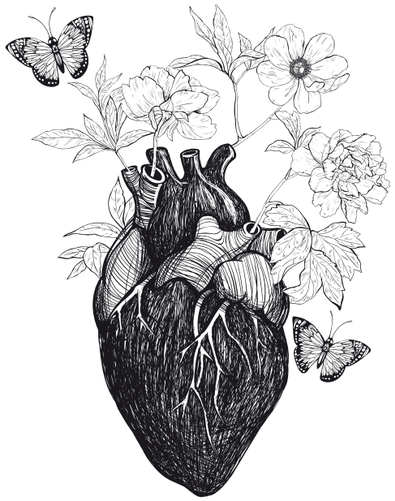
At SMP, Mattaroccia's work is bearing fruit. Other engineers now share his enthusiasm for additive manufacturing. The use of AM is growing at a compound annual rate of more than 250%. This sharp rise was fueled by a wealth of vast design scenarios and tests on the production floor, leveraging the knowledge of our dedicated service providers. Of course, not everything was perfect on the first attempt. But, as Mattaroccia puts it, »my motivation was to complete a puzzle for my colleagues to use as a guiding map. And it didn't matter if some solutions were wrong or right. It's a beautiful scenario.«

EXPERIENCE THE BEAUTY OF AM

After five years implementing hundreds of additive parts in the SMP production process, Mattaroccia will this summer move to a totally different industry, as Engineering Director at Estée Lauder Companies Inc. His role there will require a higher level of technological sophistication: »Here, I want to enable consumers to directly experience the beauty of AM.« He believes that additive manufacturing in the consumer sector can help meet the ever-increasing demands of customers and sell and convey not only products but experiences.

In his new job, the engineer will remain in New York with his family. Even though the USA, and New York in particular, has not exactly made his career path an easy one, he also sees the positive side of his years spent on the banks of the Hudson River. »Sometimes you're just a number here, but I've never felt like an outsider in New York. It makes no difference where you're from. At the same time, the city offers you the chance to reinvent yourself every day.«

»OUTSIDE THE BOX«



Text: Thomas Masuch

A Finger on the Pulse

The human heart is generally viewed as a symbol of energy, vitality, and joie de vivre. It's the motor that keeps not only homo sapiens going, but all higher forms of life. As long as anyone can remember, the heart has also served a somewhat secondary role as the dwelling of the soul and profound emotion – including, of course, love. An almost mystical aura surrounds it across many different cultures.

When Israeli researchers announced some weeks ago that they had 3D-printed a human heart, it was like hearing about not just a medical breakthrough, but something akin to a modern version of the creation story. The future of biomedicine resembled a scene from the movie The Fifth Element, which also features a bioprinter – one that turns the burned remains of an alien into Milla Jovovich, who goes on to save the world (right after she finds some clothes).

It thus came as no surprise that members of the TV, radio, print, and online media picked up the story of the 3D-printed heart and, in some cases, included it in the day's headlines.

If you discuss the project with independent scientists, however, the prospect of printing a functional heart is currently about as realistic as North Korean being introduced as the first foreign language at schools in the United States.

Without wanting to discredit the work of those researchers, it's important to mention that media coverage is probably just as important as winning over start-up investors when it comes to one's reputation and ability to secure funding in the realm of science.

As one of the most advanced and influential technologies out there right now, 3D printing is sometimes even employed – successfully, in most cases – as a marketing tool. Indeed, as soon as something less ground-breaking is created in a 3D printer, it's seen as »cool« and cutting-edge.

The AM industry, meanwhile, left all the hype behind years ago. The level of knowledge in additive manufacturing has increased tremendously, and despite all the euphoria, opportunities, risks, and business cases are being assessed more realistically without stifling visions of the future.

Even funding rounds in the millions can't hide the fact that investors also appear to have grown more discerning than several years ago, when investment-financed start-ups were springing up out of the ground and New York became the world's 3D-printing metropolis. Over the long term, the trend toward the realistic can only be a positive thing; there are more than enough exciting practical applications, after all. And let's not forget the less spectacular projects that nevertheless make just as important a contribution to products and manufacturing processes – and perhaps to changing part of our lives, as well. With the growth of the industry and the propagation of AM applications proceeding at a seemingly unstoppable rate, additive manufacturing is more exhilarating than ever (see page 2). And even if it sounds a bit … heartless, AM isn't in need of any exaggerated elation in the media.

Illustration: Adobe Stock / Martyshova

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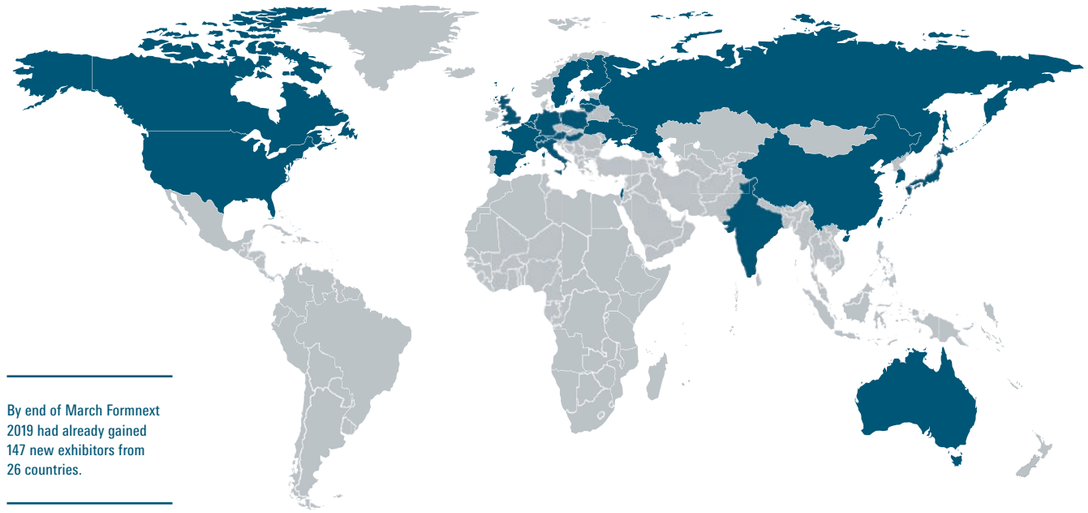
NEW EXHIBITORS FROM AROUND THE WORLD



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