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formnext magazine

Any sufficiently advanced technology is indistinguishable from magic.

[Arthur C. Clarke (1917 – 2008), British writer and futurist]

EDITORIAL

Back in the last century, the British statesman Winston Churchill philosophized that »mankind has gone too far to go back, and is moving too fast to stop.« And in »our world« of additive manufacturing and modern production, it is likewise no longer possible to slow the pace of new developments and innovations.

Even if the economic outlook in some industries is currently rather gloomy, additive manufacturing remains the cross-industry driver of innovation. Especially in challenging times, investing in prominent forward-thinking technologies is necessary and creates clear long-term advantages for sustainable corporate development. Additive manufacturing enables shorter innovation and production cycles right through to deployment in series production. These are advantages that the automotive industry, for example, leverages as additional added value to introduce new models faster, to change over to electric drives, and to personalize its products. AM will influence and shape the mobility of the future, just as it will many other areas of industrial manufacturing.

This means that the use of modern and innovative technologies will be key to finding solutions to today's challenges when it comes to the responsible use of energy, raw materials, and other resources. That applies not only to the automotive industry, but also to medical technology, mechanical engineering, aerospace, construction, and many other sectors.

Because of the ever-increasing number of applications in numerous industries, companies in the »Additive Community« are generally very heterogeneous. At Formnext 2019, we will reflect this diversity with numerous new and proven special topics. We will show visitors innovative design projects and start-ups as well as best-practice examples and the latest developments from the construction industry, mechanical engineering, and PIM/MIM/CIM production.

You can find out more in this issue of Formnext Magazine. This year, we're reporting for the first time on other highlights in »FON – Trade Show Special«, which will be distributed exclusively to Formnext visitors.

I'm looking forward to meeting you in Frankfurt from 19 through 22 November.

Sincerely,
Sascha F. Wenzler
Vice President Formnext

Cover: Carbon

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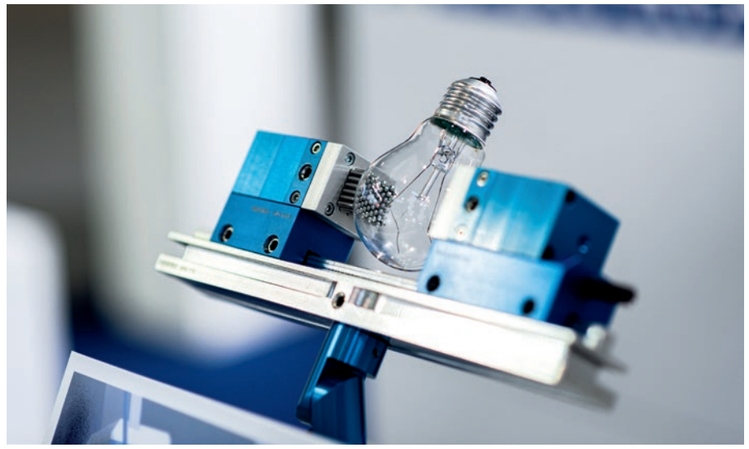
FORMNEXT NEWS



YOU ARE AM, WE ARE AM, FORMNEXT IS AM

With a wide range of solutions as well as established and brand new special topics, Formnext 2019 is the global landmark for additive manufacturing and modern industrial production. No matter if software, digitalization, pre-processing, AM manufacturing, post-processing, surfaces or quality assurance and measuring technology - the complex world of additive manufacturing and its processes are at home at Formnext.

The exhibitors will present cutting-edge solutions, products, services and expert advice for a wide range of industrial 3D printing applications in a wide variety of industries and user industries. These include mechanical engineering, automotive, aerospace, medical technology, dental, construction, oil and gas exploration, shipbuilding and jewelry. In addition, innovative start-ups present pioneering ideas in the fringe program while the exhibition offers many other highlights.

Formnext 2019 for the first time features a PIM/MIM/CIM user case area, presenting the interface between additive manufacturing and modern mass production. In 2019, the USA is the first partner country to be represented at Formnext and will not only showcase a host of leading companies from the AM world, including 3D Systems, Carbon, Desktop Metal, ExOne, HP and Markforged, but will also come up with a variety of supporting events around the U.S. pavilion and representatives of AMUG, AMT, ASME and the US Commercial Service. Wednesday, 20 November 2019, will be a special US-Day with various events at the pavilion and a »Closing Reception« sponsored by AMUG. In cooperation with the U.S. Commercial Service, the AM Standards Forum, which was launched in 2018 and has attracted much international attention, will also be continued.

Established events are being continued and expanded, such as the joint stand and the User-Case-Area »additive4industry« of VDMA AG AM, the Start-up Challenge, the ideas competition »purmundus challenge«, the AM4U platform with a wealth of career opportunities, and the BE-AM Symposium, which focuses on additive activities in the construction industry. In addition, the high-quality conference program organized by Formnext's content partner, TCT, will once again address current trends and developments in additive manufacturing in 2019, while bringing together thought leaders and users of additive manufacturing from various industries.

Also new: Formnext.TV will report live from the fair each day. Visitors seeking to gain expert insight into the AM world can take part in guided tours on all days of the fair. In addition, newcomers to industrial 3D printing will receive practical tips and valuable background information from seasoned industry experts at the daily Discover3Dprinting seminars.

Photos: Mesago / Mathias Kutt

THE HIGHLIGHTS OF FORMNEXT 2019

AM STANDARDS FORUM
19.11., Portalhaus, level 1, room Transparenz 1

CAREER DAY & JOBWALL
21.11., AM4U, 11.0-F71

DISCOVER3DPRINTING SEMINARS
daily, AM4U, 11.0-F71

FORMNEXT.TV
daily, Portalhaus, Level Via

GUIDED TOURS
daily, meeting point: Portalhaus, level 0

INNOVATION MADE IN GERMANY (BMWI)
daily, joint stand 11.0-F51

LIGHTWEIGHT CONSTRUCTION
daily, joint stand 12.0-D95

MATCHMAKING
20.11., Portalhaus, room Transparenz 2

PARTNER COUNTRY PAVILLON USA
daily, 12.0-E101

PURMUNDUS CHALLENGE
daily, showcase 12.1-E01;
21.11., award ceremony, AM4U, 11.0-F71

START-UP CHALLENGE & PITCHNEXT
19.11., Start-up pitches &
award ceremony, AM4U, 11.0-F71

TCT CONFERENCE @ FORMNEXT
daily, Portalhaus, room Frequenz 1 & 2

TCT INTRODUCING STAGES @ FORMNEXT
daily, 11.1-F81 & 12.0-B03

USER CASE AREA BE-AM & SYMPOSIUM
daily, UCA 11.0-F68 / 20.11., Symposium, Portalhaus, level, room Transparenz 1

USER CASE AREA VDMA WORKING GROUP AM
daily, 12.0-E42

USER CASE AREA PIM/MIM/CIM
daily, 11.0-A51

NEWS

MAKING CITIES GREENER

BigRep has launched the world's first fully 3D-printed urban green habitat installation, the Genesis Eco Screen. Addressing some of the biggest environmental challenges such as plastic waste, overconsumption of energy and other resources, the installation is a prototype in urban architecture and an industry-first showcase in Additive Manufacturing (AM) of a scalable, city-developing circular economy. It features innovations made possible only by using custom-made generative design algorithms and large-format, serial production 3D printers (FFF) by BigRep.

The Genesis Eco Screen features an embedded water and drainage system for plants and insect habitats, including a shelter for solitary bees. Measuring a full 4 by 4 meters, the Genesis Eco Screen is reminiscent of a massive root system, and is printed using multiple filaments – consisting of BigRep PETG and BASF Innofil3D rPET made of 100% recycled PET.

The Genesis Eco Screen is on display at the Fiction Forum exhibition center in Berlin. From August to October, it presents innovative approaches from the cultural and creative industries. BigRep CIO Daniel Büning says, »With this project, we are introducing a new and truly sustainable manufacturing protocol to the manufacturing of polymer objects using multiple pre-used plastic materials.«

Circular economy is aimed at minimizing waste by closing the gap between resource input, waste, emissions and energy usage. This is achieved by reducing consumption and material usage. Set up at Fiction Forum as a closed loop process, the PET bottles are recycled as an input material and 3D printed.

»NOT MORE SHOES BUT INNOVATION«

According to the young fashion designer Annie Foo »the world doesn't need more shoes but it deserved innovation.« For her extravagant shoe designs, Foo uses 3D printing technology and combines it with a sustainable approach.

Although Foo uses plastic as a material, she tries to achieve a high level of durability through perfect anatomical adaptation, which should reduce material consumption in the long term. »There is no such things as zero waste fashion unless we don't consume« she says. »The only solution is to buy less and select fashion products carefully.«

Annie Foo has recently completed a master degree in Fashion Womenswear at the Royal College of Art in London. Her work is inspired by linear construction, London pop culture, organic structure and contemporary abstract art.

She scans the shoes or human feet first and then draws and crafts around the model in virtual reality using 3D modeling programs. The final pieces that are produced for catwalk were made with the HP Jet Fusion 4200 3D printer, using PA12 Nylon (SLS). She is yet to discover a more flexible material for the upper part of shoes, for example printed TPU.

She is convinced that 3D printing will help reduce the fashion waste during the manufacturing process. »But every good invention could turn bad if people misuse or don't use it responsibly.«

Photos: BigRep, Annie Foo

NEWS

THE BUILD CHAMBER AS A CLEAN ROOM

Munich-based start-up Kumovis has launched its R1 3D printer to enable medical technicians to efficiently produce implants and other products using additive manufacturing that is appropriate for the industry. According to the company, with the integrated temperature control and filter system, users can create a clean room environment in the build chamber, thereby meeting the strict requirements for the manufacturing of patient-adapted medical products.

The patented temperature management system in the 3D printer enables the user to heat the build chamber homogeneously up to 482 degrees Fahrenheit, which improves the layer adhesion in the respective medical product, among other things. An optional filter turns the build chamber into a clean room. Thus, defects caused by foreign particles in the component can be avoided. All systems for comprehensive monitoring are integrated, ensuring documentation and safety throughout the entire printing process.

According to co-founder Stefan Leonhardt the Kumovis R1 meets the high requirements of the medical industry, and »leads FLM processing of high-performance plastics to industrial maturity«. Good reproducible mechanics and dimensional accuracy are necessary to make the implants fit more adaptively. For this purpose, a local cooling system is used in the Kumovis R1.

Kumovis GmbH develops 3D printers that are specially tailored to the requirements of regulated markets, medical technology in particular. The focus is on the FLM processing of high-performance plastics such as PEEK, which are already established in the industry.

SIMILAR TO INJECTION MOLDING

MakerBot launches METHOD X a manufacturing workstation using »real ABS« material, a 100°C chamber, and Stratasys SR-30 soluble supports. According to Makerbot the »real ABS« can withstand up to 15°C higher temperatures and is up to 26% more rigid.

Part deformation that occurs, due to the high shrinkage rate of the material, usually should be avoided using a heated build plate in combination with altered ABS formulations that are easier to print but compromise thermal and mechanical properties. MakerBot Precision ABS has a heat deflection temperature of up to 15°C higher, as the company says. With Method X, the 100°C Circulating Heated Chamber reduces part deformation.

MakerBot ABS for METHOD X has excellent thermal and mechanical properties similar to ABS materials used for injection molding applications—making it suitable for a wide range of applications, including end-use parts, manufacturing tools, and functional prototypes. Also new is the availability of Stratasys SR-30 material for easy and fast support removal.

Photos: Kumovis, Makerbot, Tufts University

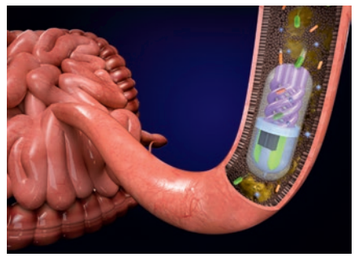
WITH 3D-PRINTED CHANNELS THROUGH THE GUT

A research team led by Tufts University engineers has developed a 3D printed ingestible pill that samples bacteria found in the gut – known as the microbiome – as it passes through the gastrointestinal tract (GI). The ability to profile bacterial species inhabiting the gut could have important implications for the understanding of conditions that affect and are affected by the intestinal microbiome, according to the researchers.

The 3D printed pill represents the first non-invasive diagnostic tool capable of providing a profile of microbiome populations throughout the entire GI tract.

The pill has been studied extensively in vitro and in vivo. It has been tested in pigs and primates.

The pill is manufactured in a 3D printer with microfluidic channels that can sample different stages of the GI tract. The surface of the pill is covered with a pH sensitive coating, so that it does not absorb any samples until it enters the small intestine (bypassing the stomach) where the coating dissolves. A semi-permeable membrane separates two chambers in the pill – one containing helical channels that take up the bacteria and the other containing a calcium salt-filled chamber. The salt chamber helps create an osmotic flow across the membrane which pulls the bacteria into the helical channels. A small magnet in the pill enables one to hold it at certain locations in the gut for more spatially targeted sampling using a magnet outside the body. A fluorescent dye in the salt chamber helps locate the pill after it exits the GI tract.



THE LONG ROAD TO FLYING AM COMPONENTS

Text and Photos Thomas Masuch

At the Airbus site in Finkenwerder, Hamburg, not only the additive production is being researched. Here, the finished airplanes are also delivered to the customers.

Airbus' site in Hamburg (Finkenwerder) features the Additive Manufacturing Speed Shop Hamburg, which is where Airbus is conducting R&D on applications of fused layer manufacturing (FLM)

Additive manufacturing plays an important role at Airbus, Europe's biggest producer of aircraft. When it comes to metal components that are relevant to aircraft safety, however, there are significant challenges to overcome in development, qualification, and production.

The aviation industry is another area in which additive manufacturing will be key going forward. By making aircraft lighter, for example, it reduces fuel consumption, which ultimately benefits both the environment and airlines' balance sheets. »The more improvements are made to a given airplane, the more additive technology is used in the process,« explains Jens Telgkamp, who worked as an airframe research and technology manager at Airbus's production site in Hamburg (Finkenwerder) until the end of July 2019. He is now a professor in the Faculty of Engineering and Computer Science at the Hamburg University of Applied Sciences.

Numerous 3D-printed components are already being used in updates of existing aircraft (Airbus's »neo« models), for instance. Although Airbus has not announced any new model series at the moment, it continues to conduct a great deal of research in the field of AM. Much of it relates to the huge amount of lead time required when 3D-printing aircraft components out of metal: Such components have to be identified, designed anew, and optimized for AM processes. A corresponding process chain also has to be established, which entails significant preparations for qualification and close collaboration with suppliers.

Before the next all-new Airbus model takes off in Finkenwerder, »plenty of water will flow down the Elbe«, as they say in Hamburg. Transitions between models take longer in the aviation industry than in the automotive sector, for example, where a new generation rolls off the production line every six or seven years.

While Airbus is already making use of AM in many ways, most of them involve plastic. Telgkamp estimates that some 50,000 to 100,000 plastic components have been built into the company's planes thus far. Instead of being relevant to safety, however, they see use in areas like cabin furnishings. Fabian Kandels, an AM specialist in production engineering in Finkenwerder, adds that 3D-printed components have also proven useful as auxiliary materials in manufacturing and assembly.

METAL PARTS: »SIMPLY A LOT MORE COMPLEX«

The number of metal components in use is much smaller – somewhere in the hundreds, as Telgkamp reveals. Metal parts are much more likely to be key to safety, and the manufacturing technology involved is also »simply a lot more complex«. Some examples of 3D-printed metal components that are already in the air include the double-walled fuel pipes in the A400M military transport plane and the nose landing gear mounts on the Airbus A350 XWB.

The fact that so few metal components have been built into aircraft despite AM already having been a topic in aviation for many years has a lot to do with the industry's high safety requirements. Telgkamp also thinks that a major challenge lies in a »process chain that's much too long due to all the testing and verification loops involved«. He says the entire manufacturing process – including post-processing (HIP) and quality control (CT) – not only takes considerable time; it also requires very large investments from suppliers. »The whole process needs to be shorter, but to make that possible, we need to know more than we do at present,« Telgkamp admits.

To continue the learning process, Airbus is exploring a series of AM technologies. In its effort to reach series production, the company has adopted most of the Technical Readiness Levels (TRLs) developed by NASA, as well. Research and development, which starts with the identification of components, accounts for TRLs 1 to 6. In the subsequent phase, the march toward series production (TRL 9) begins with the help of corresponding suppliers.

Meanwhile, the Finkenwerder site features the Additive Manufacturing Speed Shop Hamburg, which is where Airbus is conducting R&D on applications of fused layer manufacturing (FLM). The facility is also capable of producing urgently needed individual components that are already seeing use in aircraft. At its reference manufacturing shop in Filton (southern England), Airbus is researching the production of metal aircraft components using powder bed techniques. Kandels is involved here, as well – this time as a project lead whose responsibilities include the qualification of titanium components. Another technology Airbus engineers are experimenting with is wire-based deposition welding, in particular at the company's main plant in Toulouse, France. The hope is that »

this innovation will someday replace more expensive components, such as those forged or milled out of titanium.

Airbus follows several process steps to identify components that it eventually wants to produce using AM, as Telgkamp explains. The first step is about using AM as a means of reducing manufacturing costs, which relates to the question at the heart of it all: For which components is 3D printing a more cost-effective option than milling or injection molding, for example? In the second step, geometric shapes are modified, ideally as a way to reduce weight. In the end, the insights gained are to be transferred to the rest of the Airbus group, including its helicopter and aerospace divisions.

Since Airbus is »not a component manufacturer«, as Telgkamp puts it, suppliers like Liebherr-Aerospace and Premium Aerotec have to be involved in the development process and undergo related qualifications. »Airbus's qualification procedure covers the entire process description, including post-processing,« Kandels points out. Among other rigorous specifications, test labs have to be qualified by Airbus, and suppliers are required to source their powder in accordance with the company's guidelines. These relate to the necessary chemical composition, morphology, flow characteristics, and other aspects.

Premium Aerotec serves as an example of how complex this process can be. A huge supplier that generates around €2 billion in annual turnover, it completed its overall process qualification for 3D-printing titanium components using multi-laser systems in April 2019. As the company itself reports, this required two years of »intensive analysis to understand and master the intricacies of the laser powder bed fusion process, as well as the reciprocal effects that take place in the subsequent steps required (heat treatment and hot isostatic pressing, for example).« In total, Premium Aerotec trialed several thousand material samples in a complicated procedure involving various test programs.

The way in which it selects its suppliers is an important topic for Airbus, as well as an ongoing effort – although the aircraft manufacturer does generally have a »very limited number of companies to choose from« according to Jens Telgkamp. After all, he says, the most important thing is to »produce in a pragmatic and reliable fashion. Airplanes are the safest mode of transportation because the safety requirements are non-negotiable.«

Text and Photos Thomas Masuch

»Airbus«
Airbus is a world-leading company in aviation, aerospace, and related services. In 2018, its some 134,000 employees generated €64 billion in revenue. Besides offering the broadest range of commercial aircraft, Airbus is the European market leader in aircraft for refueling, military transport, combat operations, and special missions, as well as one of the world's biggest aerospace firms.

Discussing the progress of additive manufacturing for aviation at Airbus' »Additive Manufacturing Speed Shop Hamburg«: Eric Wycisk, Jens Telgkamp and Fabian Kandels (from left).

»Patience Is Key«

The aviation industry can be an attractive area of business for suppliers. We recently spoke with Eric Wycisk, co-founder and managing director of Ampower, about the development of the supply chain for AM components in aviation.

In the aviation industry, OEMs seem to be happy to rely on their usual suppliers when it comes to 3D-printed parts, as well. Why are young AM companies finding it hard to gain a foothold here?

WYCISK Up to this point, suppliers and service providers in the AM world have typically come from the prototyping sector, which is why they're flexible. In certified manufacturing for the aviation industry, however, you have to follow rigid processes that always produce the same result. EN 9100 and Nadcap are the certifications required. Suppliers enter into long-term agreements and need to be able to deliver reliably. Meanwhile, they're suddenly having to engage in intense price negotiations, as well. Series production in aviation is generally subject to very high requirements that entail a corresponding amount of effort with regard to qualification and certification. This in turn is fostering the development of the type of supply chain we've seen in milled components, for example.

What prerequisites does an aviation service provider have to meet?

WYCISK It depends on what the OEMs need. In some cases, hundreds of samples are required in order to test all kinds of different properties, and the samples need to be verified by labs that are certified for aviation applications. The costs of a complex procedure like this can quickly reach six figures, and you can't even be sure how big the orders will be in the near future – especially in the case of structural components.

Where is the most value created in the production of AM components for aircraft? Are there any parallels to other industries?

WYCISK When it comes to parts that are critical to safety, the actual production only accounts for a third of the costs. The rest is post-processing and quality assurance. In the aerospace sector in particular, the cleaning of components also plays a significant role. The cost structure we have in aviation in this regard is similar to medical technology, where you also see just a few established suppliers. The companies that bring 3D-printed hip cups to market, for example, often manufacture them themselves.

What developments are you expecting in the years ahead?

WYCISK The OEMs in aviation are in the process of getting their first components certified and putting them on the market. This is why we're seeing a stronger focus on internal production, which also helps these companies continue to develop a better understanding of the processes involved. In our view, suppliers aren't going to need greater production capacities until a few more years have passed. At the same time, it's important that potential suppliers establish the required processes and get their manufacturing certified in order to meet some of the growing demand. For now, however, they're going to need to be patient.

+ FURTHER INFORMATION:
» fon-mag.com

TALKING ABOUT

»We Aren't Even Scratching the Surface of the Current Possibilities«

Additive manufacturing has been such a success in the aerospace sector because it makes weight reductions possible that can't be achieved with conventional technologies. But how are other industries approaching lightweight designs? We recently spoke with Dr. Wolfgang Seeliger, director of the Leichtbau BW network, about the current developments in this field.

Text: Thomas Masuch

Dr. Seeliger, you're in charge of one of the world's biggest networks for lightweight construction. What role does additive manufacturing play for the companies involved?

SEELIGER AM continues to gain importance in lightweight construction, and the range of applications is always growing, as well. We can now produce bionic structures that weren't even conceivable before. By integrating functions and components, it's also possible to eliminate connecting elements and reduce both weight and costs as a result. Another thing that keeps costs down is building conduits for gas or liquid into components, which simplifies the process, as well. On the whole, AM leads to improved material and cost efficiency because material is only used where necessary. Lightweight construction isn't just about material, however: Since functional integration is one of the fundamental principles, our field is mainly about engineering – that is, how can we design components to provide a certain function while using resources as efficiently as possible?

COULD YOU GIVE US SOME SPECIFIC EXAMPLES?

SLM-Impeller
Impeller with integrated channel structures to influence the boundary layer and increase efficiency.

Photos: Rosswag GmbH (left), Leichtbau BW

SEELIGER One of the companies in our network, Jomatik GmbH, is already turning a profit manufacturing robotic grippers with additive methods. Rosswag, an open-die forging company that usually produces things like heavy turbine mounts, has now established Rosswag Engineering – a dedicated AM division that's 3D-printing blade rings in cooperation with MAN. Generally speaking, it's safe to say that the majority of the companies in our network are exploring AM, and half of them have an in-house 3D printer. In a lot of cases, however, they're still doing developmental work. Our impression is that the main challenge lies in finding new uses for 3D printing and taking advantage of the technology where it makes sense.

Considering how well lightweight construction and additive manufacturing seem to dovetail, you'd think there would be more corresponding applications …

SEELIGER Definitely; we aren't even scratching the surface of the current possibilities. In everyday settings, we're seeing plenty of reasons why this is the case. Many engineers aren't yet thinking and designing components with an eye toward AM. It's also often the case that supplier companies don't have engineers with corresponding training – or if they do have such expertise, customers still want conventional designs.

What would you recommend to break out of these patterns?

SEELIGER On the one hand, there are a great deal of training opportunities available these days, and AM is often part of the technical schooling offered at universities. On the other, we need more process innovation. The developments that OEMs come up with are usually confidential, and suppliers are often only involved after a design is already complete. We need to think and act in a more overarching way, but the changes this would require can only be made at the executive level.

How does your network support the development of additive manufacturing?

SEELIGER The topic of 3D printing first arose within our network around four years ago. Since 2015, we've been organizing regular network events like our consultation gatherings, as well as conferences with our industry partners. These gatherings focus on subjects like process safety, reproducibility, and how dependent users are on their equipment and materials. We've also published studies that explore the strategic and business-related challenges and perspectives involved in the industrial use of AM.

New technologies like additive manufacturing are met with enthusiasm at some companies, while others are more skeptical. Are there differences here between smaller and larger organizations, for example?

SEELIGER In our experience, firm size doesn't really play a role. It's more a question of the culture and the people in charge at a given company, which is where you see some stark differences. I believe the companies that prove best at overcoming the economic challenges they face in the future will be those that develop the necessary technological versatility in good time rather than simply reacting to their customers' specifications.

Dr. Seeliger, thank you for taking the time to talk to us.

»Leichtbau BW GmbH«
With 2,200 companies – including 1,100 from Baden-Württemberg and 500 from outside of Germany – and more than 270 research institutions, Leichtbau BW is likely the world's largest network in lightweight construction. This state agency supports the marketing of Baden-Württemberg's expertise in lightweight designs and cultivates the state's potential for innovation in line with its motto, »Less Is More«. At Formnext 2019, Leichtbau BW's shared booth will feature nine companies from its network: INPECA GmbH | BÖLLINGER GROUP, BURGMAIER AM, CADFEM GmbH, fabrikado GmbH, MIMplus Technologies GmbH & Co. KG, Q.big 3D, Rosswag GmbH, Schübel GmbH, and Visiotech GmbH..

Dr. Wolfgang Seeliger, director of the Leichtbau BW network

FURTHER INFORMATION:
» fon-mag.com
» leichtbau-bw.de

A 3D PRINT HEAD WITH SPIDERY LEGS OF STEEL

Text: Thomas Masuch

Photos: Metrom

Based in Hartmannsdorf (Saxony, Germany), Metrom is combining its remarkable machine tools with 3D-printing technology from the likes of Fraunhofer IWU. In doing so, it hopes to create new additive applications.

Photo on top:
Metrom's headquarters in Hartmannsdorf
Photo below:
This unique machine tool is based on the pentapod technology

At Metrom's production facility in Hartmannsdorf, the inventiveness for which the state of Saxony is known is bearing fruit that is equal parts innovative and extraordinary. One such breakthrough resembles the hemispherical dome of a small radar station, but with protruding, spider-like legs of steel that pivot and swing in a mysterious rhythm around a single point of focus. Through a small window in the dome, you can see how the legs move a drive spindle and milling tool that are giving a precise shape to a metal component more than a meter in diameter.

This unique machine tool is based on something called pentapod technology, which Metrom founder Dr. Michael Schwaar developed some 20 years ago. In essence, it involves five multidirectional ball screws that move a spindle into the necessary positions. As if that weren't remarkable enough, Metrom has now married its pentapod technology to various additive manufacturing techniques, as well.

»We didn't want to limit ourselves to the usual market for machining centers, so we asked ourselves how else we might leverage the wide-ranging potential of our machine,« explains Susanne Witt, daughter of Dr. Schwaar and Metrom's current managing director. »Our technology can move a lot more than a spindle, after all.« Along with her husband, Marcus Witt (who directs the company's technical sales activities as CTO), the 39-year-old industrial engineer thus began searching for suitable partners – and found two of them in Berlin's Gefertec and the Fraunhofer Institute for Machine Tools and Forming Technology (IWU) in nearby Chemnitz.

Thanks to the success of its resulting cooperative projects, Metrom and its 15 employees can now offer machines that use interchangeable modules to 3D-print both synthetics and metal (by means of overlay welding) and create objects up to two cubic meters in size. The company says that the machines are even capable of six cubic meters under certain conditions. »

At Formnext 2019, Metrom and Fraunhofer IWU want to set a new world record by achieving a printing speed of 1.2 meters per second.

Simply switching tools makes intermediate and post-processing possible via milling and drilling without having to reclamp the workpiece. »By combining additive and subtractive methods, we're opening up new possibilities in numerous fields of application,« Marcus Witt states. Another special feature of this flexible, five-axis hybrid machine tool is its mobility, which makes it possible to repair things like power plant turbines right where they operate.

FORMNEXT TO FEATURE WORLD-RECORD ATTEMPT

The print head Metrom's machine uses for synthetic production was developed by the aforementioned Fraunhofer IWU. The 40-kilogram extrusion unit, which leverages SEAM (Screw Extrusion Additive Manufacturing) technology, is capable of using standard granulate. This results in much lower material costs compared to conventional FDM and FLM techniques according to Christopher John, who oversees the corresponding project at the institute. Its patented bypass nozzle also makes the output volume fully variable, from zero to 100 percent. This means that the printing process

Successful cooperation between Metrom and the Fraunhofer IWU in Chemnitz: Marcus Witt, Susanne Witt, Christopher John (first row from left), Tobias Clauß, Martin Kausch, Johannes Blase (back row from left).

Photos: Metrom, Fraunhofer IWU

»It's ultimately the customer who determines our direction«

can be stopped and then restarted after a change in position. At the same time, the print head can also produce thin-walled objects. It offers yet another advantage when paired with Metrom's pentapod machine: »It produces round and angular wall shapes and stabilizing partitions in a continuous process, which takes very little time,« John explains. He adds that a wide array of applications are possible, from clamping devices for CFRP components to uses in automotive production. According to John, all of these operations can be performed at a high processing speed, which is why Metrom and Fraunhofer IWU are hoping to do more than just present their new technology at Formnext 2019 (at a shared booth hosted by IHK Chemnitz). John has already announced their intention to »set a new world record by achieving a printing speed of 1.2 meters per second« – that's at least four times faster than other current methods. It would also make a myriad of new applications more cost-effective in industrial settings.

»A DIFFERENT LEVEL OF IMAGINATION«

For Susanne Witt, the way in which additive technologies have played a prominent role in the ongoing development of Metrom's machines has to do with the »different level of imagination« customers are now exhibiting. »We used to have to explain a lot about 3D printing and make an effort to win companies over,« she recalls. »These days, they're the ones coming to us with their requests.« In that respect, her company's new innovative focus has aligned optimally with the increased acceptance of additive manufacturing.

Indeed, the years ahead could usher in further fields of application that Metrom and Fraunhofer IWU have not even begun to consider today. »For a special-purpose mechanical engineering company like ours, developments are always driven by customers,« Susanne Witt points out. »It's ultimately the customer who determines our direction,« affirms Christopher John.

+ FURTHER INFORMATION:

- fon-mag.com
- metrom-mobil.com
- iwu.fraunhofer.de
- Joint Stand of the Chamber of Commerce and Industry Chemnitz at Formnext 2019, Hall 12.0, Stand C.40

TALKING ABOUT

»The story of using 3D printers just for tooling and prototypes has been told«

The role of Carbon in the additive manufacturing industry is akin to that of Tesla in the automotive sector: Founded in 2013, the company has risen meteorically to join the ranks of large AM companies – with a new technology, a new sales strategy, and the industry's largest total investments. With its recently completed Series E funding round, the Californian company has raised up to a total of $680 million and now employs more than 400 people. We talked to Philip DeSimone, Chief Customer Officer and Co-Founder, about Carbon's progress so far and its future plans.

Photos: Carbon

Text: Thomas Masuch

Already in 2017, Adidas has partnered with Carbon to create the performance footwear Futurecraft 4D. Carbon had established an incubator factory at its headquarters to develop and validate a print method and materials.

By the standards of business development in the European AM industry, $680 million sounds like a different dimension. How has this large amount helped you in the past years, and does a U.S. company have an advantage here over the international competition?

DESIMONE Yeah, I think it does, but I think it's really about a sentiment to our success. We have raised a $680 million total since we started, but the round that we just closed was $260 million, with a valuation north of $2.4 billion. I think the funding round is more attributed to investors feeling confident in the successes we've had to date and our ability to maintain those successes going forward. It's the most that's ever been done in the 3D printing space, and we are proud of that accomplishment for sure.

You were one of the founders. Did you plan from the outset to grow this big?

DESIMONE I think there are a lot of decisive moments when you first start a company. I thought early on it was going to be big, but I didn't know how big it could be. I'll be open: I believe there's a lot of luck involved, and timing is everything. Obviously, you have great skills, but there is a lot of great technology that dies on the vine because of timing. I think we had everything timed perfectly, and a little bit of luck on our side to grow it. When we first started, I did not think this was going to be a 2.5-billion-dollar company at grand scale. I think that really clicked for me about three years in. About 2016, I knew we had something really, really special. Even now, I'm more bullish on our opportunity than I've ever been. It really disrupts the global manufacturing market in ways that people have been dreaming about for 3D printing for the last 40 years.

In its relatively short history, Carbon has already accomplished a great many things. After installing your first machine around mid-2016, you now cooperate with big-name companies in various industries and and have already achieved mature applications. How will this development continue over the coming three years?

> Now we're scaling up internationally, growing the presence in the EU as well as in the Asian markets.

DESIMONE We have had a major hold in the United States now, and we've grown here, approaching 1,000 installed printers so far. Now we're scaling up internationally, growing the presence in the EU as well as in the Asian markets. There is also a lot of R&D and new product development, whether it be software, developing recyclable materials, including building our first development facility here in California, which will be sort of a crown jewel on what is possible in digital manufacturing at scale. It's a place to educate the ecosystem. That's something that really hasn't been done before. When we first started here at Carbon, when people first decided to upscale production, we turned around and there was no ecosystem. No contract manufacturer knew how to set up a 3D printing digital facility. No one understood how they had to handle the resins or materials. So, a lot of this money is going into fueling and making that next leap into global manufacturing.

You have already mentioned that you want to strengthen your presence in Europe and Asia. Are you working with channel partners for sales, or are you building up your own sales chain?

DESIMONE Until this point, we've been doing direct sales, so we have to build our own »

supply chain. We are exploring some channel partnerships, but internationally we are going to continue to grow as we have been, which is by hiring our own employees in those locations and building out direct sales. Right now, we already have around 20 employees in Europe. We would just be adding upon that and potentially open an office there as well.

Is this because your technology is so special that it doesn't fit into a portfolio alongside other technologies?

DESIMONE Yes, we think that's some aspect of it. There are great value-adding channels out there, but channels distribute many products. With digital manufacturing, you really have to create a focus and become an expert in that field. What we've noticed is that channels spread themselves really thin and don't become experts. They are good at selling, but not necessarily at maintaining customers. Our goal is, from day one, that we better have 10 customers with 10 purchases each than 100 with one. So, we pushed heavily in post-sales support, application development, application discovery, and working with our customers to validate their components at scale, which is something that channels simply won't do. We've developed our internal focus around being experts in the technology we've built, our materials, and our process. We help our customers from idea to production upscale, without having to work with anyone else to do it.

Are there some markets that you focus on?

DESIMONE We've obviously had a lot of great success in the footwear space with Adidas. We're doing a lot of things with consumer products and applications. You'll see some at our booth at Formnext in November. For example, we work with Riddell for the American football space to protect players with helmet technology. There are more things coming in the lattice space around energy absorption, return, and performance that we're really excited about. In the automotive sector, we are doing a lot of interesting projects with Ford, Lamborghini, and BMW. There is a massive increase in usage in the process sector. We have increased our print volumes by 33-fold over the last 12 months. A lot of that's driven by this new correction to global manufacturing. There's not any other 3D printing company that's averaging more than 45 hours printing per printer per week. These machines aren't just sitting in the corner collecting dust. They're being used, and they're being used a lot.

Carbon Lab Technician with M2 Printers in Redwood City, California.
Source: Carbon

To take up one of your last points, what innovations will you present at Formnext?

DESIMONE We will announce a trailblazing project that we accomplished with a renowned partner from the sports sector. It will be one of the largest end-use production applications in the world in digital manufacturing. I think it really pushes the sentiment of who we are at Carbon and what we're trying to do, which is not just using 3D printers for tooling and prototypes. That story has been told. That story has been done well for the last 20 years. It's really about making the next step, which is: You go to the store and you're buying 3D printed products. That was the biggest jump that we've been able to achieve. For the first time ever, you can go into a store and buy a 3D-printed shoe or a 3D-printed football helmet for your child, which provides a better protection rating. You can go buy a car from Ford or BMW and it has 3D-printed components on it from us.

Phil, thanks you so much for talking to us.

+ FURTHER INFORMATION:

» fon-mag.com

» carbon3d.com

HOW TECHNICAL DOCUMENTS SAVE MILLIONS OF EUROS

Smoother product launches, cost savings in the millions, leaner processes, plus more reliable relationships between customers and suppliers: This may sound like little more than a dream for the world of additive manufacturing, but it is set to become reality – thanks to many new and globally applicable standards. International and national committees have teamed up under the dual logo of ISO-ASTM standards to create a large number of new documents spanning the entire process chain. Some have already been published, and many will soon follow.

Text: Thomas Masuch

In themselves, standards may not be particularly spectacular, but they are currently a hot topic internationally. The two associations with the greatest international power, ASTM and ISO, have joined forces to collaborate with key representatives of the AM industry – from system manufacturers and software vendors right through to users of AM technology. Many international working groups are going through an entire roadmap of processes to establish the corresponding standards. There are five core areas in which it is particularly important to close existing gaps: design, qualification and certification, process and material, non-destructive testing, and maintenance.

Integrated design of a shaft with pinion. The characteristics were designed according to ISO/ASTM 52911-1.

Photos: Fraunhofer IGCV

Professor Christian Seidel, Chairman of ISO/TC 261, also knows from his own professional experience that vast potential savings can be achieved through appropriate standards – for example, in the aviation industry: »In the past, components were tested again and again to prove that they are safe. Individual companies spent millions of euros on material and component tests, partly because no corresponding standards were available at the time,« says Seidel, who is a full-time professor of manufacturing technology and additive processes at Munich University of Applied Sciences and head of additive manufacturing at the Fraunhofer IGCV in Augsburg. If this total is extrapolated to users and manufacturers in Europe and worldwide, standards can save hundreds of millions of euros.

But standards not only help save costs, they also streamline internal processes. »What other criteria can employees use to govern the use of additives in manufacturing processes within a company – for example, when it comes to ensuring consistent quality?« asks Seidel. »Arguing for your approach by saying you have the best experience in the field is often not enough.«

Prof. Christian Seidel

RELIABLE DESIGN WORK

Just how useful ISO and ASTM's work can be in this area is shown, for example, by the ISO ASTM 52911 »design standard«, which provides a technical design guideline for powder bed fusion processes in additive manufacturing.[1] It includes information about overhangs that should have support structures, about the permissible size of cavities and internal channels or the thinness of walls. According to Seidel, this standard is important for external service providers, who can use it to certify reliable design work to their customers. In addition, guidelines of this kind can deliver significant benefits within companies: »For example, you could specify that a design is to be created according to this standard, with company-specific deviations being permitted in certain areas, of course. That would appreciably reduce the effort required for tasks and project descriptions,« explains Seidel.

To date, 12 standards have been published under the dual logo, and a further 54 are currently in progress and will follow soon. The published ISO/ASTM standards are generally adapted as European standards and replace all existing national documents in Europe with the same content.

The new standards will help the entire industry and internationally working companies immensely. It also lowers the barriers to new companies entering the market, which would certainly lead to a large number of new applications. What's more, standards can help establish a reliable relationship between customers and suppliers for additive applications.

Seidel also sees ISO/ASTM 52902 as a »valuable guideline« for checking machine accuracy with test pieces. Among other things, this standard defines thin walls and slots, a hole with a diameter of 1 mm, or a rod-shaped pin structure with a thickness of 1 mm. »Companies wishing to assess the accuracy of their own machines or a machine they intend to purchase can use the structures described in ISO/ASTM 52902 for comparative tests,« explains Seidel. »After all, some 3D printing systems deliver different levels of accuracy, depending on the positioning of the component in the modeling area.«

The technical specifications of the standards are the result of consensus between major players and experts. They already play an important role in basic and further training programs. »In the case of the ISO/ASTM standards, for example, there is very strong international consensus between some 30 countries that are entitled to comment before publication,« Seidel said.

OCCUPATIONAL SAFETY: HIGH AVOIDABLE COSTS

Standards can also answer many open questions in the field of occupational safety, which has become increasingly important in the world of additive manufacturing in recent years. These questions include: What dangers exist, how do you identify them, and how do you deal with them? And they cover areas ranging from powder to personal protective equipment and air pollution control. »Companies typically invest a lot of time in introducing technology,« explains Seidel. »In our experience, it takes a great deal of coordination with internal and external representatives to find answers to questions relating to occupational safety. Examples include the air-exchange rate for ventilation, handling of hazardous substances, and so on. Having an independent document based on technical consensus can save days of work and make it much easier to get started with the technology.«

Technical Committee 105.6 of the Association of German Engineers (VDI), which focuses on safety during the operation of additive manufacturing systems, has therefore been dedicated to this topic since 2016 and has published a highly regarded resource on laser beam melting technology in the form of VDI 3405 Sheet 6.1. According to Seidel, another document on laser sintering will be available at the end of 2019.

[1] This refers to the technologies electron beam and laser melting for metal, and laser sintering for plastics.

+ FURTHER INFORMATION:

» fon-mag.com

» The international AM Standards Forum, which celebrated its premiere at Formnext 2018, will continue at Formnext 2019 on 19 November at 2:00 p.m. The forum is organized by Formnext in cooperation with the U.S. Commercial Service.

COLORFUL JEWELRY MADE FROM WHITE POWDER

The young jewelry designer Marie Boltenstern uses additive manufacturing to create her collections – working hand in hand with Formrise and DyeMansion. She takes her inspiration from nature.

For more than 50 years, the name Boltenstern has been synonymous with high-quality jewelry, out-of-the-ordinary designs, and the finest work with precious metals. In the 1960s, painstaking craftsmanship and the skillful use of gold enabled founder Sven Boltenstern to secure his place on the global jewelry market.

The company has enjoyed fresh impetus since 2015, when his daughter Marie Boltenstern took up the post of CEO & Head of Design, steering the family business in a new direction. If you visit the showroom she opened in 2017 at Bräunerstrasse 11 in Vienna, this is immediately apparent from the storefront. These days, Boltenstern's tagline is »3D printed fine jewelry«. »Our goal is to integrate innovation into every part of the jewelry business. From designing pieces right through to our customers' shopping experience,« says Marie Boltenstern.

Marie Boltenstern over the business as CEO & Head of Design, presents her latest collection in her showroom in Vienna.

Photos: DyeMansion

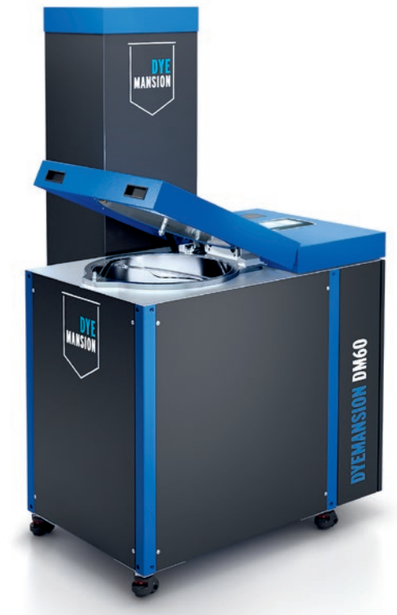
All of the young designer's collections are now produced using industrial 3D printing and then augmented with handmade elements. As she explains, her jewelery takes its inspiration from the forms of nature: »Nature is essentially very geometrical. Although natural artifacts appear organic, they follow fixed mathematical rules and patterns. I incorporate this in my designs.«

FINISHING IN STYLE

Marie Boltenstern prints jewelry from various Materials, for example also from gold. But she has always worked with polyamide - in the past, however, only for prototyping new structures. »Polyamide has always been a way for us to test new structures,« she says. In addition to enjoying working with the material, the designer realized it was suitable for series production.

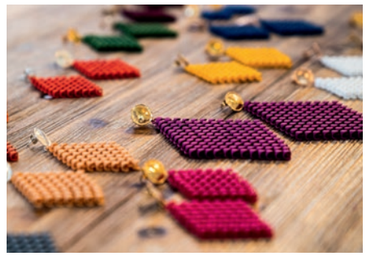
But during initial trials with the laser sintering process, the layers of the printing process remained visible. The feel of the pieces also failed to meet the requirements for products worn next to the skin. What's more, thin-walled pendants broke during the tumbling process. And when it came to the intended variety of colors, the white polyamide parts from the 3D printer posed a real challenge.

The jewelery manufacturer finally found the solution to these challenges by cooperating with German 3D printing service provider Formrise. Here the polyamide parts of the Fabnora earrings are produced on a Formiga P 110 from EOS. Formrise uses the DyeMansion Print-to-Product workflow for cleaning, surfacing, and coloring. To achieve a better feel and a matt finish, the components are depowdered and finished on a Powershot C and a Powershot S – automatically and without damaging the surfaces. The process takes 10 minutes and does not remove any material. Finally, the earrings are given their chosen color in the DyeMansion DM60 with DeepDye Coloring. The cooperation with all partners has established a reliable and reproducible production process.



After printing, cleaning and surface finishing the parts are dyed in the DyeMansion DM60 under pressure and heat.

Photo above:
The parts when being unloaded from the Powershot C (Cleaning).
Photo below:
The flexible additive production process enables a wide variety of sizes and RAL colours.



SPECIAL SEASONAL COLORS

Once the earrings have gone through the three-hour Print-to-Product workflow, they are joined to the handcrafted gold or silver ear studs. The Vienna showroom features earrings in an impressive array of sizes and colors, ranging from blue, purple, pink, and red to orange, yellow, green, and black. On seasonal occasions, the collection is rounded out by additional RAL colors, such as dark green and dark red at Christmas.

Because the Fabnora collection and additive production have proven their worth, Marie Boltenstern is planning to expand the collection – for example, by adding new colors and possibly even customized colors in line with customers' specific wishes. Thanks to the technologies and the dyeing solution deployed, there are virtually no limits to what the designer can dream up and put into practice.

+ FURTHER INFORMATION:

» fon-mag.com
» boltenstern.com
» dyemansion.com

»OUTSIDE THE BOX«

Selfie Sticks versus Horse-Drawn Carriages

Anyone who has ever visited Rome will have seen not only the Colosseum, the Palatine Hill, and the Circus Maximus, but also vast droves of tourists, countless selfie-stick vendors, and endless queues stretching off into the distance. Travel has changed, thanks not least to cheap flights, travel portals, and Google Maps. These days, anyone who wants to see other countries can do so without a hefty budget, foreign language skills, or local knowledge.

Apparently, the motivation of many travelers has also changed: In the dim distant past people, »traveled not to arrive, but to travel« (Goethe). But now, representatives of the younger generation feel magnetized by how well certain places fit their Instagram feed. One study shows that 40.1 percent of Millennials choose their destinations according to compatibility with their social media channels. According to travel portal Momondo, suitability for social media is a factor even when it comes to food. (Incidentally, avocado toast rates very highly in this respect.)

Looking back, we can't say for certain whether Goethe's famous Italian journey from 1786 to 1788 would have turned out differently if the great poet had had an Instagram account and had bought a selfie stick at the Colosseum. Maybe he would never have made it as far as Sicily – opting, rather, to take photos of himself with avocado toast at the Trevi Fountain. Instead, however, he continued his unhip journey south by horse-drawn carriage and occupied himself with dull things like »people, inns, contemporary conditions, and attitudes«.

Of course, photos, posts, and videos of foreign locations are also an attempt to bring the exoticism of these distant places back home or into our familiar network. In his day, Goethe knew only too well that this can never quite succeed, because »foreign countries have a foreign life, and we cannot make that life our own«, no matter how much we enjoy these countries as visitors.

But such words of wisdom are not necessarily true for all time. Even Goethe couldn't have imagined that, in 2019, Samsung would launch its Note10+, which allows you to capture not only photos but also 3D models. So, when you get home, you can print the most striking motifs from your time abroad – in real 3D, of course. Alternatively, you could buy a selfie 3D printer at the Colosseum for use on the road.

Text: Thomas Masuch · Illustration: feedbackmedia.de, iStock/Animaflora, iStock/fongfong2

+ IMPORTANT FACTS:

» 19 – 22 November 2019
» Messe Frankfurt, Halls 11, 12 and Portalhaus
» Further information: formnext.com

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