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formnext magazine

Crisis is a productive state – you only have to take away the flavour of catastrophe.

[Max Frisch (1911 – 1991), Swiss writer and architect]

EDITORIAL

Dear readers, hands on your hearts: Over the past several weeks, who among you hasn't thought something along the lines of »What a crazy, messed-up year 2020 is turning out to be«? COVID-19 certainly has put a few worry lines on our faces in bringing the entire global economy to its knees. Even if a reliable vaccine does become available in the foreseeable future (what hopefully will happen soon), it will take years to recover from the economic impact.

The U-shaped curve will be a long one, especially with regard to mechanical engineering and technical capital goods. The coronavirus has indeed put an even stronger spotlight on foundering industries like automotive and brought sectors that were flying high (quite literally in the case of aerospace) back down to a sobering reality on the ground.

Some rays of hope are still piercing through, however. AM technology has demonstrated how well it can produce the spare parts required for medical treatments and help compensate for breakdowns in supply chains (at least in specific areas) in times of crisis. Meanwhile, our digital working lives have settled into a good balance of days at home and at the office, with corresponding benefits for our families.

We've gotten used to social distancing, heightened hygiene, and wearing a mask every day. In spite of all the digital possibilities available to us these days, we've also learned that one thing remains irreplaceable in both our private and professional lives: the chance to meet face to face. Our disappointment at the end of the summer is all the greater now that we have to recognize that the course of the pandemic is destroying our efforts to make these personal encounters possible again.

The recent rise of the Covid-19 infection figures worldwide, and the associated increase in travel restrictions will no longer allow the international Formnext to be carried out successfully. That's why we together with the Exhibitor Advisory Board have decided to cancel the on-site event of Formnext 2020. We are now putting all our energy into the realization of a virtual Formnext, the Formnext Connect, to provide a virtual platform for business and knowledge exchange to the global AM community at the end of the year.

This edition of our magazine will fill you in on all the details. We hope you enjoy reading it – and I hope that 2021 will be again a year of personal encounters.

Sincerely, Sascha F. Wenzler
Vice President Formnext

Cover: Superstrata

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Photos: PFW, Forust, Kamp C & Jasmien Smets ,Daimler Buses

Photo: feedbackmedia.de, iStock /Maksim Tkachenko

FORMNEXT 2020 TO TAKE PLACE PURELY VIRTUALLY

Rising infection figures worldwide and increasing travel restrictions: Formnext 2020 will be carried out purely virtually. The digital event will be named »Formnext Connect«.

Formnext 2020 was previously planned as a hybrid trade fair, that is, with the on-site event at the Frankfurt exhibition grounds plus a digital add-on component. »The current rise of the Covid-19 infection figures in Germany, Europe and around the world have led to increasing uncertainty among exhibitors and visitors. Together with the renewed tightening of official and in-house travel restrictions, this will no longer allow the otherwise highly international Formnext to be carried out in the accustomed quality,« stated Petra Haarburger, President of Mesago Messe Frankfurt.

»We have been planning Formnext 2020 for months now. We have done this consistently and with the full support of our Exhibitor Advisory Board and with the highest level of protection and safety for the health of our exhibitors and visitors. In doing so, we examined the entire layout of the fair from scratch from the halls with all entrances, booths, to the aisles. We devised completely new stand construction packages, spacing and communication areas in accordance with the health and hygiene concept agreed with the authorities. Our disappointment at the end of the summer is all the greater now that we have to recognize that the course of the pandemic is destroying our efforts to make these personal encounters possible again,« explained Sascha F. Wenzler, Vice President Formnext Mesago Messe Frankfurt.

LEADING THE WAY OUT OF THE RECESSION

In the course of the crisis, the additive manufacturing industry has clearly demonstrated the potential that lies in flexible, diversified and decentralized production. There is no doubt that AM will be one of the leading technologies that will lead the way out of the recession. It will play a major role in the development of new products, the design of resilient supply chains and the development of sustainable business models.

»An exchange between technology providers and users is absolutely necessary for this, and we are now putting all our energy into the realization of a virtual Formnext, the Formnext Connect,« Wenzler continued. »It will be the central virtual platform for business and knowledge exchange for the global AM community at the end of the year.«

INTELLIGENT MATCHMAKING, LIVE STREAMS, AND MORE

Formnext Connect will start as a virtual event from 10 November 2020 and will offer a wide range of digital services. At the heart of this digital format are exhibitor profiles and a state-of-the-art matchmaking tool that will connect digital participants and suggest products and manufacturers in line with their interests. Matches will be determined by a self-learning algorithm based on users' input and behavior. If both parties agree, video calls or meetings can be arranged.

Along with the matchmaking tool (which will also have a calendar function for added convenience), Formnext Connect will feature an array of attractions – such as conferences, seminars, presentations, and award ceremonies – as live digital streams or downloadable content.

For exhibitors, the event is set to provide corresponding digital packages that will include a digital presence with extensive company and product profiles (and related videos), a chat function, and instruments for lead generation and tracking.

NEWS

FOR MEDICAL DEVICES

Lincotek Additive has completed its new Additive Production Center for medical devices in its Trento facility, by installing a new high-vacuum furnace and a validated heat treatment process, specifically designed for 3D-printed titanium parts.

The company has been working on improvements in the AM process for some 15 years. Reactive metals, such as titanium, produce specific challenges, and high-temperature heat treatments involve a great deal of complexity. As the company reports, the new investments have led to a reduction in lead times and a robust backup strategy.

Lincotek Additive is the Additive division of Lincotek, a global contract manufacturer headquartered in Rubbiano, Italy. The group has more than 1,100 employees located in 16 production facilities across Europe, North America and Asia. In 2019 the company has already opened its Additive Innovation Center in Switzerland, focused on the IGT and Aviation market. »We are already working on the next step of growth, looking at expanding our AM capability in China too.« Winfried Schaller, Lincotek, Group CEO.

»HIRTISATION« UNDER A NEW ROOF

Rena Technologies, a specialist for wet chemical surface finishing, has acquired Hirtenberger Engineered Surfaces (HES) and established a new market segment, additive manufacturing (AM). The existing team, process know-how and Hirtisation technology will be integrated into the Rena corporate structure. The new Rena Technologies Austria (Rena AT) is to operate as hub for activities in the additive manufacturing segment.

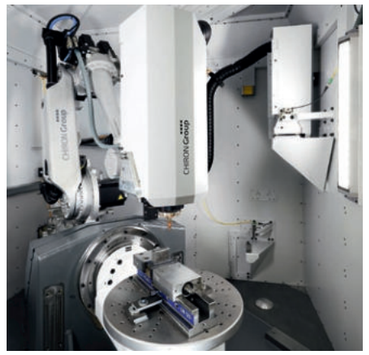
The Hirtisation technology, an electrochemical surface treatment for additively manufactured parts, is to form the core of the new Rena technology.

As Rena reports, it is precise, automated and suitable for mass production in 3D metal printing—and an alternative to conventional post-processing methods.

Headquartered in Gütenbach in the Black Forest in the South of Germany, Rena employs around 1100 people worldwide. By the integration into the Rena structure, HES aims to establish a strong basis for global marketing. »The first industrial machines have already been successfully introduced to the market. Together with Rena we can speed up establishment of our cutting-edge technology«, explains Wolfgang Hansal, managing director of Rena AT. Peter Schneidewind, Rena's CEO, adds: »The innovative segment opens a new and promising chapter with tremendous growth potential for Rena.«

Photos: Lincotek, Rena

NEWS



COMBINING WIRE AND POWDER

The Chiron Group, specialist in the field of CNC-controlled vertical milling and turning machining centers, will present the AM Cube, its first 3D printer for manufacturing larger, more complex components. It is suitable for coating and repairing components, as well as printing near net shape parts, as the company reports.

»The Additive Manufacturing department is a start-up within our own business group,« explains Axel Boi, Head of Additive Manufacturing at the Chiron Group. »With AM Cube, we are creating a facility for manufacturing larger components with long procurement times and high material prices.« According to Boi, the technology can be used in the mechanical engineering, tool manufacturing, energy production and aerospace sectors.

The new AM Cube is based on a conventional cartesian coordinate system, just like a CNC machining center. Operation and programming of the AM Cube is intuitive. All aspects of the system can be controlled using tried-and-tested Siemens components, from hardware to the HMI through to programming.

The patented technology offers the opportunity to change the print head during an active printing / coating process. This option enables the AM Cube to be used to combine different process requirements: For instance, one print head could be used to achieve a high surface quality, and another could be used to achieve a high deposition rate. The AM Cube is equipped with a total of three print heads. With the AM Cube, wire and powder as deposition material can be applied within a single manufacturing process in different production phases.

The system is designed as a platform and can be reconfigured from 4-axis machining to 5-axis machining with relatively little effort. For machining particularly reactive materials such as titanium, the entire system can be flooded with protective gas to reduce oxidation, enabling manufacturing to be performed under a protective gas atmosphere for several hours.

YOUR OWN 3D-PRINTED BIKE HELMET? THERE'S AN APP FOR THAT

Customization is one of the primary strengths of additive manufacturing. Companies that sell bike helmets have been taking advantage of this fact for a number of years by 3D-printing helmets that fit the specific shape of riders' heads. Now, London's Hexr has unveiled an app that customers can use to scan their own heads and then order a custom helmet. The company's products also get bonus points for sustainability: They are made of Polyamide 11, which is obtained solely from plant-based materials.

In partnership with EOS, Siemens, and the materials manufacturer Arkema, Hexr has devised a production process that covers everything from simulation to 3D printing and final inspection. The last step involves assembling all of a helmet's components, including its 3D-printed interior, exterior shell, and chinstrap. »Hexr offers good examples of a supply chain and production technology that are active and more flexible,« explains Markus Glasser, senior vice president for the EMEA region at EOS. »We're seeing lots of similar business cases in other industries, as well.«

Meanwhile, Hexr CEO Jamie Cook is very pleased with the current state of development of his company's scan-to-product solution. »With the precision fit made possible by our cutting-edge manufacturing process and the superior results we've achieved in independent safety tests (compared to conventional foam helmets), it's clear that we've fundamentally improved helmet technology – and it's thanks to 3D printing,« he reports.

Those looking to strap into custom headgear on their rides will, however, need to dig a bit deeper than they would for an ordinary helmet: A helmet from Hexr's online store currently costs £299 (around €330 as of August 2020).

Photos: Chiron, Hexr

FAVORING EFFICIENCY OVER ADDED VALUE

Text: Thomas Masuch

A structural component made of titanium: The image has been edited to display the machined geometry on the left and unmachined surfaces on the right.

Photo: PFW

While the rest of the aviation industry is counting on additive manufacturing to deliver better designs (and ultimately lighter jets), industry supplier PFW Aerospace GmbH is following an entirely different strategy at its headquarters in Speyer, Germany. The company, which manufactures components for the likes of Airbus and Boeing, is using industrial 3D printing to reduce its material requirements and thereby lower its production costs. It sounds quite simple, but this approach could change the competitive landscape in aviation in the years ahead.

Dr. Markus Gutensohn, head of production technology at PFW, has been dealing with additive manufacturing in his department for seven years. He started by researching powder bed technologies, which led to a discovery that was initially sobering, but eventually proved that much more valuable to the company. »PFW doesn't produce any parts that would benefit economically from the use of SLM technology,« Gutensohn reveals.

The aviation supplier, which was founded 107 years ago and now employs more than 2,200 people, counts pipe systems among its key business areas. »There's no point in optimizing the topology of pipes, for example; in terms of bionics, they already have the perfect shape,« Gutensohn explains. Instead of writing off 3D printing entirely, however, he and his team of engineers realigned their strategy and began looking for different AM technology.

WHERE CAN AM HELP REDUCE COSTS?

Tobias Theel is one of the engineers who mainly works on additive manufacturing at PFW. The 27-year-old figured out that the best match for the company was »technologies with higher build rates, like powder deposition welding«. Rather than using design programs to optimize components, PFW »takes a look at existing parts to find out where the use of AM would be more cost-effective,« as Theel puts it.

The company now sees the most potential in areas where parts are machined from solid blocks of titanium. Here, conventional milling techniques have two challenges to contend with: First, titanium is obviously hard and difficult to mill, which results in lengthy machine operations and a high degree of tool wear. Second, aircraft-grade titanium is quite expensive at around 50 euros per kilogram. Milling machines often end up turning 90 percent of these metal blocks into swarf, which indicates a great deal of optimization potential. According to Theel, directed energy disposition (DED) can help reduce the »buy-to-fly« ratio – that's weight of the raw material needed to build a given component to the weight of the component itself – from 9:1 at present to just 2:1.

A PARTNERSHIP ALONG THE RHINE

To achieve this aim, PFW became one of the first companies in its industry to enter into a partnership with BeAM. This young manufacturer of systems for powder deposition welding – a variant of the DED process – is based just around 120 kilometers up the Rhine in Strasbourg, France. »That means it doesn't take long for a technician to get here if we're dealing with some kind of issue,« Gutensohn points out. His department develops and fine-tunes many of PFW's production technologies, including in connection with automation, pipe bending systems, and workstations that have been adapted for Industry 4.0. Of the 16 engineers who work there, four focus solely on additive manufacturing.

> Some of our requests are incorporated straight into the development of the next generation of machines.

Since acquiring a Modulo 400 from BeAM in mid-2018, PFW has produced numerous components and prototypes for tensile tests and also conducted other types of trials. The two companies are working together closely to »get the machine ready for industrial series production«. To improve their ability to define their requirements, PFW's engineers have also developed and built their own AM unit for wire deposition welding. The machine and its three-kilowatt laser are capable of 3D printing components and test pieces in inert atmosphere, which Gutensohn says makes it possible to establish a benchmark between powder- and wire-based laser deposition welding.

The production director describes PFW as a company on the cutting edge of industrial laser deposition welding, which enables it to provide BeAM with valuable references. These include specifications that are meant to further industrialize BeAM's systems, such as by reducing setup and downtime or optimizing maintenance and process monitoring. Here, Gutensohn also appreciates the young French company's flexibility. »Some of our requests are incorporated straight into the development of the next generation of machines,« he says. »With a bigger manufacturer, we definitely wouldn't have that much influence.«

Frédéric Le Moullec, business development director bei BeAM, affirms that »working with our customers and taking their feedback into account is the focus of our development strategy«. He goes on to explain that DED technology has long been used to repair parts in the aviation sector, but is now evolving into an industrial method of producing high-quality components. »Our partnership with PFW has given us the chance to build up a great deal of technical expertise in this area and continue to support the industrialization of their production,« Le Moullec adds. »By sharing ideas with one another, we've been able to optimize our inert atmosphere and develop process parameters that make it possible to achieve material characteristics in line with the aviation industry's requirements.«

SIGHTS SET ON AUTOMATED PRODUCTION

To avoid becoming overly dependent on one manufacturer, Gutensohn reports that PFW is »

+ A star flange from PFW's bleed air system (the machining is 75% complete)

Photos: PFW

Tobias Theel (left) and Dr. Markus Gutensohn holding a star flange and the structural component in question in front of their Module 400 from BeAM

planning to install two other AM systems from other providers at its development facilities in Speyer in the months ahead. Meanwhile, we get a glimpse of the more distant future one floor down in the same building. There, robots are fitting dozens of milling centers with components, and the entire process chain has been automated to the greatest extent possible.

In their efforts to advance DED technology as fast as they can, PFW's engineers are trying to make a very complicated process »as simple as possible«. For example, they are only using one type of powder (from the GE subsidiary AP&C), which is already being used for electron beam welding after receiving corresponding certification from Airbus. In addition to individual components like retainers or star flanges, an array of substrate plates can be found near PFW's development unit from BeAM. These are used in the company's own labs to develop parameters for things like creating grinding patterns or carrying out tensile tests. Here, Gutensohn and Theel want to come up with statistical evidence that DED can be relied on to deliver consistent quality over extended periods of time.

While additive manufacturing is just one piece of the puzzle in this process chain, it's surely the most sophisticated one. From 3D printing to heat treatment, blasting, milling, X-ray inspection, and crack testing, there are more than 15 steps involved – »and the cleaning processes bring that number up to 25,« as Theel points out. His boss sees this as a crucial advantage for the company. »We have a lot of experience in all the other production processes, and we've had them certified for the aviation sector, as well,« Gutensohn says. »Plus, we're quite good at working with titanium and know how it will react in each processing step.«

AN INTEGRAL PART OF PFW'S TECHNOLOGY ROAD MAP

This much is clear: Only those with in-depth knowledge of the entire process chain can make industrial use of additive manufacturing. Gutensohn wants PFW to reach this milestone by 2023, but admits that the company »may have to get there even faster«. His department will develop the technology up to TRL 6 before handing it over to production. So far, PFW has reached TRL 4 with its DED process.

The fact that the Speyer-based aviation supplier might need to speed up its implementation is due in part to the tremendous amount of potential this new production method presents. »On an industrial scale, the component costs are sometimes even lower than the current material costs, where machining is involved,« Gutensohn reports.

While he says that this applies to fewer than 100 components in PFW's current products, Gutensohn believes an aircraft could eventually house several thousand such parts. This is where the use of AM could prove to be a real factor in competition; companies that don't get on board will be at risk of losing market share. It's no wonder that Hutchinson – the global manufacturer that acquired an ownership stake in PFW in early 2020 – has made metal deposition welding an integral part of the company's technology road map.

The foundation of Speyer's aircraft production operations, which can be seen from the city's famous Romanesque cathedral, dates back to the year 1913. Over the years, some of which included manufacturing automobiles, the company known as Pfalz-Flugzeugwerke (»Palatinate Aircraft Works«) evolved into an international supplier of tier-1 and -2 aviation components that generated around €450 million in turnover last year. PFW now produces some 1.24 million parts each year – landing flaps, reserve tanks, structural components, and more to complement its renowned pipe systems. Along with its base of operations in Speyer, the company has plants in England and Turkey. Twice in PFW's history, it has been majority-owned by Airbus. When the company was to be sold in 1996, ownership was instead transferred to its employees; Airbus then reacquired a majority stake in 2011 before eventually selling its shares to the Hutchinson group in 2020. Although PFW retains close ties to its former owner, it now has a total of 50 customers, including Boeing.

+ FURTHER INFORMATION:

» fon-mag.com

» pfw.aero

MORE ACCURATE THAN BRICKLAYERS

Text: Thomas Masuch

It looks as if you could move in right away, but unfortunately, it's not for sale: In the city of Westerlo (northern Belgium), Europe's largest 3D concrete printer has been used to build a two-story, 90-square-meter house that is both functional and aesthetically convincing. It can now be viewed on the premises of Kamp C, the company responsible for the project.

The residential/office building is located on Kamp C's premises in Westerlo, Belgium.

As a center for innovation and sustainability in construction in the Flemish region, Kamp C does not pursue any commercial interests. »Our main goal is to raise awareness of 3D printing as an efficient and sustainable technology for building houses,« says Emiel Ascione, project manager at Kamp C.

The 3D-printed demo house, which was funded by the EU as part of the C3PO project, could be used as a residential or office building. Among other things, the energy-efficient structure is equipped with underfloor heating, a facade of solar panels, and a green roof.

In realizing the project in cooperation with eight partners, Kamp C has demonstrated the potential additive manufacturing has in the construction industry. The walls, for example, were »printed« in just three weeks. »In addition, further time can be saved through the more efficient construction process,« explains Ascione. Meanwhile, 3D printing also delivers exactly what was planned digitally. This means that further work steps can be carried out without having to precisely re-measure the spaces involved. »Furthermore, things like pipes for electricity, heating, and water can be laid within the cavities in the walls without additional effort,« Ascione continues. This eliminates the need to open up walls after they are built.

It's no wonder that Kamp C has already attracted interested parties. »We've received several emails from people who would like to have a 3D-printed house like this,« says Ascione. Unfortunately, there are still legal hurdles to overcome before Kamp C's approach can be commercialized. That said, Ascione can well imagine that in the near future, the 3D printer will produce individual segments that can be installed in houses.

At Kamp C, research on the 3D printing of sustainable houses is set to continue. »We'll be getting even more creative in our follow-up project and involving other partners from our industry,« says Ascione. In addition to having built a demo house that is already quite famous, the civil engineer can report another achievement of the project: »The students who worked on it with us were so inspired by 3D printing for construction that they want to continue working with this technology in the future.«

Photos: Kamp C & Jasmien Smets

The low-energy house has functional furnishings *(above left)* and can be used in a variety of ways. The additive technique used produces walls with a visually appealing design *(above right)*. In the construction effort, Europe's largest 3D concrete printer was used *(left)*.

FURTHER INFORMATION:

» fon-mag.com
» kampc.be

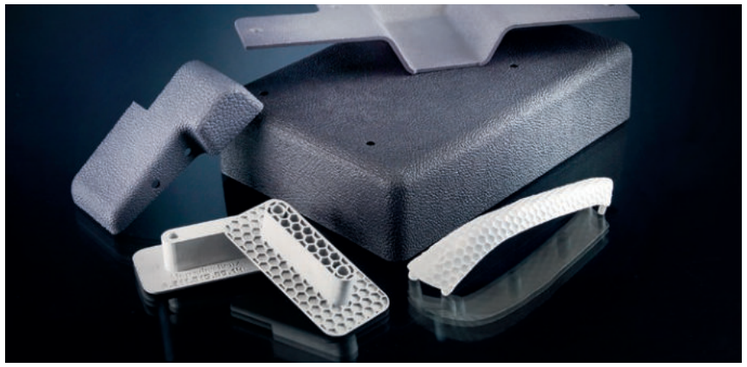
GETTING BUSES BACK ON THE STREET FASTER

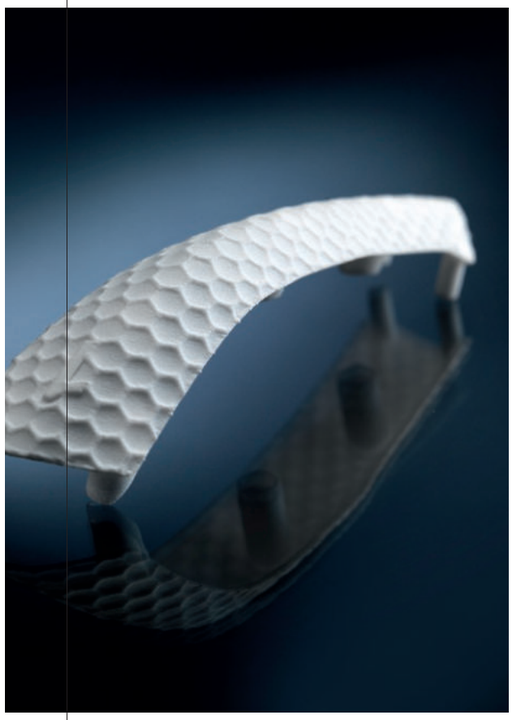
Text: Thomas Masuch
Photos: Daimler Buses

Up to this point, the 3D printing of spare parts has been one of the proven – if somewhat unspectacular – applications of additive manufacturing. At Daimler Buses, however, the tremendous potential of this field and the business models it could enable in the future are now coming into focus.

Daimler Buses belongs to Daimler Truck AG, which makes it a division of the Daimler group. It employs around 18,000 people and sold 32,600 buses and chassis in 2019, generating €4.7 billion.

Photo on top:
A selection of interior parts made of 3D-printed polymer, along with a bionically designed, 3D-printed metal component
Middle:
A 3D-printed aluminum mount with a polished surface
Below:
A handhold 3D-printed to a customer's specifications (including a honeycomb surface pattern)





When a bus company orders new custom-designed handholds for the seats on a Setra or Mercedes-Benz bus, the officially labeled handhold inserts are made by a 3D printer. These plastic components are manufactured by a certified service provider of Daimler Buses, which then inspects the parts itself before sending them on to the customer. »This is already the established process for more than 350 3D-printed spare parts in our bus and truck division. In terms of fully approved small-series components, that makes us one of the world's pioneers in 3D printing,« says Ralf Anderhofstadt, who heads the Center of Competence 3D-Printing, a facility that was founded at Daimler Trucks & Buses in early 2019. This leading position is the result of all of Daimler Buses' development efforts with regard to materials and related approval processes, as well as in component identification and certification. Meanwhile, the 38-year-old pace-setter in 3D printing has already been thinking about the next big thing for some time: the decentralized, autonomous manufacturing of the future, for example, which Anderhofstadt believes will raise the current model to a new level.

OVER 318,000 ACTIVE SPARE PARTS IN THE BUS SECTOR

For now, however, let's stay in the present. Daimler Buses currently has more than 318,000 active spare parts for its fleet. The company keeps 120,000 of them in a storage facility that is replenished daily by around 50 truck deliveries bearing up to 1,300 pallets. In addition to guaranteeing an availability period of 15 years for its spare parts, Daimler Buses strives to ensure that its customers have the best possible access to components. »In certain situations, that can be a real challenge,« Anderhofstadt reveals. »After a good number of years, it's often the case that suppliers no longer have certain tools – or even worse, the suppliers simply don't exist anymore. That's when it's twice as problematic: Customers spend more time waiting for the parts they need, and we face additional costs. We want to use additive manufacturing not only to relieve our internal pain points in this area, but especially to offer our customers much shorter delivery times, as well.«

This is why Anderhofstadt, who is also the head of 3D printing projects at Daimler Buses, »

Ralf Anderhofstadt heads the Center of Competence 3D-Printing, a facility that was founded at Daimler Trucks & Buses in early 2019.

As a result, our potential is always increasing.

has a cross-functional team that »started by focusing on the spare parts that were giving us trouble«. He goes on to describe having »already generated a lot of added value« with the more than 350 spare parts that are now certified and being 3D printed by the company's service providers. Among other things, this required the development of a special material that would meet the strict fire-prevention requirements that apply in the field of passenger transportation.

The spare parts that already support 3D printing include interior coverings, the aforementioned handhold inserts, and individual seating components, as well as metal parts like the mounts in exhaust systems. Customers that request these components now receive 3D-printed deliveries. »The response has been nothing but positive,« Anderhofstadt reports. »At the end of the day, the ability to obtain high-quality parts in short order is what counts for the customer. It isn't all that important how a part was made; the bus it's for just needs to get back on the road as quickly as possible.«

CONTINUOUS GROWTH IN THE POTENTIAL OF 3D-PRINTABLE SPARE PARTS

3D printing isn't the right production method for every spare part, of course. Anderhofstadt estimates that 8-10% of his company's overall range of bus components is compatible with additive manufacturing at the moment – but he makes a point of stressing those last three words. Indeed, new production techniques and materials (involving glass, rubber, and metal, for instance) are expanding the scope of 3D-printable spare parts. »As a result, our potential is always increasing,« he points out.

PROCUREMENT MODEL SET TO UNDERGO TRANSFORMATION

Anderhofstadt and his team – which works closely with more than 25 other departments at Daimler AG, including legal affairs, IT, training, and component manufacturing – also want to leverage the potential of additive manufacturing to transform their conventional procurement from »a purely physical into a digital business model«. Here, the concept of manufacturing at independent locations across the globe without the need for specific tools presents a huge opportunity. In other words, Daimler Buses wants to enable its partners to 3D-print spare parts right at the point of sale. Additive manufacturing could thus be a game-changer that revolutionizes the traditional business of purchasing, quality assurance, and shipping.

Daimler Buses' goal is to offer digital datasets as a supplement to its current business model. This will give customers the option to 3D-print select parts themselves or reach out to one of Daimler Buses' certified production partners. To ensure that only the ordered quantity of components is actually printed, the corresponding data deletes itself once the process is complete. What might sound like a vision of the distant future is already becoming a reality at Daimler, which is currently carrying out a pilot project with an initial partner company.

In this digital business model, Daimler provides not only the designs, but key process information regarding hardware, materials, the printing parameters required, and more. The quality of parts 3D-printed in this way has to match that of components that used to be manufactured conventionally, after all – including when external partners are involved. »For a premium manufacturer like us, quality is a top priority,« Anderhofstadt affirms.

A radical shift like this does come with challenges at many levels, however, from data security to the question of which materials and machines should be used. Daimler Buses is considering both the establishment of its own 3D printing centers at external organizations and cooperations with certified partners. »Ultimately, we're going to have a hybrid format in which we also take regional and cultural particularities into account,« Anderhofstadt predicts.

Anderhofstadt sees the transition from prototyping to series production as an essential step in this regard. Although spare parts fall within the scope of small-series manufacturing, he says all the approval processes in series production still need to be ensured. »This means that a part I print today in Germany has to be identical to a part I have printed two weeks from now in a defined decentralized location, whether that's within or outside of Europe,« he explains. This reproducibility is an integral element of the Daimler Buses model and a development topic for AM system manufacturers, service bureaus, and IT experts alike.

AN INTEGRATED MARKER TO PREVENT PRODUCT PIRACY

Meanwhile, the opportunities 3D printing is presenting at Daimler Buses could quickly become risks, as well, which is why brand protection is playing a prominent role in this development. As ongoing advancements continue to be made in scanning technology, reverse engineering methods are becoming increasingly sophisticated. It's now quite easy to generate data from a physical component and use it to create copies on a 3D printer. »This could make it possible to pirate products even more quickly despite the hurdles involved,« Anderhofstadt warns.

To prevent this, his company adds special protection to its 3D-printed parts that enable it to definitively tell whether a component was made by Daimler Buses or a certified partner – or originated from some other source.

+ FURTHER INFORMATION:

» fon-mag.com

» daimler-truck.com/brands/buses

Photos: Daimler Buses

Post-processing *(dye and blasting)* of 3D-printed parts
Below left:
Online configurator for customer-specific spare parts

WHEN SAWDUST IS POURING OUT OF THE PRINTER NOZZLE

Text: Thomas Masuch

Forust is using a 3D printer to produce surface patterns that recall the grain of real wood.

Photos: Forust

3D printing veteran Andrew Jeffery has loads of ideas for the use of 3D printed wood. In his studio in the Bay Area of San Francisco, the CEO of Forust works with a specially hacked 3D printer to test different wood materials and recipes for 3D printing. »Wood is a natural, ecological, and beautiful material,« explains Jeffery talking to Formnext Magazine. He spent much of his previous career working with 3D printed ceramics, and now is delighted with the sustainable and recyclable origins of the material wood. »We are printing with sawdust, agricultural waste, our process makes products that are lightweight, functional, beautiful and sustainable.«

Photo 1:
The founders in an online meeting.
Photo 2:
Forust's raw material is a mix of sawdust, wood scraps, wood glue, and water.
Photo 3:
Numerous experiments are being conducted on a modified ProJet 860 from 3D Systems.

We are at a very early stage and still have a lot of development work to do.

Forust was founded last year together with Virginia San Fratello, professor of interior design at San José State University, and Ronald Rael, professor of architecture at The University of California Berkeley. In 2010 San Fratello and Rael founded Emerging Objects – a »Make Tank«, that develops materials and building applications for 3D printing. Rael and San Fratello developed 3D printing wood as part of their research at their respective universities.

They've joined forces with Jeffery to develop a 3D printed collection of wood tiles and blocks for interior designers. They also have ideas for developing light fixtures, furniture, lightweight screens for partitioning offices and public spaces, desktop accessories, vent covers and a host of other products for the interior. They are even exploring the notion of 3D printing wood musical instruments. As Jeffery explains, the whole endeavor raises questions about how wood is used in the 21 century. »This is linked to the hope that it may be possible to buy such products for your home or business in your own a local shop.«

Before such concrete implementation can begin, Jeffery and his two comrades-in-arms still have a long, busy road ahead of them. »We are at a very early stage and still have a lot of development work to do«, explains Jeffery. Numerous prototypes are currently being built and tested on our new Projet 860 from 3D Systems. Modifications to the printer itself are also being made, for example the ink nozzle has been disconnected and the powder supply has been adapted for the coarseness of the wood. »We have also increased the thickness of the layers significantly in order to minimize print time,« explains Jeffery »which creates a more textured surface one that is more reminiscent of wood grain«.

The printed material is a mixture of sawdust, wood debris, wood glue, and water. The high sustainability factor comes from the fact that the printable matrix consists of waste material from the wood industry that is normally sold to power stations at a price of 70 euros per ton, for example, and is then burned there. According to Jeffery, 3D printing can also be done using fairly inexpensive timber that would otherwise be unsuitable for furniture. Trials are also being conducted using bamboo.

The technical modifications to the process and the 3D-printer were not a great challenge for Jeffery, as an engineer, he has been involved with 3D printing since the early 90's »when the technology was in its infancy.« He also has experience with start-ups and founding new companies: One of his early 3D printing projects was called Specific Surface Corporation whose technology formed the basis for his next venture Figulo, which was sold to 3D Systems in 2013. Again, in 2017, Jeffery was instrumental in starting Boston Ceramics a subsidiary of German company FIT AG who then moved the Boston-based 3D printing production to their facility in Bavaria in 2019.

In late 2019 Jeffery moved to California to start Forust with Rael and San Fratello. »Although we are actively seeking investors, but in the current adverse economic climate the company is currently self-funded and exploring and developing products for sale to generate revenue.« explains Jeffery. Their goal is to have their first collection of 3D printed products ready for market by the end of 2020.

FURTHER INFORMATION:

» fon-mag.com
» forust.io

TRENDS

DONE IN ONE PASS

The global COVID-19 pandemic has given momentum to a large number of companies not only in tech, but in the bicycle industry, as well. As of May 2020, there was no shortage of manufacturers with no more inventory to sell. This boom has also benefited several bicycle start-ups that use 3D printing to produce custom carbon frames.

Among serious cyclists, these frames have become at least as popular as those made of aluminum. The first 3D-printed bicycle frames (from manufacturers like Arevo) hit the market in 2019. Now, Silicon Valley has also brought forth the first AM-based unibody carbon frame, as the Californian bike manufacturer Superstrata recently announced. The company, which is showcasing its products on the start-up platform Indiegogo, has already produced a prototype.

Unlike other carbon fiber bikes whose frames are glued and bolted together, the Superstrata frame is constructed without joints or glue for seamless strength.

The main advantage of using 3D printers in this context is the ability to customize the geometry involved. Frames can thus be adapted to riders' height and weight, the length of their arms and legs, their preferred sitting positions, and the desired amount of stiffness. According to Superstrata, more than 500,000 different combinations of these characteristics are possible. »This bike was designed to leverage all the benefits of this new manufacturing technology to get the best of both worlds: strength and lightness,« said Bill Stephens, an award-winning bicycle designer and the creative force behind Superstrata.

Two versions of Californian bikes will be available: Superstrata C, a classic bicycle, and Superstrata E, an e-bicycle, providing for up to a 55-mile range. Shipping begins in December 2020.

EUROPE AHEAD OF THE US IN AM PATENT APPLICATIONS

European patent applications for additive manufacturing (AM), increased at an average annual rate of 36% from 2015 to 2018, a new study from the European Patent Office (EPO) shows. This is more than ten times greater than the average yearly growth of all applications at the Office combined in the same period (3.5%). The report, entitled »Patents and additive manufacturing - Trends in 3D printing technologies«, further shows that European inventors and businesses are accounting for almost half of AM patent applications filed with the EPO in the period from 2010 to 2018.

Among single countries, most patent applications filed for the period 2010-2018 came from the USA, accounting for 35 percent (5,747). Among the European patent applications filed in the same period (7,863), the majority came from Germany (3,155 applications).

The data further indicate that the impact of AM technologies spans a large variety of industries. Since 2010 the use of AM in the health sector has generated the greatest demand for patents (4 018 applications), followed by energy and transportation (2 001 and 961 applications respectively). Rapid growth was also observed in areas such as industrial tooling, electronics, construction and consumer goods, and the food sector.

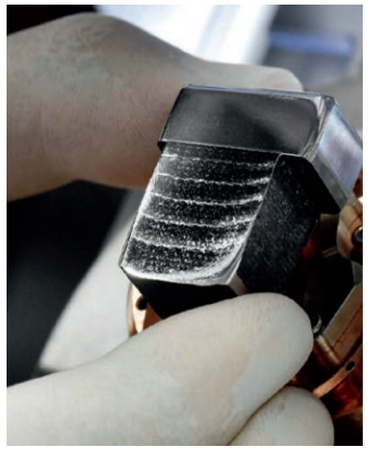
This diversity of sectors is also reflected in the profile of the top applicants at the EPO. The top 25 applicants accounted for about 30% (or 6 548) of all AM patent applications filed between 2000 and 2018. Led by large US firms General Electric and United Technologies, with Europe's Siemens in third place, the list is comprised of a diverse range of players from different technology fields such as transportation, chemicals and pharmaceuticals, information technology, electronics, imaging and consumer goods, as well as pure 3D-printing specialists such as Stratasys, 3D Systems and EOS.

Photos: Superstrata

TRENDS

3D PRINTED DAMASCUS STEEL

Damascus steel is hard yet tough because it consists of layers of different iron alloys. In ancient times, this was the material of choice, especially for sword blades. A team from the Max-Planck-Institut für Eisenforschung in Düsseldorf and the Fraunhofer Institute for Laser Technology in Aachen has developed a process that allows this type of steel to be produced layer by layer in a 3D printer. The hardness of each individual layer can be specifically adjusted. Such composites could be of interest for aerospace components or tools produced with 3D printers as the Max-Planck-Institut reports.



Celtic smiths combined various iron alloys (perhaps initially only to recycle the valuable iron) and thus obtained the material that later became known as Damascus steel or damask. It owes its name to the trading centre through which the composite material of oriental origin entered Europe.

Although there are currently ferrous alloys that are both hard and tough, they are often not specifically made for the 3D printing process. The scientists have developed a steel that consists of only a single starting material but is made up of alternating hard and ductile layers – a kind of Damascus steel, through 3D printing.

They developed an alloy consisting of iron, nickel, and titanium. At first, this alloy is relatively soft. »Under certain conditions, small nickel–titanium micro-structures form. These, so-called precipitates, harden the material«, explains Philipp Kürnsteiner, post-doctoral researcher at the MPIE.

In order to be able to create the nickel–titanium structures, the researchers interrupt the printing process for a certain time after each newly deposited layer. The metal cools down to below 195°C. »Below this temperature, a transformation of the crystal structure occurs in the steel«, explains Eric Jägle, head of the »Alloys for Additive Manufacturing« group at the Max-Planck-Institut für Eisenforschung and, since January 2020, professor at the University of the Bundeswehr Munich.

CHICKEN NUGGETS OUT OF THE LABORATORY

Photos: KFC, Frank Vinken

KFC, a global chicken restaurant brand, is launching the development of 3D bioprinting technology to create chicken meat in cooperation with the Russian 3D Bioprinting Solutions research laboratory. The idea of crafting the »meat of the future« arose among partners in response to the growing popularity of a healthy lifestyle and nutrition, the annual increase in demand for alternatives to traditional meat and the need to develop more environmentally friendly methods of food production. The project aims to create the world's first laboratory-produced chicken nuggets. As 3D Bioprinting Solutions reports, the both taste and appearance will be as close as possible to the original KFC product, Receiving a final product for testing is already planned for the fall of 2020 in Moscow.

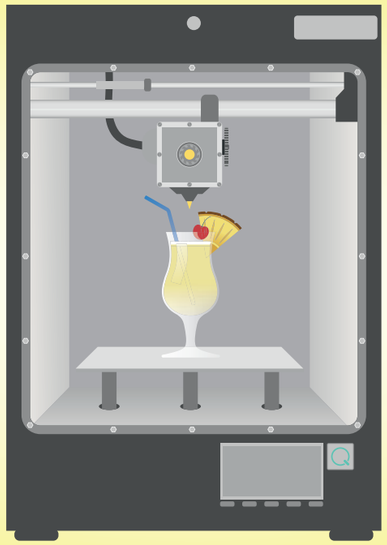
3D Bioprinting Solutions is developing additive bioprinting technology using chicken cells and plant material, allowing it to reproduce the taste and texture of chicken meat almost without involving animals in the process. KFC will provide its partner with all of the necessary ingredients, such as breading and spices, to achieve the signature KFC taste.

The Russian laboratory confirms that the used biomeat has exactly the same microelements as the original product, while excluding various additives that are used in traditional farming and animal husbandry, creating a cleaner final product.

»Our experiment in testing 3D bioprinting technology to create chicken products can also help address several looming global problems. We are glad to contribute to its development and are working to make it available to thousands of people in Russia and, if possible, around the world«, said Raisa Polyakova, General Manager of KFC Russia & CIS.

OUTSIDE THE BOX

Fluid Growth



While the past few months have seen companies in IT and other high-tech sectors garner most of the praise for this summer's economic upswing, a far more traditional Chinese firm has gone almost unnoticed in taking its unparalleled growth to dizzying new heights. Kwaichow Moutai, a distillery named after the picturesque community it calls home in southwest China, produces potent potables that have set the heads of many investors and stock traders to spinning. Since going public in Shanghai in 2001, its share price has risen by more than 15,000%, giving the company a stock market value of around €250 billion.

It may thus come as some surprise that actually drinking Kwaichow Moutai's baijiu – which packs an alcohol by volume of up to 70% – is something like »drinking razor blades«, as U.S. news anchor Dan Rather claimed around 50 years ago. Nevertheless – or perhaps for that very reason? – the company manages to sell some 50,000 tons of the stuff every year. The tradition of distilling it from fermented sorghum goes back more than 2,000 years, and neither the price of a bottle (upwards of €200) nor the countless counterfeits out there have been able to slow Kwaichow Moutai's success.

Considering the potential growth and profit margins in this industry, one wonders why the world of 3D printing hasn't taken a very close look at beverages up to this point. It seems that hardly a week goes by without a company reporting a corresponding breakthrough in solid foods. In the future, everything from chicken nuggets (see page 21) to salmon, steaks, and other fare is expected to be served up by 3D printers. Some restaurants even have additive items on the menu today.

While you rarely hear of additive innovations when it comes to beverages, the groundwork has at least been laid. In 2017, Benjamin Greimel (a student) used a robotic arm to add tiny droplets of oil to a cocktail, creating a floating work of art in a glass. Ranch Companies, an organization ex-boxer Mike Tyson invested in some years ago, is taking a slightly less artistic approach. In cooperation with the California start-up Smart Cups, the company wants to 3D-print a variety of soluble added ingredients – including cannabis – into plastic cups. According to Ranch Companies (and its somewhat shaky reasoning), this practice will be both medically useful and environmentally friendly because with customers adding their own water to the cups, they can be transported empty. From the environmental perspective in particular, this fluid approach to AM will need some more fine-tuning before it can really go to people's heads. Until then, you can always reach for a bottle of Kwaichow Moutai. The taste does take some getting used to, but for now, it (along with the headache you'll have the next morning) is definitely more sustainable. In that spirit – ganbei!

Text: Thomas Masuch

Illustration: feedbackmedia.de, iStock /discan, iStock /IkonStudio

AM4U – READ, SEE AND UNDERSTAND ADDITIVE MANUFACTURING

AM Field Guide

The AM Field Guide was designed in cooperation with Prof. Dr.-Ing.Steffen Ritter from Reutlingen University and now also provides a digital basic understanding of the individual process principles and materials of AM production.

+ Deepen your theory knowledge: formnext.com/amfieldguide

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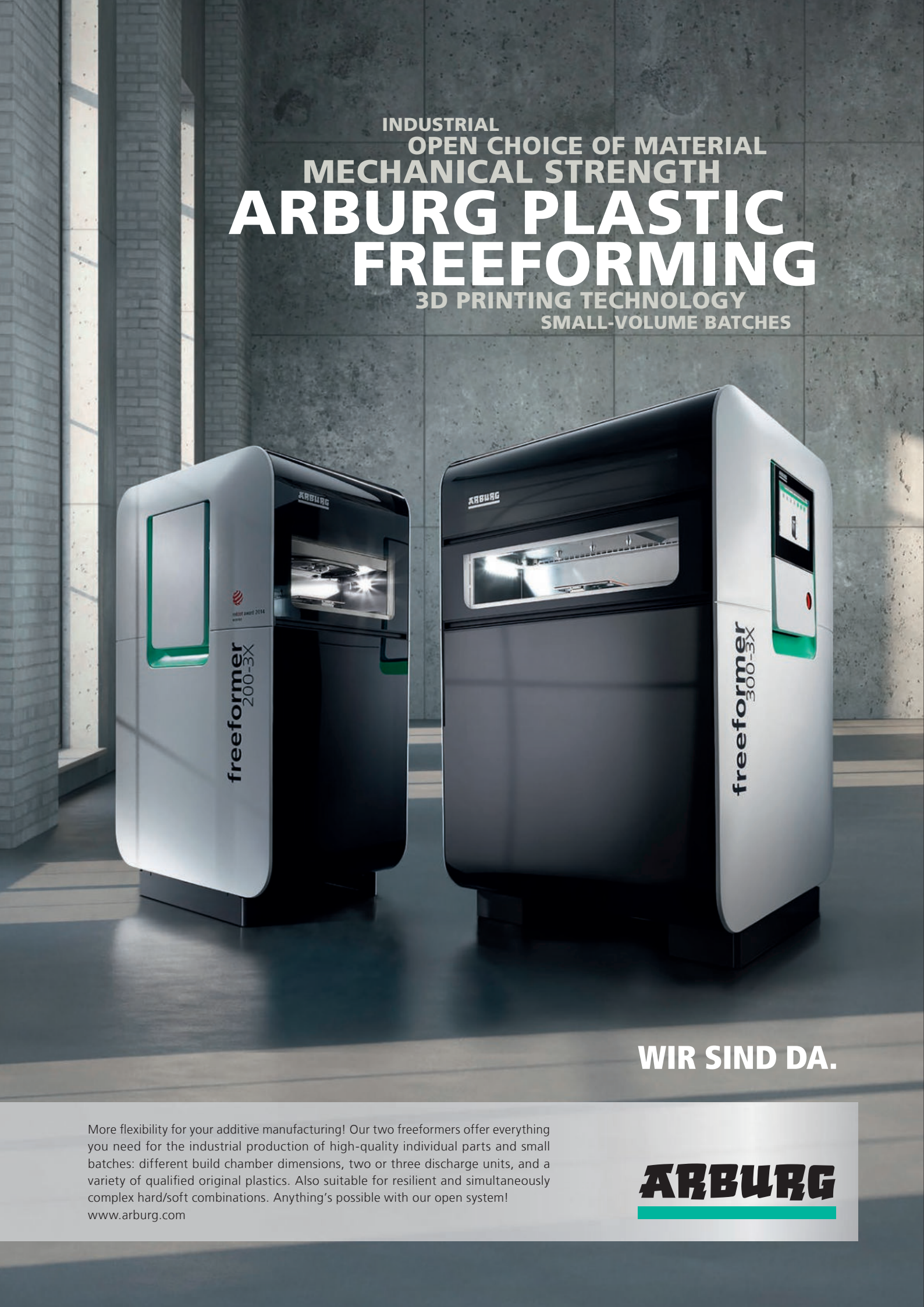
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