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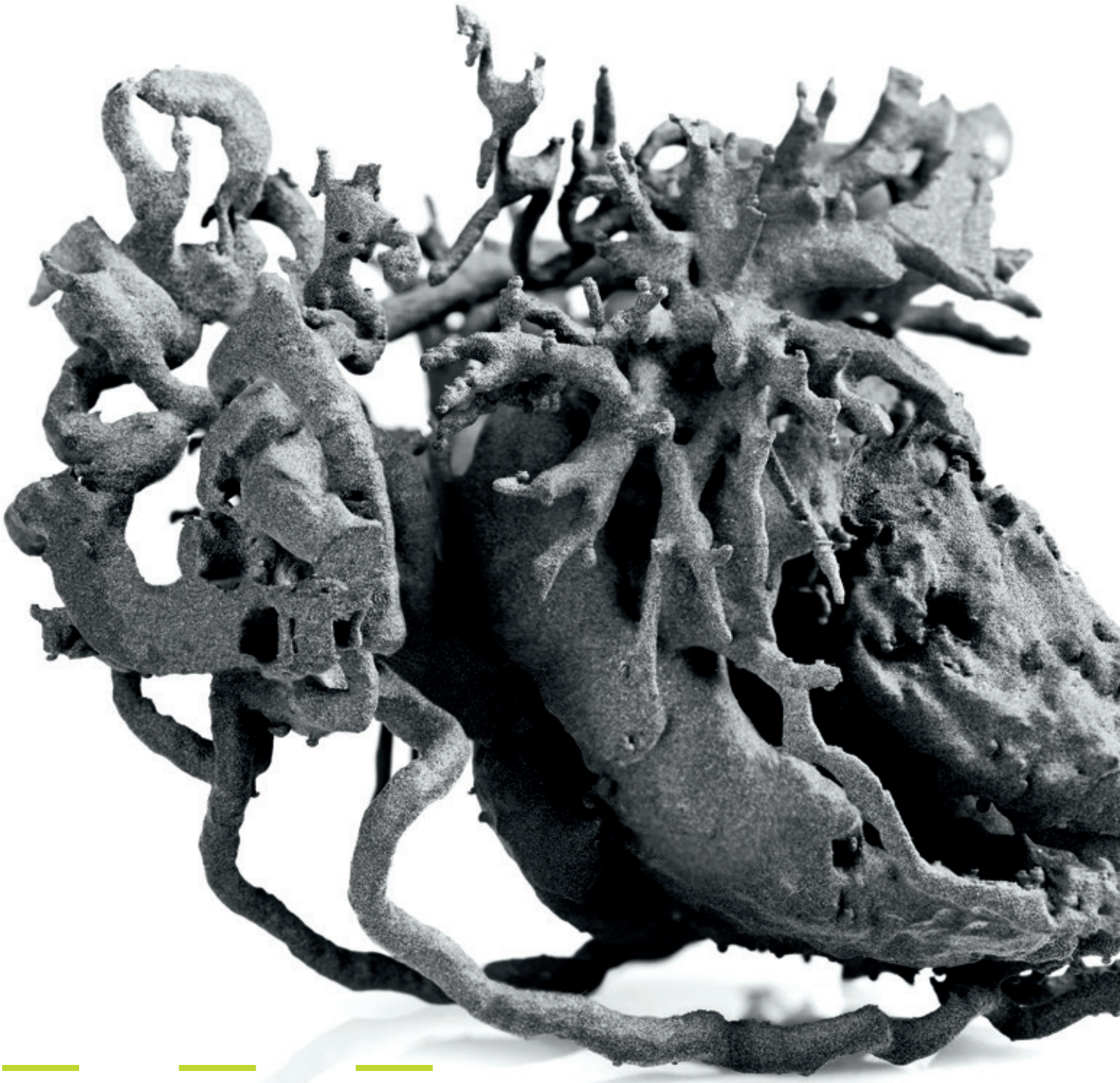
formnext magazine



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The past is knowledge-driven and manufacture-driven. The future is creativity-driven.

[Chak Ma, Executive Chairman, Alibaba Group]

EDITORIAL

Is additive manufacturing still a future topic? This may surprise you, but I'd say it's not. While we still have lots of plans for the future, additive manufacturing is already well under way. And that doesn't just apply to a few pioneers in the sector.

Additive manufacturing is now well established in the industry. This is not only demonstrated by our experience and that of our exhibitors and partners; it is now statistically proven. According to a survey conducted by Bitkom Research, 27% of German manufacturing companies are already using 3D printing. In the larger companies with more than 500 employees, the figure is as high as 45%. Even more impressive is the result of a survey by the German industry association VDMA, which found that 47% of VDMA members use additive manufacturing – mainly for prototypes, but often also for tools and spare or series parts.

Considering that there are more than 200,000 companies in the manufacturing industry in Germany alone, this gives a good idea of just how widespread additive manufacturing has now become.

Of course, not all companies that use 3D printing produce large volumes using additive manufacturing techniques. Sometimes the development department has only one plastic printer. But even this is an important step in many companies. After all, the additive thinking of developers and designers is the starting-point and prerequisite for the success of industrial 3D printing.

In this issue, we'd like to show you how additive manufacturing can be deployed in various industrial sectors. That's why we've visited many industrial companies exclusively for you. We'll show you how midsize companies can produce high volumes and how printed components can create added value even in the extreme environment of a forge.

The success story of additive technologies is also evident at Formnext. This summer – despite significant growth at the Frankfurt exhibition center – our Formnext exhibition in Hall 3 is already at full capacity. And if you, too, would like to share your success stories with us, you're welcome to contact us.

I hope you find the read enjoyable and inspiring. And I look forward to seeing you at Formnext 2018 in Frankfurt!

Sincerely,
Sascha F. Wenzler
Vice President Formnext

Cover: Sinterit / Wojciech Hajduk

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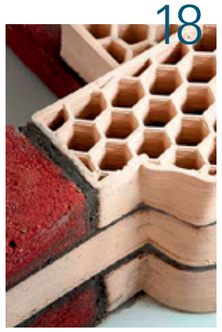
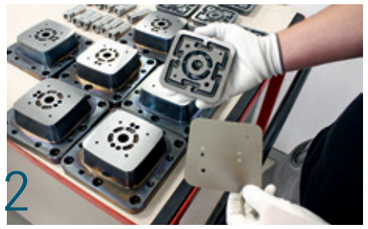




Photos: ismd / TU Darmstadt, Zikomm / Th. Masuch (2), Robert Hofmann

FORMNEXT NEWS

10 WEEKS BEFORE START, ENTIRE HALL 3 FULL TO CAPACITY

In 2018, Formnext will continue to show itself from its best side: 10 weeks before the start of the fair, the two hall levels of Hall 3 are already full to capacity with 550 exhibitors expected and 36,000 square metres of exhibition space.

The leading international exhibition for additive manufacturing and the next generation of manufacturing technologies has again seen significant growth, both in terms of exhibitors and exhibition space.

To continue to meet the rising demand in the future, Formnext will next year move to the newly built Hall 12 at Frankfurt's exhibition ground, which, together with Hall 11, will provide an exhibition area of some 58,000 square meters. »A move of this kind poses challenges for the exhibitors and for us as organizers. But we're naturally pleased to have this new combination of halls with their state-of-the-art infrastructure at our disposal,« says Sascha F. Wenzler, Vice President for Formnext at event organizer Mesago Messe Frankfurt GmbH.

Photo: Mesago / Klaus Mellenthin

TRANSATLANTIC SUMMIT ON AM STANDARDS

Uniform production standards have been a key issue in additive manufacturing for years and are essential for many industrial applications. Many developments in this area have already been initiated in Europe and the USA. To present these efforts on both sides of the Atlantic and promote joint further development, the first international standards summit will be held at Formnext in Frankfurt on 14 November 2018. The event brings together experts and decision-makers from the USA and Europe.

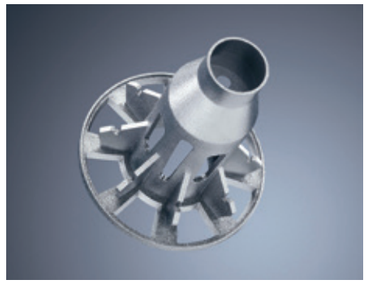
Entitled »AM Standards Forum«, the standardization summit is organized by Formnext in cooperation with the U.S. Commercial Service and in conjunction with German and American partners.

One of the goals is to highlight the advantages of international cooperation on standards even more strongly and to develop important fields of cooperation. »Advances in areas such as industry 4.0, quality assurance, and the increasing integration of additive manufacturing in cross-technology processes is making uniform standards even more important,« says Sascha F. Wenzler, Vice President for Formnext at event organizer Mesago Messe Frankfurt GmbH. »This makes it all the more important to bring standards to a uniform level in the world's most important additive markets, Europe and the USA.«

Current developments relating to additive manufacturing standards will be presented at the summit, also with regard to specific industry sectors. Summit participants include high-ranking representatives from the world of politics, from leading international companies, and from standardization institutions.

+ FURTHER INFORMATION:
» formnext.com/Visitors

NEWS



CORRECTLY QUALIFYING AM IN THE AEROSPACE INDUSTRY

Additive manufacturing has been used in the aerospace industry for years. At the same time, the challenges regarding component quality are exceptionally high. That's why Ampower and Trumpf conducted a study that has developed best practices for the additive manufacturing qualification process in the aviation sector. Trumpf will be presenting the resulting recommendations for action, which also apply to other sectors, for the first time at Formnext 2018.

According to the study, extensive process-specific documentation and verification are required to qualify additive manufacturing. Because of the lack of general standards, the only guidelines currently available are the specifications of OEMs, such as Airbus.

To ensure products are totally traceable, suppliers in the aerospace industry have to implement these internal instructions and continuously record their manufacturing process.

For suppliers, the study provides clear recommendations for action. These include comprehensive process documentation, specialization in one material, employee training, and a clear commitment on the part of management. According to the study, developing a qualified additive manufacturing process chain generates high costs. Becoming a supplier therefore entails a high degree of willingness to invest.

» Trumpf at Formnext 2018: 3.0-D50
» The study as a booklet: am-power.de/en/insights
» Ampower at Formnext 2018: 3.0-E30

SMART CONCRETE WALL

BigRep is blazing a new trail in architecture – with the first smart concrete wall. Developed at NOWlab, the innovation department at the Berlin-based company, the wall combines a smooth surface, sophisticated geometric forms, and an intelligent, sensor-controlled lighting system.

The wall was produced with project partners in Dubai and with the help of plastic forms manufactured on a BigRep ONE large-scale printer. In contrast to direct 3D concrete printing, the printed forms enable a high surface quality, says Jörg Petri, project manager and co-founder of NOWlab.

The octagonal light elements, which are also printed, are activated by touching a sensor in the wall. According to BigRep, the great advantages of the patented technology are that the 3D printed forms can be used to produce larger numbers of wall elements and that architects have direct control over development of their designs.

»Techniques that once belonged to skilled craftsman, and have all but vanished from current building sites, can be reinstated thanks to 3D printing«, says Maik Dobberack, Communications and Event Manager at BigRep.

» BigRep at Formnext 2018: 3.1-E20

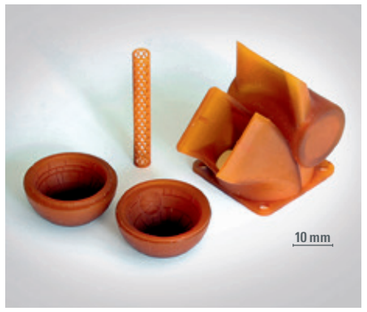
OPERATING TEMPERATURE ABOVE 250°C

At Formnext 2018, Cubicure will be presenting a new photopolymer with high strength of more than 70 MPa and a high heat deflection temperature (above 250°C). This is the company's response to the requirements in plastic injection molding, where 3D printed forms have to offer a high degree of production accuracy combined with good material properties.

Especially when it comes to small, complex tools, 3D tool printing offers an economic advantage over aluminum tools but still allows components to be produced from original material for prototypes and (small-scale) series production.

With its Hot Lithography technology, Cubicure offers a stereolithography process that processes viscous photopolymers with high precision at greatly increased structuring temperatures of up to 120°C. The high printing temperature enables the use of highly viscous chemical building blocks that were previously not suitable for stereolithographic processing. According to Cubicure, this significantly expands the range of materials for 3D printing.

» Cubicure at Formnext 2018: 3.1-G59



Photos: Trumpf AM Power (on top), BigRep Beton (centre), Cubicure (below)

NEWS

12 METERS LONG

Think big! That's a slogan that applies to the US company Thermwood, which has installed what it describes as the world's largest composite 3D printer. The printer, called Thermwood LSAM 10'x40', is more than 12 meters long and produces components for the self-driving Olli shuttle bus, which is manufactured using additive technologies at Local Motors in Knoxville, Tennessee. The bus was developed back in 2016 and is suitable for deployment in cities, stadiums, or large companies.

Thermwood's printer uses a two-step production process. The part is first 3D printed layer by layer, to slightly larger than the final size, then it is trimmed to its exact final net size and shape using a CNC router. Both printing and trimming is performed on the same machine using two gantries, one for printing and one for trimming.

» Further photos and information: fon-mag.com

JUST ONE CORRECTION LOOP

Werth Messtechnik has integrated the new Formcorrect function into its Winwerth metrology software, promising significant cost reductions for the development process in plastic injection molding. The new function, which will also be presented at Formnext 2018, enables the tool or CAD model for the 3D-printing process to be modified so that the finished workpiece is within the specified toler-ances.

A new simulation of the manufacturing process is performed based on the corrected workpiece CAD model, and a data set is generated for postprocessing the tool. The simulation parameters are the same as those for producing the first sample workpiece. Thanks to the high degree of precision, only one correction loop is often necessary with Formcorrect.

» Werth at Formnext 2018: 3.1-G91

Photos: Local Motors (on top)

NEWS

LASER MELTING INSTEAD OF SOLDERING

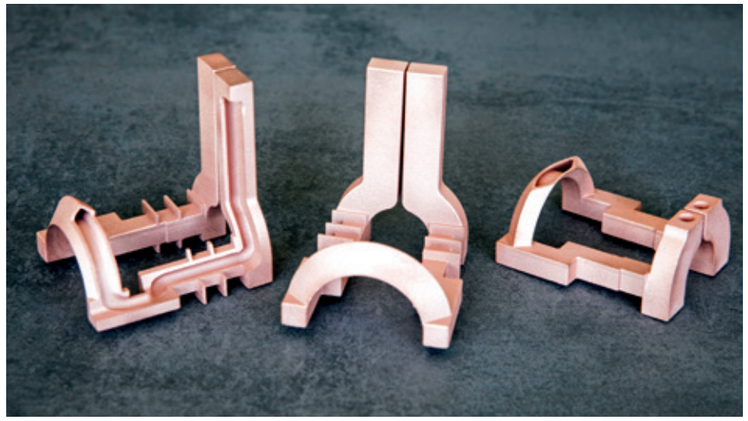
As a supplier to numerous industries, GKN Powder Metallurgy is increasingly focusing on additive series production. For about a year now, the company has also been producing 3D printed inductors, which are already being used in large volumes in automotive series production. GKN will also showcase its expertise in the production of electrically conductive copper alloys at Formnext.

The copper inductors are used in inductive hardening. »However, the unpredictable service life and quality of manually manufactured copper inductors do not meet growing industrial demands,« says Ümit Aydin, Global Business Development Director Additive Manufacturing at GKN Powder Metallurgy. For one thing, production using manual soldering is relatively cost-intensive. What's more, each soldering point disrupts the flow of current, leading to significant energy loss.

At GKN, the inductors are manufactured using the laser melting process primarily at the company's production facility in Bonn, which is certified to the IATF 16949:2016 standard. Aydin sees the particular challenge in manufacturing copper components as »developing the process parameters for the material in such a way that the material can be processed in the laser process, while also achieving electrical conductivity«.

In addition to copper parts, GKN offers components made of six different metal powders. The range also includes special powders such as the case-hardenable steel 20MnCr5.

» GKN Powder Metallurgy at Formnext 2018: 3.1-E30



GKN Powder Metallurgy produces 3D printed inductors, which are already being used in large volumes.

Cover photo!

SLS PRINTING TO SAVE TINY LIVES

Pediatric cardiac surgery is one of the most demanding medical specialties. It needs to deal with delicate structures like tiny little hearts of neonates. 3D printing helps to plan surgery. Medical doctors are not the only beneficiaries, it is also important for the patients and in this case, parents to understand the situation and give the permission to operate.

An example is the story of Kordian, a 3-week old infant from Poland was suffering from the heart disease called interrupted aortic arch. Doctors along with the mother had to decide quickly about undertaking the procedure.

Doctors at University Clinical Center in Gdańsk, Poland, decided to use 3d printed model of Kordian's heart in the original size as a support. The model of the heart was printed on the SLS printer Lisa. According to the Polish 3D printing manufacturer Sinterit, common FDM printers didn't reach a solution that would provide surgical precision.

»Touching this printed model helped me realize the seriousness of my child's disease«, reported the mother. Today Kordian is 18 months old.

» Sinterit at Formnext 2018: 3.1-G41

Photos: GKN Powder Metallurgy (on top), Sinterit (below)

RED-HOT STEEL MEETS HIGH-PRECISION COOLING

Text: Thomas Masuch

At temperatures of 1,250 degrees Celsius, the red-hot steel in forges places extreme demands on employees and materials alike. That's why cooling the dies is a key factor in the production process. At the forge company Hammerwerk Fridingen a plastic spray head, manufactured using additive techniques, has been tested for the first time. And even after several months, it is still standing up to the infernal conditions.

Photos: Zikomm/Th. Masuch

We can optimally adapt the droplet size and distribution to the conditions.

Entering Workshop 7 at the Hammerwerk Fridingen is like stepping into a bygone industrial age. The air reeks of steel, and the presses, each weighing several thousand tons, rock the surroundings with each deafening stroke. Rugged, powerful men grip the red-hot steel parts with long iron tongs hanging on chains, heaving them skillfully into the machines or from one die into the next. The steel hammers and presses tirelessly forge the glowing metal into universal joints and pistons that weigh several kilograms and will later be used in trucks.

The earplugs and steel toe-capped boots that visitors like us have to wear are certainly needed here. There could hardly be a greater contrast than between these surroundings and a sterile, clean car plant or even an additive manufacturing facility, where the environment is spotless, and conversations can be held in a whisper.

And yet additive manufacturing is also venturing into this tough, power-packed, and unforgiving world: or to be more precise, into the belly of a 5.5-meter-high Manzoni SR 2000 hot forging press, which effortlessly crushes glowing steel sections with its regular, 2,000-ton strokes into cross-shaped automotive components. The press contains a spray head created using additive manufacturing techniques, which repeatedly sprays a mist of saline solution onto the dies between strokes. This not only cools the dies, but also ensures that the red-hot blocks, which have a temperature of 1,250 degrees Celsius, are easily released from the mold.

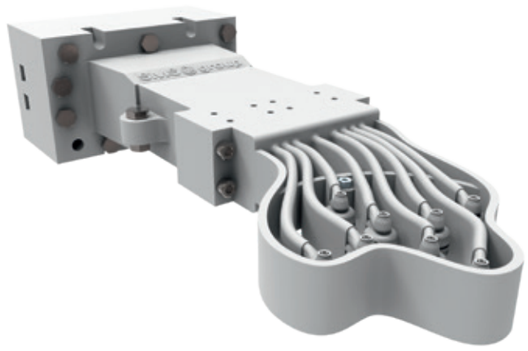
The 3D printed spray head has already withstood 200,000 strokes. »We really didn't expect this at the outset,« explains Axel Roßbach. The engineer from the SMS Group developed the spray head in cooperation with Hammerwerk Fridingen and tailored it to local requirements. Both project partners already rate the fact that the laser-sintered polyamide spray head has survived these hellish conditions for months as a great success. According to Roßbach, installing and connecting the head also went off smoothly and without significant additional effort.

In the 3D printed version the cooling medium (a mixture of various salts and water) is fed to the desired points via curved pathways. At the outlet, the coolant is converted into a fine aerosol by compressed air and sprayed onto the hot dies. An additional control air line for switching the coolant on and off, directly at each nozzle, was rapidly installed. »We can optimally adapt the droplet size and distribution to the conditions,« says Roßbach. Quite apart from this, the spray head was also nominated for the German Design Award 2018, no doubt thanks to its eye-catching contours. »

Photo left:
The additive spray head is used regularly between the individual strokes of the press.
Photo on top:
Axel Roßbach, Dr. Marco Laufer and Kai Allweil (from left).
Photo below:
Hammerwerk Fridingen is located in the Danube valley.

In the forging press, red-hot steel blocks are transformed into cross-shaped automotive parts at temperatures of 1250 degrees.

Photo below:
The spray head developed by the SMS Group is not only functional, but also attractive. Thanks to its eye-catching form, it was nominated for the German Design Award 2018.



Usually, the SMS Group supplies die presses for forging companies such as the hammer mill or builds entire production plants. Individual additive components are visible only on closer inspection, but the group nevertheless sees the technology as playing an important role. SMS has set up its own internal additive manufacturing group, which is looking for ways to achieve optimization through additive manufacturing across the entire organization.

»We want to be an innovative project partner for our customers and, of course, also demonstrate this through the use of state-of-the-art technologies,« says Roßbach, who worked in the drop forging industry for several years and thus has close ties to the sector.

However, deployment of the additive spray head in Hammerwerk Fridingen got off to anything but a flying start. »The 3D printed spray head looked great, but we wondered if it would last,« says Dr. Marco Laufer, Technical Plant Manager, Metal Forming Technology. The first model did not hold up, confirming Laufer's initial skepticism. The wall thicknesses were too small, causing the cooling medium to penetrate them, was Roßbach's subsequent diagnosis. And Laufer, a man who doesn't mince his words, remembers »a foam gun«.

Roßbach and his team optimized the spray head, and it has now been in service reliably for four months – in close conjunction with a conventional stainless-steel spray head. The 3D printed variant weighs considerably less, lightening the load on the underlying mechanical components. This is a benefit that cannot be quantified directly but, according to plant

Photos: SMS Group (below), Zikomm / Th. Masuch (on top)

The 3D printed spray head looked great, but we wondered if it would last.

manager Laufer, it will certainly become apparent during the next maintenance.

THE FINE ART OF SPRAYING

The hammer mill was founded in 1953 in Fridingen, where the upper Danube is still a small river that loops gently through the fir-covered valleys. With 458 employees and sales of 83.5 million euros, it is one of the larger drop forges in Germany. 38,000 tons of steel are processed here annually into around six million parts, which are subsequently used in applications in areas including the automotive industry, mechanical engineering, or agricultural technology.

The plant also has its own tool shop and CNC production facility, where forged parts are processed further. But it is the eight spindle and eccentric presses that are the heart of the company. And their production output depends to a great extent on cooling and spraying the dies correctly. »It's important that the die is cooled down quickly and effectively,« explains Dr. Laufer. At the same time, the spray mist should cover the entire die without any liquid remaining in the mold. »Otherwise the red-hot component will literally shoot upwards through explosively evaporating water.« If cooling is inadequate, on the other hand, the strain on the dies increases. »Thermal cracks form. This can reduce service life by up to a quarter,« says Kai Allweil, who was closely involved in the development process as a foreman at the forging shop.

The importance of spraying the dies correctly is also illustrated by the fact that »Industrieverband Massivumformung«, the German industry association for massive forming, is pursuing its own research project with Technische Universität Darmstadt. (Mentor group »Spray Cooling« IMU 58). The initiative investigates the effects of spraying on hot surfaces and how the temperature of the dies can best be reduced. »There's no one-size-fits-all solution for good spraying. Often the right spraying process also depends on the die and the component,« explains Laufer. To further improve the procedure, the spray heads would have to be individually adapted to the specific molds. This is something that Dr. Laufer, Allweil, and Roßbach, in their respective roles as plant manager, foreman, and engineer, agree on. »Based on the current additive-manufactured spray heads, we can now go a step further and create additional added value for the forging process,« says Roßbach. Allweil also has specific added value in mind: »Additive manufacturing is so flexible that we may also be able to develop three-dimensional spray heads with outlets in different directions.«

FURTHER INFORMATION:

» fon-mag.com
» hammerwerk.de

Series: The path to additive series production

»YOU CAN'T LEARN THIS ON YOUTUBE«

Photos: Robert Hofmann GmbH / B/E Aerospace Systems

The new hall, with a footprint of 2,000 square meters, already houses 15 additive machines and many more are set to follow.

Robert Hofmann was one of Germany's pioneers of additive manufacturing. Today, he has firmly established industrial 3D printing in his company and even prints metal parts in series production.

Text: Thomas Masuch

For more than ten years, Robert Hofmann has also been printing metal serial components and takes an end-to-end approach to this task.

While some people are still discussing whether metal 3D printing is moving toward series production, additive manufacturing of large numbers of units is already a reality at Robert Hofmann GmbH, also known as Hofmann – your »make it possible company«, in Lichtenfels, Germany. »We print batch sizes ranging from an average of 1,000 to 2,000 units,« says owner and managing director Robert Hofmann in conversation with formnext magazine.

Robert Hofmann is one of the pioneers of additive manufacturing in Germany. And he was quick to make industrial 3D printing the name of the game at his company, which was originally founded as a model construction firm. As early as 1992, this new field was a source of impetus for the trained toolmaker and master model-maker. Shortly after founding his company, he flew to the USA and returned with a stereolithography printer, putting »one of the first 3D printers in Germany« into operation. Compared to today's plastic printers, the device was quite expensive »and didn't always deliver the desired results«. Multiple tests were required before the first usable parts could be produced. Nevertheless, he was so fascinated by the technology that his company soon had many more printers.

GETTING STARTED IS NOT EASY TODAY

Thanks in part to additive manufacturing, Robert Hofmann GmbH is developing rapidly and now employs more than 300 people in Lichtenfels and at its facilities in Spain and China. At the same time, the company's hometown of Lichtenfels in Upper Franconia has evolved into an important center of additive manufacturing in Europe, thanks to the founding of Concept Laser, which he and his family actively supported.

Unlike in the early 1990s, the technology is now faster, more reliable, and more broadly based. However, that doesn't necessarily mean that getting started in additive manufacturing has become easier for companies, especially in the metal sector, says Robert Hofmann. Unlike in the early years of 3D printing, »today you need not only a printer, but also facilities for design and finishing, furnaces, a lab, quality control and certifications,« explains the 55-year-old entrepreneur. And he predicts a tough market environment for companies specializing purely in printing and delivering parts: »There will be a great many of them. But that's not the business we're in.«

For more than ten years, Robert Hofmann has also been printing metal serial components and takes an end-to-end approach to this task. In addition to production, the process includes design, finishing, and quality control. Sometimes customers come with a part that was milled in the past and now needs to be printed. »This usually makes little sense, but it's often the starting point for meeting with the customer and thinking about how to further improve the part,« explains Robert Hofmann. To make the most of the possibilities of additive »

Photo on top:
First 3D printer from Robert Hofmann GmbH (1992).
Photo below:
3D printed serial parts for the aviation industry.

We want to be involved in component development at the customer's premises.

Robert Hofmann (above) is one of the pioneers of additive manufacturing in Germany. His son Oliver (below) has been a member of the management board since August.

manufacturing, he continues: »We want to be involved in component development at the customer's premises.« This entails more time and effort, »and sometimes it can take two years before a decent part is printed«. But this enables useful additive components to be developed, which often enhance the next generation of the end product and create added value.

AM INTEGRATED INTO MODERN PRODUCTION PROCESSES

The success of additive manufacturing at Robert Hofmann GmbH is also due to the integration of this technology into a modern and partially automated production process that includes post-processing and quality assurance. In addition, Robert Hofmann invests heavily in expanding his company. A new hall, with a footprint of 2,000 square meters, already houses 15 additive machines – from Concept Laser, of course – and many more are set to follow.

Alongside additive manufacturing, Robert Hofmann offers other, conventional manufacturing methods such as milling or injection molding. After all, 3D printing is not always the best solution. Currently, classic production generates more revenue, »but we want to continue growing strongly with 3D printing,« states Robert Hofmann's son Oliver, who has been a member of the management board since August and intends to follow in his father's footsteps.

As a service provider, Robert Hofmann also depends on whether his customers are convinced of the advantages of additive manufacturing and whether they adapt their designs. »Most of our customers are pretty open to changing the design of their parts,« says Oliver Hofmann. When customers visit Lichtenfels, they often find the company's enthusiasm for additive manufacturing contagious.

At the end of the day, customer contact is crucial for service providers in the additive space, says Robert Hofmann. »The decisive factor here is the company's own technical expertise,« adds Oliver Hofmann. »After all, industrial 3D printing is not something you can learn on YouTube.«

FURTHER INFORMATION:

- » fon-mag.com
- » hofmann-imm.de
- » Robert Hofmann GmbH at Formnext 2018: 3.0-D31

TALKING ABOUT

»Concrete, Glass, and Steel«

Interview: Thomas Masuch

Although additive manufacturing (AM) is still a recent development in the construction industry, it is already the focus of several research projects, has been used in some early applications, and has generated many creative and useful ideas. Three years ago, Professors Oliver Tessmann and Ulrich Knaack from Technische Universität Darmstadt launched the BE-AM (Build Environment Additive Manufacturing) Symposium with the intention of bringing together active players in the industry. As of this year, Formnext will be supporting the symposium as a sponsor and will be addressing this subject in the AM4U area. We spoke to the professors about current developments in AM in the construction industry, similarities between the construction industry and other industries in this regard, and future challenges.

Photo on top:
Prof. Dr.-Ing. Oliver Tessmann
Photo below:
Prof. Dr.-Ing. Ulrich Knaack
Photo below:
The four-meter high 3D-printed supporting column stands in the courtyard of a school in Aix-en-Provence. It comes from startup XtreeE.

Apart from the well-established 3D printed design models, AM is still a relatively new field in the construction industry. What developments are you focusing on as part of your research at TU Darmstadt?

KNAACK At TU Darmstadt, numerous projects are under way to investigate the applications of additive technology using various materials. Our research focuses on subjects ranging from deposition welding with steel, to laser sintering, glass, and brick. We also have plans for paper-based 3D printing. In the context of additive manufacturing and Formnext, construction represents a completely new area. While AM technologies are being applied in isolated cases, there is no overall structure. We want to change this. One of our goals in teaming up with Formnext is to increase our focus on these activities in the next few years.

TESSMANN At the same time, we are also keeping an eye on processes and developments in architecture and wondering what new shapes and designs will be made possible by AM. Obviously, we don't want to print anything that can already be created using other highly efficient systems. An example of this would be the sophisticated formwork systems that are already available for flat concrete walls. Instead, we are considering ways in which AM can help us reduce the amount of material we use and respond better to specific contexts. We can only achieve this if the technology is meaningfully incorporated into the overall process.

From other industries, we are already familiar with the use of 3D printing in the quest to achieve added value. Can you draw any parallels between these other industries and your own?

TESSMANN On one hand, yes. On the other hand, however, the construction industry has its own distinctive features. In principle, every building is a one-off, even if it is constructed from industrially manufactured elements. Our processes are not yet optimized to the same extent as they are in the automobile industry, where thousands of identical products are manufactured. In our case, when mistakes happen, we do not necessarily call the entire process into question. Instead, we just get the crowbar. The second major difference between our industry and others is that there tends to be a clear separation between planning and production: the architect designs the product

Photos: ismd, TU Darmstadt, XtreeE / Lisa Ricciotti

and the construction firm builds it. Deploying new technologies such as those used in AM, however, calls for a more integrated approach. Our deeply entrenched control construct will need to be broken open to allow this.

KNAACK The quest for more added value is undoubtedly the main area of common ground shared by all industries that use AM technologies. The construction industry is subject to major cost pressure and is fairly conservative as a result. This is why we will not see widespread adoption of AM. It is more likely to be used to create individual intelligent building elements, particularly those with more complex geometries.

What tangible benefits can already be reaped in the construction industry today because of additive manufacturing?

TESSMANN As we see it, two different approaches are possible. You can concentrate on producing architecture with complex features by allowing development to be driven by the creative process. In Darmstadt, however, we prefer to focus on small improvements, such as optimizing the topology of building components, asking ourselves questions such as »Is it possible to design steel support structures along load paths to make them lighter and more elegant?« Even the junctions between steel supports provide huge potential for improvements, if their topology can be optimized to make them lighter. When there are several hundred junctions, this can reduce the overall weight considerably. So, you see how seemingly small developments can have a significant impact on the big picture.

KNAACK With some technologies, we are on the verge of a breakthrough. For example, we are now starting to use a relatively simple deposition welding technology for component testing, which we expect to put on the market in the next year or two. Some projects have already been implemented, such as a cycle bridge printed from concrete.

Are there any developments that could fundamentally change the way we build? Is there a chance that building may even become less expensive?

KNAACK Individual building components produced using 3D printing will become more compact and functionally integrated. Other components will become simpler. Overall, »

construction will become more efficient as a result. However, the price of buildings will not fall, since this is always determined by the value placed on them by society. However, the companies that use AM in construction will enjoy economic benefits. This economic aspect is also what encourages companies to collaborate with us on researching new applications and patents.

TESSMANN Today, we insulate our houses with thick layers of insulating foam to fulfill energy conservation requirements. In the coming decades, this will generate a huge need for renovation as well as enormous amount of hazardous waste. There are ideas about returning to monolithic construction instead. Hopefully, we will soon be able to use AM to give concrete a range of different material properties. We will be able print concrete to be solid where it needs to provide support and porous where it needs to provide insulation, with a gradual transition in between. This will simplify the manufacturing process as well as subsequent recycling. At the same time, additive manufacturing can help us to create more customized, versatile, and context-specific buildings.

The success of any new technology also depends heavily on the users. What challenges can you see with this?

TESSMANN We in the construction industry are a few years behind other industries. But things are starting to happen. What we still need are specific products as well as solutions in the areas of quality control and fire protection. If we can make progress here, the wheels will be set in motion.

KNAACK We still have many more technical ideas, regarding the integration of materials, for example. Market penetration is a big challenge and we will also need rules. The whole process is likely to take another 20 to 25 years.

Mr. Tessmann and Mr. Knaack, thank you for taking the time to talk to us.

+ FURTHER INFORMATION:

» fon-mag.com

» be-am.ddu-research.com

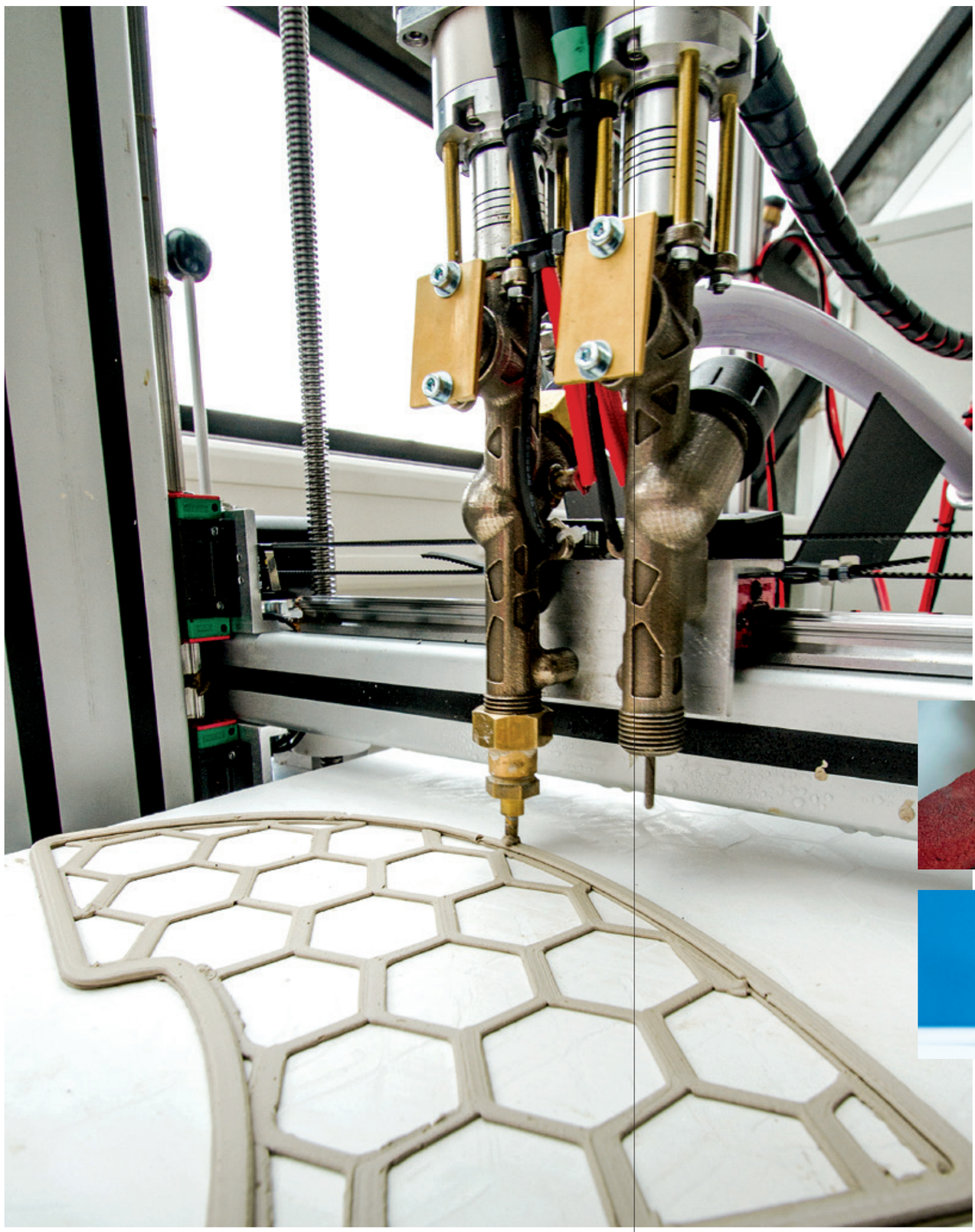


Photo left:
Employing an extrusion process, bricks with special shapes are printed.
Photos below:
3D printed clay tiles and steel nodes can be used for complex purposes.

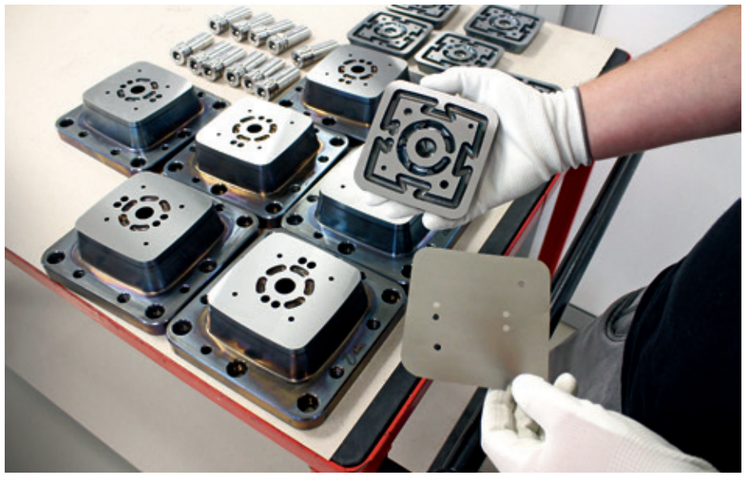
NOT RIVALS AFTER ALL

Form-makers have a whole range of technologies to fall back on when it comes to conformal cooling: Listemann and Renishaw combine the strengths of additive manufacturing and vacuum brazing under one brand.

Text: Thomas Masuch

The tool- and form-making industry is quite conservative. »But for form-makers, there is no getting away from additive manufacturing,« states Günther Rehm, head of marketing and sales at Listemann Technology AG. »In fact, some injection molding companies are already explicitly demanding it.« And Rehm should know what he is talking about: few people know as much as he does about the world of form-making in German-speaking countries and beyond.

The Liechtenstein-based company Listemann does not offer additive manufacturing. »In fact, we used to think of additive manufacturing technologies such as 3D printing as rival technologies,« recalls Rehm. After all, Listemann is one of the few companies to specialize in vacuum brazing and has amassed a wealth of technical expertise over the years in the production of forms featuring conformal cooling channels. Increasingly, however, additive manufacturing technologies are also being used to produce these tools.



Preparation for vacuum brazing: a thin foil is placed between the components. The form inserts here are from Glaroform AG in Näfels, Switzerland.

Photos: Zikomm/Th. Masuch

BRAZING VERSUS ADDITIVE MANUFACTURING

Rehm and his colleagues later realized that there is very little overlap between the two technologies and that vacuum brazing and additive manufacturing complement one another very well. The strengths of one technology compensate for the weaknesses of the other. Listemann decided years ago to take advantage of the strengths of both technologies by teaming up with LBC Engineering (which was later acquired by Renishaw GmbH). In 2017, Listemann and Renishaw established the »iQ temp« brand to offer powerful conformal cooling solutions to its customers using vacuum brazing and additive manufacturing technologies. Depending on which technology is used, the form inserts are either brazed in Liechtenstein or produced using additive manufacturing on one of 12 machines at Renishaw's Pliezhausen site.

Precision and cleanliness are essential in vacuum brazing: production employee Bekim Fazli shapes the solder foil at Listemann.

Vacuum brazing involves separating the form insert or core into several components, which are usually machined. At Listemann, these components are then fused together in a vacuum furnace, at the curing temperature of steel and under a negative pressure of less than 10^{-5} mbar, in a process known as vacuum brazing. The braze material is a foil that can be as thin as 50 µm, which melts and softens at the brazing temperature, flowing out to wet and bond the surfaces of the individual components. The metallurgical bonds formed in this multi-stage process are exceptionally strong – possessing 70 to 90% of the tensile strength of tool steel, according to Günther Rehm.

SOPHISTICATED HIGH-TECH PARTS

Vacuum brazing is the core business of Listemann Technology AG, which employs around 50 staff at its three sites in Liechten- »

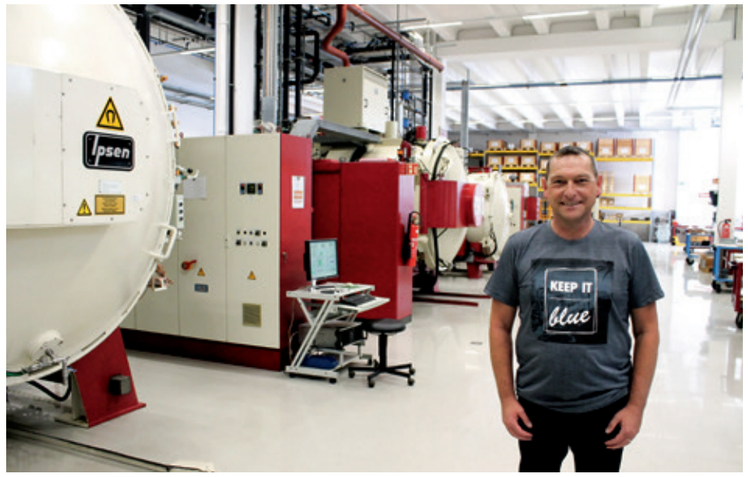


Photo on top:
Marketing and sales manager Günther M. Rehm in front of the vacuum furnaces in Listemann's production hall.
Photo below:
The internal cooling channels are milled into the individual components of the tools and form inserts.

The investment generally pays off very quickly – in some cases, within a matter of days.

stein, Switzerland, and Poland. And form-making companies are not its only customers. Listemann also supplies extremely sophisticated, high-tech vacuum-brazed parts to customers in the mechanical engineering and aerospace sectors.

Compared to additive manufacturing, the vacuum-brazing process is significantly less expensive – »sometimes by factors, depending on the application,« according to Rehm. Vacuum brazing is therefore ideal for large form inserts while additive manufacturing is more suitable for intricate, complex cooling circuits. Another advantage of vacuum brazing identified by Rehm is the variety of materials that can be used. »Currently, only two types of steel can be used to produce form inserts using additive manufacturing: 1.2709 and Corrax.« Vacuum brazing, on the other hand, can be used to join an almost unlimited range of materials, from steel and copper to ceramics and diamond.

Günther Rehm is convinced of the advantages of conformal cooling, since it not only decreases cycle times but also results in higher-quality components. For this reason, it can sometimes pay to use it even for small quantities of components. Although the tempered tools may be more expensive, Rehm estimates that the additional costs are in the region of a few percent. »The investment generally pays off very quickly – in some cases, within a matter of days.«

»EVER-INCREASING DEMAND«

Listemann supplies several hundred form-makers in German-speaking countries as well as further afield. In Rehm's experience, most customers are receptive to new technologies such as additive manufacturing or vacuum brazing. »Every now and then, however, you still come across traditionalists who have been drilling cooling channels in their tools for 30 years and don't want to do things any other way.«

Overall, Rehm expects the demand for tempered tools to continue to rise. Because, in addition to injection molders, die casters have now also discovered the benefits of having cooling circuits integrated into their tools. The use of these technologies in die casting is still in its infancy and, according to Rehm, is lagging around 20 years behind its use in formmaking. »But demand is also increasing in this area.«

+ FURTHER INFORMATION:

- » Further pictures and information at fon-mag.com
- » listemann.com / iQtemp.com
- » Listemann Technology AG at Formnext 2018: 3.1-D68

»OUTSIDE THE BOX«

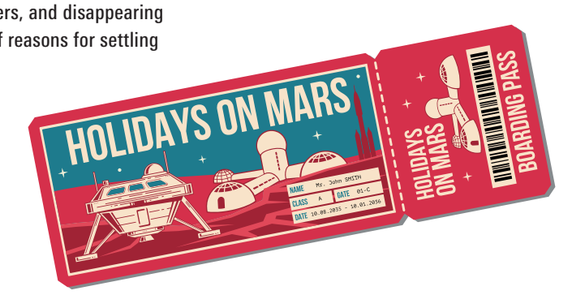
Longing for Space

A significant number of researchers believe mankind's future will be in space. NASA and ESA are among those who have already drawn up plans for the first colonies on Mars. And SpaceX founder Elon Musk has very clear ideas about how he will send a space shuttle with as many as 120 people on board to the planet in 2024.

From a technical point of view, the visions for space colonization are making rapid progress – thanks in part to additive manufacturing. If everything goes according to plan, raw materials such as titanium will soon be extracted on the moon or on asteroids and converted into components for rockets and space stations by 3D printers. The water that is assumed to exist on asteroids and Mars could even be used to produce fuel.

But if you're not a scientist drilling the Martian rocks for traces of past life, it's not entirely clear why you would want to go to Mars. It's not as if Earth has nothing to offer. There's something magical about the simple things like a walk in the woods or the mountains, or swimming in the sea – not to mention visits to wonderful places like Rome, Paris, and New York or the countless idyllic towns that reveal their distinctive charm only on closer inspection. Why would we give up all this to spend our life in a kind of greenhouse on Mars? (And why would we spend a fortune to get there?)

Unfortunately, not everything on our planet is in the »green range«. Polluted seas, deforestation, seemingly never-ending global population growth, (anthropogenic) climate change, natural disasters, and disappearing species: The number of reasons for settling on Mars is on the rise. Though that's not to say we should try to evade our responsibilities here on Earth. And then there was this year's record summer in Germany and almost all of Europe, with no rain and with unrelenting tropical nights from June through August. The protracted heatwave even put people off their otherwise much-loved barbecues. Instead, with the temperature at almost 30 degrees, they could look up into the late-evening sky and now and again glimpse the reddish shimmering form of Mars. There, 1.5 times farther away from the sun than our planet, the temperature is never more than a cool 20 degrees, even during the day. So maybe it's worth taking that trip after all.



Text: Thomas Masuch · Illustration: iStock / MicrovOne

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