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formnext magazine

by formnext

What makes innovative thinking happen? I think it's really a mindset.

[Elon Musk, entrepreneur and founder of Paypal, SpaceX, Tesla and others]

Cover: feedbackmedia.de, iStock/Elen11

EDITORIAL

We've arrived in 2021, and hopes are high – indeed, much higher than they were at the beginning of last year. While large parts of the world are still struggling to contain the coronavirus, humanity has also begun fighting back with newly developed vaccines. These medicines will make it possible to get this pandemic back under control.

As the global vaccination effort starts rolling and taking effect, however, we'll need to be patient for several more months. If all goes well, everyone will be more optimistic about interacting with one another freely in the second half of the year. The same can't be said of the economic recovery, unfortunately. It will certainly take longer for us to get back to the level of activity we had achieved prior to the pandemic. Some industries will have to adjust to permanent changes in their fields of business, while others will benefit from the upheaval.

The trade fair sector is one that is still struggling mightily with the ramifications of the pandemic. At the same time, trade fairs are sure to make a comeback because they offer ideal platforms where professionals can gather in person to share their ideas. They just need to be enhanced with digital tools in the right areas.

That is why Formnext 2021 – scheduled for 16–19 November in Frankfurt am Main – is now the primary focus of our planning for the year. The fact that industrial 3D printing will without a doubt be one of the most prominent technologies in the years ahead makes the AM community's premiere event all the more important. Whether it's in medical technology, the aerospace or automotive sector, rail transport, mechanical engineering, or the many other industries that use it, most future products will be impossible to develop and manufacture without additive manufacturing. Furthermore, AM continues to gain influence with regard to supply chains and sustainability.

We're looking forward to witnessing these exciting developments. With that, I'd like to wish you a happy new year – one with plenty of positive news!

Sincerely, Sascha F. Wenzler
Vice President Formnext

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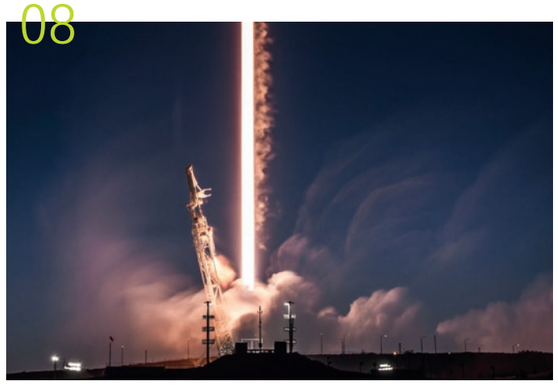


FORMNEXT NEWS

Photo: Mesago/Mathias Kutt

BEATING TO THE RHYTHM OF INNOVATION: THE DIGITAL HEART OF AM

On 10–12 November 2020, the all-virtual Formnext Connect offered compelling proof that Formnext continues to be the leading trade fair for the AM industry and the next generation of industrial production. In addition to producing some impressive numbers – 8,541 active participants from more than 100 countries, the event was packed with world premieres.

»This year's virtual format didn't stop Formnext from demonstrating how essential it is as a global catalyst of technological and economic development in this forward-thinking industry,« declared Sascha F. Wenzler, Vice President for Formnext at Mesago Messe Frankfurt GmbH. At Formnext Connect 2020, 203 exhibitors presented a total of 1,412 products. Meanwhile, an intelligent and modern matchmaking system generated more than 450,000 recommendations, which led to 23,311 new contacts and 4,733 business meetings.

Among the many world-firsts at this year's event was the new NXG XII 600 from SLM Solutions, which boasts 12 one-kilowatt lasers and a build area measuring 600 cubic millimeters. According to the manufacturer, the machine opens the door to numerous applications in the automotive and aviation industries. In the field of FDM, Ultimaker unveiled the Ultimaker 2+ Connect – an advancement on the Ultimaker 2+. This new 3D printer can operate at up to 300 mm/s and includes enhancements such as wireless and Ethernet connectivity, a touchscreen, and more. Also in attendance was Smart3D, which presented Macro HT, an industrial, high-temperature 3D printer capable of working with materials like Ultem, PEEK, and PEKK. Another leading manufacturer, Mimaki, is promising a striking variety of color and reliable production quality with its new inkjet 3D printer, the 3DUJ-2207 (which also supports UV curing).

MORE STREAMLINED CONSTRUCTION

In post-processing, Solukon used Formnext Connect as an opportunity to show off the SFP 770, an innovative platform that offers efficiency and reliabilty in unpacking and cleaning plastic components produced by means of SLS. The Dutch start-up AM-Flow – one of the winners of the Formnext Start-up Challenge 2020 – also presented its AM-BAGGING unit, which can print high-resolution graphics, text, or barcodes on packages and automatically prepare them for shipping.

The field of materials was particularly innovative in 2020, with corporations like BASF, Covestro, Evonik, and HP revealing new solutions – including some sustainably produced synthetics. In metals, Fehrmann presented AlMgty 90, an aluminum alloy for 3D printing. The Hamburg-based company says that the material facilitates »even lighter and more streamlined designs« thanks to its tensile strength (over 400 MPa) and an elongation at break of over 25%.

In addition to the new products exhibited, Formnext Connect's participants had the chance to take in a high-quality lineup of stage features and sessions, most of which were streamed live. Experts from around the world discussed current and future trends, developments, and applications in numerous webinars and roundtables.

»The best trade fair in additive manufacturing is off to a good start in the digital realm,« said Gianluca Mattaroccia, an engineering fellow at Estée Lauder Companies. Marie Langer, CEO of EOS, added that with Formnext Connect, »Mesago has proven that it's possible to do a digital trade fair right.« At the same time, she is looking forward to »getting back together in person in Frankfurt« in 2021. The next iteration of Formnext is scheduled to take place in the city on the Main on 16–19 November.

NEWS

NOT LAYERS, BUT VOLUME

There are now dozens of different additive technologies, but they all have one thing in common: They create components by adding material in specific locations – usually by layering it on. That's why they call it »additive manufacturing«, after all. The German start-up xolo GmbH, however, is taking an entirely new approach. It recently unveiled a »volumetric« 3D printer it calls the xube, which is designed to impress in three main ways: technology, printing speed, and printing resolution.

Utilizing a process dubbed »xolography«, the xube produces entire components rather than building them layer by layer. It does so by combining different lasers operating at specific wavelengths to harden acrylic resin inside of a material tank (which is still on the small side at the moment). If that sounds simple enough to you, the underlying process is actually quite sophisticated. The first laser is used to activate molecules in certain places, which are then »photopolymerized« – hardened – by a second laser. This technique can be used to achieve complex structures, as well as a variety of mechanical and optical characteristics.

According to xolo, its new method offers a resolution several times higher than previous approaches (up to 30 µm [x,y], 50 µm [z]) and much faster printing. It claims that some components can be produced in just 20 seconds, while others take up to five minutes.

As mentioned, the xube – which is currently meant to serve as a test unit for exploring potential applications – offers a build area measuring just 5 x 7 x 9 cm. The company behind it nonetheless believes it has the potential to play an important role in both nano- and macro-environments.

SMOOTH SURFACES, SHARP EDGES

Spaleck Oberflächentechnik GmbH & Co. KG has come up with a new technique for smoothing and polishing components produced through AM. Known as linear force finishing (LFF), this innovative method involves moving isolated components at a high frequency, which enables it to work with complex geometries and very coarse surfaces, as well. Spaleck – a Bocholt-based company (western Germany) that has over 100 years of experience in surface treatment – has also developed a machine capable of applying LFF. It says that the PPL300 supports a high degree of automation, which makes it relatively easy to integrate into AM environments.

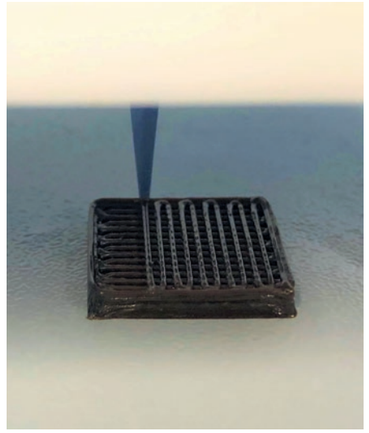
The LFF technique itself constitutes a response to the special characteristics of 3D-printed metal components. According to Spaleck, the surfaces of such components are often very rough and require a lot of smoothing, but this process has to avoid rounding off a part's edges. In addition, extremely hard materials like titanium are frequently used, which results in longer post-processing times.

In conventional slide-grinding processes, complex geometries can lead to what's known as the »cover effect«. Spaleck says its new method keeps this effect to a minimum. In its extensive testing, the company was also able to prove that LFF can reduce the processing time required by a factor of 15 compared to a traditional vibratory barrel-finishing machine depending on the component in question.

Photos: Spaleck Oberflächentechnik, Xolo

NEWS

WOOD-BASED BIOPASTE



Researchers at the University of Freiburg and the Freiburg Material Research Center have now succeeded in developing a wood-based biopaste using green engineering principles. »The new material, which is a polymer paste, can be processed to make lightweight components using direct ink writing,« explains Lisa-Sophie Ebers, doctoral student at the University of Freiburg.

She is writing her dissertation on the wood-based material Woodmimetics 3D, which is being developed based on a bionic approach. The organic substance is made exclusively of the wood-based raw materials lignin and hydroxypropyl cellulose – an additive frequently used in the pharmaceutical, cosmetics and food industry (E463) – as well as water, ethanol and acetic acid as a solvent.

Because of this, the material is not only bio-based, but also 100% biodegradable. The biodegradability was tested using fungi, with results comparable to the biodegradability of PLA (polylactides).

Another economic benefit is that processing the material takes very little energy. Woodmimetics3D has particularly advantageous rheological properties for direct ink writing. In 3D printing, the viscosity of the material drops solely due to shear stress during the process. Because of this, we can process the material at room temperature,« says Ebers.

LIGHTER ELECTRIC DRIVE

Porsche has produced its first complete housing for an electric drive using 3D printing. The engine-gearbox unit produced using the additive laser fusion process passed all the quality and stress tests without any problems. »This proves that additive manufacturing with all its advantages is also suitable for larger and highly-stressed components in electric sports cars,« says Falk Heilfort, Project Manager in the Powertrain Advance Development department at the Porsche Development Centre in Weissach.

The additively manufactured alloy housing is more lightweight than a conventionally cast part, and reduces the overall weight of the drive by approximately ten percent. Thanks to special structures that have only become possible due to 3D printing, the stiffness in highly stressed areas has nevertheless been doubled – despite a continuous wall thickness of only 1.5 millimeters. The honeycomb structure reduces the oscillations of the thin housing walls and thus considerably improves the acoustics of the drive as a whole. Another advantage of additive manufacturing is the fact that numerous functions and parts can be integrated. This considerably reduces assembly work and directly benefits part quality.

Optimization of the electric drive started with the design integration of components such as bearings, heat exchangers and oil supply. This was followed by the computer-calculated definition of loads and interfaces. Determination of the load paths then took place on this basis. The next step in the virtual development method was optimization of the load paths by integrating the so-called lattice structures.

Photos: University of Freiburg, Porsche

ACQUIRING JOINT VENTURE

Trumpf plans to strengthen its additive manufacturing division: The Ditzingen-based company is in advanced talks with its Italian partner Sisma S.p.A., a leader of manufacturing high-technology machines, to acquire the joint venture Trumpf Sisma S.R.L. completely. Up to now, Trumpf holds 55 percent of the shares. In addition, Trumpf intends to continue SISMA's additive manufacturing business activities in the industrial, dental and medical sectors.

Simultaneously with its divestment from the joint venture, Sisma plans to focus on the jewelry and fashion industry and for this purpose to enter into a cooperation with Trumpf in 3D printing.

Trumpf Sisma was founded as a joint venture in 2014 and is based in Schio in northern Italy. Around 60 employees work there in the development and production of metal 3D printing machines with Laser Metal Fusion technology. The transaction is expected to be completed in the first quarter of 2021.

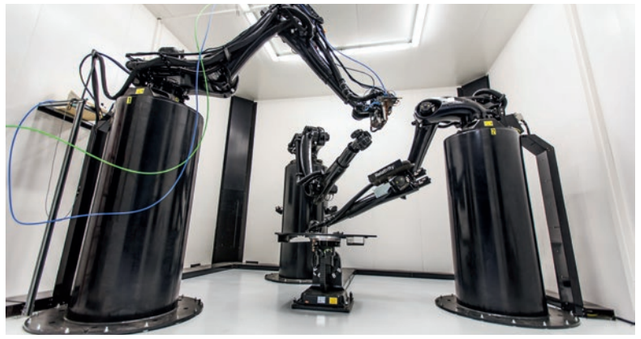
A BOOMING BLACK BOX

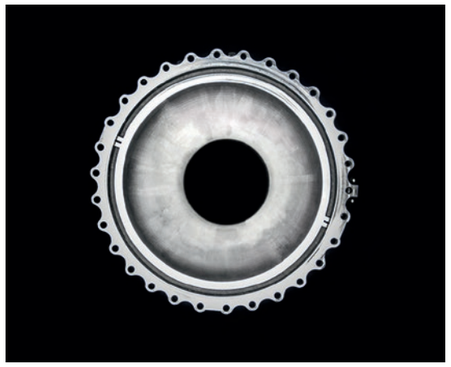
Text: Thomas Masuch

Photo, page 08: A Falcon 9 takes off at Vandenberg Air Force Base

Photos: SpaceX, Relativity Space

When it comes to building rockets and satellites, additive manufacturing has become indispensable. No other field enables industrial 3D printing to leverage its strengths in weight reduction and complex designs like the space industry does. That's why it's no wonder that both young and more established companies are relying more and more on AM. Indeed, the space sector has become a key market for additive service providers, machine manufacturers, and firms that offer material and software. Gaining a foothold isn't easy, though: This is an industry shaped to a certain extent by national interests, political circumstances, and closely guarded technological secrets. We thought that was reason enough to take a closer look at an exciting and booming field that nevertheless remains somewhat inscrutable. The first article of this two-part series is about additive manufacturing in rocket construction.



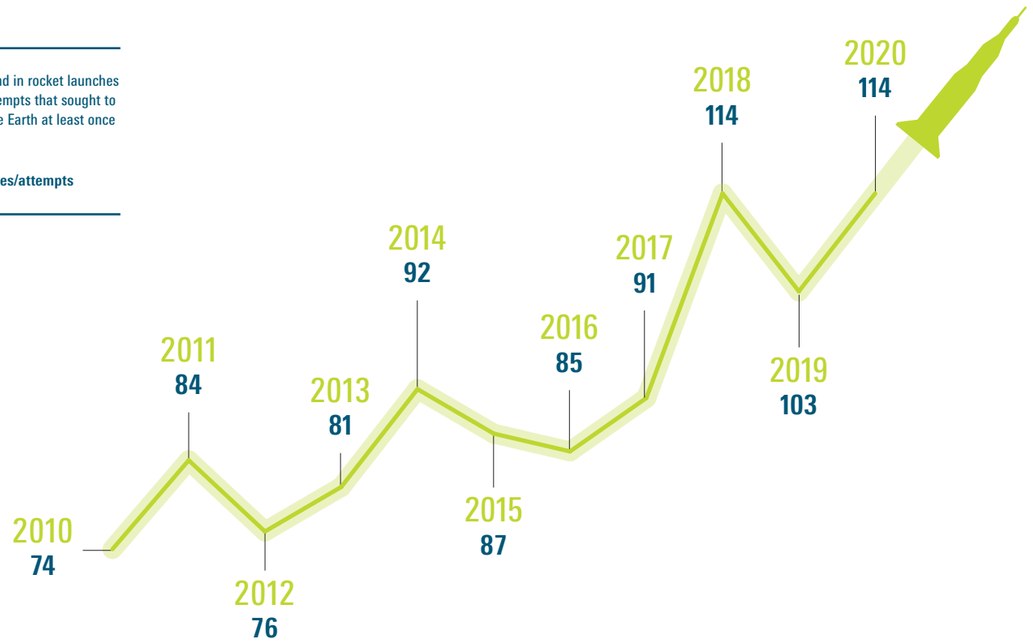


At the heart of Relativity Space's technology is the 3D printer Stargate, which has already produced numerous large-scale rocket components

Among the industry's users of AM, Relativity Space has chosen the most resolute path: The young, Los Angeles-based company wants to build entire rockets using not much more than Stargate, a 3D printer of its own design. In its 35-meter-long Terran 1, it claims to be »building the world's first 3D-printed rocket – from raw material to flight in 60 days«. This has enabled Relativity Space, which was founded in 2015 by Tim Ellis and Jordan Noone and now employs 230 people, to take in around €550 million over several rounds of financing. The company's value is now estimated at just under €2 billion, making it second only to SpaceX (approx. €37 billion) in the private aerospace sector. Stargate, a wire-arc 3D printer that takes its name from the 1994 science fiction film, comprises machines that manufacture other machines. According to Relativity, it's the largest metal printer in the world. It has already been used to 3D-print a fuel tank measuring around 3.7 by 2.1 meters. Terran 1, meanwhile, is scheduled to launch for the first time in late 2021 and will eventually carry payloads of up to 1.25 tons into orbit.

Technology, however, isn't the only area where start-ups like Astra, Firefly Aerospace, Rocket Lab, Virgin Orbit, and others are ushering in a new age of what Relativity calls »software-driven manufacturing«. These newcomers want to use the millions at their disposal to break free from well-worn ways of thinking, as well. At Relativity Space, this effort includes monthly »lunch-and-learn« meetings that have featured guest speakers like Rick Sternbach, who designed a Klingon battlecruiser for the Star Trek franchise; and Adam Mojo Lebowitz, visual effects supervisor for Battlestar Galactica.

That said, the industry's established rocket builders and suppliers have also gained new capabilities in 3D printing – usually by creating an in-house AM center and entering into various technology partnerships. The main things being 3D-printed at the moment are individual components, especially those connected to the propulsion system and the combustion chamber. This is where industry experts say the greatest potential savings lie. It's also possible to significantly reduce production time and the »



The trend in rocket launches and attempts that sought to orbit the Earth at least once

Year
Launches/attempts

number of components used. »If a company wants to remain competitive, AM is a must for producing propulsions,« says Terry Wohlers, an expert in AM and president of Wohlers Associates. »The benefits of using AM for propulsion outweigh the costs. This is why we're seeing organizations such as Aerojet Rocketdyne, Airbus, Boeing, NASA, Raytheon, Safran, and SpaceX adopt AM.« In addition to cost savings, 3D printing offers another key benefit according to industry experts. »The value of saving time in production is going to be one of the main factors pushing companies to choose 3D printing,« says Eliana Fu, who worked as a senior engineer for Relativity Space for several years before joining Trumpf North America at the end of 2020.

»COMPANIES DON'T SHARE THESE DETAILS«

SpaceX has played a leading role in incorporating 3D printing into rocket construction for years. Back in January 2014, one of the U.S. company's Falcon 9 rockets lifted off with a 3D-printed oxidizer valve in one of its nine Merlin 1D engines. It now builds eight 3D-printed SuperDraco engines into its Dragon 2 spacecraft. According to SpaceX founder Elon Musk, the first SuperDracos were manufactured using Inconel and a 3D printer from EOS.

Not every firm in the industry is this forthcoming, however. Social media may be full of »successful« tests involving 3D-printed engines or other rocket components, but the number of 3D-printed parts that actually find their way into rockets (and how exactly they were made) is often anyone's guess. »It's difficult to know exact numbers because most companies aren't publishing or sharing these details,« Wohlers explains. Just how tight-lipped the space industry can be became apparent in our research for this article, as well: Many of the inquiries we sent to rocket manufacturers and consulting firms elicited no response at all. In other cases, the right contacts were said to be unavailable due to COVID-19, or our questions related to areas that were subject to confidentiality. This was our experience in every relevant region, by the way – China, Europe, and the United States.

SpaceX, on the other hand, is a welcome exception in terms of how transparent it is about its activities. For example, you can calculate the cost of transporting your freight of choice and reserve space for it on an upcoming flight right there on the company's website. Launching an 830-kilogram satellite into low Earth orbit (LEO), for instance, will currently run you U.S.$4.63 million (which includes an adapter, a U.S.$430,000 separation system, fueling at the launchpad, and insurance[1]). That corresponds to around U.S.$5,500 per kilo. Adjusted for inflation, SpaceX has thus reduced the cost of transporting freight into orbit by a factor of 10 in just 15 years. On a NASA space shuttle, it actually used to cost the equivalent of 30 times the current price to launch a kilogram of material into LEO.

A CHALLENGING AND DYNAMIC SECTOR

These lower transport costs are part of the reason why the space industry continues to grow increasingly dynamic. This is already evident in the number of rockets launched into orbit each year, which rose to 114 in 2020 (see graphic). Assuming the projects currently under development really do take off, this upward trajectory is likely to continue in the future. The ongoing decline in transport costs, the trends toward smaller rockets and satellites, and space tourism will also add to the sector's momentum.

Before that happens, however, several technological hurdles remain. The notion that not everything that passes its tests actually

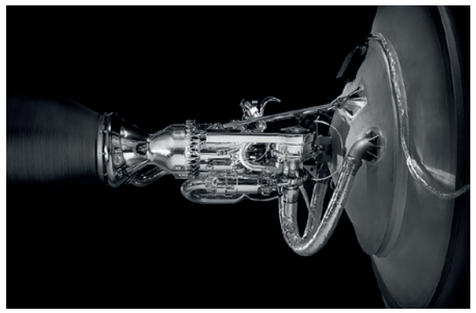
[1] As of January 2021

Illustration: feedbackmedia.de/Source: Wikipedia

gets put into use is something Carl Fruth knows only too well. At Formnext 2019, he and FIT AG introduced the throngs of international experts in attendance to a 3D-printed fluid manifold for the Vulcain 2 engine, which is part of the new Ariane 6 rocket. Made of Inconel using wire-arc additive manufacturing (WAAM), this component was to increase the engine's performance while reducing the production costs involved. To fulfill the space industry's strict safety requirements, FIT AG – one of the world's largest AM service providers – had worked with ArianeGroup on developing a suitable system for quality assurance. »After all, when you have a new technology, you also need to adjust your testing methods,« Fruth explained in a conversation with FON Mag. In the case of the fluid manifold, for example, five times the usual amount of material was applied by means of WAAM and then milled off the side of the manifold in order to have surfaces appropriate for ultrasonic inspection. Among other things, the elaborate testing process also eventually resulted in much higher component costs – around eight times higher than those accrued in additive production, in fact. »In that case, it turned out that AM wasn't that much cheaper on the whole. Plus, there was still the general risk associated with implementing a new technology,« Fruth recalls. »Ultimately, Ariane decided not to go the AM route.«

»HIGHLY COMPLEX SUBJECTS«

This example also demonstrates how lengthy and resource-intensive the process of developing improved components is in the space industry. »These are highly complex subjects where you can't come up with solutions in just a few months,« Fruth explains. »As a service provider, you have to reconfigure your production, which then also needs to be certified for the customer in question. That's when you really find out what you're made of.« Establishing a partnership is another thing Fruth »



Photos: Relativity Space, EOS, FIT AG – Lisa Kirk

3D-printed prototypes for rocket manufacturing: a fluid manifold for the Ariane 6's Vulcain 2 engine *(left)*; an injection nozzle *(below)*; and an engine built into Relativity Space's Terran 1 *(below left)*

describes more in terms of years rather than months. »In the first two years, you get to know each other and show what you're capable of in smaller projects,« he says. »It's usually three or four years before you start taking on real, more lucrative orders.« The considerable amount of time required for aerospace developments is also apparent in the case of the SuperDraco engines made by SpaceX – the industry's indisputed alpha, and not one that's known to dawdle. Although the development of these innovative engines was completed in 2012, they wouldn't embark on their first »real« mission until after a seven-year test phase.

Like other renowned rocket builders, SpaceX has its own in-house AM division. »Most companies in the space industry are using commercially available systems, although the software tools, DfAM, and materials can differ from one company to the next,« Wohlers reveals. »What especially sets apart one company from the next is their experience and willingness to adopt entirely new ways of thinking about design and manufacturing.«

This is where the strengths of external suppliers like FIT AG come into play. At its headquarters in Lupburg, Germany, this company has a wide array of different AM technologies at its disposal, including numerous methods of measurement. Meanwhile, Carl Fruth doesn't see his firm as an AM service provider alone. »We produce certified components, but AM is just one part of our highly complex process,« he points out. »That means we don't compete so much with other AM service providers as we do with the established supply structures.«

AM EXPECTED TO PUT EUROPE'S SPACE INDUSTRY BACK ON TRACK

Meanwhile, the space sector in Europe has been suffering a great deal from the fallout of COVID-19. While SpaceX launched at least one Falcon 9 into orbit every month in 2020, the maiden flight of the newly developed Ariane 6 has been delayed from the end of 2020 to late 2021 / early 2022. The effects the coronavirus has had on the region surrounding the Guiana Space Centre were cited as the official reason. The two failures that smaller Vega rockets have experienced in their last three launches in Kourou have not exactly improved the situation, either. After leading its industry for years, Europe's Arianespace SA (which sold payload space on the two rockets in question) is now under a great deal of pressure not to fall well behind SpaceX and competitors from China and Russia.

In addition to FIT AG's fluid manifold, ArianeGroup has initiated numerous other AM developments for Ariane 6 and future generations of its rockets – including an injection nozzle that was designed in cooperation with EOS. The group has some ambitious goals: Its upcoming Prometheus engine, for example, is expected to cost just €1 million thanks in part to 3D printing, which would be 90 percent less expensive than the Vulcain 2 that propels the Ariane 5. To ensure that Prometheus sees use as planned in a reusable descendent of the Ariane 6 in around 10 years, the Council of Ministers of the European Space Agency (ESA) approved a project budget of €82 million at its meeting in the summer of 2020. The next generations of the Vega rocket are also to take to orbit with a 3D-printed thrust chamber assembly from the M10 engine starting in 2025.

Additive manufacturing still has a long road ahead of it in the European space industry. On the other hand, 3D-printed cardan crosses have already been used in the Ariane 5 for some time. This component measures just three centimeters on each side and won't make the difference in competition with SpaceX, but ArianeGroup is »about to implement more individual parts« according to a statement from Steffen Beyer, who was speaking as the group's head of production technology (materials and processes) at an international conference of experts in the summer of 2019. Along with laser melting, Beyer cited direct energy deposition (DED), laser metal deposition (LMD) and cold spraying as manufacturing technologies of interest in the space sector. He also pointed out a number of challenges that still need to be overcome, however, including with regard to the purity of powder and its removal from cavities.

Left:
Relativity Space's headquarters in Long Beach, which features more than 11,000 square meters of production space
Right:
SpaceX has already been building 3D-printed components into Falcon 9's Merlin engines since 2014

Photos: Relativity Space, SpaceX

Launch vehicles by country of origin in 2020

Other:
India, Israel, Iran, Japan

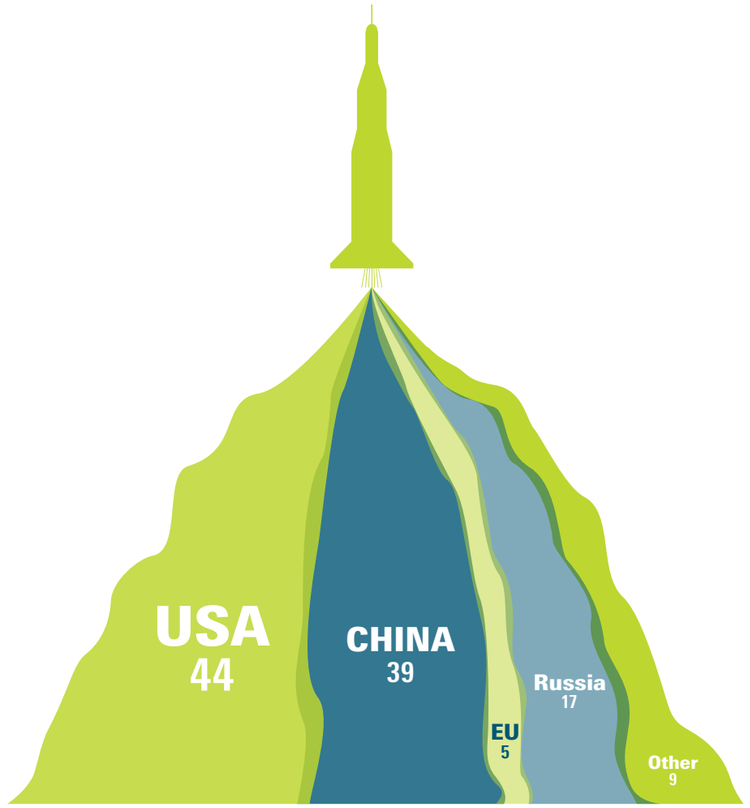


Illustration: feedbackmedia.de/Source: Wikipedia

The problems Ariane and Vega have been contending with have taken a toll on European suppliers, as well. »For the foreseeable future, the unfortunate reality is that those of us in the European launch vehicle industry can only make extended plans based on the four or five launches organized by the institutional market each year,« stated Hans Steininger in the summer of 2020 regarding the delayed debut of Ariane 6 and the reduced production volume it entailed. Steininger is the chairman of the board at MT Aerospace AG, one of the largest German suppliers to the aerospace industry. FIT AG's Carl Fruth, meanwhile, sees a further drawback in the sector's dependency on ESA programs. »There's no real competition, which means there's no impetus to make more of an effort to implement new technologies,« he points out.

BUSINESS BOOMING IN THE U.S. AND CHINA

While those in the European space industry were fearing the loss of jobs and years of expertise due to the Ariane postponement in late 2020, both up-and-coming and more established companies elsewhere were stepping on the gas – especially in the U.S. and China.

Founded in Beijing by the 21-year-old Hu Zhenyi in 2014, Link Space has been attracting attention with its New Line 1, a reusable two-stage rocket 24 meters in length. The country's aerospace industry achieved another milestone in July 2020, when Beijing Star-Glory Space Technology Co. Ltd. became the first private company to reach orbit and release its »Double Curve One Remote Launch Vehicle« (also known as SQX-1 Y1). Following a round of financing that brought in a total of ¥1.193 billion (around €150 million) in August 2020, the company hopes to advance its development of a reusable engine and its Twin Curve series of rockets.

Overall, China has long since joined the ranks of the established spacefaring nations: In 2020, it surpassed Russia and nearly pulled even with the United States in completing approximately 39 launches (see graphic). Since the Middle Kingdom began allowing private firms to participate in 2014, its domestic space sector has been booming. The number of companies involved has risen from 30 in 2018 to more than a hundred. »3D printing technology has become the backbone of rocket manufacturing in the process,« reports Kitty Wang, who has been keeping a close eye on China's AM industry for years through her platform, 3D Science Valley.

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TALKING ABOUT

»The Key is Expertise on the Customer Side«

Text: Thomas Masuch

Over its 100 years in business, Chiron has amassed generations of experience in manufacturing and selling machining centers that see use in conventional metal processing. It's now been two years since the company took the plunge into additive manufacturing and began developing its first corresponding system. Having unveiled its new AM Cube in the spring of 2020, Chiron plans to bring it to market in the course of this year. We recently spoke with Axel Boi, head of additive manufacturing at the Chiron Group, about the steps ahead, the differences and commonalities between conventional and additive manufacturing, Chiron's other plans, and much more.

Additive deposition welding presents a surprising number of applications, including (clockwise from left) this 3D-printed and finished turbine, a length of aluminum bronze, and a coated brake disc resistant to corrosion and wear

Axel Boi
An aerospace engineer by training, Axel Boi has been with the Chiron Group since 2000. After working as a regional sales director and a key account manager for milling/turning machines and the aerospace sector, he became the managing director of Chiron France in 2008. Mr. Boi then began heading the group's product planning in 2014, which led to his current position as head of additive manufacturing in 2018.

Photos: Chiron Group

Mr. Boi, most of the providers in the AM market are relatively young companies. The larger, more traditional organizations that have gotten involved have largely done so by means of acquisitions. What prompted a conventional machine manufacturer like Chiron to establish a new AM division and start developing products of its own?

AXEL BOI Let me take you back about five years. That was when I was tasked with taking a close look at metal 3D printing to determine whether it presented a threat to our machine tools or the Chiron Group's business model more generally. We came to the conclusion relatively quickly that it didn't; even today, metal 3D printing is mainly suitable for producing small or very limited quantities. At Chiron, we deal more in medium-size production runs, complex products, and large-scale series manufacturing. Still, we found the market attractive: Unlike in the case of machine tools, there aren't that many players involved in metal 3D printing, and we're seeing some intriguing growth figures. That's what originally led us to consider what a Chiron product for the AM industry might look like.

And how did things proceed from there?

BOI We thought our path forward was relatively clear. The powder bed concept was already widely established, and it involves a complex process that a number of providers have covered. Deposition welding, on the other hand, seemed like a good option for us. This process is often still performed manually, which is how it has already achieved a certain level of acceptance in the market. We've automated the welding aspect and added in a quality control option.

How did the Chiron Group succeed in building up and solidifying this new internal business area?

BOI In some ways, it's taken on the features of a start-up. Ours is a small team that's agile and dynamic, for example. At the same time, we continue to have access to the Chiron Group's resources, which we can draw on as required. Our team now has 12 members, but there are around 25 people in total who put their technical expertise at our disposal. That enables us to implement a lot of processes faster than the norm at our company. Chiron's owners and executives have given us their full support, as well.

The Chiron Group has already established a broad customer base and a considerable network in conventional machining. How can you capitalize on those things in the 3D printing business?

BOI Sales is another area where we're in a position to take advantage of our group's widespread network. Those who sell our conventional machine tools are spreading the word that we're also focusing on 3D printing »

now. It gives us the chance to sound out a great many customers and pinpoint those that might be open to additive manufacturing. That opens a lot of doors for an AM department like ours. Once a particular project starts getting into the technical details, the AM team starts providing support.

Speaking of sales, what do you think AM systems and conventional machining centers have in common in this regard, and how are they different?

BOI At the Chiron Group, we sell traditional machine tools as products, but also project-related services. These services account for a very significant portion of our revenue: Around half of our projects involve more than »just« a machine, and that share is much larger in 3D printing – close to 100 percent, in fact. Here, what we discuss with the customer is typically a technical solution where the 3D printer plays more of a secondary role. In other words, we sell the overall solution and offer the right hardware for the job. That's our approach in both conventional machines and AM now, as well. The big difference, however, lies in the underlying physical process. Customers are familiar with drilling and milling, of course, but that's usually not the case with 3D printing.

One of the biggest challenges many AM companies face has to be working with customers on coming up with specific projects and applications before making them happen. How do you find projects like these – particularly when many people haven't yet developed an in-depth understanding of AM, as you've mentioned?

BOI Well, on the one hand, we're seeing a positive development in that many companies are now engaging with the subject of metal 3D printing. On the other, you have the simple fact that the market is rife with false perceptions. There's still the traditional CEO mindset, for example: Soon, we won't need a warehouse for spare parts because we'll print everything on-demand – ideally on the customer side, all around the world! Customers often contact us with ideas like these. That's when we have to carefully bring them back to the real world. 3D printing isn't as simple or superficial as it seems in some discussions, after all.

But you do consider additive manufacturing to be less complex in comparison?

BOI Yes; 3D printing doesn't have to involve a complete disruption, or even the production of three-dimensional components. In principle, 3D printing is just about adding material, which is something we also do when coating or repairing a part. It's surprising how many related topics and applications there are.

Many larger companies and corporations have built up their own AM departments, hired specialists, and amassed corresponding expertise. As a technology provider, have you found the market more accessible, especially when it comes to specific projects?

AM Cube and AM Coating
The first AM product from the Chiron Group is the AM Cube, which was first presented in the spring of 2020 and is set to hit the market in January 2021. This laser deposition welding unit can work with both wire and powder and is suitable for use in coating and repairing components, as well as in the near-net-shape manufacture of semi-finished products. The AM Cube is currently undergoing a pilot phase in which it is being used to repair hydroelectric turbines at Stellba AG (Switzerland). The specific applications involve turbine blades, guide plates, and valves. An even newer Chiron solution, AM Coating, is designed to coat brake discs in larger serial operations. The group plans to unveil an initial prototype in the second quarter of 2021.

BOI Yes and no – how's that for a clear answer? I think it's obvious enough that a bigger company will have more expertise. Small contract manufacturers have an expert or two, but their staff numbers are naturally limited. Meanwhile, most of today's 3D printing applications are designed for small production runs. These are better suited to smaller companies than to corporations – particularly in the automobile industry. We're in the middle of a pilot phase involving the AM Cube and a midsize organization, whereas with AM Coating, we're working with a major corporation on the subject of coating brake discs. We're finding potential customers in all kinds of areas.

Where are you seeing a lot of potential?

BOI It's hard to give you an answer there, as well. There are plenty of small contract manufacturers that are just interested in one basic system, but then you'll have a corporate group that wants to buy 10 units and discuss some very specific requirements. At the end of the day, a large number of uncomplicated customers represent at least as much potential as one big one.

Which is easier to win over?

BOI Put it this way: The smaller a company is, the easier it is to sit down at a table with the people calling the shots. If you find they're on the same wavelength, it doesn't take long to get results. The wheels turn quite a bit slower at a large corporation, of course. There are lots of topics you can't influence from the outside. Budget decisions, political decisions – one area gets funded, another doesn't.

It sounds like you think that smaller companies represent the quicker path to gaining a foothold in AM. What do you consider key when it comes to carrying out a project?

BOI You're definitely right; with companies of that size, it usually takes less time to get started on actual applications. 3D printing is an area where there still aren't a great many applications that really make economic sense. When we can leverage a technical advantage that's so clear that an end customer will pay for it, that's an opportunity for us. Many things are possible, but a lot of them can be done using conventional methods, too. If we don't offer a technical edge, why would a customer be interested? As for the ongoing development of this field, the key is expertise on the customer side. If we have more bright minds exploring the subject of AM, more useful and economically viable applications of the technology will emerge.

You just touched on the idea that additive manufacturing needs to be worth the investment in order to succeed. How is the Chiron Group doing in that respect? When do you need to start generating tangible turnover, or even a profit?

BOI We've put together a solid business plan with real-world figures, of course, and we're sticking to it in spite of the pandemic. Without it, we wouldn't have even been able to get started or secure funding. I can't reveal any exact numbers, but I can tell you they're ambitious and I remain confident that we'll achieve them.

Could you give us a sense of the scale you're talking about?

BOI As I mentioned, we're in the middle of a pilot phase and are looking to sell a realistic number of units in 2021. We also want to bring our AM Coating system to market this year. Let me put it this way: Before I took this job, I was the managing director of Chiron's French subsidiary for 10 years. I'd now like to generate the same amount of revenue in AM as we did there.

Mr. Boi, we wish you the best in that endeavor – thank you very much for talking with us.

Chiron Group
The organization now known as the Chiron Group was founded as Chiron Werke GmbH & Co. KG in 1921. Headquartered in Tuttlingen, Germany, it specializes in vertical CNC machining centers and turnkey manufacturing solutions. Chiron and its 2,100 employees generated €443 million in turnover in 2019. The group comprises the brands Chiron, Stama, and Factory5 (new machines), as well as CMS (retrofitting). Products and solutions for additive manufacturing now round out its portfolio.

+ FURTHER INFORMATION:
» chiron-group.com
» fon-mag.com

»YOU NEED TO MIX IN MORE STRAW«

Text: Thomas Masuch

The cement industry is one of the world's largest emitters of CO_2. 3D printing is therefore associated with the hope of building in a more material-friendly and sustainable way. Meanwhile, even greater sustainable potential lies in alternative building materials: MIT researcher Sandy Curth and collaborators from the University of California, Berkeley have bravely taken on one such substance that dates back millennia – clay – and have already 3D-printed some initial test buildings on the plains of Colorado. The challenges, however, are immense.

The pieces of western red cedar *(right)* connect the inside and outside walls. This was not only done for the aesthetic, referencing some of the vernacular earthen architecture of Djenné, Mali where wooden elements are embedded as permanent scaffolding for the annual re-plastering of the walls but also as a novel approach to a hybrid structural system that could ultimately be useful for incorporating insulation into the walls.

Photos: Sandy Curth

The local farmers certainly did their share of smirking at the unfamiliar construction technology required. Indeed, simply operating it took as many people as an entire construction site of the same size. But they also offered some well-intentioned advice: »You guys need to mix in more straw,« one said. »How are you going to insulate it or put a roof on it?« asked another. Sandy Curth – who worked with a team consisting of researchers Logman Arja, Ronald Rael, and Virginia San Fratello that 3D-printed the first clay prototype on the prairie near Antonito, Colorado – was pleased with how people with lots of hands-on experience reacted. After all, they were dealing with this new technology and didn't see anything superfluous – much less threatening – in it. »That's an indicator that the technology is going in the right direction. People are starting to see these machines as something that's robust,« Curth reports.

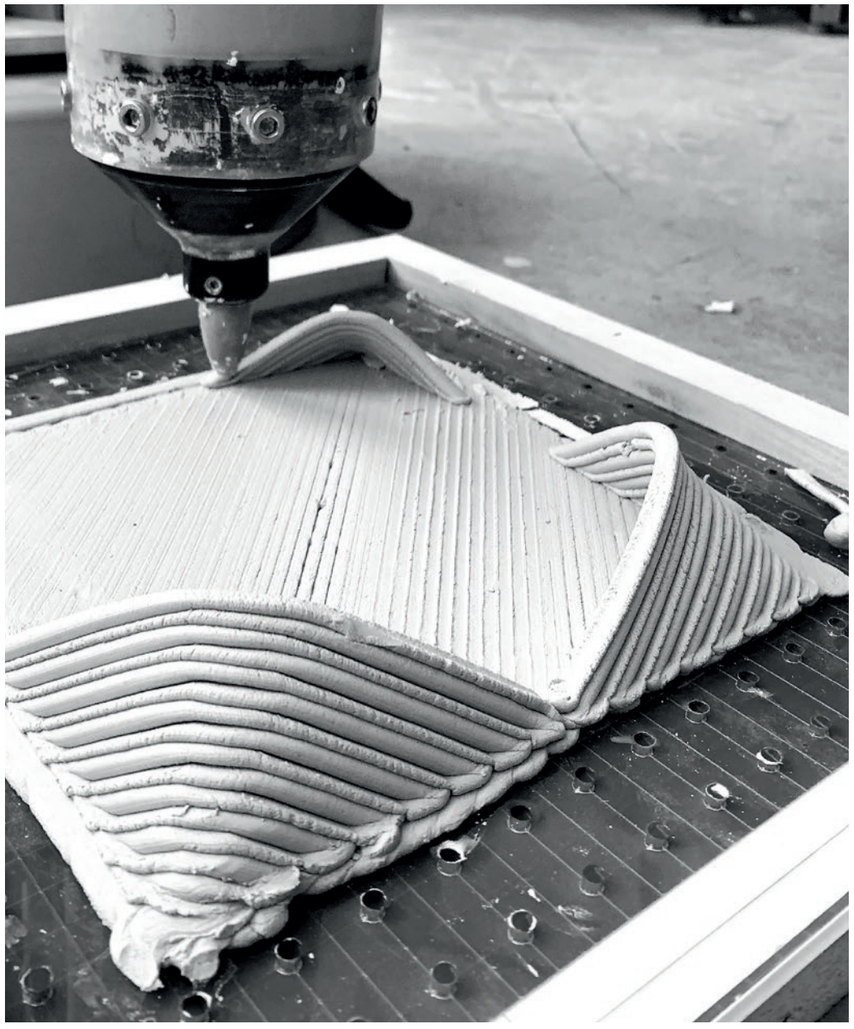
MINIMAL USE OF MATERIAL

The technology used by the MIT/UC Berkeley research team has deliberately been kept as simple as possible. The building material (a mixture of local sand, clay, straw, and water) is pumped through a tube and placed in the desired location by the arm of a SCARA-type robot. In this way, one coil of clay overlays the next,

The prototypes that have been built on the steppes of Colorado combine traditional adobe architecture with the unique possibilities 3D printing affords

forming the honeycomb walls of a round structure that looks like a mixture of a beehive and an indigenous lodge. Curth, who cites sustainability as his main motivation, uses resources as sparingly as possible in terms of both materials and technology. »Sustainability is about minimal use of material and being able to use minimal amounts of equipment on-site to produce something that is large and complex and highly functional,« he explains.

Examples of the capabilities of clay in architecture can be seen on the Arabian Peninsula in Wadi Hadhramaut, which is also known as the »Chicago of the Desert« thanks to its nine-story buildings. Or look to Weilburg / Germany, where a six-story adobe house has withstood countless long, cold, and damp winters since 1836. In recent years, the growing quest for sustainability has given new momentum to the use of adobe in the construction industry in Europe, the United States, and China. For instance, clay was used extensively in the new headquarters opened by the organic food company Alnatura in 2019. Walls made of rammed earth are clearly in vogue – especially where they don't play a load-bearing role. The advantages of this building material, which has been used for thousands of years, are enormous compared to cement: Besides being free of harmful substances and climate-neutral in »



The team's research efforts with adobe also include explorations in structural design

production, it provides a healthier indoor climate and makes a striking visual impression thanks to its natural structure. Sandy Curth even sees a »super growing industry« in the U.S..

NOT A LABORATORY

That said, working with 3D printing does pose major hurdles in this context. Unlike in the industrial 3D printing of metal, where the process takes place in an environment that is as clinically constant as possible, many variables can hardly be predicted when 3D-printing clay. This starts with the material itself, which should be available locally to avoid long transport routes. Among the other regional characteristics in play, environmental factors such as sunlight and wind play a major role; the clay has to dry before it can support further layers, after all. »And actually, we 3D-print in an environment that's not unlike a real construction site, where you're outside, the weather changes, and equipment gets roughed up and pushed around. It's not a laboratory,« Curth points out.

Another unusual factor is time. While there is concrete that hardens very quickly, 3D-printing earthen material requires patience. »Concrete has a fixed curing time. For us, you have to consider drying,« Curth reveals. This meant it was only possible to print for two to three hours at a time; then the waiting began. In the meantime, however, the MIT researchers were able to move their clay 3D printer to the next building and continue there. »We were printing in three or four places at once and started to have a continuous workflow across the construction site,« the MIT researcher says.

Leveraging this technique in a professional setting (which would also include certification, of course) seems almost impossible at first glance due to the many unpredictable factors at hand, but Sandy Curth remains confident. In order to get a handle on the numerous variables, he is developing software that calculates appropriate 3D printing parameters based on things like the current weather conditions and the properties of the specific material in use. In the future, Curth plans to make it compatible with both earthen and concrete structures to give 3D printing an additional boost in his chosen field. »Improving the software is going to make this technology available for widespread use in the construction industry,« he predicts.

To that end, Curth is working with various concrete manufacturers – even if that does somewhat cloud the sustainability aspect. »We can validate a lot of what we want to do with earth, and any material savings allowed by 3D printing can significantly lower the embodied carbon of a concrete building,« he maintains. In addition, Curth has his sights set on much more unusual applications in developing his 3D printing technique for clay. »I think earthen construction with 3D printers as a kind of construction model is maybe the most compelling model currently running on Earth for how we're going to build buildings in space.«

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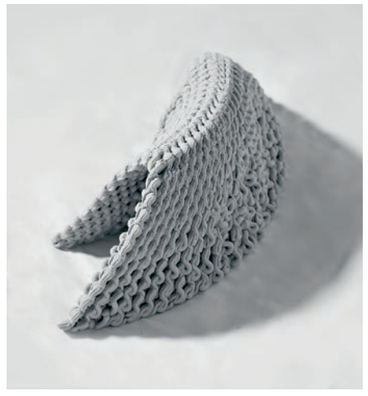
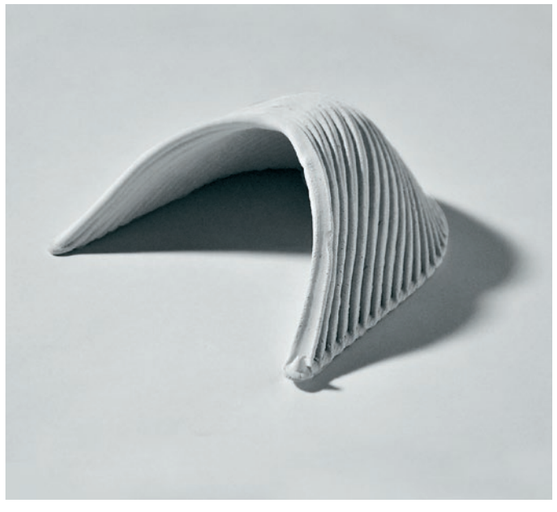
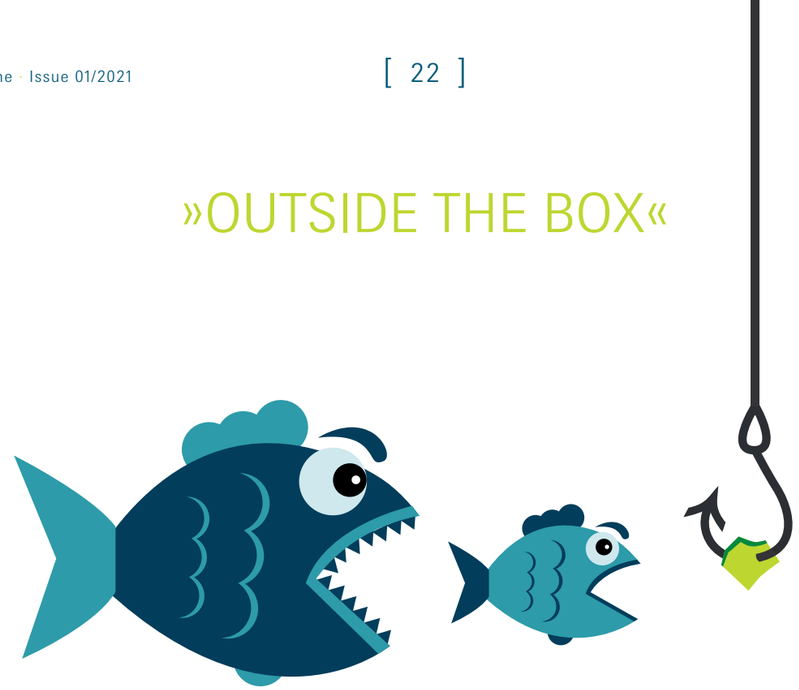




The results of this research may eventually aid the 3D printing of buildings in space

»OUTSIDE THE BOX«



A Fish-Eye View?

Text: Thomas Masuch

These days, when we talk about the next generation of employees and those just starting out in the world of work, we talk about »talents«. Did you know that the word can be traced back to an antique unit of weight that the Romans went on to use as a unit of currency? It was only later that »talent« began being ascribed to people as a way to imply that they had a certain type of value. Intrinsic riches waiting to be discovered, if you like.

Even though it's hard to imagine from the perspective of the AM world, young people today are growing less and less interested in making use of their varying levels of talent – at least in professional settings. This was the conclusion drawn by an EY study that surveyed more than 2,000 students in Germany in October 2020. When asked about what they will be looking for most in their future jobs, the respondents most often cited job security (67%), an attractive salary (55%), and the ability to balance their work and family (39%). Aspects like advancement opportunities (33%), flat hierarchies (22%), and an employer's innovative capability (16%) were deemed much less important. It's no wonder that more and more young and talented people here in Germany are looking to become employees of the state, who enjoy set working hours, the aforementioned job security, and (eventually) a generous retirement package.

Still, the aversion to accepting some uncertainty in one's choice of employment could soon wane, and the reason why could have something to do with a substance that is proliferating in seas, rivers, and the very ground beneath us: Microplastic. Researchers have already witnessed related behavioral changes in fish. According to a study by Australia's James Cook University, juvenile ambon damselfish that had eaten polystyrene particles just two tenths of a millimeter in diameter along with their usual nourishment were much more willing to take risks in their search for food. The explanation as to why is as simple as it is enlightening: Their stomachs were full, but they were still hungry.

There are, of course, some reasonable doubts as to whether this special diet will prove to be a reliable method of fostering more enterprising mindsets in young people. In the case of the damselfish, eating plastic turned out to be something of a bad omen. Just 72 hours after they were released into the waters of the Great Barrier Reef, fish higher up the food chain had turned every last one of them into a meal.

Illustration: feedbackmedia.de, iStock/SusiO

END OF ISSUE – CONTENT CONTINUES

AM Field Guide

The AM Field Guide is a hands-on introduction and provides an initial, structured overview of the complex, multilayered world of additive manufacturing processes.

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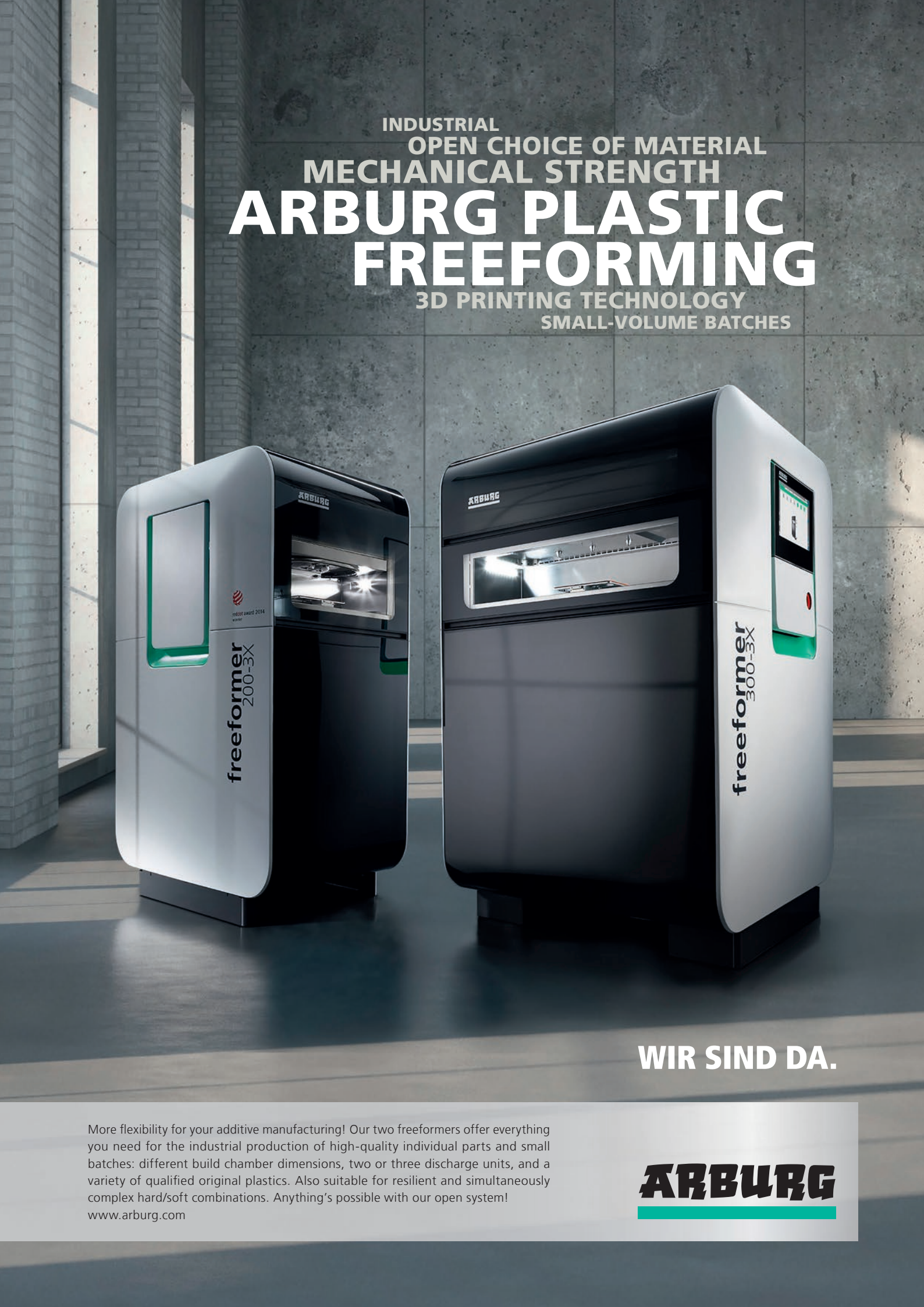
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