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and insights about Additive Manufacturing

SYSTEM ASSEMBLY

How to build an AM department – using desktop printers and plenty of expertise

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SERVICE PROVIDER

Read about a conventional manufacturer of small series and prototypes that's getting a boost from SLS printing

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There is never a moment
when you can say, I've
done a good day's work
and tomorrow is Sunday.
As soon as you stop,
you have to start again.

[Pablo Picasso]

Cover: Jánosch Schallert

EDITORIAL

As the German poet Theodor Fontane once said, courage is good, but endurance is better. Additive Manufacturing has both qualities: the courage to identify and develop more and more innovations and applications, and the endurance the industry has demonstrated in expanding continuously for more than two decades.

That happened again in 2022 (see page 7 for more details) and next year is looking good, as well. With that, the market is defying ongoing dilemmas like inflation, the war in Ukraine, and the shortage of skilled employees in Europe and the United States.

The latest survey conducted by the VDMA – the conceptual sponsor behind Formnext – also paints an optimistic picture: While companies are looking ahead with some caution, they seem to be in a positive mood overall.

Here, the particular branch of industry you look at is an important factor. More and more AM components are being built in the medical and aerospace sectors, for example, which is providing for a good bit of momentum. We saw a striking example of AM's increasing importance in aerospace just a few weeks ago during the successful launch of Relativity Space's new (almost entirely 3D-printed) rocket. The mechanical engineering and automotive industries, meanwhile, are taking a more conservative approach to the future, but Additive Manufacturing continues to present tremendous potential in these fields, as well. To find out how to leverage such opportunities, check out the article on page 8.

Formnext is also on track for some outstanding results this year: Since the beginning of the year, we've received more registrations than ever before and now have our sights set on the overall figures from 2019 (the year before the COVID-19 pandemic). Our exhibitors will be representing the entire AM process chain – including key sectors like post-processing and services – on an even higher level in 2023. By the way, if you're looking to succeed as a service provider both at Formnext and in your day-to-day business, don't miss the article on page 14.

On the whole, we're pleased to see a clear trend in industrial firms optimizing their production operations and making a conscious effort to apply AM in the process. At Formnext, you can find partners and solutions that will help you get the most out of activities like these. In providing an ideal showcase for innovative production solutions, we want to enable you to share in the success of our exhibitors, attendees, and community partners – and become part of the »fAMily«!



Sincerely, Sascha F. Wenzler
Vice President Formnext



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FORMNEXT NEWS



FULL STEAM AHEAD FOR NOVEMBER PLUS YEAR-ROUND CONTENT

Formnext has hit the ground running in 2023 with the highest number of registrations to date. By mid-April, more than 550 companies had already signed up for the world's leading trade show for Additive Manufacturing and next-generation manufacturing solutions, 62% from outside Germany. To meet this enormous demand from the community, Formnext is developing a range of specialized offerings for the November show and is increasingly becoming a hub for AM all year round.

The continued momentum and confident mood of the AM industry are reflected in Formnext's outstanding registration figures. Big exhibitors already on board include such companies as 3D Systems, Additive Industries, Arburg, BigRep, Carbon, DMG Mori, Dyemansion, Dyndrite, EOS, EPlus, Farsoon, Formlabs, GE Additive, GKN Sinter Metals Components, Hage 3D, Hexagon, HP, Keyence, Markforged, Massivit, Nexa3D, Open Mind, Prima Additive, Renishaw, Ricoh, Roboze, Rösler, Sandvik Additive Manufacturing, Shining 3D, Siemens, Sisma, SLM Solutions, Stratasys, Trumpf, Velo3D, Voxeljet, and Xjet. In addition, numerous new companies as well as renowned international groups along the entire process chain will showcase their expertise, including BASF,

Bosch, Evonik, Höganäs, Linde, Nikon, Oerlikon, and Praxair. Contract manufacturers specializing in 3D Printing are often the entry point for users into Additive Manufacturing. So far, FKM Sintertechnik, Jabil, Materialise, Promod Prototypenzentrum, and Quickparts have already registered.

»The AM industry is developing at break-neck speed and offers enormous growth potential for established companies as well as for start-ups and SMEs,« says Sascha F. Wenzler, Vice President Formnext at event organizer Mesago Messe Frankfurt GmbH. »The number of suppliers along the process chain who are taking advantage of Formnext to successfully establish and expand their Additive Manufacturing offerings is growing all the time.«

HUB FOR ADDITIVE MANUFACTURING

Formnext is so much more than a trade show. The brand also offers a wide range of services beyond the show floor. In addition to the quarterly Formnext Magazine, the Formnext Newsroom presents articles from selected trade media. Formnext.TV reports live from the trade show and also provides inspiring and entertaining reports throughout the year. The AM Field Guide provides a helpful introduction

to the wide array of additive technologies available, outlining the key features of individual AM processes, and the highly successful Discover3Dprinting seminars are invaluable for anyone considering adding industrial 3D Printing to their production portfolio.

»The AM industry is innovative, and developments are moving so fast that ongoing discussion is vital,« explains Wenzler. With its various media and formats, Formnext is aimed at a broad audience from a wide range of industries and is developing into a hub for all things Additive Manufacturing. »With events like Formnext, we are successfully bringing together key stakeholders to sustainably connect technology, business, and the community. By offering additional formats, we are underlining our commitment to providing year-round content alongside the trade show and supporting the AM sector as a specialist partner,« explains Petra Haarburger, President at Mesago Messe Frankfurt.

IMPROVED CONFERENCE DESIGN

Formnext has also optimized its conferencing program organization. For the first time, this year's conference program will be held across three different stages in the exhibition halls.

The Industry Stage will focus on topical, seminal issues such as sustainability and digitization. However, the agenda also includes new business opportunities as well as valuable insights into specific areas such as the start-up and funding world. The program will be broadcast live on Formnext.TV. Providing a morning and afternoon session on each day of the trade show, the Application Stage will showcase a variety of exciting applications from different industries. On the Technology Stage, Formnext exhibitors will present solutions along the entire process chain.

+ FURTHER INFORMATION:

» formnext.com

NEWS

IMPROVING THE PROPERTIES OF TISSUE

The production of human tissue using 3D Printing promises great potential for medicine, and there have already been numerous promising developments in this field. The sector is not insignificant in economic terms either: various analysts (Persistent Market Research, Grand Views Research, Markets and Markets) see the current market volume at around 2 billion US dollars and growth over the next ten years to around 8 billion euros. This is equivalent to around 10 percent of the total 3D Printing market. In addition, the USA plays a significant role with around one third of the market volume. Continued growth of this sector

is primarily linked to the development of the corresponding materials and 3D Printing systems. For example, the German company Matrihealth GmbH has launched a new elastin that is expected to significantly improve the results of tissue printing. Named Elma, the elastin methacrylate enables, according to the manufacturer, »the incorporation of elastin in the formation of new tissue and thus the production of natural-mimetic tissue, as well as the targeted adjustment of mechanical properties and improved replication of the extracellular matrix.« The need for bioprinting arises in part from the shortage of donor organs as well

as the body's immune response to implanted organs and tissues. 3D-printed tissue based on the body's own cells is expected to help. For this purpose, the body's own cells are usually printed into a support structure made of biocompatible hydrogels. These are usually made from cell-compatible materials such as collagen, alginate, gelatin as well as special ceramics and biocompatible polymers, some of which are already found in natural tissue.

GOING HIGH TECH WITH TRADITIONAL MANUFACTURING METHODS



come a long way since medieval times. The specialized coils from Fortius Metals are used in 3D printers and are processed using additive arc and laser welding. The young company is primarily targeting demanding industries such as aerospace, defense and automotive.

To achieve success in the already competitive market for Additive Manufacturing materials, Fortius Metals relies on the expertise of materials manufacturer Elementum 3D, from which the startup was spun off in 2021. Fortius Metals has licensed the materials innovations from Elementum 3D and offers high performance welding wire. Materials include various aluminum series, which the company promises will result in improved component quality. According to Jeff Lints, founder and CEO of Fortius Metals, their alloys offer dramatically improved grain structure and thus advanced mechanical properties. »When our alloys are twice as strong as conventional alloys, customers can design their parts with a significantly reduced overall component weight; sometimes half the expected weight.«

»The printing of large-format metal components offers major opportunities in the coming years,« explains Lints. That is why, in addition

to the production of wire, the company is also acting as an AM service provider and, together with Trumpf, is setting up a laser welding cell that is intended to offer real added value to the next generation of applications. Lints is also reassured by the numerous inquiries from traditional companies that would typically use cast components, which are interested in 3D printed parts on account of the unacceptable foundry delivery times of up to one year. Besides that, Lints sees significant potential in the space industry: »Around half of rocket engines are now 3D printed, and we see great opportunity in the printing of larger structural components.«

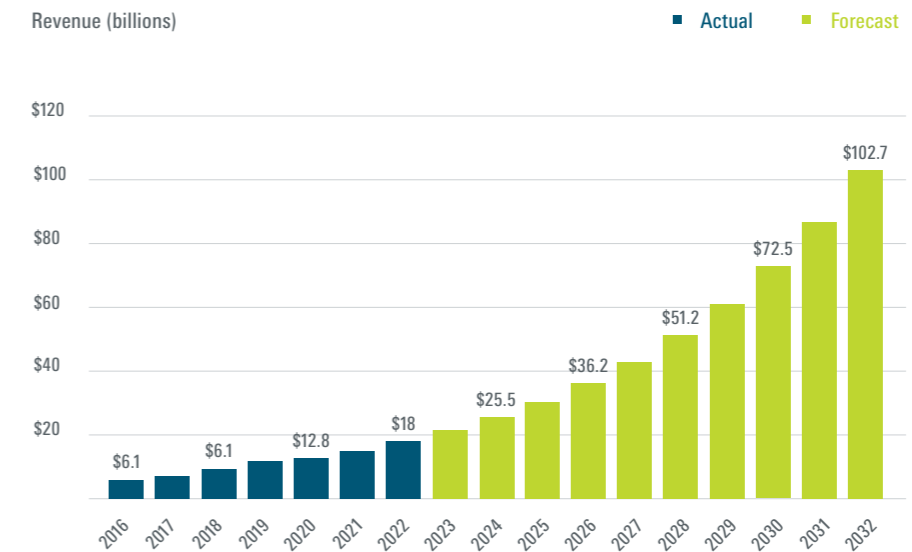
To accelerate further growth, Fortius Metals recently closed a \$2 million seed funding round with AM Ventures acting as lead investor. Since being founded two years ago, the company, in which the former parent company Elementum 3D also continues to hold an interest, has thus generated a total cash inflow of \$3.7 million.

Photo: Fortius Metals

Infographic: Wohlers Associates / ASTM International

NEWS

GROWTH AND PROFITABILITY



Wohlers Report 2023 predicts that the global AM market will grow from U.S.\$18 billion to U.S.\$102.7 billion over the next 10 years

After a difficult 2021, the AM industry revved back up to its previous rate of growth in 2022. According to Wohlers Report 2023, the volume of AM products and services increased by 18.3 percent compared to the previous year, reaching U.S.\$18 billion in size. Things are expected to continue at a similarly impressive pace for the next decade, which would put the market's volume at U.S.\$102.7 billion in the year 2032. This positive development is also evident in the recent figures announced by well-known system manufacturers like SLM Solutions, voxeljet, Desktop Metal, and Markforged. On the whole, companies in the sector will continue to target growth in their future planning, but profitability is also becoming more of a focus. The aforementioned SLM Solutions Group AG, for example, disclosed €105.7 million in turnover for the 2022 fiscal year – a remarkable increase of 41 percent compared to 2021. Recently acquired by Nikon, this firm attributes its strong performance to the launch of the NXG XII 600 production system and its growing business in after-sales.

SERVICES DRIVING GROWTH

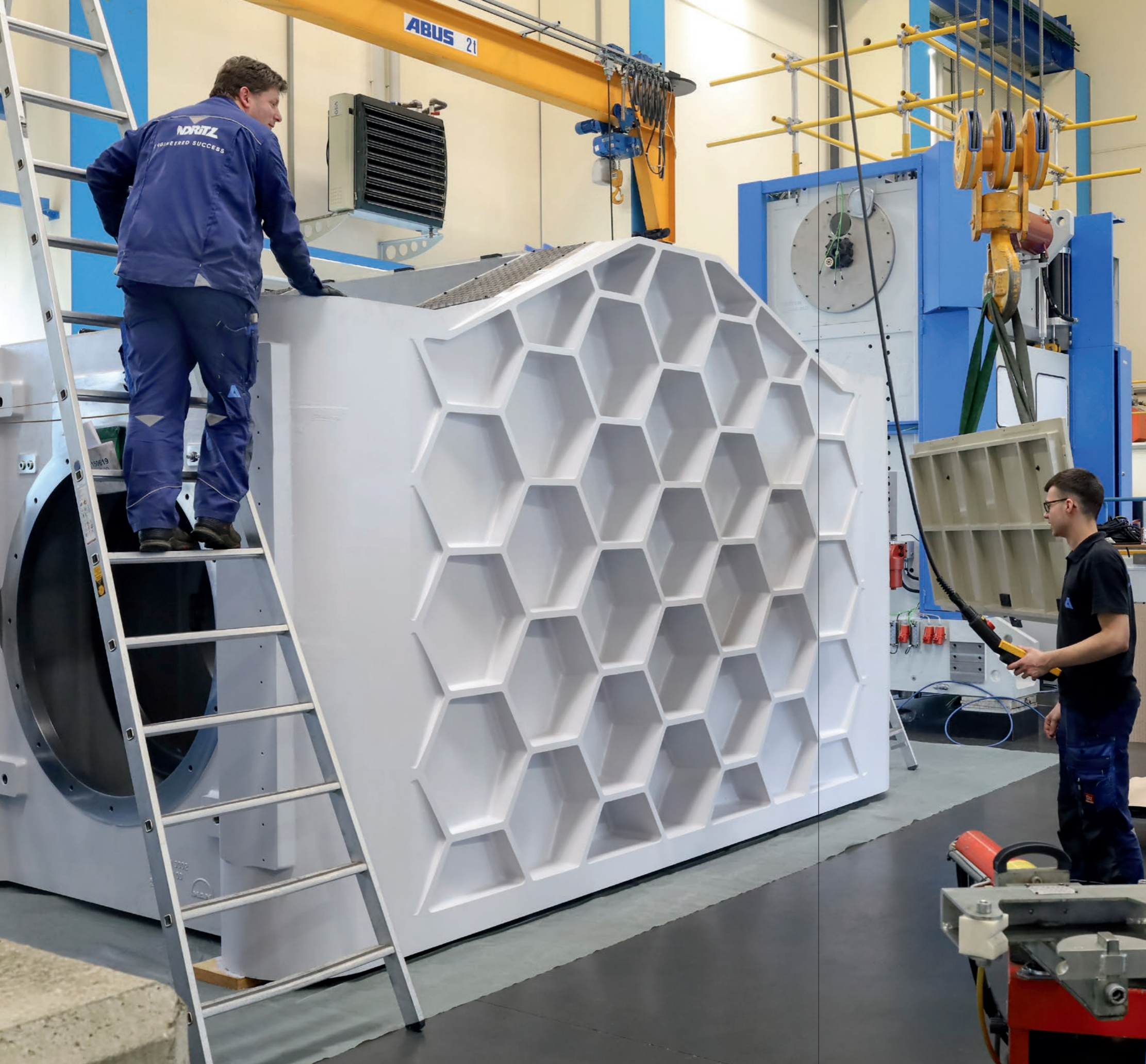
Another company that did well for itself in 2022 was voxeljet, a specialist in binder jetting and HSS 3D printers that generated €27.8 million in revenue (12.1 percent more than in the previous year). While its turnover from selling 12 new and three refurbished printers was roughly the same as in 2021 at just under €16 million, voxeljet managed to increase its revenue in services from €9.1 to €12 million. It cites the larger contributions made by its German service center and its subsidiary voxeljet America as the reasons for this considerable rise. Meanwhile, the German company also announced gross earnings of €8.2 million and a corresponding margin of 29.4 percent.

AN 86-PERCENT INCREASE IN REVENUE

In the case of Desktop Metal, a larger product portfolio is clearly reflected in the resulting sales figures. The Massachusetts-based company raised its annual turnover to U.S.\$209 million last year, representing an increase of 86 percent. Desktop Metal generated 24 percent of that sum through consumables, services, and subscriptions. While the company did disclose a GAAP gross margin of 7.2 percent, it also

reported a GAAP net loss of U.S.\$740.3 million. This was one reason why founder and CEO Ric Fulop announced that Desktop Metal would be concentrating more on profitability going forward. »We've also taken measures to streamline the company and expanded our planned cost reductions to U.S.\$100 million per year,« he stated. Desktop Metal currently expects to generate U.S.\$210–260 million in turnover in 2023.

Finally, Markforged achieved an 11-percent increase in sales in the 2022 fiscal year, bringing its own total to U.S.\$101 million. Also based in Massachusetts, the company was keen to point out that this growth was largely organic. Shai Terem, president and CEO of Markforged, attributed it to the increased demand for its Digital Forge platform. At the same time, Terem sees the disruptions in the global supply chain as a key ongoing catalyst for growth in the sector, as production companies can shorten their own supply chains by manufacturing parts right where they are needed. Markforged reported a gross margin of 50 percent for 2022, along with a (non-GAAP) net loss of U.S.\$60.1 million. The company is projecting U.S.\$101–110 million in turnover for 2023.



The press's top section, which features a honeycomb structure that reduces vibration and makes the cast-iron colossus a bit less heavy

THE COMPONENT WHISPERER

With a bionic mindset, inexpensive desktop printers, a wealth of expertise, and an extraordinary concept for Additive Manufacturing, Paolo Matassoni has built up an AM department at Andritz Kaiser GmbH that now supplies a portion of the Andritz group with 3D-printed parts. The department's additive approach has also played a formative role in the development of Andritz Kaiser's latest 300-ton mechanical press.





Top left:
Paolo Matassoni presents the press bed and its bionically formed feet
Top right:
This 40-ton press ram features a bionic design both inside and out

We stand before a cast-iron giant wearing a honeycomb crown. Paolo Matassoni runs a hand over the elegantly designed top section of the new mechanical press, which is three meters tall and weighs in at 60 tons on its own. The smile of an artist gazing in silent satisfaction upon a work that has taken countless hours of effort spreads across his face.

A short walk away on the gray-and-black floor of Andritz Kaiser's assembly hall in Bretten (southwest Germany), a heavy-looking press bed painted in white waits, ready to anchor the press securely to the floor once it is installed inside the machine's base. Like the roots of a mangrove, its supports branch into individual struts that form hollow spaces and combine with the 100-ton bed to create a single sinuous unit. The bionic balance of this cast-iron creation – which is roughly the size of a single-family house – is seamless but for a few locations that have been machined to a steely shine with millimeter-level precision to allow for the installation of further components.

While the press bed was cast using conventional methods, the head of development at Andritz Kaiser GmbH reveals that he »never would have dared to design something like this without borrowing from the world of 3D Printing«. Matassoni had already integrated numerous 3D-printed components into this machine's much smaller predecessor (which we reported

on in our 02/2020 issue). The ToP-Line KSH2 in front of us – officially described as an »automatic stamping and forming press« – represents the next milestone in Andritz Kaiser's efforts to incorporate Additive Manufacturing into its machines.

A total of 120 3D-printed parts have been built into this 300-ton unit, which was specifically developed to meet the requirements of hydrogen technology. It will be used to produce the kind of bipolar plates that constitute the core of hydrogen fuel cells. The AM components in the ToP-Line KSH2 press range from smaller joints and enclosures to oil return components and collection trays, lamp mounts, and gear wheels. Like the press bed, the honeycombed top section and the ram were conventionally cast, but still maintain the bionic aesthetic that was inspired by 3D Printing, as Matassoni explains.

Another special feature will eventually be attached to the side of the top section: a safety brake and angle encoder for the press's 800-kilowatt servo motor. »That's an important safety component; we printed and cast the mount for it,« reports Manuel Mozer, one of Matassoni's coworkers. »As a result, the brake helps reduce vibration, and machining it is also possible.«

The various 3D-printed, bionically designed parts that have gone into the ToP-Line KSH2 make it lighter (and thus more efficient) with-



Text & Photos: Thomas Masuch

out sacrificing stability. This improved performance is key in the production of bipolar plates, which requires a high degree of both precision and output. In addition, Andritz Kaiser can now handle special requests and repairs in a more cost-effective manner. The company's additive strategy has also impacted the time needed for related developments. »We've gotten much faster in that respect, thanks in particular to all the things we've learned,« says Matassoni. »It feels like it takes half the time it used to!«

A LIFELINE FOR COLLEAGUES ON A DEADLINE

If you're wondering how a soft, elegant engineering aesthetic could have come to guide the development of powerful new machines in a conservative industry where elemental forces drive heavy press rams at seemingly impossible speeds, look no further than Paolo Matassoni himself and the management board at Andritz Kaiser. The 53-year-old has been immersed in 3D Printing and bionic designs inspired by nature since 2002. His comfortable knit jacket and gray slacks are a fair reflection of his mindset: Matassoni is a free spirit, but a practical one who expresses himself with style and intent through his knowledge of the importance of nuance.

The fact that he develops house-sized presses instead of Italian sports cars may be related to the freedom he has had at Andritz

Kaiser to gradually take advantage of the benefits of AM in mechanical engineering. Describing himself as a »free thinker who has managed to capture the imaginations of the higher-ups on occasion«, he has indeed won over more and more colleagues at this traditional company, which has belonged to the international Andritz group since 2004.

Its AM department, Tec-Farm, has since added three young, disruption-minded members with a passion for 3D Printing. It now operates as a service provider within the Andritz group, which has more than 250 production locations and some 28,000 employees around the world. Tec-Farm's additive services are offset through an internal cost center based on the time required, materials purchased, printer depreciation, and other costs. »We can then invest the profits in more technology – meaning printers,« says a pleased Matassoni.

Handling internal projects for its international corporate group is now »how we earn our keep«, says Lena Glöckler, another design engineer at Andritz Kaiser. Sometimes colleagues come to Tec-Farm when they discover that a certain part is missing and their project's deadline is looming. »We're usually able to throw them a lifeline and help out in a hurry,« Glöckler says. While conventionally manufactured parts normally take four to six weeks, the department's 3D-printed components are typically ready in just two days. Meanwhile, Addi-

tive Manufacturing has continued to establish a stronger presence in Andritz Kaiser's assembly hall, as well. »We didn't expect that area to be an ongoing source of inspiration for so many innovations,« Manuel Mozer reveals. »You can tell that our colleagues there are thinking about AM.« That wasn't always the case, as Mozer goes on to explain. »In the beginning, plenty of people at the company weren't big believers in the direction we were taking, and some of them even had a certain amount of antipathy toward 3D Printing,« he recalls. »It's completely different now; there aren't nearly as many skeptics.«

The amount of appreciation people now have for AM at Andritz Kaiser is evident in a promotional video that highlights the company's use of 3D Printing. Matassoni has also received a design award from the entire Andritz group. »

An eccentric shaft with oil drainage rings



»CUSTOMERS AND PURCHASERS UNDERSTAND THE FORMS«

Along with the 16,000 kilonewtons of pressing force it can generate, the unique bionic design of the ToP-Line KSH2 has played a central role in winning over not only the people at Andritz Kaiser, but potential customers, as well. »They see what we're capable of in terms of innovation,« Matassoni affirms. »Even if they don't grasp every technical detail, customers and purchasers understand the forms because they come from nature and seem familiar right away. That makes the machine more logical.«

These innovations can be traced all the way back to the development phase. According to Matassoni, this is another area where the benefits of the company's additive strategy are readily apparent. His AM team is also forging into more and more new territory that would have been unthinkable in the past. »Thanks to 3D Printing, we've gotten bolder and honed our innovative capability,« Matassoni says, adding that the technology gives his team a type of safety net in the event of failure. »We can reverse course quickly if something doesn't work out.«

»THINK BIG, PRINT SMALL«

Tec-Farm's plastic components are 3D-printed in a room located at the end of an office hallway in Andritz Kaiser's administrative building. Here, one finds a row of around a dozen desktop printers, most of them from Ultimaker and Prusa. »We started with FDM six years ago, and we've stuck with it,« Manuel Mozer says. The printers are affordable – the basic versions of some of the printers in use at the company cost around €1,000 – but »you can produce

quality results in industrial settings as well,« Mozer continues. »It does take a good bit of expertise, though.«

That's exactly what hobbyists like Mozer, Lena Glöckler, and their colleague Alena Dehm have. As we pass by, they point out a belt printer from iFactory that seems to have sprouted a tangled mass of colorful cables, all of which lead to a control box. It's difficult to imagine how the printer looked in its original form. »For our purposes, FDM printing is actually better because the technical systems available are more open and less complex, which gives us the freedom to make our modifications. That wouldn't be possible with SLS printing, for example,« Mozer explains. This kind of improvised, yet technically flawless creativity is what Paolo Matassoni likes to see. »I'm happy to have young people contributing their knowledge and taking our AM production to the next level,« he declares.

This expertise is also enabling Andritz Kaiser to use its desktop printers to produce large parts like oil drainage rings or the enclosure for the ToP-Line KSH2's angle encoder. Such components are split into segments, bonded together, partially filled with plastic, and then machined into their final form. »To make sure the parts fit right, we include the tongues and grooves when printing them,« reveals Alena Dehm. This was how Andritz Kaiser printed its biggest component yet: an air deflector ring for a generator turbine measuring 1.2 meters in diameter. »Think big, print small« is how Matassoni describes his philosophy, which sometimes means using small FDM printers to manufacture parts for systems that cost millions of euros. »That probably makes us

something of a black sheep in the world of AM,« he admits. Applying this DIY method on an industrial scale has nevertheless resulted in a single-digit machine hour rate, as Lena Glöckler points out. »That means we can more than compete with CNC,« she adds.

FILLED COMPONENTS OFFER GREATER STABILITY

Virtually all of Andritz Kaiser's AM components are 3D-printed using fiber-reinforced plastic (PA6). In cases involving larger parts, this is how the external enclosure is made before being filled with a type of duroplast that contains metal particles. Since this filling material doesn't come cheap, Manuel Mozer has come up with another DIY solution: Like reinforced concrete, duroplast can simply be filled with metal wool.

»The method works in the same way as a human leg, where the bone provides stability inside a covering of muscle and skin,« explains Matassoni, who once served as an EMT alongside his job as a design engineer. He says this technique also presents a great deal of further potential, as well. It's also easy to add bits of brass to the composite, for example, or electronic components like sensors. This opens the door to solutions on many new levels.

During tensile testing, the team also discovered that their filled components were able to withstand much more strain than those made entirely of fiber-reinforced plastic. Matassoni attributes this to the way the filling significantly increases a part's stability along the z-axis and improves the bonds between its individual layers.



Various components produced by Tec-Farm, including a mount for the main motor encoder (top left)

ASKING THE MATERIALS DIFFERENT QUESTIONS

Next to each of the desktop printers in Tec-Farm's room is a black case of nearly the same size that supplies the unit with filament. These cases preserve spools of the material in an air-tight environment. »We've conducted numerous material tests, and one of the things we've figured out is that the raw material we use has to be as dry as possible,« says Mozer.

One morning, he found fairly definitive proof of the need for such tests waiting for him on his desk. Mozer had printed a series of test components the day before. »They still looked good that evening, but just a day later, one had sort of exploded all by itself,« he recalls. It wasn't long before the AM had figured out the reason why. »With some materials, a component of a certain size can basically tear itself apart due to its internal tension,« Mozer explains.

Meanwhile, parts made of other materials had deformed because they were too sensitive to humidity. »We tested materials and came up with different results even though the specification sheets said the same thing,« reports Matassoni, who then developed a test series of his own that was different from the standard procedures. »The manufacturers had obtained their data using tensile testing; we simply came up with different questions for the materials to answer.«

ing company is spending on research. However, pouring all that effort into material development enables Andritz Kaiser to save a great deal in other areas. »That's the path we've chosen, and it's not the beaten one,« Matassoni says.

»AS STANDARD AS A POWER DRILL«

Meanwhile, the Tec-Farm team is far from finished: For one thing, its members plan to keep spreading the AM gospel at Andritz Kaiser, including by implementing decentralized manufacturing at specific locations and installing 3D printers in the vehicles of mechanics in the field. This would enable them to print the spare parts they need on-site. »We want 3D printers to be as standard as a power drill,« declares Matassoni, who adds that settling the issue of fire safety at customer locations is the last thing standing in the way.

At the same time, he wants to continue establishing the additive mindset not only at Andritz Kaiser, but throughout the entire Andritz group. Matassoni believes that the core concern here is »figuring out what the components themselves need and forgetting all about the requirements of manufacturing«. In this way, the company's design engineers could leave their complex two-dimensional plans behind and immerse themselves more and more in bionic systems. »We're talking about a paradigm shift, and that requires a certain amount of mental anarchy,« Matassoni states. He says that the solutions are just waiting to be found in nature, albeit in different places. »You just have to know how to put the answers together.«

A THREAD CUBE BECOMES THE NORM

Known as the »AK norm«, the test procedure developed in Bretten involves 3D Printing a cube with a screw thread in the middle. A torque wrench is then used to turn a screw into the cube until it bursts. »One of the things we discovered is that some materials are really hard, but don't offer much bonding between their layers,« Matassoni says. Throughout this process, Andritz Kaiser's material partner was FiberThree from nearby Darmstadt, which Matassoni met at Formnext 2019. »They follow a philosophy similar to ours and have grown along with us,« he continues.

At this point, the team turned its attention to finding the right material for its internal applications. »Ideally, you'd have a special material for every printing job,« says Mozer. To operate efficiently, however, Tec-Farm chose a material that offered the best possible balance of stability, resistance to oil and temperature, and machinability. »Going with a compromise like this does involve making some concessions, though,« points out Matassoni. »There's just no universal solution that works well for every intended use.« Matassoni and his colleagues compensate for any shortcomings that arise by adapting their designs accordingly.

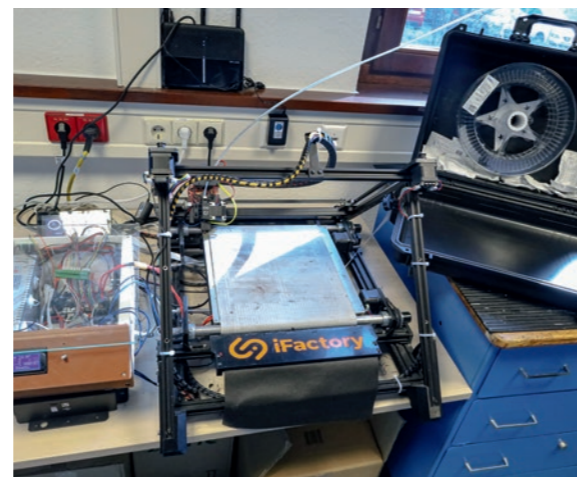
He goes on to describe how a number of the company's suppliers have been amazed to find out how much time a mechanical engineer-



Material Extrusion:
For further information on this procedure, check out the AM Field Guide at:
formnext.com/amfieldguide

Left:
Lena Glöckler, Manuel Mozer, and Alena Dehm (from left) in Andritz Kaiser's Tec-Farm department

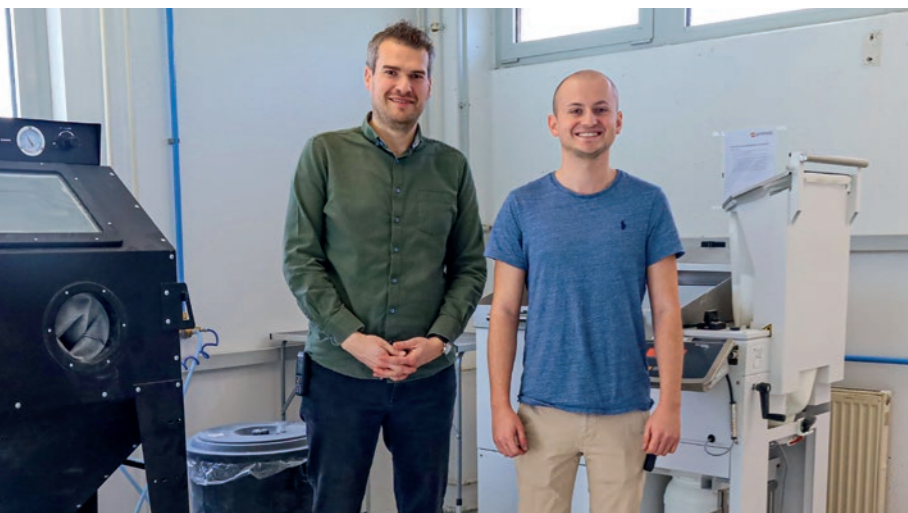
Right:
A lot of expertise has gone into modifying this iFactory belt printer. On the right, an air-tight case has been opened to access the filament inside



+ FURTHER INFORMATION:

» andritz.com
» formnext.com/fonmag

TURNING A THREAT INTO AN OPPORTUNITY



The manufacturing of prototypes and small series is a rather traditional industry that is largely made up of small and midsize companies. This is where the young enterprise Priomold has turned in an impressive run of growth, one that has made it one of the largest providers of its kind in Germany. Having initially perceived Additive Manufacturing as a threat to its business, Priomold is now hoping that the technology will help it write the next chapter of its success story.

The fields of the northern Black Forest are covered in frost this winter morning. An icy wind is blowing across the gently rolling mountain landscape that surrounds the town of Schömburg (elevation: 650 meters). In the business park of this community – which is otherwise most known for its spa and wellness facilities – a few electric vehicles stand in a row next to the entrance of a three-story building that looks like it was made to house both offices and industrial operations. Up on the second floor, we find employees dressed in t-shirts attending to their machines. The conditions outside would otherwise make their attire surprising, but not here: The heat emanating from the injection molding units that fill the space in two long rows is providing for a rather balmy temperature.

Pellets of plastic are being melted down and injected into molds, producing components that roll off the conveyor belts alongside the machines nearly every second. We're not allowed to take pictures of the parts; they're prototypes and small series, some of which are meant for automotive customers that plan to build them into their next-generation vehicles. That makes them closely guarded secrets, and the people who make them are required to sign corresponding NDAs.

There must be hundreds of companies with similar product portfolios in Germany alone. In this highly concentrated market, Priomold has nevertheless managed to advance from a start-up to the country's largest manufacturer of prototypes and small batches in just eight years. The company and its 65 employees generated

€8 million in revenue last year – and that's without any investment backing, just a clear strategy. »For us, the ability to deliver quickly is key,« explains 32-year-old Thomas Schönbucher, who founded Priomold in 2015 along with Moritz Zumdick, a friend from university with whom he shares management responsibilities at the company. In prototype manufacturing, Priomold guarantees turnaround times as short as one week.

WORRY AND MOTIVATION

Even though the company used nothing but injection molding machines in its early years, Schönbucher and his team still made sure to exhibit at Formnext. »We were something of an exotic animal among the other exhibitors,« he admits with a grin. The aerospace engineer

Text & Photos: Thomas Masuch

then reveals the secret of Priomold's success back then. »Firms that were looking for 3D-printed parts usually needed injection-molded prototypes or small series, too.«

Priomold's first appearance also had a memorable anecdote in store for Schönbucher, one that would go on to have a certain amount of influence on the company's future development. »A company that was all about providing AM services was presenting at a booth next to ours, and one of their staff told me Priomold wouldn't be around in five years because soon, everything would be 3D-printed,« he recalls. For Schönbucher, who had just gotten his company off the ground, that claim was a source of both worry and motivation. Today, he can have

a good chuckle about hype-driven predictions like these, which seldom have a long shelf life.

Additive Manufacturing has actually been a constant companion for Schönbucher over the course of Priomold's development. »In our SWOT analyses, 3D Printing keeps popping up as a threat to our business,« he affirms. »We eventually decided to go ahead and incorporate the technology into our own operations.«

After all, Priomold needed to have AM technology and corresponding expertise in order to hold its own in the new market in case this innovation does turn the production of plastic parts entirely on its head one day, as Schönbucher points out. »Plus, it was a chance to turn that threat into an opportunity.« »

Left: Thomas Schönbucher and Felix Parsch in Priomold's AM department
Below: The core of Priomold's business: an array of injection molding machines producing prototypes and small series





Above (top):
Thomas Schönbucher (32) started Priomold in 2015 along with Moritz Zumdick, a friend from university
Above (bottom):
Felix Parsch, who heads up Priomold's AM production project, operates the company's Formiga unit
Opposite:
Before assembling them, Priomold manufactures these aluminum injection molds in segments on dozens of cutting machines

SLS MANUFACTURING »NO LONGER AN EXPERIMENT«

Fast-forward to 2021, which was when Priomold made the decision to get into SLS technology in order to »be able to offer prototypes with the same kind of surface quality and mechanical characteristics as mass-produced parts,« as Schönbucher recalls. He attributes this move to the tremendous rise in related expectations, which now has customers demanding prototypes with at least the same level of quality as serial components – if not higher. »Prototypes get passed around a lot, after all, and at an automotive corporation, they sometimes make it all the way up to the board,« Schönbucher points out.

Just a week after acquiring an EOS Formiga in 2022, Priomold was ready to ship out its first sintered plastic components to customers. Felix Parsch, who oversees the company's AM production project, believes that Priomold was able to implement this new technology so quickly because »SLS is no longer an experiment; it's an industrial manufacturing process that works.«

While Parsch has only been with the company officially since last year, he had already helped out previously in its production operations while studying for an aerospace degree. More than anything else, 3D Printing is enabling Priomold to stay competitive even when jobs involve very small production runs. »We didn't want to risk losing that kind of business to AM service providers,« Schönbucher reveals. »With our own SLS equipment, we've already been able to score some wins.«

SECOND MACHINE ON THE WAY

Every week, Priomold's EOS Formiga unit prints around 400 parts (mainly from PA12), which range from various mounts and fixtures to casings for endoscopes and vehicle charging stations, and even display models of implants. The company supplies customers from a variety of industries, including mechanical engineering, medical technology, automotive construction, and electronics.

Although he acknowledges that the market for AM services is already very price-driven due to the many providers in the business,

Schönbucher wants to keep expanding Priomold's AM division. »Thanks to our speed and expertise, we're keeping pretty busy in this area, and we've already got a second machine on the way,« he reports.

The Formiga can be found on the lower floor of the company's space next to an unpacking station, a table for powder removal, and equipment for adding color to printed parts. Head through the next door and you'll enter a room some 20 meters long filled with dozens of milling machines. Everything is clean and has the feel of a laboratory, which due in part to Priomold's preference for dry machining – that is, milling components without using coolant. This area is where blocks of aluminum are turned into parts for the molds that give other parts their shape in the injection molding units upstairs. Aluminum molds like these can produce around 20,000 components before requiring correction.

EVERY SECOND COUNTS

With the help of AM, Priomold wants to keep reducing its already speedy delivery times – to just two or three days, in fact. Felix Parsch is even willing to drive components over to customers himself when time is absolutely of the essence. This is definitely the case in some

projects, as Schönbucher knows from working with the major automotive companies in the region around Stuttgart. »When a car company is in the middle of a prototyping phase, every second counts,« he affirms.

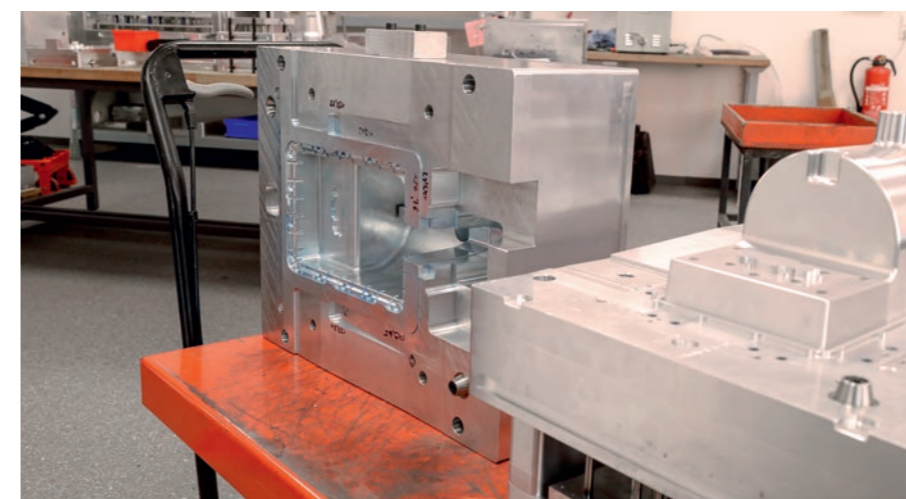
This area of southwest Germany is where Priomold generates most of its turnover, 75 percent of which comes from customers across the country (with the remaining quarter attributable to clients elsewhere in Europe). Over time, Schönbucher has grown used to the special rules that apply to the production of prototypes and small series. The lead time for orders is relatively short: just four to five weeks in most cases. Not even Priomold's two managing directors know what they'll be manufacturing six weeks from now. »What we do know is that we've sent out enough quotes, and that orders always come in,« Schönbucher says. »Doing business like this does come with quite a lot of pressure, though – especially when you've got more than 60 employees on the payroll.«

LEARNING TO LET GO

In spite of that pressure, Schönbucher – who grew up right here in the northern Black Forest himself – wants Priomold to keep growing. Why? »Because we can; we're young and we're having fun doing it,« Schönbucher

declares. He then reveals what the biggest challenge has been: »In the beginning, we did everything ourselves. When we had 10 people on staff, I was right there with them, running the machines and writing up quotes. You gradually have to let go of a lot of things, and your role in the company changes a few times over the years.«

While rapid growth does require a constant influx of new employees, this is another aspect Schönbucher sees as an advantage. »Fresh faces are always a source of fresh input, as well, and that helps us evolve,« he says. This has also enabled the company to improve on the technological side, where the CEO cites a case in which Priomold was able to cut its tool machining time by around half. Meanwhile, Schönbucher says that the company's growth has qualified it to take on larger orders. »That's another area where we want to keep making progress; we're just getting started!«



Powder Bed Fusion:
For further information on this procedure, check out the AM Field Guide at:
» formnext.com/amfieldguide

+ FURTHER INFORMATION:

- » priomold.com
- » formnext.com/fonmag



From left: Frank Carsten Herzog talks with Naddcon development engineers Florian Walter and Prasanna Rajaratnam and Florian Bechmann (CTO, HZG Fund Management GmbH)

»THE FINANCIAL CLIMATE HAS HAD REPERCUSSIONS FOR START-UPS IN AM«

The interest rate increases instituted by the world's central banks have redefined the rules of the game in the investment industry, as well. To talk about how much these changes are impacting the world of 3D Printing and what lies ahead for AM start-ups and investors, we sat down with Frank Carsten Herzog, founder of Concept Laser and managing partner of the investment firm HZG Group.



TALKING WITH

Mr. Herzog, you look at hundreds of start-ups every year. The changing situation in the capital market has surely also had an effect on the financing of young companies in Additive Manufacturing, hasn't it?

HERZOG Right now, things are different than they were just a year or two ago. Then, it wasn't rare for rounds of financing to involve hundreds of millions of euros, and I often found myself wondering when we'd see that kind of investment again. This situation has also led to a particular mindset among start-up entrepreneurs. In the past, some companies were valued in the tens of millions at very early stages despite there being no reliable technical tools for arriving at numbers like those. That has changed dramatically: Lots of investors who used to throw money around are now acting with more caution.

If investment partners are now fewer and farther between, you must have

fairly decent cards when it comes to negotiating with start-ups.

HERZOG We are indeed in a better negotiating position these days, even though the HZG Group hasn't been in the market for that long. Still, we've already noticed that start-ups were exuding a lot more confidence a year ago, as if to say, »If you don't agree with our valuation, we'll just get the money from someone else«. That's another thing that has changed.

Perhaps that also has to do with the fact that outside of venture capital, start-ups don't have a all that many ways to get infusions of fresh cash ...

HERZOG Yes, that's true. It isn't common for banks to grant loans to start-ups, especially in their early stages. What you're left with then is venture debt – but the interest rates involved tie companies up for quite a few years. If you aren't already growing, that's a really difficult situation.

Along with the general financial circumstances at hand, Russia's invasion of Ukraine and the subject of inflation continue to cause uncertainty.

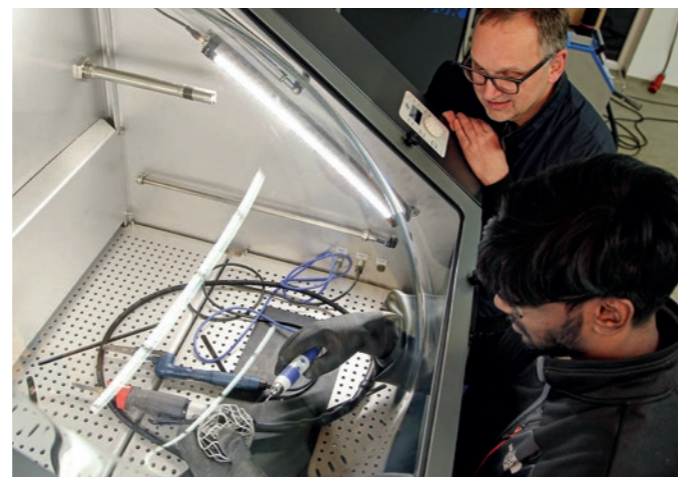
HERZOG And that really has an effect on start-ups. For many of them, it really is a matter of success or failure, and cutting costs isn't enough; they have to take a good look at the purchases they make. At the same time, we're investors in Additive Manufacturing, which is a market that's still growing and still a target for investment. When you're assessing the current economic situation, it's not the same for every sector.

In other words, the economic situation in AM is different than in other areas of industry?

HERZOG In Additive Manufacturing, we're dealing with a special kind of market. The technologies in it are disruptive and playing an important role in the transformation of

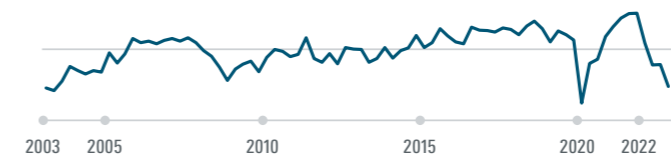


AIM3D is one of the companies Frank Carsten Herzog has invested in through the HZG Group, and one of its machines is used by Naddcon. At right, Herzog watches development engineer Prasanna Rajaratnam at work

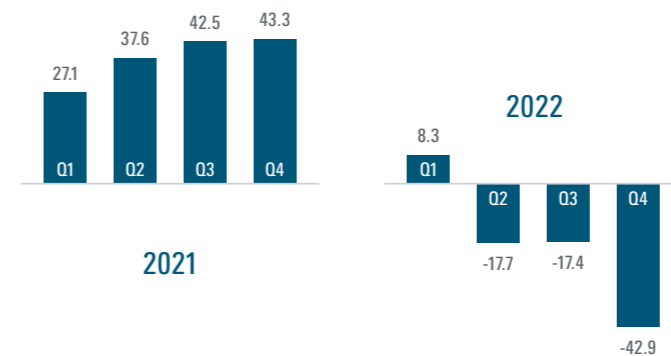


Photos: HZG Group/Markus Drossel (3), Sebastian Buff (1)

Interview: Thomas Masuch



— Business climate
— Business situation
— Projection



Infographics

The general mood is at a low point in the world of venture capital. Over the past 12 months, the business climate, current situation, and projections have all taken a sharp downward turn

conventional industries. I come from northern Bavaria, for example, where the economy is dominated by the automobile industry. That kind of focus can also be dangerous. Plenty of suppliers are under pressure and thus continuing to invest in AM because it offers technologies that give them the chance to compete at the highest level.

That sounds like an optimistic forecast for the AM market. Meanwhile, the German Venture Capital Barometer is now nearly as low as it was in early 2020 at the start of the Covid-19 pandemic (see graphic). The economic activity, interest level, and exit opportunities in the country all receive very negative scores. How have you and the HZG Group responded?

HERZOG The financial climate has obviously also had repercussions for start-ups that deal with Additive Manufacturing. The times when tremendous growth was more or less taken for granted are over, at least for the moment. At the HZG Group, we have the luxury of being able to take our foot off the gas when necessary. After all, we already have a number of very exciting investments that we spend a great deal of effort looking after.

Does that mean you're taking a more positive view of the current climate as an investor?

HERZOG The main thing we're benefiting from is our focus on long-term investment. We make conscious decisions to work with specific firms and accompany them during their ongoing development. The HZG Group offers an entire ecosystem that includes contacts in the realms of politics, research, and sales, along with our own R&D center, Naddcon. That makes us an effective catalyst for such advancement. These are factors that some start-ups don't have at their disposal, even if they do have significant funding. What we provide is really resonating with the market because start-ups are often busy developing technology and don't have a lot of time to spend worrying about sales or



Infographics: KfW Research, BVK, Deutsche Börse Venture Network

reaching out to potential users. That's where we can help. It's become quite clear that the support we offer has made us the first choice among start-ups, which means we end up dealing with the kind of companies we want to work with. This is a definite benefit for our fund investors, as well – we only make high-quality investments!

For many start-ups and investors, rapid growth used to be the main goal, even if achieving it took a considerable amount of capital. What advice do you give the companies you invest in these days?

HERZOG We keep our feet firmly on the ground with our investments. Back when I founded Concept Laser, I had €750,000 in funding; the people investing were my relatives. It was a pretty modest budget to start out with. The four of us in the company presented our first prototypes at a trade show, and then it was about keeping our heads above water. It wasn't easy, but we learned to be very conscientious in dealing with money. I definitely wouldn't say that every start-up needs to go through the same ups and downs, but being really careful with invested funds is still important.

You have strong ties to the place where you grew up: When you sold your

company to GE, you secured over €150 million in investment in a new location in the area; you're the president of your local soccer club, and you invest mainly in the German-speaking countries. How does Germany stack up as a location for start-ups? The complaints about high taxes and energy prices – not to mention the bureaucratic red tape – certainly aren't getting any quieter.

HERZOG These are valid points and I can imagine them making foreign investors wary to some extent. But like you said, I kept Concept Laser in the place I came from, and we've worked with GE on investing €150 million in a modern 3D-printing campus in Lichtenfels – which involved selling the company for €100 million less. In the past few years, different entrepreneurs have poured another €100 million into 3D Printing in and around the city. It's worked out well. For years, though, it's been aggravating to watch as hurdles keep popping up on the administrative side. It's making it harder and harder to get things done. I'm not criticizing the officials themselves; it's the political conditions that have been established. What we need is a measure that really cuts through that red tape and gets people's attention abroad, as well. We won't get anywhere resting on our laurels. That said, we do have an outstanding network

in the areas of research, industry, and policy, and start-ups are among the beneficiaries. That's why we'll continue on the more difficult path with the public administrations if necessary. We just need to keep the lines of communication open.

Along with your connection to home, your commitment to the HZG Group has to do with your own personal motives. After selling Concept Laser to GE, you could have just kicked back and enjoyed life.

HERZOG I guess it's the idealist in me – which is something people often don't buy, but it's there. I've had a lot of success in business, and it's definitely given me opportunities to effect change. I want to leverage these opportunities and the attention I get to benefit others in a socially minded way, in particular by enabling kids and teenagers to imagine their future in rural surroundings like ours. On top that, I've experienced the process of shaping a company from its foundation all the way to its integration into a major global corporation. We've put our capital into the next generation of Additive Manufacturing and continue to invest in up-and-coming technicians and engineers.

Mr. Herzog, thank you for taking the time to talk with us.

Frank Carsten Herzog now wants to pass his experience from growing Concept Laser on to young start-ups



SIFTING THROUGH 1,200 START-UPS – AND INVESTING IN FIVE



It's rather rare for U.S. companies to find venture capital in Germany. This was nevertheless how it happened for Aextra3D, a young manufacturer of 3D printers with locations in Charlotte (North Carolina) and Vicenza (Italy) that specifically chose the HZG Group as its lead investor. As a result, the bulk of the company's funding is now coming from northern Bavaria instead of Boston or California. Part of the reason for Aextra3D's decision was the experience HZG's founders had in building and growing Concept Laser, as chief revenue officer Paul Spoliansky explains. »We chose HZG because they know the AM market and what it takes to turn a start-up into an industry leader,« he says.

That's the kind of thing Frank Carsten Herzog, managing partner of the HZG Group, surely likes to hear. In establishing this investment fund in 2021, he wanted to become more than just another source of venture capital in the world of AM (see interview). After founding Concept Laser in 2000 and growing it into one of the world's leading AM companies, Herzog sold a majority stake to GE in 2016. The 51-year-old, who holds patents on more than 120 inventions, stayed on as CEO of Concept Laser and a member of the supervisory board at GE Additive before departing his company for good in 2019.

The HZG Group began with a start-up fund that was to comprise €50 million, half of which

was contributed by Frank Carsten Herzog and his wife, Kerstin. Further partners have since joined them, most recently increasing that sum to €60 million. The HZG Group has earmarked a total of €45 million for initial investments of €1–5 million in tech start-ups in the field of AM. It plans to use the remaining €15 million on additional rounds of financing for the companies already in its portfolio.

The HZG Group focuses on Series A and B funding. »In that phase, companies should have products that are already on the market or on their way to series production,« Frank Carsten Herzog explains. »Our investments usually amount to 20–40 percent stakes in companies like these, which makes us the lead investor.«

Herzog's group, which he describes as having a very close-knit network of partners, employs a total of 17 people (including the staff at its R&D center, Naddcon). Since its foundation, HZG has taken a close look at around 1,200 companies. It has invested in just five of them so far: the AM system manufacturers AIM3D, Aextra3D, and Xolo, and the software providers Amsis and Trinckle.

Putting all these firms under the microscope has taken Frank and Kerstin Herzog and their team just under two years. »In the selection process, we start by focusing more on technical criteria before getting to know the people behind the companies,« Frank reveals. Those that make it to the third round are subjected to financial

screening. In addition to his investment activities, Frank Carsten Herzog has also maintained close ties to northern Bavaria, where he was born and raised. An ardent fan of soccer, he has been the president of his local club, 1. FC Lichtenfels von 1906 e.V., since 2020. Herzog has also turned part of his 16th-century home into a »makerspace« where people of all ages can try out 3D Printing and learn more about digital technologies. This project also laid a foundation for the FADZ, a research and application center for future digital technologies that Herzog founded along with local public stakeholders and the Coburg University of Applied Sciences and Arts.

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TRENDS

AIMING HIGH WITH LOCAL MATERIALS



The world's tallest 3D-printed building has recently been completed in the Saudi Arabian capital of Riyadh. The three-story villa is 9.90 m high and offers an area of 345 m². The building was produced by Saudi Arabian real estate developer Dar Al Arkan using a

Cobod 3D printer. Low-cost local materials were used to produce the 3D printable concrete. The villa was 3D printed in just 26 days and fully complies with building codes, according to Cobod. This, he said, makes the house an example of how »technology and innovation

can go hand in hand with safety and regulations.« Heat-reflective nanotechnology was used to paint the exterior walls, making the villa up to 40% more heat resistant, he said. Using advanced 3D Printing technology, Dar Al Arkan aims to provide its customers with a customized experience, building homes tailored to their unique tastes and preferences. »The introduction of 3D construction printing enables us to focus on greater flexibility of design, strengthen productivity and achieve higher cost efficiency,« said Wael al Hagan, 3D construction printing project manager from Dar Al Arkan. Saudi Arabia is open to the use of advanced construction technologies as the kingdom aims to enable 70 percent of the Saudi population to own their own homes by 2030. The villa in Riyadh was built using local materials and the D.fab solution developed by Cemex and Cobod. This enables 99% local and cost-effective materials to be used, while only 1% is sourced from a central location.

792 DISPLACEMENT BODIES LIGHTEN CONCRETE ROOF

The recently completed building yard in Bludenz, Austria, has a special flat roof: it is 32.5 percent lighter than comparable concrete ceilings. This is made possible by »displacement bodies« from the start-up Concrete 3D. »The order of the day is to save material,« emphasizes Philipp Tomaselli, managing director of Tomaselli Gabriel Bau. By installing lost formwork from the 3D printer, the company found an efficient way of achieving this aim. 792 displacement formers were produced - each one unique for the 717-square-meter flat roof, which rests on two 46-meter-long supporting arches spanning two wooden halls. In total, Concrete 3D printed more than 60 tons of concrete for this purpose. The elements, weighing up to 80 kilograms, were

numbered, delivered to the construction site, positioned there on the formwork using a total station, reinforcing steel was laid in-between and the whole thing was filled with concrete. The result: a slab that is one-third lighter and whose manufacture emitted 24.4 percent less in greenhouse gases. »For us, this is a reference for the potential of digitalization in the construction process and sustainability in solid construction,« Tomaselli emphasizes. And architect Marcus Ender praises the design possibilities of the technology: »The shape and positioning of the recesses makes the course of the forces visible.« The additional expense for handling and logistics is compensated by the material savings and the expanded structural possibilities, Concrete 3D explains. There is



Photos: Cobod, Janosch Schallert

TRENDS

3D-PRINTED FERRY TO TRANSPORT OLYMPIANS

A 3D-printed electric ferry is to be used for the first time at the 2024 Summer Olympics in Paris. Visitors and athletes will thus have the opportunity to travel to the competition venues in an environmentally friendly way. The autonomous ferry also features a modern design and a 3D-printed hull made from recycled material. Docking and recharging is automatic. In December 2022, Holland Shipyards Group, Sequana Développement and Roboat were selected as winners of a national call for autonomous passenger vessel projects by the French inland navigation authority Voies Navigables de France. The boat designed by the winning consortium is the largest 3D-printed autonomous ferry in the world, measuring 9 x 3.90 meters. »3D printed construction opens an exciting new chapter in shipbuilding,« enthuses Leendert Hoogendoorn, director of Holland Shipyards Group.



CONCRETE LIGHTWEIGHT CONSTRUCTION

The construction industry is considered one of the world's biggest CO₂ emitters - the production of cement in particular produces enormous amounts of greenhouse gas. A team from the University of Michigan has now developed a method to drastically reduce these emissions. The new approach, called »Shell Wall,« combines topology optimization and 3D concrete printing. The method was developed by architect Mania Aghaei Meibodi and researchers Alireza Bayramvand and Yuxin Lin of the Dart Lab at the University of Michigan's Taubman College of Architecture and Urban Planning. The production of ultra-light, zero-waste concrete is expected to reduce weight by 72 percent compared to conventional, solid concrete of the same size. At the same time, it also aims to change the way concrete has been printed in the past: conventional concrete printers build horizontal walls that are later stabilized and filled. »This leads to

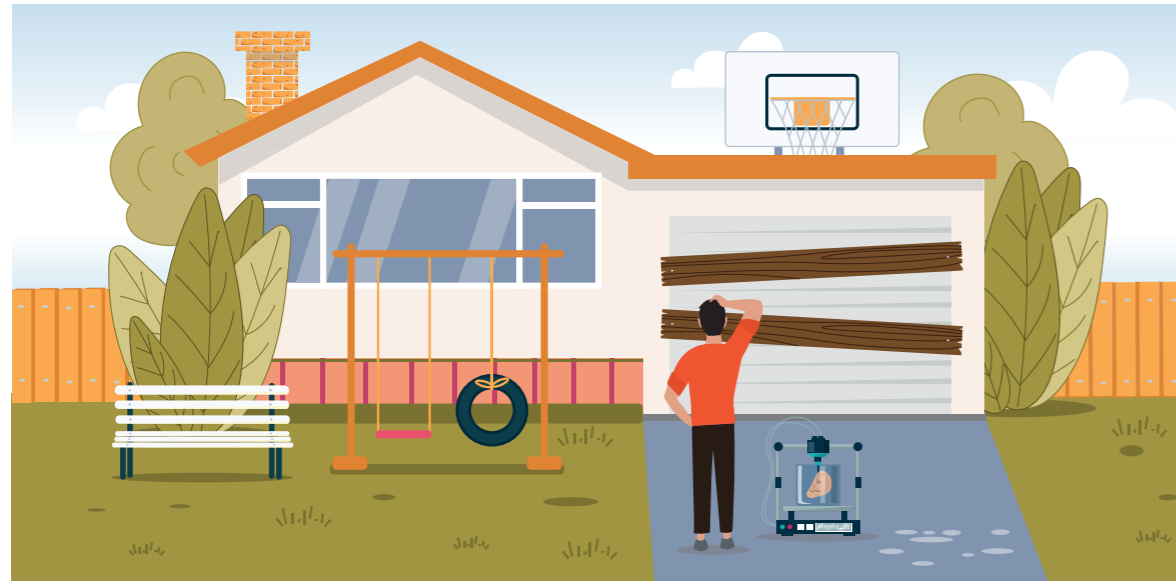
high concrete consumption and limits its application for lightweight forms that entail intricate shapes like branching and angular tubular forms, overhangs, layer cantilevers, and filament section or angle variations,« said Aghaei Meibodi, assistant professor of architecture at Taubman

College. The »Shell Wall,« on the other hand, allows for efficient use of materials by placing the material exactly where it is needed for structural purposes, »and eliminates unnecessary overbuilding with excessive amounts of materials,« says Aghaei Meibodi.



Photos: Holland Shipyards Group, Dart Laboratory

OUTSIDE THE BOX



Opening Up the Garage Door

Companies that have exciting origin stories can count themselves lucky. They're automatically more interesting to customers and investors, and employees also identify more strongly with their organization as a result. The best tales of how a firm got its start are based on a founding myth that often begins in a garage: Surrounded by dusty tennis rackets and used tires, brilliant inventors and daring business buffs put their heads together to lay the groundwork for a wildly successful corporation.

The most famous garage in the history of business can be found at 2066 Crist Drive in Los Altos, California. It was here that Steve Jobs, his adopted sister, Patricia, and Steve Wozniak cobbled together the Apple 1 some 46 years ago. Customers stopped by the garage to see this new »computer«, and it was also the place where the Apple Computer Company was officially established with U.S.\$1,300 in seed capital in 1976. Today, Apple Inc. is worth far in excess of U.S.\$2 trillion, and the old Jobs garage is a protected historical site.

Jobs and Wozniak were actually following the blueprint laid out by Bill Hewlett and David Packard, who had founded HP just a few kilo-

meters away in Palo Alto in 1939 – in a garage, of course. Google and Microsoft also got off the ground in similar environs.

Perhaps you're asking yourself the same question we are: Why are nearly all these stories about garage start-ups set in the United States? Does it have to do with the particularly entrepreneurial spirit one finds in the Land of Unlimited Possibilities, or maybe just with the country's very spacious garages? The vehicles there are generally much bigger than those here in Europe, for example.

While we're not aware of any founding myth of this kind that took place in Germany, that's not necessarily due to a lack of creativity on the part of the country's inventors. Some of the largest German companies were founded back in the 19th century, including BASF (1865) and the Daimler-Motoren-Gesellschaft (1890, but operating as Daimler-Benz AG since 2022). Back then, there just weren't that many cars, and that meant no garages, either.

The fact that more recent German history hasn't delivered any celebrated accounts of firms established in the midst of old license plates and questionable calendars (although

the AM sector seems to offer fertile ground for such ventures – see page 18) is more difficult to explain. It's likely the fault of Germany's painstaking bureaucracy, which has earned itself a very meticulous reputation around the world and prescribes to the letter what is and isn't permitted in the country's garages. To make sure our young creators don't have it too easy, each German state actually has its own garage regulations, and they all state that such spaces can only be used for vehicles and associated items (tires, for instance).

Storing other things – or, heaven forbid, setting up a workshop – is verboten, which makes a founding myth in the style of Apple or HP more or less impossible. Someone with an active imagination might consider installing a 3D printer in a car they could then park in their garage, but we can't guarantee this would be completely kosher from a legal point of view. What we can say for sure is that new German companies will have to find another place to celebrate their first accomplishments; parties aren't allowed in German garages, either!

Text: Thomas Masuch

Illustration: feedbackmedia.de, iStock / Gleb Kosarenko, Five Stars

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» formnext@mesago.com
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mesago.com

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ZIKOMM – Thomas Masuch
thomas.masuch@zikomm.de

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