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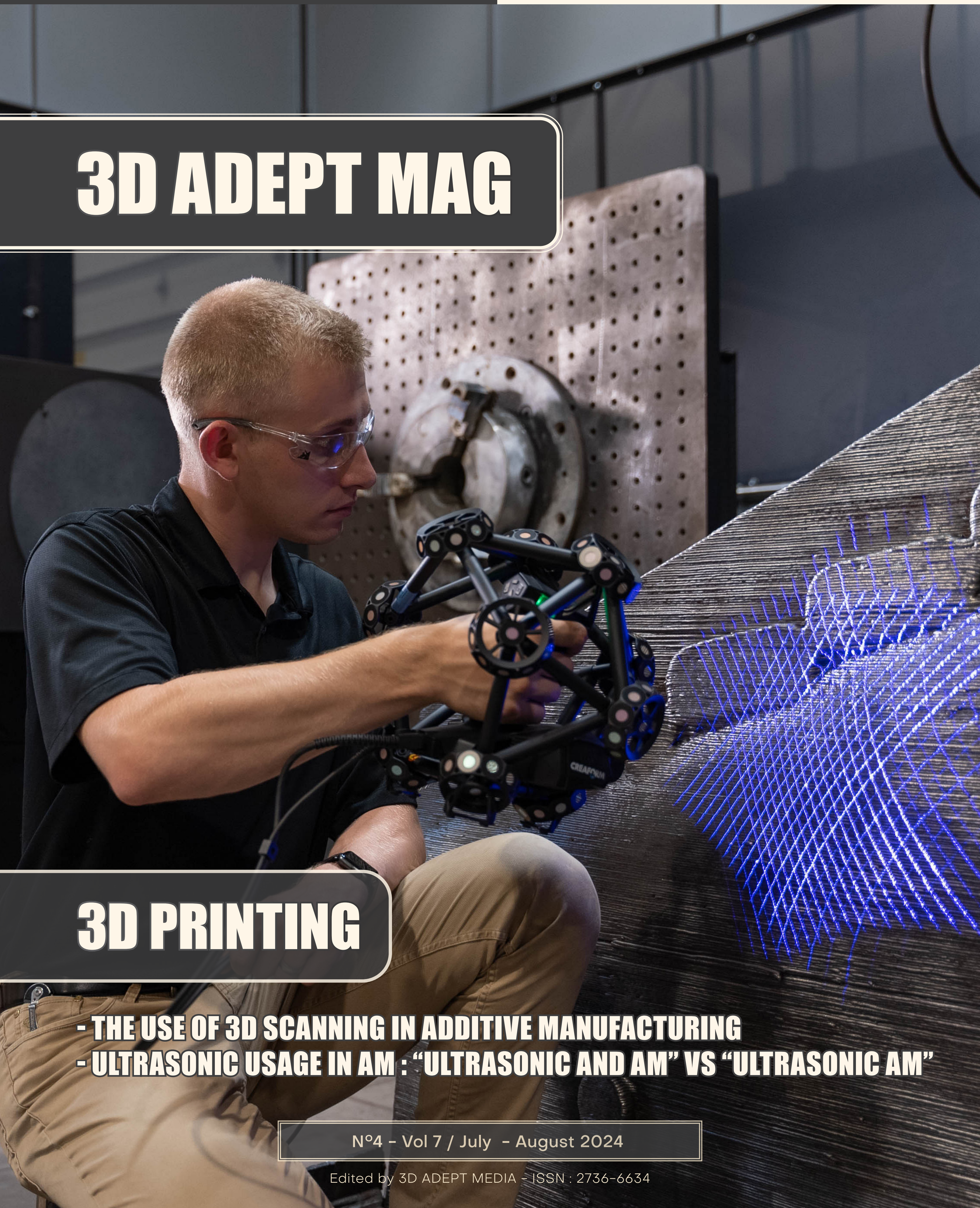
3D ADEPT MAG



3D PRINTING

- THE USE OF 3D SCANNING IN ADDITIVE MANUFACTURING
- ULTRASONIC USAGE IN AM : "ULTRASONIC AND AM" VS "ULTRASONIC AM"

N°4 - Vol 7 / July - August 2024

Edited by 3D ADEPT MEDIA - ISSN : 2736-6634

Edited by 3D ADEPT Media

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Periodicity & Accessibility:
3D ADEPT Mag is published on a bimonthly basis as either a free digital publication or a print subscription.

Cover image credit: Creaform

3D ADEPT MEDIA
All about Additive Manufacturing

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HELLO & WELCOME

What comes next for Additive Manufacturing?

The more we witness new developments enabled by Additive Manufacturing (AM), the more our wording evolves. What is still qualified as “new technology” by newcomers and new users has become an obvious manufacturing path for production applications across certain vertical industries.

At this stage of the technology maturity, we, at 3D ADEPT Media, do not believe one should still qualify the technology as a “new” one. We should rather continuously assess what might come next in this field.

Interestingly, on the technology providers’ side, some solutions are still considered secondary, whereas on the user’s side, there are certain discrepancies in the way technology is adopted across the world.

In this summer edition of 3D ADEPT Mag, we shed light on these solutions that are not yet on the top of companies’ agenda – they include for instance ultrasonic AM, design automation or even antimicrobial additives –; we provide insights into these applications that could help users make the most of AM in the mobility industry and we provide a business perspective on the current landscape of certain emerging solutions such as AI.

We believe, as an echo to the current vibrant, dynamic and sunny days, this blend of timely themes can help both beginners and advanced users stay active and keep track of their progress in the industry.

Kety SINDZE
Managing Editor at 3D ADEPT Media
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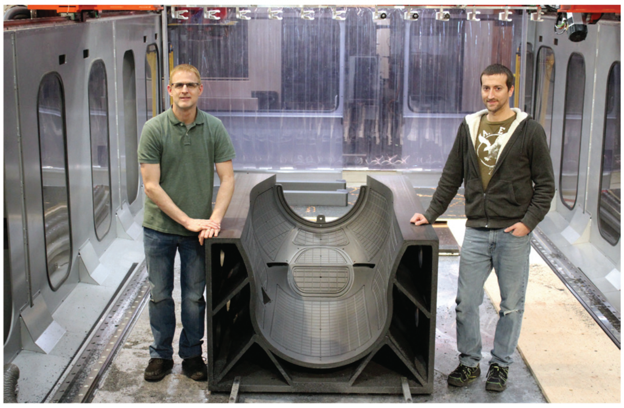
Significant Cost Savings on Additive Tool

Partnership between Thermwood and General Atomics

The Details

Using a Thermwood LSAM 1020, the tool was printed from ABS (20% Carbon Fiber Filled) in 16 hours. The final part weighing 1,190 lbs was machined in 32 hours.



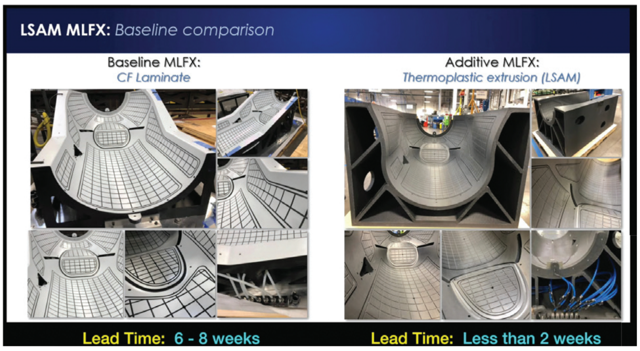
Cost Savings of around $50,000 vs traditional methods

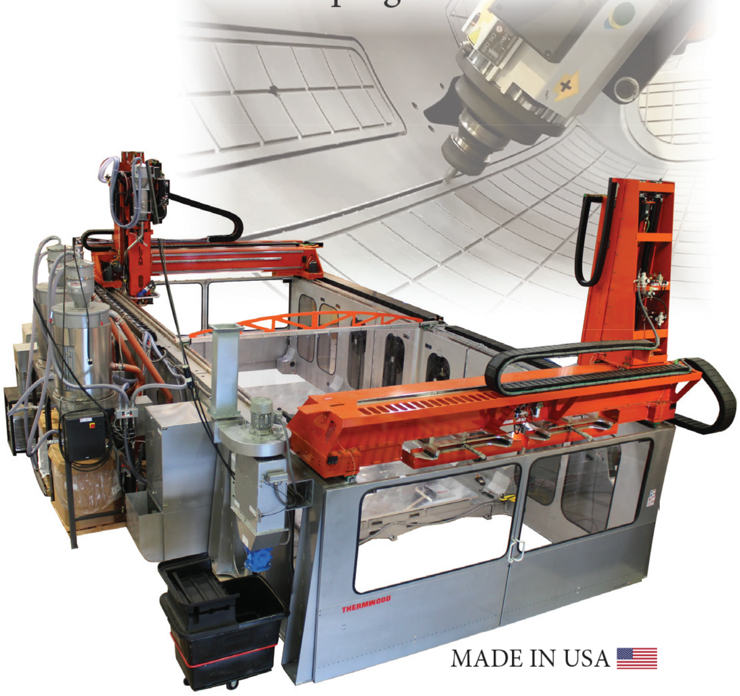
Total lead time for the part decreased from 6-8 weeks to less than 2 weeks by utilizing the powerful LSAM system.

The Results

- Cost Reduction: 2-3 times
- Faster Development: 3-4 times
- Production Capable Tool
- Vacuum Integrity
- Suitable for Large, Deep 3D Geometries, Backup Structures & Vacuum Piping

GENERAL ATOMICS AERONAUTICAL





Scan QR code to view a video of the LSAM and General Atomics process.

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THE USE OF 3D SCANNING IN ADDITIVE MANUFACTURING

If you work in the engineering field, you are probably already familiar with **3D scanning**, this process that consists in capturing a physical subject to represent its geometry in a digital environment. The 3D scan data captured can serve for visualization, analysis, or Additive Manufacturing. The question is, what are the essentials one should keep in mind when using 3D scanning in an Additive Manufacturing production process?

Most of the time, beginners in AM (usually or unconsciously) go through a well-known route for the manufacture of parts: **design, manufacture** and **post-processing**. The more you acquaint yourself with the technology, the more you realize that specific stages of the manufacturing process may require the use of 3D scanning.

One of the first applications that justifies the use of 3D scanning in Additive Manufacturing is **reverse engineering**. In such cases, a 3D scanner helps to create drawings of parts that are not originally available.

Another reason why it makes sense to use 3D scanning in AM is **quality control**. Simplifying this process is important to maintain consistency and repeatability in manufacturing operations.

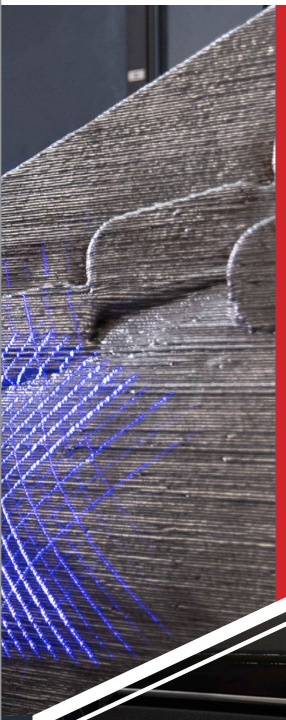
"Additive Manufacturing like other manufacturing processes can present many challenges in dimensional conformity. For example, the stress created in a printed part when it cools down can generate deformation that could cause quality issues. Having a better understanding of those deformations is extremely useful to correct and compensate for them. It is clear to me that 3D scanning and 3D printing are two technologies that benefit from each other," Creaform's Product Manager, **Simon Côté** explains.

That being said, it's important to keep in mind that achieving precise quality control requires standardized methods to assess functionality, reliability, safety, and other factors. Establishing these standards for additive manufacturing is inherently challenging due to the significant variation in manufacturing processes across different AM technologies. Issues such as support structure and build plate removal, heat flux, trapped powder or resin, and post-processing add other complexities.

On another note, measuring parts with complex shapes can be challenging and time-consuming with traditional tactile inspection methods.

"Due to their optical and non-contact nature, 3D scanning devices are ideal for measuring these complex surfaces," **Kristof Peeters**, Product Manager at Nikon said.

Measuring overstock on 3D printed parts, intermediate inspection during the printing process and final inspection of 3D printed parts are other applications where it makes sense to consider using 3D scanning. **Peeters** provides further clarification about each of these items:



"a. **Measuring overstock on 3D printed parts**: when printing high-accuracy parts, the 3D printing step is typically followed by machining to remove overstock on the "rough" 3D printed part and machine it to its final specification. Using a laser scanner to capture the precise freeform surface of the rough 3D printed part allows generating exact machining paths to finalize the part. This combination of additive manufacturing and subtractive manufacturing (also called hybrid machining) with intermediate measurements using a laser scanner in between these 2 steps, is not only applied for new parts but also for repairing broken parts. In this case the damaged part is first roughly repaired by adding material through 3D printing in the worn or damaged area. This repaired area is then laser scanned, which gives the exact information needed to machine the part back to its original condition.

b. **Intermediate inspection** during the printing process: especially for parts that take a very long time to print or are highly expensive, it is beneficial to check the dimensional quality of the part regularly during the printing process, i.e. while the part is still on the 3D printer. If deviations are detected, appropriate measures can be taken (e.g. adjusting printing parameters, scrapping the part, …) to avoid wasting time and effort on a part that wouldn't pass final quality control. This application is specific to 3D printing technologies such as Direct Energy Deposition (DED) or Wire Arc Additive Manufacturing (WAAM), where the part remains accessible during the printing process, unlike powder bed printing technologies, where the printed part is covered in powder.

c. **Final inspection of AM parts**: the previous 2 applications focus on inspection of the 3D printed part during the manufacturing process and are therefore typically performed on or close to the 3D printing machine. There is of course also the final inspection of the AM part after all the machining is finished. 3D laser scanners are ideal for digitizing the often very complex outer shape of an AM part quickly and in great detail. This digital copy can then be compared to the CAD model to create an easy-to-interpret color map, providing an overview of the part's dimensional quality.

For the final inspection of both the outer shape as well as the inner shape of the part, 3D CT scanning is a great solution: with its ability to "look through parts", CT scanning is a technology that allows not only to inspect the outer dimensions of the part but also detect internal defects, which is critical given that AM parts are often functional parts."

The different types of 3D scanning hardware

The more 3D scanning hardware is being developed, the more complex it becomes to assess their pros and cons in specific use cases. However, among the most widely used 3D scanning techniques, one can identify **laser triangulation, fringe projection, structured light 3D scanners, photogrammetry, and contact-based methods.** Other specialized scanners rely on X-rays, sonars or other sensing methods for niche applications.

Speaking of laser 3D scanners and structured light 3D scanners, Creaform's Côté explains:

"Laser 3D scanners use laser beams to capture the precise dimensions and shapes of objects, making them highly accurate and effective for detailed work. Structured light 3D scanners, on the other hand, project a pattern of light onto an object and measure the deformation of the pattern to create a 3D model. While structured light 3D scanners offer a balance of speed and precision, they may not always match the high level of detail and accuracy required for many manufacturing applications."

Nikon's product manager completes:

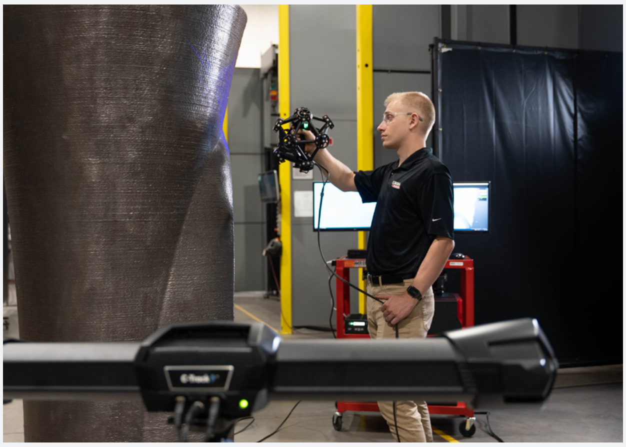
*"**Laser triangulation scanners** use a laser line that is moved across the part. A camera records the shape of the laser line to dynamically digitize the part. At Nikon, we offer laser triangulation scanners known for their exceptional performance in measuring «difficult» materials, such as very shiny or dark surfaces, without requiring the operator to change scanner parameters or prepare the surface. Additionally, Nikon optics in these laser scanners ensure the highest accuracy data.*

***Fringe projection scanners** project a rectangular pattern of stripes onto the part. One or more cameras record the deformation of the pattern caused by the object's surface geometry and can as such create a digital copy.*

3D Scanners can also be categorized by their type of operation into handheld devices and automated devices.

*· **Handheld 3D scanners**: These devices require an operator to "move" the laser scanner over the part to perform a measurement. The main benefit is that these devices are very quick and easy to deploy. They are fully mobile, so can be used anywhere.*

*· **Automated 3D scanners**: These devices are typically mounted onto a Coordinate Measurement Machine (CMM), but more recently also onto CNC machines or Additive Manufacturing machines. They can be programmed to automatically perform the laser scanning measurement. The obvious benefit is that they don't require an operator to be present during the measurement, making them ideal for automated setups that run continuously and autonomously. Furthermore, automated systems tend to be more accurate than their handheld counterparts because they operate in a more controlled environment."*



Considerations and limitations to keep in mind before investing in a 3D scanning technology

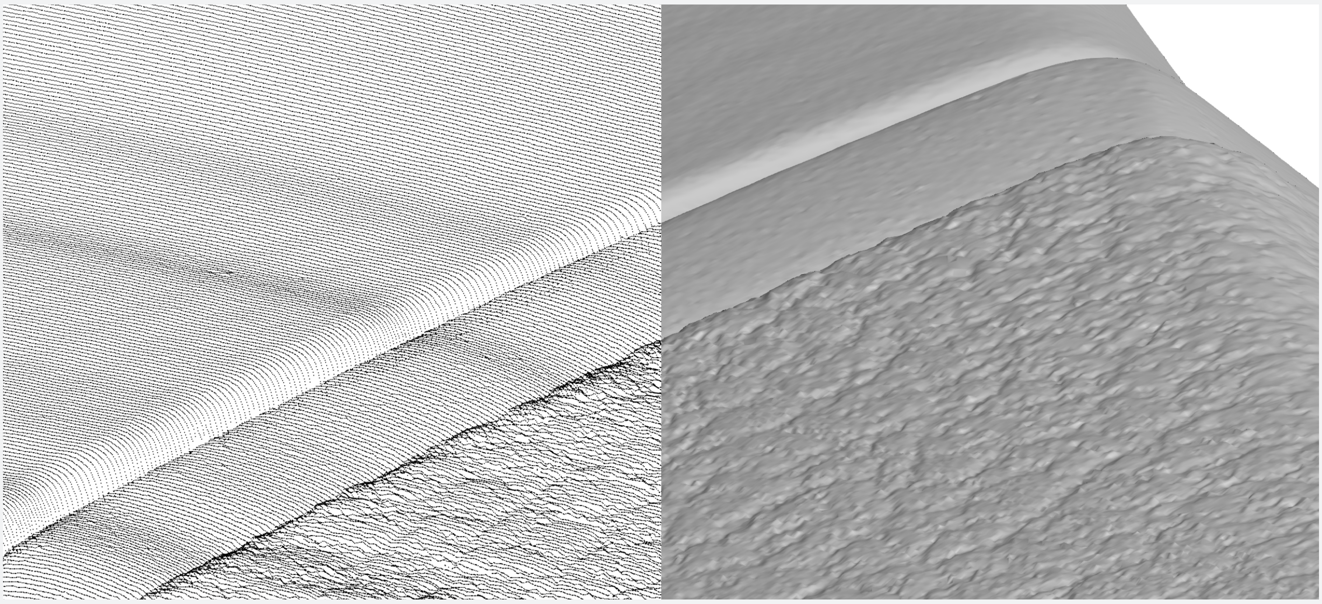
As you may guess, it's one thing to know the different types of 3D scanning, it's another one to know in which solution to invest for your AM applications. Obviously, budget, 3D scanning details, subject type and size are some of the important factors to consider before buying, but depending on one's situation, some factors simply overshadow others.

For Peeters, *"the decision on whether the inspection of the part with a laser scanner is to be performed by an operator or needs to be performed fully autonomously is an additional important factor for the selection of a 3D scanner."*

For Côté, *"the accuracy is also a fundamental characteristic. Simply using a scanner that delivers a good level of detail does not guarantee the accuracy of the scan data. The accuracy is definitely crucial for inspection application, but also for integrating physical objects to a new product design. Another important factor to consider is the user-friendliness of the software and the availability of local support from different vendors, which can significantly impact your overall experience and satisfaction."*

3D scanners are becoming more and more accessible because of the growing use of smartphone apps that can use cameras or LiDAR sensors to act as a 3D scanner or simply competition on the market.

However, just like any technology, 3D scanning techniques still require some areas for improvement. If for Creaform's expert, translucid material is still a big challenge for most 3D scanners, Nikon's expert lays emphasis on the need to adapt laser scanners so that they can withstand harsh conditions and can be used effectively inside or near the AM machine. Key areas for improvement include enhancing the scanner's resistance to the harsh AM environment and simplifying its integration into AM machines, he said.



Editor's notes

To discuss this topic, we invited two companies that specialize in the development and commercialization of 3D scanning solutions.

Creaform: Founded in 2002, experts from this Canadian company have seen significant improvement in the 3D scanning market during the past ten years. Over time, 3D scanning solutions are getting better and better at capturing virtually any physical object in a matter of minutes, enabling digital twin analyses and improvement across different manufacturing processes. The company provides a range of portable and easy-to-use 3D scanning solutions that cater to various needs and budgets. Its product lineup includes everything from affordable entry-level scanners to high-end, metrology-grade 3D scanners that provide the highest level of accuracy and precision. In addition to its portable options, it also provides automated 3D scanning solutions designed to enhance efficiency and consistency in large-scale manufacturing and quality control processes. For those involved in Additive Manufacturing, its scanners are equipped to handle the complexities of 3D printing, ensuring precise measurement and quality control throughout the additive manufacturing workflow.

Nikon: First known as an optics and photographic equipment manufacturer, Nikon has over the years diversified into new areas like 3D printing and regenerative medicine to compensate for the shrinking digital camera market. In the AM industry, it offers a comprehensive portfolio of laser triangulation scanners in both handheld and automated versions. The automated laser scanners, including the LC15Dx model for high-accuracy applications and the L100 model for high-productivity applications, can be integrated directly onto an AM machine. These scanners are ideal for fully automated production and inspection processes. In its latest development, they have introduced wireless data communication technology for these automated laser scanners, facilitating easier integration into manufacturing machines. Further enhancements to enable their usage in a CNC and AM production environment are on the way.

Additionally, they provide a handheld laser scanning solution featuring the company's H120 laser scanner combined with the MCAx S articulated arm. This flexible solution allows for quick part inspection in or near the AM machine.

Nikon believes that integrating metrology directly into the manufacturing process is essential for enhancing the quality of produced parts and improving cost efficiency. As an active player in the AM market now, the company focuses on the synergy between 3D laser scanning and AM. Consequently, it is actively investing in 3D scanning solutions tailored for AM.

Copyright: Gustav Gullholm

EXTREME BIKE TUNER STEERS INTO THE FUTURE WITH 3D PRINTING

Extreme bike tuner **Dangerholm** makes science fiction rideable. His idea of the bike of the future poses challenges for manufacturers. But together with **TRUMPF** and the TruPrint metal 3D printers, a prototype was ready to ride at Eurobike 2024.

Denim vest, shorts and a bike that is the envy of the cycling world. This is how the extreme bike tuner Dangerholm, alias **Gustav Gullholm**, is known from countless photos. His concept: ***he builds bikes out of pure passion for aesthetics and riding***. With a wealth of ideas and perfectionism, the tuner has produced bikes that have made him one of the stars of the bike industry.

One of his ideas: A **completely new handlebar**. The Norwegian-born mechanic, who lives in Sweden, first built it with wood and says: *"Compared to what the TRUMPF engineers achieved, my design was rather caveman-like."* In addition to its futuristic design, the handlebars are essentially based on a unit with semi-internal ducts for the brake cables. And: assembly and maintenance should work without time-consuming disassembly and bleeding of the brakes. A so-called snap-push connection made this possible: the cables run in channels and are held in place by clips. These clips have undercuts, which would require a very complicated mold to produce the handlebars with carbon. 3D printing is a better process and enables a more elegant design.

Prototype development with 3D printing

Maxime Lallemand, Syncros Components Engineer at **Scott**, one of the major brand manufacturers in the bicycle industry, reports:

We have been working with Dangerholm for many years. This time, he wanted to produce the prototype of his idea of the bike of the future with us for Eurobike 2024 – not a design study, but a fully operational mountain bike. The new handlebar concept was also a particular challenge for us.

Copyright: TRUMPF – Component of the future: Application developer Chris Lengwenat (left) and his colleague Nicolas Haydt, technology expert for additive manufacturing at TRUMPF, with the freshly printed Dangerholm handlebar.

The clock started ticking: there were five months until Eurobike. A tight deadline for development, production on the **TruPrint 3000** and ISO certification of the handlebars. Scott developer **Maxime Lallemand** and **Quentin Beauregard**, MTB Lead Designer at Scott, therefore activated their contacts with the TRUMPF specialists for 3D printers:

> *For prototype development, aluminum 3D printing is unbeatable in terms of cost and speed compared to classic carbon/mold construction. From a technical point of view, 3D printing pushes the boundaries in terms of form and function. This enables us to build a technically perfect handlebar for Gustav that eliminates everything visually disruptive.*

Copyright: TRUMPF
Joint project: Syncros, Scott's component manufacturer, extreme bike tuner Dangerholm and high-tech company TRUMPF are building handlebars for the bike of the future.

Two years earlier: Door-to-door canvassing in the bike scene

Maxime Lallemand and **Quentin Beauregard** met application developers **Chris Lengwenat** and his colleague **Nicolas Haydt**, technology expert for additive manufacturing at TRUMPF, at Eurobike in 2022. The two had a brake lever, a brake caliper and a pedal in their luggage - developed by the two TRUMPF experts and printed on a TruPrint with aluminum and titanium.

«We went from stand to stand with our little suitcase,» recalls **Lengwenat** - and Haydt adds:

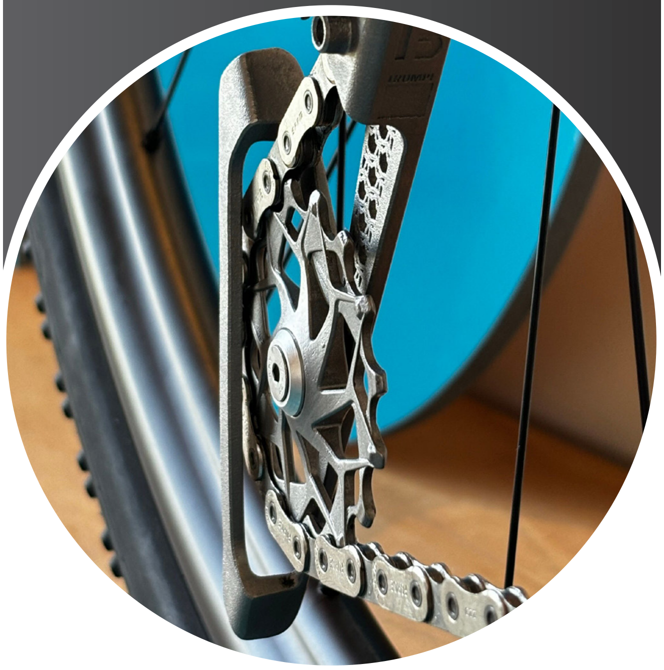
«At the end of the day, we had many new contacts in the development departments of major manufacturers, including Maxime Lallemand. And he also introduced us to bike tuner Dangerholm.»

Copyright: Gustav Gullholm
Prototype with ISO certification: Dangerholm builds bikes for riding. That's why these one-offs have to withstand even the toughest trails.

Today: Pioneers in aluminum printing

A meeting that made an impression. In the run-up to Eurobike 2024, the threads between ***TRUMPF, Scott*** and ***Dangerholm*** came together again: *«The fact that 3D printing with aluminum is even an option for components such as handlebars is due to a new high-strength alloy,»* explains TRUMPF expert **Christian Lengwenat** who adds: ***«Aluminum 6061 has already found great favor in the bicycle sector. And we are currently the only ones in Europe with experience in printing with this material.»***

For the TRUMPF experts, the project was an opportunity to exchange ideas with the carbon experts from **SCOTT Sports** because they have decades of experience in the production of high-quality carbon bicycles and components. For Lallemand, it was obvious: ***«We were able to combine our respective expertise in the best possible way for the handlebar project.»***



Copyright: Faction Bike Studio
Titanium components: For the same bike, Dangerholm and the TRUMPF specialists for Faction Bike Studio printed exposed and error-prone rear derailleur components on a TruPrint 1000 with titanium.

Full design freedom

As 3D printing specialist **Lengwenat** explains, there are no design restrictions with additive manufacturing:

> *Unlike conventional methods, such as milling, metal 3D printing scores points for its freedom of form. Tools reach their physical limits, whereas powder can be built up in any shape.»* Haydt adds: *«The internal cable channels of the Dangerholm handlebars can only be realized with 3D printing and we achieve high stability with low weight – this is what makes aluminum printing so interesting, especially for the bicycle industry.*

Dangerholm thanks 3D printing

Dangerholm, Scott and TRUMPF completed the sophisticated handlebar design just in time for Eurobike 24. Back in Sweden, Dangerholm is delighted:

> *3D printing is like science fiction. You literally hold a little piece of the future in your hands.*

Additive Manufacturing with titanium

Same bike, different supplier – Dangerholm works with Faction Bike Studio from Canada for the derailleur components. TRUMPF specialists Lengwenat and Haydt fitted the bike with titanium components on behalf of Faction Bike Studio. These are exposed and error-prone rear derailleur components such as the parallelogram and the cage. The components were printed on a TruPrint 1000 using Ti64 Gd.23, a special titanium alloy with a particularly low oxygen content. This took stability and design to a new level.

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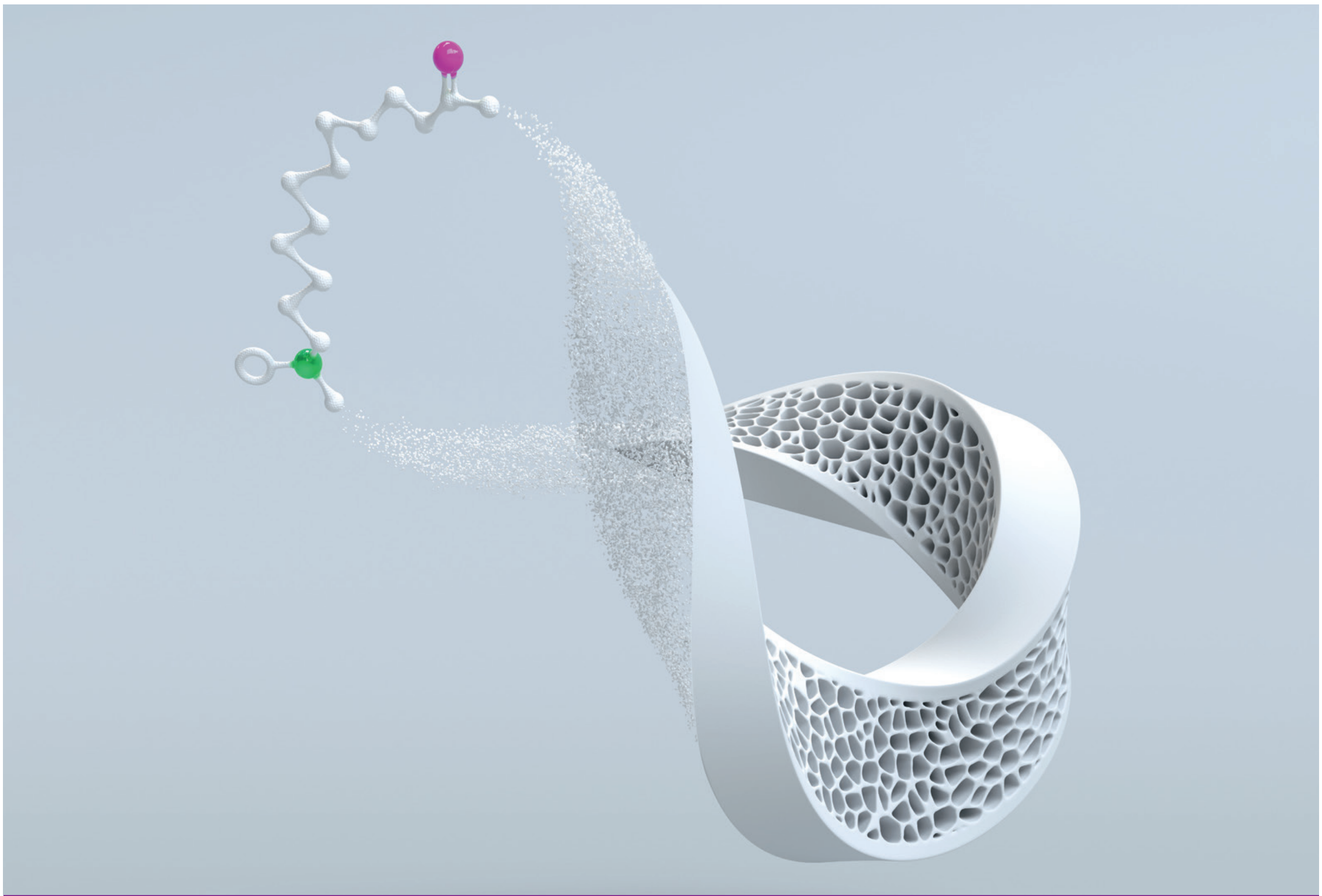


HOW EVONIK'S USE OF LCA HELPS DELIVER A STRONG SUSTAINABLE INFINAM ECO LINE FOR THE AM INDUSTRY

*As I told you before, I am one of those people who believes that a circular economy strategy for 3D printed plastics starts with material. While decisions that influence each strategy vary from one company to another, they need to start with **life cycle assessments** (LCAs). Interestingly, it takes a conversation with **Evonik** to understand the perspective of a material producer on LCAs and how this has driven the development of the INFINAM® eCO line.*

Specialty chemicals company **Evonik** is one of those companies that no longer needs any introduction. Its activities in support of Additive Manufacturing technologies (AM) have spawned the development of several innovative products, which in turn, have benefited several vertical industries adopting AM. In a context where circularity increasingly becomes the cornerstone of a sustainable future, Evonik implements a strategy that goes beyond the simple idea of waste management.

According to its stated sustainability goals, the company intends to generate more than 50% of sales by 2030 from its Next Generation Solutions, which the company describes as, *"products and solutions that have a positive sustainability profile clearly above the market reference level."*

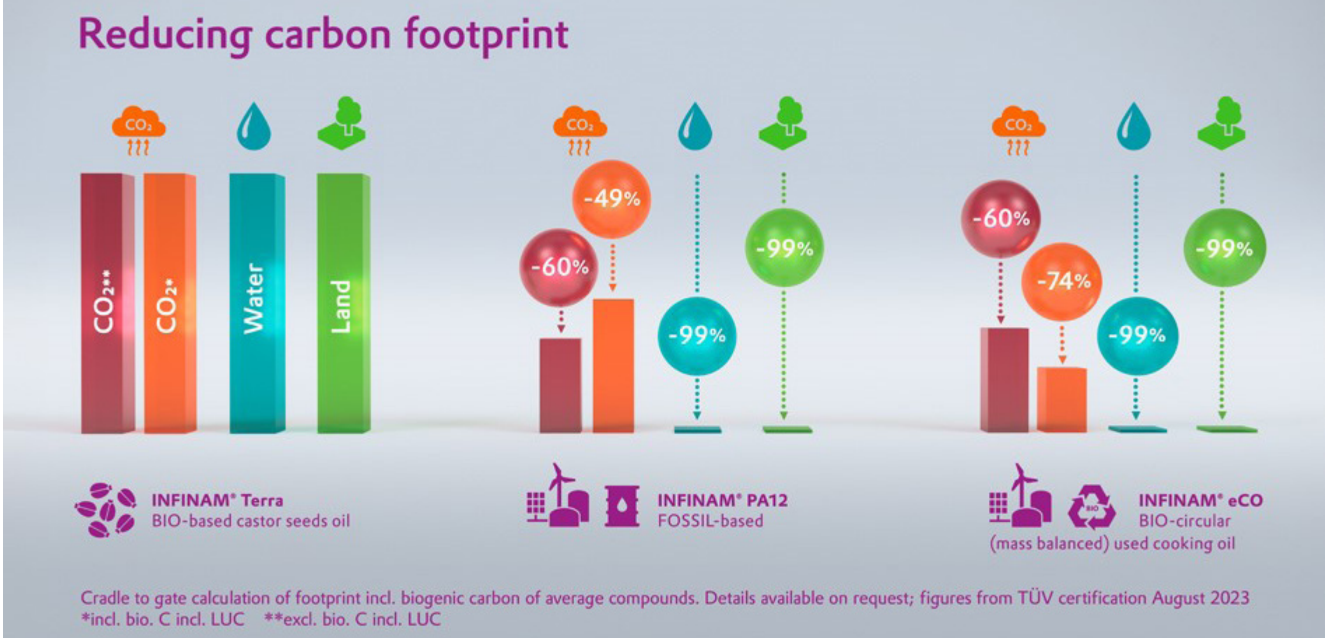
"To get us closer to our 2030 goal, it's essential to be able to measure the sustainability of our products and services using the best tools, methods and expertise possible, such as *"life cycle assessments" or LCAs,* "

says **Dominic Stoerkle**, Head of the Additive Manufacturing & Material Solutions product line at Evonik.

Used in business and environmental planning across many industries, ISO-compliant LCAs remain one of the most reliable methods, I dare say the most reliable method, to verify environmental impacts and support claims. Leveraged by most AM companies, this technique is not only useful for engineers but also for designers and regulators looking for valuable information to assess decisions in each life stage of materials, buildings, services and infrastructure.

An LCA is a methodical analysis that quantifies the environmental impact of a product or service. All of Evonik's LCAs are based on ISO 14040 and 14044. Additional guidelines come from ISO 14067, the Together for Sustainability's (TfS) "Product Carbon Footprint Guideline for the Chemical Industry," the Product Environmental Footprint's (PEF) "Greenhouse Gas Protocol," guidelines from the World Business Council for Sustainable Development (WBCSD), and further relevant regulations and widely accepted standards.

At Evonik, LCAs help to make informed decisions. It's as simple as that. The company's sustainability choices come from a full LCA that involves carbon footprint and other impact categories such as water usage – the ultimate goal being to show the environmental impact of its products and services.



INFINAM® eCO 3D Printing Circularity. Credit: Evonik.

In this fact-based approach, different materials can be compared with each other, but also different manufacturing technologies. Also, the sustainability benefits of an application have to be considered in order to quantify sustainable effects (also known as a product's "handprint"). For instance, if we make a sturdy lightweight material that can be used in the manufacturing of lighter-weight, aircraft, the ability to save a lot of fuel has increased and thus, the ability to reduce a lot of carbon emissions. The material would have to be analyzed based on the carbon emissions required to produce it, as well as the carbon emissions reduced once the material is put to the appropriate use, says **Arnim Kraatz, Director of powder bed fusion at Evonik.**

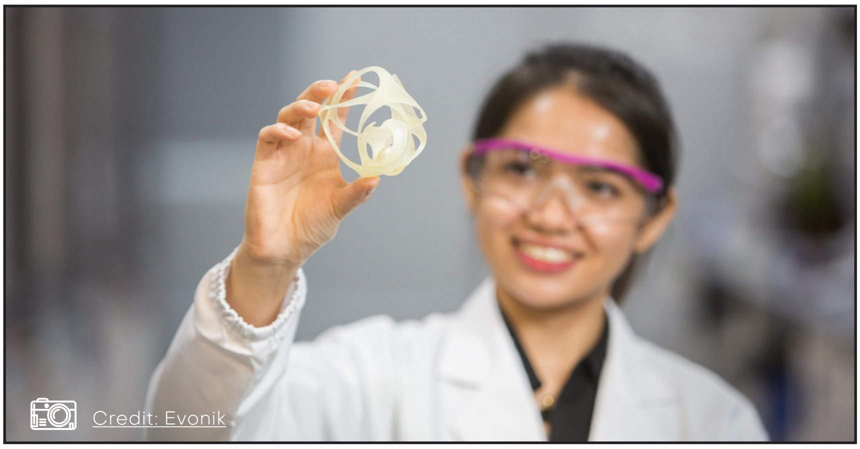
While some customers would be willing to pay a premium for sustainable products, the trap they might fall into is to buy a product that is labeled *« circular or sustainable »* without any certified metrics to justify this circularity. For this reason, Evonik is committed to highlighting the key metrics that support its worldwide sustainability transformation. Among many others, these metrics include indicators regarding a product's impact on land-use, blue water consumption, and water scarcity.

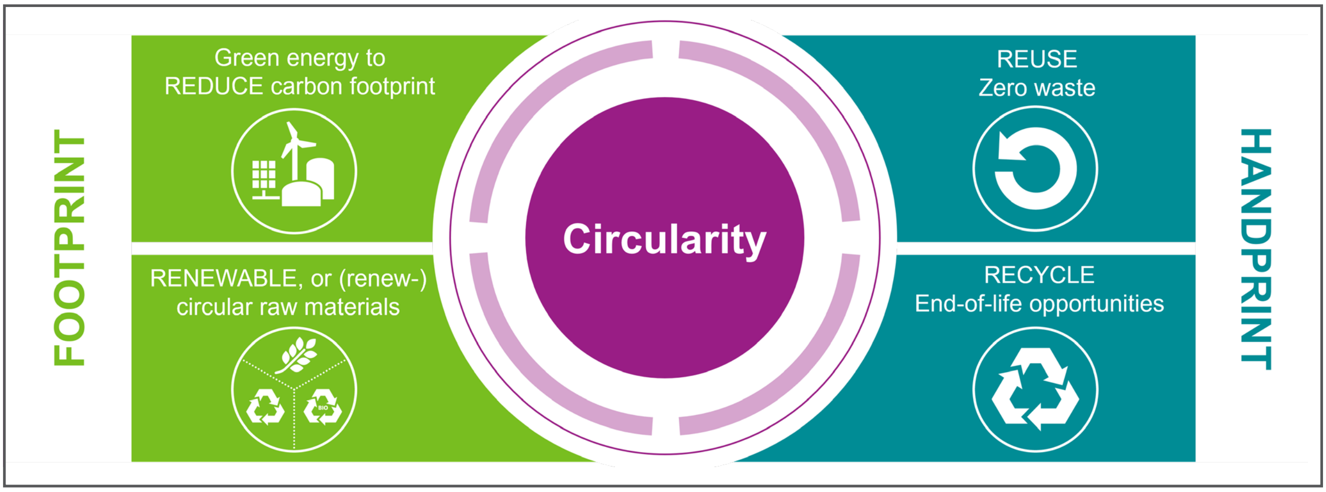
How does this support a more sustainable development and commercialization of the company's INFINAM® product line?

As a regular reader of 3D ADEPT Media, the name **INFINAM®** may be familiar to you. This brand was launched four years ago to group all AM materials from the company within the same business line. Two years ago, Evonik decided to shed light on its *« RHILOSOPHY »* – its formula to drive the circular plastics economy with the launch of the **INFINAM® eCO range.**

INFINAM® eCO is a low-footprint polyamide 12 based on a mass-balanced feedstock of used ***cooking oil****. It excels in terms of carbon footprint but also in terms of water and land usage, thanks to the use of this waste-based feedstock. At the same time, it excels in performance which is identical to classical INFINAM® grades. The* ***eCO designation*** *stands for the use of renewable or circular feedstocks via the mass balance approach, to further reduce CO2 emissions*, says **Dominic Stoerkle**, Head of the Additive Manufacturing & Material Solutions product line at Evonik.

Evonik's RHILOSOPHY is based on four cornerstones: **reduce, reuse, recycle** and **renewable** or **circular raw materials.**


Credit: Evonik



Through a mass-balance approach, Evonik sources bio-circular raw materials, such as used cooking oil for use as feedstock. Furthermore, the company states that its INFINAM® powders for 3D printing are also designed in such a way that, in many cases after a printing job, it is possible to reuse 100% of the powder that is left over.

> *Currently, the market standard among printing powders for* **SLS (Selective Laser Sintering)** *is that once a 3D printing job has finished, only about 80% of the powder remaining in the chamber can be reused. This means about 20% of that powder is not fit for use and is wasted. Our INFINAM® powders for 3D printing have the market's best reusability rate at 100%. This maximizes the EFFICIENCY potential for 3D printing manufacturers, as less remaining powder is rendered into wasted raw material. EFFICIENCY means less waste and less waste means maximizing the potential of any given raw material,*

says **Arnim Kraatz**, Director Powder Bed Fusion at Evonik.

As far as advantages are concerned, it should be noted that compared to INFINAM® Terra, INFINAM® eCO has 74% less carbon emissions. *« It offers a considerably lower carbon footprint but as it's chemically identical to INFINAM® PA12 powders, it retains 100% of the performance benefits of these powders. In other words, there is no change in performance, »* says **Arnim Kraatz**.

Beyond just reducing CO2 emissions, Evonik's understanding of circularity in the AM industry is about conducting a comprehensive analysis that includes other important factors like water consumption and land use to improve the overall ecological balance. By *« thinking plastics from beginning to beginning »*, the company plays its part in contributing to both footprint and handprint values.

This content has been produced in collaboration with Evonik. All images: courtesy of Evonik.

BMF on the current state of the micro 3D printing market and where it is headed for.

Two years ago, when we discussed the fundamentals at the heart of micro 3D printing technologies, we didn't realize how strong the impact of these technologies would be across different industries. When you think you've seen it all, you stumble upon something smaller and smaller. Whether miniaturized devices are made for electronics, MedTech or consumer goods, product designers demonstrate that certain technologies can deliver the desired accuracy and micron-level precision cost-effectively. Yet, micro 3D printing remains one of the least highlighted sectors in the AM industry. This observation is particularly striking when one realizes that most companies operating in the market of professional and large industrial 3D printing technologies are dealing with corporate restructuring or financial struggles. To understand why the micro 3D printing niche is on a steady path, we asked **John Kawola**, **CEO of** Boston Micro Fabrication (BMF) a few technical questions.

Teeth veneer. Credit: BMF

ULTRA-HIGH RESOLUTION 3D PRINTERS **microArch® D1025**

microArch® is the first commercialized high resolution, 3D micro-fabrication equipment based on PμSL (Projection Micro Stereolithography) technology, which is designed for the production of high resolution, highly precise parts for prototyping and short-run production.

Simply put, **BMF** focuses on scaling micro-3D printing technology to a range of industries that demand a high level of resolution and precision. The company develops a **Projection Micro Stereolithography** (PμSL) technology that can hold micro-precision injection molded tolerance, down to +/-10μm tolerance. To do so, it utilizes ultra-high resolution 3D printing technology, software, specialty materials and precision motion control to rapidly manufacture parts. Founded in 2016, the company, 3D ADEPT Media has been following the key milestones of the company (its various funding rounds, the launch of its microArch S350 solution, its debut on the dental market or even its partnership with Horizon) over time and was eager to discover how it perceives this market and where it is heading.

3DA: Industrials are looking to adopt AM to foster industrialization. What would you say the key objectives of micro 3D printing are?

John Kawola (JK): *For many years, molding for prototyping was the only solution available for micro-sized parts, but it was a time-consuming and expensive process. Today, manufacturers and engineers are using micro 3D printing as a cost-effective option that allows them to quickly move from prototyping to production and push the boundaries of innovation in their industries.*

In some instances, engineers are looking for a level of precision that is simply impossible to achieve with traditional manufacturing methods. Many of our customers are looking for a solution that allows them to consistently achieve extremely small features and complex geometries with high-precision, resolution and accuracy.

3DA: BMF recently partnered with micro component and coatings expert Horizon Microtechnologies to create an end-to-end offering that begins with initial product design through manufacturing. Could you provide further details on this collaboration?

JK: *Horizon Microtechnologies specializes in in-house coating processes that enhance the functionality of microstructures, including coatings in copper, ceramic-like metal oxide, and transparent conductive coatings. These coatings can be applied precisely and selectively to parts of virtually any shape. The company acquired a BMF microArch S240 micro-precision 3D printer last year, allowing them to produce intricate micro-AM parts and apply proprietary coatings. The microArch S240 offers high precision and is designed for industrial production. This acquisition enables Horizon to act as a one-stop-shop for design, manufacturing, and delivery, streamlining R&D and improving customer interaction. Some of the benefits of vertical integration include reduced development time and costs, improved quality control, and elimination of dependencies on external vendors, delivering highly accurate components. Horizon can support customer development efforts by designing functional parts best suited to their 3D micro-printing and coating capabilities.*

3DA: Where does micro 3D printing currently excel – in terms of applications?

JK: *Micro 3D printing is a unique solution for creating high-precision parts across a diverse range of industries from medical devices and technology, electronics, optics and photonics, microfluidics, and consumer packaged goods. Many of these parts and resulting products are important pieces in our modern world – from high-performance electrical connectors to personalized healthcare devices.*

As products and technology get smaller, so do the intricacies of the parts that hold them together. Micro 3D printing excels in allowing manufacturers to produce innovative, micro-scale parts and products with unprecedented precision and design flexibility. At BMF, we are committed to offering solutions that allow engineers and product designers to innovate with micro-sized parts that are highly precise and accurate. For example, we recently launched the industry's first hybrid micro-precision 3D printer series, ***the microArch D1025****, to offer more flexibility for customers looking for high precision 3D printing solutions. The dual-resolution printer allows users across industries and applications to print two resolutions, either in 10μm or 25μm, within a single layer or in different layers.*

3DA: What advancements can we expect to foster the adoption of micro 3D printing?

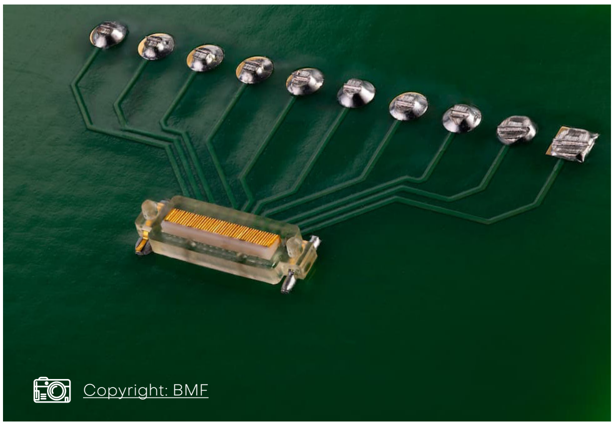
JK: *Trends of miniaturization and personalization are sweeping across industries and propelling product innovation. Regardless of industry, there's an urgent need for highly precise and accurate manufacturing methods that allow engineers and product designers to consistently create small-scale parts with the precision, resolution and accuracy needed to move industries forward. Micro 3D printing is one such solution.*

From advancements in consumer goods – such as our shrinking cell phones that are simultaneously more powerful with each iteration – to innovative drug delivery methods – such as micro-needle patches – the adoption of micro 3D printing as a manufacturing solution is well underway.

3DA: What can we expect from BMF moving forward?

In 2023, BMF experienced a landmark year where the company experienced 30% sales growth, secured its Series D funding, launched in new markets, such as in dental with the world's thinnest cosmetic dental veneer (3x thinner than alternatives), and expanded its San Diego Research Institute (SDRI), growing to 200+ team members globally and serving more than 1,800 companies worldwide. A huge component of BMF's success lies in our ability to not only cater to our customers' needs, but also our dedication to creating solutions to meet future market needs by actively seeking out opportunities to innovate.

In April 2024, BMF received U.S. FDA 510(k) clearance for its innovative UltraThineer zirconia material, which allows dental labs to offer this highly precise alternative to traditional veneers for dental practices across the U.S., so that patients can experience a more comfortable and less invasive option for tooth restoration and aesthetic improvement. BMF has secured partnerships with dental labs across the country to start piloting test cases and has begun construction of a new dental lab facility at their headquarters outside of Boston, MA, due to be completed by the end of the summer.



Copyright: BMF

To better support the use of highly precise, microfluidic solutions in advanced drug development, pharmaceutical and cosmetic research, BMF recently introduced BMF Biotechnology Inc., which is dedicated to developing and commercializing innovative BioChips (organ-on-a-chip platforms) to help accelerate new drug and cosmetic development. BMF Biotechnology will be continuously innovating to enhance the functionality and performance of the BioChip platforms, with a focus on improving human tissue replication, disease modelling, and drug response validation and prediction capabilities.

As the AM industry continues to evolve, BMF is committed to providing technological solutions that can solve real-world problems and looking for the ways in which its PμSL technology is uniquely suited to enable innovation and end-use products across industries.

ULTRASONIC USAGE IN AM : "ULTRASONIC AND AM" VS "ULTRASONIC AM"

Remember when we told you that, sometimes long-time existing processes or technologies can help refine and enhance production processes? Among the wide range of technologies or features that can be used to enhance production with AM, there is ultrasonic. Interestingly, we first discovered ultrasonic Additive Manufacturing as a manufacturing process, but the more we dive into the different usages of ultrasonic, the more we find out that the term can be applied to other applications.

Andreas Hartmann, CEO & Cofounder of Solukon Maschinenbau GmbH

Simply put, "ultrasonic" refers to a frequency greater than the upper limit of the audible range for humans —that is greater than 20 kilohertz. The term "sonic" is applied to ultrasound waves of very high amplitudes. This implies that the term itself is not limited to the manufacturing field. By sticking to this basic definition, **Andreas Hartmann**, CEO & Cofounder of Solukon Maschinenbau GmbH said *it is therefore always about the stimulation of a substance or material*.

In the AM industry, Hartmann identified two types of ultrasonic usage:

"applications where the main purpose is to use ultrasound technology - This is the «Ultrasonic Additive Manufacturing as a fabrication process» but also, for example, ultrasonic cleaning equipment." "The second area of application is, in my view, where ultrasound is used as a feature or add-on or extension of an existing technology. For example, as with our SFM-AT350-E powder removal system. In LPBF [for instance], ultrasonic excitation is used in various process steps like depowdering, powder recovery, powder preparation (sieving) or final cleaning in ultrasonic fluid baths. Ultrasonics are often required where certain material properties like flowability are challenging," he adds.

When ultrasonic AM is not a manufacturing process…

Today, ultrasonic technology is utilized in several industrial applications, to measure distances, for parking assistance, flow-rate measurement, level detection, and composition analysis. The development of smart machines and the Internet of Things have paved the way for applications of ultrasonic sensors.

According to Hartmann, if little information is shared about the use of ultrasonic technology as an add-on to an existing technology, it's probably because "the know-how usually lies with external experts who offer their ultrasound solutions for many industries", not to mention that developers of ultrasound solutions are keen to protect their "intellectual property".

We don't often realize it, but different stages of the AM process chain can benefit from ultrasonics.

"First of all, applying ultrasonic in powder removal is beneficial for the overall process chain. With the precise tracking of its parameters and the possibility of fine adjustment, it effortlessly achieves all the sophisticated objectives of process monitoring and therefore quality assurance.

As Ultrasonic works electrically with only little energy consumption it means significant energy-saving potential for the entire production chain and drives sustainability.

Furthermore, thinking of other steps of the production line, ultrasonics can be integrated into the AM process for real-time monitoring and quality control:

Defect Detection: ultrasonic sensors can detect internal defects such as porosity, cracks, and delamination during the build process. This allows for immediate correction or rejection of defective parts. Process Optimization: real-time feedback from ultrasonic sensors can help optimize process parameters, such as laser power and scanning speed, to improve part quality," Hartmann explains.

Key examples

The experts from Zetec are using ultrasonics to **support nondestructive testing (NDT) methods for 3D printed parts**. Ultrasonic NDT Methods consist of using various ultrasonic imaging methods to detect porosity and other flaws in 3D printed metals.

In the same vein, researchers at University of Bristol recently developed **ultrasonic sensors for AM quality control**. This process employs non-contact ultrasonic array sensors, akin to those used in medical imaging. The team created a mathematical model that incorporates the physics of ultrasonic wave propagation through layered metallic materials produced by AM. With some adjustment of the input parameters, this model enhances the information output, which is essential for evaluating the mechanical integrity of the 3D printed parts.

"There is a potential sensing method using a laser-based ultrasonic array and we are using mathematical modeling to inform the design of this equipment ahead of its in situ deployment," said Professor **Anthony Mulholland**, head of the School of Engineering Maths and Technology.

As he anticipates rapid adoption within the industry, the professor is exploring collaborations to integrate this technology into AM processes. This integration could lead to streamlined production, innovative designs, and bolstered economic competitiveness for UK manufacturing.

In the materials segment, we have seen AMAZEMET, a developer of laboratory-scale units for the in-house manufacturing of powders, use ultrasonic vibration for metal atomization. With its **rePowder machine**, metal is poured or melted directly on the vibrating part resulting in tiny droplets being ejected from the surface. Droplets solidify in the surrounding inert gas atmosphere forming powder particles. This leads to highly spherical metal powders with narrow particle size distribution – up to 80% is good to use in desired processes, the company explains.

In the depowdering phase, ultrasonic is a **key add-on to Solukon's automated powder removal.**

"From nearly a decade experience in depowdering, we saw that for certain geometries pneumatic excitation reaches its limits. This is especially the case for delicate structures like long winded channels or lattice structures like in medical industry. The main aim of ultrasonic excitation is to excite the component above the damaging natural frequency of the part. Initially, we had several tests with external ultrasonic exicators integrated into a depowdering machine. They proved to be successful and appeared to be a game-changer in some specific applications – for instance, copper. So, we decided to launch a dedicated depowdering system, the SFM-AT350-E with piezoelectric (=ultrasonic) excitation.

Ultrasonic depowdering solutions will not replace the well-established and proven solution with pneumatic excitation and an optional knocker. Pneumatic turbines are simple, robust and depowder very efficiently; especially for large and heavy parts, this is the way. Launching an ultrasonic depowdering solution, we have rather created a wealth of variants to adapt even better to the individual requirements of our customers. It is like a new dedicated tool in our big toolbox for powder fluidization," Hartmann points out.

For Solukon's CEO/CTO, the use case of ultrasound shows that there is always a need to further develop core technologies and exchange ideas with experts from other fields.

Automated depowdering machine SFM-AT350-E | Credit: Solukon.

When ultrasonic AM is a manufacturing process…

Ultrasonic additive manufacturing (UAM) also known as **ultrasonic consolidation** (UC), is a solid-state additive manufacturing process invented in 1999 by **Dawn White**. This hybrid sheet lamination process brings together ultrasonic welding and computer numerically controlled (CNC) milling. The process is described as a low-temperature metal 3D printing solution, because materials are not melted during the process. They are rather joined through ultrasonic welding. This welding technique employs high-frequency vibrations to join surfaces while the metal stays solid. By repeatedly welding layer upon layer, the process fabricates solid, dense metal parts.

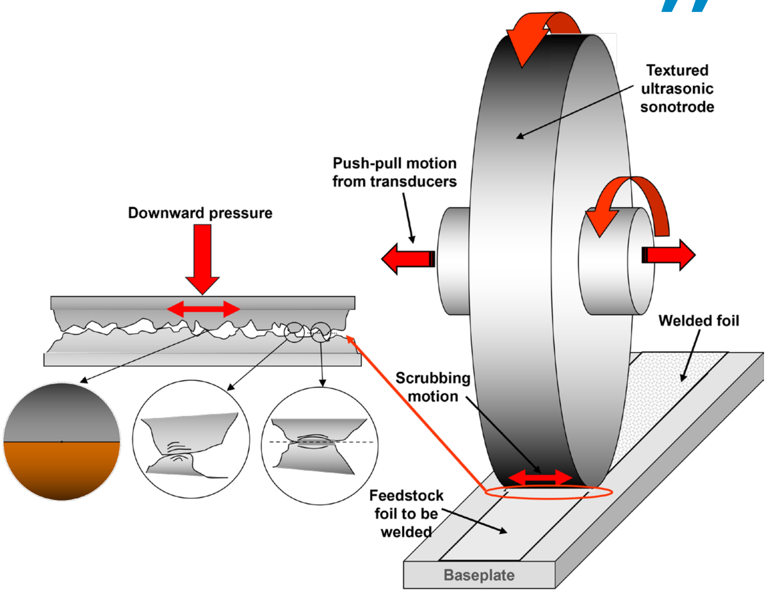
In the short list of manufacturers who have made UAM their core business, one counts **Fabrisonic**, a small tech startup headquartered in the USA that patented this process in the USA and in Europe.

According to **Mark Norfolk**, President & CEO, the process always works as explained above. However, applications that can be achieved with this process can be of different sizes, depending on the size of the machine one uses. ***"It's a matter of scale,"*** he says.

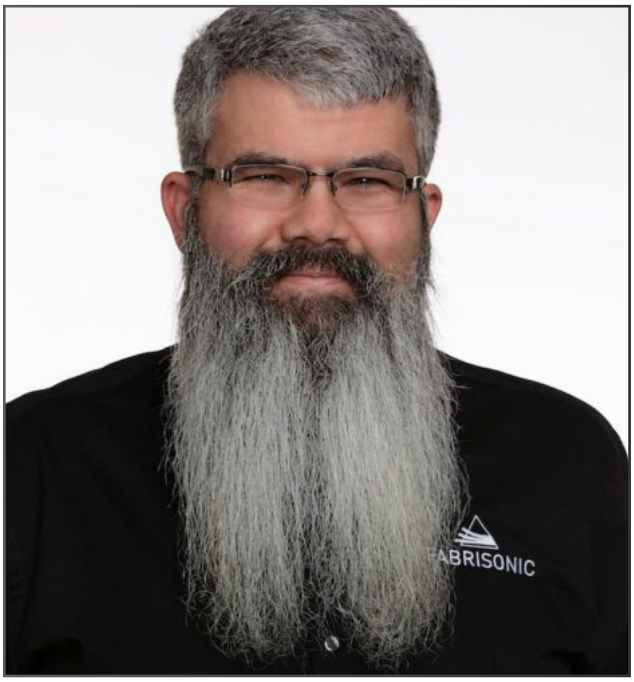
As you can understand from the definition, UAM can be combined with other processes.

"One problem in the AM industry is people feel like they have to 3D print the entire part and nothing could be further from the truth", **Norfolk** said. *"We have customers who provide us cast aluminum heat exchangers, and then we print additional features onto a casting. We have customers who send us preexisting weldments and we add features to those weldments."*

"Our process is not ideal for very organic, cellular-looking structures but powder bed fusion is fantastic at that. So, our partners can manufacture very complex organic shapes that we will embed in our product, through ultrasonic additive," he adds.



UAM 101: Mechanics – Credit: Fabrisonic



Mark Norfolk, President & CEO of Fabrisonic.

These possible combinations with manufacturing techniques such as DED and LPBF facilitate the transition between materials or the creation of dissimilar metal joints that enhance said manufacturing technique.

As a matter of fact, dissimilar metals are the first area where the company sees a greater use of its technology.

"We can combine titanium with tantalum, aluminum, or nickel, all in the same part without having to worry about metallurgical problems", the CEO explains.

While Norfolk lays emphasis on the fact that UAM is just another manufacturing tool, we couldn't help but think that the process is already serving emerging industries where AM applications are yet to be discovered. Those industries include **energy** and **electrification** – in addition to well-known sectors such as space and aerospace.

"The second area that highlights the benefits of our technology is embedded electronics", Norfolk enthuses while remembering that one of their customers made 35 million parts last year in the electric vehicle space. *"Our technology which uses foil as a feedstock lends itself to EV construction."* [The low-temperature process makes it easy to embed a sensor, a tracking device, etc. forever in solid metal or parts. The build is paused to insert the embedded object, and then it resumes to seal it inside. The bonding temperature for all metals remains below the melting point, preventing issues with thermal deformation.]

Furthermore, given the fact that the price point is much lower for foil, UAM does not deal with the same challenges other manufacturing techniques face when it comes to material accessibility. Indeed, while one can hear prices that vary from $100 to $200 per kilogram for powder, it's possible to pay $10 per kilogram for metal foil typically – *"unless it's something like gold"*, Norfolk warns us.

So, how can we explain the slow adoption of UAM?

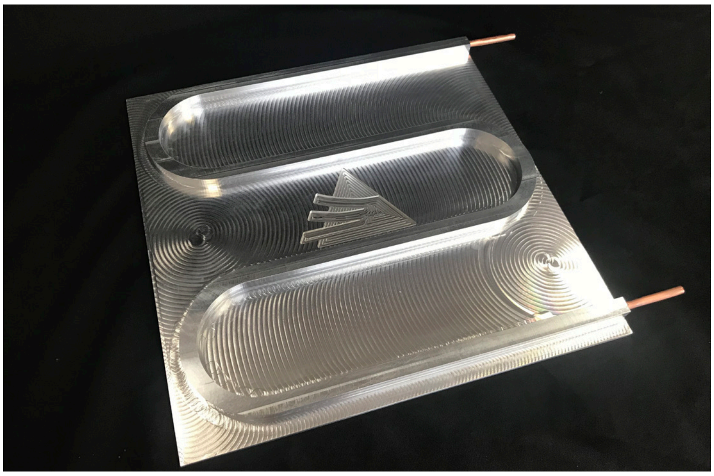
On paper, UAM has everything to be propelled in the AM industry: the possibility to achieve coveted applications such as heat exchangers, embedded sensors, dissimilar metals, selective reinforcement, to name a few; a wide range of opportunities in terms of materials and a low-temperature point which plays to the strengths of this process.

As no technology is perfect, Norfolk recognizes that they still need to work on their ability to deal with fine geometries: *"We can't weld on very delicate structures. The higher the strength of the metal, the harder it is to weld. We still need to do more research and development to get into production in this area."*

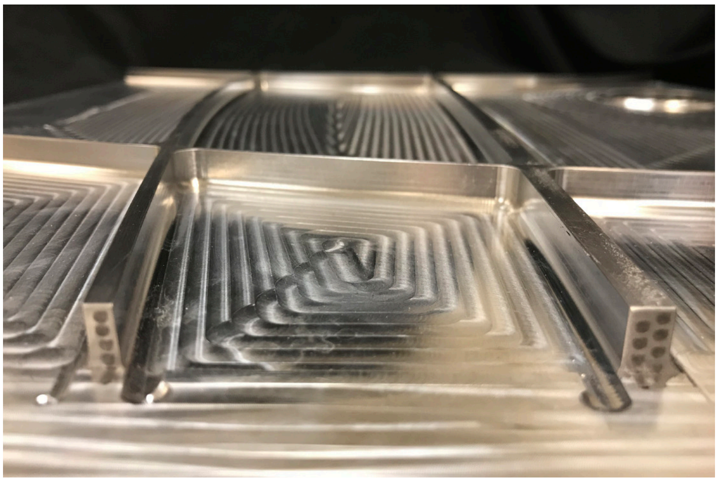
Despite these slight adjustments to make, the process strives to position itself as a strong force in the industry.

In the case of Fabrisonic, one reason that may explain this slower adoption compared to LPBF for instance, is their **business model**. The startup is owned by a non-profit – therefore *"exists for the benefit of mankind"*. This means that resources are limited to invest in large marketing campaigns as other businesses do to grow in this market.

That being said, the company's technology is distributed globally. Fabrisonic's UAM is CE-certified and is already being used in the UK, Spain and France. If it has firm intentions to expand its geographical scope, one should appreciate Fabrisonic for its ability to focus its strength on areas where they have a strong advantage.

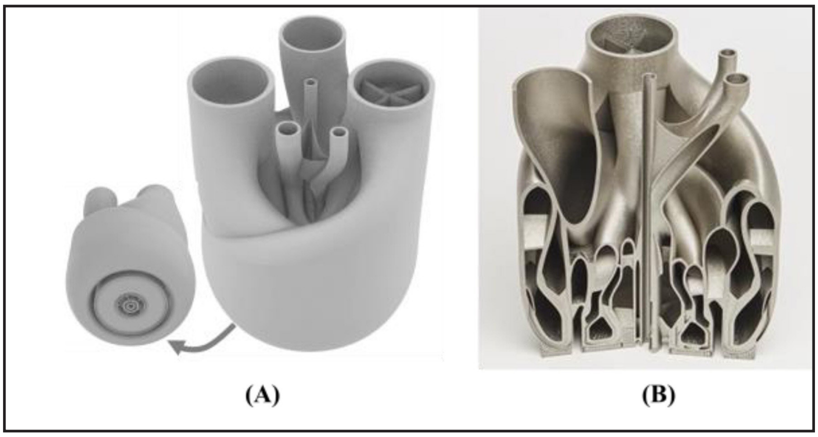


Legend: Embedded tubes. To avoid sealing issues, tubes can be embedded in place of machined channels. Credit: Fabrisonic.



MMC Wires. Legend : NASA test article was fabricated using commercially available high-strength (> 200ksi) MMC wires. Sample was selectively reinforced in thin ribs to improve buckling performance. Credit: Fabrisonic.

Areas where design automation for Additive Manufacturing makes sense



(A) AM burner nozzle with multiple flow channels (developed and provided by Siemens Corporate Technology, further described in [5]); (B) Section cut of part fabricated with PBF (Image by MBFZ toolcraft). Source.

With the increasing need to create complex 3D printed parts, it makes sense to rely on a design approach that is not manual. Indeed, the more complex the part is, the more it requires several CAD tools which designers do not necessarly have expertise in. Not to mention that every AM process comes with its challenges or constraints that need to be considered during the manufacturing process. Given these considerations, automating the design of AM parts during the DfAM process is a legitimate path to explore but the framework surrounding this process is yet to be mastered.

If we had to explain what design automation is, we would use **Dr. Ir. Lieven Vervecken**'s words: "Design automation allows product developers, engineers, and designers to incorporate knowledge from various domains into their workflows without needing deep expertise in each area. For instance, using generative design to reduce product mass by introducing lattice structures doesn't require the designer to be an expert in lattice structures or optimization."

Vervecken is the founder and CEO of Diabatix, a Belgium-based company developing **ColdStream**, a software solution that focuses on the automated design of thermal components.

His explanation makes sense when one realizes that knowledge-based systems, and software applications designed for intelligent knowledge capture and use are pivotal to achieve **design automation (DA)**. According to Vervecken, when this knowledge is lacking, attempts to convert conventional designs into AM-suitable ones often fail, [making the design process] time-consuming and hard to automate due to the uniqueness of each part. Therefore, by relying on automated design algorithms, designers can reduce, even remove frequently recurring and time-consuming tasks when designing 3D printed parts.

It can be easy to appreciate the advantages of design automation when assessing different applications. That being said, three areas where DA has proven its worth include **batch processing, design exploration** and **mass customization.**

The example of batch processing seems obvious when one knows that repetitive tasks can be achieved by applying the same design processes to dozens or hundreds of similar parts at the same time. This allows the designer to gain time in engineering design tasks, such as managing product families, assigning unique serial numbers to individual parts, or even meshing numerous parts.

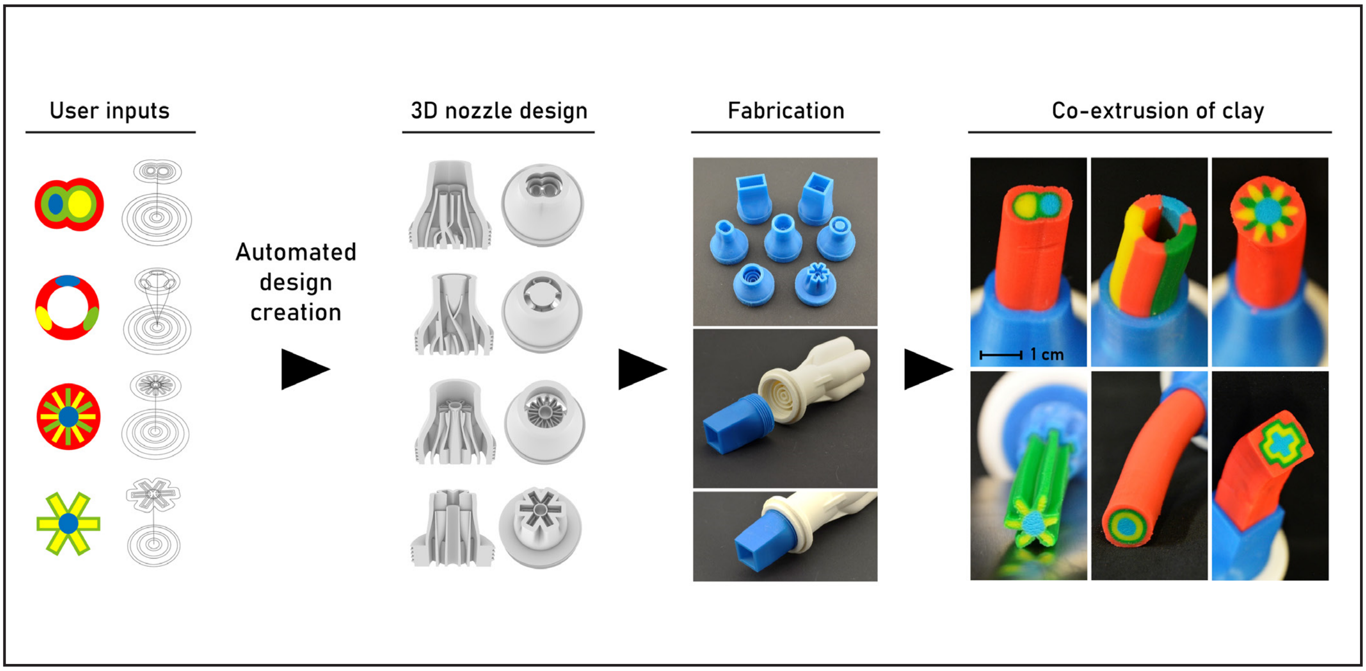
In a mass customization case, for instance, a design automation approach facilitates the generation of different designs based on new inputs over time. Without such an approach, the time to get to market would be delayed as a technician would have to manually process each individual custom order request.

Examples of applications where it makes sense to rely on DA

To provide a specific example of application where DA has been leveraged, researchers from ETH Zurich recently shared the example of **multi-flow nozzles**. The research team's design toolbox included various design elements that are usually required for the design of nozzles: cross-section shapes, flow channels, channel branches, guiding vanes, and reinforcement ribs.

The research team explains they "*apply these design elements to specify the layout of a nozzle using a high-level definition of the required design elements (e.g., position and shape of channel cross-sections). Based on these intuitive user inputs, design algorithms translate the nozzle layout into a detailed 3D nozzle geometry. In the example, the design toolbox is demonstrated by showing the automated design of different nozzles that are tested using co-extrusion of clay materials.*"

On another note, Diabatix has built up expertise in developing automated thermal design in cooling applications. The company has integrated DfAM (Design for Additive Manufacturing) rules into its ColdStream platform powered by generative AI.



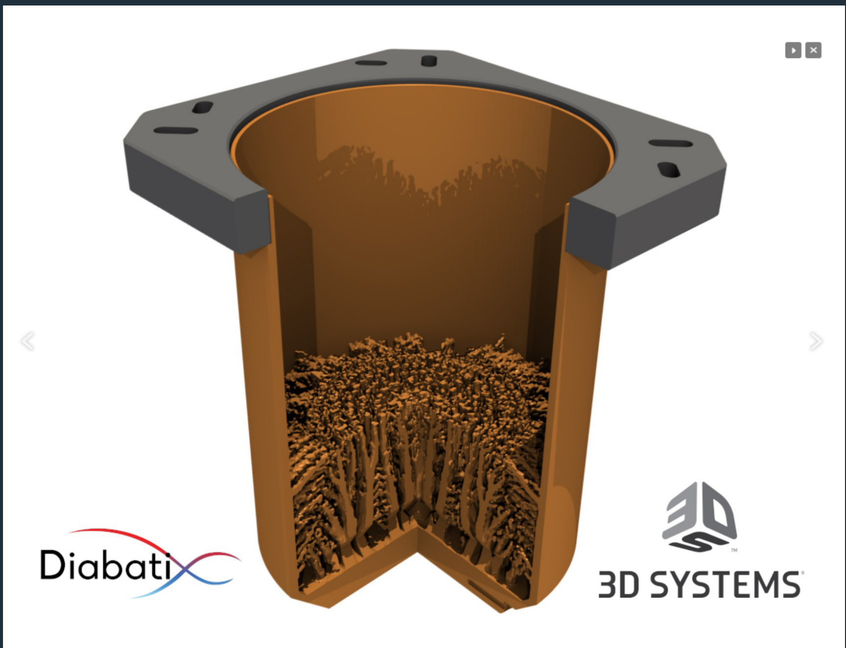
Legend: Automated design of multi-flow nozzles showing user inputs and automated generation of nozzles, as well as fabrication and testing of nozzles using co-extrusion of clay materials. Credit: ETH Zurich

"This means designers can create highly efficient heat sinks without needing in-depth knowledge of fluid mechanics or heat transfer. […] For AM, users control DfAM parameters like overhang angles, unsupported bridge lengths, and feature sizes. This flexibility allows adaptation for powder bed fusion, binder jetting, and more, all within the same interface. Collaborations with companies like 3D Systems, Desktop Metal, and Amnovis have demonstrated this flexibility," the CEO explains.

The company recently shared how the joint development of heat sinks for CPUs with 3D Systems led to a +50% performance gain compared to manual design for both cases.

With the key focus on generative AI as a key strength in the design of this 3D printed liquid nitrogen (LN2) heatsink, one concern we had was to know if design automation features should absolutely be powered by AI. To this question, Vervecken answers:

"No, not necessarily. Most DfAM rules can be translated into mathematical expressions that don't require AI to evaluate them or to integrate them during a design process. That being said, I do see value in using AI for assessing manufacturability during the preprocessing phase, especially for complex parts. When trained on a proper data set, I can imagine that AI can speed up this time-consuming



process by identifying patterns."

In the end, "*design automation is only effective when the design process accounts for the specific AM process's limitations*," he points out.

To sum up

Learning how to make the most of a design automation approach is important for both beginners and advanced designers in AM who would like to accelerate their learning curve with the technology.

From industrial hardware development to the development of complex parts, all while reducing material waste and automating labor-intensive workflows, design automation tools provide advantages, which as per Vervecken's words, often come down to three items: "*higher reliability through integrated analysis during the design process, reduced human error, and shorter time-to-market due to fewer design iterations.*"

BEHIND THE SCENES OF FORD'S AM JOURNEY IN EUROPE

"THE NUMBER OF 3D PRINTERS YOU HAVE DOES NOT TELL THE FULL STORY"

If I had to pass an exam where I am asked to list 5 key industries where Additive Manufacturing (AM) is unstoppable, Automotive will definitely be part of my list. Surprisingly, in the short list of car manufacturers who are betting on AM, not all of them truly succeed in saving millions through this technology. Ford is an exception here and the more I learn about this company, the more I realize that its adoption curve across different regions involves different capacities and purposes.

If you are a regular reader of 3D ADEPT Media, you may already know that Ford's AM activities sometimes go beyond the production of 3D printed accessories and parts for its vehicles to involve technology partnerships with 3D printing OEMs. A closer look at our coverage reveals that most of the company's activities covered so far are related to operations held in North America –3D ADEPT being a global trade press.

Nevertheless, with more than 60% of our readership based in Europe, one question that may easily come to anyone's mind is: What's the strategy behind Ford's adoption of AM? Or like I said in the beginning, how does Ford succeed in saving millions through AM?

An innovation strategy based on 6 pillars

If Ford has been using AM for several years, the company attracted attention when its Valencia-based plant started adding SLA 3D printers to its fleet of 3D printers. At the time, in 2021, we knew the short-term goal was to manufacture plastic caps used in vacuum tests to test for engine leaks.

"[Our 3D printing journey] starts with trial activities. Valencia was the first plant where we have a 3D printing center and what we did here was copied all over Europe and globally," **Rene Wolf**, Managing Director of Manufacturing at Ford-Werke, told 3D ADEPT Media. *"In 2022, we established an EU Innovation Team that defined 6 key pillars on which we should focus our strategy. Those pillars include* ***vision systems, robotics, digitization, big data, automated vehicles*** *and obviously* ***Additive Manufacturing****. With AM as one of our key innovation pillars, we wanted to come out of a niche with better applications."*

For this reason, Ford's ultimate goal was not to achieve mass production – at least not at the time –, but to exchange knowledge and share 3D printable designs between experts across different locations; and later on, gradually implement a system for parts digitalization.

With Valencia selected as a pilot project to ensure a smooth rollout across the EU region, the first seeds of this strategy were observed 18 months later, with the opening of the **Cologne Electric Vehicle Center**.

AM at the Cologne Electric Vehicle Center

February 2023: Ford announced the transformation of its production facilities at Cologne with the goal of driving digitization and industry 4.0. Most people (including myself) who hear about the establishment of a 3D printing center would be quick to ask: *"What does the production environment look like there?"*. To that question, Wolf answers:

"About 24 3D printers in the center and additional 3D printers in key areas of the plant." And then he adds: *"The number of 3D printers you have does not tell the full story."*

For Wolf, one may have different 3D printers based on the same technology, or different 3D printers for different applications but what matters is the way you use them. With AM especially, different technologies are pivotal to scale one's production roadmap, he explains.

Ford's 3D printers are based on **FDM, SLS, SLM** and **SLA**. The FDM 3D printers include machines from the likes of Markforged, Weber, Bambu Lab, BigRep, UltiMaker, and Creality; the SLS machines are coming from Formlabs, SLA from Anycubic and SLM from Aconity. In Valencia and in the UK, Ford also has other 3D printers available.

With the opening of the Cologne Electric Vehicle Center, the car manufacturer established ***"3D printing Key Performance Indicators"*** that aimed to save a seven-digit number per year and per site (Cologne and Valencia).

One initiative the company prides itself on is **the development of a digital inventory for spare parts and special parts for jigs and fixtures**. *"The online catalog is used across different plants and enables our teams to save both time and money. With this catalog, each plant does not have to develop its own process. They would just copy the digital models and adapt them to their needs,"* he points out.

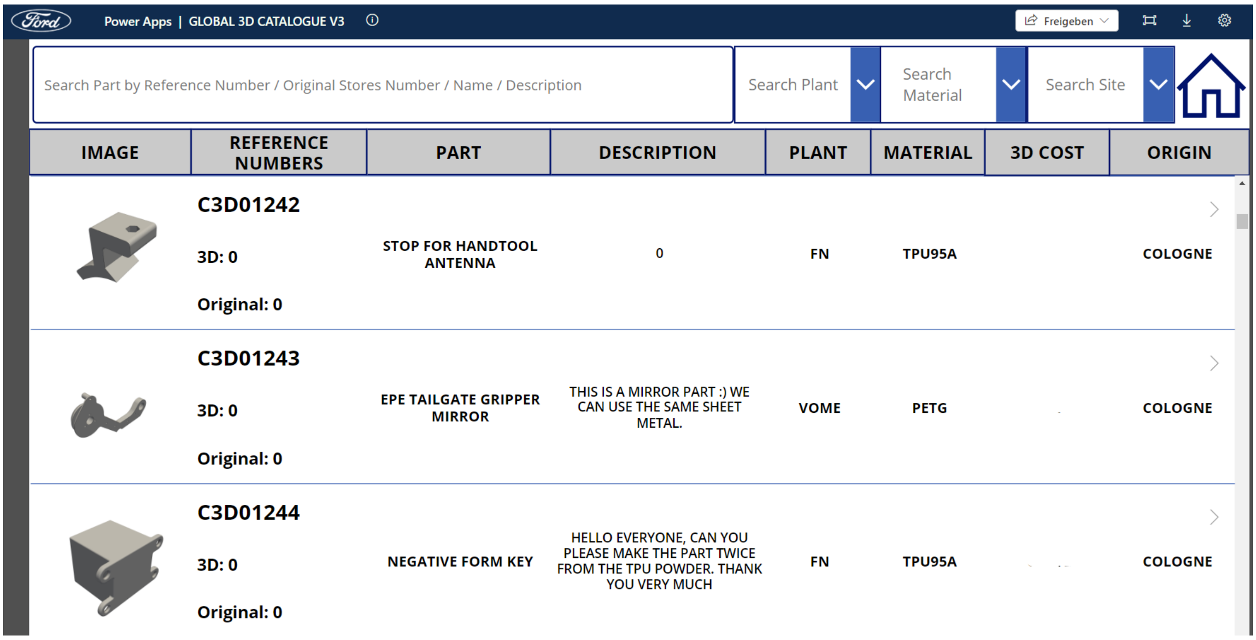
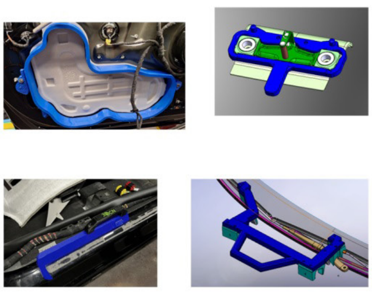
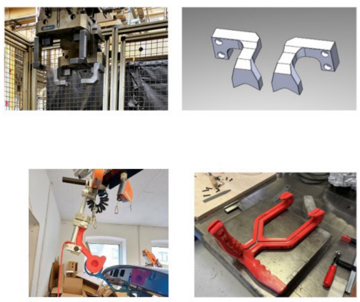


IMAGE	REFERENCE NUMBERS	PART	DESCRIPTION	PLANT	MATERIAL	3D COST	ORIGIN
	C3D01242 3D: 0 Original: 0	STOP FOR HANDTOOL ANTENNA	0	FN	TPU95A		COLOGNE
	C3D01243 3D: 0 Original: 0	EPE TAILGATE GRIPPER MIRROR	THIS IS A MIRROR PART :) WE CAN USE THE SAME SHEET METAL.	VOME	PETG		COLOGNE
	C3D01244 3D: 0 Original: 0	NEGATIVE FORM KEY	HELLO EVERYONE, CAN YOU PLEASE MAKE THE PART TWICE FROM THE TPU POWDER. THANK YOU VERY MUCH	FN	TPU95A		COLOGNE

In practice, the 3D printing center of Cologne has produced over 20,000 parts since its opening in 2023. A few production cases that recently kept the team busy include hand tools for production, a water shield baffle, a boot striker assembly, a gauge for screwing on the windshield wipers, grippers for various components, and hybrid grippers for car bodies.



- Hand tools for production
- Water shield baffle (leakage problems)
- Boot striker assembly scuff plate assembly
- Gauge for screwing on the windshield wipers (LHD &RHD



- Grippers for various components
  Small parts gripper for gearboxes (metal printing)
- Hybrid gripper for car bodies in paint (special material and safety requirements)

Over time, the company embarked on some EU innovation activities and has been working closely with the US team since 2023.

What about electrification?

When Ford opened the Cologne 3D printing center, it said it wanted to support the production of its first all-electric mass production vehicle built in Europe. Although electrification is at the heart of conversations among OEMs and politics, AM's role here is still subject to debate.

As a matter of fact, the HaPiPro2 project (where Ford was involved as a partner), that ambitioned to investigate new production processes for the next generation of electric motors, stopped for several reasons. One of the reasons is that *"AM cannot be used for mass production purposes in such context. That's why for electric components that will constitute automotive parts, we are not considering AM yet,"* Wolf explains.

That being said, Ford is currently exploring the use of AM for the **development of copper terminals used on e-motors** in collaboration with Birmingham University. Another project includes the use of AM for the **development of e-motors for line trials and packing trials**.

And today?

Valencia and Cologne may be at the forefront of Ford's innovation strategy, but this strategy is gradually being rolled out across other EU plants. By decentralizing 3D printing equipment in all maintenance areas across the continent to handle emergency actions and prototyping of first ideas under the guidance of 3D printing experts, Ford 3D printing centers will enable the company to save costs and avoid external production support.

In addition to Valencia and Cologne, other 3D printing centers in Europe include Dagenham, Halewood, Saarlouis, Merkenich and Dunton.

In the long run, and from a technology standpoint, the company believes that a faster adoption of AM processes can be achieved if testing and validation methods are standardized, if cycle times are faster, and if there are better control features of the printing process.

When European manufacturers are optimistic about AI but struggle with implementation

MakerVerse, the platform for on-demand manufacturing, released a new survey revealing a significant gap between AI's potential and its current utilization in European manufacturing operations. The 2024 AI in European Manufacturing Report sheds light on the current adoption rates, benefits, and future expectations of artificial intelligence (AI) in manufacturing. The report reveals that most European manufacturers have high hopes for AI, but fail to implement the technology.

Key facts include:

· Nearly half of European manufacturers (43%) say AI isn't integrated at all into their processes

· However, most (58%) say adopting AI is important for optimizing manufacturing

· Most manufacturers (79%) anticipate a great impact on efficiency within the next five years

· 60% say a lack of expertise is the biggest challenge in adopting AI

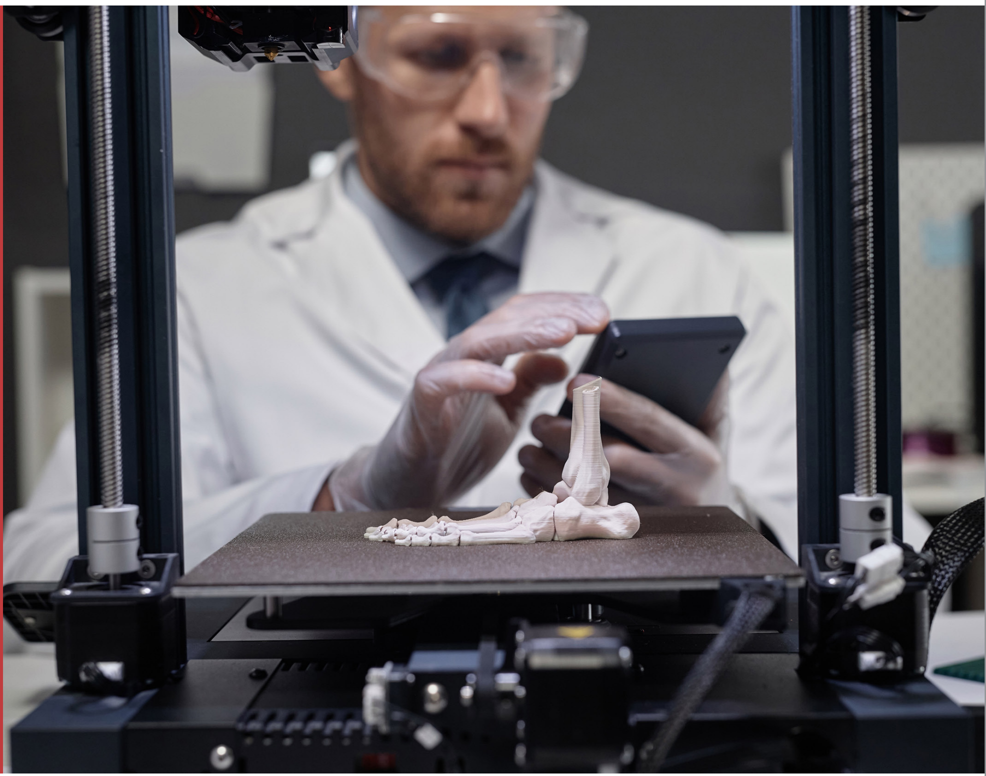
The survey of more than 50 European manufacturing professionals shows that a mere 5% of European manufacturers have "extensively" integrated AI technologies into their manufacturing processes, with 43% not using AI at all. However, this also presents a promising opportunity for the industry to harness the power of AI. "While the interest and strategic importance of AI remains high, the actual implementation is lagging, highlighting a significant opportunity for growth and innovation in manufacturing," says **Dr. Markus Seibold**, CEO of MakerVerse.

The survey further explores the reasons behind this slow adoption, with many manufacturers pointing to challenges such as a lack of expertise and high initial investment costs.

Looking ahead, European manufacturers are optimistic about the role of AI in enhancing operational efficiency. 79% of respondents anticipate AI will greatly help improve efficiency within the next five years.

ANTIMICROBIAL ADDITIVES IN 3D PRINTING FILAMENTS:

TRANSFORMING INDUSTRIES THROUGH HYGIENE SOLUTIONS



In industries where hygiene is paramount, such as healthcare, food processing, and aerospace, the incorporation of antimicrobial additives into 3D printing filaments has become pivotal. These additives inhibit the growth of microorganisms on printed surfaces, ensuring a cleaner and more hygienic environment for end-users. This article explains the use of antimicrobial additives in 3D printing filaments, exploring their significance, mechanisms, and industry-specific applications.

The integration of antimicrobial properties into 3D printing materials, specifically filaments, enables to address the growing demand for enhanced hygiene and microbial control.

Antimicrobial additives play a crucial role in inhibiting the growth of microorganisms on surfaces. In the context of 3D printing, these additives are incorporated into filaments during the manufacturing process, imparting antimicrobial properties to the resulting 3D printed objects.

The mechanisms by which antimicrobial additives function can vary, but they typically involve one or more of the following processes:

1. Disruption of cell membranes: Certain antimicrobial additives can disrupt the cell membranes of microorganisms, leading to the leakage of essential cellular components and ultimately causing cell death.

2. Interference with metabolic pathways: Some antimicrobial additives can interfere with crucial metabolic pathways within microorganisms, preventing them from carrying out essential functions and hindering their growth and reproduction.

3. Generation of reactive oxygen species: Antimicrobial additives can generate reactive oxygen species (ROS), such as hydrogen peroxide or singlet oxygen, which can damage cellular components and lead to oxidative stress, ultimately killing the microorganisms.

4. Inhibition of enzyme activity: Antimicrobial additives may also inhibit the activity of enzymes essential for microbial growth and survival, effectively halting their metabolic processes.

The choice of antimicrobial additive and its mechanism of action largely depend on the intended application, the target microorganisms, and the desired level of antimicrobial efficacy.

A variety of antimicrobial additives can be incorporated into 3D printing filaments, each with its unique properties and advantages. One of the most used antimicrobial additives is **Silver-based**. Silver ions have long been recognized for their antimicrobial properties. These additives can be effective against a wide range of microorganisms, including bacteria, fungi, and viruses.

Incorporation of antimicrobial additives into 3D printing filaments

The process of incorporating antimicrobial additives into 3D printing filaments typically occurs during the filament manufacturing stage. The antimicrobial additives are added to the base polymer material, which is then extruded into filament form using specialized equipment.

The incorporation of antimicrobial additives can be achieved through various methods, including:

1. Melt compounding: In this process, the antimicrobial additive is mixed with the polymer resin in a molten state, ensuring uniform dispersion throughout the material. The molten mixture is then extruded into filament form.

2. Solvent-based techniques: For polymers that are soluble in specific solvents, the antimicrobial additive can be dissolved or dispersed in the solvent along with the polymer. The resulting solution or dispersion is then extruded or cast into filament form, and the solvent is subsequently removed.

3. In-situ polymerization: In this method, the antimicrobial additive is incorporated during the polymerization process of the polymer itself, ensuring homogeneous distribution within the polymer matrix.

The choice of incorporation method depends on factors such as the compatibility of the antimicrobial additive with the polymer, the desired concentration and distribution of the additive, and the processing conditions required for filament extrusion.

It is essential to ensure proper dispersion and distribution of the antimicrobial additive throughout the filament to achieve optimal antimicrobial efficacy in the final 3D printed product. Additionally, the concentration of the additive must be carefully controlled to strike a balance between antimicrobial performance and potential impacts on the mechanical and physical properties of the printed object.

Industry applications

The integration of antimicrobial additives into 3D printing filaments has opened up new possibilities across various industries, addressing specific hygiene and microbial control challenges.

Aerospace and Defense

In the aerospace and defense sectors, where precision, reliability, and safety are paramount, the need for antimicrobial properties in 3D prints arises from several crucial factors:

1. Hygiene in aerospace components: Aircraft and spacecraft components are subject to stringent hygiene standards to ensure safe operation and longevity. Any microbial contamination on critical parts could compromise performance and hygiene levels. Incorporating antimicrobial additives into 3D printing filaments helps mitigate microbial growth on these components.

2. Maintenance and repair: Despite rigorous maintenance procedures, microbial contamination can occur in hard-to-reach areas or components with complex geometries. Antimicrobial 3D printed parts can help address this issue, reducing the risk of microbial growth and ensuring optimal hygiene during repair and maintenance operations.

3. Space exploration and extended missions: In space exploration missions, where astronauts spend prolonged periods in confined environments, maintaining a hygienic habitat is crucial. Antimicrobial 3D printed components in spacecraft interiors and equipment can help mitigate the risk of microbial contamination, ensuring a more hygienic environment for astronauts during extended missions.

4. Regulatory compliance and safety: The aerospace and defence industries adhere to strict regulatory standards and certifications to ensure the safety and reliability of their products. Incorporating antimicrobial additives into 3D printing filaments enables manufacturers to meet regulatory requirements related to hygiene and microbial control.

Key example: Antimicrobial 3D printed aircraft interior components

In collaboration with the **European Space Agency** (ESA), **Airbus Defence and Space** explored the use of antimicrobial 3D printed components for aircraft interiors. The project aimed to address the potential buildup of microorganisms on high-touch surfaces within aircraft cabins.

Researchers developed a filament embedded with silver-based antimicrobial additives and used it to 3D print various interior components, such as tray tables and armrests. These components were thoroughly tested and demonstrated significant antimicrobial activity against common pathogens like Staphylococcus aureus, Escherichia coli, and Candida albicans.

By incorporating antimicrobial properties into 3D printed aircraft interior components, Airbus aimed to enhance passenger hygiene whilst also reducing maintenance costs associated with microbial growth and contamination.

Automotive and Transportation

While the primary focus of antimicrobial additives in automotive applications may not be as evident as in sectors like healthcare, it remains a crucial consideration, particularly in shared mobility and autonomous vehicle contexts. In ride-sharing services and autonomous vehicles, where multiple passengers may come into contact with interior surfaces, maintaining hygiene is essential. Antimicrobial 3D printing filaments can be used to produce interior components and high-touch surface parts with in-built antimicrobial properties, ensuring a more hygienic environment for occupants.

Moreover, the integration of antimicrobial additives into 3D printed automotive components can contribute to overall vehicle hygiene, reducing microbial growth and associated odours.

Regulatory landscape and compliance

As the integration of antimicrobial additives into 3D printing filaments continues to gain traction across various industries, it is crucial to navigate the regulatory landscape and ensure compliance with relevant standards and certifications. Different industries and regions may have specific requirements and guidelines governing the use of antimicrobial agents in products and materials.

The healthcare industry is subject to stringent regulations to ensure patient safety and product efficacy. Antimicrobial additives used in 3D printed medical devices must comply with standards set by regulatory bodies such as the **U.S. Food and Drug Administration** (FDA), the **European Medicines Agency** (EMA), and other regional authorities.

In the United States, the FDA regulates antimicrobial agents used in medical devices through the 510(k) premarket notification process or the Premarket Approval (PMA) pathway, depending on the device classification and risk level. Manufacturers must provide evidence of the antimicrobial agent's safety, efficacy, and compatibility with the intended use.

The International Organisation for Standardization (ISO) has also established guidelines for evaluating the antimicrobial activity, including ISO 22196 for testing the antibacterial activity on plastics and other non-porous surfaces.

The aerospace and defence industries operate under strict regulatory frameworks to ensure the safety and reliability of aircraft, spacecraft, and related components. Antimicrobial additives used in 3D printed aerospace parts must comply with relevant standards and specifications.

In the United States, the Federal Aviation Administration (FAA) and the Department of Defence (DoD) have established guidelines and certification processes for the use of antimicrobial materials in aerospace applications. These agencies may require extensive testing and documentation to validate the performance, compatibility, and safety of antimicrobial additives.

The European Aviation Safety Agency (EASA) and other international regulatory bodies also have specific requirements for the use of antimicrobial agents in aircraft components and systems.

The use of antimicrobial additives in consumer products is regulated by various governmental agencies and organisations to ensure consumer safety and environmental protection. In the United States, the Environmental Protection Agency (EPA) regulates antimicrobial agents under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Manufacturers must ensure they use **EPA-registered additives** for their antimicrobial products. The EPA also establishes guidelines for labelling and marketing claims related to antimicrobial properties.

In the European Union, the Biocidal Products Regulation (BPR) governs the use of antimicrobial agents in various product categories, including consumer goods. Antimicrobial additives must undergo a thorough evaluation process to ensure their safety and efficacy before being approved for use in the EU market.

Compliance with these regulatory frameworks is crucial for businesses operating in the antimicrobial 3D printing domain. Partnering with reputable suppliers and consulting with regulatory experts can help navigate the complex landscape and ensure that products meet the necessary standards and certifications.

Emerging trends and future outlook

Emerging trends and future projections suggest exciting possibilities for enhancing antimicrobial properties, exploring new applications, and addressing sustainability concerns.

Potential New Applications

As the understanding and adoption of antimicrobial 3D printing solutions expand, new applications across various sectors are likely to emerge. In the food and beverage industry, antimicrobial 3D printed components could be utilized in food processing equipment, packaging, and utensils to enhance food safety and extend shelf life.

The agricultural sector may also benefit from antimicrobial 3D printed solutions, such as irrigation systems, greenhouse components, or farming tools.

Additionally, the integration of antimicrobial properties into 3D printed building materials and architectural components could revolutionise the construction industry.

Collaboration and Knowledge Sharing

The future success of antimicrobial 3D printing solutions lies in fostering collaboration and knowledge sharing among stakeholders, including researchers, manufacturers, regulatory bodies, and end-users. Cross-disciplinary collaborations can drive innovation and address complex challenges, such as optimizing manufacturing processes, and navigating regulatory frameworks.

The establishment of industry-wide standards, best practices, and knowledge-sharing platforms can facilitate the dissemination of research findings, case studies, and successful implementations, accelerating the adoption and advancement of antimicrobial 3D printing solutions across various sectors.

Conclusion

By harnessing the power of antimicrobial 3D printing solutions, industries can unlock a myriad of benefits, including the reduced opportunity for microbial contamination in various applications. From medical devices and aerospace components to consumer goods and industrial tools, the possibilities are vast and far-reaching.

As highlighted throughout this article, the successful implementation of antimicrobial 3D printing solutions requires a multifaceted approach. It involves a deep understanding of antimicrobial mechanisms, material science, and manufacturing processes, as well as a commitment to navigating complex regulatory landscapes and ensuring compliance with relevant standards and certifications.

Furthermore, the future of antimicrobial 3D printing solutions lies in continuous innovation and collaboration. Researchers, manufacturers, and industry stakeholders must work together to explore new frontiers, including sustainable practices, and novel applications across various sectors.

By embracing the transformative potential of antimicrobial 3D printing, we can pave the way for a future where hygiene, and innovation converge seamlessly, driving progress and improving the quality of life for people around the world.

This article has been written by Addmaster.

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EPMA releases EURO PM2024 congress & exhibition technical program

As you may know, for its annual event that takes place in a new European country, the European Powder Metallurgy Association (EPMA) gathers a line-up of industry insiders who bring a wealth of knowledge on the Powder Metallurgy manufacturing process, case studies and publications.

With the increasing use of metallic powders to produce robust metal 3D printing applications, Additive Manufacturing has become over the years a key component of EPMA's events.

As a reminder, the event will take place from **September 29th to October 2nd this year at the MalmöMässan in Malmö, Sweden**.

To help attendees prepare for their participation in this event, EPMA has recently released the technical program that will be the backbone of this week.

This year we received a total of 254 abstracts. The very high quality of the submitted papers allowed the TPC members to create a high number of sessions (50 sessions on 3 days) and a wide range of topics within powder metallurgy are represented, EPMA said.

The Euro PM2024 plenary session will be held on Monday 30 September morning, with the participation of EPMA's president **Mr. Ralf Carlström**, who will present an "Overview of the status and trends in the European PM Industry" and two plenary speakers, **Mrs. Annika Roos** (Jernkontoret) with a presentation on "Steel and metal powder in the Swedish transition – past, present and future" and Dr **Henrik Karlsson** (Volvo group) with his presentation "The journey towards sustainability. How can powder technology support the green transformation?"

The plenary session will also welcome the winner of the thesis competition who, in addition to being invited to the Congress, will make a short presentation about his work. The plenary session will also offer the opportunity to recognize the winners of the DSA and Fellowship awards as well as the 2024 Keynote Paper Awards.

This year, the PM Component Awards are back, 13 components were presented in 3 categories.

In addition to the usual Industry corners and campfire meetings held in the exhibition hall, this year in Malmö will also give attendees the opportunity to attend a «PM for beginners» lecture given by **Dr. Vlad Kruzhanov**, open to all participants on October 1st.

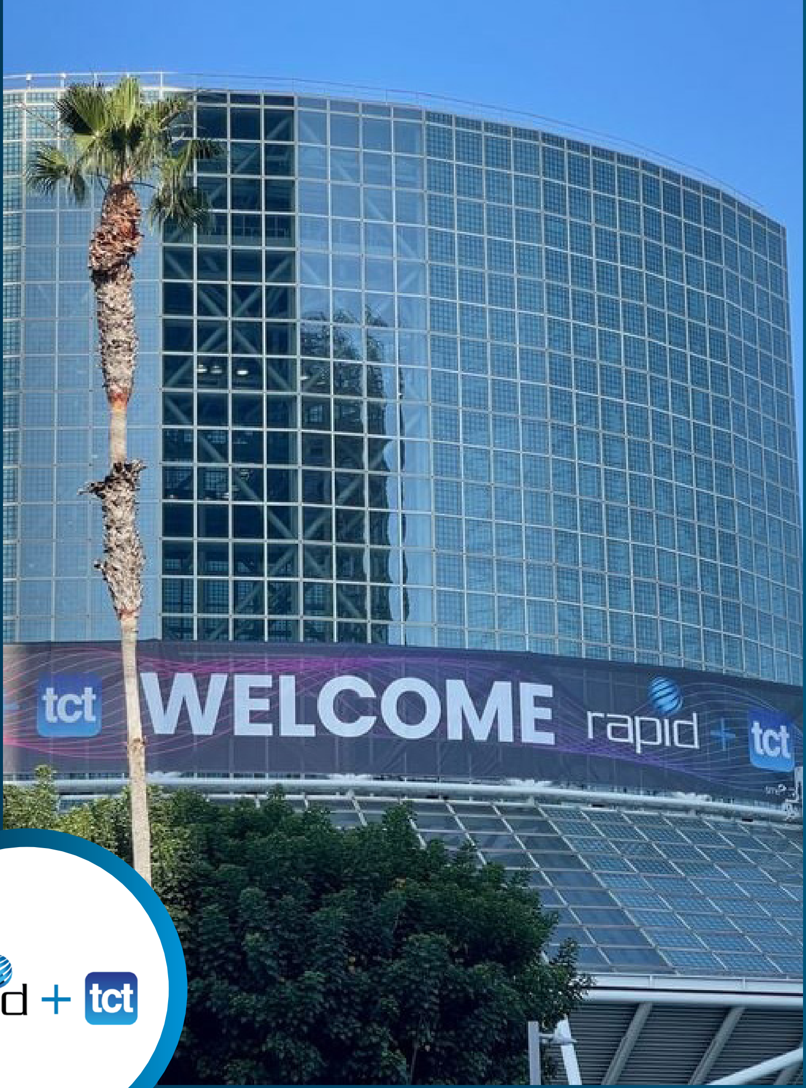
The technical program will be enhanced by 11 Special Interest Seminars and 6 Sectoral meetings. Full details of the program can be found here.

Euro PM2024 – Registration

Registration is now open, and the early rate deadline is **30th August**. All information about the congress will be presented in EPMA's technical guide & Exhibition 2024.

REGISTER HERE HTTPS://OIC.EVENTSAIR.COM/PM2024/REGISTRATIONS/SITE/REGISTER

RAPID+TCT 2024: HOLLYWOOD MEETS ADDITIVE MANUFACTURING



With over 400+ exhibitors, 200+ conference speakers including 125 educational hours of industry-leading presenters, and 100,000+ attendees, this year's **RAPID + TCT** show was a highly anticipated event. With California as a whole being the largest manufacturing producer in the United States, there were a multitude of West Coast small businesses, students, scientists, innovators, makers, and general 3D Printing nerds alike all centered in the City of Angels to learn about the latest technology in the Additive Manufacturing space.

Familiar groups like **Women in 3D Printing, Stratasys** and the **3D Printing Nerd** all hosted fun, rooftop karaoke sessions and happy hours following the first few nights of the conference. There was a noticeable increase in presence from Asian manufacturers as well, given the proximity to Eastern countries for overseas exporting. Additionally, the influence of Hollywood and the film industry was on full display, with a variety of booths and showcases displaying movie props, figurines, and full life-sized prints for recognizable American pop culture references throughout the conference halls.

Faster, smarter more affordable, desktop 3D printers

A decade ago when Netflix launched the 3D printing documentary *"Print the Legend"*, Desktop 3D printers were thought of as nothing more than an inexpensive means to produce plastic prototypes. Fast forward to 2024, and we now have a large emergence of Desktop 3D printing companies producing quality products for the casual hobbyist all the way up to Fortune 500 Design & Engineering companies – with machines becoming faster, quieter, more affordable, and a wider envelope of material selection.

Companies like **Bambu** have gained a ton of momentum in more recent years, especially within the maker and retail consumer market. This year, Bambu and a variety of other maker-centric brands with large show presence in heavily-trafficked areas ambition to cater to the masses that were in attendance.

Creality, UltiMaker, Raise3D, and many more FDM (FFF) 3D Printing OEM's all had their printer heads buzzing in booths showing off just how far servo systems, material science, and print processes are exceedingly fast, efficient and accurate for a low barrier to entry of capital investment for most. Similarly, there were a variety of polymer material companies representing their various types and grades of 3D printing spools and powders.

With the hobbyist 3D Printing companies creating economies of scale, there's a noticeable uptick in high schools, colleges & universities adopting Additive in their curriculum for Mechanical Engineering, CAD Design, and other Manufacturing-centric areas of study. It's been great to see more and more students and teachers attend RAPID compared to years past.

Read more on the topic: ***The "fall and rise" of desktop 3D printing*** **(Jan/Feb edition of 3D ADEPT Mag, PP 12-15)**

COLIBRIUM ADDITIVE
a GE Aerospace company

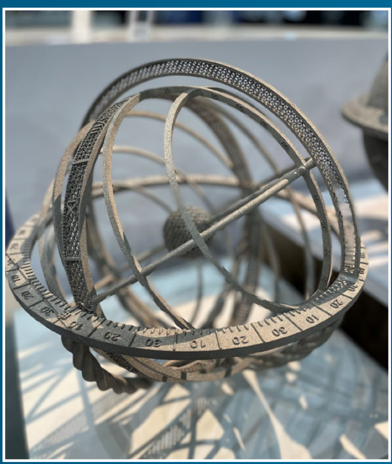
Volume production Additive Manufacturing (Colibrium)

Bearing the newly branded name, Colibrium Additive (a GE Aviation Company) made its splash for the first time at this year's show. **Shaun Wootton** headed up the name change after extensive research and consumer studies: *"While the branding is the same, we're still the disruptor we've always been in the space. Being an educator, giving back to universities and educational institutions, and continuing to disrupt the industry. The fundamentals remain the same, our ties to Aviation, advancements in Metal Additive systems, and educator for future generations to come."*

Wootton later went on to explain "***Collaboration and Equilibrium***" was the inspiration behind this universal branding that was chosen after.

Collibrium had a number of parts on display (as shown above) to showcase their PointMelt technology, which enables things like support-less prints, eliminates the need for a build place, and plots layers with points instead of traditional layer lines. For electron beam melting (EBM) process control, this means a multitude of improvements in quality control, design possibilities, cost efficiency, and more. *"With our newer technology, we can manipulate powder size, laser power, layer thickness, infill and others to make for a more efficient print and lower cost run,"* **Dan Frydryk**, Sr Engineering Manager,explains. *"By tweaking just the layer size, we can get very detailed with how our prints will perform all by just dialing in or out certain aspects of how we want the part to look."*

The spheres (shown above) are just a small example of the improvements in print speed and quality in more recent years. Now with PointMelt, the need for support is far less than before. Colibrium also showcased their well known Aerospace-certified and medical grade parts (as shown on the left) at the show this year.



LITHOZ

Continued expansion of materials (Lithoz)

Ceramic 3D printing was once a far off thought, but is now being brought fruition in the Additive community with advancements in hardware and material technology.

Initially AM was used only with cheaper polymer materials such as PLA, ABS, and ASA. As the technology became widely adopted, came the emergence of Metal 3D printing with powder-bed and laser-sintering technologies. The next giant leap in material science with 3D printing is likely in the realm of **being able to additively manufacture high quality ceramic components.**

Norbert Gall of Lithoz explains "Ceramics is the next step in the Additive Manufacturing revolution. It offers immense control under extremely hot and cold conditions, while maintaining part resolution and fine features for a variety of applications and component sizes."

Lithoz showcased a very large, circular part (as shown below) which was all printed in one batch.

“We’re continuing to push the boundaries of what can be done with Ceramic 3D Printing, and are some of the only ones on the market doing it today,” explains Gall. “In addition to handling extreme temperatures, our ceramic chemical makeup also allows for extreme corrosion resistance against a variety of harsh chemicals a given component might encounter in the real world.”

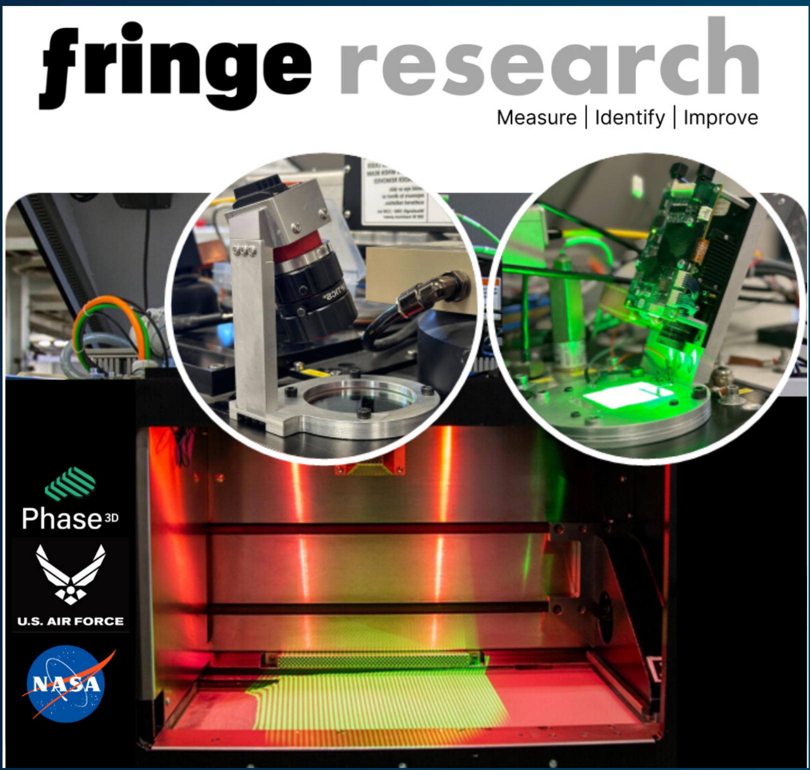
One of the most impressive small parts displayed came towards the end of my time with Gall, which was eye-catching, to say the least. These components represent the breadth and depth of their printers capabilities, and portfolio of applications from in-body medical device parts from aerospace, consumer packaging, and more.

Quality / Traceability (Phase3D)

While it’s been an exciting time to see the Additive Manufacturing community grow up and mature, there’s still a lot of moving parts to consider, especially when it comes to **quality control and part traceability.** With the recent announcement on fringe research with the Air Force and NASA teams, **Noah Mostow** of Phase3D believes digitizing quality control is the next logical advancement for taking Additive Manufacturing and part qualification to the next level.

“This year’s RAPID is all about quality. Our system is helping a variety of powder-bed processes by verifying the accuracy of each individual layer all throughout the printing process. This is huge for any manufacturer that’s needing to qualify their parts, but produce detailed reporting of the entire component, layer by layer.” Phase3D demonstrated its **In Situ Porosity Prediction Software** for Laser Powder Bed Fusion (LPBF) Additive Manufacturing.

Along with Phase3D, there were a variety of hardware & software vendors at the show offering specialized solutions to address QA and QC specifically. Whether it was your 3D scanning, metrology, and measuring equipment, to software-enabled digital tools to automate processing and qualifying parts. Lumafield was another returning exhibitor, showcasing their 3D CT Scanning technology for footwear and a variety of athletic applications.



Increased attention on post-processing capabilities

While the dream of AMis simply loading a CAD file and just pressing go, the reality is that there’s often a much needed intervention of post-processing and after-print treatment that’s involved for the majority of 3D prints. Organizationslike Solukon are addressing just that with their automated depowdering systems.

Marina Haugg of Solukon was at the booth this year showcasing the SFM-AT1000-S; a large format automatic depowdering system for parts of up to 1,000mm and 800kg. “While many focus on all of the features & capabilities of the 3D printers themselves, it’s crucial to not forget about the post-secondary operations that are done post-print,” Haugg explains. “Our systems are geared towards OEM’s and end- users in a high-volume production environment and are looking to automate the way they handle metal (and plastic) components once they’re off the print bed.”

For 10 years now, this German-based solutions provider has engineered a variety of systems to work with large, complex, and often hazardous materials for industries that demand highly precise and accurate 3D printed components. These industry-grade systems fair well especially with titanium, nickel alloys, aluminum, and other reactive metals.

Star of the show (nTop + Cobra Golf)

Without a doubt, the busiest attraction and eye-catching demo had to be the metal 3D printed golf irons designed using **nTop software** in collaboration with San Diego-based **Cobra Golf. Ryan Roach** of Cobra headed up the design innovation that is taking the golf industry by storm through the help of nTop's AI-enabled topology optimization design & analysis software.

Allowing for variable wall thickness, hollow internal channels, and complete customization; Roach explained the design thought-process in a keynote presentation on Day 2 of the show. nTop's CAE software has been utilized in industries beyond golf, spanning heavily into aerospace for heat exchangers, and other commonly 3D printed components for rockets, aviation, and more.

nTop showcased their irons alongside Cobra Golf at the RAPID show the only logical way; by allowing attendees to put them through the test in a series of 3 shots on a golf simulator. As an avid golfer myself, I can attest to the light-weighting aspects of this club, in addition to the cushiony feel of the ball coming off the face of the club. It seemed to be easier to swing, and was more forgiving at times compared to traditional nickel or forced aluminum clubs on the market today.

Aside from the amazing weather, inviting industry celebration events each night, and insightful minds; the 2024 RAPID + TCT show was definitely one to remember. In just a decade's time, it's been truly an experience to see 3D printing transform from a novelty rapid prototyping methodology to a full fledged force in the industrial manufacturing economy worldwide. While there is still much room for advancements between hardware and software companies alike, we're sure to see continued investment and increased attention to this ever growing sector.

Next year's RAPID is just 10 months away, and will be set in Motor City USA; Detroit, MI with anticipation of various Automotive-centric themes and displays to come. We're excited for Formnext coming up in November and beyond, see you next year in April for RAPID+TCT 2025.

Read more news on RAPID+TCT 2024 here.

This article has been written by Will Kruspe. Featured image, courtesy of RAPID+TCT 2024, Instagram.

Industry events 2024

Stay up-to-date with the latest additive manufacturing industry events, conferences, exhibitions and seminars.

EUROPE

Powder Metallurgy and Additive Manufacturing of Titanium (PMTi 2024)
September 4–6, Madrid, Spain
www.pmti2024.com

The 12th Edition RM Forum
September 25–26, Milan, Italy
www.rmforum.it

The Atomising Systems Course on Atomization for Metal Powders
September 26–27, Manchester, UK
www.atomising.co.uk/news

Euro PM2024 Congress & Exhibition
September 29–October 2, Malmö, Sweden
www.europm2024.com

Scotland Manufacturing & Supply Chain Conference & Exhibition
October 23–24, Glasgow, Scotland
www.manufacturingexposcotland.com

AM Summit 2024
October 24, Copenhagen, Denmark
www.amsummit.dk

Advanced Engineering
October 30–31, Birmingham, UK
www.advancedengineeringuk.com

Space Tech Expo Europe 2024
November 19–21, Bremen, Germany
www.spacetechexpo-europe.com

Formnext
November 19–22, Frankfurt, Germany
www.formnext.com

USA

Formnext + PM South China
August 28–30, Shenzhen, China
www.formnext-pm.com

IMTS 2024
September 9–14, Chicago, IL, USA
www.imts.com

Metal Additive Manufacturing Conference (MAMC 2024)
September 17–19, Aachen, Germany
www.mamc.at

The Advanced Materials Show USA
October 8–9, Pittsburgh, PA, USA
www.advancedmaterialsshowusa.com

World PM2024
October 13–17, Yokohama, Japan
www.worldpm2024.com

Global AM Summit 2024
October 15–16, Singapore
www.namic.sg/events/gams2024/

International Conference on Advanced Manufacturing (ICAM 2024)
October 28–November 1, Atlanta, GA, USA
www.amcoe.org/event/icam2024/

Aerospace & Defense Manufacturing & R&D Summit
December 5–6, Dallas, TX, USA
www.dec24.aerospacedefensesummit.com

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International exhibition and convention on the next generation of manufacturing technologies
Frankfurt, Germany,
19–22 November 2024

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AMSC 2024

The International Catalogue of AM Solutions

Once you've decided that Additive Manufacturing/3D Printing is right for your project/business, the next step might be quite intimidating. In their quest for the right technology, be it by email or during 3D printing-dedicated events, professionals ask us for advice or technical specifications regarding different types of 3D printing technologies & post-processing solutions that raise their interest. Quite frequently, these technologies are not provided by the same manufacturer.

The International Catalogue of Additive Manufacturing Solutions comes to respond to this specific need: be the portal that will provide them with key insights into valuable AM & post-processing solutions found on the market.

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