2022/Q1

AM CHRONICLE

3D Printing Voice of the Region

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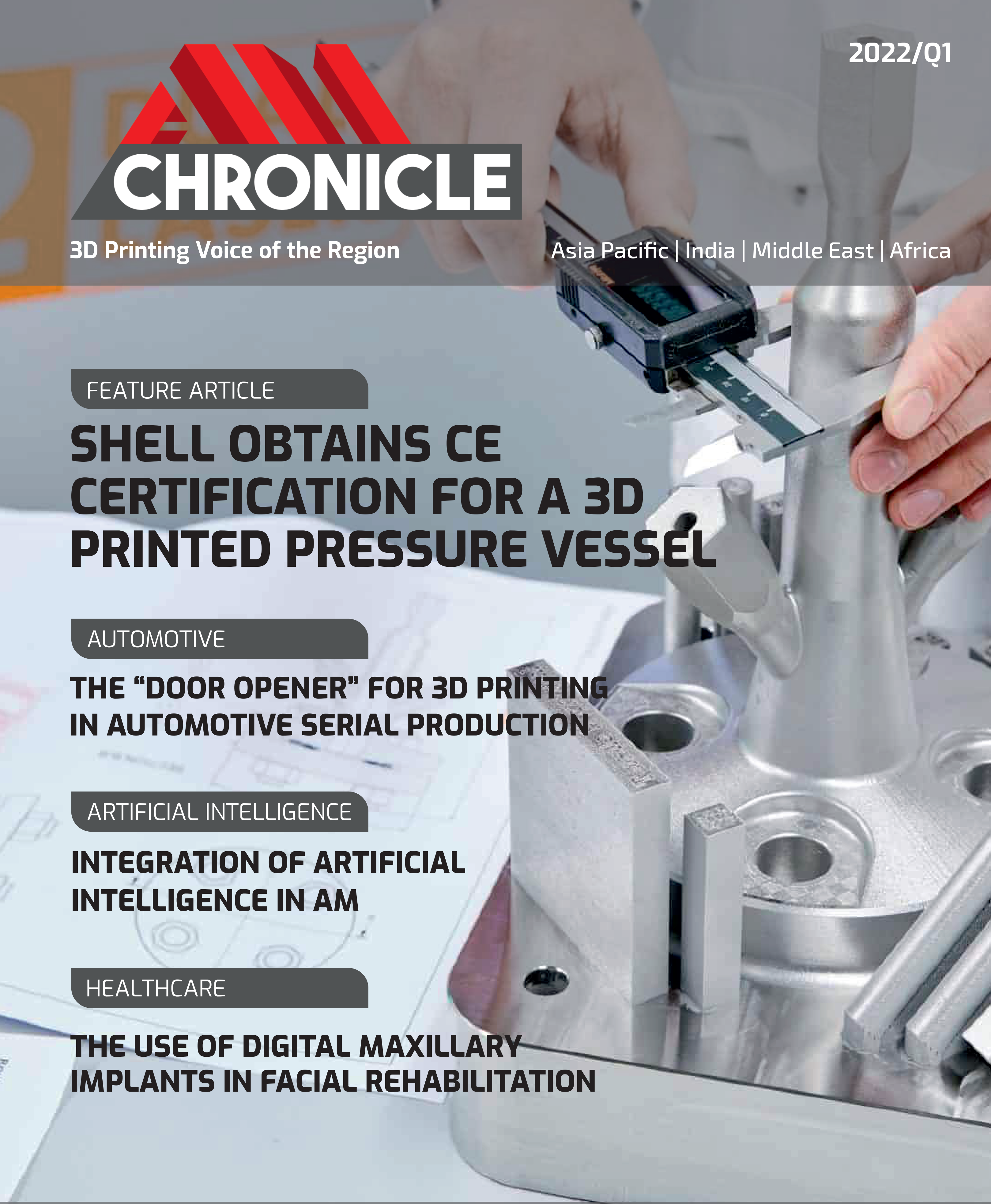

FEATURE ARTICLE

SHELL OBTAINS CE CERTIFICATION FOR A 3D PRINTED PRESSURE VESSEL

AUTOMOTIVE

THE “DOOR OPENER” FOR 3D PRINTING IN AUTOMOTIVE SERIAL PRODUCTION

ARTIFICIAL INTELLIGENCE

INTEGRATION OF ARTIFICIAL INTELLIGENCE IN AM

HEALTHCARE

THE USE OF DIGITAL MAXILLARY IMPLANTS IN FACIAL REHABILITATION

Metal Additive Manufacturing Symposium (MAMS)

Advancing the Indian Metal Additive Manufacturing Ecosystem

27th July 2022 | Taj Yeshwantpur

Bengaluru

ABOUT

The Metal Additive Manufacturing Symposium (MAMS) is a user focussed technical conference mapping the latest developments and trends in the world of Metal Additive Manufacturing. The conference will be supported by a table top exhibition to enhance the interaction and networking.

The aim of event is to bring the entire Metal AM ecosystem on one platform including Users, Software Providers, Hardware and Material Manufacturers, Research and Standards to advance the utilization of this technology.

This event is curated by the publishers of AM Chronicle and organisers of the leading AMTech Expo.

TOPICS COVERED

> Materials for Additive Manufacturing

> Equipments for Additive Manufacturing

> DfAM

> L-PBF, EBM and DED

> AM Process, Quality Control, Standards, Certification

> Post-processing of AM parts

> Tooling, Space and Aircraft, Automotive, Medical and others

> Recent Research Topics

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EDITORIAL

AM Chronicle widens market focus

At AM Chronicle we have been constantly evolving with the needs of the industry in India and neighboring regions. In the last 12 months we have built a stronger end user connect, robust digital presence, enhanced our content platform and expanded our sphere of influence globally.

I am also happy to welcome on board our editorial advisory group at AM Chronicle. The group will include AM experts and will be a guiding force for the magazine to ensure all segments of the industry are represented. We are joined by Dr Sastry Y Kandukuri (Norway), Vaman Kulkarni (India), Dr Satya Ganti (USA), Dr Alexander Liu (Singapore), Dr. Jayaprakash Jaganathan (India) and Manoj Pillai (Dubai) to the Group providing a global outlook.

Our cover image which is from our Feature article for this issue, epitomizes the evolution Additive Manufacturing has seen in recent times - Shell and LRQA (formerly Lloyd's Register) have certified a 3D printed pressure vessel in accordance with the European Pressure Equipment Directive (PED), which is a milestone achievement. The issue also covers developments of Additive Manufacturing in industries such as Automotive, Mining, Healthcare and more.

We are also excited to announce the Metal Additive Manufacturing Symposium which Advancing the Indian Metal Additive Manufacturing Ecosystem which is now at its inflection point with the advent of local hardware and material manufacturers. The aim of event is to bring the entire Metal AM ecosystem on one platform including Users, Software Providers, Hardware and Material Manufacturers, Research and Standards to advance the utilization of this technology.

We look forward to serving the Additive Manufacturing Industry better and further catalyzing the adoption of this technology in 2022. Stay tuned for more existing stuff coming up !

Aditya Chandavarkar
Co-Founder - AM Chronicle

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AM Chronicle is the Leading 3D Printing Voice of the Region focused on India, APAC, Middleeast and Africa working with the industry to advance adoption of Additive Manufacturing.

Our service offering consists of an online knowledge sharing portal, Quarterly Magazine, weekly newsletter and social media activation.

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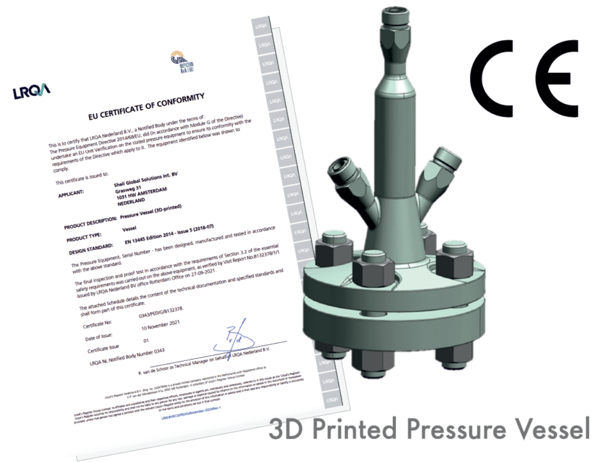
Shell obtains CE Certification for a 3D Printed Pressure Vessel

Aditya Chandavarkar

Shell and LRQA (formerly Lloyd's Register) have certified a 3D printed pressure vessel in accordance with the European Pressure Equipment Directive (PED)

Shell is the first company in Europe to have obtained CE certification from a third-party authority for a part 3D printed in-house.

Shell and LRQA (formerly Lloyd's Register) have certified a 3D printed pressure vessel in accordance with the European Pressure Equipment Directive (PED). This is the culmination of a 4-year collaboration to demonstrate the application of 3D printing in the energy industry. Shell is the first company in Europe to have obtained CE certification from a third-party authority for a part 3D printed in-house. LRQA, acting as a Notified Body, categorized the printed vessel in PED Category III.



3D Printed Pressure Vessel

"This represents a significant milestone, not only for the additive manufacturing industry but also for the pressure equipment community. This is the first CE Marked pressure vessel approved by an independent Notified Body" explained David Hardacre, Lead Specialist, LRQA. "The journey taken together by Shell and LRQA has been technically challenging but immensely rewarding. We have now established a path for anyone to certify additively manufactured pressure equipment under the PED."

This represents a significant milestone, not only for the additive manufacturing industry but also for the pressure equipment community.

The vessel was manufactured through Powder Bed Fusion at the Energy Transition Campus in Amsterdam and is designed for pressures up to 220 bar. This certification is an important milestone for the energy industry because there are, to date, no legislation or global standards specifically for 3D printed pressure retaining parts. This lack in regulations means that the use of 3D printed pressure equipment is generally not permitted at industrial assets around the globe. Shell printed this pressure vessel to gather research data that help improve the sector's trust in additive manufacturing as a technical solution to source spare parts "just in time" instead of stocking the spare parts for years.

Shell runs multiple demo projects with relevant technical experts to gain knowledge in various applications of 3D printing, ranging from spare part management to rapid prototyping and testing novel designs. The work in qualifying the pressure vessel provides valuable data points and insights in support of discussions with standards bodies going forward to scale up the use of additive manufacturing for pressure equipment.

Aditya Chandavarkar, Managing Editor, AM Chronicle got in touch with Angeline Goh, 3D Printing Technology Lead at Shell to get deeper insights about this significant milestone of certifying this 3D printed pressure vessel, not only for the additive manufacturing industry but also for the pressure equipment community.

What were the challenges which were overcome to achieve this certification?

Angeline Goh: Three main challenges were overcome over the course of the research project

1. **Getting the primary material approved for pressure purposes**

Unlike material bought in batches, tested upfront, with 3D printing, the part is created as the material is printed. Therefore, the formed material must be certified after the pressure vessel is already produced. To approve the primary material, the team printed test specimens in parallel to printing the pressure vessel and used the test specimens to test and approve material properties. The material was then formally approved by the certified for pressure purposes through the Particular Material Appraisal (PMA) process which is used for non-pre-approved materials.

2. Defining acceptance criteria for defects:

Most pressure vessels must undergo Non-Destructive Testing (NDT) to detect the defects in the material/welds. Although 3D Printing could be compared to welding, the technology has its own unique defects. Therefore, using the same acceptance criteria was not considered appropriate by the certifier. The lack of acceptance criteria for defects limited the certifier in judging if the vessel could be approved. Therefore, the team 3D modelled defects and analysed their effects on the vessels performances. This helped define what are the maximum acceptable defects. In a second step, they printed specimens with defects to confirm the results of the modelling works on the test bench. The sector is still lacking general acceptance criteria for defects in 3D-printed pressure vessels. This research project defined criteria for this very piece and provided valuable research data. It took a lot of R&D time and effort form Shell and LRQA to be confident with the final product. Still, more data must be collected and shared by part producers for standards setting bodies to define general acceptance criteria for defects in 3D-printed pressure vessels which can be adopted by certifiers in Europe and globally.

3. Defining inspection protocols to catch any defects

Compared to traditional manufacturing techniques, 3D printing has its own unique flaws. Some types of defects in 3D Printing have never been seen. Therefore, some research needed to be done to see what NDT should be used to find these defects. Also with 3D Printing unique shapes can be made which make it more challenging to detect defects in hard to reach places. The research team used computed tomography scanning, dye penetrant testing and other non-destructive techniques to find defects in printed parts. The team also defined protocols to spot defects in parts of the vessel hard to reach. They printed a dummy vessel with deliberately added defects to test if they could be found using various NDT techniques.

How does this milestone or development impact the future adoption of 3D printed pressure retaining parts in the Energy Industry?

Angeline Goh: The work in qualifying the pressure vessel provides valuable data points and insights in support of discussions with standards bodies going forward to scale up the use of additive manufacturing for pressure equipment. Close collaboration with certifiers in the R&D project can help speed-up standard setting processes as they often are involved parties. For example, in the European Union, we believe that the data collected in the project can support the effort of defining standards for 3D-printed pressure vessels under the EN 13445 – Unfired Pressure Vessels standard. But much more data is required to ensure robust standards are defined that help improve the economics of 3D printing for pressure vessels in our industry. We hope other companies, research institutes and companies who have invested in similar research also see the value of sharing their learnings with standard setting bodies. This data is required to create the confidence for European regulators to set standards and later on for other standards setting bodies in the world to be willing to take up these standards.

Shell will continue to be a leader in the research and development of additive manufacturing.

“Shell will continue to be a leader in the research and development of additive manufacturing. We collaborate with multiple partners globally to grow our own capabilities and the scope application of 3D printing in the energy sector. We now have the knowledge to also help our partners certify their printed parts for commercialization” concluded Angeline

ABOUT THE AUTHOR

Aditya Chandavarkar

Co-founder - AM Chronicle

Aditya Chandavarkar is a established entrepreneur with business interests in manufacturing, innovative technology, training consulting. He is closely associated with cutting edge application industries for inkjet, 3D Printing (Additive Manufacturing) and Packaging.

Long-Term Mechanical Performance for 3D Printed Resins

Aditya Chandavarkar

3D Systems working on enabling Production Applications by improving long-term mechanical performance of 3D Printed Resins

3D Systems working on enabling Production Applications by improving long-term mechanical performance of 3D Printed Resins

The value of 3D printing within manufacturing is undisputed. It enables faster development cycles for a shorter time-to-market, reduced product costs and lead-times, greater design flexibility, and countless opportunities to advance final parts and processes. However, 3D printing has spent the majority of its history building its reputation as a prototyping technology – mainly due to the inherent limitations of photopolymer resin technologies. Now, thanks to new developments in photopolymer materials science, its role is expanding with advanced chemistries that deliver long-term mechanical performance to open the door to a host of production capable applications.

In particular, two resin-based additive manufacturing (AM) technologies are evolving: stereolithography (SLA) and projector-based imaging technologies such as 3D Systems' Figure 4 platform. Both SLA and Figure 4 use ultraviolet (UV) light to cure sequential layers of photoreactive (photopolymer) resin, which is a material type that polymerizes and hardens when exposed to certain wavelengths of light. Where SLA uses a UV laser to draw each layer point-by-point, Figure 4 uses a digital light source to project images layer-by-layer. For this reason, along with differences in platform size, SLA has long been considered the champion of high accuracy and large format printing, whereas Figure 4 is generally favored for scalable, higher volume printing.

The Challenges of Photopolymer Resins

The photopolymers materials used by these technologies are thermoset plastics, and are often described with reference to their closest engineering thermoplastics equivalent, such as polypropylene (PP), acrylonitrile butadiene styrene (ABS), and polycarbonate (PC). These thermoplastics polymers are used frequently in machined, cast, and injection-molded parts, which is why 3D printing photopolymers are generally formulated to replicate their properties. Compared to more conventional polymers, photopolymers provide a versatile, cost-effective path to a wide range of applications from prototypes and low-volume jigs and fixtures to investment casting patterns.

The challenge of using 3D printing photopolymers for long-term applications hinges on how photopolymer parts are created. Because photopolymer resins are cured with exposure to UV light, exposure to additional UV light – namely, sunlight – has historically been problematic, causing issues such as discoloration and/or loss of mechanical properties quickly over time. Although other 3D printing technologies avoid these problems by using different methodologies and material chemistries, the accuracy advantages of Figure 4 and SLA have kept 3D Systems' chemists determined to find a breakthrough. Their efforts have been rewarded, and they have revolutionized photopolymer material capabilities to open the door to true production-ready polymers for additive manufacturing.

Developing AM Materials for Long-Term Use

Evaluating these new materials has taken time and thorough measurement. To evaluate outdoor stability, for example, 3D Systems measured natural outdoor weathering over months and years, as well as performed industry-standardized accelerated weathering in accordance with multiple ASTM and ISO standards. This allowed the company to generate both natural and accelerated aging curves to develop an acceleration factor that it could apply to new chemistries and routinely validate through comparison to natural weathering.

Figure 4® TOUGH-BLK 20 was the first photopolymer introduced by 3D Systems to offer long-term mechanical and color stability measured beyond 18 months' outdoor exposure. It was formulated with the company's patented UV-stability technology and has since been joined by several other production-ready AM materials. These materials demonstrate the ability to retain mechanical properties such as tensile strength and modulus, elongation at break, and notched impact strength, which is critical to assessing their suitability for any given application.

Making Informed Decisions About Material Capability

To support the need of product designers and manufacturers for thorough information, all of 3D Systems' production-grade materials have technical datasheets that provide a consistent display of properties, including information on long-term environmental stability. This documentation also includes information about the material's chemical resistance to industrial detergents and automotive fluids, biocompatibility and mechanical properties after sterilization, thermal resistance, and isotropic properties as relevant. 3D Systems makes this information easy to find so materials can be properly evaluated for any given application.

Knowing that a product will retain its color and mechanical performance for years is important to any manufacturer, and resin-based AM materials can now provide these assurances. Longer-lasting parts through these material advancements also mean a better shelf life and fewer warranty complaints, while the higher production speed and high accuracy of these technologies opens the door to lower manufacturing costs and a host of applications once dominated by plastic injection molding.

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Aditya Chandavarkar is a established entrepreneur with business interests in manufacturing, innovative technology, training consulting. He is closely associated with cutting edge application industries for inkjet, 3D Printing (Additive Manufacturing) and Packaging.

The “door opener” for 3D printing in automotive serial production

Fraunhofer ITAP

Fraunhofer IAPT has carried out a redesign project using the example of a sports car door hinge to identify, step by step, the factors that influence the component´s cost.

With approximately 50 percent lower cost and 35 percent weight savings compared to the equivalent milled part, a redesign of the arm of a door hinge for a high-profile sports car shows that innovation with additive manufacturing is economically feasible and application of 3D printing in automobiles. This is made possible thanks to 3D printing-centred design methods developed by specialists at Fraunhofer IAPT.

3D Printing in Automobile Engineering

The advantages of additive manufacturing (AM) best come in play when components are designed from the ground up specifically for this process. This fact is well-known. But how this aspect, combined with other optimization measures, can positively influence both the technical properties and the costs of the finished component, may come as a surprise to even some experts.

Now, Fraunhofer IAPT has carried out a redesign project using the example of a sports car door hinge to identify, step by step, the factors that influence the component´s cost.

Aided by a special software tool which in the meantime is commercially available at 3D Spark (a successful spin-off of Fraunhofer IAPT), the Fraunhofer engineers first identified a suitable component.

At a very early stage of the design, the experts then determined the cost-optimal orientation of the component in the 3D printing process. Using the optimized orientation, it was possible, for example, to minimize the number of support structures required while maximizing the number of components that could fit on a build platform. The thus identified component orientation leads to cost savings of 15 percent compared to an additive manufacturing process without such optimization.

In the next step, the structure of the hinge arm was optimized in a targeted manner, using one of the benefits of additive manufacturing in that it enables completely new component geometries. This gave the component a basic shape that only contained material where the simulated force flow required it. In total, this reduced the weight of the door hinge arm by 35%. And because of the reduced material requirements and the shorter print time, the costs compared to 3D printing without structural optimization dropped by another 20%.

Any support structure that does not have to be removed saves time and thus avoids part of the significant costs incurred in the highly manual post-processing phase. Reducing the number of support structures in the design also has a positive effect on production time and material requirements, which cuts costs again by 10%. Skilful selection of the optimum metal powder material from the increasingly broad portfolio of 3D printable materials makes it possible to lower costs by another 10%.

Adjusting the 3D printing in automobile process parameters provides additional ways to reduce costs. For example, higher layer thickness during printing, optimization of process parameters, and deformation of the laser beam profile significantly reduce build time. Even though this results in a slight loss of parts quality, (though still superior to that of cast parts), it enables printing costs to be reduced by a further 15%. Optimizing machine utilization by nesting and, if necessary, stacking in the build area, leads to further cost savings of 10%.

Summary of the results of the IAPT study for 3D printing in automobiles: designing with additive manufacturing in mind and following a »Design to cost" approach throughout allowed the hinge arm to be manufactured at 80% less cost than a 3D printed part without the same optimizations. This overall percentage can be broken down as follows: Orientation and topology optimization as well as support optimization contribute 45%. Optimized material selection, speed parameters and workload maximization in the AM process reduce costs by a further 35%.

Fraunhofer IAPT was able to show that a cost reduction of additive manufacturing by a factor of five is feasible. In parallel, brought an increase in the technical performance of the vehicle through lower weight and improved optics. The most important point, however, is that this enabled the cost of manufacturing a small series of hinge arms for a sports car door to be reduced by 50% compared to conventional milling. Additive manufacturing is therefore not only superior to milling in terms of technical performance, but also significantly more cost-effective.

ABOUT THE AUTHOR

Fraunhofer IAPT

The Fraunhofer IAPT is one of the leading institutions in the field of additive production with the core competencies AM design, AM processes and AM systems..

Intergration of Artificial Intelligence in Additive Manufacturing

Dr. Sachin Salunkhe

AI can assist additive manufacturing in a variety of ways, including design correlation, design improvement, defect reduction, and microstructural design.

Artificial intelligence (AI) refers to computer-connected devices that mimic human intelligence. There are currently additive manufacturing (AM) applications in the food, chemical, aerospace, automotive, and healthcare industries, among others. Perhaps the most significant advantage of 3D printing is that even complex objects can be created based on the customer's specifications. It is better suited for small-scale production in the current state of affairs. The stages of additive manufacturing are 3D model preparation, component prototyping, and component production. The goal of the prefabrication stage is to determine whether it is technically possible and feasible to print a given 3D model. When 3D printing with artificial intelligence is used, it is also referred to as smart manufacturing. As a result of smart manufacturing, productivity would rise. The global 3D printing market is expected to reach $6 billion by 2022, with the most growth opportunities for businesses in the home improvement and life sciences industries. Although the additive manufacturing process has made significant advances in recent years, there are still a number of challenges to overcome before it is widely adopted by the industry. To achieve a reasonable level of print accuracy in additive manufacturing, for example, numerous and complex variables must be monitored and controlled throughout the process. Experimenting with different lattice positions or designing appropriate support structures is not a long-term or time-efficient way of determining the best configuration. Machine learning is currently being used to solve this problem in the pre-fabrication stage, through generative design and testing, to increase printing efficiency and cost savings while also improving print quality. Artificial intelligence is currently being used in 3D printing and additive manufacturing to develop intelligent service-oriented production processes for the industrial sector. Because of the ever-expanding data repository, it offers a diverse set of algorithmic, theoretical, and methodological options that have the potential to improve current manufacturing standards. Artificial neural networks, machine learning, adaptive neuro-fuzzy inference systems, evolutionary algorithms, and so on are examples.

Artificial Neural Network Algorithm

The 3D printing process includes model design, material selection, printing, and part evaluation and characterization. This section combines the use of ANN for 3D printing process monitoring, design, and correlation between process parameters and final component characteristics.

Process Surveillance

Process monitoring via various sensors provides direct information regarding quality supervision and control during the printing process. Three distinct types of data sources can be distinguished: (a) one-dimensional data sources such as spectra; (b) two-dimensional data sources such as graphs and images; and (c) three-dimensional data sources such as morphologies. While one-dimensional data is faster to process, it contains less information than two- and three-dimensional data.
2.1.2 Designing

Design is a critical area of research that necessitates a thorough understanding of the capabilities and limitations of 3D printing technologies. It is the initial and most critical step in the workflow process. A well-designed CAD model not only ensures printability but also minimizes the amount of support material required. The design process, on the other hand, is typically iterative and time-consuming. A data-driven approach to 3D printing design would aid designers in their work.

Machine Learning (ML)

As shown in Figure 1, it is beneficial to break down the applications into the pre-processing, process, and post-process for the application of AI in AM, given the complexity of the process. Design space can use ML during the pre-processing stage (geometrical design, topology optimization, raw materials design, and powder properties). Predicting material properties is now possible thanks to advances in machine learning (ML) in raw material design. Designing new novel materials is also made easier with it, and it can take advantage of AM's unique manufacturing capabilities to bring designs to life that otherwise would not be possible. Even though machine learning has been applied to design space (geometric design and topology optimization), it has not been applied to powder properties, which are the least explored areas. The process itself categorizes ML applications for experimentation in-process monitoring and optimization, and simulation work in the same area. One of the areas that have seen much research is experimental process monitoring and optimization.

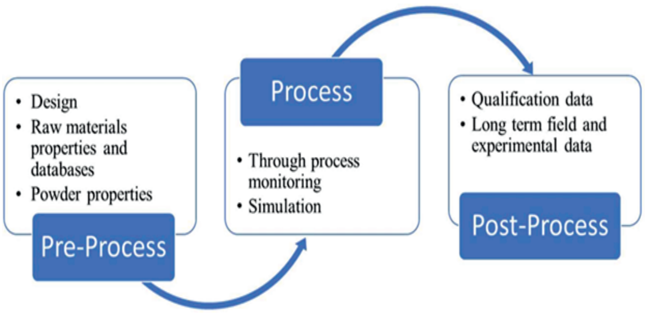

Figure 1. AM powder bed manufacturing process

Adaptive Neuro-Fuzzy Inference System (ANFIS)

One of the soft computing techniques, adaptive neuro-fuzzy inference system (ANFIS), plays a significant role in accurately modeling input-output matrix relationships. Because of the nonlinearity of the 3D printed PLA process, ANFIS is an excellent tool for predicting weight gain based on input variables. ANFIS has also been utilized in the modeling and evaluation of metallic slurry erosion.

Evolutionary Algorithms (EA)

EAs are widely used in the AM domain to solve complex multiobjective design, process planning, and machine setup problems. Future applications are expected to benefit from increased computational power, allowing for more sophisticated and precise new algorithms. The increased exploration of EAs in the AM domain is sparked by the complexity created by combining additive and subtractive technologies. Finally, machine learning-based closed-loop process control and optimization could be critical in the drive to industrialize additive manufacturing. If additive manufacturing is going to be widely adopted in manufacturing, it must produce high-quality, repeatable parts. Engineering analysis (EA) tools are critical in the optimization processes required to achieve this goal, with collaboration between academics and industry serving as the final link in the chain.

Summary:

Artificial intelligence (AI) implementations have a lot of potential for additive manufacturing. Despite some progress, AI applications in streamlining additive manufacturing to be integrated into other manufacturing techniques or become a commodity for users are still a long way off. AI can assist additive manufacturing in a variety of ways, including design correlation, design improvement, defect reduction, and microstructural design. The main stumbling block right now is the availability and reliability of data needed for training. The available experimental data has a wide range and is not always open to the public, thanks to the research community or AM manufacturers; the available experimental data has a wide range and is not always open to the public, thanks to the research community or AM manufacturers. The integrity of the data is critical in the development of AM-specific AI algorithms. Experiments have been carried out or are currently being carried out with a wide range of observations and outcomes. As a result, establishing a data storage facility is critical for the manufacturing industry. To work properly for AI algorithms, the data generation condition must be disclosed along with the data. To recreate the data, information such as process parameters, exact details of raw materials such as powder or feedstock, composition, raw material properties such as flowability of powder, particle size, and so on, as well as the type of machine, should be disclosed and shared. Furthermore, the difficulties of the process, such as high temperatures or high speeds, make it difficult to monitor and measure. The majority of currently available technologies rely on thermal or optical imaging of the material's surface, and depth information is rarely available. Companies and academics must collaborate to develop tools that track a wide range of process conditions and parameters accurately and quickly. It's still not possible to detect defects, create a 3D image of the build while it's being built, or keep track of the microstructure and grain orientations, for example. These areas would undoubtedly present some challenges that a motivated and willing community could overcome.

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Dr. Sachin Salunkhe is an Associate Professor in the Mechanical Engineering Department at Vel Tech University Chennai, India.

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Lasers for Additive Manufacturing

Anant Deshpande

In this article let us examine, what role the Laser plays in the Additive manufacturing process and what properties and characteristics of a laser made it an ideal tool to be used for this application.

Laser as we all know was invented in 1960 with Ruby Laser and has evolved over the years. Laser is an acronym for Light Amplification by Stimulated Emission of Radiation. Lasers are naturally coherent and monochromatic sources ultraviolet (UV), to visible (VIS), to the infrared (IR). Depending on the type of laser and wavelength desired, the laser medium could be solid, liquid or gaseous.

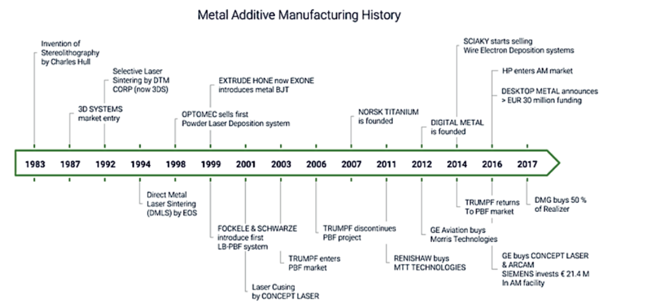
Lasers have a significant influence in fields as diverse as telecommunications, instrumentation, medicine, quantum computing and entertainment. In manufacturing their applications including cutting, drilling, welding, cladding, cleaning, marking, heat-treatment and many others. They are being used more and more with growing range of scales; increasing powers enabling larger scale work and higher beam qualities and shorter pulse widths enabling smaller scale work, in short laser are used for macro to micromachining.

The growth of laser technology in last decade or so has been very rapid and one of the segments where this technology is playing a key role is the Additive manufacturing, which is set to grow by leaps and bound in coming decade.

In this article let us examine, what role the Laser plays in the Additive manufacturing process and what properties and characteristics of a laser made it an ideal tool to be used for this application.

Additive manufacturing (also called 3D printing) is a process where digital designs from computer aided design (CAD) software are used to build a component, layer by layer from the respective material. Additively manufactured components are typically lighter, more durable and more efficient than traditional casting and forged parts as they can be made as one piece, requiring less welds, joints and assembly. Depending on the technology the material could be polymer, metal, ceramics or composites

Looking into the history of the Laser Additive processes, Additive manufacturing first emerged in 1987 with stereolithography (SL) from 3D Systems, a process that solidifies thin layer of ultraviolet light sensitive liquid polymer using Laser and then various companies ventured into the different material and optimization of the process for better quality of part and speed accuracy. Find below a chart of the various additive manufacturing technologies and how they have emerged over the years



Metal Additive Manufacturing History Source: AMPOWER Report

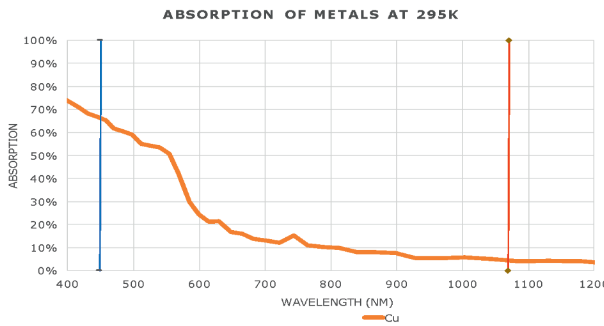
One can see that SLA process has been in existence and for these lasers are being used for a long time. The early laser used for the polymers which were sensitive to the blue wavelength. However with the process of Metal Additive Manufacturing, the laser YAG one was the first one to be used for the additive manufacturing process by POM. EOS was the first company to introduce the UR laser for the additive process and the process was knows as Powder bed fusion.

As per ASTM, there are 7 additive manufacturing process are listed such as Binder Jetting, Direct energy deposition, Material extrusion, Material Jetting, Powder Bed Fusion, Sheet lamination and Vat Polymerization. Out of these processes, laser technology is used in Direct energy deposition, Powder bed fusion and Vat Polymerization.

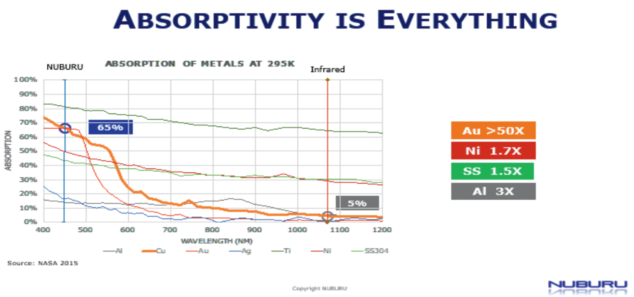
The commercial Additive Manufacturing systems currently use lasers with power ranging from watts to multiple KW and higher. The wavelengths range varies from UV (354.7 nm) to the infrared (10.6 um). The criteria for choosing the laser for AM process depends on the material absorption, type of material (metal/nonmetal), processing speed and part size geometry. This will define what wavelength and type of laser to be used, what power level and beam quality required for the laser.

IR fiber laser dominates the AM market as it works for bulk of the AM Materials. Also, the market is mainly focused on the aerospace, medical and automotive which typically uses Titanium, SS, CoCr as the material for AM process and for other too IR laser works best giving the cost performance ratio. However, with reflective materials such as copper, gold coming into foray, the process window becomes tight for operating the laser.

Have a look into the absorption curve of different material and laser wavelength below .



Source: NASA 2015



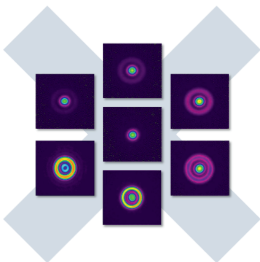
Source: NASA 2015, NUBURU

As seen from above chart that the highly reflective material such as Copper, Silver and Gold absorbs better at shorter wavelength. If one compares, the absorption of green laser (532nm) is better than IR laser and the absorption of UV (405 nm) is better than Green Laser for material say copper. The limiting factor today for use of UV and Green laser is the power level of these lasers, beam quality and cost. As we know that for AM application a laser beam quality M2:< 1.1, single mode are prime requirements in order to achieve the smaller spot diameter for fine features. Laser manufacturers such as Trumpf are focusing more on the green laser for the different process for reflective materials including AM, while for the UV, Nuburu from USA are pushing their lasers for Additive Manufacturing and other applications. In coming future with the improvement in power level, beam quality and cost coming down, one will see green and UV Lasers will be used for the AM process specially for reflective material.

For non-metal, UV lasers are typically used for the SLA process and the wavelength depends on the polymer absorption spectrum.

Additive Manufacturing machines for powder bed fusion use lasers and scanners for producing the parts and limitation is the size of the part that can be printed in the build envelope. However, companies like GE and some others are eyeing to make machines with large build volume machine size up to 1.1x 1.1m x 0.3m. AM systems with multiple lasers are quickly becoming the bench mark to produce multiple part at faster turnaround rate. Such machines are currently more expensive, however, the demand for such machines is going to increase in coming years as more companies would like to reduce production time and there by cost per part.

DED typically uses 500W to multi-KW fiber laser/Diode laser for making 3D parts with 5 axis CNC/ Robot within a closed atmosphere, thereby giving advantage to print large parts more than a meter cube. The build speed is faster in DED over PBF as PBF typically uses a spot size of 50 to 100 microns when building parts, however, spot size on laser-based DED systems can range from about 0.5 to 3.0 mm., large spot size means a higher deposition rate, which means a faster build. DED can build parts faster using less material, but DED parts require extensive machining and finishing to meet tolerances compared to PBF.



In the AM process currently, the lasers used fall into the category of single mode beam quality. These lasers are required when one wants to make a fine feature part, However, in order to make large bulk parts which do not require fine features, having a small beam becomes a disadvantage as it takes time for a smaller beam to scan the larger surface area. In order to overcome this, now laser technology with programmable beam fiber laser offered by companies such as nLIGHT AFX 1000 is available, wherein depending on the requirement the laser can change beam profile from single mode to ring mode (3x spot magnification with ring intensity profiles) to provide faster building of parts.

In a nutshell, laser technology which has evolved over the years from being just a R&D tool to fiber laser which has been the workhorse for industry. The fiber laser with its ease of use, compact size, efficient has mainly captured the Laser market for Metal AM. As the AM market is set to grow further and with new lasers such as changing programmable fiber laser, green and UV laser, we may see different laser technologies being used for different AM applications depending on the requirement

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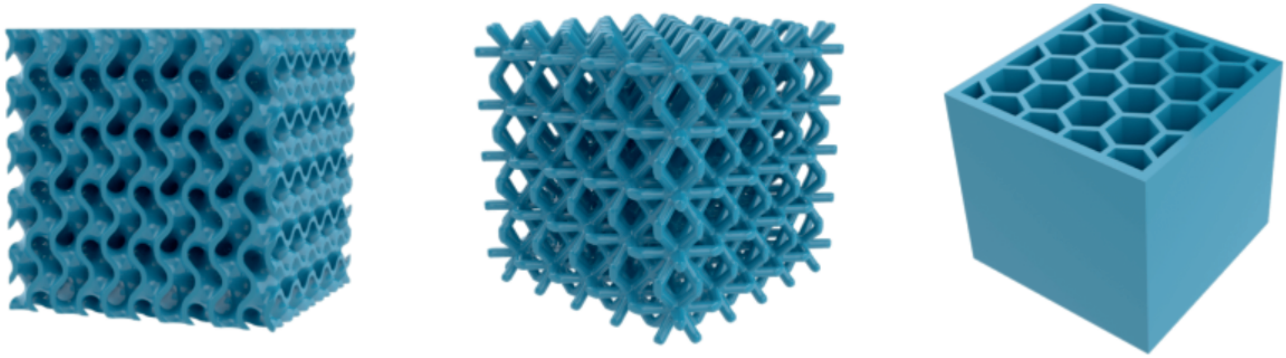
Mr. Anant Deshpande is Technical Director of Trokut Solutions Pvt Ltd. and holds a M. Tech degree in Laser Technology and application from DAVV Indore with project at RRCAT Indore in Industrial Co2 Laser Division under Dr. A .K.Nath and Dr. Manoj Kumar and MBA. He is on advisory board of Industrial Laser Solutions for India and has published various articles on industrial Laser market.

Additive Manufacturing: Designing for Performance

Priyanka Nadig

It is paramount for design engineers to be exposed to both the capabilities and the process limitations while designing for AM, or Design for Additive Manufacturing (DfAM)



The growth of additive manufacturing (AM) has been remarkable in the last few decades. This is due to advances in market-driven technologies, increased personalization, new and improved materials, customization, shorter product development cycles, and emergence of new business models. New AM techniques have been implemented in industries such as aerospace, biomedical, transportation, etc. with processes such as selective laser melting (SLM), fused deposition modelling (FDM), binder jetting, selective laser sintering (SLS), and other advanced processes. Also, thanks to increased precision in AM machines, a variety of materials can be manufactured with enhanced mechanical properties, with designs that are impossible to manufacture with conventional manufacturing techniques. AM thus aims to integrate the advantages of engineering design and prototypes into a final functional product.

Vast opportunities have begun to open up with AM given its benefits of freedom of design, topology optimization, opportunity to experiment with different materials or combination of materials, colors, strength, and surface finish for finished products. Despite several advantages offered by AM, manufacturing constraints such as small holes, thin walls, overhang structures, and enclosed voids prevent removal of unmelted material or support structure. Besides, anisotropy and thermal distortion, residual stress, and internal cracks in super alloys are inherent process limitations which could compromise the final product outcome. Hence, it is paramount for design engineers to be exposed to both the capabilities and the process limitations while designing for AM, or Design for Additive Manufacturing (DfAM).

Freedom of design offers several opportunities to modify the original design or, in most cases, arrive at a new design and address the challenges in conventional manufacturing. DfAM approaches such as introduction of cellular or lattice structures, consolidation, part complexity, design for performance enhancement, light weight, etc. are often used to address these challenges. One of the approaches that has gained significant importance is cellular or lattice structures, due to its ability to selectively dispense material in specific regions of the part to improve strength and mechanical properties. Cellular structures take inspiration from nature such as structures of cork, corals, sponge, bone, honeycomb etc., which are often replicated to achieve desired strength. These designs, coupled with a suitable material, allow high strength-to-weight ratios, high heat transfer, energy absorption, and thermal insulation in the manufactured part which is beneficial for industries such as aerospace and health care where lower part weight is a fundamental requirement.

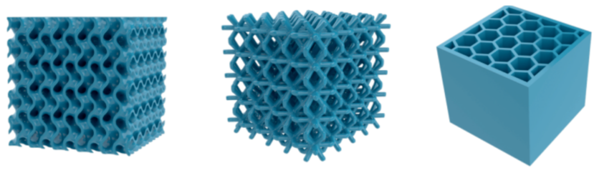


Fig. 1 (L to R): Types of lattice structures—surface based, strut based, planar based
Image Source: gen3d.com

Many engineering components come with multiple parts that are independently designed and assembled to create a functional part. However, designing parts individually and further assembling with appropriate fasteners and welding, followed by NDT tests to eliminate losses, damage etc., are extremely laborious, increase lead time, and pose challenges in maintaining the spares for each part in case of failure. Additive manufacturing allows the designers to consolidate all the parts that are feasible to manufacture with AM in the design stage itself. DfAM accounts for part thickness, orientation, critical regions of failure, desired surface finish, and creates a model that is not only convenient to manufacture but also simplifies processes in supply chain and quality management systems.

Fig. 2 refers to a rectangular waveguide, a conducting cylinder of rectangular cross section used to guide the propagation of waves. The conventionally manufactured waveguide is manufactured in three segments followed by joining them either by welding or by fastening. If we choose to use fasteners, 103 parts are required for a foolproof assembly. However, there are chances of losses due to poor assembly or wear and tear. Additive manufacturing gives the freedom to consolidate 103 parts and bring the entire assembly count to one, thus eliminating the need for any test for losses or strength, besides improving the part life and efficiency.

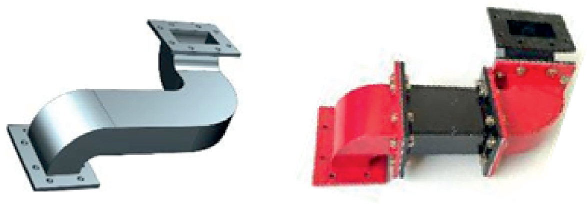


Fig 2: Rectangular Wave Guide - 103 Parts reduced to 1
Image Source: Unique Broadband System

Heat sinks find application in diverse engineering domains such as transportation, aerospace, appliances etc., with a functional objective to effectively transfer heat—conductive material and design being determinants of its efficacy. However, despite selecting an appropriate conducting material, due to design constraints, conventional manufacturing systems restrict the freedom to increase the surface area of heat transfer. Due to the design freedom offered by AM, additively manufactured heat sinks enjoy the benefit of both highly conducting materials and also increased surface area of heat transfer, thus improving the efficiency and performance (Fig. 3).

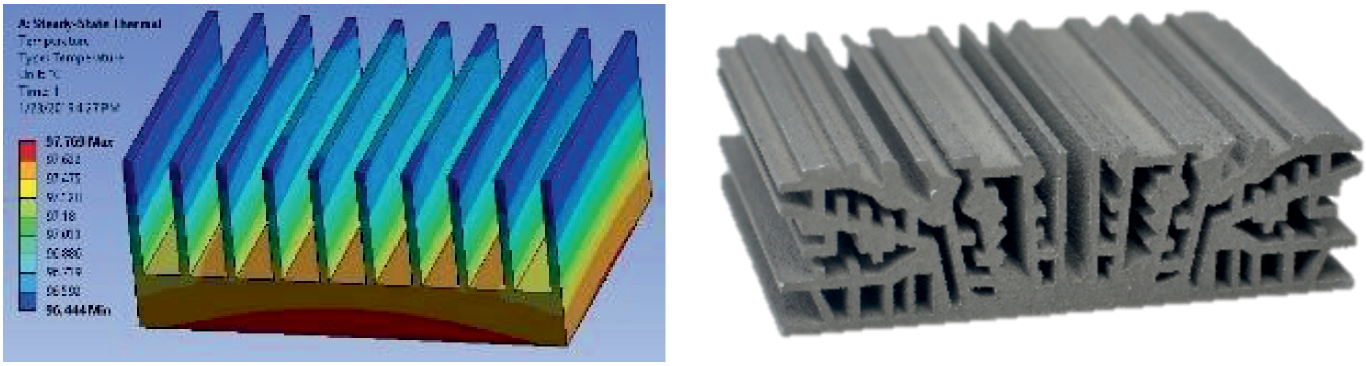


Fig 3: Modified heat sink using principles of DfAM

Additive manufacturing is rapidly growing into a revolutionary technology that has the ability to transform design methodologies. Although it is not feasible to manufacture every part with AM, technically complex parts or high-mix, low-volume parts are often best candidates for AM. DfAM integrates AM process parameters and materials and then designs parts to meet functional needs with a focus on creating value-added parts and providing industrial solutions. DfAM's impact is not just limited to the part, but extends to the entire product ecosystem.

ABOUT THE AUTHOR

Priyanka Nadig

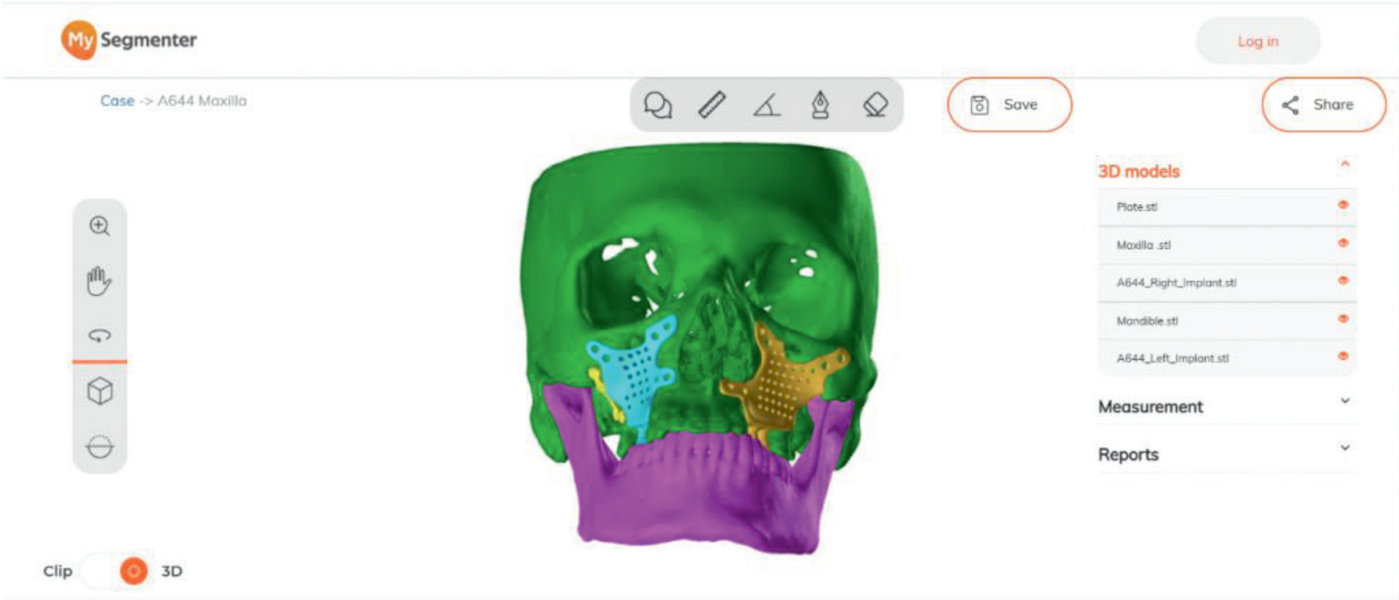
Senior Technical Lead, Cyient Ltd

Priyanka Nadig works with Cyient Ltd. to establish process-material-property relationships using the AM processes to reduce manufacturing cost, weight, lead time, and enhance performance of parts.

The Use of Digital Maxillary Implants in facial rehabilitation

Jitendra Singh

In this case study, the team from Jajal Medical worked closely with a surgeon for pre-op planning and intraoperative support with 3d printed patient-specific implant.



The reconstruction of acquired maxillary bony defects after facial trauma is among the most challenging areas in oral and maxillofacial reconstruction. The main goal of these reconstructive efforts is to maintain or improve the patient's quality of life by trying to restore the lost form and function. Reconstructing the maxillary deformities can be largely benefited from virtual pre-operative planning procedure.

One such medical 3D printing solution provider Jajal Medical provides customized Oral maxillofacial implants. The patient-specific designs and 3D models can be used to create prototypes, duplicate broken parts, and even entire organs.

Challenge

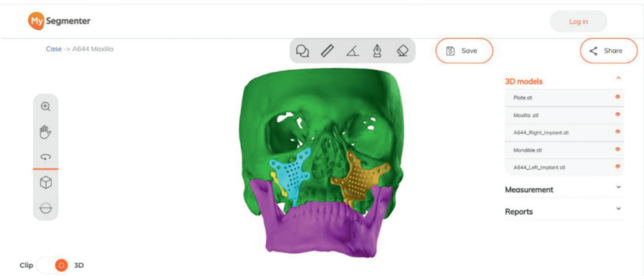
Maxilla is the most important bony support of the midface skeleton and is critical for both aesthetics and function. Thus, maxillary defects, such as those resulting from gunshot injuries, can cause severe functional deformities. Treatment in these patients is very challenging. Moreover, post-treatment infections are a serious problem in such cases. Thus, step-by-step surgery is essential to obtain a better result in these patients.

One such case was treated by Dr. Vivek Saxena, New Delhi considering the 3D-printed titanium implant with pre-mounted dental implant fixtures.

The team of Jajal Medical worked closely with the surgeon for pre-op planning and intraoperative support with 3d printed patient-specific implants.

Solution

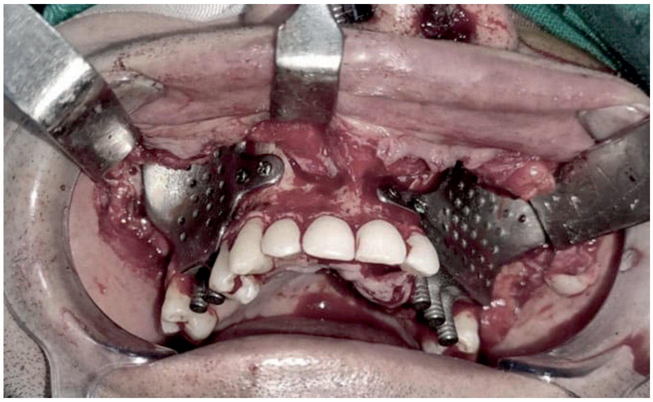
Detailed preop planning played a pivotal role in the outcome of the surgery. Virtual sessions through a



digital point of care 3D printing platform Mysegmenter.com helped Dr. Vivek understand the perception and intended use. Once the requirements were clear the complete plan was proposed to the surgeon. He further decided to lay down the sub-periosteal (wire frame to strengthen the weak bone and add dental abutments) maxillary implants with thick and strong surface.

Outcome:

The implant was successfully inserted, and the discontinuous maxillary defect was rehabilitated with 3D-printed titanium implants on both sides.



Preplanning the surgical approach and use of the customised surgical guides and patient specific implant, helped in achieving accurate reconstruction, reduced intra-operative time and faster recovery of the patient.

ABOUT THE AUTHOR

Jitendra Singh

Director clinical operations – Jajal Medical

Vedanta, Revolutionizing the Metal & Mining Industry with 3D Printed spare parts from Markforged 3D Printers

Markforged

In this case study, Vedanta Limited, a leading Mining and metals company, showcases how they use 3D printed parts to overcome the supply chain gaps.

Vedanta and Markforged collaborate to revolutionize the metal and mining industry with 3D printed parts to overcome the supply chain gaps.

The collaboration will help to improve the supply chain response with help of composite 3D printed parts.

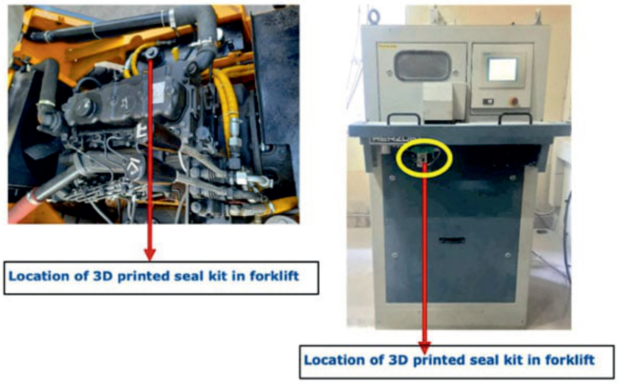
VEDANTA LIMITED

Vedanta Limited, a subsidiary of Vedanta Resources Limited, is one of the world's leading Oil & Gas and Metals company with significant operations in Oil & Gas, Zinc, Lead, Silver, Copper, Iron Ore, Steel, and Aluminium & Power across India, South Africa, Namibia, and Australia. For two decades, Vedanta has been contributing significantly to India's nation building. Governance and sustainable development are at the core of Vedanta's strategy, with a strong focus on health, safety, and environment. Vedanta has put in place a comprehensive framework dedicating itself to the highest ESG standards to emerge as leaders in this space. It is among the 24 Indian companies who are signatories to the 'Declaration of the Private Sector on Climate Change' and is committed to decarbonizing its operations by 2050 or sooner and has pledged $ 5 billion over the next ten years to accelerate the transition to net zero operations.

Vedanta Aluminium Business, a part of Vedanta Limited, is India's largest producer of Aluminium, producing almost half of India's aluminium or 1.96 million tonnes per annum (MTPA) in FY21. Vedanta is a leader in value-added aluminium products that find critical applications in core industries. With its world class Aluminium Smelters, Alumina Refinery and Power Plants in India, the company fulfills its mission of spurring emerging applications of aluminium as the 'Metal of the Future' for a greener tomorrow.

Supply Chain Challenges

Metal and mining operations are predominantly businesses located in remote environments away from traditional supply chains, requiring a broad array of inputs. Given the rigorous conditions in which the

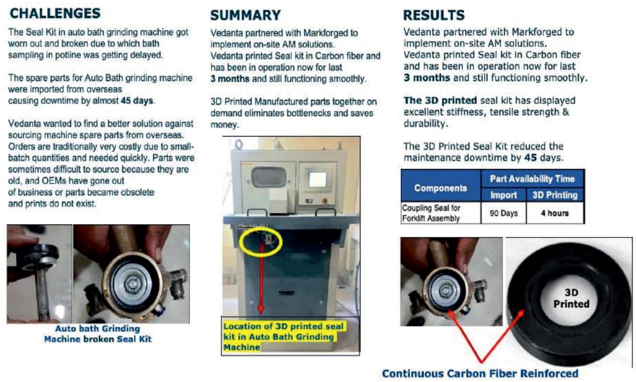


equipment is used, spare parts or replacement parts are needed at high frequency. This leads to metal and mining companies having large inventories for replacement parts and long lead times for spare parts with huge bearings in operational downtime and economic impact due to this situation. As a front-runner in technology innovations, Vedanta Limited was looking at radically redefining some of the persistent supply chain issues at its metal and mining sites with immediate effect to improve operational efficiency. Coupling seal used in the Forklift Assembly needed frequent replacement within 3 months due to the friction in the fluid coupling kit and a Seal Kit in the Auto Bath Grinding machine had to be replaced in a short time due to which the bath sampling in the potline was getting delayed. Both these parts for the forklift and the auto bath grinding machine were being imported and came with high cost considering the small-batch quantities ordered. The downtime in the case of Auto Bath grinding machine was critical with almost 45 days of lead time. Spare parts were difficult to source as the machinery being used was old with OEMs out of business and further most of the spare parts were obsolete with no supply chain for replacement.

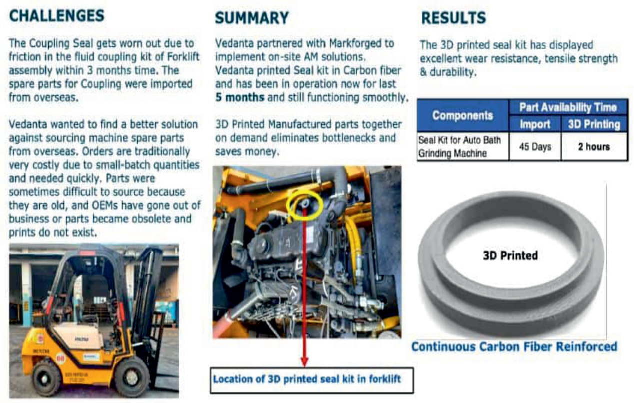
Bridging the SCM gap with 3D printing

In line with its ESG mission statement, 'Transforming for Good', Vedanta sought to implement a sustainable disruptive technology to address such nagging supply chain issues once for all. After in-depth analysis of the best suited alternative for imported spare parts, Markforged Additive Manufacturing Technology was identified as a suitable partner and was implemented on-site to support the spare part requirements.

Seal Kit of Auto Bath Grinding Machine



3D Printed Fluid Coupling Kit for Forklift



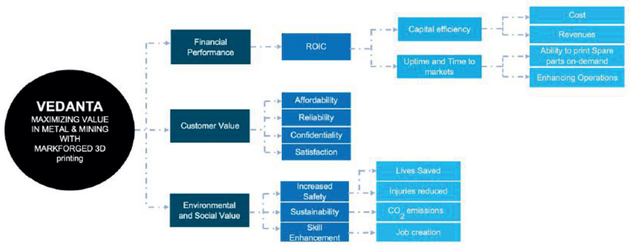
The Future – Ability to print Spare parts on-demand

With the transition to Markforged 3D printers in the overall production process, Vedanta can now focus on quick turnaround time, reduced cost and durability as 3-4 months of downtime has been bridged to a few hours, thereby ensuring a winning proposition.

Going forward this initiative is a huge step towards enabling timely and cost-effective mobilization for the Metal and Mining industry as it will make supply-chain of critical spares more seamless with 3D printed spare parts while significantly reducing the downtime of the machines.

On-ground owing to their superior quality, a true trademark of Markforged, the machines have been functioning for longer duration in a smooth manner. Operationally, this has been a boon for the Metal and Mining industry in India as it pitches the domestic manufacturers on par with international players who had a monopoly on the production of such critical spare parts at their own convenience.

India's key role in Additive Manufacturing has been redefined with such cases across various applications.



'In a dynamic world, where everything must work seamlessly, Markforged 3D printed Spare parts have been an excellent example of wear resistance, tensile strength and durability" shares Mr. Bibhudatta Mohanty, Head of Innovation Cell, Vedanta Limited. "This has not only reduced the downtime significantly from a few months to only a couple of hours but has also resulted in significant savings per annum. Time is precious and we are grateful to the innovations by Markforged that have made this possible."

ABOUT THE AUTHOR

Markforged

Markforged

Markforged is an American public additive manufacturing company that designs, develops, and manufactures The Digital Forge — an industrial platform of 3D printers, software and materials that enables manufacturers to print parts at the point-of-need.

Part 2: Dealing with Metal Additive Manufacturing selection related Dilemmas

Dr. Sastry Kandukuri

This article introduces you to the TR 70 -2019, Guidelines on the selection criteria for metal additive manufacturing processes which is a Technical Reference published by Singapore Standards council.

When an organization thinks about AM adoption they are often confronted with a lot of dilemmas related to choice between additive vs conventional manufacturing route, selection of AM materials and process alternatives, design suitability of AM processes etc.

Sometimes such a dilemma can be resolved by taking advice from machine makers or suppliers or otherwise by writing down a list of all the benefits and all the costs for each option. But this method could be tedious and often misleading due to lack of domain knowledge.

However, the best method to resolve the issue would be by finding out more information from a reliable source such as AM standard or best practice guideline. Through this series of AM standards we would like to introduce you to relevant standards to help you in gathering enough information to make an informed decision. Standards are the distilled wisdom of people with expertise in their subject matter they represent.

In this article, I would like to introduce you TR 70 -2019, Guidelines on the selection criteria for metal additive manufacturing processes which is a Technical Reference published by Singapore Standards council. I was an active member of the Technical Committee on Additive Manufacturing that developed this document. The Singapore Standards Council (SSC), the Ministry of Defence (MINDEF) and the Singapore Armed Forces (SAF) developed TR 70 with key stakeholders including the Defence Science and Technology Agency, Singapore University of Technology and Design, the National Additive Manufacturing Innovation Cluster (NAMIC), the additive manufacturing industry, and the Singapore Manufacturing Federation – Standards Development Organisation.

A Technical Reference (TR) is a pre-Singapore Standard that is used by the market before a full consensus is reached. It could be about making a product, managing a process, delivering a service or supplying materials etc. Users of the TR are invited to provide feedback on its technical content, clarity and ease of use.

Scope of TR 70 -2019 :

This is a document with a total of 41 pages. Among other things TR 70-2019 primarily provides guidelines for process selection between conventional manufacturing (CM) and additive manufacturing (AM) involving metals. It also helps to determine the suitability of AM as a manufacturing process on an existing design or new design. In addition, benefits and limitations of manufacturing processes and factors of process selection are illustrated to support the decision-making of the process

Major topics covered :

- Comparison between conventional and AM processes
- Advantages and disadvantages of conventional and AM processes
- General framework of process selection
- A selection procedure for material and AM process alternatives
- Comparison of manufacturing processes based on redesign purpose using AM
- Common metal materials for metal PBF-M
- Comparison of CNC machining, metal PBF-M and DED

Other interesting topics :

- Formulation of the selection decision support problem
- Relative importance through the ranking method
- Rating process alternatives with respect to attributes
- Recommended manufacturing process according to the number of parts
- Cost comparison according to the number of parts

Useful charts :

- A chart for part and process selections based on design complexity and production volume after design feasibility check
- A chart for process selection based on the relationships between manufacturing cost and design complexity

Highlights of main sections

Framework for manufacturing process selection:

Section 6 of TR 70 -2019 provides a general framework to guide the users to decide appropriate manufacturing processes when adopting AM processes.

This framework outlines design benefits of existing and new part design, manufacturing benefits as a viable solution to resolve constraints of CM and economic benefits. The process starts with the consideration of either an existing part design or the opportunity to design a new part or module.

General framework of process selection is illustrated in a flowchart to guide the users through a systematical sequence of various steps such as AM feasibility of design, material selection to rank process alternatives etc.

Design suitability for AM process:

Section 7 of TR 70 -2019 provides guidance to users in the form of questions to help them assess the AM possibility of the design rather than assessing the design in terms of specific manufacturability and economic benefits. A detailed flow chart with a procedure for design suitability check is provided.

Selection of AM material and process alternatives

Section 8 of TR 70 -2019 provides a process of material selection for AM through three steps. Users should identify design requirements of a part or definition of application of the part first. Then proceed with other steps. A detailed flow chart with selection procedure for material and AM process alternatives is included in this section.

AM process feasibility from the business perspective and AM process selection

Section 9 of TR 70 -2019 provides guidance on business analysis when adopting AM and the final selection of an appropriate AM process and complemented with a detailed flowchart. After the business analysis, users can select an appropriate AM process.

Relevance:

Target users of this TR are AM design engineers, manufacturing engineers, maintenance engineers, industry associations, research institutions and government agencies. However, this document is useful as a reference for AM based digital warehouse architects, AM roadmap developers, AM software developers etc.

Concluding remarks:

TR 70 will guide end users in the evaluation of business and technical feasibility and the selection of additive manufacturing processes to produce a part for its intended application. Through providing clear and comprehensive guidelines on matching suitable processes to specific parts and purposes, This would significantly shorten the time needed in additive manufacturing processes, enabling faster turnaround for the manufacturing of parts.

TR 70 -2019 provides a wealth of qualitative information related to topics discussed in this document that is very helpful for new AM adopters to expedite their learning curve. Even though this document only covered a few AM processes the methodology suggested may be useful for other AM processes that are not included here. It is a recommended document to refer to when relevant.

ABOUT THE AUTHOR

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Dr. Sastry Kandukuri is a passionate and experienced digital materials and manufacturing technology professional with Doctorate/Maters/Bachelor degrees in Metallurgy and Materials Engineering and Masters degree in Computer Science coupled with more than 20 years of diverse experience in Maritime, Oil & Gas and Manufacturing sectors.

Additive Manufacturing Qualification Standards Overview

Dr Satya Ganti

This article provides an useful overview on the various Additive Manufacturing Qualification Standards

To accelerate the widespread adoption of additive manufacturing (AM) technology, international standards organizations have started to tackle this issue. Towards this effort the following organizations have begun to release guidelines and standards surrounding qualification and process control:

- ASTM international formed the ASTM F42 Committee for Additive Manufacturing Technologies in 2009 in joint conjunction with ISO/TC 261. To date, nearly 40 standards have been published, and more than 70 standards are under development covering a wide range of topics such as general AM, feedstock materials, process, and equipment, finished AM parts and application-specific standards.

- AWS D20.1 standard on "Specification for fabrication of metal components using additive manufacturing" was released in 2019. This is the first standard that provided detailed qualification criteria and risk levels for different AM processes.

- DNVGL ST-203 on "Additive Manufacturing of metallic parts" was released in 2020. This provides standard requirements to follow for production of parts including process and part qualification.
- ASME PTB-13-2021 "Criteria for Pressure-Retaining Components Using Additive Manufacturing" has released a standard in 2021 on use of Additive Manufacturing for construction of metallic pressure retaining equipment using powder based additive manufacturing.

- The API 20S Standard for "Additively Manufactured Metallic Components for Use in the Petroleum and Natural Gas Industries" was released in 2021. API 20S standard addresses the fundamental question "is the additive manufacturer qualified to print parts"? The standard uses a tiered approach to process qualification (Additive Manufacturing Specification Levels) to identify different levels of criticality in part qualification.

All the standards AWS D20.1, API 20S, DNVGL ST-B203, and ASME PTB-13-2021 share similar definitions of risk and risk assessment needed to qualify an additively manufactured process and part. This helps in transitioning from one standard to another based on customer requirements with minimal effort on the part of the manufacturer while ensuring consistency and safety on the part of the customer.

Reference: Malkawi, Ameen, Ganti, Satya, Aleid, Zahra, Sharrofna, Hussain, Minhas, Naeem, and Nicholas Barta. "Considerations and challenges of qualifying a metal powder bed fusion 3D printing process." Paper presented at the Abu Dhabi International Petroleum Exhibition & Conference, Abu Dhabi, UAE, November 2021. doi: https://doi.org/10.2118/207628-MS

ABOUT THE AUTHOR

Dr. Satya Ganti

Technical leader, Baker Hughes

Dr. Satya Ganti is the technical leader for Baker Hughes additive manufacturing technology center located in Houston, TX

ASTM supports eight new Additive Manufacturing Research to Standards Projects

Aditya Chandavarkar

After a thorough review, eight high-impact ideas were approved by the ASTM executive section focused on research and innovation (F42.90.05) within the committee on additive manufacturing technologies (F42).

Global standards developer ASTM International announced it's third round of funding to support research that helps expedite standards in additive manufacturing (AM).

This investment which includes additional in-kind contributions will support the ASTM International Additive Manufacturing Center of Excellence (AM CoE) goal of aligning technical standardization with the rapidly evolving AM industry.

"We are thrilled to support these crucial and high-impact research projects in additive manufacturing that seek to accelerate standardization," said Dr. Mohsen Seifi, ASTM International's director of global additive manufacturing programs. "These eight projects will join the 14 existing projects that address the AM CoE's high-priority research areas for standardization, including design, data, modeling, feedstock, processes, post processing, testing, and qualification." Each of these projects will address one or more standardization gaps listed in the AMSC (Additive Manufacturing Standardization Collaborative) roadmap published by ANSI/America Makes.

This year, over 60 ideas for projects were submitted by ASTM International members for consideration. After a thorough review, eight high-impact ideas were approved by the ASTM executive section focused on research and innovation (F42.90.05) within the committee on additive manufacturing technologies (F42).

The AM CoE partners will conduct these projects, covering a broad range of topics:

- Auburn University will develop a standard coupon design for evaluating lattice structures in metal AM under compressive loading. This work will improve reliability of lattice structures used in applications ranging from bone ingrowth for medical implants to weight reduction in transportation structures.

- Applied technology developer EWI will develop a common data exchange format (CDEF) for powder characterization. This standard will enable efficient data sharing throughout the AM supply chain by serving as a link between different data management systems.

- The UK-based Manufacturing Technology Centre (MTC) will develop standard guidance for evaluating polymer powders during recycling and re-use in AM. This guidance aims to improve confidence for manufacturing with recycled powders.

- MTC will also lead a project to develop guidance on metal powder feedstock sampling and recycling strategies. This research will identify strategies currently used for sampling and recycling powder feedstock and provide guidance on the suitability of these methods for AMprocesses, materials, and end-use applications.

- NAMIC – Singapore's National Additive Manufacturing Innovation Cluster – and the Singapore Institute of Manufacturing Technology (SIMTech) will develop standard sub-sized tensile specimens for witness testing of metal AM. These specimens will reduce the time and material costs of witness testing, a method of monitoring build quality by testing a coupon printed alongside the components in an AM build.

- NAMIC and A*Star's National Metrology Centre of Singapore will develop standard guidance for volume traceability of non-destructive testing for metal components produced with powder bed fusion and binder jetting. This project will assess components made with both processes and will provide guidance for use in assessing part quality.

- NAMIC and the Singapore University of Technology and Design (SUTD) will conduct a study of maraging steel, an alloy commonly used by the automotive, aerospace, sports, and tooling industries, among others. This work will provide a basis for developing a material specification for this class of alloys in AM applications.

- NASA and Auburn University will design a series of test components and a methodology to assist validation of process parameters for powder bed fusion. The proposed test components will enable manufacturers to confirm that a parameter set is robust and produces suitable part quality across a variety of local thermal conditions by incorporating challenging geometries.

- Wichita State University's National Institute for Aviation Research (NIAR) will continue two previous projects started in round two. The first project will provide guidance for polymer design values in additive manufacturing, while the second project establishes coupon-part property relationships for dynamic testing of additively manufactured polymers.

ASTM International's Additive Manufacturing Center of Excellence (AM CoE) is also participating in three new America Makes projects aimed at advancing the adoption of additive manufacturing as announced earlier.

ABOUT THE AUTHOR

Aditya Chandavarkar

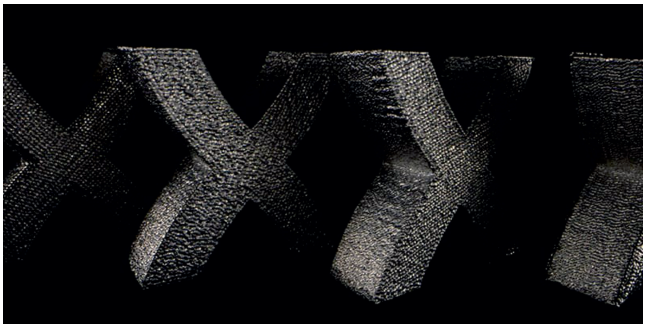
Co-founder - AM Chronicle

Aditya Chandavarkar is a established entrepreneur with business interests in manufacturing, innovative technology, training consulting. He is closely associated with cutting edge application industries for inkjet, 3D Printing (Additive Manufacturing) and Packaging.

AM NEWS

Xerox Ventures Announces Investment in Advanced Manufacturing Startup Seurat Technologies

Xerox Ventures, the corporate venture capital subsidiary of Xerox Holdings Corporation, announced



today an investment in advanced manufacturing startup Seurat Technologies, alongside Capricorn and True Ventures, who led the company's Seed and Series A rounds.

More about the Investment

Through its investment in Seurat, Xerox Ventures is executing on its strategy to invest in high-growth companies focused on connected work, empowered businesses, and green enterprise. Specifically, Seurat's novel area printing technology, which aims to mass produce parts at cost and scales competitive with traditional manufacturing but without the same rigid and centralized infrastructure that necessitates complex and vulnerable supply chains, has the potential to enable distributed, resilient and sustainable manufacturing.

Focusing on a more distributed, resilient and sustainable future for manufacturing is a broader theme at Xerox, as evidenced by the launch last year of the company's ElemX 3D liquid metal printer, which reduces manufacturers' dependency on complex global supply chains by producing reliable metal replacement parts when and where needed. The investment in Seurat represents a synergistic opportunity for Xerox and Seurat to further accelerate the realization of distributed manufacturing, with Seurat's technology addressing high volume, mass production parts and the ElemX addressing quick turnaround, cost-effective replacement parts.

"Seurat exemplifies the type of game-changing company Xerox Ventures looks to invest in," said Chris Fisher, managing director of Xerox Ventures. "The advanced manufacturing market is poised for tremendous growth over the next several years, and Seurat's innovative technology, which enables mass production with the touch of a button, positions the company to capture the high-volume metal additive manufacturing market and compete against traditional manufacturing. Everyone at Xerox is excited to work with Seurat's world-class team to accelerate bringing their technology to market."

"Having Xerox Ventures on board is a win-win for the whole team," said James DeMuth, CEO of Seurat. "Their professionalism and speed were impressive, and having access to the support, global business network and technical expertise of Xerox will be huge on our journey to revolutionize metal advanced manufacturing."

3D Printing in Car Design and Fabrication by Vital Auto

When major automakers want to experiment and push the boundaries of automotive design, they turn to Vital Auto, which has a well-equipped 3D printing department to make those visions a reality.

UK-based Vital Auto is an industrial design firm that specialises in automotive projects. Many major automakers, including Volvo, Nissan, Lotus, McLaren, Geely, and Tata, are among the company's clients.

Chinese EV concept

One of the company's first projects was for the Chinese electric NIO EP9 supercar concept, which set the team on a path to producing extremely realistic, high-fidelity vehicle prototypes.

Depending on the client's request, the team may begin with a simple sketch on a piece of paper or with an already designed vehicle. The team creates cars from the ground up, designing all of the mainframes, exterior and interior elements, and interactive elements. A typical project could take three to twelve months with five to thirty people working on a single concept.

A typical show car goes through up to a dozen core design iterations, with additional iterations of smaller components occurring within those iterations until the design meets the customer's expectations.

From milling clay to 3D play

Unlike traditional show cars, which are typically made entirely of milling clay, the team also employs three- and five-axis CNC milling, hand forming, hand clay modelling, and GRP composites. Traditional processes, on the other hand, are not always ideal for producing the custom parts required for one-of-a-kind concepts.

Multi-material combinations realized via multiple 3D-printing formats.

Today, Barnicott runs a whole 3D printing department, equipped with three Formlabs 3L large-format stereolithography (SLA) printers, five Fuse 1 selective laser sintering (SLS) printers, and 14 large-format fused deposition modeling (FDM) printers.

Complex designs from multiple materials

The Form 3L machines are designed for anything with an A-class finished surface. So, in an automotive environment, an interior with parts that are not trimmed with leather, Alcantara, or some sort of cloth material. Formlabs materials provide us with a nice, smooth finish for our painters to work with; these parts go straight from the printer to the vehicle.

What intrigues me the most about the Form 3L machines is their versatility, the ability to change materials in less than five minutes, and the variability of those materials — going from a soft, flexible material to a hard, rigid material is priceless for us.

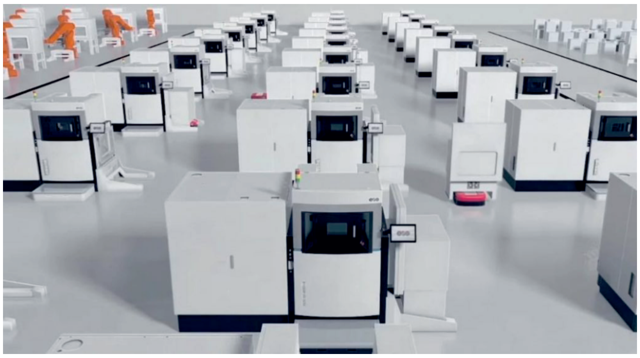
The team of Vital Auto employs Form 3L printers with a variety of materials for a variety of applications, one of which is air vents. It's a common problem for us as a company when a customer comes to us with a proprietary product and wants to encase it in their own design. Once, a customer came to us with a proprietary air vent from another vehicle that they wanted to install in their own interior. This part was digitally reproduced using 3D scanning technology, and an external skin was created. This was first created in draught form to test the design and allow the customer to verify it. We then moved on to the white material to create a production-ready part.

Production-ready air ducts and air vents are 3D-printed.

Door seals are another good application for SLA. They were able to experiment with Flexible 80A, one of Formlabs' newest materials. The Form 3L allowed us to print sections of this door seal overnight to test different geometries, and it was printed to within 50 microns of the actual design. The flexibility of rubber or TPU is emulated by Flexible 80A.

EOS launches certified 'end-to-end production network'

EOS, constant innovator, and a leading supplier for responsible manufacturing solutions via industrial 3D



printing technology, announced the launch of a new End-To-End Production Network designed to connect companies of all sizes in search for high quality serial additive manufacturing (AM) support

New partner network connects start-ups, mid-sized companies and OEM's with certified member manufacturers to bring 3D printed parts to market at speed and in high quality volumes

Prototal Industries, Scandinavia's largest additive manufacturing company, announced as first member

About the Launch

EOS, constant innovator, and a leading supplier for responsible manufacturing solutions via industrial 3D printing technology, announced the launch of a new End-To-End Production Network designed to connect companies of all sizes in search for high quality serial additive manufacturing (AM) support with selected, certified EOS partners. Prototal Industries, Scandinavia's largest and most specialized additive manufacturing company, is the first contract manufacturer to join the network.

With this EOS expands its already existing contract manufacturing network with the much-needed end-to-end production component. To become a partner in this network, companies run through a certification process where the end-to-end capabilities are the key criteria. From part design, to design optimization for AM, manufacturing capabilities, pre- and post-processing including surface treatment, to quality assurance and assembly to create high-end final parts in series.

Companies joining the new EOS network have a deep understanding of serial production requirements and have proven excellence in all production steps. As such, they enable those in search for a partner to realize serial additive manufacturing (AM) on an industrial scale and across a wide range of industries with the ability to scale further.

Finding the right partner for serial AM solutions

From start-up businesses, to SME and OEM organizations, bringing products to life at scale can be a demanding experience, particularly if working in a certified industry or wanting high volume production that does not compromise on the quality of the final product, or global distribution. Once the right AM solution is identified, one of the biggest hurdles can be finding the right manufacturing method and deciding how to organize part production.

EOS not only enables companies by identifying the best application and technology framework, but also

AM Factory Setup

consults companies on in-house vs. external production. If a third-party production partner is the best choice, then there are other important considerations. Businesses not only need partners that are solidly positioned and can produce high-quality 3D-printed parts at scale, but which also share the end-customer commitment to creating the right product and have the experience needed to bring products to the market.

EOS end-to-end production network partners will be able to help companies mitigate these risks and move rapidly to final serial part production on a large scale. Members will be able to bring their expertise from a range of manufacturing technologies to help them ramp-up production at speed, ensuring quality standards throughout and supporting every aspect of an end-to-end production.

With more than 30 years of experience in offering comprehensive additive manufacturing solutions, EOS understands market requirements for AM series production. With this network we want to create added value for both parties involved – those offering manufacturing services and those in search for it.

This will take much of the complexity and risk out of choosing a manufacturing partner for serial production businesses, with the most innovative product designs. They will be able to bring products to market faster, using the latest state-of-the-art 3D printing technology, and draw on the vertical industry expertise and know-how within the network

Markus Glasser, Senior Vice President EMEA at EOS

There are many industry standards and assessments designed to give customers confidence in a manufacturer's capabilities, but they normally place the burden of research on the company in need of the parts. Customers choosing to work with members of the EOS End-to-End Production Network will have the confidence that each manufacturing partner has been assessed by EOS against criteria that not only verify their financial security and competence, but that they have leading industry and application know-how, particularly for heavily certified industries such as aviation, automotive and medical devices.

Prototal Industries: first certified member of EOS End-To-End Production Network

The first member of the EOS End-To-End Production Network is Prototal, Northern Europe's biggest supplier in industrial 3D printing, vacuum casting, aluminium tools, and injection moulding.

The company has been an EOS customer for more than 20 years. With its longstanding AM expertise and more than 50 EOS polymer systems on-sight, Prototal offers end-to-end additive manufacturing capabilities for large scale serial production and to demanding and highly regulated industries such as aerospace, medical or automotive, to name but a few.

It is with great pride that we become the first member of the EOS End-To-End Production Network. At our various sites across Europe Prototal Industries for many years has built up the competence and the knowledge in how to additively manufactured larger series. The future looks bright for the technology in terms of even further developments in automation and more sustainable production, 3D-Printing really is a production method offering great benefits. And EOS is one of our most valuable partners.

f.l.t.r: Jan Löfving, CEO of Prototal with Markus Glasser, Senior Vice President EMEA at EOS – at the Prototal GTP site

Jan Löfving, CEO at Prototal Industries

The network initially will be set up in EMEA. It will grow within the next few months. Stay tuned.

Meltio develops wire based additive manufacturing range for metal 3D printing

Meltio, a metal 3D printing hardware developer, has announced the first release of its proprietary wire-based 3D printing materials range.

Because the business had previously boasted an open materials platform for its wire Laser Metal Deposition (LMD) technology, the new product line represents a shift in gears.

Nonetheless, Meltio's 3D printing technology is still compatible with commodity welding wires from third parties. LMD is currently suitable with the majority of stainless steels, mild steels, tool steels, titanium alloys, and nickel alloys. Furthermore, invar, cobalt-chrome alloys, and precious metals such as gold have performed admirably in customer-led projects.

The new Meltio Materials line now includes Stainless Steel 316L, Stainless Steel 308, Mild Steel ER70S, Titanium 64, and Nickel 718. (Inconel). Materials such as copper, aluminium, and refractories are still being developed.

Open Materials vs Meltio Materials

So what new benefits will the Meltio Materials range actually provide? To understand the implications of the launch, it's necessary to weigh up the pros and cons in the 'open materials versus closed materials' debate.

Open material platforms are heralded for the sheer number of materials they are compatible with, giving users ample choice when it comes to material selection. Not only does this enable a wider range of applications, but it's also often more economical to have more than one materials supplier. However, the user is still left alone to figure out the quality of each supplier and craft the print settings for each alloy themselves.

Closed material platforms, on the other hand, tend to provide an excellent 'out-of-the-box' experience. Customers can be sure their feedstock has been validated with system-specific parameters, saving time on benchmarking and trial-and-error.

With Meltio's new disruptive model, customers will be able to utilize Meltio Materials as well as third-party open materials, bridging the benefits of both types of ecosystems. This is very much a novelty in the DED space, since many of the firm's direct competitors have had to remain open due to a lack of technological maturity – they simply haven't been able to provide reliable proprietary printing recipes.

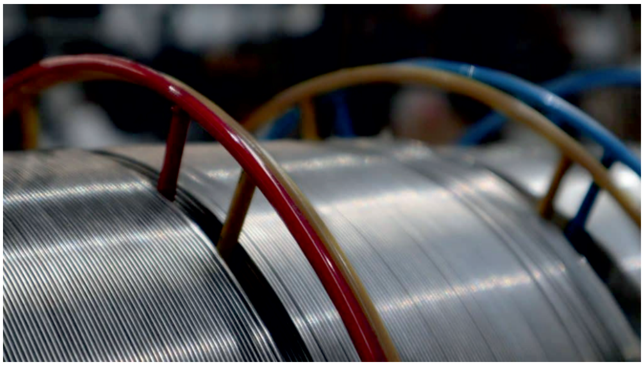
Meltio attributes its success to its focus on welding wire-based materials, which has helped the company fast-track print profile optimization, material qualification, and supplier qualification. By contrast, other powder-based DED platforms have historically struggled with complex system usage issues and problems with cross-contamination. As such, Meltio believes the use of powder naturally stifles the rapid iteration cycles required to qualify and parametrize new materials.

As an aside, each of the offerings in the Meltio Materials range will be competitively priced to be in line with commodity welding wires. Placing importance on both ROI and accessibility, the product line is ultimately intended to enable higher print success rates wrapped in a more streamlined user experience.

Brian Matthews, CTO of Meltio, said, "Meltio is the first company in the DED space to provide parameterized materials to fast-track industrial adoption and an open material ecosystem to foster user-driven innovation."

LMD 3D printing with Meltio

Since its launch in May 2019, Meltio has built a name for itself with its LMD multi-metal additive manufacturing technology, with the new in-house materials range now enabling a whole host of potential applications.



Close-up of a Meltio Materials wire spool. Photo via Meltio.

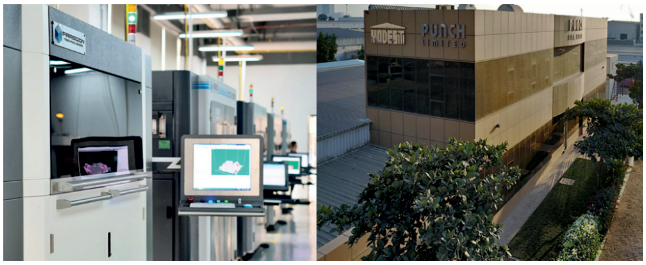
The Stainless Steel offerings, combining corrosion resistance and great mechanical properties, are expected to see use in marine and chemical applications. On the other hand, Mild Steel will offer high ductility for easy weldability and machinability. Finally, Titanium offers an excellent strength-to-weight ratio and biocompatibility, while Inconel is known for its outstanding heat and chemical resistances. The firm expects to see these metals used to 3D print high-performance parts in industries such as aerospace, energy, healthcare, and consumer electronics.

The firm's LMD technology is a form of Directed Energy Deposition (DED), whereby multiple fiber-coupled diode laser sources are used to melt metal materials fed out of a central nozzle. The intersection point forms weld beads which are deposited directly onto a substrate below, resulting in fully dense metal layers.

The company's product portfolio comprises the Meltio M450 3D printer and the Meltio Engine, a modular 3D printing tool head that can be integrated seamlessly with CNC machines, robotic arms, and gantry systems. Aimed at SMEs and large corporations alike, the Meltio Engine is designed to fuse the benefits of LMD with large-format control systems to deliver affordable and accessible metal 3D printing capabilities to its users.

Farsoon expands into the Middle East with Modest Company

Farsoon Technologies has announced a partnership with Modest Company LLC, under their new Additive Manufacturing division '3DTIV Tech', to represent its truly open metal and plastic laser powder bed fusion 3D printers for distribution, demonstration and service.



Modest Company has served the UAE & GCC industrial markets since 1975. 3DTIV Tech will represent Farsoon in the United Arab Emirates (UAE), Saudi Arabia, Qatar, Kuwait, Bahrain, Jordan, Oman, Tanzania and Kenya (Eastern Africa).

Being a highlight of the partnership, 3DTIV Tech will establish an Additive Manufacturing Demonstration Center in Dubai, UAE, housing 5 Farsoon metal & plastic 3D printing machines, including: a Flight HT403P, HT403P, eForm, FS273M and FS121M. The goal of this Additive Manufacturing Center is to provide a variety of functionalities for Mideast users including machine demonstration, benchmarking, training, as well as service & support. The 3DTIV Tech AM Center is expected to open to industrial customers in April 2022.

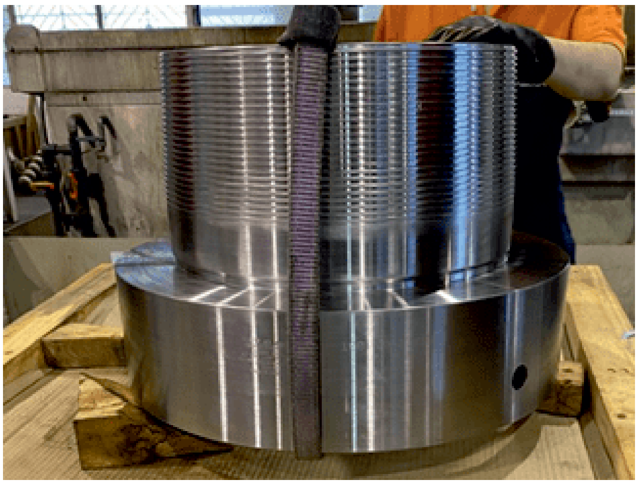
"As a company with diversified activities, we are pleased to offer Additive Manufacturing machines to our product line and aim to be one of the pioneers in providing Selective Laser Sintering and Melting systems for plastic and metal parts in the Gulf and East

African regions," says Ali Akbar Khimjee, Director of 3DTIV Tech, "With over 10 years' of research and development in the field, Farsoon Technologies is at the forefront in this dynamic industry and our partnership will present the region with innovative opportunities to a wide range of enterprises. This collaboration in the revolutionary 'Industry 4.0' as it's known, is sure to expand worldwide and we want to be a part of this journey."

"We highly value the collaboration with Modest Company for their solid experience of offering industrial manufacturing solutions in Mideast and Eastern Africa," says Vince Zhao, Global Channel Manager (AMEA) of Farsoon, "being one of the most powerful economics in AMEA, we see a great potential in Mideast and Eastern Africa additive market for a wide range of industrial applications driven by Oil & gas, automotive, aerospace and researching institutions. With years of technology innovation and practice in the Global industrial 3D printing market, Farsoon is confident to offer Middle East and Eastern Africa customers with our truly open, high-performance and cost-efficient additive manufacturing solutions."

Vallourec produces 3D-Printed Lifting Plug for Weatherford using WAAM

Vallourec has recently produced 2 lifting plugs using Wire Arc Additive Manufacturing (WAAM) meeting Weatherford's urgent operational demands.



Lifting plugs are crucial safety components that serve as the interface between the rig elevator and the pipes. They are utilised on the rig's surface to enable operators to safely handle and transport long tubular items.

Historically, lifting plugs have been manufactured from forged thick-wall bars. Due to the fact that they are a safety-critical component utilised on the surface, they require non-standard material with specific mechanical qualities, resulting in extended lead times. Due to the fact that lifting plugs connect to existing equipment, specific dimensions are occasionally required to assure compatibility across all components, further extending lead times. Additionally, maintaining inventories of raw materials in non-standard sizes is inefficient and may result in waste if they are never used. All of this results in the inability to meet critical deadlines.

When Weatherford approached Vallourec with an urgent need for a VAM® TTR HW Riser Lifting Plug capable of 100T for a customer's workover scope off the coast of Australia, Vallourec suggested a more cost-effective and quicker solution based on additive manufacturing (AM).

The lifting plugs were redesigned in collaboration with WAAM to accommodate custom non-standard diameters compatible with Weatherford's current equipment. As a result, the outer diameter (OD) of the lifting plugs was raised by 15% at the customer's request. Vallourec was able to reduce any weight gain by re-designing the component without impairing lifting performance by leveraging WAAM's flexibility.

These new lifting plugs were 3D-printed using the Vallourec WAAM robot in Singapore, which is only a 6-hour flight from the end-customer. The safety-critical components were supplied in less than two months, rather than the customary three to four months.

Changing the industry

Wire Arc Additive Manufacturing (WAAM) is an additive manufacturing (AM) process that employs a welding source and a robot arm to drive a printing nozzle to deposit material in near-net forms layer by layer. After depositing all of the material, the blank is machined, tested, and VAM® threaded.

Welding is a critical component of industrial component production processes and a subject in which Vallourec is renowned as a specialist.

Vallourec's first 3D-printed safety-critical component was a waterbushing developed in partnership with TotalEnergies and placed in the North Sea's EIG Franklin well in early 2021. This successful project paved the way for other opportunities, including this newest one with Weatherford.

WAAM – and AM more broadly – provides various benefits to the oil and gas sector, the most significant of which being reduced, assured lead times, which would benefit end users significantly.

Additionally, WAAM enables greater form flexibility – parts may be manufactured to the precise size and requirements specified by the client – as well as printing of extremely big components. The end result of this procedure is that businesses may construct a digital or virtual warehouse from which they can order spare components in the form of a printed file.

Israeli startup Plantish developed 3D-printed, plant-based salmon fillet

Six-month-old food tech company, Plantish, says it made a fully structured, boneless cut with the same nutritional value as the fish, minus the mercury and toxins.

About the start-up

A new Israeli firm claims to have created the first plant-based whole-cut salmon fillet that mimics the appearance, taste, and texture of the real thing.

Plantish, a six-month-old firm, showed the prototype on Thursday, announcing that it was developing a patent-pending additive manufacturing method — the industrial term for 3D printing — to produce plant-based fish substitutes at a cheap cost and on a large scale.

Plantish, based in Rehovot, claims to have created a fully vegan, structured, boneless salmon fillet that has the same nutritional value as the actual fish — high in protein, omega 3 and omega 6 fatty acids, and B vitamins — but without the mercury, antibiotics, hormones, microplastics, and toxins that are commonly found in ocean or aquaculture species.

Because of client demand, the company stated it chose the complexity of whole-cut production over minced. Approximately 80% of fish ingested is whole-cut, either as whole fish or fillets.

According to the company's statement on Thursday, the Plantish product may be cooked in the same ways that conventional salmon is.

Israeli startup Plantish unveiled a 3D-printed, whole-cut, plant-based salmon fillet in January 2022.

Plantish, which was previously in stealth mode, was founded in mid-2021 by Ofek Ron, the former general manager of the Israeli organisation Vegan Friendly, who serves as CEO; Dr. Hila Elimelech, a chemistry PhD and expert in additive manufacturing processes who serves as head of R&D; Dr. Ron Sicsic, chief scientific officer; Dr. Ariel Szklanny, a bioengineering Doctorate who serves as cto; and Eyal Briller, a former Plantish received a $2 million pre-seed round from TechAviv Founder Partners, an Israeli-focused fund that has backed firms like as drone logistics firm Flytrex and creative firm Nas Academy.

According to the business, its plant-based salmon product will be available in limited pop-up locations by the end of 2022, with an official launch scheduled for 2024.

According to a Good Food Institute report due out in June 2021, Plantish is one of 90 businesses worldwide engaging in the plant-based seafood market, with another dozen or so creating farmed seafood or fish created from animal cells.

According to market research firm IMARC Group, companies developing alternative fish and seafood products increased by 30% between 2017 and 2020, with further growth expected in the coming years as concerns about depleted supplies and overfishing grow and more firms transition from development to commercial launch.

Some are already well on their way. Mimic Seafood of Spain launched a tomato-based tuna product last year, while Ocean Hugger Foods of the United States launched a plant-based alternative to raw tuna and raw eel (for sushi) in 2019 with plans to focus on the United States and Europe this year in collaboration with Bangkok-based Nove Foods.

Plant-based crab cakes, shrimp, fish sticks, smoked salmon, and cod fillets are being produced by a variety of enterprises.

Large food corporations are also attempting to find success in the industry. Tyson Foods, a US meat corporation, purchased a minority share in New York-based plant-based shrimp developer New Wave Food in 2019. Thai Union Group, a Thailand-based seafood manufacturer that owns the Chicken of the Sea brand, developed OMG Meat, a plant-based meat range that includes crab cakes and fish burgers marketed to stores and restaurants, last year. Nestle will debut Vuna, a fish-free tuna product created with pea protein, in 2020. In addition, Cargill, an American global food business, announced a new range of plant-based items, including vegan scallops, with Japan-based convenience store chain Lawson in 2020.

Swiss food giant Nestlé launched a plant-based tuna product

According to the Good Food Institute report, the plant-based seafood market is still small in comparison to the plant-based meat industry, but sales in the coming years "could grow by $221 million if the category was able to capture the same share of the seafood market that plant-based meat has of the meat market."

3D printed cement foam could reduce carbon emission

Researchers at ETH Zurich employed 3D-printed formwork pieces composed of recyclable mineral cement foam to build a pre-cast concrete slab that is lighter and more insulated while using 70% less material, according to the researchers.

ETH Zurich develops formwork from 3D-printed foam to slash concrete use in buildings

The FoamWork technology involves filling a typical rectangular mould with 24 mineral formwork parts of various shapes and sizes before casting concrete over them and allowing it to cure, resulting in hollow cells throughout the panel. The resulting internal shape was optimised to reinforce the slab along its primary stress lines, resulting in the required strength while dramatically lowering the amount of concrete required to construct it. If implemented on a large scale, architect Patrick Bedarf believes it could assist to reduce the carbon footprint of buildings, particularly cement, which is the world's largest single emitter of CO2. With FoamWork, emissions from material use in the concrete slab would be decreased. Lowering the bulk would also have a secondary influence on the dimensioning of the overall load-bearing structure, as well as reducing shipping and handling efforts on building sites.

Ultra high-performance fibre-reinforced concrete is poured around the formwork elements

The formwork pieces are 3D printed by an autonomous robotic arm utilising mineral foam, which is traditionally generated by foaming cement and is increasingly employed as an insulating material in construction due to its high porosity. To minimise the emissions associated with cement manufacture, the FoamWork system uses a substitute developed by the Swiss start-up FenX that is formed of fly ash, a waste product from coal-fired power plants. According to the business, this helps to reduce the carbon footprint of the foam, especially when considering the emissions associated with coal combustion.

The formwork can be left in place or removed, recycled and reprinted

The final FoamWork of cement foam elements can either be left in place to improve the insulation of the precast concrete slab or recycled and reprinted to create new formwork. Considering that no offcuts are created in the additive manufacturing process, this means the entire system has the potential to be zero-waste.

The system was 3D-printed using an autonomous robotic arm

Hollow plastic forms can be used to decrease concrete in big standardised slabs, while sophisticated formwork for concrete is manually made in lumber or CNC-cut from dense plastic foams for smaller non-standardized applications. Both methods are time-consuming and waste a lot of material due to chipping and offcuts.

The internal geometry of the concrete panel (cement foam) was optimised for its specific shape, inspired by the way Italian architect Pier Luigi Nervi built ribbed floor slabs in the 1940s along their main stress lines. The shape and structure of the inside cells, on the other hand, may be customised to create a variety of concrete building elements ranging from walls to whole roofs.

The FoamWork provides additional insulation through its porosity

In an effort to reduce its massive carbon footprint, the Global Cement and Concrete Association recently pledged to achieve net-zero emissions by 2050. To do this, the industry is striving to develop alternatives for clinker, the most carbon-intensive component of cement, as well as using carbon capture technology to eliminate emissions generated during the clinker manufacturing process. At the moment, it entails burning calcium carbonate at high temperatures to separate the calcium required to make cement from the carbon, which is discharged into the environment. Until such technologies are widely accepted, the simplest method for architects to reduce the embodied carbon footprint of their buildings from materials and construction is to utilize high-carbon materials like concrete and steel more sparingly and efficiently. Currently, a large number of buildings in the UK are overdesigned according to Cambridge University engineering professor Julian Allwood.

Australian start-up hypersonix launch systems working on 3D printed space planes

An Australian startup- Hypersonix Launch Systems is developing a new space launch vehicle, the majority of which will be manufactured using a 3D printer, including the hydrogen engine. Here's a look at the future of space flying as imagined by the start-up.

Satellite launch has traditionally been linked with huge rockets that take off vertically from a launchpad. Hypersonix Launch Systems, an Australian aerospace engineering business, is now attempting to devise a revolutionary method of doing so. What is its solution? A space plane that travels faster than sound and is comprised of 3D printed materials. The space vehicle, known as Delta Velos, is being built in Sydney, Australia, in collaboration with the University of Sydney. The one-of-a-kind plane is now being built and tested at the University of Sydney's Darlington campus' engineering sector.

When completed, it will address two major concerns with current spaceflight. For starters, it will reduce the amount of carbon dioxide emitted during a rocket's takeoff. Second, it will optimise the manufacturing process by employing various materials from the periodic table as well as innovative methodologies for their application.

The engineering team led by Professor Simon Ringer of the University of Sydney will assist the start-up with this new production. Using powerful 3D printers, the crew will create pieces for the fuselage and the scramjet engine for Delta Valid. These printers will use additive manufacturing technology, which will enable the mixing of different elements from the periodic table to create new alloys.

'This is a completely novel method of producing metallurgical materials.' It's not like a foundry, and it's not like what happens at a steel plant," Prof Ringer told AAP in an interview.

"In 3D, we can create shapes and designs that we could never create before." "You may let your imagination run wild," he continued. The ability will allow the researchers to create and test novel alloys that may have beneficial features such as high-temperature strength, which is vital for space flight.

Once completed, the hypersonic spaceship will use the world's first 3D printed scramjet engine to launch tiny satellites into orbit. However, it is not the current aim. Hypersonix intends to test the scramjet engine in proof-of-concept vehicles before creating the actual spaceplane.

It will launch the prototype spaceplanes utilising a single hydrogen-powered engine for a 500-kilometer flight distance. During flight, the real Delta Velos will use six of these green engines.

The utilisation of a hydrogen engine for space flight will allow Hypersonix to leave its mark in history, as such an engine would only emit water as a byproduct of combustion and no carbon emissions. The day it becomes a reality will be a watershed moment in the aerospace industry.

3D printed concrete building completed in Oman

A team composed of Danish 3D printer maker Cobod, Mexican cement company Cemex and the German University of Technology in Oman (GUtech) has produced a 3D-printed building using real concrete.

The 190 sq m structure is designed as a typical Oman house, with three bedrooms, a living room, kitchen and reception area.

The concrete used for the house's walls cost €1,600, with Cobod saying the printable dry-mix mortar usually used in printed buildings would have cost upwards of €20,000.

Work on the development took place over two stages, the first of which focused on the training of the Omani crew and fine-tuning of the concrete recipe, followed by its construction over the course of five days.

Henrik Lund-Nielsen, Cobod's founder, said: "While we have been happy to help cement and concrete manufacturers develop dry-mix 3D printable mortars, we have also insisted on a solution using real concrete made from local available materials, which will be needed for the mass application of our technology."

Juan Romero, Cemex's executive vice president of sustainability, said: "The introduction of this revolutionary 3D-printing system is a testament to our customer-centric mindset and relentless focus on continuous innovation and improvement.

Hussain, GUtech's acting rector, said: "Today's display of the 3D printed building is perhaps the first step in a 1,000-mile journey. A step that will not be success without the support of all parties involved.

"In this regard, I sincerely thank all the local and international parties who contribute to supporting the centre and the university. We hope that this centre will play its part in supporting Oman's efforts to achieve Oman's Vision 2040."

Al Seer Marine sets up inhouse Additive Manufacturing unit

Al Seer Marine, a subsidiary of Abu Dhabi's International Holding Company (IHC) has announced the launch of an additive manufacturing unit for 3D printing.

The boat building company said it would use the technology for in-house manufacturing of unmanned vehicles and vessels, enabling engineers to design parts with increased complexity in shorter time frames.

The business unit will also develop large-scale additive manufacturing (LSAM) products and parts that are in high-demand regionally and globally, the company said.

Guy Neivens, CEO, of Al Seer Marine, said: "The company's decision to pursue additive manufacturing is testament to the technology's growing influence and diverse applications across a range of sectors.

"This increased adoption has been largely driven by the digital process behind additive manufacturing, which allows for the creation of bespoke parts with complex geometries and little wastage – rapidly reducing costs and weight considerations while maintaining the part's strength and integrity.

"We are confident that our additive manufacturing business unit will be in a position to lead the segment across the region by 2025, introducing numerous advantages to our industrial capabilities and transforming the region's shipping industry."

The company said the global 3D printing market was valued at $13.78 billion in 2020, with an expected annual growth rate of 21 percent from 2021 to 2028.

Al seer marine is a leading marine organisation in the Arabian maritime region, with a portfolio of products & services that caters to the needs of the marine industry's owners, operators and end-users.

Space company in California orders two NXG XII 600s by SLM Solutions

A leading California based rocket company has ordered two NXG Xll 600s to make its space missions more affordable and efficient by creating lighter, faster, and more robust space components.

As space companies battle with unprecedented demand to get space-based technology into orbit, the need for solutions to meet their requirements accelerates. The NXG Xll 600 overcomes many challenges due to its large build envelope, ability to work with space-friendly alloys such as nickel and copper, and high-speed production rates that are crucial for the space sector's tremendous demands.

Dr. Simon Merkt-Schippers, EVP Product Management of SLM Solutions, remarked: "The NXG XII 600 is a true game-changer for the rapidly growing (New) Space industry. Here, traditional space companies and established players must cope with strong growth and an urgent need for complex parts to win the modern space race. SLM Solutions technology enables more affordable missions due to smarter designs that make rocket engines more efficient, bringing their performance to the next level. There is probably no faster and more efficient way to explore orbit and come out triumphant than utilizing the capabilities of the NXG XII 600."

Up to five times faster and featuring >40% more build volume than the industry benchmark, the NXG Xll 600 is the ultimate solution for space companies looking to take advantage of its power, quality, and reliability. On top of this, premium part quality is ensured by best-in-class scanning strategies, including patented overlap technology that exceeds spaces' requirements in terms of surface quality and mechanical properties.

ASTM part of three new America Makes Additive Manufacturing projects

ASTM International's Additive Manufacturing Center of Excellence (AM CoE) is participating in three new America Makes projects aimed at advancing the adoption of additive manufacturing.

America Makes

These projects, totaling over $1 million in combined efforts, address critical aspects of the additive manufacturing industry, including training, inspection, qualification approaches, and in-process monitoring.

"We are proud to be selected to launch these projects that will train the AM industry's workforce and equip them with new tools to solve quality and inspection problems," said Dr. Mohsen Seifi, ASTM International's director of global additive manufacturing programs. "America Makes has been a key contributor in the development and maturation of AM technologies, with key insight on the important role standardization and training plays in further adoption and industrialization of additive manufacturing", said Seifi.

The three projects funded by America Makes include:

- Introductory Inspection and Quality Assurance of Additive Manufacturing using the AMES Test Artifact – This project will develop an introductory course to quality assurance and inspection for additive manufacturing, intended for audiences ranging from beginners to QA or AM professionals who wish to expand their existing knowledge. This project is led by ASTM AM CoE and supported by Castheon. (America Makes Project 5001.002.001.004);

- Best Practices for Additive Manufacturing Part Families Relating to Product Qualification & Certification – This project aims to develop definitions, best practices, and guidance to enable the application of a part family framework for qualification and certification (Q&C), enabling similar parts to be qualified using shared/common material data and reducing both time and cost. The project includes participation of dozens of aerospace and defense corporations including Boeing, Airbus, Raytheon Technologies, Northrop Grumman, Lockheed Martin, and others. This project is led by ASTM AM CoE and supported by FAA and NASA. (America Makes Project 5001.002.002.003); and

- Open Framework for Real-Time Control and Mitigation of Defects in Metal Powder Bed Fusion (OFF-RAMP) – This project will develop and assess methods for mitigating defects in metal powder bed fusion, once they are detected by in-process monitoring tools. The project is led by The Applied Research Laboratory at Penn State University, and other team members include Applied Optimization and 3D Systems. (America Makes Project 5001.002.001.002)

Formed in 2018, the AM CoE is a collaborative partnership among ASTM International and organizations from industry, government, and academia, that conduct strategic R&D to advance standards across all aspects of AM technologies. The center aims to accelerate the development and adoption of robust, game-changing technologies by supporting standardization, developing training and certification programs, and providing market intelligence and advisory services.

3D-printing of custom-made shoe sole

Siemens, EOS, and DyeMansion are collaborating to utilize 3D Printing for manufacturing custom-made shoe soles demonstrating how each of these factors can be realized economically. With this reference factory for selective laser sintering with polymers, Siemens is expanding its digital Additive Manufacturing Experience Center.

The automated chain of coordinated production steps from all suppliers, from design and printing to post-processing, as well as end-to-end IT integration, is crucial for high productivity and maximum flexibility. This applies to series parts as well as to a highly flexible lot-size-1 production for individualized products or spare parts.

Therefore, together with its partners EOS and DyeMansion and its end-to-end digitization and automation solutions, Siemens has created a seamlessly integrated end-to-end value chain for industrial additive manufacturing with selective laser

In a seamlessly integrated end-to-end value chain for industrial additive manufacturing this midsole was printed sintering and industrial post processing solutions using polymers.

For volume production, the EOS P 500, which can be seamlessly integrated into an automated production, is being used within this cooperation. The EOS P 500 manufacturing platform is ideally suited for laser-sintering of plastic parts on an industrial scale.

For small, highly flexible AM factory cells, the FORMIGA P 110 systems are being used, which can now also access the NX design tools directly thanks to the EOSPRINT integration. With the NX design tools, users can design complex lattice structures and, using the example of the footwear application, simulate the digital twin of the created midsole in action on the people who wear it.

When it comes to post-processing, DyeMansion's coordinated three-step print-to-product workflow allows scaling from prototyping or small series production to additive series production. The integrated Siemens automation can be implemented in industrial shop-floor IT and offers optimized maintenance and operator handling.

Simatic S7-1500 controllers are key in the automation concept of the additive manufacturing plant. The seamless integration of all machines into the entire production chain is enabled by communication via standardized interfaces, especially OPC UA. Efficient commissioning shortens the time to market. The uniform machine operation and integration into enterprise IT leads to further time savings and reduces costs. Finally, all the necessary safety and security aspects can be implemented quickly and easily.

Rocio takes 3D Printed Handbag to Paris Fashion Week

Rocio bags is using 3D Printing to create Bags which it will take to Paris Fashion Week, scheduled to begin on February 28, 2022.

The Rocio 3D printed Handbag is a result of a partnership between Scottish luxury eco-brand ROCIO and the NMIS and was created to explore sustainable manufacturing techniques. The National Manufacturing Institute Scotland (NMIS), operated by the University of Strathclyde is testing out a new 3D printing technique to manufacture sustainable leather handbags.

“A core aim of NMIS is to engage with and support SMEs to facilitate a positive impact on the local economy and the wider industry. We have a team dedicated to helping SMEs in their route to innovation and exploitation of new goods and services in response to industry needs – and this ROCIO project is a prime example.” says Andrew Brawley, NMIS Research & Design Engineer.

Rocio's signature bags are usually made out of wood, placing them on the fine line between sculptural art and fashion. With the inner structure of the bag developed, it was then taken as a base for Atelier, a fashion business school in Spain, to create a fully structured leather handbag—a first for ROCIO.

This 3D printing method is allowing Rocio more room for customization and to mitigate environmental consequences in production. This makes for an easier way to customize and add detail to the design of the product, which stands true for the ROCIO handbag as well. Being able to design the product through 3D software not only reduces material waste during the initial developmental stages, it also reduces the time needed to reach the design and saves production costs.

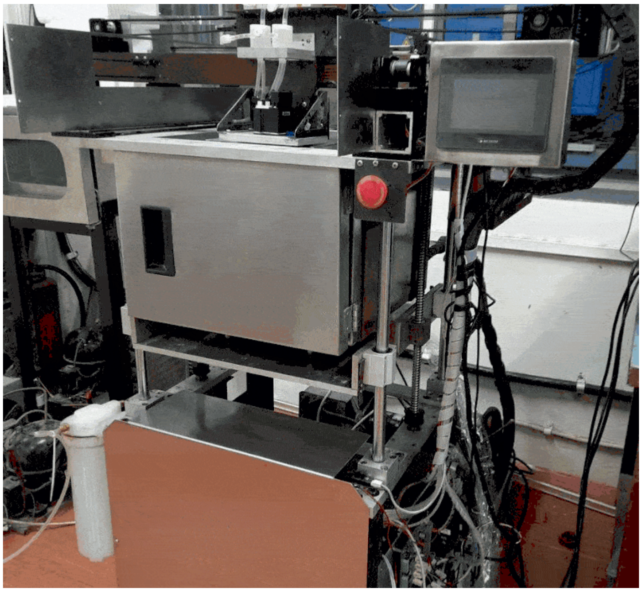
"For us, exploring the use of a 3D printed prototype is more cost, time and material efficient in the long term. Through using this technology, we are one step closer to improving our endeavours to be even more sustainable, whilst unlocking and embracing the future capabilities of our industry" says Hamish Menzies, ROCIO Creative Director.

The structure captured the same structured art form of ROCIO wooden bag sculptures, which enabled the brand to retain its signature characteristics in aesthetic and silhouette.

IIT Bombay develops innovative multi-jet ice 3D printer

IIT Bombay had developed a prototype of multi-jet ice 3D printer which is a sub zero 3D printer that is capable of realizing frozen parts of water and aqueous solutions.

All AM processes involve a precise temperature and/or pressure control. While conventional AM processes for metals, polymers and ceramics are carried out at ambient or elevated temperatures, some emerging materials such as water, aqueous solutions, colloids, gels and slurries require sub-zero temperatures. At IIT Bombay, a prototype is developed for sub-zero additive manufacturing that is capable of realizing objects out of ice.



The prototype is capable of producing parts of deionized water of size 50 mm x 50 mm x 50 mm. Multi-jet technology is used for dispensing the water on a sub-zero surface layer-by-layer. The work space is insulated and maintained at typically -20° to -25°C with the help of a refrigeration system augmented with liquid nitrogen.

Additively manufactured ice parts can be used as patterns for investment casting. The slurry for investment is always maintained a few degrees below the 0°C with the help of additives. The slurry is poured over the ice pattern and maintained inside a refrigerated environment until it undergoes gelation. Once gelation is complete, the mould is freeze-dried to evacuate the ice pattern casting.

Researchers at IIT Bombay believe that with further research this multi-jet ice 3D printer could enable them to slowly replace wax as pattern materials, with a greener material alternative such as water for investment casting applications.

Further investigations are underway to understand this process better and devise it for commercial use. The integration of the printer was made possible with the help of 360 Digital Printing Innovations, which is a Indore based inkjet electronics and integrations company.

For further details, you can also take a look at the recent article published in Rapid Prototyping Journal

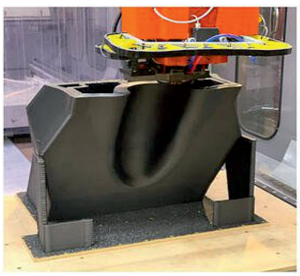
Thermwood receives 32 patents in Additive Manufacturing

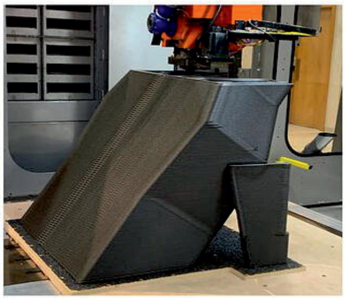
Thermwood routinely applies for patent protection on additive manufacturing technology it develops for its LSAM large format additive systems. During COVID, we received electronic copies of patents that were granted, however, the official hard copies were withheld.

A couple of days before Christmas 2021, they received a package containing the official hard copy of 32 additive manufacturing patents. This was certainly a one-day record for Thermwood and a welcome sight!

In addition to these latest patents, Thermwood already has a large portfolio of earlier issued patents covering the unique, large format (5×10 foot table and larger) 3D print technology it has developed. This LSAM technology is currently the most widely used large scale additive print technology operating in industry today. It's used in a wide variety of industries including aerospace, transportation, heavy equipment, foundry and large decorative structures. It is being used to produce a diversity of products including aerospace patterns, molds and tooling, heavy equipment foundry patterns, bus chassis, large valve body foundry patterns and trim tooling. It was even used to print the tallest 3D printed structure in the world, the 92 foot tall Al Davis Memorial Torch at Allegiant stadium in Las Vegas.

Thermwood offers this unique patented technology on a wide variety of equipment, the largest, most diverse





product offering of its kind available today. It includes a broad selection of machines, including single and dual gantry, fixed and moving table configurations, with both print-only and print-and-trim systems, from 5 by 10 foot to 20 by 60 foot print envelopes. They are working on even larger machines but that's for another day.

The primary focus of the patented LSAM technology is to reliably and repeatedly produce the highest quality, best fused, most homogeneous printed structures possible from a variety of reinforced thermoplastic polymer composites including those intended to operate at elevated temperatures.

Massivit and Kanfit sign strategic collaboration for defense applications

Massivit 10000 printer to be installed at Kanfit for defense applications.

Massivit 3D Printing Technologies is entering the defense industries market with their strategic collaboration agreement with Kanfit to install its state-of-the-art Massivit 10000 printer at Kanfit's plants and for the purpose of customer beta testing.

Kanfit is an Israeli manufacturer of products made from composite materials, metals, and hybrid assemblies for the aviation, aerospace, medical devices, and defense industries. The Company has expertise in four key areas: design and manufacture of products and assemblies; manufacture of hybrid assembly and integration structures for aircraft; 3D printing of titanium (including medical implants), aluminum, and plastic parts; design and manufacture of prototypes and production tools and assemblies. Kanfit manufactures parts and assemblies for key players in the Israeli aerospace market, among others, such as the Israel Aerospace Industries, Elbit Systems, Rafael Defense Industries, Israel Air Force, Ministry of Defense, etc.

Massivit 10000 3d printer

Massivit CEO, Erez Zimerman, said: “We are excited to sign the first agreement of this kind, for the strategic collaboration with Kanfit – one of the most important defense manufacturers in Israel. This agreement is a momentous milestone in achieving Massivit's goals and business strategy.”

The Massivit 10000 printer is one of Massivit's next-generation printers. The printer operates on the cast in motion technology, which is designed to produce composite parts and can be used for printing molds, production tools, and large-scale models that industrial companies can use for manufacturing. Massivit is continuing preliminary sales of the printer, prior to its launch in 2022. As of the end of the third quarter of 2021, Massivit has 12 pending (non-binding) orders, which it plans to deliver in the second half of 2022. Kanfit's order will be delivered immediately and constitutes the 14th order for the Massivit 10000 printer.

EVP of Business Development, Marketing and Sales at Kanfit, Shachar Fine, said: “Kanfit recognizes the significant potential in the Massivit 10000 printer, that allows us to streamline manufacturing processes, to significantly cut down manufacturing time and to substantially lower costs.

Conflux Technology develop 3D printed heat exchangers with Dallara

Conflux Technology – an Australian metal additive manufacturing (AM) innovator of heat exchangers, led by Michael Fuller – are developing 3d printed heat exchangers for Dallara Automobili, Italy. Due for delivery in February 2022.

This is an important and exciting project to announce – Dallara are contract builders for every motorsport category across the globe. Their reputation for designing and building race cars is impeccable. For Conflux Technology this is an extension of our motorsport pedigree, proof of performance capabilities and commercially viable products. Conflux Technology began its AM journey in motorsport, giving this project special significance for the team.

“Conflux heat exchangers derive their performance from highly complex geometries that make use of the inherent freedoms afforded by Additive Manufacturing. Dallara set us an initial challenge to produce small heat exchangers that meet stringent performance, quality and cost targets. To achieve this, our engineers are working alongside Dallara personnel with the ultimate aim to improve fundamental efficiencies in the automotive and motorsport sector” said Michael Fuller, CEO & Founder of Conflux Technology.

Dallara is also the sole manufacturer of racing cars for the Indycar, Indy Lights, Formula 2, GP3 and Super Formula Championships. Dallara produces cars for endurance races such as the 24 Hours of Le Mans and the 24 Hours of Daytona. It also deals with cars with electric engines such as the Formula E. Dallara provides specialized consultancies and gives assistance to manufacturers and racing teams with regards to developing race cars and high performance road cars. In recent years, this latter activity has captured the interest of important car manufacturers such as Alfa Romeo, Audi, Bugatti, Ferrari, KTM, Lamborghini, Maserati, Renault and Porsche.

About Conflux Technology

Conflux Technology is a world-leading additive manufacturing (AM) company pioneering thermal and fluid applications through expert engineering and production. Conflux began in the world of F1 engineering, where founder & CEO Michael Fuller, transformed heat exchanger designs and performance outcomes.

Today, Conflux is a well-established, senior-by-design team leading the advancement of AM applications. Its revolutionary heat exchange technology has transformed product and system performance across aerospace, automotive, motorsports, micro-electronics, industrial and energy industries.

With vertically integrated, advanced manufacturing operations, Conflux encompasses all aspects of the engineering process – from design and CFD analysis through to in-house AM serial production, post-processing and independent validation. Conflux consistently pushes AM technology to the cutting edge, deriving ground-breaking outcomes for its customers.

Boeing and Titomic partner to develop sustainable 3d printed titanium

Boeing has teamed up with Titomic, the Melbourne-based company behind the Titomic Kinetic Fusion (TKF)

3D printing technique, to develop additive manufacturing in the space industry.

The firms will collaborate to research the usage of sustainable titanium powders for 3D printing space system parts. The Australian government has granted Titomic a $2.325 million Modern Manufacturing Initiative grant, which the company will use to study and manufacture components for space vehicles and satellites utilising a local titanium mineral deposit.

Fusion of Titomic Kinetics

The TKF technique from Titomic is a type of cold spray additive manufacturing. The method is spraying a fine metal powder into a solid substrate underneath, similar to how you would spray paint onto a graffiti wall. A construction platform or an existing metal element can serve as the substrate.

It's called cold spray because it doesn't use lasers or other heat-based energy sources, instead relying on kinetic energy. A high-velocity pressurised gas stream is used to jet out metal powder, which gives the material enough energy to deform and attach to the solid portion below, generating new layers.

Titomic's patented TKF technology, in particular, is distinguished by its high-pressure nature. This qualifies the process for high-performance applications in areas like aerospace and military, where the company is a well-established operator and certified research provider.

Titomic has announced a collaboration with machine tool maker Repkon to develop a new defense-focused 3D printing production facility in Australia. Using the company's additive technology, the plant will be utilised to manufacture Repkon-designed weapons system barrels.

More recently, the company increased its footprint in Europe with the acquisition of Dycomet Europe, a competitor cold spray technology company located in the Netherlands. The purchase not only provided Titomic with a new European base, but it also provided an instant stream of revenue, since Dycomet Europe carried with it a large pipeline of client orders from throughout the continent.

Sustainable titanium 3D printing for space

Titanium is defined by its high strength-to-weight ratio and excellent corrosion resistance, making it one of the most commonly used materials in aerospace. In the military, aircraft such as the F-22 and UH-60 Black Hawk rely on large quantities of titanium, while the space sector is using increasing amounts of the metal for rocket engines, pressure vessels, and structural parts.

According to Boeing and Titomic, titanium is readily available in Australia and is considered to be more environmentally sustainable when compared to other similar alternatives. The use of the metal can also help enable significant time and cost savings by eliminating the need for vast amounts of raw mineral processing.

The collaboration is also expected to position Titomic as a leading supplier within Australia's space manufacturing sector.

APF process by Arburg to aid Medical 3D Printing

Lukas Pawelczyk, head of freeformer sales, Arburg explains how the APF process with the freeformer is particularly suitable for AM in medical technology.

The medical plastics market was one of the first to make extensive use of additive manufacturing (AM) technology, creating complex and often custom-designed components and devices in relatively small numbers. This trend has accelerated as the imagination of medical designers and new 3D printing equipment have made the previously impossible possible. Now, a different type of system is extending those boundaries even further by allowing the use of the same plastic granules used in injection molding, including biocompatible, resorbable, sterilisable, and FDA-approved original materials.

Developed and built by Arburg, the German manufacturer of precision injection-moulding machines, the freeformer machine, with its Arburg Plastic Freeforming (APF) process, facilitates sophisticated medical applications that cannot be achieved with any other process.

'Open system' is the key

Similar to injection molding, the freeformer operates by melting conventional plastic granules via a heated plasticising cylinder. A high-frequency pulsing rigid nozzle then discharges tiny droplets of the liquid plastic melt. The part carrier, which can be moved along three axes, enables each individual droplet to be set down precisely. The applied droplet bonds with the existing surrounding material so that, layer-by-layer, three-dimensional components with a high mechanical strength are produced.

Part production starts from 3D CAD data in basic stereolithography STL format. Unlike conventional filament-fed AM systems, freeformers work using a wide variety of qualified standard plastics granules. In addition, users can process their own custom-compounded materials with this 'open system' and optimize the droplet size and process themselves. Alternatively, they can access Arburg's material database and select certified plastic granules, such as ABS (acrylonitrile butadiene styrene), amorphous PA (polyamide) and PC (polycarbonate), elastomeric TPU (thermoplastic polyurethane) and semi-crystalline PP (polypropylene), PLLA (poly-L-lactic acid) and other special and certified original materials including biocompatible, absorbable, sterilisable, and FDA-approved original materials.

Resorbable implants

An outstanding example of the use of the APF process in medical technology is the processing of Resomer LR 706 (composite of poly L-lactide-co-D,L-lactide and ß-TCP) from Evonik to create implant plates that are inserted directly into the body in the case of bone fractures. The polymer composite, which is modelled on human bone, contains 30% ceramic additives, known as ß-TCP. This makes the component stronger and releases calcium to promote bone regeneration. After a given time, the implant dissolves completely.
Resorbable cranial bones, cheekbones, and finger bones have also been made from medical PLLA (Purasorb PL18, Resomer LR 708). In addition, the plastic granules can be loaded with anti-inflammatory agents, for example, to minimise rejection.

Permanent implants are also being produced using the APF process. For instance, spinal implants have been made using Bionate thermoplastic PCU (polycarbonate polyurethane), and a multimaterial meniscus (using different types of polyurethane) were developed within a few days eliminating the time-consuming (and more complicated) development of an overmoulded part produced by conventional overmoulding.

Medical aids

The APF process is also used for medical devices and aids. The freeformer processes medically approved SEBS (styrene-ethylene/butylene-styrene) (Cawiton PR13576) with a hardness of 28 Shore A, for instance. This very soft material is dense and tear-resistant and is suitable for producing items such as functional bellows. Another typical example is sawing templates made from PA, which are used as customised surgical aids. Flexible and electrically conductive strain gauges are one example of future developments. These consist of soft TPU material (Desmopan) with carbon components and an inserted LED. The two-component functional part produced with the freeformer is both flexible and electrically conductive. Depending on the strain and thus the electrical resistance, the LED lights up with different brightness. Strain gauges of this kind could be used in physiotherapy, emitting an acoustic signal as soon as an injured arm or operated knee is overstretched or under stretched.

Filling level can be selectively changed

To date, the freeformer is the only AM system that can process the FDA-approved TPE Medalist MD 12130H (hardness 32 Shore A) and, without changing processing parameters, adjust the filling level of the part – how close together the droplets are – to fine-tune mechanical properties and achieve different hardnesses. For example, at a fill level 100% (that is, drops as dense as possible), maximum mechanical strength and stiffness is achieved. At a fill level of 20%, for example, there is a greater distance between the drops and the part is more flexible. It is even possible to create different material densities in different parts of the same component.

A current research project at the University of Belfast, Ireland, is looking at how vaginally inserted rings loaded with active ingredients can protect women from HIV infection. Using medical-grade TPU, rings with different filling levels (100, 50 and 10%) were investigated. The lower the filling level, the more porous the TPU ring and the greater the active ingredient release. Result of the study: at a filling level of 50%, about 60 of a total of 111 mg of active ingredient are released over a period of 30 days. This compares with only five out of a total of 190 mg for an injection-moulded ring. In addition, the APF process is also gentler than injection molding, so there is less temperature degradation, less stress and the active ingredient remains more stable.

Freeformers are suitable for cleanrooms

With just a few minor modifications, all freeformers are suitable for use in cleanrooms. They operate with low emissions, are virtually dust-free, and their build chamber is generally made from stainless steel. An optional robotic interface allows the AM to be automated and the freeformer to be integrated into IT-networked production lines. Process quality can be reliably documented and the components individually traced if required.

Conclusion

The APF process with the freeformer is particularly suitable for AM in medical technology. Geometric freedom combined with material freedom opens up completely new plastic applications, including for use within the human body.

SRTI Park qualifies Emirati engineers in additive manufacturing

The Sharjah Research, Technology, and Innovation Park (SRTI Park) announced the graduation of the first batch of young Emirati engineers who completed a three-month training and qualification programme for additive manufacturing.

During the programme, participants gained the knowledge to interact with, adapt to, and apply advanced technologies including additive manufacturing in a variety of industries.

The training sessions were conducted in collaboration with Immensa Technology Lab in the Middle East Test Centre for Smart Manufacturing, located at the Sharjah Research, Technology, and Innovation Park's headquarters.

Additionally, applied workshops on a variety of technologies were offered at the Park's "Sharjah Open Innovation Lab – SOILAB," Sharjah's first incubator for start-ups and innovative enterprises.

Recognising the fact that Additive Manufacturing or 3D printing is enabling the '4th Industrial Revolution', the Sharjah Research, Technology, and Innovation Park (SRTI Park) is developing an integrated work system for smart companies in the emirate to boost innovations in self-driving vehicles, oil and gas sector, medical and allied sciences, manufacturing, and other industries. Sharjah Innovation Park is forging the future of 3D printing in the region.

DOST's AMCen uses 3d printing technology to honor PH national hero

The project will highlight and promote available high-end technology of AMCEN that will produce Rizal's 12.5-ft 3D-printed statue as an icon of Rizal as a Filipino Scientist.

As a showcase of the 3D printing capability of the Advanced Manufacturing Center (AMCen) of the Department of Science and Technology (DOST) and to display its capability in creating complex and big structures using additive manufacturing technology, the first and largest 3D-printed monument of our national hero will be built. This is to commemorate Dr.

Jose P. Rizal's 125th year of martyrdom this coming 30 December 2021.

Made by Professor Manuel Sicat of the University of the Philippines, College of Fine Arts, the monument is made of Acrylonitrile Styrene Acrylate (ASA), with reinforced steel inside that can withstand winds of 330kph and a 7.0 magnitude earthquake. The material used is also known for its high-quality mechanical properties that can resist strong impact and high temperature as well as ultraviolet (UV).

The initiative to create a 3D Rizal monument is also anchored on the desire of the Department of Science and Technology to pursue the development and innovation of additive manufacturing technology, production, processes, and materials in the country.

The making of the tallest 3D printed Rizal monument in full swing.

With the said project, the DOST along with its collaborating proponent, the Metals Industry Research and Development Center, seeks to encourage local enterprises to team up with them to explore and adopt additive manufacturing technology to improve production processes attuned to the demands of the 4th Industrial Revolution.

AMCen's capacities such as 3D Scanning, Printing, Modeling, and Design Optimization, Virtual Warehousing, and Remanufacturing pitched to make a design more diverse and improved as it aims to be the premier hub for developing the next generation of manufacturing engineering poised to revolutionize production processes of different industries.

The unveiling of the monument will happen on 30 December 2021, following the celebration at the Rizal Monument, Rizal Park, Manila in a simple ceremony to honor the martyrdom of Dr. Jose P. Rizal and his works and contributions in the field of science. This will be live-streamed via the DOST FB page. (Mark Lavien R. Inocencio, DOST-STII)

Intech Additive Solutions installs its Metal 3D Printing system at IIT Madras

Intech has emerged as the front-runner over stiff competition from competitors and has successfully sold its powerful high-precision Laser Powder Bed Fusion (LPBF) Metal 3D Printing System, iFusion SF1, to the prestigious IIT Madras.

iFusion SF1 will significantly aid IIT Madras in advancing its Metal 3D Printing research capabilities and developing new components for various industries. With build dimensions of 150mm dia x 180mm ht., iFusion SF1 is primarily intended for low-batch production of small to mid-size components and New

Alloy parameter development. The cost-effective iFusion SF1 also delivers parts-per-build at a high rate and is one of the best entry-level Metal 3D Printers to facilitate the adoption of the Additive Manufacturing (AM) ecosystem.

iFusion SF1 is integrated with Intech's Build Preparation Software – AMBuilder. Intech has also provided IIT Madras with its optional parameter optimization software – AMOptoMet, which predicts the ideal print parameters to achieve higher productivity and better surface finish.

"We want our students, research scholars, and faculty to be familiar with the latest cutting-edge technologies by working on industry-oriented projects that benefit their careers. In addition, we plan on doing a lot of R&D using the AM system. We will be working on new material development and manufacturing new components for various industries at our Joining & Additive Manufacturing Laboratory," says Dr. Ravi Kumar N. V, Professor & HOD, Metallurgical & Materials Engineering, IIT Madras.

"We were thrilled to know that an Indian company, Intech Additive Solutions, has successfully developed an AM system 'iFusion SF1' with integrated software 'AMBuilder' for build processing and 'AMOptoMet,' which provides us with the ability to optimize the build process parameters for new alloys. Traditionally, it would take several weeks or months to optimize the parameters for new materials through a physical iterative process. Using AMOptoMet, it happens in minutes. Our collaboration with Intech also aims towards developing the ecosystem for Metal AM Technology in India for self-reliance," says Dr. Murugaiyan Amirthalingam, Incharge – Joining and Additive Manufacturing Laboratory, Assistant Professor, Metallurgical & Materials Engineering, IIT Madras.

"It is our privilege to partner with IIT-Madras, recognized globally as a top-notch engineering institute. With over 70% of the components in the iFusion manufactured or sourced indigenously – winning this contract from IIT-Madras against established global players further bolsters our confidence that Intech is on track in putting India on the Global Metal AM Map with homegrown products and technologies," says John Fredrick James, Business Development Manager at Intech Additive Solutions, Bengaluru. With this deal, Intech continues to move forward in its vision of supporting technological advancements in Additive Manufacturing.

Primaeam Inaugurates Additive Manufacturing Centre In Chennai

Primaeam Solutions Pvt. Ltd., an additive parts manufacturing company, inaugurated its new Additive Manufacturing Customer Experience Centre, Innovation & Incubation Centre for Healthcare in Chennai.

Mr. S. Pankaj Kumar Bansal, IAS, Chairman & Managing Director, TIDCO, inaugurated the centre in the presence of Dr. S. Christopher, Former Chairman – DRDO, Dr. N. Vivek, MDS, Dean- SRM Dental College and Dr. Rita Christopher, Dean – NIMHANS.

The 10,000 sq. ft. centre, which came at an investment of Rs 20 Cr, will allow the company to develop its position as a technology leader in additive manufacturing service bureau with technologies such as Electron Beam Melting (EBM), Selective Laser Sintering (SLM), Fused Deposition Modelling (FDM), Stereolithography (SLA), Multi Jet Fusion (MJF), and Continuous Filament Fabrication with Fiber reinforcement (CFF). Primaeam's Innovation & Incubation Centre will provide access to the software and further give a physical shape to the design through the company's in-house world-class Additive Manufacturing facility.

During the inauguration, Mr. S. Pankaj Kumar Bansal, IAS, Chairman & Managing Director, TIDCO, said, "We are proud of Primaeam for launching the Additive Manufacturing Centre and for partnering with SLM and Materialise. Companies like Primaeam can demonstrate the capacity of Tamil Nadu in the field of precision making, aerospace and defence technology to the world market leaders."

The partnership with Belgium based company Materialise, for the Incubation centre is the first of its kind in India. The partnership will benefit the Healthcare segment and provide access to a state-of-the-art Materialise Mimics Innovation suite helping the start-ups, medical device companies, hospitals, and academics.

Commenting on this partnership, Mr. Karthik Rajendiran, Managing Director, Primaeam Solutions Pvt. Ltd. said, "Additive manufacturing is already an integral part of worldwide production system today and digitalisation strategy. The opening of our new centre in Chennai will further shorten the development time for the Indian Industries. It will also help improve patient care by giving shape to innovative ideas, wide-ranging design concepts and products from these new designs."

Mrs. Ayushi Bhan, Account Manager, Materialise Medical India, said during the signing of the agreement, "The partnership with Primaeam in its establishment of the first incubation centre for medical 3D printing, fully powered by Materialise medical software in India, is an important step in our efforts to expand the access of 3D printing technology to local start-up, medical device companies, hospital and academic Institutions. Our software is essential in enabling personalized solutions in the medical industry, and with each new partnership, we are bringing greater patient-specific care to more hospitals for a better, healthier world."

The partnership with SLM Solutions, Germany will be a turnaround in the Indian Engineering and Aerospace Industries. The initiative aims to promote applied research collaboration activities in the areas of indigenous metal powder development and necessary parameter requirements.

Mr. Srinivas Shastry, Managing Director, SLM Solutions India, pleased on the partnership said, "At SLM Solutions, we are excited to have Primaeam as our customer with our trailblazing SLM 280 twin 700w machine which would empower Primaeam in industrializing and growing their 3D Metal printing offerings to both Indian and Global markets. We are proud to have Primaeam using our reliable SLM technology to support and to realize AM business cases of their customers, from prototype up to serial production. Providing consulting services throughout the customer's AM journey with emphasis on DFAM, new powder and parameter development to suit the customer-specific requirements."

Kanoo Industrial and Energy launches 3D manufacturing and reverse engineering solutions

In partnership with Imaginarium, for KSA manufacturing companies

Dammam : Kanoo Industrial and Energy, the leading provider of engineering services to the industrial sector

in the Kingdom of Saudi Arabia (KSA) and the GCC region, announced the launch of additional manufacturing and reverse engineering solutions using 3D technology. The company has partnered with Imaginarium, India's leading 3D manufacturing technology company and home to the largest collection of 3D printing products and systems.

Kanoo's advanced solutions for additive manufacturing and reverse engineering have the advantage of being versatile for different industrial uses of manufacturing companies in the Kingdom. Contributing significantly to the reduction of prototype production costs, the solutions will increase efficiency and turnaround time of small-scale production operations. Additionally, they aim to improve and simplify the production process and support electronic storage, which aids in managing space and inventory as well as aim to preserve resources and energy during the production processes in the Kingdom.

Commenting on the occasion, Mr. Ali Abdallah Kanoo, President of Kanoo Industrial and Energy, stated: "We are pleased to offer additional manufacturing and reverse engineering solutions to our clients in the Kingdom of Saudi Arabia. With regards to sophisticated three-dimensional manufacturing techniques, clients benefit from the provision of innovative methods that enhance production efficiency across their various activities and businesses. We are proud to be partnering with Imaginarium to provide these solutions, reiterating our immense confidence that through this collaboration we continue to contribute to fulfilling the needs and demands of industries across the Kingdom."

Mr. Ahmed Fawzi Kanoo, Vice-President of Kanoo Industrial and Energy, said: "At Kanoo Industrial and Energy, we are collaborating with the world's best equipment distributors and pioneers of the technology sector to deliver customers the best possible services and solutions, helping their businesses towards achieving new levels of excellence and quality. Additive manufacturing contributes to the Kingdom's Economic Vision 2030, through the development of a sustainable industrial foundation and localising advanced manufacturing techniques."

Kanoo Industrial and Energy is focused on providing customers with the best services and solutions that help them reach their goals. The company's activity extends to oil, gas and energy, industrial projects, machinery and utilities, and other industrial fields and engineering services in the Kingdom of Saudi Arabia, the United Arab Emirates, the Kingdom of Bahrain and the Sultanate of Oman.

Kanoo Industrial and Energy is a division of the Yusuf bin Ahmed Kanoo Group – one of the largest family-owned, independent companies in the Middle East. The company operates in accordance with the national objectives and visions of the GCC, thereby promoting economic growth and prosperity in key industrial sectors.

Imaginarium provides 3D printing solutions to more than 50 industrial areas. Amongst these solutions are Imaginarium Rapid, a comprehensive, all-inclusive solution for 3D manufacturing needs, Imaginarium Life, serving the special needs health-care sector, Imaginarium Solutes, providing comprehensive working coverage for the best results in production processes, and Imaginarium Precious, which provides sophisticated 3D printing techniques for intricate, beautiful pieces.

Hitachi Metals Singapore and A*Star Extend Additive Manufacturing Collaboration

Hitachi Metals Singapore, A*Star Extend Joint Lab Collaboration In Metal Powders To Develop New Solutions For Local Additive Manufacturing Players

Hitachi Metals Singapore (HMS) and A*STAR's Singapore Institute of Manufacturing Technology (SIMTech) have extended by three years their existing jointlab collaboration to develop metal powders for additive manufacturing (AM) to enable players in the local AM ecosystem to reap more benefits from 3D printing. An additional investment of S$8.5 million brings the joint lab's total investment to S$14 million over six years1.

Metal powders customised for AM processes are an emerging technology; most metal powders used in AM today are made for traditional manufacturing processes. Metal powders customised for AM processes could help manufacturers achieve breakthroughs in the performance of printed parts, such as in terms of quality.

The collaboration will continue to help HMS build capabilities to venture into AM by developing and producing metal powders for AM processes in sectors such as aerospace, automotive, oil and gas, and semiconductors.

Combining HMS's expertise in materials with SIMTech's capabilities in advanced manufacturing, the joint R&D team will continue to undertake projects in three key areas: develop new high-performance metal powders for metal AM; develop AM processes and relevant post-processes for industrial components; and develop quality assurance methodologies to evaluate the quality of printed parts.

In the past three years, the joint R&D team has established methodologies to optimise metal powders for AM processes, developed end-to-end AM solutions for industrial components, and developed a new process flow for quality assurance. In the next three years, the team will continue to co-innovate and co-develop technologies and processes for high-performance metal powders aligning to the requirements of the industry, and refine powder atomisation process recipes to improve yield and quality.

Players in the local AM ecosystem that could benefit from the joint lab's R&D work include product owners, service bureaus, and AM equipment makers. Local companies can use AM materials developed at the joint lab to design new products and spare parts, or package the AM materials in their equipment processes. Product owners will be able to achieve faster product development with better performance and qualifications through co-innovation, while service bureaus will be able to leverage a wide range of highperformance materials to expand into higher-value businesses. AM equipment makers will be able to develop equipment solutions to better address the quality requirements of critical applications.

3D Metalforge, one of the most established additive manufacturers with manufacturing sites in Houston and Singapore and sales offices in Australia, is using Hitachi Metals' AM powder and metallurgical knowhow to enhance its value proposition for oil and gas parts printing, which require high performance quality such as high corrosion resistance and high strength. Hitachi Metals is looking forward to working with more such AM ecosystem players to bring AM adoptions to greater heights.

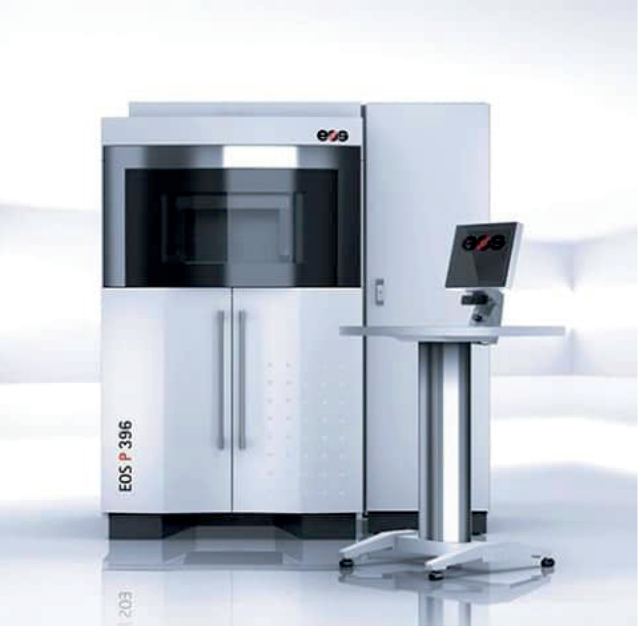
Housed at HMS's facility, the joint lab features an atomiser from SIMTech and is equipped with advanced powder-handling and quality assurance facilities. The atomiser can produce reactive powders such as titanium-based and aluminium-based ones, and nonreactive powders such as nickel-based and cobalt-based ones. It can also produce powders in smaller quantities to support local AM ecosystem from the development stage.

Dr Hajime Murakami, Chief Technology Officer of Hitachi Metals, Ltd, said: "Materials make the difference in the quality of AM printed parts. Having this joint lab with SIMTech and our local AM team in Singapore, we are looking forward to enhance our support to Singapore's AM ecosystem and to help accelerate adoption of AM and create value with our powder and the optimal processes jointly developed with SIMTech."

Dr David Low, Executive Director of A*STAR's SIMTech, said: "The quality of 3D-printed parts is crucial in manufacturing, and metal powders are an integral component. Publicprivate partnerships like the SIMTech – HMS joint lab continue to play an important role in encouraging businesses to adopt advanced manufacturing technologies to improve their processes, products, and services to become more competitive. We are excited to embark on another three years of co-innovation with Hitachi Metals Singapore to develop additive manufacturing solutions for Singapore and beyond."

Mr Lim Tse Yong, Vice President of Conglomerates for the Singapore Economic Development Board (EDB), said, "Congratulations to Hitachi Metals and SIMTech on the extension of their joint lab collaboration. This joint lab is a good example of how companies can forge partnerships with Singapore's public research ecosystem to drive the development of technologies including additive manufacturing. Such public-private partnerships will contribute to Singapore's ambition to be a global business, innovation and talent hub for advanced manufacturing."

Objectify expands their fleet of Additive manufacturing systems



Objectify has purchased a new selective laser sintering (SLS) system that promises enhanced capacity for a growing client base. The announcement follows on Objectify Technology's recent introduction of new SLS Flexible material, a new shot peening finishing service and new color options. The new machines are part of the company's expansion plan.

Objectify Technology is an established high volume additive production company that uses Powder Bed Fusion(PBF) printing systems to create polymer objects. The company focuses on the manufacturing space between prototyping and injection molding, where volumes are notoriously too low to profitably run injection molds. The company can scale its production runs from a single unit to tens of thousands of parts.

The company plans to increase its fleet of EOS selective laser sintering systems to increase its market share. The company has now completed the installation of

EOS Formiga P396 machines at the Delhi, Patparganj manufacturing plant. Objectify Technology already operates two Formiga P110 and P396 SLS machines. These latest additions bring the company's machine count to a total of 3.

The P396 systems enhance Objectify Technology's client offering because the systems operate a more powerful laser. This laser reduces energy consumption by up to 38%—a huge potential saving in a country.

The additional lasers also take the strain off each laser in the array, which allows Objectify Technology to lessen downtime between builds. The improved array ultimately benefits clients through faster turnaround times without compromising the quality of the build.

Porsche invests in Intamsys to get into additive manufacturing

Porsche has invested in INTAMSYS, a company that specialises in 3D printing from prototype manufacturing to volume production. As with the gradual digital transformation that the automotive world is undergoing, 3D printing is seeing steady progress and to benefit from it, Porsche is getting into the application of this method.

The sports car manufacturer is looking into exploring the possibilities of 3D printing technology to develop and manufacture small-series parts and components.

Launched in 2016 with its headquarters in China, products of INTAMSYS have been used in the fields of aerospace, automotive, medical, scientific research and much more. Jens Puttfarcken, President and CEO of Porsche China conveyed that the company is planning to boost the application of additive manufacturing technology and benefit from 3D printing in terms of both product and process to attain more flexible production and customisation services. "Digital transformation has seeped into every aspect of production and daily life, and is listed as one of the core issues in Porsche's operation strategy," he added.

As Porsche is trying to expand the application of additive manufacturing to establish itself as a digital mobility solution provider in the luxury car segment, INTAMSYS too said that this collaboration will help the company's products to get recognition. "In the future, we at INTAMSYS will continue our close cooperation with Porsche to develop more innovative products, expand the application of additive manufacturing and empower the digital manufacturing transformation of the automotive industry, in a bid to benefit more customers with high-tech solutions," said Charles Han, CEO of INTAMSYS.

In an earlier report, Porsche announced that it created a new 3D-printed bodyform full bucket seat for some of its models. These seats will be available as part of the new performance parts offering from Porsche equipment. The company also informed that these seats are suitable for various Boxster, Cayman and 911 models.

SLM Solutions and MAHLE Strengthen their Additive Manufacturing cooperation

SLM Solutions is excited to announce its cooperation with MAHLE, one of the world's leading automotive suppliers and development partners from Stuttgart, Germany. MAHLE will utilize SLM Solution's systems to empower OEMs and Tier 1 suppliers to fulfill their need for metal Additive Manufacturing in serial production. By joining forces, the two companies are improving the speed and quality of automotive components in both prototype and serial production.

The components will be printed with aluminum and stainless-steel alloys, which are remarkably resilient, corrosion resistant, and topology optimized to reduce overall weight. Structures that are too complex for conventional manufacturing methods are easily produced while still adhering to the strict quality standards of the automotive industry.

“3D printing for mobility just makes sense,” comments Sam O'Leary, CEO of SLM Solutions. “Our cooperation with MAHLE revolutionizes the production of automotive components by making them better, stronger, and lighter, not to mention more climate-neutral.”

MAHLE's strategic 3D printing center in Stuttgart will play a crucial part in strengthening its role as the leading development partner for OEMs by revolutionizing the pace of prototype production. The new center will reduce production time from several months to just a few days, thereby simultaneously accelerating the drive towards climate-neutral mobility. The focus will rest primarily on components from the fields of thermal management, mechatronics, and electronics.

“The development of new systems and components has to be much faster today than it was a few years ago, especially when it comes to solutions for sustainable CO2-neutral drive systems,” says Michael Frick, Chairman of the MAHLE Management Board (ad interim) and CFO. “With our new 3D printing center and SLM Solutions as a technology partner, MAHLE is once again stepping up the pace in its strategic fields, for example, E-mobility.”

This collaboration formalizes the existing cooperation between the two companies. Around the world, an estimated 120 SLM Solutions systems for automotive applications are already running at OEMs and Tier 1 suppliers. A dedicated Application Engineer from SLM Solutions will support MAHLE at every step of the journey, from prototyping to series production and the production of manufacturing equipment.

Introduction to Composite Additive Manufacturing

Chinmay Saraf

The article provides a primer and takes you through the landscape of composite additive manufacturing

Composite Additive Manufacturing: Part 1 - Introduction and Landscape

Additive manufacturing has evolved considerably since its inception, it has transformed from being just a prototyping technology to now being used in wide range of domains and production applications owing to the contribution from researchers and the industry adopters. The aim of this article is to introduce the reader to Composite Additive Manufacturing and provide a glimpse into its current landscape.

Composites are materials made by combining two or more materials with notably different chemical or physical properties. The result composite material is usually exhibits significantly higher mechanical properties than the principal materials. Some of the standard composites used in the industry are carbon fiber, glass fiber, Kevlar, and natural fiber-reinforced material. Today, composites are used in various industry sectors such as aerospace, automotive, sports equipment, machine tools, and robotics.

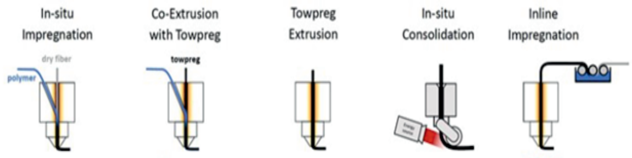
Manufacturing and designing composite material is technologically challenging. One of the most critical challenges is the manufacturing process of the composites. Several researchers have shown that misalignment of even a degree in the laminate (sheet of composite) can significantly degrade mechanical properties. In addition to this, the design process of composites is complex and requires a skilled workforce. Additionally, designing new composites and manufacturing novel composites with the desired performance is critical.

Composite Additive Manufacturing provides a solution to this manufacturing challenges and enables to manufacturing the fully functionally composite component layer by layer, which has mechanical and chemical properties close to the traditionally manufactured composite.

Earliest Works on Composite Additive Manufacturing

The earliest industrial development in composite additive manufacturing was a photosensitive resin made by a French company "Optoform." The company mixed ceramics and composite materials into photosensitive resin. Post-curing, the photosensitive resin had properties of composite materials. Later the company Optoform was acquired by 3D Systems. After which, DSM Somos introduced new resins in April 2005. The resin was using a nanocomposite material with high-elongation material and low-durometer material.
During this era of 2012-2015, various companies evolved around the technology of hybrid additive manufacturing and composite additive manufacturing. Suppose we categorize the composite 3D printing landscape based upon the foundation years of some of the significant companies. In that case, it can be distinguished that most of the companies were formed during 2017-2021. This fact helps to identify that composite additive manufacturing technology is yet under the development phase, as it is not mature. Additionally, when these companies and their technology mature more, we will likely see further development in composite additive manufacturing.

Recent Composite Additive Manufacturing Methods Used in Industry



Source: Alexander Matschinski, Virtual Symposium on AFP and AM, TU Munich, Chair of Carbon Composites (LCC), Sep. 2020.

Based on the evolutions of this technology various companies and researchers have approached this process with different tecniques. The commonly used approaches can be divided into five types: in-situ impregnation, co-extrusion with towpreg matrix, towpreg extrusion, in-situ consolidation and inline impregnation.

Dry fiber is introduced to the print bed through a nozzle in the in-suit impregnation. After which, the epoxy and the resin are added at an elevated temperature.

In co-extrusion with the towpreg matrix, the tape is added to the print bed through the nozzle. Materials are added to the matrix tape through an attachment in the nozzle.

The towpreg extrusion is one of the most straightforward processes of composite additive manufacturing as only a single nozzle is used to print the composite materials. The process works like the fused deposition modeling method and can be added to traditional FDM printers.

In-situ consolidation is also known as the automated fiber placement process. The fiber is placed through the nozzle and heated with added support (laser, heat source, heated epoxy).

The inline impregnation process integrates the advantages of both traditional manufacturing and additive manufacturing. In this process, the composite fibers are prepared through conventional manufacturing and printed on the print bed through a nozzle.

Few other approaches are also seeing traction in recent times and we have attempted to provide a snapshot on a few of them.

Robot-based fiber reinforced plastic additive manufacturing is a robotic arm used to print the material. The advantages of robotic additive manufacturing over cartesian additive manufacturing are robotic additive manufacturing does not require the print bed to print the material, and added printing axis (from 3 axes to 5 axes) can be added easefully. Moreover, the process of robotic additive manufacturing is considered to overcome several technological challenges of cartesian-based additive manufacturing. In addition to this, the robotic arm can be attached with diverse types of nozzles and help integrate different composite additive manufacturing methods, which is challenging with cartesian-based additive manufacturing.

Additive Molding is a process that automates the additive manufacturing and moulding of complex items made of continuous 3D-aligned fibres (such as carbon and glass), thermoplastics, and components.

Fiber Placement is an automated composites manufacturing technique that involves heating and compacting pre-impregnated synthetic resin non-metallic fibres on often complex tooling mandrels.

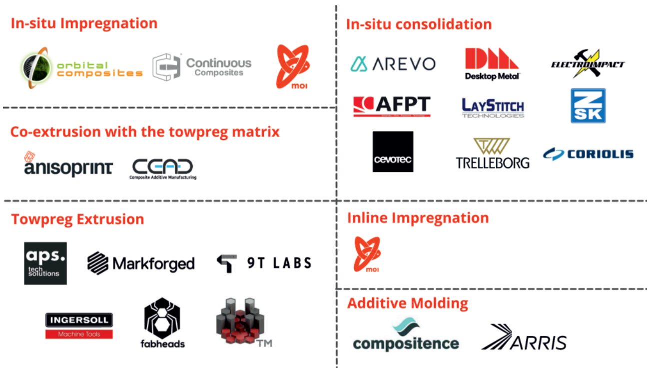
Fiber patch placement (FPP) technology is a robotic manufacturing process used to create fibre composite items.

TFP, or Tailored Fiber Placement, is a novel and extremely disruptive technology for composite additive manufacturing that uses a stitching approach to place fibrous materials in specified routes.

To make the material printable, the fibre strands in conventional fiber-filled filament are cut very short. The most evident disadvantage is that there is limited overlap between the fibres and no fibres that span adjacent layers. As a result, parts produced with fiber-filled materials are frequently just slightly stronger or stiffer than ordinary 3D printed ones.

3D printing using continuous fibre is exactly what it sounds like. Instead of embedding millions of half-millimeter-long strands of fibre into the filament during manufacturing, a spool of fibre is utilised to embed very long strands of fibre into items as they are printed. Because it better resembles the production process of traditional carbon fibre products, where long strands of fibre are piled on top of one another in a resin, continuous fibre 3D printing gives far higher strength and stiffness.

The following infographic and table summarises key companies in the Composite Additive Manufacting Landscape in the knowledge of the author and AM Chronicle.:



Sno	Company	Technology Specialization
1	Arris Composites	Additive Molding
2	Ingersoll Machine Tools	Towpreg Extrusion
3	Markforged	Towpreg Extrusion
4	Anisoprint	Co-extrusion with the towpreg matrix
5	CEAD Group	Co-extrusion with the towpreg matrix
6	Continuous Composites	In-situ impregnation

7	9T lab	Towpreg Extrusion
8	APS Technological Solutions	Towpreg Extrusion
9	Fabheads Automation	Towpreg Extrusion
10	MOI Composites	In-situ impregnation
11	Orbital Composites	In-situ impregnation
12	Mantis Composites	Towpreg Extrusion
13	AREVO	In-situ consolidation
14	Desktop Metal	In-situ consolidation
15	Electroimpact	In-situ consolidation
16	AFPT Composites	In-situ consolidation
17	Trelleborg	In-situ consolidation
18	Compositence	Additive Molding
19	Coriolis	In-situ consolidation
20	Cevotoc	In-situ consolidation
21	Laystitch	In-situ consolidation
22	ZSK Machines	In-situ consolidation

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ABOUT THE AUTHOR

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Chinmay Saraf is a scientific writer living in Indore, India. His academic background is in mechanical engineering, and he has substantial experience in fused deposition-based additive manufacturing. Chinmay possesses an M.Tech. in computer-aided design and computer-aided manufacturing and is enthusiastic about 3D printing, product development, material science, and sustainability. He also has a deep interest in "Frugal Designs" to improve the present technical systems.

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- MARCO POLO — PROTOTYPING • TOOLING • COMPONENTS
- Markforged
- materialise — innovators you can count on
- METAL AM — THE MAGAZINE FOR METAL ADDITIVE MANUFACTURING
- NAMIC — NATIONAL ADDITIVE MANUFACTURING INNOVATION CLUSTER
- 铖联激光 CHAMLION
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