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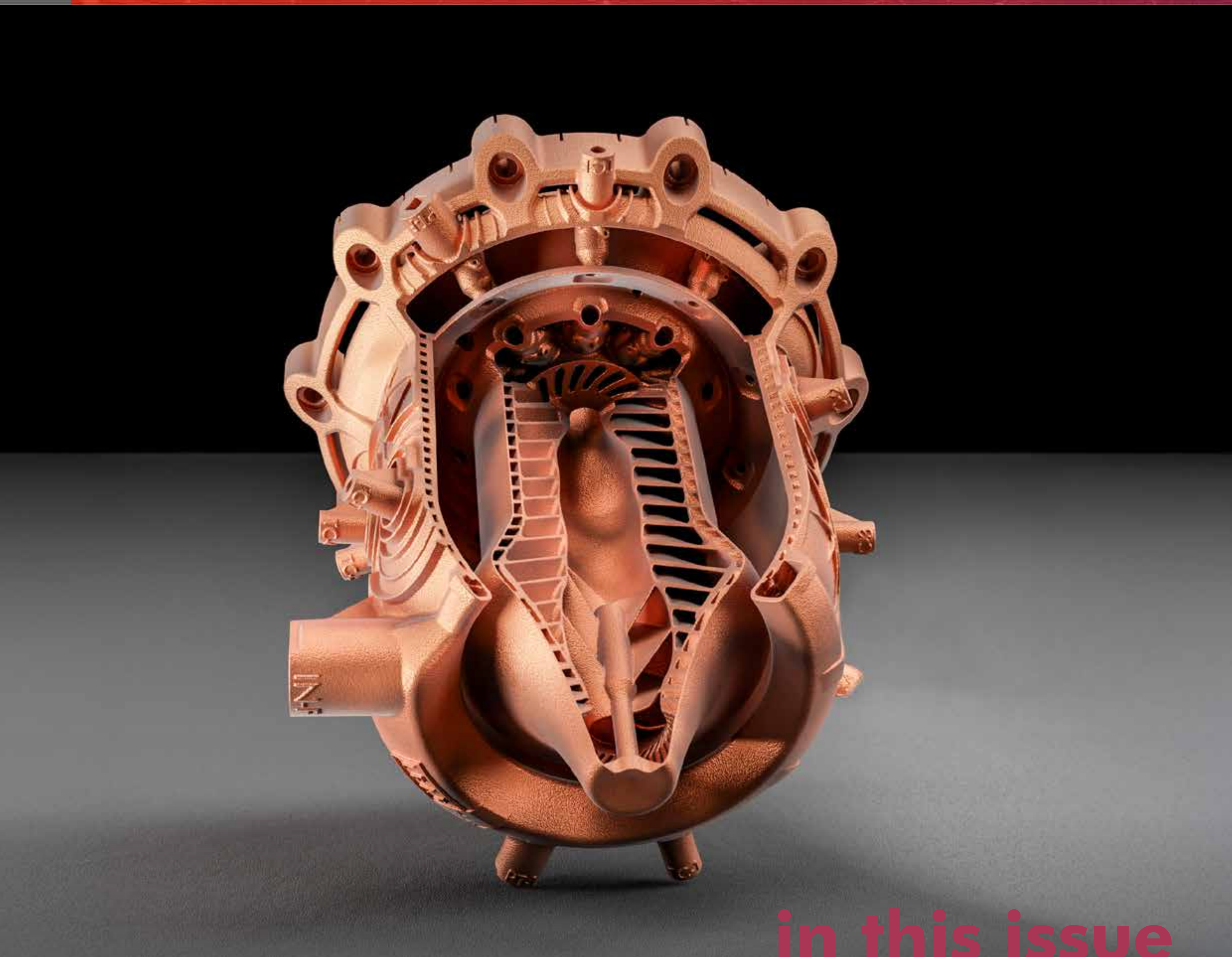
THE MAGAZINE FOR THE METAL ADDITIVE MANUFACTURING INDUSTRY

METAL AM



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LEAP 71: ENGINEERING BEYOND CAD

AM & EUROPEAN DEFENCE – A CALL TO ACTION

SURFACE ENGINEERING WITH REM & NASA

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Publisher & Editorial Offices
Inovar Communications Ltd

11 Park Plaza
Battlefield Enterprise Park
Shrewsbury SY1 3AF
United Kingdom

Tel: +44 (0)1743 469909
www.metal-am.com

Managing Director & Editor
Nick Williams, nick@inovar-communications.com

Group News Editor & Director
Paul Whittaker, paul@inovar-communications.com

Advertising Sales Director
Jon Craxford
Tel: +44 (0)207 1939 749
jon@inovar-communications.com

Assistant News Editor
Charlie Hopson-VandenBos
charlie@inovar-communications.com

Editorial Assistants
Amelia Gregory, amelia@inovar-communications.com
Emma Lawn, emma@inovar-communications.com

Technical Consultant
Dr Martin McMahon

Digital Marketer
Mulltisa Moung, mulltisa@inovar-communications.com

Production Manager
Hugo Ribeiro, hugo@inovar-communications.com

Operations & Partnerships Manager
Merryl Le Roux, merryl@inovar-communications.com

Office & Accounts Manager
Jo Sheffield, jo@inovar-communications.com

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METAL ADDITIVE MANUFACTURING MAGAZINE

From strategy to deployment: Unlocking AM's role in modern defence

Additive Manufacturing is no longer on standby in defence logistics. In the US and China, AM is being embedded into operational frameworks – resourced, integrated, and deployed. Europe, by contrast, remains stuck in strategy mode, with a fragmented approach and hesitant adoption. As contributors to this issue of *Metal AM* stress, there is a real risk of Europe falling behind – and not for lack of capability, but for lack of coordination.

This issue explores the vital role AM can play in supporting logistics that are digital by design, partner-integrated, and adaptable to shifting operational demand; precisely the attributes modern defence operations require. Whether enabling in-theatre sustainment or accelerating the development of next-generation defence platforms, AM has proven itself as an enabler of speed, resilience, interoperability, and security.

But defence stakeholders now seek outcomes, not technology: reduced downtime, agile response, and robust localised production. To meet these expectations, the AM industry must evolve from supplier to strategic partner – integrated within a coherent ecosystem, not isolated in pilot programmes.

While Europe may lack a single military force, through NATO it has a collective defence framework capable of unified action. As threats intensify and the burden of readiness grows, so does the need for an agile, coordinated industrial base. AM can meet this need – but only if it is embedded, connected, and prepared to scale.

Readiness is not a future ambition; it is a present imperative – and AM is ready to deliver.

Nick Williams
Managing Director

Cover image
A 5,000 Newton aerospike rocket engine, generated entirely using LEAP 71's Noyron software and manufactured by Aconity3D (Courtesy LEAP 71)

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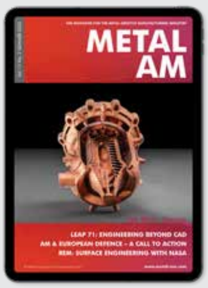


Regular features...

Industry news

To submit news please contact Paul Whittaker, Group News Editor: paul@inovar-communications.com

Pratt & Whitney successfully tests rotating AM turbine parts for its TJ150 engine

Pratt & Whitney, an RTX business headquartered in East Hartford, Connecticut, USA, has successfully completed a series of tests on its additively manufactured TJ150 turbine wheel. According to the company, these positive results mark a significant step forward in its AM capabilities, as the turbine wheel is reportedly one of the first rotating parts to be produced by Additive Manufacturing.

The TJ150 is a compact, high-performance turbojet engine that can be manufactured quickly while meeting reliability and scalability (both production and size) requirements. With 68 kg (150 lb) of thrust, it can light and operate at high altitudes and is designed to power a variety of autonomous systems and weapons for domestic and international customers.

"Our TJ150 engines exemplify the modified off-the-shelf solutions that Pratt & Whitney has available for advanced and cost-efficient effectors at scale," stated Chris Hugill, Executive Director of Pratt & Whitney Gatorworks. "Production capacity is in place today, ahead of demand, which strongly positions our TJ150 engine for a range of high-rate production scenarios."

Pratt & Whitney Gatorworks was the driving force behind the initial TJ150 redesign, drawing on close collaboration between its technical and manufacturing teams and the RTX Technology Research Center. Leveraging a process called 'unitisation', engineers decreased core module part count from over fifty to just a handful, reducing production time and cost. Using in-house capabilities, they designed and tested the engine within eight months. This latest round of testing marks a significant step toward moving from static structures to rotating hardware.

"Today we're fielding and flying static engine parts. Rotating engine components, especially for expendable class applications, is the next step," added Hugill. "Our testing confirms we're on track with the engine performing at full operating speeds and temperatures and meeting expected life duration. This technology is transforming how we design, develop and deliver capabilities faster."

www.prattwhitney.com

The TJ150 engine (Courtesy Pratt & Whitney)

Additively manufactured rotating turbojet turbine wheels for the TJ150 engine (Courtesy Pratt & Whitney)

Ursa Major wins $32.9 million contract for Stratolaunch hypersonic engine

Ursa Major Technologies Inc, located in Berthoud, Colorado, USA, has secured a $32.9 million contract to develop and deliver sixteen upgraded Hadley H13 rocket engines to Stratolaunch.

The multi-year agreement is said to build on a history of successful flight partnerships and supports a growing operational cadence.

"This contract directly supports US hypersonic test infrastructure and the broader imperative to accelerate high-speed flight programs that deliver for national security," said Dan Jablonsky, CEO of Ursa Major. "As the proud partner and hypersonic propulsion provider to Stratolaunch, we're focused on getting real capability into the field – faster, at scale, and without compromising performance."

The Hadley H13 is a mission-upgraded variant that increases engine reusability with additional starts, driving down cost per flight while supporting new test objectives and mission profiles.

Ursa Major's Hadley engines have successfully powered multiple Talon-A test flights, including sustained Mach 5+ flight and vehicle recovery, demonstrating the engine's performance under operational conditions.

www.ursamajor.com
www.stratolaunch.com

Ursa Major has secured a $32.9 million contract to develop and deliver sixteen upgraded Hadley H13 rocket engines to Stratolaunch (Courtesy Stratolaunch)

Divergent to support US Air Force's $46 billion EWAAC programme

Divergent Technologies, Inc, located in Torrance, California, USA, has been selected as part of the US Air Force's Eglin Wide Agile Acquisition Contract (EWAAC), a multiple-award, $46 billion Indefinite Delivery/Indefinite Quantity (IDIQ) vehicle designed to accelerate the development and fielding of advanced weapon systems.

As part of the EWAAC programme, Divergent will apply its proprietary Divergent Adaptive Production System (DAPS) to deliver next-generation aerospace and defence technologies. DAPS is an end-to-end engineering and manufacturing platform that integrates AI-driven design, industrial-rate Additive Manufacturing, and universal robotic assembly. It enables the development and production of structures with higher performance, speed, and scalability than conventional manufacturing systems.

The system will allow the US Air Force to conduct rapid R&D on both new and modified legacy weapon systems, allowing for faster design and production of higher-performing munitions. Using DAPS, Divergent can reportedly deliver clean-sheet designs through to flight-test-ready prototypes in a matter of months.

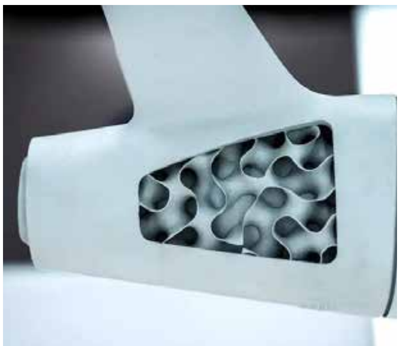
"EWAAC is built to move quickly from concept to fielded system. DAPS enables that pace due to its fully integrated system that utilises end-to-end production of advanced systems. It can produce systems faster, leaner, and with more flexibly than traditional defence manufacturing," said Lukas Czinger, president & CEO of Divergent.

Under the contract, Divergent will focus on delivering mission-critical subsystems and components that meet stringent performance, reliability, and survivability requirements. Its modular development process and digital production platform are designed to improve manufacturability while reducing technical and supply chain risk.

Managed by the Air Force Life Cycle Management Center (AFLCMC) at Eglin Air Force Base, EWAAC is structured to streamline acquisition and accelerate the deployment of next-generation capabilities to counter near-peer threats.

Divergent's selection is said to reflect its growing role in defence modernisation and underscore its readiness to support the Air Force's agile development and deployment priorities.

www.divergent3d.com
www.ewaacportal.com


DAPS will allow the US Air Force to conduct rapid R&D on both new and modified legacy weapon systems (Courtesy Divergent Technologies)

Velo3D and US Navy R&D collaboration to develop aerospace and defence applications

Velo3D, Inc, Fremont, California, USA, has announced a Cooperative Research and Development Agreement (CRADA) with two US Naval Air Systems Command (NAVAIR) federal laboratories, Naval Air Warfare Center Aircraft Division (NAWCAD) and Fleet Readiness Center East (FRC East), to advance Additive Manufacturing capabilities for the United States aerospace and defence sectors.

The partnership aims to enhance the understanding of AM for the production of complex, high-performance components used in military aircraft and systems (Courtesy Velo3D)

Under the terms of the four-year agreement, Velo3D will collaborate with NAWCAD and FRC East to explore and characterise advanced materials tailored for military flight hardware. The partnership aims to enhance the understanding of AM for the production of complex, high-performance components used in military aircraft and systems, ensuring these parts meet the rigorous standards required for defence operations.

"This CRADA with NAWCAD and FRC East represents a significant milestone in advancing our ability to provide precise, repeatable and scalable Additive Manufacturing solutions for the defence industry," stated Arun Jeldi, Chief Executive Officer for Velo3D. "By focusing on engineering-driven solutions, we are helping to bridge the gap toward qualifying AM flight hardware and enabling the production of mission-critical parts that meet the stringent reliability and performance demands of defence applications."

The collaboration will leverage Velo3D's Additive Manufacturing capabilities, including its Sapphire family of metal AM machines, which are designed for high-precision, high-performance parts. Velo3D's engineering team will work closely with NAWCAD and FRC East's technical experts to characterise and understand the manufacturing processes, developing applications and AM techniques that can meet the demanding qualification requirements and the real-world conditions of military applications.

The goal is reportedly to understand this advanced manufacturing capability that can produce part designs that not only meet the military's rigorous performance standards but also allow for rapid iteration, cost efficiency and flexibility in production.

"The collaboration brings together the shared expertise of NAVAIR and Velo3D to develop and expand the application of Additive Manufacturing technology for sustainment of Naval aviation platforms," added Paul Charron, Additive Manufacturing Lead, Fleet Readiness Center East, NAVAIR. "The utilisation of advanced technology, such as AM, drives positive fleet outcomes including improved mission readiness and increased system performance."

www.navair.navy.mil
www.velo3d.com

Elementum 3D included in $46 billion US Air Force EWAAC contract

Elementum 3D, based in Erie, Colorado, USA, has been selected by the US Air Force to be included in the Enterprise-Wide Agile Acquisition Contract (EWAAC) indefinite delivery/indefinite quantity (IDIQ) vehicle initiative.

This contract, capped at $46 billion through to 2031, funds an initiative to quickly meet PEO (Program Executive Officer) Weapons programme requirements, primarily emphasising Armament and Digital Trinity (agile software development, open architecture, and digital engineering, aimed at facilitating a digital transformation) air armament-related activities. The EWAAC IDIQ initiative will come from interagency collaborations and external agency allocations. It was stated that no predetermined funding will be issued.

EWAAC IDIQ's goal is to expedite the acquisition process with enhanced modernisation efforts, including weapons systems requirements development, research and development, testing and evaluation, production and fielding, prototyping, weapon design, system modelling, and demonstrations. The contract emphasises the implementation of digital acquisition and sustainment practices aimed at maintaining the Air Force's technological superiority.

Elementum 3D stated it will integrate its extensive metal Additive Manufacturing expertise and high-performance materials knowledge to support the open, agile, and digital armament mission.

www.elementum3d.com

GKN Aerospace celebrates delivery of 200th additively manufactured fan case mount ring

In April, GKN Aerospace Material Solutions has announced the successful production of its 200th additively manufactured fan case mount ring. The latest achievement was celebrated at GKN's Additive Manufacturing sites based in Trollhättan, Sweden, and in Newington, USA, where the rings are produced.

GKN Aerospace Material Solutions celebrates the production of its 200th AM fan case mount ring (Courtesy GKN Aerospace Material Solutions)

GKN Aerospace Material Solutions began Additive Manufacturing of the large fan case mount ring at the beginning of 2024 and subsequently celebrated the completion of its 100th unit in November of that year.

The company also announced that it has received full approval for its new production cell, and a second cell is now operational.

"We are on track to take part on the first flight featuring AM components - anticipated already in August 2025," it was stated in a post on LinkedIn. "These accomplishments are a testament to our team's dedication and innovation, driving remarkable advancements in aerospace manufacturing. Thank you to everyone involved for your hard work and commitment to excellence. Together, we are shaping the future of aerospace technology."

www.gknaerospace.com

ASTM and Nikon partner on defence manufacturing and workforce training

ASTM International and Nikon Advanced Manufacturing Inc have signed a Memorandum of Understanding to collaborate on strategic initiatives aimed at accelerating advanced manufacturing capabilities, with a particular focus on defence applications and workforce development.

The partnership will prioritise the co-development of comprehensive education, training, and personnel certification programmes tailored to Department of Defence needs, particularly those of the US Navy, and will be hosted primarily at the Nikon AM Technology Center in Long Beach, California. The Long Beach facility houses the company's most advanced large and ultra-large format Laser Beam Powder Bed Fusion (PBF-LB) metal Additive Manufacturing machines, alongside metallurgy and metrology capabilities. Education programmes at this facility will serve to train the next generation of manufacturing professionals, equipping them with the skills required to sustain and grow domestic production capacity.

In addition to joint education and research initiatives, the partnership will support engagement with federal agencies and pursue government-funded projects that promote manufacturing innovation. Nikon AM will also play an active role in ASTM-hosted events, including the ASTM International Conference on Advanced Manufacturing (ICAM), as well as co-led seminars and workshops.

"It has become increasingly clear that advanced manufacturing is critical to national competitiveness, and over the past couple of years, Nikon AM has been executing a strategic plan focused on onshoring these vital capabilities. In order to develop, build and operate the next generation of manufacturing equipment and solutions, we also need to inspire, educate and train the next-generation workforce about AM technology," stated Hamid Zarringhalam, CEO of Nikon AM. "Combined, Nikon AM and ASTM bring nearly 235 years of legacy in quality, precision, and integrity — names that people already know and trust."

Andrew G. Kireta, Jr, President of ASTM International, added, "For more than a century, ASTM has helped industries move from possibility to production by transforming markets, enabling standards, and assisting in technological developments. This collaboration with Nikon AM brings together two institutions with unmatched legacy and global recognition. Together, we're reinforcing the connection between workforce development, resilient supply chains, and national security — all while helping accelerate the adoption of advanced manufacturing at an industrial scale."

The MOU establishes a framework for the two organisations to collaborate in future opportunities while maintaining confidentiality and protecting intellectual property.

www.astm.org
ngpd.nikon.com

UK MOD embraces AM in new defence strategy, targets £110M savings

The UK Ministry of Defence has published its first Defence Advanced Manufacturing Strategy, which identifies Additive Manufacturing as crucial to the British military's strategic roadmap and highlights AM's role in strengthening supply chain resilience. The document stresses the urgent need to accelerate Additive Manufacturing adoption across the UK's defence sector. The MOD has outlined three core initiatives to accomplish this goal: investing to incentivise industry, adapting policies to remove barriers, and integrating AM into the defence supply chain.

The key benefits of Additive Manufacturing for defence applications include faster production, reduced lead times, access to obsolete parts, and improved sustainability. The Defence Science and Technology Laboratory (Dstl) identified obsolescence as the primary supply chain challenge affecting military operations in 2021, impacting both legacy and modern platforms. With an inventory exceeding 1.3 million items, the MOD views Additive Manufacturing as a viable solution for producing many obsolete components.

The UK defence leadership believes Additive Manufacturing will significantly improve platform and equipment availability. According to a Defence Innovation Unit (DIU)-commissioned report, producing just 15% of the defence inventory using Additive Manufacturing could yield £110 million in savings over the next fifteen years, with potential annual net benefits of £35.5 million thereafter. According to the new defence strategy, AM represents the "first step" toward the MOD's broader adoption of other advanced manufacturing technologies.

Vice Admiral Andy Kyte, Chief of Defence Logistics and Support, shared, "This strategy outlines our intent to embrace AM in new designs, to help resolve obsolescence and to increase our competitive edge through development of expeditious battle damage repair techniques. This exciting technology has been in existence for some time, and defence must now realise the latent benefits it offers, in terms of operational availability, improved supply chain resilience and efficiency."

Supply chain challenges

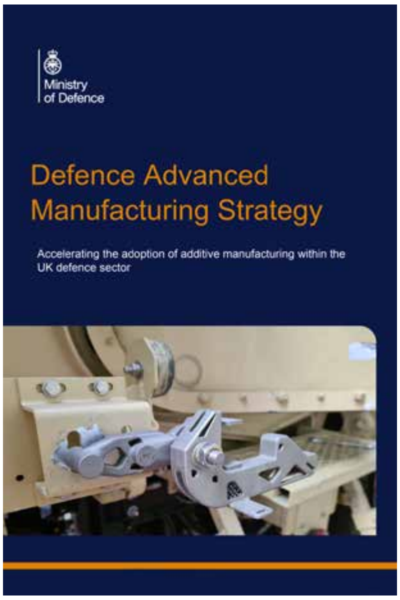
Conflicts in Ukraine and the Middle East have worsened supply shortages, limiting access to essential products and raw materials. These global challenges have increased the need for more resilient supply chains. Additionally, reductions in Armed Forces and Civil Service personnel, combined with smaller fleets and ageing equipment, have reduced availability, productivity, and efficiency.

The MOD is adopting AM to tackle these challenges through its new Advanced Manufacturing initiative. The strategy demonstrates how Additive Manufacturing enables the creation of decentralised networks of qualified suppliers with the aim of reducing lead times, addressing obsolescence issues, and enhancing sustainability. The MOD's Additive Manufacturing vision rests on four key pillars: design sources, digital thread, certification, and mobile production capabilities that enable parts fabrication near the point of need.

Design sources create additively manufactured parts through two methods: designing new components specifically for Additive Manufacturing (DfAM) or reverse engineering existing parts. The digital thread securely transmits sensitive design information from a design library to the Additive Manufacturing machine, while enabling users and manufacturers to send design change requests back to designers. Ensuring cybersecurity and information consistency is crucial. The MOD is exploring the development of a unified, fully integrated digital service to connect with design libraries. The finalised design is certified before being deemed fit for military operations and additively manufactured, sometimes near the frontlines.

These stages will operate within a circular economy that leverages the recyclability and reusability of Additive Manufacturing materials. The British military is currently developing methods to recycle high-end scrap metal into new metal Additive Manufacturing feedstock. For example, British engine manufacturer Rolls-Royce recently partnered with the MOD to convert old Tornado fighter jet components into new additively manufactured jet engines. This initiative, called Tornado 2 Tempest, has successfully produced components for the Orpheus jet

The Tornado 2 Tempest programme has successfully additively manufactured components for the Orpheus jet engine concept using recycled metal from scrap Tornado aircraft (Courtesy UK Ministry of Defence)



The UK Ministry of Defence has published its first Defence Advanced Manufacturing Strategy, identifying Additive Manufacturing as crucial to strengthening supply chain resilience (Courtesy Ministry of Defence)

engine concept, supporting the Future Combat Air System (FCAS) programme.

Increasing adoption of AM

In order to incentivise industry, additional investment will be used to promote AM adoption through direct funding and industry partnerships. This initiative will incorporate AM into existing and future designs as well as digitising strategically important inventory and spare parts. The MOD will also establish clear protocols for securely transferring digital information between industry, MOD units, and Front Line Commands (FLC).

To tackle the removal of constraints, another key pillar of the Additive Manufacturing strategy, the MOD will collaborate with industry partners to establish accessible cross-functional processes that align with updated policies and encourage adoption. It will also create a 'knowledge hub' to improve access to essential information. Additionally, the MOD plans to implement new metrics to better track both financial and non-financial benefits of Additive Manufacturing.

The MOD will design and create supply networks, allowing Additive Manufacturing technology to be brought into the defence supply chain. Equipment, training, and consumables will be standardised, making them accessible through regular supply channels to meet industry standards and qualifications.

New partnerships between industrial partners, FLCs, and MOD units will be encouraged with the goal of facilitating rapid learning and build trust through 'trusted agent status' in an extended 'hub' and 'spoke' supply network. Inter-industry partnerships will also be incentivised to enhance resilience and improve Additive Manufacturing capabilities.

Advantages and challenges

The MOD identifies the ability to address inventory shortages caused by technical or commercial obsolescence as the main benefit of AM. The technology can also reduce lead times while enabling a more resilient, agile, and distributed supply network.

The organisation identified several key challenges that limit AM development in the UK. It emphasised the need for more agile market routes, especially when sourcing obsolete parts. The organisation suggests creating separate supply chains for AM components to avoid delays caused by traditional procurement methods.

The document also highlights interoperability challenges. Rapid advances in AM technology and increasing machine versatility can quickly make AM files obsolete. Furthermore, different AM machines often produce varying results even when using identical manufacturing methods, which impacts repeatability. Additionally, the MOD identified challenges related to through-life support, training, access to consumables, digital thread uncertainties, and high manufacturing costs.

The full paper can be found on the government website.

www.gov.uk

Velo3D signs exclusive $22 million powder supply agreement with Amaero

Amaero Ltd, based in McDonald, Tennessee, has announced a five-year exclusive supply agreement with Velo3D, headquartered in Fremont, California. As Velo3D's hardware is manufactured, and software developed, in the US, and its data packets stored by a US-based company, Velo3D is positioned to play a role in the nation's efforts to reshore advanced manufacturing and accelerate the adoption of Additive Manufacturing. Based on demand estimates, Amaero's revenue from C103 and titanium alloy powder sales over the five-year agreement is expected to total approximately $22 million, subject to Velo3D's production demand.

Through the agreement, Amaero will be Velo3D's exclusive supplier of Niobium C103 and other refractory alloy powders, including molybdenum, tantalum, tungsten, and zirconium alloys, and its preferred supplier of titanium alloy powders.

Velo3D will qualify Amaero's spherical powders and develop proprietary build parameters exclusively for Amaero's C103 spherical powders and refractory alloy powders on all Velo3D Sapphire family of AM machines. Velo3D will qualify Amaero's titanium alloy powder and exclusively develop build parameters for new machine sales. The build parameters will be provided with AM machine licencing at no additional cost to customers.

Velo3D will also exclusively offer Amaero's C103, refractory and titanium alloy powders for sale to its AM machine customers.

Dr Arun Jeldi, Velo3D's CEO, commented, "Velo3D is the leading US equipment manufacturer for scalable metal 3D printing technology with integrated hardware and software systems. As the United States undergoes a domestic manufacturing renaissance, it's imperative that US companies lead on the innovation front, scale manufacturing throughput, and create more resilient supply chains.

"Velo3D is very excited to enter a long-term supply agreement with Amaero and to extend Velo3D's proprietary print parameters to include C103 and refractory alloy powders. Increasingly complex geometry of parts coupled with iterative design and faster production cycles drive accelerated adoption of metal 3D printing. And, as space and defence applications evolve to require materials that perform in very high temperature and extreme condition environments, a proficient capability to 3D print parts from C103 and refractory alloys is an important and differentiating capability," he continued.

"Developing print parameters in collaboration with Amaero is important for domestic high-value manufacturing and it's an important new market for Velo3D. Given the extensive installation of Velo3D Sapphire printers in leading space companies, this is a natural extension of our core capability and will benefit Sapphire printer customers, as well as Rapid Production Solutions customers.

"Amaero's team has over three decades of pioneering experience in atomisation of refractory and titanium alloy powders and has made forward-leaning capital investment to commission the industry-leading atomisation technology. Amaero has installed the only EIGA Premium technology in the US. With the first atomiser commissioned, a second scheduled to be commissioned in June and a third atomiser to be commissioned next year, Amaero has created the largest and most responsive production capacity for refractory and titanium alloy powders in the United States. Our partnership with Amaero is an important milestone for Velo3D."

Hank J Holland, Amaero's chairman and CEO, shared, "The re-shoring, development and scaling of US domestic advanced manufacturing and supply chain capabilities are foundational to Amaero's corporate strategy. Following three decades of offshoring manufacturing, including capital investment and workforce development, the Trump Administration has established industrial policy as a priority initiative that supports national security and economic policy."

www.velo3d.com
www.amaeroinc.com

Amaero's refractory powders are engineered for extreme environments, with high-temperature resistant materials like C103, Titanium, Niobium, Molybdenum, Tungsten, and Tantalum. Ideal for mission-critical applications in defence, space, and aerospace (Courtesy Amaero Ltd)

IperionX awarded US defence contract worth up to $99 million to supply titanium components

IperionX's SBIR Phase III Department of Defense contract will enable qualifying US government agencies to place orders for the supply of parts and components from IperionX (Courtesy US Department of Defense)

IperionX, based in Charlotte, North Carolina, USA, has been awarded a Small Business Innovation Research (SBIR) Phase III contract by the US Department of Defense (DoD). The contract will support achieving low-cost domestic titanium for defence applications and is part of a funding mechanism through which qualifying US government agencies can place project-specific orders – collectively capped at $99 million – for the supply of parts and components from IperionX.

"Securing this Phase III contract is a pivotal milestone for IperionX," stated Anastasios (Taso) Arima, IperionX CEO. "It validates the performance of our technologies and underscores the Department of Defense's commitment to reshore an all-American titanium supply chain. We look forward to delivering mission-critical components that are lighter, stronger and more cost-effective while reducing reliance on international supply chains."

The SBIR programme, administered by the US Small Business Administration, progresses innovations through three stages. Phase III is reserved for commercialisation activities, allowing federal agencies to procure proven SBIR-funded technologies without further competition. This award is said to recognise IperionX's readiness to deliver strategic titanium components for US defence applications.

IperionX is currently working with US DoD agencies on project task orders that will draw down on the contract ceiling. Initial titanium manufacturing and supply projects, expected to commence in the coming months, will include titanium fasteners produced using IperionX's patented titanium production and advanced forging technologies. These titanium parts will be manufactured at IperionX's Titanium Manufacturing Campus in Virginia, supporting local skilled jobs and strengthening the US defence industrial base.

Task orders may encompass additional product forms outside of fasteners, including higher-value aerospace components, positioning IperionX as a partner in the US DoD's drive for American-made titanium.

www.iperionx.com

Rocket Lab reserves two of Nikon SLM's upcoming ultra-large-format metal Additive Manufacturing machines

Nikon SLM Solutions has announced that Rocket Lab USA, Inc, based in Long Beach, California, has signed a Memorandum of Understanding to reserve two of its upcoming ultra-large-format metal Additive Manufacturing machines.

Rocket Lab has reserved two of Nikon SLM Solutions' upcoming ultra-large-format next-generation metal AM machines (Courtesy Rocket Lab)

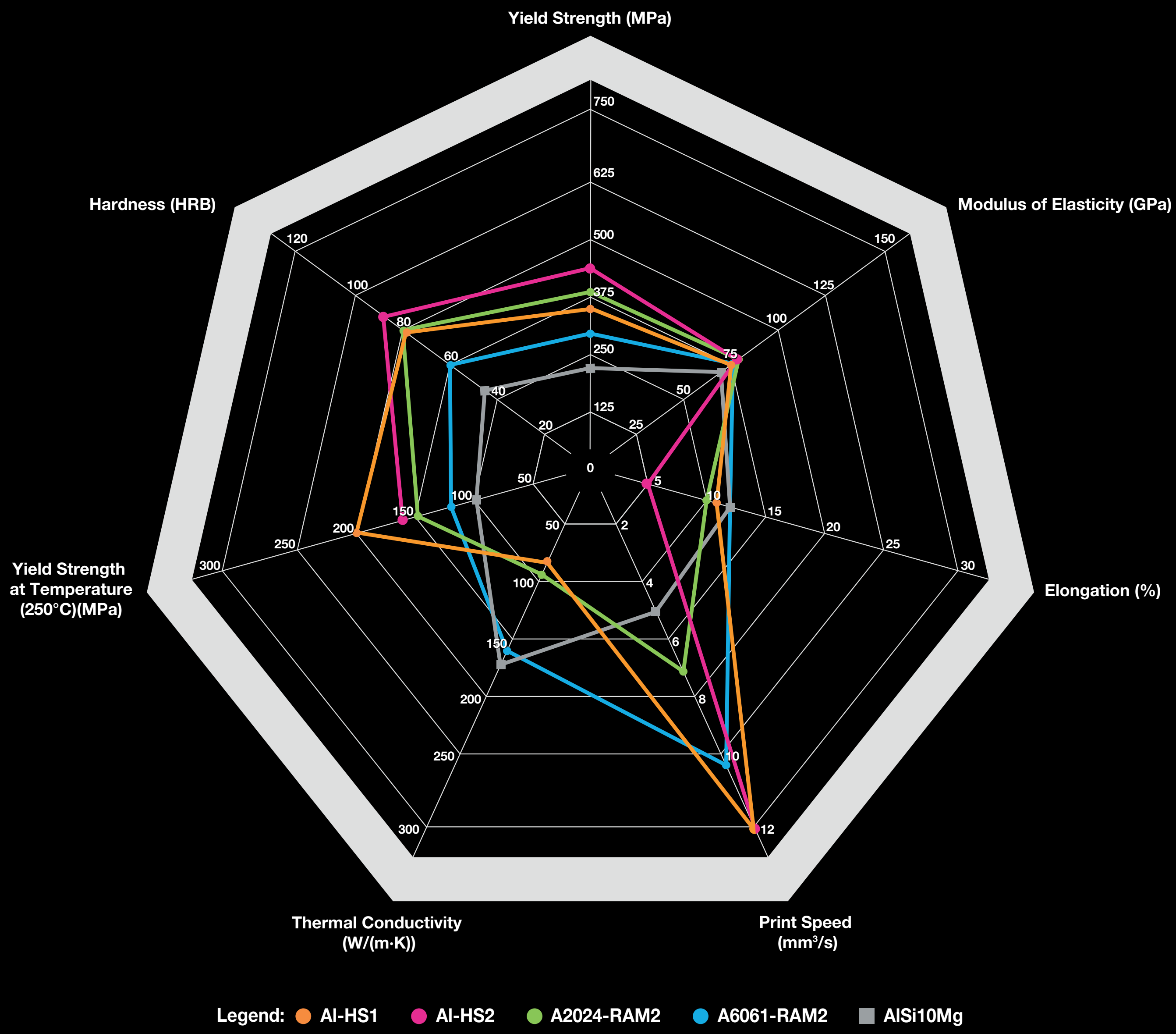
While full technical details of the next-generation machines have not yet been disclosed, Nikon SLM Solutions stated they will be capable of producing significantly larger parts with unmatched productivity. The aim is to help manufacturers such as Rocket Lab reduce part counts, optimise component design, and accelerate time to launch.

"We are proud to deepen our collaboration with Rocket Lab as they continue to pioneer scalable, high-performance AM for space," said Sam O'Leary, CEO of Nikon SLM Solutions. "Their decision to reserve our forthcoming ultra-large platform underscores a shared belief in pushing the limits of innovation – and doing so with confidence at scale."

The agreement is said to represent a major step forward in Rocket Lab's continued investment in advanced manufacturing technologies and underscores its commitment to scaling high-performance AM solutions. The new machines are expected to provide greater design freedom, throughput, and build volume to support Rocket Lab's growing aerospace operations.

www.nikon-slm-solutions.com
www.rocketlabcorp.com

Höganäs Aluminum Powder Properties Comparison Chart



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www.hoganas.com

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GE Aerospace's $1 billion investment to include its AM facilities

GE Aerospace plans to invest nearly $1 billion in its US factories and supply chain to strengthen manufacturing and increase the use of innovative new parts and materials needed for the future of flight. This new investment is nearly double last year's commitment and will help increase engine safety, quality, and delivery, benefitting more than two dozen communities across sixteen US states.

$100+ million to scale AM, innovative materials and parts

The company's investments are also scaling the production of innovative parts made from new materials and advanced manufacturing processes that provide engines with more range, power, and efficiency. This includes Additive Manufacturing, as well as ceramic matrix composites (CMCs). The AM facility investments include $51 million in Auburn, Alabama. Here, there will be additional AM machines, upgrades to existing equipment and tooling to increase capacity and ensure quality. Some $14 million was also earmarked for its West Chester, Ohio site. There will be additional AM machines, industrial furnaces, and upgrades to facility to increase capacity.

"Investing in manufacturing and innovation is more critical than ever for the future of our industry and the communities where we operate," said H Lawrence Culp, Jr, Chairman and CEO of GE Aerospace. "We are committed to helping our customers modernise and expand their fleets while scaling technologies that will truly define the future of flight. Together, this will keep the United States at the forefront of aerospace leadership."

GE Aerospace will add additional Additive Manufacturing machines at its Auburn, Alabama, and West Chester, Ohio, facilities (Courtesy GE Aerospace)

$500 million to expand capacity to strengthen quality and delivery

Other investments will include growing capacity and expanding several key sites, especially those that support the production and assembly of the narrowbody CFM LEAP engine, made by CFM International, a 50-50 joint company between GE Aerospace and Safran Aircraft Engines, where deliveries are expected to increase by 15-20% this year. These investments, combined with GE Aerospace's proprietary lean operating model, Flight Deck, are improving safety, quality, delivery and cycle times.

$100+ million for external supplier base

The almost $1 billion investment includes $100+ million dedicated to the company's external supplier base. These investments ensure suppliers are using the newest tools to produce parts, further reducing defects and supply chain constraints.

www.geaerospace.com

Thrustworks targets space and defence industries with new AM facility in Mönchengladbach

Thrustworks Additive Manufacturing GmbH, a service provider specialising in the Additive Manufacturing of refractory alloys for aerospace and hypersonics, has announced the opening of its new headquarters and production facility at Mönchengladbach airport in Germany.

Said to mark a strategic milestone for the rapidly expanding start-up, the move is enabling full in-house production of high-performance components made from refractory materials such as C103 niobium alloy, pure tungsten, and Inconel. The facility brings pre-processing, Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing, post-processing and quality control systems under one roof.

Through the combination of AM and its experience handling sensitive materials like niobium, the company is building the production infrastructure required for propulsion and hypersonics hardware.

The location, chosen for its strong innovation ecosystem and proximity to leading technical universities such as RWTH Aachen, offers an ideal position for collaboration, recruitment, and growth. The expansion is expected to position Thrustworks as a key enabler for the space and defence industries.

www.thrustworks.com

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Carbon Emission
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Texas A&M receives funding to speed certification of critical military AM components

Texas A&M, College Station, Texas, USA, has announced it will receive $1.6 million from the US Defense Advanced Research Projects Agency's (DARPA) Structures Uniquely Resolved to Guarantee Endurance (SURGE) programme. This funding is dedicated to accelerating the process that determines the quality and anticipated lifespan of additively manufactured components used in the military.

At present, it reportedly takes an average of eighteen months for a supercomputer to evaluate a single 3D part and accurately predict its lifespan or expected date of failure. Texas A&M's approach to predicting lifespan will increase the speed at which parts are made and deployed in critical applications and accelerate the adoption of Additive Manufacturing technologies by increasing the amount of AM machines at US Department of Defense (DoD) bases. It is also expected to provide millions of dollars in savings for the DoD.

If adopted, the team's proposed approach could go on to impact the entire Additive Manufacturing industry and make Texas A&M a key player in that transformation.

"This is an exciting moment for the Additive Manufacturing field, a community that increasingly recognises the urgent need to accelerate the qualification of 3D printed parts," said Dr Mosen Taheri Andani, assistant professor of mechanical engineering at Texas A&M and a member of the grant team. "By integrating in-situ data with the underlying microstructural features formed during printing, the programme will bridge expertise in process monitoring, microstructure characterisation, and property evaluation – paving the way for faster, more reliable deployment of additive-manufactured parts."

Andani will work with Texas A&M faculty Dr Raymundo Arróyave, Chevron Professor (II) of materials science and engineering; Dr Aala Elwany, professor of industrial and systems engineering; and Dr Ibrahim Karaman, Chevron Professor and head of the department of materials science and engineering. Drs Taheri Andani and Elwany are associated with materials science and engineering.

Prior to the advent of Additive Manufacturing, the evaluation of metal components was based largely on the specific machine or manufacturing process used to produce the parts. However, with additively manufactured parts, each part exhibits its own unique signature of microscopic features or defects, varying in location and size even among parts built on the same machine and using the same batch of raw feedstock. These microstructural defects, while currently unavoidable, play a critical role in determining the rate at which a part may ultimately fail.

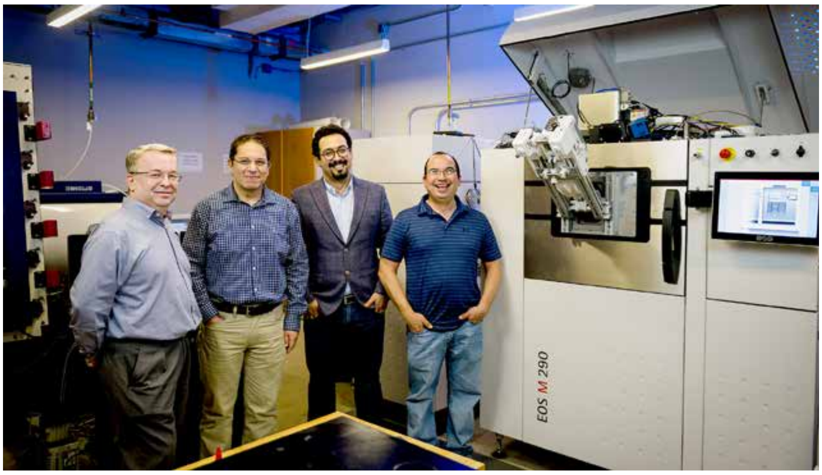
"Accelerating the certification of metal Additive Manufacturing parts is extremely challenging," Andani said. "Our team at Texas A&M is proud to contribute to this effort and help solve a challenge that is vital to advancing national capabilities."

The $1.6 million awarded to Texas A&M is part of a larger $10.3 million, four-year grant shared with collaborators at the University of Michigan; Auburn University; the University of California, San Diego; ASTM International; and industry partners Addiguru, Metairie, Louisiana, and AlphaStar, Irvine, California.

The key metrics for success on this project are speed and accuracy – a combination that makes the project particularly demanding, Andani explained.

The Texas A&M team will work with Addiguru during the first two-year phase of the grant to develop a sensor package that can be installed directly into a commercial Additive Manufacturing machine to monitor the build process by capturing real-time information from multiple sensor modalities. Once the sensor system is perfected, the team will work to develop an AI-driven, high-resolution defect-detection system capable of reading, combining, and processing data from heterogeneous sensor sources. In parallel, Texas A&M will coordinate with the University of Michigan team, the company AlphaSTAR and ASTM International to accelerate the prediction of microstructural features generated during the Additive Manufacturing process.

www.tamu.edu
www.addiguru.com
www.umich.edu
www.alphastarcorp.com
www.astm.org



(Left to right) Dr Ibrahim Karaman, Dr Alaa Elwany, Dr Mohsen Taheri Andani and Dr Raymundo Arroyave next to an Additive Manufacturing machine (Courtesy Texas A&M)

Oerlikon marks 25,000 additively manufactured suppressors

Oerlikon AM has delivered its 25,000th additively manufactured suppressor, manufactured using Oerlikon MetcoAdd nickel powder (Courtesy Oerlikon)

Oerlikon AM, the Additive Manufacturing division of Oerlikon, headquartered in Pfäffikon, Switzerland, has achieved a major production milestone with the delivery of its 25,000th additively manufactured suppressor, produced using Oerlikon MetcoAdd nickel powder.

Manufactured at Oerlikon's 11,600 m² production facility in Huntersville, North Carolina, USA, Oerlikon leverages Laser Beam Powder Bed Fusion (PBF-LB) technology to produce metal components for critical defence applications. Suppressors have become a standout use case, benefitting from Additive Manufacturing's design freedom and efficiency.

Dan Haller, Head of Commercial at Oerlikon AM, shared, "Unlike traditional suppressors that require complex, multi-part assemblies and often generate high back pressure, the 3D-printed suppressors we manufacture are single-piece designs with significantly lower back pressure."

Oerlikon works directly with firearms and suppressor customers to develop innovations that reduce gas blowback, minimise operator exposure to harmful gases like carbon monoxide and lead, and lower the risk of hearing loss and brain injuries caused by repeated muzzle blasts. These innovations are also extremely durable, enhancing reliability and longevity in the field.

This milestone underscores Oerlikon's focus on defence applications, extending well beyond Additive Manufacturing to include a broad portfolio of high-performance materials and coating solutions.

www.oerlikon.com

Vaya Space and Velo3D enter $4 million partnership to advance space propulsion

Velo3D, Inc, Fremont, California, USA, has signed a $4 million, two-year Master Services Agreement with Vaya Space, a hybrid rocket company focused on space propulsion systems based in Cocoa, Florida.

As Vaya's key strategic partner in propulsion development, Velo3D's Rapid Production Solution (RPS) will be used to enable the accelerated manufacturing of critical propulsion system components and meeting key development timelines. Vaya will build on its use of Velo3D's Additive Manufacturing technologies – it has additively manufactured an expander cycle hybrid rocket engine on the company's Sapphire machine – to produce GRCop42 and Inconel 718 parts. These propulsion parts will be manufactured on both Sapphire and XC1MZ AM machines.

As part of the partnership, Velo3D will also serve as Vaya Space's exclusive provider of GRCop42 additive components, delivering guaranteed capacity, advanced engineering support, and Flow software training intended to streamline design-to-production cycles for propulsion assemblies, including nozzles, injectors, and turbopumps, through 2027. The two companies will work collaboratively to produce high-quality engine components for aerospace and defence applications faster and at a lower cost than traditionally achievable.

Vayaa Space Lead Propulsion Engineer Kineo Wallace and COO Rob Fabian on Vaya's hot fire test pad with Brice Cooper, VP of Defense, and Michelle Sidwell, CRO of Velo3D (Courtesy Velo3D)

"This partnership is a powerful example of how our Rapid Production Solution helps scale complex hardware manufacturing for today's most ambitious aerospace companies," said Dr Arun Jeldi, CEO of Velo3D. "By combining our capabilities in GRCop42 and Inconel 718 with deep engineering collaboration, we're helping Vaya Space achieve faster, more cost-effective production – right here in the United States."

"Additive Manufacturing plays a central role in our ability to reduce design complexity, increase performance, and scale production," said Aaron Blankenship, Vice President of Operations at Vaya Space. "Velo3D offers the production readiness, material capabilities, and deep technical partnership we need to bring our vision to life and deliver flight-ready engines on schedule."

The agreement includes a joint marketing roadmap and formal signing event at Vaya Space's testing facility in Cocoa, Florida, where one of the propulsion systems produced with Velo3D parts will be on display.

www.velo3d.com

Metal Powder Works appoints defence executive Jim McDowell to board

Metal Powder Works (MPW), based in Pittsburgh, Pennsylvania, USA, has announced the appointment of Jim McDowell as a Non-Executive Director, effective immediately.

McDowell brings more than thirty-five years of international executive experience across the defence, aerospace, advanced manufacturing, and public sectors. He has held senior roles including CEO of BAE Systems Australia, CEO of BAE Systems Saudi Arabia, Managing Director of Nova Systems, and Chief Executive of the South Australian Department of the Premier and Cabinet.

Most recently, McDowell served as Deputy Secretary for Naval Shipbuilding and Sustainment at the Australian Department of Defence. In this role, he was responsible for overseeing what has been called Australia's largest-ever defence industrial programme.

His appointment is said to strengthen MPW's ability to meet the growing demand for high-performance metal powders in the defence and aerospace sector. McDowell's knowledge of government procurement, sovereign industrial strategy, and international defence programmes is expected to support the company's growth.

"We are honoured to welcome Jim to the board," stated Stuart Carmichael, MPW chair. "His leadership in defence and public sector transformation - most recently as Deputy Secretary overseeing Australia's naval shipbuilding strategy - brings a wealth of experience as MPW expands its role in supplying innovative materials to strategically significant industries."

www.metalpowderworks.com

Phillips integrates Meltio Engine Blue with Haas CNC to target defence sector

Phillips Corporation, headquartered in Hanover, Maryland, USA, is reported to be the first company to integrate the Meltio Engine Blue into a Haas CNC machine. Meltio, based in Linares, Spain, stated that the achievement marks a significant evolution in hybrid manufacturing, combining additive and subtractive technologies into one streamlined workflow.

This hybrid configuration is expected to enable defence manufacturers to produce complex metal parts with greater precision, shorter lead times, and reduced material waste – capabilities noted as essential for logistics, sustainment, and rapid-deployment environments The integration builds upon previous defence collaborations between Phillips and Meltio, including the deployment of Meltio technology aboard a US Navy shop for onboard metal Additive Manufacturing and the US Department of Defense's adoption of Meltio's wire-laser Directed Energy Deposition (DED) Additive Manufacturing machines to support supply chain resilience.

"Integrating Meltio's impressive new Engine Blue into the Haas CNC platform unlocks a new level of control and versatility for manufacturers," said Brian Kristaponis, General Manager of Phillips Additive Hybrid. "We're proud to be the first Meltio partner to deliver this configuration through our Hybrid product line, which is already proving its value in fast-moving, resource-constrained environments like defence."

Gabriel Ortiz, Meltio Channel Manager in the United States, stated, "The demand for manufacturing increasingly complex 3D printed parts with Meltio's DED metal technology using a CNC machine is increasing in different industries in the United States. As our long-standing partnership with Phillips Corporation in the United States demonstrates, the integration of Meltio into Haas CNC certifies that we continue to keep pace with this growing industrial demand for DED metal parts."

"Meltio's laser-wire metal 3D printing solutions offer all types of industries in North America the ability to manage the entire manufacturing process using hybrid solutions like those offered by Phillips Corporation It is extremely rewarding to help a large range of industries, from automotive to aerospace, as they aim to print and repair reliable metal parts with our reliable laser-wire DED solutions," Ortiz concluded.

www.meltio3d.com
www.phillipscorp.com

Velo3D offers customers AM part production under new Rapid Production Solutions service

Velo3D is now offering Additive Manufacturing part production under its new Rapid Production Solutions service. The company will use its fleet of Sapphire XC machines at its facility in California, USA, to produce parts for customers (Courtesy Velo3D/LinkedIn)

Velo3D, headquartered in Fremont, California, USA, is now offering Additive Manufacturing part production. Under its new Rapid Production Solutions (RPS) service, customers can develop and produce AM parts using Velo3D's in-house production cells, enabling rapid scaling without significant capital investment.

The introduction of RPS is said to be a direct response to the industry's need for flexible, efficient, and repeatable production solutions. With RPS, Velo3D aims to provide customers with a path from concept to production supported by Velo3D technology, including a fleet of Sapphire XC large-format metal Additive Manufacturing machines.

Arun Jeldi, CEO of Velo3D, shared, "At Velo3D, we are committed to enabling our customers to scale with confidence. Rapid Production Solutions are designed to accelerate the adoption of Additive Manufacturing by providing flexible, high-quality solutions that are rapidly tailored to each customer's unique production needs. This capability seamlessly compliments our success in supplying metal AM hardware systems to today's leading OEM's, accelerating AM adoption. By combining our technology, deep expertise, and robust ecosystem, we're not just meeting industry demand - we're helping shape the future of manufacturing quickly."

Reliability and consistency are critical for customers seeking to scale production, explains Velo3D. RPS integrates metrology, software, process control tools, and data-driven solutions, ensuring predictable output and rapid qualification across diverse industries.

The company reported that it is working hand-in-hand with customers to develop application-specific solutions, enabling rapid innovation in production-ready manufacturing. With a focus on aerospace, defence, energy and other industries – companies can shorten design cycles and reach production qualification faster.

"Velo3D's RPS achieved more in four months than we were able to accomplish in the previous four years - building eleven large-format proof-of-concept parts across three materials, moving two of eleven parts into the production pipeline, and making substantial progress on IN718 material qualification," said a Supply Chain Executive from a leading aerospace engine manufacturer. "This was made possible by Velo3D's unique combination of in-house expertise, production cells and patented technological capabilities."

Velo3D added that its new Rapid Production Solutions business is expected to account for up to 40% of revenue in 2026.

www.velo3d.com

Tekna appoints semiconductor industry veteran Claude Jean as new CEO

Tekna Holding ASA, Sherbrooke, Quebec, Canada, has announced that Claude Jean has been appointed as the new CEO of the Tekna Group, effective April 28, 2025.

Jean is an accomplished senior technology executive with a proven track record of building and leading world-class electronic manufacturing services and R&D. He joins Tekna from Teledyne Technologies where he has held several leading positions including Executive Vice President, Strategy & Partnership, Semiconductor and as General Manager of Teledyne DALSA, an international leader in high-performance digital imaging and semiconductors.

"It is an honour for me, and I am excited to take over as CEO of this impressive high-tech company," Jean stated. "Together with the highly competent Tekna team I am looking forward to executing on its strategy and growth plan to increase value for our customers and shareholders."

Jean replaces Luc Dionne, who is stepping down from the role. "The Board would like to thank current CEO Luc Dionne for leading Tekna through a period of strategic growth in a very dynamic era for the Additive Manufacturing industry. Since 2014, Tekna has grown its strong plasma technology foundations to a leading provider of advanced materials and plasma solutions to several industries – serving the most demanding customers within aerospace, defence, medical and microelectronics," stated Dag Teigland, Chair of the Board of Tekna Holding ASA.

www.tekna.com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HBD
HBD 400

Elmet and Taniobis partner to bolster North American supply of niobium C-103 and FS-85 AMtrinsic powders

Elmet Technologies Inc, Lewiston, Maine, USA, has signed a strategic agreement with Taniobis GmbH, based in Goslar, Germany, to support the creation of a more resilient and agile North American supply chain for AMtrinsic Nb-Hf-Ti (C-103) and AMtrinsic Nb-Ta-W-Zr (FS-85) metal powders. The agreement also enables the potential distribution of other AMtrinsic powders, particularly those alloys based on niobium (Nb) and tantalum (Ta).

Under the agreement, Elmet Technologies and Taniobis will leverage their respective experience and expertise in refractory metals, Powder Metallurgy processing, and Additive Manufacturing for the mutual benefit of both parties. They will work collaboratively to develop and enhance the Western supply chain for niobium, tantalum, and related Nb and Ta-based alloys for critical high-performance applications.

"For Taniobis, with our leading position in niobium-based Additive Manufacturing powders, including C-103, FS-85, and Cb-752, Elmet is the ideal partner to deliver comprehensive customer and application support to the US aerospace and defence industries," stated Dr Ole Brettschneider, Chief Commercial Officer at Taniobis. "Combining Taniobis' deep expertise in niobium powder manufacturing and Elmet's advanced capabilities in Powder Metallurgy and application development, our long-shared history provides a strong foundation for continuing this journey together."

Both companies share a common heritage in HC Starck. Elmet Technologies acquired HC Starck Solutions Americas in 2023, while Taniobis, formerly HC Starck Tantalum and Niobium GmbH, was acquired by JX Metals and Mining Corporation in 2018 and rebranded as Taniobis in 2020.

Elmet Technologies' Executive Vice President of Strategy, Scott Knoll, commented: "We believe this strategic collaboration will garner strong support from end-users, and we intend to continue cultivating similar collaborations and alliances in line with our strategic objectives. In addition to unlocking a more comprehensive materials, products, and services portfolio for our customers, this collaboration also enhances supply chain resilience and reliability across critical United States and North American industries. Through our shared commitment to innovation and operational agility, the agreement is aligned on long-term growth, sustainability, and supply chain security."

The agreement will see a more resilient and agile North American supply chain for AMtrinsic Nb-Hf-Ti (C-103) and AMtrinsic Nb-Ta-W-Zr (FS-85) powders (Courtesy Elmet Technologies)

AMtrinsic powders

C-103 alloy is reported to meet the requirements of space propulsion applications thanks to its high-temperature strength, ductility, and high creep resistance. In addition to good mechanical properties, the alloy's reduced weight compared to other refractory alloys is said to bring several advantages to aerospace applications and a lower cost compared to platinum group metals.

FS-85 (Nb-28Ta-10W-1Zr) is a high-strength niobium base alloy with good creep performance, tensile strength, and fatigue resistance. Due to its high-temperature stability, FS-85 is considered a structural material for various aerospace applications.

Niobium is the lightest refractory metal and exhibits unique properties such as high temperature stability, superconductivity, high ductility and biocompatibility. Niobium powders are widely used in aerospace, medical, nuclear, energy, and automotive industries.

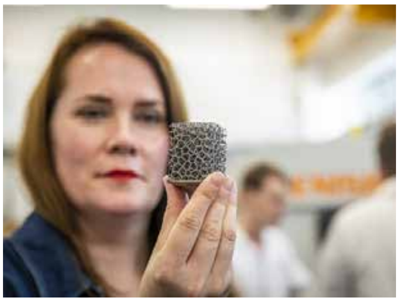
Tantalum exhibits outstanding properties such as high strength, high ductility, excellent corrosion resistance and biocompatibility, providing unique possibilities for application in aerospace, medical, nuclear, and chemical industries.

Discover more about C-103

Coinciding with the announcement was the launch of a website centred around C-103. The website provides information about the products and services of Elmet and Taniobis' capabilities related to the C-103 material.

www.elmetc103.com
www.elmettechnologies.com
www.taniobis.com

Atomik AM secures £600k investment to scale sustainable materials technologies



Atomik AM, a University of Liverpool spin-out company founded by Professor Kate Black, has secured £600k investment from the Northern Powerhouse Investment Fund II (Courtesy University of Liverpool)

Atomik AM, a UK-based advanced manufacturing start-up, has secured a £600,000 investment from the UK's Northern Powerhouse Investment Fund II, managed by Praetura Ventures, to scale its sustainable materials technologies.

Founded by Professor Kate Black (FREng) in 2022, Atomik AM creates sustainable materials and patented technologies to support scalable and efficient advanced manufacturing. The company is working with companies including Unilever and Ricoh to transform manufacturing, as well as developing and patenting its own intellectual property.

With the funding, Atomik AM is expected to grow its Liverpool-based team by 40% and explore larger premises, as it scales its operations.

"At Atomik AM, we believe that true innovation starts with putting materials and sustainability first," explained Professor Black. "This investment will allow us to grow our team and scale our patented technologies, accelerating our ability to deliver cleaner, more efficient manufacturing solutions. From our base in Liverpool, we're proud to lead this transformation and work with global partners to set a new benchmark for sustainable, materials-led innovation in advanced manufacturing."

The company also produces inks for 2D sensor printing and specialist pastes used in electronic coatings. It has delivered solutions to help companies remove unnecessary resources, such as water, from their manufacturing processes. Atomik AM has also developed a sustainable process for turning aluminium metal waste into more durable products, with the excess waste from this process then recycled into energy, representing a more end-to-end approach to sustainability.

Atomik AM is currently in the process of patenting a series of new and innovative manufacturing products, including a universal binder for Binder Jetting metal Additive Manufacturing. Its universal binder is designed to work across multiple material systems, removing the need for unique formulations for different metal powders. This development could have major implications for manufacturers, particularly those working with a range of materials or looking to switch between materials without overhauling their entire process.

"Atomik AM prides itself on a solutions-focused way of working," added Louise Chapman, NPIF II Fund Principal at Praetura Ventures. "In other words, taking a holistic approach to vastly improve existing processes instead of fixing individual problems. Kate's enthusiasm and determination to make the advanced manufacturing space truly sustainable is reflected in the incredible work done by Atomik AM so far. Because of this, we jumped at the opportunity to support a female founder scaling a business of this nature from the Liverpool City Region, an area with a long history and reputation for manufacturing."

This latest funding also follows a £125,000 investment from Liverpool City Region Combined Authority-backed LYVA Labs, who invested in Atomik AM earlier this year.

Sue Barnard, Senior Investment Manager at British Business Bank, said, "Finding ways to lower our greenhouse gas emissions across all sectors is of paramount importance, and it is fantastic to see a fast-growing North West business, backed by NPIF II, look to do this in the manufacturing area. Its plans for expansion and team growth are some of the transformational change that gaining access to finance can unlock."

Akshay Bhatnagar, Head of Investment, LYVA Labs, added, "We are delighted that Atomik has secured investment from NPIF II and Praetura. This is great news for the Liverpool City Region. We are excited to be working with Praetura to support Kate and the team to accelerate the Additive Manufacturing revolution which is underway."

www.atomik-am.com

PyroGenesis gains Boeing approved supplier status for its titanium Additive Manufacturing powder

PyroGenesis titanium metal powder as produced by its NexGen plasma atomisation system (Courtesy PyroGenesis)

PyroGenesis Inc, headquartered in Montreal, Quebec, Canada, has received official confirmation of approved supplier status with Boeing. The company stated that its Ti64 'coarse' metal powder, with a particle size that is within the range of 53-150 µm, has been qualified for use and added to Boeing's qualified list of metal powders available for use in Additive Manufacturing.

"PyroGenesis is proud to achieve official supplier status with Boeing," said P Peter Pascali, president and CEO of PyroGenesis. "The high standard of Ti64 metal powder produced at PyroGenesis Additive for Boeing is the result of years of groundbreaking design and engineering work that went into developing our NexGen™ plasma atomisation process." Massimo Dattilo, Vice-President of PyroGenesis Additive, added, "Our stated goal to produce some of the highest quality metal powders in the Additive Manufacturing industry required being assessed by the highest quality client under the toughest standards. Having received qualification of our 'coarse' powder, we look forward to serving the needs of Boeing and its parts manufacturing and service centres with metal powder produced by PyroGenesis' NexGen™ plasma atomisation system."

PyroGenesis invented the plasma atomisation process and coined the term 'plasma atomisation' in its original patent. The company has created proprietary, patented and advanced plasma technologies that are being vetted and adopted by multiple multibillion-dollar industries in four key markets: iron ore pelletisation, aluminium, waste management, and Additive Manufacturing.

www.pyrogenesis.com

Gevorkyan reports strong start to 2025 with major defence and automotive contract wins

Gevorkyan a.s., headquartered in Vlkanová, Slovakia, has reported a successful start to 2025, with Q1 revenues of €20.88 million and statutory EBITDA of €8.35 million, resulting in an EBITDA margin of almost 40%. This represents an increase in revenues of 11.2% and an increase in EBITDA of 14.35% compared to the same period of the previous year. The company reported an operating EBIT of €4.21 million, an increase of 7.15% compared to the same period last year. The profit after tax (EAT) was reported at €2.98 million, representing a 26.32% increase compared to the same period last year.

"Our strong performance in an uncertain economic environment underlines our resilience and ability to use global uncertainties to our advantage," stated Artur Gevorkyan, Chairman of the Board "We are optimistic about our plans and will combine organic growth with selective and value enhancing acquisitions."

In the announcement, the company reported that it has won nine new long-term projects in the arms industry for the European and American markets. Following the success at a recent international trade fair, an agreement was signed to develop components for sporting arms in the USA.

At the same time, mass production of components for a $30 million project that the company won in a 2024 tender, has now started.

The first phase of a project for a European manufacturer of optoelectronic devices using night vision, thermal imaging, and laser technology has been successfully completed. In the next phases, development and mass production for new applications in armaments and aerospace will continue.

In the automotive segment, new projects for autonomous robotic taxis have been acquired in the US and Europe. Additionally, after several years of technical and commercial negotiations, the company won a project for the petrol station and oil industry in the USA.

The company reports that it has also received orders from European-based customers, notably one to supply a European plant wholly owned by a renowned Asian brand. Following the rapid and successful completion of development based on specific customer requirements, series production is scheduled to ramp up soon.

As part of investments in new premises, automation and robotisation, Gevorkyan reported that a warehouse and production area were expanded by approximately 1,000 m^2. In Q1 2025, a project to robotise two calibration presses was also completed, helping further reduce operational costs.

www.gevorkyan.sk

Titomic USA opens Huntsville, Alabama, facility

Titomic Limited has officially opened its new facility in Huntsville, Alabama, USA, at a ribbon-cutting ceremony attended by partners in government and the defence and aerospace sectors. Titomic said it will use this location as its new global headquarters, supporting commercial and defence initiatives. The 5,500 m^2 facility will support advanced production capabilities, host live equipment demonstrations, and serve as a regional training and customer support centre. It was added that the site will be the only location where all of the TKF products are manufactured and produced.

"The ability for the Huntsville facility to be able to produce machines and products for our customers provides us with the ability to meet a variety of requirements to support our customers," stated Dr Patricia Dare, Titomic USA President. "This direct control of the production of machines and components provides us with the ability to meet our customer expectations."

Active partnerships are reportedly underway with large defence primes and government agencies. The Huntsville facility will produce critical components such as titanium pressure vessels, domes, launcher coatings, and space-grade shielding. These applications support not only defence systems but also the US Department of Defense's broader goals of supply chain resilience, rapid sustainment, and operational readiness.

Titomic officially opened its Huntsville, Alabama, facility with a ribbon-cutting ceremony (Courtesy Titomic)

"This is more than just a facility opening," said Jim Simpson, CEO and Managing Director of Titomic. "It's a launchpad for the next generation of high-performance manufacturing technologies in the United States. Huntsville offers the perfect blend of industrial heritage and forward-thinking energy that aligns with Titomic's mission to redefine what's possible in materials science and manufacturing."

Titomic's move to Huntsville was supported by Innovate Alabama. The company has been a recipient of Innovate Alabama's LendAL initiative, which stimulates the Alabama economy by supporting small businesses by providing capital through partnerships and private lenders.

"Innovate Alabama is excited to partner with Titomic and bring their technology to the Huntsville market," stated Charlie Pond of Innovate Alabama. "We believe their capabilities can make a meaningful impact on our community and support ongoing partner programmes."

Andy Whitt from First National Bank was also said to have been instrumental in the project and assisted with the initial facility reviews to ensure the Titomic team had a facility to meet their requirements. "I am pleased to be a part of this monumental moment for Titomic USA, Inc," he stated. "Their leadership team has impressed me, and their technology is innovative, making it a perfect fit for Huntsville to continue to be a leader in technology development."

www.titomic.com

Valimet to atomise APWORKS' Scalmalloy powders in the United States

Valimet, headquartered in Stockton, California, USA, reports it has entered into a non-binding agreement with APWORKS to atomise Scalmalloy powder in the United States. The high-strength aluminium alloy powder, developed for Additive Manufacturing, is well-suited to a wide range of aerospace and defence applications.

"In 2024, we were awarded a Phase I SBIR grant by the Defense Logistics Agency to support the atomisation of scandium–aluminium powders. It makes perfect sense that we have this type of conversation with APWORKS," stated Luigi Alzati, Valimet VP – Sales and Marketing.

"We're grateful to Jonathan Meyer, CEO, and the team at APWORKS for their trust in Valimet's capabilities. We're united in our commitment to establishing a US-based supply chain for Scalmalloy AM parts, for the benefit of aerospace and defence applications," added Alzati.

Scalmalloy is claimed to be the only AM processable alloy that can effectively substitute high-strength 7000 series aluminium alloys from plate or forging. Thanks to its low density, Scalmalloy provides density-specific properties that are said to be extremely competitive, even with the highest-strength alternatives.

www.valimet.com
www.apworks.de

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Accenture and Siemens launch business group to bolster AI-powered manufacturing

Building on a longstanding partnership, Siemens and Accenture, headquartered in Dublin, Ireland, have announced the formation of the Accenture Siemens Business Group. Launched at Hannover Messe 2025, the dedicated business practice will be comprised of around 7,000 professionals with proven manufacturing and IT experience globally. Through the group, the companies will co-develop and jointly market solutions to clients that combine automation, industrial AI and software from the Siemens Xcelerator portfolio with Accenture's data and AI capabilities.

"By strengthening our partnership, we combine the unique capabilities of two market leaders: Siemens' technology, access to data and deep domain knowledge in software, automation and industrial AI with Accenture's power to apply data and AI in engineering and manufacturing," said Roland Busch, president and CEO of Siemens. "With the new business group, we will empower customers in all industries to supercharge their entire value chain by embedding AI at the core of their businesses."

"Engineering and manufacturing are the next digital frontier," said Julie Sweet, chair and CEO, Accenture. "The Accenture Siemens Business Group scales the power of automation, data and AI to help clients reinvent their products and how they make them. Together with our long-standing partner Siemens, we will increase speed and efficiency, reduce cost and strengthen the digital core, which is essential for continuous reinvention and the creation of new value."

Scalable engineering, manufacturing and services solutions for industry

The Accenture Siemens Business Group will work to create solutions for software-defined products and factories for clients in industries including aerospace and defence, automotive, consumer products and goods, electronics, heavy equipment, industrial machinery, semiconductors and transportation.

The group plans to introduce new engineering services that will focus on reinventing engineering and R&D models. It will help clients create global engineering capability centres and develop software-defined products. It will also optimise clients' use of Model-Based Systems Engineering (MBSE) and speed the adoption and use of Accenture's and Siemens' software-defined vehicle (SDV) framework for automakers.

New manufacturing services will support clients in implementing, harmonising and migrating manufacturing execution systems to track and control manufacturing in real-time. By applying IT principles, the group aims to advance clients' AI-powered shop-floor operations and automation. Additionally, it will help clients mitigate and prevent cyber threats to operational technology (OT) devices and critical engineering and manufacturing systems with managed security services including Accenture's Managed Extended Detection and Response (MxDR) platform. New industrial assets services will include after-sales service and MRO.

Agentic AI-powered industrial process reinvention

The Accenture Siemens Business Group will enable its solutions for clients with Accenture's suite of Industry X digital engineering and manufacturing assets. These support clients in building AI agents, customising pre-built agents in building AI agents, customising pre-built agents and foundation models – for example, for simulation and robotics – and ensure governance across all their AI components.

Agent AI can increase the efficiency and productivity of product development by, for example, automatically validating the impact on feasibility, cost and performance of engineering changes and new designs. Other areas said to benefit from agentic AI are PLM, asset management and servicing of industrial equipment, and remote operations.

www.siemens.com
www.accenture.com

Siemens and Accenture have announced the formation of the Accenture Siemens Business Group (Courtesy Accenture)

Sodick finalises Prima Additive acquisition, rebranding to Prima Additive by Sodick

Sodick Co, Ltd, based in Yokohama, Japan, has completed its acquisition of Prima Additive from Prima Industrie Group. Going forward, the company will operate under the new brand name Prima Additive by Sodick, retaining its Italian headquarters.

Through its new brand identity and strategy, Prima Additive by Sodick aims to scale its Additive Manufacturing for industrial production to deliver solutions in the world of advanced laser technologies for Additive Manufacturing and material processing. Sodick will use the acquisition to expand its laser-based manufacturing portfolio.

"Since Prima Additive was founded, we have been thinking about which direction to take, which technologies to focus on, and how to position ourselves in the global market," said Paolo Calefati, CEO of Prima Additive by Sodick. "In recent years, we have experienced significant growth in terms of product development and international expansion, strengthening our ambition to build highly industrial and automated advanced laser solutions.

"Sodick is the right partner to take on this challenge: with their industrial experience and strong support, we will continue to pursue bold goals in our core markets. A special thank you goes to Prima Industrie, which allowed us to reach this point and helped shape the mindset with which we faced the challenges of our journey. We are proud of our origins and look forward with enthusiasm to what lies ahead," Calefati concluded.

Prima Additive began its R&D activities within Prima Industrie in 2015 as part of the European Borealis project and officially launched as a brand in 2018. Currently, the company provides turnkey solutions in Laser Beam Powder Bed Fusion (PBF-LB) and Directed Energy Deposition (DED) Additive Manufacturing technologies.

As part of its portfolio expansion, the company has also added advanced laser processes such as remote laser welding for e-mobility and laser surface treatment for tooling and industrial components. Through R&D initiatives and strategic partnerships, Prima Additive has been involved in numerous European projects aimed at advancing laser technologies and sustainable manufacturing.

www.primaadditive.com
www.sodick.co.jp

Outokumpu announces stainless steel powder for aerospace and aviation AM applications

Having entered the metal powder market for Additive Manufacturing in 2023, Outokumpu, headquartered in Helsinki, Finland, reports that it is now expanding its range to include metal powders for the aerospace and aviation sectors. The company has already delivered the first batch of a new stainless steel powder grade for a unique aerospace application.

The spherical stainless steel powder is refined with specific alloy additives to make it a high-performance austenitic stainless steel powder. The solution is intended as an alternative to nickel-based alloys in highly demanding Additive Manufacturing applications and has been developed to meet customer demand for components in small quantities and with shorter development cycles.

To demonstrate its capabilities, a jointly engineered heat exchanger component has been developed for the aerospace sector, subject to prototype validation. This is said to support the company's primary focus on producing metal powders that are not yet on the market and are suitable for producing parts for demanding applications.

"Outokumpu is committed to accelerating circular business models for high-tech stainless steel applications," stated Marten Franz, Head of Metal Powder Business at Outokumpu. "Our go-to-market strategy is to innovate product designs for complex, high-performance geometries for niche applications. While we focus on our expertise in creating new recipes for metal powders, we rely on our ecosystem of 3D printing engineering partners to create end-products according to customer specifications. We are excited to enter the aerospace and aviation industry with our powder solutions."

Besides producing stainless steel for Additive Manufacturing aerospace and aviation applications, Outokumpu hopes to develop new powder grades to serve a variety of sectors.

"We have been ideating medical-grade powder specifications for the health-tech applications, dedicated to the development of nickel-free materials. Such material grade can also be used in jewellery, such as nickel-free stainless steel earrings or watches. In addition, Outokumpu is working on developing heat-resistant alloys for additively manufactured components such as turbines or for use in power plants," explained Franz.

www.outokumpu.com

FormAlloy X5R DED Additive Manufacturing machine to be installed at Neighborhood 91

Melanie Lang, John Barnes and Jennifer Coyne (Courtesy The Barnes Global Advisors)

Neighborhood 91, a global advanced manufacturing hub based in Pittsburgh Airport Innovation Campus, USA, has announced an expansion of its capacity with the addition of an X5R Directed Energy Deposition (DED) Additive Manufacturing machine from FormAlloy Technologies Inc, San Diego, California, USA.

The acquisition was made possible through the Resilient Manufacturing Ecosystem (RME) programme managed by The Barnes Global Advisors (TBGA) and funded by the US Department of Defense (DoD) through its Industrial Base Analysis and Sustainment (IBAS) programme. The RME programme has been established to de-risk the adoption of advanced manufacturing to fulfil the needs of the DoD.

HAMR Industries will operate the X5R system to develop next-generation components designed for extreme environments, with a focus on propulsion, hypersonics, and to support the Maritime Industrial Base (MIB) advanced manufacturing initiatives.

"The ability for the X5R to operate with multiple feedstocks, build meter-sized components, and functional grade is a huge advantage," said Michael Schmitt, CEO of HAMR Industries. "We expect to utilise both wire and powder capabilities to balance economics with part size and complexity, while functional graded materials will be used for a variety of high-performance applications."

A feature of the X5R is its integrated robotic arm, which extends the machine's build volume. Melanie Lang, CEO of FormAlloy, explained, "We saw the demand signal from industry for scalable DED. The development of this robotic arm enables a significant increase in build volume, meeting industry needs for larger and more complex components."

Jennifer Coyne, Director of Operations at The Barnes Global Advisors, emphasised the broader significance of the acquisition. "RME was established as a model to demonstrate how to structure a sustainable advanced manufacturing supply chain. The ability to integrate innovative equipment like the X5R provides immense value to moving this endeavour forward."

The installation at Neighborhood 91 reinforces the site's growing role as a hub for advanced manufacturing innovation and supply chain advancement in the United States. The X5R will be introduced later this year when the campus hosts its first Defense Day Open House.

www.barnesglobaladvisors.com
www.neighborhood91.com
www.formalloy.com

CDG 3D Tech opens industrial Additive Manufacturing Centre in UK with metal, polymer and ceramic capabilities


CDG 3D Tech has expanded its business and opened a showroom, service centre, and warehouse in Basingstoke (Courtesy CDG 3D Tech)

CDG 3D Tech, headquartered in Alton, UK, has expanded its business and opened a showroom, service centre, and warehouse in Basingstoke, UK. The new Additive Manufacturing Centre will house large-format industrial AM machines, alongside 3D scanners and post-processing equipment, allowing customers and potential customers to see demonstrations of the latest Additive Manufacturing equipment and materials.

CDG 3D Tech already operates a 3D Technology Centre in Derby, where customers can also gain hands-on experience of the latest technologies.

Grant Cameron, founder and managing director of CDG 3D TECH, said, "While 3D printing is now well established in the UK, Additive Manufacturing is only recently being adopted by general manufacturing companies. By opening our new AM Centre, we will be able to showcase the very latest industrial 3D printers and post-processing, so that we can help our UK customers to manufacture in metal, polymers and ceramics."

CDG 3D Tech has increased its headcount to support its expansion, with additional appointments planned.

As part of the company's ongoing initiatives, a 3D Scanning Open Day was held at the Basingstoke Additive Manufacturing Centre on July 1. A 3D Printing AM Open Day will also be held on September 25.

www.cdg.uk.com


SOPHIA
HIGH TECH
MECHANICSFORSPACE

AM 4 AM and Gränges to share advanced materials testing platform for metal powder development

AM 4 AM, a producer of metal powders for Additive Manufacturing based in Foetz, Luxembourg, has announced a strategic partnership with Gränges Powder Metallurgy (GPM), a leading global supplier of aluminium powders and Dispal alloys. This collaboration centres on the shared use of GPM's materials characterisation equipment park, housed at AM 4 AM facility in Luxembourg.

By leveraging GPM's equipment and AM 4 AM's analytical expertise, both parties aim to accelerate materials development, enhance quality control and customer service in their respective product lines.

"This collaboration reflects our shared commitment to excellence, resource efficiency, and innovation in the Powder Metallurgy space," said Maxime Delmée, co-founder & CEO of AM 4 AM. "By giving us access to GPM's advanced characterisation tools, we're enabling faster iteration cycles and better-informed decision-making in our development and production."

The agreement includes joint use of a suite of advanced instruments for powder and material analysis, including particle size analysis, CNC machining, thermal behaviour evaluation and mechanical testing (static and dynamic). These capabilities are crucial in understanding and improving powder performance in Additive Manufacturing for high-tech applications.

AM 4 AM will use Gränges Powder Metallurgy's materials characterisation equipment to improve powder performance (Courtesy AM 4 AM)

"AM 4 AM and GPM had complementary needs: at GPM, we did not have the R&D facilities that we needed and at AM 4 AM, they had space and competences to support us so we decided to relocate our equipment in their facility and let AM 4 AM operate them," said Peter Vikner, Managing Director at Gränges Powder Metallurgy.

www.am-4-am.com

QuesTek develops nickel superalloy for Stoke Space's daily-launch reusable rockets

In collaboration with Stoke Space, Kent, Washington, USA, QuesTek Innovations LLC, Evanston, Illinois, has successfully developed a novel nickel-based superalloy designed for Additive Manufacturing and high-pressure, high-temperature oxygen environments. The goal was to enable high-performance, fully reusable launch systems at lower costs and with a higher launch frequency.

This alloy is regarded as critical for Stoke Space's Zenith engine, which operates using a full-flow staged combustion cycle, a high-efficiency machine that demands materials capable of withstanding extreme combustion environments where conventional alloys would be expected to fail catastrophically. The alloy has been fully qualified and meets all performance targets.

QuesTek designed the alloy using its ICMD digital materials design and engineering software platform, to which it attributed the rapid optimisation of composition and processing.

"The development of this printable, burn-resistant alloy is an absolute requirement for Stoke Space to achieve its mission of building reusable rockets that fly daily," said Jason Sebastian, Executive Vice President of QuesTek. "It's not an overstatement to say that this type of milestone can change the world. Once this hurdle is removed, I don't see a limit to the growth potential for the space industry."

Enabling the future of space access

The nickel-based superalloys are suitable for production via Additive Manufacturing, which enables complex geometries and cooling channels that would not be possible with traditional manufacturing methods. Leveraging manufacturability also allows for rapid implementation of design changes without the lengthy lead time and expense of producing new tooling.

Bill Mahoney, Chief Operating Officer at QuesTek, added, "The material compositions commonly used to increase strength often reduce printability and burn resistance."

"QuesTek technology helps clients find their sweet spot where all three critical properties coexist – something that would take traditional metallurgy approaches decades to develop. We achieved it in just months," Mahoney concluded.

www.questek.com
www.stokespace.com

Freemelt machine orders continue as it outsources machine manufacturing

Freemelt AB, based in Mölndal, Sweden, has reported a number of orders for its Electron Beam Powder Bed Fusion (PBF-EB) Additive Manufacturing machines over the past few months. In May, the company also announced that it was outsourcing the full manufacturing of its AM machines to Scanfil, a global systems manufacturer headquartered in Finland.

At the time, Daniel Gidlund, CEO of Freemelt AB, stated,"Through our partnership with Scanfil, we accelerate our strategy to improve production scalability and enhance global competitiveness. The opportunity for regional manufacturing strengthens our position to meet changing market conditions and contributes to a more resilient supply chain. Additionally, this transition allows us to focus on innovation and further development of our PBF-EB technology, creating value for both our customers and shareholders."

Freemelt reported orders for its Additive Manufacturing machines, including the Freemelt ONE (Courtesy Freemelt)

UK Atomic Energy Authority to develop fusion components

In March, an order for an eMELT machine was received from the United Kingdom Atomic Energy Authority (UKAEA).

Freemelt has been collaborating with UKAEA since April 2023 and is currently delivering large-scale production tests of AM tungsten tiles for fusion machines, as part of an ongoing proof-of-concept. UKAEA will utilise the new eMELT to advance to in-house development and production of fusion components.

University of Alabama order

In April, Freemelt received an order from the University of Alabama, USA, for the delivery of a Freemelt ONE. The machine will be used for materials research, focusing on unique high-temperature refractory metals for critical applications of interest to the US industry and government.

"This collaboration strengthens our presence in the US and successful R&D will open new opportunities in defence and energy-related applications," stated Darin Everett, President, Freemelt Americas Inc.

Dutch technology hub 3D Makers Zone

An order was also received in April for a Freemelt ONE from 3D Makers Zone, located in Haarlem, the Netherlands.

With 3D Makers Zone moving to intensify its feasibility work for the defence industry, the organisation changed its original order of an eMELT AM machine to the Freemelt ONE, a machine optimised for material and application development.

Korea Institute of Materials Science for aerospace development

In May, Freemelt received an order from the Korea Institute of Materials Science (KIMS) for the delivery of a Freemelt ONE. The machine will be used for material process development of titanium aluminides, various superalloys, and high-entropy alloys for industrial applications in the aerospace industry.

South Korea has one of the highest adoption rates of Additive Manufacturing, and this order marks Freemelt's first machine order in the Asian market.

Swedish defence industry research

In June, Freemelt reported it had received an order from a customer in the Swedish defence industry for a Freemelt ONE. The machine will be used for advanced materials research and development in defence-related applications.

"The geopolitical landscape is rapidly changing, driving an urgent need for new materials, technologies, and advanced manufacturing methods to support the modernisation and strengthening of Europe's defence capabilities," said Gidlund at the time.

Second order from North Carolina State University

A further order was announced in June for a Freemelt ONE from North Carolina State University's Center for Additive Manufacturing and Logistics (CAMAL) in Raleigh, USA. This followed recent collaboration which saw the establishment of a joint Application Center aimed at supporting industrial customers with development projects.

The new order is CAMAL's second purchase of a Freemelt ONE machine, following the initial delivery in 2023. The agreement also includes an option to upgrade to an eMELT industrial machine during 2026.

Freemelt secures first German order

Freemelt announced a Freemelt ONE rental agreement from an un-named company in Germany. Although several Freemelt machines are in operation at German universities and research institutes, this marked the first machine ordered by a German industrial user.

The customer will reportedly use the machine to accelerate applied research and development efforts, particularly in prototyping and the advancement of metal alloys.

www.freemelt.com

3D Systems reports growth in new AM machine sales for the second straight quarter

3D Systems, Rock Hill, South Carolina, USA, has announced its financial results for the first quarter ended March 31, 2025, reporting growth in new Additive Manufacturing machine sales for the second straight quarter. Despite this, revenue for Q1 2025 decreased 8% to $94.5 million, compared to the same period last year. The company stated that its growth in hardware sales and related services was offset by a decline in materials sales, driven primarily by inventory management in the dental aligner market.

The company's previously announced $50 million cost-saving initiative was reported to be progressing as planned, with completion expected by mid-2026. Operating expenses in the first quarter reflected continued efforts to improve cost efficiency.

In response to ongoing macroeconomic uncertainties and potential tariff risks, 3D Systems announced a new cost reduction initiative aimed at delivering an additional $20 million in savings during 2025. The move is intended to accelerate organisational alignment and strengthen the company's financial position.

"Our first quarter revenues reflect a continuation of challenging top-line pressures as many customers are delaying their capital investments in order to get greater clarity around potential tariff impacts on their manufacturing and distribution strategies," explained Dr Jeffrey Graves, president and CEO of 3D Systems. "This is in addition to the ongoing geopolitical and broader macroeconomic uncertainty that we have been experiencing for some time."

Due to the risk of sustained weakness in customer capital expenditure, the company said it is withdrawing its full-year guidance. It stated that its top priority is achieving profitability at its current scale. With a strong portfolio of new metal and polymer products, 3D Systems believes it is well-positioned to benefit when customer spending rebounds.

"While we were pleased to see this growth in new printer sales for the second straight quarter, the rate was clearly impacted by these capital spending delays. Encouragingly, this growth in printer sales was driven predominantly by our newest hardware systems, as our strengthened technology portfolio delivered strategic wins for all three of our metal printing platforms, and steady growth broadly in aerospace and defense markets. These wins bode well for the future, particularly in the high-reliability Healthcare and Industrial markets, which include aerospace and defense, and AI infrastructure, areas that have been an increasing focus for us for some time," Dr Graves added.

The company's balance sheet has been significantly strengthened following the April sale of its Geomagic software portfolio, which added more than $100 million in post-tax cash. As of April 30, 2025, total cash reserves stood at approximately $250 million.

"So, in short, we have followed a very deliberate strategy for the last three years of investing to be a technology leader in both metals and polymers, and one that has full control over all design, production and sourcing operations that are essential to the quality of our products, as the market for new production applications of 3D printing now opens in earnest. While the short-term headwinds driven by tariff risks and other factors are painful and require us to implement significant cost savings initiatives, in the longer-term the new opportunities for localised manufacturing within the US, Europe, India and other nations is a significant driver for long-term value creation for all of our stakeholders," concluded Dr Graves.

www.3dsystems.com

Epson Atmix establishes European sales office to expand metal powder business

Epson Atmix Corporation, a group company of Seiko Epson Corporation based in Aomori, Japan, has partnered with Epson Europe Electronics GmbH to establish a sales office in Munich, Germany. The new office, which opened on April 1, 2025, is expected to strengthen and expand the group's metal powder business in Europe.

Epson Atmix is a leading producer of high-quality water-atomised spherical metal powders, suited to both Metal Injection Moulding and metal Additive Manufacturing. The company's range includes iron-based, nickel-based, and cobalt-based alloy powders.

Parts made using its powder can be found in electronic and automotive components, medical devices and more.

Prior to the new sales office, Epson Atmix had been serving the European market directly from Japan. The Munich office will enhance the sales and service functions, enabling quicker response times to enquiries from across Europe.

Parts made using Epson Atmix's powder can be found in numerous applications (Courtesy Epson Atmix)

www.atmix.co.jp
www.epson-electronics.de

Stratasys acquires former BASF Additive Manufacturing business Forward AM

Forward AM offers a range of Ultrafuse metal filaments, including 17-4 PH and 316L stainless steels (Courtesy Forward AM)

Stratasys Ltd has acquired the key assets and operations of Forward AM Technologies GmbH, based in Rheinmünster, Germany. While continuing to operate under the Forward AM brand, the business will now function as a standalone company within Stratasys, named Mass Additive Manufacturing GmbH.

Forward AM, the former Additive Manufacturing business of BASF, entered insolvency proceedings in November 2024, having undergone a management buyout in July 2024. The company offers a range of Ultrafuse metal filaments, including 17-4 PH and 316L stainless steels, for the Material Extrusion (MEX)-based Additive Manufacturing process Fused Filament Fabrication (FFF).

Operating as an independent materials business, Forward AM stated that its portfolio will remain open to all partners and platforms, allowing it to provide the materials, technical support, and collaboration, regardless of the hardware used.

"With the backing of Stratasys, we now have greater resources and reach to drive innovation, expand our offering, and better serve your needs. This partnership empowers us to do more of what we do best: helping you succeed in Additive Manufacturing," Forward AM stated in its press release.

"To our customers, partners, and friends: thank you for standing with us. We're back, and we're just getting started," the company added.

www.forward-am.com
www.stratasys.com

Sciaky to additively manufacture Inconel 718 components for power generation systems

Sciaky Inc, based in Chicago, Illinois, USA, a subsidiary of Phillips Service Industries (PSI) Inc, has announced that it has received an order to additively manufacture Inconel 718 parts for an undisclosed critical power generation project.

Sciaky's scalable Electron Beam Powder Bed Fusion (PBF-EB) Additive Manufacturing – referred to by the company as EBAM – technology can produce parts ranging from around 200 mm to >6 m in length. The company's AM technology offers gross deposition rates of up to 18 kg of metal per hour. It uses IRISS – the Interlayer Real-time Imaging and Sensing System, a real-time adaptive control system able to sense and digitally self-adjust metal deposition with precision and repeatability. This closed-loop control enables Sciaky's process to deliver consistent part geometry, mechanical properties, microstructures and metal chemistry.

The order involves the total deposition of over 318 kg of Inconel 718, which has a deposition rate of around 1.8 kg per hour using Sciaky's EBAM machines. This is said to compare favourably to laser- and arc-based AM technology when processing Inconel 718 – which often operates at lower rates.

"Our Additive Manufacturing technology not only enhances production speed but also improves material properties through precise control of the deposition process," said Scott Phillips, Sciaky president. "We are proud to be able to deliver such a significant quantity of high-performance material, leveraging our expertise in additive technologies."

Inconel 718 is used in aerospace, power generation, and oil and gas industries, where its ability to withstand extreme conditions is critical.

www.sciaky.com

An example of an additively manufactured part produced using Sciaky's EBAM technology (Courtesy Sciaky)

Xact Metal achieves record first-quarter revenue up 60%

Xact Metal, headquartered in State College, Pennsylvania, USA, has announced that Q1 2025 was its highest Q1 order revenue to date, up over 60% year on year from the same period in 2024.

"Our strategy to bring metal Powder Bed Fusion to small- and medium-size organisations and to decentralise central labs at large organisations continues to be welcomed by our customers," stated Juan Mario Gomez, CEO. "We are excited to see this continued growth, especially since in 2024 we grew first quarter order revenue by 40% in comparison with the same period in 2023.

"Our growth has been driven by a strong product development focus," Gomez continued. "Our XM200G single- and dual-laser 3D metal printer continues to perform well, attracting new and repeat customers in manufacturing, defence and research applications. In addition, we continue to introduce new product features, like the new XM Mini material development module, an extended build height option to our current print envelope, and the XM Sieve for reclaiming of metal powder."

Founded in 2017, the company's low-cost Additive Manufacturing machines began shipping in 2019 with the XM200C, its first powder-bed fusion machine. This machine operates with an XY gantry system and was designed for R&D, Universities and those transitioning from plastic printing into metal.

In 2021, Xact Metal introduced the XM200G family of single-and-dual laser AM machines that utilise galvanometer mirrors, that achieve faster build speeds for high through-put industrial applications.

Xact Metal's range of metal Additive Manufacturing machines includes the XM200G (left) and XM200C (centre). The XM300G (right) is currently under development (Courtesy Xact Metal)

In 2022, Xact Metal announced the launch of the XM300G series, a mid-size machine family to support customers who want to produce larger parts or larger quantities. The XM300G is reported to still be under engineering development, without a set shipment date.

www.xactmetal.com

Conflux Technology establishes UK hub for R&D, materials certification and customer support

Conflux's Australian manufacturing floor (Conflux Technology)

Conflux Technology, headquartered in Geelong, Australia, has announced it is establishing a new business hub in the United Kingdom to better serve its growing European market, particularly in core manufacturing sectors like aerospace, automotive and motorsport.

Expected to open later this quarter, the site will initially focus on R&D, materials certification, and supporting customers with local supply chain constraints. Conflux said it plans to scale into a fully operational production centre as customer demand increases.

The new hub – its first physical presence in the region – is seen as a milestone in the company's global growth strategy and underscores its established portfolio of European clients. Historically representing 35% of Conflux's business, the company's European portfolio includes partnerships with brands such as Rocket Factory Augsberg, AMCM and several Formula 1 teams, alongside strategic engagements with key industry bodies.

"We are extremely proud to celebrate ten years of spearheading transformation in heat exchanger technology for superior performance with such a significant milestone," comments Michael Fuller, CEO and founder of Conflux Technology. "Europe is a key market for us – Conflux UK will not only shape the future of the automotive, motorsport and aerospace markets, but also establish supply chain resilience, so we're excited and ready to expand our operations and work closer with some truly innovative companies."

The focus of Conflux Technology's offering is its Production System, a combination of thermo-fluid design expertise and advanced metal Additive Manufacturing to produce high-performance heat exchangers that are lighter, more compact, and tailored to meet the challenging performance demands of industries such as aerospace, automotive, energy and defence.

www.confluxtechnology.com

DEEP unveils HexBot six-arm robotic DED machine for large-scale metal Additive Manufacturing

DEEP Manufacturing Limited, based in Bristol, UK, has revealed its HexBot robotic Wire Arc Directed Energy Deposition (DED) Additive Manufacturing machine, a technology also referred to as Wire Arc Additive Manufacturing (WAAM), for large-scale metal part production.

The HexBot is designed for use in the energy, offshore, and maritime sectors, where customers requiring large, custom components quickly and accurately stand to benefit significantly from the technology. Applications include structural parts for offshore wind platforms, subsea energy infrastructure, and shipbuilding, with the system aimed at addressing longstanding engineering and operational challenges.

The six-arm synchronised DED setup operates in unison to manufacture large-scale metal components. Each robotic DED arm can independently build parts up to 3 m in diameter, and when working together, the full HexBot system can produce components up to 6.2 m in diameter and 3.2 m high.

DEEP Manufacturing sees the HexBot project as a major technological milestone. Compared to conventional methods, it enables faster and more flexible production of complex, high-strength parts, allowing DEEP to address the needs of the offshore, maritime, and energy industries.

"HexBot pushes the boundaries of what's possible in ultra large-scale Additive Manufacturing, offering speed, scale, and customisation on a level never achieved before," stated CEO Peter Richards. "This is a uniquely capable system backed by our world-class technical expertise – one that's not only delivering on DEEP's vision but also contributing to the advancement of manufacturing as a whole."

Launched in January 2025, DEEP Manufacturing was established as a specialist division of DEEP, which is developing next-generation underwater pressure vessels to support the creation of subsea human habitats. These ambitious structures demand highly customised, large-scale metal components, produced with extreme precision and at speeds beyond the reach of conventional manufacturing.

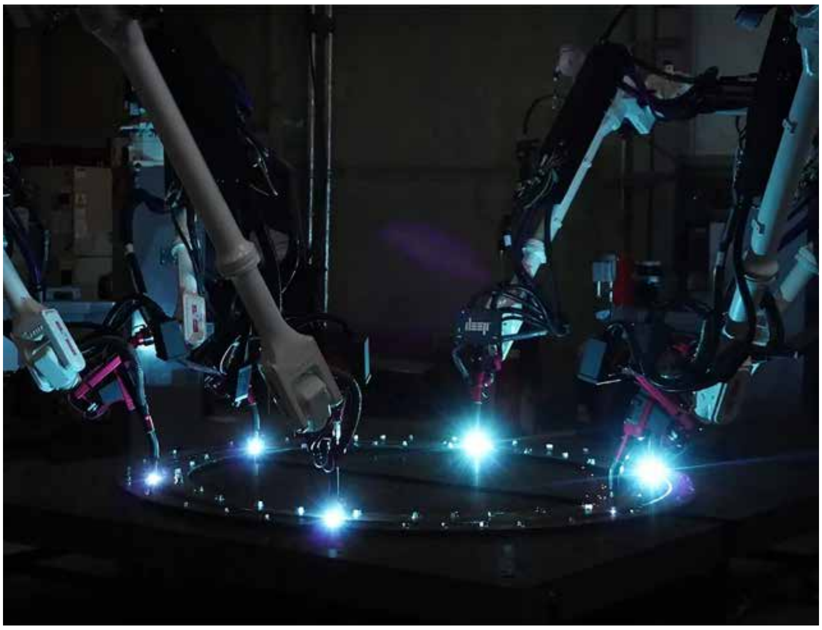
The company secured DNV approval in principle (AiP) for its use of Wire Arc DED in the production of steel pressure vessels for human occupancy in February.

While initially developed to meet internal demands, the company states it quickly became clear that DEEP Manufacturing's unique capabilities have far wider industry applications. The business is now supporting external clients across offshore, maritime, energy, and aviation sectors – industries where the need for fast, scalable, and structurally sound metal components is constant.

DEEP is also in discussions with a number of UK and US-based partners to explore Joint Industry Projects (JIPs) aimed at accelerating WAAM adoption and helping shape global industry standards.

"It's a challenging and uncertain time for many industries, but advances in technology – particularly Additive Manufacturing, and more specifically WAAM – have the potential to empower companies not just to survive, but to thrive in difficult conditions," added Richards.

www.deepmanufacturing.com



The six-arm synchronised DED machine manufactures large-scale metal components as large as 6.2 m in diameter and 3.2 m in height (Courtesy DEEP Manufacturing)

Each robotic arm can independently produce parts up to 3 m in diameter (Courtesy DEEP Manufacturing)

Materials Solutions to add two NXG XII 600 machines to enable large part production

Materials Solutions – a Siemens Energy Business, based in Worcester, UK, is expanding its Additive Manufacturing fleet with two twelve-laser NXG XII 600 Laser Beam Powder Bed Fusion (PBF-LB) machines from Nikon SLM Solutions. The first of these machines was installed in May 2025, with the second planned for later in the year.

Materials Solutions is set to install two NXG XII 600 machines from Nikon SLM Solutions by the end of 2025 (Courtesy Nikon SLM Solutions)

The NXG machines will initially be focused on the production of a yet-undisclosed large power generation part, reportedly the first of its kind produced by PBF-LB Additive Manufacturing. While specifics aren't available, the completed component is set to replace five separately additively manufactured parts – which already substantially improved on the conventional manufacturing process previously used.

Trevor Illston, one of Material Solutions' co-founders and its Chief Manufacturing Engineer, commented in the Spring 2025 issue of *Metal AM* magazine, "When the machine is fully operational, it will lead to significant reductions in cost and lead time for this very large part, whilst significantly improving fuel efficiency and the emissions of Siemens Energy's most advanced gas turbine."

www.materialssolutions.co.uk
www.nikon-slm-solutions.com

Boeing opens Farnborough HiLACC collaboration centre to support advanced aircraft innovation

Boeing has opened its High-Lift Aerodynamics Collaboration Centre (HiLACC) in Farnborough, UK, to provide a dedicated research space for Boeing, industry and academic partners to collaborate, test and analyse future aircraft concepts. The facility will support testing and development for a range of programmes for Boeing's commercial aeroplanes and derivative aircraft.

"The future of aerospace is made possible, in part, by facilities like HiLACC," said Maria Laine, president of the Boeing UK, Ireland and Nordic region. "The UK continues to play a pivotal role in the development of aerospace innovations, and we are excited to see how the new technology developed here will support the evolving needs of our customers."

With around 930 m2 of space across three floors, HiLACC will act as a dedicated space for Boeing partners to collaborate on aerodynamic testing and aerodynamics research at the nearby Farnborough wind tunnel. The five metre QinetiQ wind tunnel, located next to HiLACC, is one of only three large, low-speed pressurised wind tunnels in the world and the only one in the UK. It has supported the testing and design for Boeing aeroplanes, including the 787, 777, 747 and the 737 MAX.

The HiLACC facility is expected to enable Boeing and its collaborators to reduce the time needed to refine an aircraft's design and test a model of this design in the nearby wind tunnel. High-lift, low-speed wind tunnel testing is important to aircraft development because it assesses how design changes affect take-off and landing performance. Aerodynamic improvements that increase an aircraft's fuel efficiency must perform well at take-off and landing, as well as at cruise levels.

"As we look to the future, we know our customers will continue to count on us to deliver breakthrough products that meet the highest levels of safety, quality and performance," said Jeff Hogan, chief engineer, Airplane Characteristics, Boeing Commercial Airplanes. "HiLACC supports the work we'll do today and tomorrow to develop our next generation of aerospace innovations."

"This is a significant investment from Boeing and a massive vote of confidence in the future of the aerospace and defence industries in this area. It will ensure that Farnborough continues to be at the forefront of aviation research and development, providing hundreds of well-paid jobs and opportunities for local residents," stated Alex Baker, Aldershot and Farnborough MP, at the centre's unveiling.

Since 2015, Boeing has invested more than £110 million in the UK, working closely with government, industry and academia to drive forward technologies that support the UK and global aerospace industry.

www.boeing.co.uk

AMEXCI opens new Additive Manufacturing facility in Örebro, Sweden

AMEXCI announced the grand opening of its new facility in Örebro, Sweden (Courtesy AMEXCI/Anja Degerholm, 3dp.se)

AMEXCI, based in Tampere, Finland, has announced the grand opening of its new 4,700 m^2 facility in Örebro, Sweden. The inauguration is said to mark a significant milestone in AMEXCI's continued commitment to shaping the future of manufacturing through cutting-edge metal Additive Manufacturing technologies.

Founded in 2017, AMEXCI operates in both Sweden and Finland and is backed by prominent industrial owners, including FAM, Saab, Ericsson, and Scania.

The new facility has been purpose-built to meet increasing demands for efficiency, capacity, and technological advancement. With a strong focus on automation, material efficiency, and reduced lead times, AMEXCI is now equipped to support its customers from early development to full-scale serial production.

During the inauguration, key stakeholders, including AMEXCI's founder, Marcus Wallenberg, Joakim Westh, Chairman of the Board, and representatives from FAM, Saab, Ericsson, and Scania, reflected on the strategic importance of AMEXCI's role. Wallenberg recounted the inspiration for AMEXCI, born from a visit to SpaceX, where he witnessed additively manufactured rocket engines. This experience sparked the realisation that this expertise was vital for Sweden's future competitiveness.

Saab's Micael Johansson emphasised AMEXCI as a strategic partner and highlighted its industrial impact, showcasing 609 submarine motor components being replaced with one single additively manufactured part. The value of Additive Manufacturing competence and capabilities in shortening the development cycles in the journey towards sustainable transportation was accentuated by Scania's Lars-Henrik Jörnving and further confirmed by Ericsson's Anna Dicander, who emphasised the importance of the technology in the development of the next product generation.

The inauguration concluded with a guided tour for around 70 guests, offering a glimpse of insight into the component refinement workflow from production to the finished additively manufactured part, including capabilities in material analysis and testing.

Among the attendees was Lena Rådström Baastad, Governor of Örebro County, who highlighted the strategic regional importance of AMEXCI's investment, "We are a region experiencing rapid growth. AMEXCI's expansion is a proof of unite collaboration and signals strong confidence in the region's potential."

Edvin Resebo, CEO of AMEXCI, said, "We are incredibly proud of what this new facility represents."

"It's not just an investment in technology and infrastructure - it's an investment in the future of sustainable manufacturing and in our customers' success," Resebo added.

www.amexci.com

Honeywell qualifies 6K Additive's Ni718 for aerospace Additive Manufacturing

6K Additive, a division of 6K, based in North Andover, Massachusetts, USA, has announced that Honeywell Aerospace Technologies has qualified its Nickel Ni718 metal powder for use in the Additive Manufacturing of aerospace components.

"Honeywell is a clear leader in aerospace and avionics, with parts found on virtually every commercial, defence and space aircraft," stated Frank Roberts, president of 6K Additive, in a post on LinkedIn. "They're a company that leads with sustainability in everything they do, and that includes their cutting-edge, end-to-end Additive Manufacturing operations. We're extremely proud that our nickel alloy has now been qualified by the team at Honeywell, empowering sustainable Additive Manufacturing production in the aerospace industry like never before."

6K Additive's nickel Ni718 powder is a Ni-Cr-Mo-Ti precipitation hardening alloy offering high-temperature strength and corrosion resistance. The powder's properties are said to make this alloy an attractive material for Additive Manufacturing applications where high-temperature oxidation is a concern, such as aerospace, land-based turbine components, and other high-temperature industrial parts.

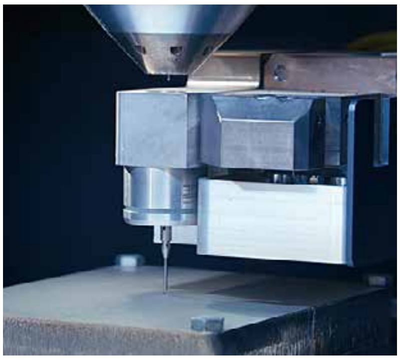
aerospace.honeywell.com
www.6kinc.com

Meltio names official sales partners as it looks to expand

Meltio, headquartered in Linares, Spain, has announced a number of official sales partners as it looks to expand the reach of its laser-wire Directed Energy Deposition (DED) Additive Manufacturing technology.

ERM Fab&Test for the French market
It was reported that ERM Fab&Test, based in Carpentras, France, will be an official sales partner in the French market.

Boris Hromadka, ERM Fab&Test Business Unit Manager said, "At ERM Fab&Test, we are proud to add Meltio to our portfolio of digital manufacturing solutions. Meltio's DED technology combines new capabilities in metal fabrication with exceptional ease of use. The technology allows industrial manufacturers to make metal parts at a minimal cost, repair used or broken parts, and do metal cladding with the possibility to use different materials during the same process.



Meltio's wire-based DED process (Courtesy Meltio)

PrimeOut becomes Portuguese sales partner
PrimeOut, located in Embra, Portugal, is now the official sales partner in the Portuguese market. Supported by Sicnova, Meltio's primary Iberian partner, PrimeOut will focus on building a supportive ecosystem for Meltio's technology in Portugal, generating business opportunities alongside technology centres, machine tool companies, robotic integrators, academia, and industry.

"Sicnova is delighted to be able to work closely with PrimeOut to consolidate the presence of Meltio technology in Portugal," stated Pablo Flores, Meltio Product Manager at Sicnova. "Our mission has always been to facilitate the implementation of advanced Additive Manufacturing solutions in industry, and this new agreement reinforces our commitment to innovation and development in the Iberian market.

ProductionToGo Benelux
ProductionToGo Benelux, based in Amsterdam, the Netherlands, was been announced as an official sales partner for distribution and support of Meltio's metal AM solutions in the Benelux market. This follows on from the announcement that ProductionToGo had become an official sales partner for the German, Austrian and Swiss (DACH) markets at the end of 2024.

"We at ProductionToGo Benelux are honoured to collaborate with Meltio," stated Ahmed Abo Seada, CEO of ProductionToGo Benelux. "Their unique capabilities in metal Additive Manufacturing and the impressive results their printers deliver make them a valuable addition to our 3D printing portfolio. We are excited to offer our partners and customers exclusive metal 3D printing solutions that focus on efficiency and the future."

Tecnológico de Monterrey, Alar and Sitres Latam in Mexico
Sitres Latam, Alar, and Tecnológico de Monterrey, all based in Mexico, have partnered to promote Meltio's DED) Additive Manufacturing machines to companies in Mexico. Meltio's AM technology makes it possible to create, transform and repair functional metal parts with materials such as stainless steel, titanium, Inconel and copper.

Both Alar and Tecnológico de Monterrey offer access to the technology for companies and institutions interested in developing functional parts.

www.erm-fabtest.com
www.primeout.pt
www.sicnova3d.com
www.production-to-go.nl
www.alar.tech
www.tec.mx
www.sitres.com.mx
www.meltio3d.com

Impact Innovations reports over 100 Cold Spray machines worldwide

Impact Innovations GmbH, based in Rattenkirchen, Germany, has announced the successful sale of eight new EvoCSII Cold Spray machines during Q2 2025, bringing the company's total to over 100 globally installed machines. This sustained growth is said to reflect the strong confidence in Impact Innovations' technology, product quality, and application expertise across a range of industries worldwide.

"Our growth reflects the trust our customers place in our systems, technology, and team," said Leonhard Holzgassner, Co-CEO and Technical Director at Impact Innovations. "We are proud to support industries worldwide with solutions that deliver reliability, performance, and future readiness."

The newly sold machines will support a diverse range of industrial applications, from aerospace and electronics to cookware manufacturing and repair, highlighting the versatility and reliability of Cold Spray Additive Manufacturing.

"With these eight new machine sales, customers in Germany, the USA, China, India, Australia, and Korea have joined the growing network of manufacturers choosing Impact Innovations as their Cold Spray partner," the company added.

www.impact-innovations.com

California Metals and CNPC Powder partner for sustainable Additive Manufacturing powders

The partnership will see the production of AlSi10Mg powder and Ti6Al4V powder from 100% recycled feedstock (Courtesy CNPC)

California Metals, Newport Beach, California, USA, and CNPC Powder, headquartered in Vancouver, Canada, have formed a strategic partnership to supply and distribute sustainable Additive Manufacturing powders made from 100% recycled feedstock.

"This partnership represents a significant step forward in creating a more sustainable supply chain for the Additive Manufacturing industry," said Michael Resl, CEO at California Metals. "By utilising 100% recycled feedstock, we're helping customers reduce their environmental footprint without compromising on quality or performance."

The collaboration combines California Metals' experience in environmentally responsible metal solutions with CNPC Powder's experience in metal powder production. The partnership will initially result in two 100% recycled products: AlSi10Mg powder for lightweight, high-strength applications and Ti6Al4V powder offering high strength as well as corrosion and fatigue resistance.

Both powders are said to have comparable performance to virgin powders, whilst offering a significant reduction in carbon emissions compared to traditional, environmentally costly manufacturing processes. They have already been successfully applied in various sectors (e.g. aerospace, motorsports, consumer electronics and luxury goods), demonstrating their performance and sustainability benefits.

Kathy Liu, president at CNPC Powder, added, "Our combined expertise allows us to deliver powders that not only meet but exceed industry standards. Our advanced manufacturing facilities and R&D capabilities, coupled with California Metals' commitment to sustainability, create a powerful offering for the growing Additive Manufacturing market."

www.californiametals.com
www.cnpcpowder.com

Renishaw and Metalpine develop copper-nickel alloy powders for marine applications

Renishaw, headquartered in Wotton-under-Edge, Gloucestershire, UK, has collaborated with Metalpine, based in Graz, Austria, to create copper-nickel alloy (CuNi) powders for use in marine applications. It was stated that a major European naval force is set to use the new powder to manufacture replacement parts in-house using Renishaw's RenAM 500Q Flex Additive Manufacturing machine.

Naval operations in saltwater environments present challenges, with hydraulic components and other essential parts subject to accelerated wear and corrosion. Rather than relying on extensive supply chains, the naval force opted to additively manufacture replacement parts in-house.

CuNi powders form a protective layer on the surface of components, preventing degradation. This makes them highly durable in the challenging marine conditions where parts are constantly exposed to moisture and sea elements. Engineers from Renishaw and Metalpine partnered to develop process parameters tailored to two specific copper-nickel alloys: CuNi 10, a combination of 10% nickel and 90% copper, and CuNi 30, using 30% nickel and 70% copper.

"Metalpine uses a stable and outstandingly efficient process to manufacture high-quality metal powders focused on particles with high sphericity and no pores. So, it is straightforward for us to develop and produce new powders," Gerald Pöllmann, CEO of Metalpine, shared. "Collaborating with the AM engineers at Renishaw was a great experience. The team quickly shared what they achieved with our powders during their qualification process, enabling us to create and deliver powders that fit the application perfectly."

Renishaw has collaborated with Metalpine to create copper-nickel alloy (CuNi) powders for Additive Manufacturing (Courtesy Renishaw)

With an open-loop powder system, the RenAM 500Q Flex allows for efficient and quick powder swapping, making it ideal for developing and optimising material properties, part designs and process parameters. With the Reduced Build Volume (RBV) accessory fitted, material prove out can be performed with as little as 0.25 litres of powder, with the same processing environment and optics as the full-scale production system.

"Metal powders made with copper are difficult to process with AM. CuNi 10 is a highly reflective material which is resistant to laser energy, whereas CuNi 30, due to its higher nickel content, is easier to process," explained Alex Garcia, AM Design and Applications Engineer at Renishaw. "Leveraging Renishaw's advanced laser melting technology, we conducted extensive experimentation to refine the energy input parameters. We adjusted the RenAM 500Q Flex power, scan speed and hatch distance to optimise the process for manufacturing with these materials."

"With these precise settings, we have been able to overcome the material's challenges, ensuring high-quality, durable parts that can withstand harsh marine environments. This optimisation not only enhances part strength and longevity but also ensures consistent results, allowing our naval customer to manufacture parts that perform reliably under tough conditions," Garcia added.

www.renishaw.com
www.metalpine.at

ADDiTEC adds PBF-LB to Additive Manufacturing portfolio with Fusion S

ADDiTEC, headquartered in Palm City, Florida, USA, has added Laser Beam Powder Bed Fusion (PBF-LB) technology to its lineup of Additive Manufacturing machines. At Rapid + TCT 2025, the company launched the Fusion S range, a new AM machine intended for high-value applications in aerospace, defence, medical, energy, and tooling industries. In addition to PBF-LB, the company offers Directed Energy Deposition (DED) and Liquid Metal Jetting (LMJ) machines.

"Our new [PBF-LB] platform, Fusion S, brings high-precision, production-grade metal 3D printing to the forefront of our offering," stated Brian Matthews, CEO of ADDiTEC. "This launch marks a major milestone in our mission to deliver a full-spectrum metal AM portfolio that addresses the most demanding use cases – from aerospace and defence to medical and energy. RAPID is the perfect venue to showcase this evolution."

Developed through strategic collaboration, the Fusion S features a 200 W laser with a 50 μm welding spot. The machine can produce layer thicknesses of 10-50 μm and build speeds of up to 5 m/s. Operating with AL3D-OS software, the machine also offers optimised build parameters for advanced alloys such as titanium, stainless steel, and cobalt chrome.

The turnkey machine also features integrated post-processing capabilities and an intelligent powder cartridge system to enable the safe, economical handling of powder. The Fusion S also includes the Fusion Cabin unpacking station, which allows users to clean the additively manufactured component of residual powder in a closed process chamber.

ADDiTEC's range now includes the Fusion S PBF-LB Additive Manufacturing machine (left) and the Fusion Cabin unpacking station (right) (Courtesy ADDiTEC)

www.additec3d.com

One Click Metal to expand presence in India through Altem Technologies partnership

One Click Metal, Tamm, Germany, has announced a partnership with Altem Technologies, Bengaluru, India. By combining One Click Metal's BOLD-series metal Additive Manufacturing machines with Altem Technologies' distribution network and industry expertise, the collaboration aims to provide cost-effective, user-friendly solutions tailored to the needs of Indian SMEs.

Martin Heller, Global Sales Director at One Click Metal, shared, "Collaborating with Altem Technologies aligns with our mission to democratise metal 3D printing. Their deep understanding of the Indian market and commitment to customer success make them an ideal partner as we expand our global footprint."

Abhishek Kalra, Associate Vice President (Digital Manufacturing) at Altem Technologies, commented, "Partnering with One Click Metal enables us to offer cutting-edge metal 3D printing solutions to our clients. This collaboration will empower Indian manufacturers to innovate and enhance their production capabilities, keeping pace with global advancements in Additive Manufacturing."

www.oneclickmetal.com
www.altem.com

One Click Metal has partnered with India's Altem Technologies (Courtesy One Click Metal)

EDM Performance Accessories named exclusive US distributor for Klaeger metal AM saw solutions

EDM Performance Accessories (EPA), headquartered in Brea, California, USA, reports it has become the exclusive USA distributor for Italy-based Klaeger, a developer of bandsaw technology that includes a line of saw solutions specifically designed for metal Additive Manufacturing.

Klaeger's Bitron 3D and VBS 3D saws are built for metal Additive Manufacturing applications and include band deflection technology, built-in plate fixturing, integrated powder vacuum and spark suppression, and a built-in safety shield. These features are said to make them ideal for bandsaw cut-offs of up to 500 mm.

EDM Performance Accessories uses the company's HB Moly Cut EDM machines to provide EDM cut-offs for its customers; the addition of the Klaeger bandsaw enables EPA to serve as a one-stop supplier for all its customers' post-processing cut-off needs.

www.edmperformance.com
www.klaeger.com

Klaeger's Bitron 3D and VBS 3D saws are designed for metal AM applications (Courtesy Klaeger)

MetalWorm partners with Brazil's IFMA for academic and research activities

MetalWorm, based in Ankara, Türkiye, has announced a partnership with the Instituto Federal do Maranhão (IFMA), São Luís, Brazil, in an effort to facilitate academic and research activities focused on Wire Arc Additive Manufacturing (WAAM).

As part of the partnership, IFMA has purchased a WAAM machine from MetalWorm which will support various applications, including training programmes, new alloy development, WAAM process research, toolpath planning, and digital twin studies.

The machine is planned for installation within the Department of Mechanics and Materials (DMM) at the São Luís – Monte Castelo Campus.

The Instituto Federal do Maranhão is a public higher education institution operating in the fields of education, science, and technology. The DMM plays a role in engineering education, research, and technical applications. The department is equipped with laboratories that offer students hands-on training and conducts various industry-oriented projects, such as analysing and repairing faults in laboratory automation systems.

www.metalworm.com
portal.ifma.edu.br

Mears Machine Corporation adds fourth Sapphire XC Additive Manufacturing machine from Velo3D

Velo3D, headquartered in Fremont, California, USA, has announced that Mears Machine Corporation has purchased its fourth Sapphire XC Additive Manufacturing machine in response to customer demand. This order is said to underscore Mears Machine's commitment to adopting advanced manufacturing technologies and follows the previous purchase of three Velo3D Sapphire XCs in 2024.

"As precision machine shops increasingly adopt advanced manufacturing technologies, like 3D printing, we are pleased to support their mission to modernise and better serve their customers," said Arun Jeldi, CEO of Velo3D. "Our partnership with Mears Machine, now integrating a fourth Sapphire XC printer, highlights the sales momentum for our technology and underscores the value that our Additive Manufacturing solutions bring to manufacturers looking to enhance productivity, scale operations and drive innovation."

Mears Machine has ordered a fourth Sapphire XC (Courtesy Velo3D)

The new Velo3D Sapphire XC machine at Mears Machine will be configured to produce parts in nickel super-alloy H282. H282 is a strengthened superalloy developed for high-temperature applications, primarily for aerospace propulsion systems, industrial power generation, nuclear power and critical CO_2 systems. It processes a unique combination of strength, thermal stability, and fabricability not found in currently available commercial alloys. Manufactured parts also have better weldability, creep resistance in the range 649–927°C, oxidation properties and great thermal stability. Velo3D sees significant opportunities for parts in H282, including many that support critical defence-related programmes.

"Integrating the Velo3D Sapphire XC printer into our operations has represented a significant leap forward in addressing the evolving needs of our existing customers. The new industries and customer base attracted by this capability has exceeded our expectations," said Roger Mears, Executive Chairman of Mears Machine. "This technology empowers us to efficiently deliver complex, high-quality components to our customers. Coupled with our world-class machining capability and post-process supply chain management experience, we are positioned as a leading partner in the Additive Manufacturing landscape. Our customers' demands have increased, and we have met production with Velo3D's highly scalable Additive Manufacturing solution, which makes us unique in the industry."

Velo3D's fully integrated solution, which combines software, hardware, and manufacturing processes, enables unparalleled scalability and affordability. Once a part has been qualified on a Velo3D machine, production can be easily scaled across any system of the same model of AM machine that is configured for the same alloy. This capability is crucial for Mears Machine's customers who seek to affordably scale production of additively manufactured components while navigating supply chain challenges.

The Velo3D Sapphire XC machine sets itself apart in the Laser Beam Powder Bed Fusion (PBF-LB) with its unique build capabilities and large format. The machine uses eight 1-kilowatt lasers and can produce parts 600 mm in diameter and 550 mm in height, with the option of 1,000 mm in height for the Sapphire XC 1MZ.

www.mearsmachine.com
www.velo3d.com

David Goulbourne appointed president of Sandvik Powder Solutions Division

Sandvik AB, headquartered in Stockholm, Sweden, has announced the appointment of David Goulbourne as the new president of the Powder Solutions division, effective May 1, 2025. The Powder Solutions division belongs to business area Sandvik Manufacturing and Machining Solutions, part of the Sandvik Group. The division includes the Osprey line of products as well as the Wolfram and Buffalo Tungsten brands. Goulbourne will also be the president of Wolfram Bergbau und Hütten AG.

Goulbourne brings nearly twenty-five years of experience in the manufacturing industry and an entrepreneurial mindset. Before taking this role, Goulbourne held the position as Vice President Business Unit Solid Round Tools at Sandvik Coromant.

"I am thrilled to join the Powder Solutions division and contribute to strengthening and expanding our leadership in the powder manufacturing industry. My focus will be on ensuring that customer value remains our top priority, by continuously developing more sustainable processes and high-quality powder solutions," said Goulbourne.

He will succeed Alex Nieuwpoort, who has decided to retire after twenty-eight years of dedicated service and significant contribution to Sandvik's growth and business development. Nieuwpoort will remain with Sandvik until the end of June.

www.metalpowder.sandvik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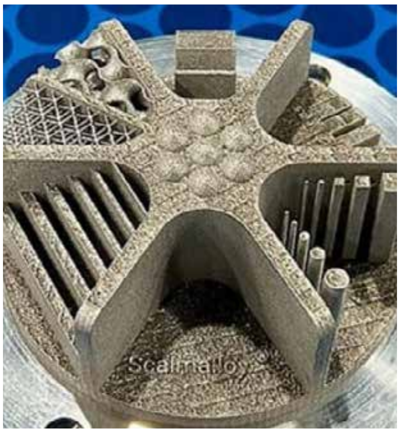
www.hybrid-am.com

Equispheres to establish North American production of APWORKS' Scalmalloy aluminium alloy

Equispheres, Inc, based in Ottawa, Ontario, Canada, and APWORKS, headquartered in Taufkirchen, Germany, have announced their collaboration on the development of North American production capacity for APWORKS' Scalmalloy powder, a proprietary high-strength aluminium alloy designed specifically for Additive Manufacturing. The two companies have entered into a non-binding understanding and are currently exploring avenues for future production, distribution, and technical alignment.



Equispheres will provide a secure supply chain for Scalmalloy powder (Courtesy Equispheres)

Scalmalloy is a patented aluminium-magnesium-scandium alloy developed by APWORKS, a subsidiary of Airbus. The alloy offers mechanical properties comparable to 7000-series aluminium and is engineered for optimal performance in metal AM. Scalmalloy is currently licenced to producers in Europe and Asia, but Equispheres will be the first to establish a North American supply chain, using primarily locally sourced raw materials.

"Scalmalloy will be a great addition to our line of high-performance materials for serial AM," stated Kevin Nicholds, CEO of Equispheres. "We're excited to be in discussions with APWORKS about producing this high-strength alloy for aluminium parts. North American supply of critical materials such as aluminium-scandium alloys is a key step toward securing the aerospace supply chain."

Combining high strength with superior ductility and excellent processability, Scalmalloy is widely used in critical, highly loaded components across aerospace, defence, and motorsport industries.

"Equispheres is a logical choice for expanding Scalmalloy production into North America," said Jonathan Meyer, CEO of APWORKS. "They are widely regarded for their expertise in producing high-quality aluminium powders for Additive Manufacturing, and their access to domestic sources of aluminium and scandium is an important factor in supply chain resilience in an increasingly uncertain world."

"Scalmalloy powder made in Equispheres' North American facility will eliminate many of the adoption barriers that have historically limited the use of this alloy in critical programmes," added Evan Butler-Jones, Vice-President of Product & Strategy at Equispheres. "By combining the excellent properties of Scalmalloy with our proprietary powder technology, we can deliver an ideal material solution for the most demanding AM applications."

Equispheres produces optimised aluminium powders that have repeatedly demonstrated the capability to enhance the performance of metal AM processes, supporting faster production, better mechanical properties, and more reliable parts. It also produces aluminium alloy powders from standard alloys, which are said to achieve faster build rates compared with traditional powders, with no adverse effects on mechanical properties.

www.equispheres.com
www.apworks.de

AO Metal series brings affordable PBF-LB Additive Manufacturing to labs and universities

Additive Plus, based in Torrance, California, USA, has launched AO Metal, its first in-house developed line of compact metal Additive Manufacturing machines. The product family – comprising the A30, A50, and A100 models – is engineered to meet the needs of labs, universities, and small production teams seeking high-performance metal Additive Manufacturing in a compact, affordable package.

"Hands-on access to metal 3D printing shouldn't require a six-figure investment," said Ashkhen Ovsepyan, founder and CEO of Additive Plus. "We built AO Metal to support researchers, universities, and small-scale innovators who are pushing material boundaries but need tools that fit their space and budget."

Each AO Metal machine supports open process parameters, giving users full control over laser power, scan strategies, and thermal management – key for material research, alloy development, and prototyping. A unique laser setup, with infrared and blue laser options, allows for manufacturing traditionally difficult materials like copper, gold, and high-entropy alloys, providing unmatched material flexibility at this scale.

This modular ecosystem is reported to enable faster material development, reduce lead times, and offer an all-in-one solution for technical programmes and applied material labs. The cost of the AO Metal range starts at $59,000.

www.aometal.com
www.additiveplus.com

CNPC launches high thermal and electric conductive Al0407 aluminium powder

CNPC Powder, headquartered in Vancouver, Canada, with production facilities in China, has launched CNPC-Al0407, a new aluminium alloy powder for Additive Manufacturing. The alloy is reported to offer high thermal and electrical conductivity, alongside excellent mechanical properties.

The optimised aluminium alloy powder achieves a conductivity exceeding 50% IACS and a thermal conductivity as high as 200 W/m·K. The material is compatible with mainstream Additive Manufacturing technologies, including Laser Beam Powder Bed Fusion (PBF-LB) and Electron Beam Powder Bed Fusion (PBF-EB).

Low oxygen content and high flowability also ensure stable Additive Manufacturing processes, allowing users to achieve part density exceeding 99.5% and reduce post-processing costs.

The powder is produced using CNPC Powder's proprietary AMP (Automated Metal Production) process. This technology ensures precise control of alloy composition ratios, guaranteeing consistent high performance across all production batches, while significantly enhancing production efficiency.

Compared to traditional gas atomisation methods such as VIGA (Vacuum Induction Gas Atomisation) and EIGA (Electrode Induction Gas Atomisation), the AMP process reportedly demonstrates higher sphericity and flowability, minimal satellite particles, and optimised AM performance. The process results in over 60% yield in target particle size and supports continuous and efficient production, with shorter cycle times also helping to reduce costs.

Applications

CNPC-Al0407 is intended for use in sectors such as electronics and telecommunications, new energy vehicles, aerospace, and other high-end manufacturing sectors.

With high electrical conductivity, the alloy is said to meet requirements for precision circuits, electromagnetic shielding, and conductive connectors. Its high thermal conductivity enables efficient heat dissipation, reduces operating temperatures, enhances device stability and lifespan, and significantly boosts system performance.

Combining excellent thermal performance with the low density of aluminium alloy, CNPC-Al0407 can be used to produce lightweight heat exchangers for aerospace and automotive electronics. It is also ideal for thermally sensitive components such as electronic chip heat sinks and LED cooling modules.

www.cnpcpowder.com

IperionX secures $11M loan for titanium and Additive Manufacturing expansion

IperionX, based in Charlotte, North Carolina, USA, announced that the Board of Directors of the Export-Import Bank of the United States (EXIM Bank) has approved an equipment finance loan of $11 million. Subject to the completion and execution of definitive documentation, this loan will support the significant expansion of IperionX's advanced titanium manufacturing capabilities.

The EXIM Loan will finance the acquisition of state-of-the-art manufacturing equipment, including advanced Additive Manufacturing systems and precision machining tools. These manufacturing assets will enhance IperionX's capabilities to produce a broad array of high-performance titanium components, leveraging proprietary and patented technologies at its Advanced Manufacturing Center in Virginia, USA.

This financing initiative is directly aligned with EXIM Bank's strategic objectives, notably the 'Make More in America Initiative' and the China and Transformational Exports Program, which aim to strengthen US manufacturability capabilities, mitigate foreign supply chain vulnerabilities, and bolster economic resilience and national security.

The EXIM Loan provides IperionX with a low-cost, non-dilutive funding pathway to further scale its advanced materials and Additive Manufacturing capabilities, and underpin a fully integrated, end-to-end titanium supply chain within the United States. Titanium is prized for its superior strength-to-weight ratio, exceptional corrosion resistance, and outstanding performance under extreme conditions, making it critical for advanced industries such as aerospace, defence, automotive, and healthcare. Currently, the US is overwhelmingly reliant on foreign sources for primary titanium (sponge) and titanium minerals, creating significant economic and national security vulnerabilities.

Through its Advanced Manufacturing Center, IperionX is utilising its patented technologies to produce high-value titanium products in Virginia, creating highly skilled American manufacturing jobs and addressing critical supply chain gaps. IperionX's technology portfolio enables the production of low cost and high-performance near net shape products, semi-finished titanium products, spherical titanium powder for AM and MIM, and angular titanium powder for a wide range of advanced manufacturing applications.

The EXIM Loan directly supports IperionX's mission to re-shore a low-cost, uninterruptable 'all-American' titanium supply chain, essential for both national security and sustained economic growth.

www.iperionx.com

IperionX has secured an $11 million loan for titanium and Additive Manufacturing expansion (Courtesy IperionX)

Nano Dimension adds Sriubas and Tanghal to board

Nano Dimension, headquartered in Waltham, Massachusetts, USA, has appointed Andy Sriubas and Eileen Tanghal to its board of directors. The announcement is reported to come at a pivotal moment for the company, as it shifts from M&A integration to scaling a unified technology platform across its global markets.

"We are strengthening our board at a critical moment in Nano Dimension's development," stated Ofir Baharav, CEO, Nano Dimension. "With our digital manufacturing platform now aligned and abundant opportunities in front of us, Andy and Eileen bring forward-thinking leadership and operational experience that will help guide our next phase with a focus on delivering for shareholders. Both bring a deep understanding of technology at its core and a broad perspective on how to translate it into value."

Sriubas is a veteran commercial executive and former CCO at Outfront Media, where he led digital transformation, strategic partnerships and new revenue generation. He spent over two decades as an investment banker with JPMorgan, UBS, and DLJ, advising on complex M&A and capital markets transactions. Sriubas earned a bachelor of science degree in finance at Boston College's Wallace E Carroll School of Management.

Tanghal is co-founder and general partner at venture capital firm Black Opal Ventures, with experience in evaluating and scaling breakthrough technologies. A former partner at In-Q-Tel, a venture capital firm established by the CIA, and executive at ARM and Applied Materials Ventures, she brings a unique ability to assess technical foundations and translate them into scalable, disruptive outcomes. Tangal has an MBA in International Finance and Entrepreneurial Management from the London Business School, and a bachelor's degree in electrical engineering and computer science from MIT.

www.nano-di.com

Bentley's Black Rose Batur detailed with additively manufactured solid rose gold

Bentley Motors, headquartered in Crewe, United Kingdom, has revealed The Black Rose, a custom version of its limited-run coachbuilt Batur grand touring coupé. The car's interior features a rose gold theme and includes several additively manufactured solid rose gold components.

The Black Rose is one of eighteen Baturs being built by Bentley's bespoke Mulliner division, and results from an extensive co-creation journey between the client and Mulliner's design team. Bentley is using Additive Manufacturing to add up to 210 g of hallmarked 18-karat rose gold to the interior at key driver touchpoints, including the Drive Mode Selector and Bentley's Organ Stop vent controls on the dashboard. There is also a rose gold insert marker on the steering wheel.

Bentley collaborated with Cooksongold, based in the jewellery quarter in Birmingham, UK, to combine new and advanced manufacturing technologies with more traditional materials and finishing techniques. The manufacturers noted their use of sustainably sourced raw materials from 100% recycled jewellery reflects a commitment to sustainability that aligns with goals to be carbon-neutral by 2035.

www.bentleymotors.com
www.cooksongold.com

Bentley is using Additive Manufacturing to add up to 210 g of hallmarked 18-karat rose gold at key driver touch points inside the Black Rose Batur coupé (Courtesy Bentley Motors)

Thermo-Calc Solutions formed following the acquisition of QuesTek Europe

Thermo-Calc Software AB, based in Solna, Sweden, has announced its 100% acquisition of QuesTek Europe AB. Previously a joint venture, QuesTek Europe is known for its expertise in integrated computational materials engineering (ICME). The company will now operate under the new name Thermo-Calc Solutions AB, expanding its ability to deliver advanced ICME services alongside software solutions.

Going forward, Thermo-Calc Solutions will leverage Thermo-Calc Software's suite of products to deliver cutting-edge services in materials design, process simulations, and alloy optimisation. The company aims to enable its clients to accelerate product development, reduce costs, and meet performance and sustainability targets.

"Thermo-Calc Solutions is the next step towards delivering a comprehensive ICME platform," said Anders Engström, CEO of Thermo-Calc Software AB. "Full integration enables closer collaboration and greater innovation for our global customers."

The engineering services team, formerly operating as QuesTek Europe, has a history of solving materials challenges across aerospace, energy, industrial, and automotive sectors using a variety of commercial and proprietary modelling design tools and simulation-based workflows. Under Thermo-Calc Solutions, the group will retain its experienced workforce while gaining broader resources and visibility within the Thermo-Calc network.

"This new name reflects our identity and mission," said Ida Berglund, Managing Director of Thermo-Calc Solutions. "Clients can expect the same dedication to innovation and engineering excellence, now more tightly aligned with the software and tools that power our work."

The integration delivers key benefits for customers, including tighter cooperation between engineering services and Thermo-Calc's software products and seamless ICME workflows from simulation to material deployment. Customers will also benefit from expanded global support across Europe, North America, and Asia, along with a unified brand experience that combines software, data, and engineering solutions.

www.thermocalc.com

Rosswag invests in qualloy's metal powder marketplace

qualloy, based in Düsseldorf, Germany, an intermediary for buyers and sellers in the metal powder market, has secured Series Seed funding from Additive Manufacturing service provider Rosswag Engineering, headquartered in Pfinztal. The strategic investment is said to strengthen its position as a trusted sourcing platform, while enabling it to expand its core business.

Using an intelligent search algorithm, qualloy enables users to find well-suited metal powders for their specific machines and specifications from a broad range of certified global suppliers. This marketplace allows users to freely switch between different powder manufacturers, optimising price, delivery time, and quality, while enabling a transparent and efficient procurement process.

Building on its existing marketplace for metal powder sourcing, qualloy also plans to expand its business in the coming months with its own line of internationally sourced powders that are Rosswag-qualified. Customers will be able to purchase the powders through qualloy's procurement processes, backed by local support representatives.

Dr-Ing Gregor Graf, Head of Technology at Rosswag, stated, "Platforms and online marketplaces hold tremendous potential in the B2B sector, enabling effective procurement and streamlined processes. Together with qualloy, we are creating the perfect partnership to offer an unmatched price-quality ratio for metal powders to drive the upcoming AM market growth."

Users can find metal powders for their specific machines and specifications from a broad range of certified global suppliers (Courtesy qualloy)

"With Rosswag, we have found the perfect partner to take qualloy to the next level. Their knowledge, network, and infrastructure are an ideal match for our vision of revolutionising metal powder procurement. We look forward to the exciting opportunities ahead," Yannik Wilkens, CEO and co-founder of qualloy, stated.

www.rosswag-engineering.com
www.qualloy.com

Technical University of Munich adds metal Binder Jetting from Addimetal

The Technical University of Munich, Germany, has expanded its Additive Manufacturing capabilities with the installation of a new K2-2 metal Binder Jetting machine from Addimetal, headquartered in Toulouse, France.

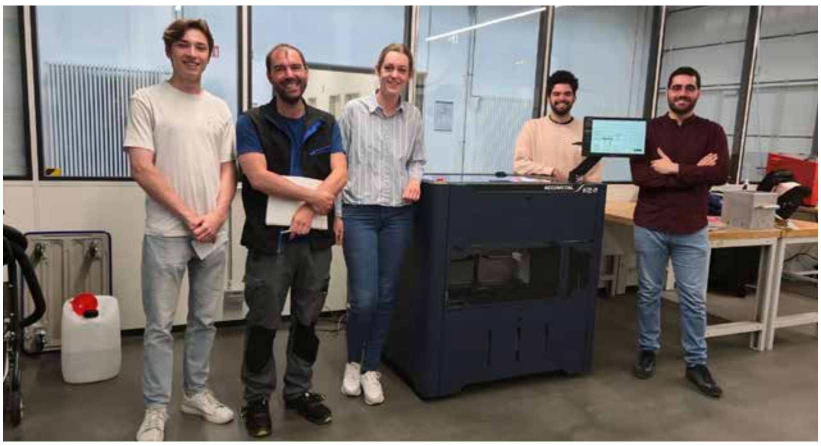
"After many successful years working with various laser-based Powder Bed Fusion systems, we're excited to expand our Additive Manufacturing capabilities by installing our first metal Binder Jetting machine," stated Professor Dr-Ing Katrin Wudy, Professorship of Laser-based Additive Manufacturing at the TUM School of Engineering and Design, on LinkedIn.

Launched at Formnext in November 2024, the K2-2 can process a wide variety of metal powders and binders. It features a build box measuring 200 x 200 x 200 mm and offers high-resolution printing from 360 up to 1080 DPI.

The K2-2 also features an open system that enables the use of non-proprietary binders, giving users greater material flexibility. The machine incorporates real-time environmental control with visual sensors to optimise the workspace for maximum performance.

"This new technology opens up entirely different processing routes, materials, and application possibilities, adding a valuable dimension to our research and development work," added Prof Wudy. "We're thrilled to begin exploring the potential of metal Binder Jetting and look forward to the new insights and opportunities it will bring."

www.addimetal.com
www.tum.de



The Technical University of Munich has installed an Addimetal K2-2 – its first metal Binder Jetting machine (Courtesy Technical University of Munich)

Oerlikon launches MetcoMed brand with metal powders for medical Additive Manufacturing applications

Oerlikon Metco, headquartered in Winterthur, Switzerland, has launched its new MetcoMed brand with the release of two materials tailored for the Additive Manufacturing of medical components and implants. The new metal powders, MetcoMed Ti64 G23-C, a titanium alloy, and MetcoMed CoCrMo F75-A, a cobalt-chromium alloy, are now available through the company's distribution network.

MetcoMed Ti64 G23-C

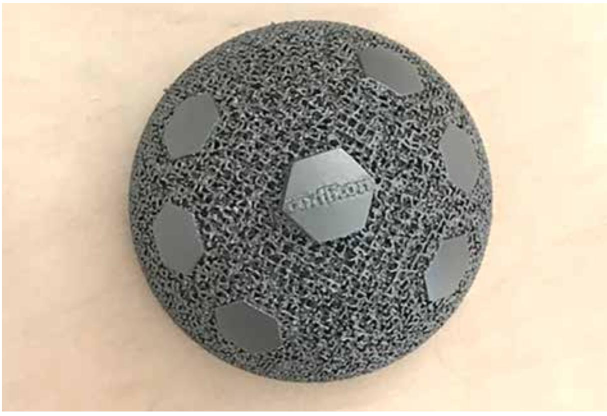
Building on the established and industry-approved alloy for Additive Manufacturing, Oerlikon's MetcoMed Ti64 G23-C is said to provide high load-bearing capacity, good ductility, excellent biocompatibility, and good corrosion resistance. The material reportedly offers a tensile strength of over 1,000 MPa at 10% elongation. It has been optimised for Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing technology and can function as a direct drop-in solution for most machine brands.

MetcoMed CoCrMo F75-A

Cobalt-chromium alloys are widely used for various orthopaedic and dental implants, with CoCrMo one of the most-used alloys for tooth implants and total hip replacement due to its superior corrosion qualities, antibacterial properties, improved cell adhesion, and potential for reducing inflammation markers.

Oerlikon has developed and launched a CoCrMo material specifically for PBF-LB Additive Manufacturing, noting the material's high strength, ductility, and biocompatibility. MetcoMed CoCrMo F75-A provides a reported tensile strength of 1,050 MPa and 35% elongation despite its low carbon content (desirable for an implant material). The powder exhibits a particle size distribution that enables its use on most PBF-LB AM platforms.

www.oerlikon.com/metco

Additively manufactured titanium knee tip base (left) and titanium hip implant (Courtesy Oerlikon Metco)

ASME acquires Women in 3D Printing global community

The American Society of Mechanical Engineers (ASME) has finalised an agreement to assume the operations and acquire the assets of Women in 3D Printing (Wi3DP). Since 2014, Wi3DP has focused on providing promotion, support and inspiration to women using Additive Manufacturing across a variety of industries and applications. The organisation currently has over 13,000 members enrolled in its 100 global chapters.

"Women in 3D Printing has had an incredible ten-year journey. Along the way, it became clear that additional resources were needed to sustain and expand our mission," said Nora Toure, founder and board chair. "Joining forces with ASME ensures that the spirit and impact of Wi3DP will be preserved, while gaining the structure and support needed to grow, evolve, and reach even greater heights."

Across the board, women are underrepresented in engineering fields. According to Wi3DP research and Diversity for Additive Manufacturing reports, only 13% of the AM workforce is currently made up of women; 11% of businesses are women-owned. In the wider sector, 16-17% of engineers are women, precise numbers varying by discipline, with women accounting for roughly 9% of mechanical engineers. Wi3DP is focused on bringing the proportions of women in Additive Manufacturing to 50%.

"An inclusive engineering community leads to more innovation," said Stephanie Viola, executive director of the ASME Foundation and managing director of ASME Philanthropy and Programs. "Together, ASME and Women in 3D Printing can help address the workforce gap while also ensuring that engineering remains an open and welcoming field for all who have the ability, and aspire to contribute toward solutions for global challenges."

www.womenin3dprinting.org
www.asme.org

Epson Atmix opens $38 million recycling facility to support sustainable metal powder production

Epson Atmix Corporation, a group company of Seiko Epson Corporation based in Aomori, Japan, has completed construction of a new $38 million metal recycling facility at Kita-Inter Plant No 2. The new centre will recycle used metals from the Epson Group's operations and the local community to produce raw materials for Atmix's metal powder products. The recycling facility was first announced in 2022, with construction beginning in 2023.

Atmix will recycle out-of-specification metal powders, metal scraps from its own production processes, and used moulds and metal offcuts from Epson Group operations. These materials will be refined into high-quality raw materials, which will then be used at Atmix's headquarters and Kita-Inter Plant to produce metal powders suitable for Metal Injection Moulding.

Kita-Inter Plant No 2 is expected to play a key role in advancing Epson's goal of becoming natural resource free (Courtesy Epson Atmix)

Epson stated that it is committed to developing environmental technologies that support resource circulation and carbon reduction, particularly through materials innovation. Its Environmental Vision 2050 outlines its goal of becoming carbon negative and underground resource-free by 2050. Kita-Inter Plant No 2 is expected to play a key role in advancing this goal.

Atmix produces a range of metal powders for a variety of manufacturing processes, including Metal Injection Moulding and Additive Manufacturing. The company also produces magnetic powders for use in power supply circuits, as coils for IT equipment, and for components in hybrid and electric vehicles.

www.atmix.co.jp

Alleima adopts thermal spraying technology to support green transition

Alleima, headquartered in Sandviken, Sweden, reports it has invested in new thermal spray technology. The company aims to develop new products in the field of sustainable energy, where, for example, it can be used in the production of electrolysers used for green hydrogen production. The company said it is in dialogue with several customers, with the first prototype of coated material having been sent for evaluation.

Thermal spraying is an advanced manufacturing method in which material in powder or wire form is melted and sprayed onto a surface to create a coating with specific properties. The technology enables coatings that are crucial for improving products such as electrolysers for the production of green hydrogen. Green hydrogen – produced by the electrolysis of water using renewable energy – plays a central role in the transition to a carbon-free economy. Thermal spraying enables the development and industrial production of key components in an electrolysis stack.

"This investment is part of the company's long-term strategy to drive innovation and create sustainable solutions. It is a pilot that will primarily be used for research purposes but will also be used for small-scale production when possible. By using this technology in our manufacturing processes, we can offer advanced materials and components that meet the high demands of hydrogen production. This initially includes the development of components for electrolyser cells, but also other applications that require robust and durable coatings," stated Tom Eriksson, Head of Strategic Research at Alleima.

Alleima anticipates that the adoption thermal spray technology will eventually make it possible to develop products that replace expensive material solutions, thus reducing the cost of electrolyser stacks and, in turn, lowering carbon emissions through the increased use of green hydrogen.

One of the advantages of thermal spraying is that it is a fast process and can be used in many different areas, depending on the base material used. Common materials include metals, metal alloys, composites, and ceramics. These coatings can withstand high temperatures and protect components from wear and corrosion, making them ideal for industrial applications. The coatings can also enhance the properties of the component (e.g. friction, electrical conductivity or insulation).

www.alleima.com

Emery Oleochemicals achieves ISO 50001 energy management certification

Emery Oleochemicals, headquartered in Cincinnati, Ohio, USA, has achieved ISO 50001: Energy Management Systems certification at its manufacturing facility in Cincinnati. In May 2025, the Ohio Chemistry Technology Council (OCTC) recognised this certification, honouring the company with an Award for Excellence in Environmental Performance at its 36th Annual Conference.

This certification was awarded in December 2024 following a rigorous third-party audit at its Cincinnati manufacturing site, which has held ISO 9001 and ISO 14001 certifications for over two decades.

In 2024, Emery launched a comprehensive Energy Management System (EnMS), including initiatives such as steam trap testing and repair, ozonator efficiency studies, steam boiler tuning, and employee training focused on eliminating wasteful energy practices. These actions are said to have already delivered results – most notably, per the company, a 25% reduction in nitrogen oxide (NOx) emissions, or 16 tons annually, due to improved boiler performance.

Emery's Energy Committee is now focused on setting new targets and identifying additional energy-saving opportunities for 2025 and beyond.

MIM, CIM and sinter-based AM at Emery Oleochemicals

Emery Olechemicals provides a wide range of sustainable polymer additives, including binders for Metal Injection Moulding (MIM), Ceramic Injection Moulding (CIM), and sinter-based Additive Manufacturing feedstock.

Eric Cecilio, North America Regional Managing Director (left), and Mike Flaherty, Safety, Health & Environmental Manager accepted the award (Courtesy Emery Oleochemicals)

The company's polyamide-based binder system is supplied as a ready-to-use solution to be compounded with the powder to make a feedstock. It also supplies single ingredients for customers who want to tailor the binder composition to their specific requirements.

www.emeryoleo.com

MetalWorm enters Malaysian market with Wire Arc Additive Manufacturing machine sale

MetalWorm, based in Ankara, Türkiye, has announced the sale and forthcoming installation of one of its robotic Wire Arc Additive Manufacturing (WAAM) machines to a Malaysian university. The company referred to the sale as a key milestone in its global expansion, aligning with its goal of supporting metal Additive Manufacturing education and development.

The deal with the university was supported by partner Pebblereka, based in Subang Jaya, Malaysia, which has a network of over 500 customers and a portfolio of over 2,000 products to support the region's Additive Manufacturing ecosystem.

In a statement, MetalWorm said, "Our cutting-edge WAAM system will empower the university and its partners to explore new frontiers in research, education, and industrial-scale production – with agility, precision, and sustainability."

MetalWorm's robotic WAAM machines, also referred to as wire-based Directed Energy Deposition (DED) machines, are customisable and include a range of monitoring and control options to meet the specific needs of clients. The machines are built on the framework of either the MetalWorm

MetalWorm will install a Wire Arc Additive Manufacturing machine in a Malaysian university (Courtesy MetalWorm)

Compact System or the MetalWorm Special System and feature active cooling and heating technology, vibration technology, and arc voltage control.

www.metalworm.com

Azoth 3D adds Incus lithography-based metal AM machine for fast-turnaround complex parts

Azoth 3D, a precision Additive Manufacturing parts maker based in Ann Arbor, Michigan, USA, will expand its production capabilities with a Hammer Lab35, a lithography-based metal manufacturing (LMM) machine from

Azoth 3D will expand its production capabilities with a Hammer Lab35 lithography-based metal Additive Manufacturing machine (Courtesy Incus)

Incus GmbH, Vienna, Austria. This collaboration is expected to enable Azoth 3D to deliver small, complex metal parts with shorter turnarounds.

Azoth stated that the adoption of Incus' LMM technology marks a significant step forward in its mission to provide high-quality metal components with shorter lead times, increased design freedom, and cost efficiency. It will focus its work on 316L and 17-4 PH stainless steels and titanium.

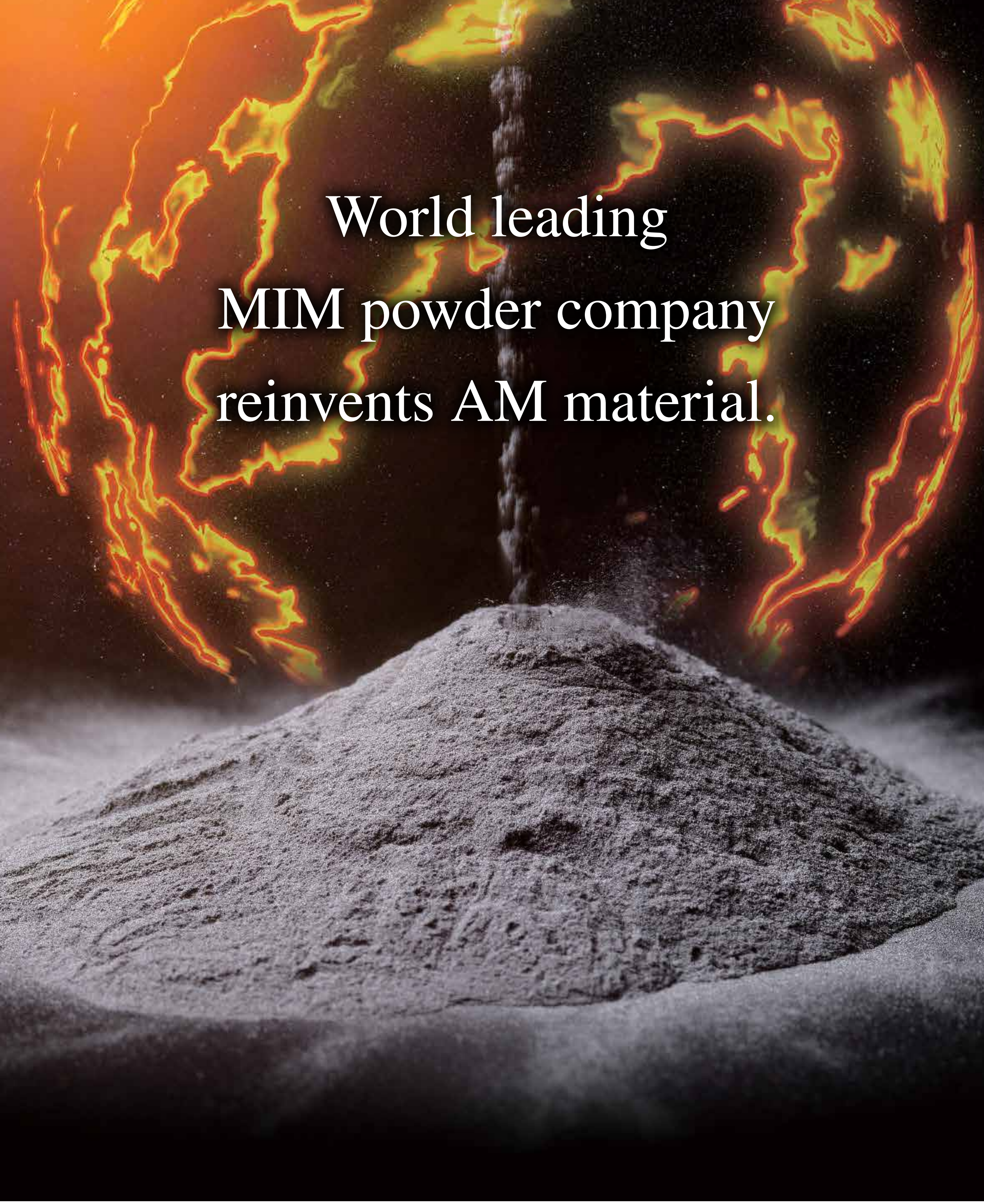
"Incus' LMM technology allows us to bridge the gap between rapid prototyping and end-use production with an unmatched lead time of just 5-7 days," stated Cody Cochran, General Manager and co-founder. "This is a game-changer for industries that require high-quality metal components quickly and cost-effectively."

"We are excited to collaborate with Azoth 3D and bring the advantages of LMM technology to more manufacturers," added Denise Moedder, Head of Application Engineering at Incus. "The Hammer Lab35's ability to produce fine-detail metal parts with exceptional surface quality aligns perfectly with Azoth 3D's vision for rapid and efficient production."

The Hammer Lab35 machine utilises a photopolymerisation-based process to achieve its fine feature resolution and surface finish, making it well-suited for complex geometries and intricate designs.

The integration of Incus' technology further strengthens Azoth 3D's commitment to delivering cutting-edge Additive Manufacturing solutions and reducing supply chain constraints. For customers ready to order parts, Azoth provides its secure Smart Quote system, a digital tool that streamlines the process for parts that need to be delivered sooner. With the Smart RFQ platform, users can quickly upload 3D data and 2D drawings and receive quotes on the same day for most projects.

www.incus3d.com
www.azoth3d.com


World leading
MIM powder company
reinvents AM material.

USC Racing and Wayland partner to create innovative titanium part for Formula SAE race car

Wayland Additive, based in Huddersfield, UK, has partnered with the University of Southern California's (USC) Formula SAE Team to produce and supply a titanium exhaust collector for its 2025 race car. The complex part, traditionally challenging to manufacture, was successfully produced using Wayland's NeuBeam Electron Beam Powder Bed Fusion (PBF-EB) metal Additive Manufacturing machine.

Samuel McCarthy, a student at USC and Suspension Lead for the USC Racing – Formula SAE Team, shared, "The exhaust collector is the part that joins each cylinder's exhaust into one stream, and it directly affects engine efficiency and performance. Physically it is a complex part with a series of connected tubes. There are usually two critical design considerations: performance versus manufacturing difficulty. Optimal performance requires optimised angles of the tubes where the exhaust flow meets, a certain initial contact of flow. Manufacturing the ideal exhaust collector with these preferred angles is generally not possible with traditional methods, such as welding, and there is always a trade-off between the two. By using AM, specifically Wayland's NeuBeam process, we have been able to minimise the trade-off and get the best of both worlds."

The challenges in manufacturing the USC Racing exhaust collector traditionally would require welding nine 1 mm titanium tubes. McCarthy added, "The part would consist of nine custom-copied tubes, which means that they need to be cut by hand following complex contours, with compromises on the angles. In addition, five of the nine needed to be stretched to size. Getting all nine to fit together with minimal gaps takes many, many hours by a highly skilled fabricator, and even then, there is still margin for error."

Utilising Additive Manufacturing not only allowed USC Racing to overcome the constraints of traditional manufacturing processes but also addressed available space issues.

"Because traditionally manufactured collectors are welded and made from tubes which must be cut very precisely at difficult angles it compounds available space problems: the tighter the packaging requirement the more difficult it is to make. The Wayland produced part reduced the length of our exhaust collector by 50%. And this is a really big deal," McCarthy commented.

This project began when members of the USC team first approached Wayland at Rapid TCT in August 2024, seeking a collaborative relationship. Further discussion led to collaborative design and some subsequent test pieces ahead of producing the final part.

McCarthy also noted how the capabilities of the NeuBeam process and producing the part on Calibur3 were essential to the successful outcome, "The ability to produce a complex part of this nature in Titanium together with the low thermal stresses was fundamental for our application. The heat cycles seen and high vibratory environment could fracture a DMLS part. Also, the small hook retaining feature would have proven too difficult to descale."

One of the additional advantages of the NeuBeam process is minimal post-processing steps required for the exhaust collector. With no sinter cake around the part, it was quickly and easily removed from the powder bed and only required minimal cleaning.

"Some machining was required. The bore was machined to allow a sealing fit for each exhaust tube to be pressed into and a flange was machined to match a V-band, an industry standard exhaust quick disconnect," McCarthy stated. "The main challenge in machining any complex part is indicating and holding. A feature was included on the printed part to assist in indication. And a custom clamp was made to hold the part while machining, a standard practice."

www.waylandadditive.com
www.uscformulasae.com

Wayland Additive has partnered with USC Racing – Formula SAE Team to produce and supply a titanium exhaust collector for its 2025 car (Courtesy Wayland Additive)

CSIR offers 316L metal powder to South Africa's Additive Manufacturing industry

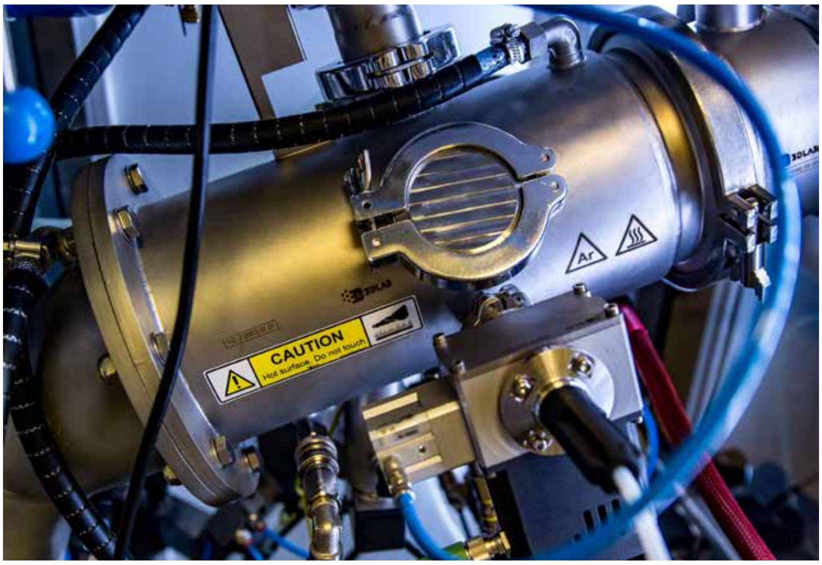
The Council for Scientific and Industrial Research (CSIR), based in Pretoria, South Africa, reports it has begun producing 316L stainless steel powder for the country's Additive Manufacturing industry. The metal powder is made using a recently commissioned ultrasonic atomiser, co-funded by the National Research Foundation (NRF), an entity of the Department of Science, Technology and Innovation (DSTI).

The atomiser is said to produce high-quality powders that have the required particle size, flowability and density for AM. The process involved characterisation using advanced analytical methods to ensure consistency. Utilising the machine's capability to atomise both reactive and non-reactive materials, CSIR hopes to provide 316L stainless steel powder to the South African market on a pilot scale. Currently, South Africa depends on imports to access powders of this quality.

Dr Miemie Maminza, who leads the Powder Metallurgy Technologies research group at the CSIR, explained, "Our aim has been to create a sustainable local supply of high-quality stainless-steel powder, which currently has significant demand in the Additive Manufacturing space. Utilising our capabilities and expertise, we believe we can contribute to the establishment of locally produced powder to grow the AM industry. We are excited about the potential this holds for driving industrial growth and localisation."

Using its own atomised powder, CSIR additively manufactured prototype tools for industrial use on a Hyrax Laser Beam Powder Bed Fusion (PBF-LB) machine from Aditiv Solutions, Pretoria.

Dr Ntombi Mathe, a principal researcher in AM at the CSIR, stated, "By manufacturing our own metal powders and developing printers, we are fostering an ecosystem where innovation breeds economic empowerment; advancing in technology, supporting local businesses, and creating job opportunities. This approach leads to a cycle of positive economic growth and development."



CSIR has atomised 316L powder for Additive Manufacturing (Courtesy CSIR)

"After reviewing the report on the initial batch production of 316L stainless steel powder produced by the CSIR, Metal Heart has found the quality of this domestic powder to align with that of internationally sourced materials," added Gerrie Lombaard, Director of AM company Metal Heart. "The powder meets standards in aspects such as oxygen content, density, particle size and morphology. Therefore, Metal Heart is confident in using this powder for their production processes, anticipating no compromise in quality."

This initiative is intended to act as an integral part of a broader national agenda to drive localisation, reduce dependence on imports and enhance the technological capabilities of local industries. The DSTI has made substantial investments in growing the additive manufacturing value chain in all its dimensions. This includes advancements in Additive Manufacturing, including Design for AM (DfAM) and machine building. Additionally, the organisation has focused on the downstream, post-processing aspects like surface heat treatment as well as the upstream development of powder/feedstock and designing for circularity.

Beeuwen Gerryts, Chief Director of Technology Localisation, Beneficiation and Advanced Manufacturing at the DSTI, said, "The CSIR is to be congratulated on this milestone, which was achieved with DSTI and NRF funding, as this is an important step in helping to strengthen the upstream Additive Manufacturing value chain and to increase the local national capacity in powder processing. We look forward to receiving further positive feedback on how the technology can be scaled up to match industry demand at competitive prices."

www.nrf.ac.za
www.dsti.gov.za
www.aditiv.co.za
www.metalheart.co.za
www.csir.co.za

3D Systems completes sale of Geomagic software portfolio to Hexagon for $123 million


Hexagon has acquired the Geomagic software portfolio from 3D Systems (Courtesy 3D Systems)

3D Systems, Rock Hill, South Carolina, USA, announced the successful completion of the sale of its Geomagic software portfolio to the Manufacturing Intelligence Division of Hexagon, headquartered in Stockholm, Sweden, for $123 million before working capital adjustments and following the satisfaction of customary regulatory approvals and closing conditions.

As part of its strategic focus, 3D Systems will now concentrate on advancing its core Additive Manufacturing software platforms, including 3D Sprint and 3DXpert, as well as the Oqton Industrial Manufacturing OS. The company intends to continue expanding the capabilities of these solutions by leveraging artificial intelligence and automation to enable accelerated adoption of Additive Manufacturing technologies in high-volume production environments.

"Hexagon is well-positioned to take the Geomagic portfolio to new heights, ensuring continued innovation and value for its users," said Dr Jeffrey Graves, president & CEO of 3D Systems. "We are grateful for the contributions of our Geomagic team members and confident they will thrive in this next chapter. For 3D Systems, with today's completed sale, we are pleased to further strengthen our balance sheet and continue our focus on fuelling profitable organic growth through R&D and investing in our core platforms. By concentrating on 3D Sprint, 3DXpert, and Oqton, we will enhance our ability to deliver innovative solutions that improve workflows, reduce costs, and enable our customers to scale production effectively. With approximately $100 million of net proceeds coming to our balance sheet, the transaction significantly enhances our cash reserves and provides us with an exceptional footing to execute in the quarters ahead."

www.hexagonmi.com
www.3dsystems.com

Adeline Riou replaces Ralf Carlström as EPMA President

The European Powder Metallurgy Association (EPMA) has appointed Adeline Riou as its new president. Riou, who serves as Market Development Director – Metal Powders at Aubert & Duval, France, succeeds Ralf Carlström of Höganäs AB, Sweden, who is stepping down after six years as the association's president. The EPMA also announced Steven Moseley, Chief Scientist Hard Materials & Key Expert at Hilti, as its new Treasurer.

The appointments were confirmed during the association's General Assembly. Every three years, the EPMA Statutes require members to elect a new president and treasurer, both subject to a maximum of two terms.

"I'm very pleased that Adeline accepted the appointment as president of EPMA," stated Carlström. "Her long experience within the Powder Metallurgy field, combined with her dedication, will be a very valuable asset for EPMA in the future."

Riou has worked in the field of metal powders for close to thirty years, having been at Aubert & Duval since 2018 and at Erasteel for twenty-two years. Over that time, she has been very active within EPMA, where she initiated the EuroHIP sectoral group in 2009 and the EuroAM sectoral group in 2013 before joining EPMA Board and Council in 2023.

She served as co-chair at the WorldPM2022 Congress and received the EPMA Distinguished Service Award in 2023. Riou is also the co-author of the EPMA's Introduction to HIP technology and Introduction to AM technology publications.

Adeline Riou (left) is the EPMA's new president, succeeding Ralf Carlström (right) (Courtesy EPMA)

"I am very happy and deeply honoured to have been elected as EPMA's new president and even more so as the first woman to hold this position," added Riou. "Many thanks to Ralf Carlström for the opportunity and for the excellent work and new ideas implemented in the last six years to strengthen the EPMA, in particular to recover from the challenging Covid crisis."

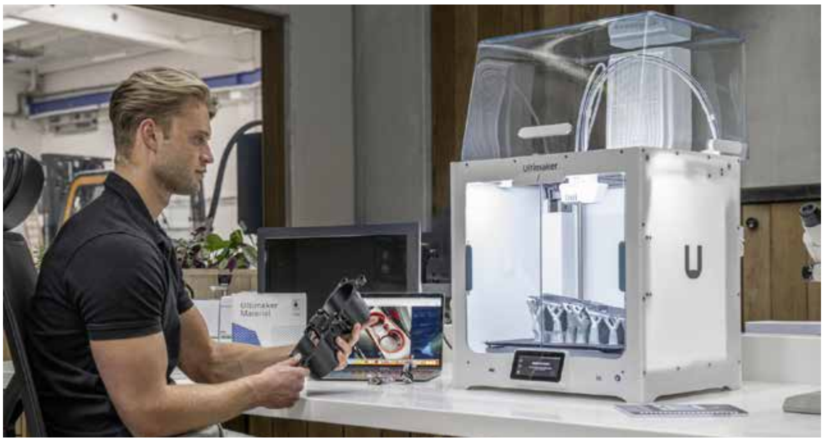
www.epma.com

UltiMaker launches S6 and adds SUS316L stainless steel filament to Marketplace

UltiMaker, based in Utrecht, the Netherlands, has launched the UltiMaker S6, a Fused Filament Fabrication (FFF) Material Extrusion (MEX) Additive Manufacturing machine. Designed for maximum versatility, the S6 is reported to be fully backwards compatible with the company's popular UltiMaker S5, and can be similarly upgraded to process metal filament with the UltiMaker Metal Expansion Kit.

Capable of delivering build speeds of up to 500 mm/s, the UltiMaker S6 offers 4x faster build times than its predecessor. Material stations, air managers, build cores, and materials are interchangeable across the entire S series. For larger manufacturing operations, previously sliced parts can be reused, enabling continued production flow without the need to recreate files. The familiar interface and ecosystem are designed to be instinctive, allowing teams to begin work quickly.

"The S6 is about giving our users more – more speed, more versatility, and more freedom – without needing to start from scratch," says Marc Uyttenboogaard, Product Manager at UltiMaker. "We've kept everything users love about the S5 and made it even better, while ensuring backward compatibility to protect our customers' investments long-term."



The UltiMaker S6, designed for engineers, manufacturing teams, and maintenance crews, can be upgraded to process metal filament (Courtesy UltiMaker)

The S6 seamlessly integrates with UltiMaker's software, materials, and hardware, powered by UltiMaker Cura and UltiMaker Digital Factory. The Cura Cloud – available through Digital Factory – allows users to slice, manage, and additively manufacture from anywhere, enabling a streamlined workflow across time zones. The S6 Additive Manufacturing is manufactured in-house at UltiMaker's ISO 9001- and ISO 14001-certified facilities.

CeraFila SUS316L stainless steel filament added to UltiMaker Marketplace

It was also reported that Dai-ichi Ceramo Co Ltd, based in Shiga, Japan, has joined the UltiMaker Marketplace, making its CeraFila SUS316L stainless steel filament available to those wishing to build metal parts as they would with any other standard polymer filament.

Dai-ichi Ceramo's CeraFila SUS316L stainless steel is composed of polymer binders with a high content of metal powder. After the Additive Manufacturing stage, high-density sintered parts are produced following a thermal debinding and sintering process. This debinding and sintering process can be performed in any furnace meeting the required specifications, or undertaken by a toll sintering service bureau.

www.dai-ichi-ceramo.co.jp
www.ultimaker.com

TAV showcases Performance Lab's role in advancing heat treatment R&D

TAV Vacuum Furnaces, based in Caravaggio, Italy, highlighted the work of its Performance Lab, a key strategic resource within the company's R&D department, in a recent blog post.

The laboratory is equipped with a range of highly specialised furnaces designed to support R&D activities focused on refining heat treatment processes. Through its range of technical features, the company can perform numerous fundamental tests on metals and ceramics, including common heat treatments, sintering, brazing and thermochemical treatments.

In addition to research and development activities, the TAV Performance Lab also serves as a technology transfer platform, allowing the company's customers to save money on their R&D activities and become operational with tested and qualified processes directly after the furnace installation phase.

"Our commitment to research and development offers a concrete response to the most advanced industrial challenges and needs, ensuring our customers always have cutting-edge products and processes," the company explained. "We offer the opportunity to carry out dedicated test runs and this collaborative approach allows us to develop tailor-made solutions that perfectly meet specific needs, ensuring top-level performance."

www.tav-vacuumfurnaces.com

Renishaw helps Irish Manufacturing Research advance aerospace optics manufacturing

Renishaw, headquartered in Wotton-under-Edge, Gloucestershire, UK, has collaborated with Irish Manufacturing Research (IMR), based in Rathcoole, Ireland, to support research into the use of Additive Manufacturing for novel aerospace materials. This collaboration is part of a Disruptive Technology Innovation Fund (DTIF) project led by mBryonics, a manufacturer of freeform optics for the space industry based in Galway.

Through the placement of a Renishaw RenAM 500Q Flex Laser Beam Powder Bed Fusion (PBF-LB) AM machine at IMR's facility, researchers are developing advanced process parameters for the metal Additive Manufacturing of freeform optical components used in laser-based satellite communications. By shifting from conventional machining, the project aims to improve production speed and efficiency.

The RenAM 500Q Flex, equipped with Renishaw's TEMPUS technology, was said to have been selected for this project due to its ability to overcome the specific challenges of additively manufacturing highly temperature-sensitive aerospace materials. IMR found that other PBF-LB Additive Manufacturing machines can struggle with thermal fluctuations, which can lead to defects such as cracking, while the 500Q Flex's four-laser configuration and enhanced process control enable faster layer completion and minimised temperature variations.

The Renishaw RenAM 500Q will be used at Irish Manufacturing Research for the development of novel aerospace materials (Courtesy Renishaw)

"Our approach will improve build quality and enable scalability," explained Colin Meade, Additive Manufacturing Technologist at IMR. "This research isn't just about lab-based experimentation; it's about developing technology that is ready for full-scale production as quickly as possible. We need to reach a technology readiness level (TRL) of around seven or higher to ensure rapid transfer to industry."

Looking ahead to the project's completion target of autumn 2026, Meade added, "In practice, this research could enable mBryonics to scale production from single-digit units per month to hundreds or even thousands."

The partnership is noted as reinforcing the importance of collaboration between industry leaders and research institutions in advancing Ireland's aerospace manufacturing sector. Combining IMR's advanced manufacturing research, Renishaw's Additive Manufacturing and mBryonics' work in freeform optics, the project is hoped to deliver transformative results.

"Our collaboration with IMR is about more than just supplying technology, it's about providing the expertise and support needed to drive innovation," said Chris Dimery, AM Business Manager (EMEA) at Renishaw. "By working closely with IMR, we're ensuring that advanced Additive Manufacturing solutions are developed with real-world industrial adoption in mind."

www.mbryonics.com
www.renishaw.com
www.imr.ie

TEMISTh and Eplus3D collaborate on metal AM heat exchangers for sustainable desalination

TEMISTh, based in Marignane, France, has partnered with Eplus3D, located in Hangzhou, China, for the Additive Manufacturing of advanced thermal exchange solutions. Using Eplus3D's metal AM machines, TEMISTh has produced complex nickel-alloy heat exchangers with 99.9% density for use in extreme conditions.

The heat exchangers were designed as part of the H2020 Desolination project, a European collaborative initiative to develop desalination solutions that will ensure future sustainable water resources. The project integrates Concentrated Solar Power (CSP) with advanced thermal exchange technology. The core challenge is to optimise heat transfer between supercritical CO_2 and a highly concentrated desalination solution – a task requiring intricate geometries that only AM can achieve.

Using the Eplus3D EP-M300 metal Additive Manufacturing machine, equipped with a 300 x 300 x 450 mm build volume and dual 500 W lasers, TEMISTh successfully produced IN718 nickel-alloy heat exchanger cores with a 50 µm layer thickness, completing the build in 130 hours of continuous manufacturing. Post-process heat treatment achieved a material density exceeding 99.9%, while the modular design allowed welding assembly into large-scale heat exchangers (0.4 x 1.2 x 1.6 m), surpassing traditional manufacturing size constraints.

By combining CFD-driven fluid dynamics and FEA-validated mechanical designs, TEMISTh reduced material waste by up to 40% and cut production time in half compared to conventional methods.

Rigorous testing under Desolination conditions – high temperature, extreme pressure, and corrosive exposure – confirmed structural integrity and performance alignment with operational demands. These results not only validated CFD/FEA simulations but also established critical mass production parameters, proving the feasibility of AM for industrial-scale thermal solutions.

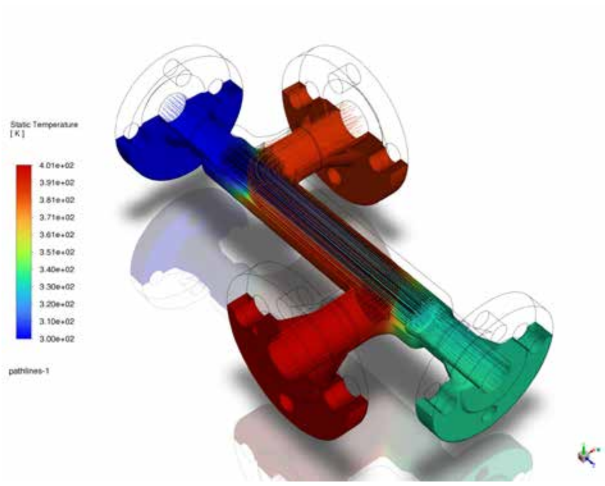
Jean-Michel HUGO – CEO TEMISTh, commented, "For over three years, we have partnered with Eplus3D to integrate Additive Manufacturing into our production. Their teams both in China and Germany have consistently supported our unique requirements, ensuring a seamless installation with expert technical guidance and training-driven optimisations.

The heat exchanger was additively manufactured by TEMISTh using an Eplus3D EP-M300 (Courtesy Eplus3D)

We especially value their responsive technical team, which helps minimise production downtime. This collaboration has enabled us to fully control our heat exchanger manufacturing, refine design methods, and shorten delivery times."

Martin Bizot, Account Manager at Eplus3D Tech GmbH, added, "Combining TEMISTh's expertise in heat exchanger engineering with the precision and stability of our metal 3D printer unlocks new possibilities for advanced thermal management. This synergy will drive high-performance solutions that support economically viable decarbonisation, redefining the future of energy-efficient industries."

www.temisth.com
www.eplus3d.com



The work combined CFD-driven fluid dynamics and FEA-validated mechanical designs (Courtesy Eplus3D)

The additively manufactured heat exchanger (Courtesy Eplus3D)

GranuCharge AL measures electrostatic charges in powders

Granutools, based in Awans, Belgium, has introduced its GranuCharge At Line (AL), an instrument designed to measure electrostatic charges in powders during flow in real time and directly on the production line.

The new GranuCharge AL is designed to measure electrostatic charges in powders (Courtesy Granutools)

Electrostatic charging is a common challenge in powder processing industries such as Additive Manufacturing, and metal powder handling. This phenomenon affects powder flowability, causes handling difficulties, and can even present safety risks.

Unlike traditional lab-based methods, the GranuCharge AL provides instant access to the charge per mass measurement through an integrated load cell combined with a Faraday cup connected to a highly sensitive electrometer. As powder flows through the process and into the device, the GranuCharge AL automatically captures the accumulated electrostatic charge, delivering high-precision results with minimal setup, all without stopping production.

GranuCharge AL allows users to assess how equipment such as hoppers, feeders, and blenders influence electrostatic charge accumulation to optimise material handling and process design. It also enables users to monitor charge effects on powder spreadability in Powder Bed Fusion machines or during nozzle flow in Directed Energy Deposition (DED), helping to improve powder bed quality and process reliability. Additionally, the GranuCharge AL identifies charge build-up hotspots on production lines in real time, enabling swift corrective actions without interrupting operations.

GranuCharge AL is reportedly the only compact instrument capable of real-time electrostatic charge measurement under true process conditions. This innovation helps industries reduce downtime, optimise materials, and enhance process reliability by providing critical data precisely where it is needed.

www.granutools.com

Titomic and Metal Powder Works form strategic partnership to optimise cold spray metal powder

Titomic Limited, based in Brisbane, Australia, has formed a strategic partnership with Metal Powder Works (MPW), based in Clinton, Pennsylvania, USA. The partnership focuses on optimising MPW's proprietary DirectPowder process for use in Titomic's Additive Manufacturing solutions, addressing critical applications in aerospace, oil & gas, energy, MRO, and other high-tech industries.

This agreement marks an important step in Titomic's ongoing efforts to secure and refine high-quality metal powders to complement its cold spray technology. MPW's Direct Powder process offers a uniquely tunable powder production method, enabling tailored solutions that enhance material performance for demanding industrial applications.

Jim Simpson, CEO & Managing Director of Titomic, stated, "We are excited to partner and collaborate with best-in-class powder suppliers specific to applications and customer needs. This strategic collaboration with MPW will explore the unique benefits their technology brings to Additive Manufacturing. This aligns with our strategy to secure material sources for our customers across multiple sectors. This agreement is an important step as we continue to cultivate relationships to ensure we maintain a diverse and robust supply chain."

"Under the Memorandum of Understanding (MOU), Titomic and MPW will conduct joint material testing, performance evaluations, and process optimisations. Upon successful outcomes, the companies will negotiate an offtake agreement to establish future commercial supply arrangements," Simpson added. "This partnership will allow Titomic to provide customers with material test results, reducing the amount of time required during the Non-Recurring Engineering (NRE) phase of a contract. The investment increases speed to market and our ability to support our customers while reducing their programme cost and schedule."

John Barnes, CEO of Metal Powder Works, added, "We're excited to expand our relationship with Titomic to achieve better results for them and their customers with powder consistency. We have seen in other trials that cold spray users achieve high deposition rates with the DirectPowder™ process aluminium and titanium powders."

This collaboration is part of Titomic's broader initiative to expand its US presence and further solidify its role in advanced manufacturing through strategic partnerships, research collaborations, and supply chain diversification.

www.metalpowderworks.com
www.titomic.com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Hexagon launches MAESTRO coordinate measuring machine for advanced manufacturing precision

The Manufacturing Intelligence division of Hexagon AB has launched MAESTRO, a new coordinate measuring machine (CMM) engineered to meet the rising productivity demands of modern manufacturing and the increasing quality requirements. The CMM's digital-first architecture offers rapid measurement routines, an intuitive user experience and seamless data integration. With modular software and hardware, it is designed to scale with evolving production needs, making it ideal for aerospace, automotive, and high-precision manufacturing environments where there is a high demand for accuracy to deliver safety, compliance, and performance.

MAESTRO features a newly developed digital architecture, incorporating digital sensors, a single cable system, and a completely new controller with brand-new firmware. Together, these new capabilities increase throughput, streamline the complete measurement operation, and ensure future-ready connectivity for modern production environments.

"Manufacturers told us they needed a next-generation system that tackles rising quality demands and skills shortages," stated Jörg Deller, General Manager Stationary Metrology devices at Hexagon. "By rethinking our hardware and software from the ground up, rather than iterating on existing systems, we've had the freedom to create a high-accuracy inspection solution that is so intuitive that anyone from expert to new hires become significantly more productive. Meeting the needs of industry head-on, MAESTRO's digital backbone also makes it straightforward to integrate into modern connected factories, so stakeholders can improve quality quickly and definitively."

Hexagon AB has launched the MAESTRO coordinate measuring machine (Courtesy Hexagon)

Pilot users report dramatic productivity gains and reduced inspection lead times, helping to avoid production bottlenecks and to keep pace with fast-changing customer requirements. Customers have tested various sensors, ranging from high-speed laser scanning to tactile probes, with consistently strong results in both R&D and production applications.

Hexagon's software tools and services, such as PC-DMIS and the Metrology Mentor, Metrology Asset Manager, and Metrology Reporting Nexus Apps, were developed in tandem with MAESTRO to create an integrated system that significantly boosts productivity from part loading to analysis, compared to isolated component solutions. The end goal is to deliver ease of use and fast workflows, from programming, execution, and usage to reporting and collaboration with colleagues in design and manufacturing.

MAESTRO will be offered initially in multiple sizes and configurations, each engineered for automated multi-sensor workflows utilising tactile probes and laser scanning probes from a new 'digital rack' that tracks occupancy status, sensor supply health and status that can be accessed on-device and throughout the desktop and cloud-native apps. Additional future-ready models and enhancements will follow, all based on a single, coherent platform.

www.hexagon.com

Goodfellow expands materials testing capabilities with acquisition of BAS and Suisse Technology Partners

Goodfellow's CEO, Simon Kenney, and CFO, Andrew Watson (Courtesy Goodfellow)

Goodfellow, a specialist metals and material supplier based in Huntingdon, UK, has acquired both the UK-based Bureau of Analysed Samples (BAS) and Switzerland's Suisse Technology Partners (STP) in two deals that will give it access to state-of-the-art laboratories, testing facilities, and an unrivalled Certified Reference Materials (CRM) capability.

These transactions will position the business as a critical partner to research and industry through its ability to offer 170,000+ different materials and access to customisation, certification, fabrication, and full testing services.

They follow Goodfellow's acquisition of Potomac Photonics last year, supporting the firm's ambitious growth targets of over £50 million in revenue within the next two years.

"We set out at the start of this year our desire to achieve growth through an increase in organic sales and several key acquisitions – these first two are strategically important purchases for setting our future direction," explained Simon Kenney, CEO of Goodfellow. "BAS has been one of the leading figures in Certified Reference Materials (ISO:17034 and ISO/IEC:17025) for decades and these CRMs play a vital role in the development of new products in electronics and technology, renewable energy, automotive, defence and healthcare."

"Suisse TP complements this deal perfectly. It is extremely well respected in the global R&D scene and its certified laboratories and expertise in surface technology bridges the gap between material supply and application testing," Kenney continued.

"We are constantly looking to add further value to our global customer base and these acquisitions do exactly that, adding Certified Reference Materials to our range and additional material testing capability," Kenney concluded. "There are other acquisitions in the pipeline, with discussions progressing well across multiple fronts."

www.goodfellow.com

Waygate debuts high-resolution computed tomography system

Waygate Technologies, a Baker Hughes business based in Hürth, Germany, has introduced its Phoenix Nanotom HR (High Resolution) computed tomography (CT) system. The new system is designed to make advanced X-ray imaging technology accessible to a broader range of users and is reported to be ideal for applications across numerous fields, including Additive Manufacturing, material science, semiconductor and electronics inspection, battery technology research, geoscience, life sciences, and cultural heritage preservation.

As part of the new product introduction, Waygate also announced a technology collaboration with X-ray equipment supplier Excillum, Kista, Sweden. Through this collaboration, Phoenix Nanotom HR will use a new high-resolution nanofocus X-ray tube supplied by Excillum for high imaging resolution and contrast across the full voltage range (40-160 kV).

"We are excited to present our Phoenix Nanotom HR here at Control 2025 and announce our strategic collaboration with Excillum," said Ludovic Milosevic, General Manager Radiography Systems at Waygate Technologies. "Leveraging Excillum's nanofocus source, the new HR version delivers up to five times better resolution than our existing state-of-the-art Nanotom M. That puts it on par with advanced optical magnification scanners – but with a simpler system, faster learning curve, greater flexibility, and at a better price point than comparable solutions."

Waygate Technologies has launched its high-resolution Phoenix Nanotom HR computed tomography system (Courtesy Waygate Technologies)

With its 300 nm focal spot technology, the Phoenix Nanotom HR is said to enable high geometric sharpness and detail detectability down to 50 nanometres (0.05 microns). It also allows for high contrast in high- and low-absorbing materials within a single image. The company states that high resolutions can be achieved 3-5x faster than with the Nanotom M or optical solutions, thus reducing scan times for samples requiring 120 minutes for 0.5 µm resolution to as little as forty minutes, or from one hour to ten minutes.

The Phoenix Nanotom's user interface, featuring automated focal spot selection, is designed to increase ease of use. It allows users to explore sub-micron particles, design deviations, manufacturing issues, material flaws, and geometric structures.

In addition, the system is capable of 24/7 operation with a reportedly excellent stability, effectively reducing the need for maintenance work to a quarter of standard industry levels.

www.waygate-tech.com

MPIF launches University Outreach Program to promote metal powder technologies to engineering students

The Metal Powder Industries Federation's (MPIF) Industry Development Board has launched a new University Outreach Program to promote metal powder technologies to future engineers.

Over the past eight years, hundreds of students have attended the annual PowderMet and AMPM conferences with grants from the National Science Foundation (NSF), Center for Powder Metallurgy Technology (CPMT), and MPIF reserves.

However, post-conference interviews revealed that while student grant recipients had a good understanding of metal Additive Manufacturing, they had limited knowledge of other metal powder technologies, such as press and sinter, Metal Injection Moulding (MIM), and isostatic pressing.

The Outreach Program provides an opportunity to engage with students in their local educational environment and teach them that there are many ways to consolidate metal powders. As part of this, the MPIF reported that Stephen Madill of Nichols Portland Inc and Stefan Joens of Elnik Systems, LLC, recently held a Design of Machine Elements class at the University of North Carolina, Charlotte, USA.

Building on this, the Industry Development Board plans to take the Outreach Program to four universities during the autumn term.

www.mpif.org

LEAP 71: Why engineering must move beyond CAD to realise the promise of AI and Additive Manufacturing

While AI is accelerating innovation across industries, engineering design remains slow, manual and opaque, constrained by tools such as CAD that capture geometry but not intent. In this article, LEAP 71 co-founder Lin Kayser argues that to realise the full potential of Additive Manufacturing, and enable meaningful AI in hardware development, we have to rethink how machines are designed. His solution is Computational Engineering, a system that encodes physics, constraints, and logic directly into code, transforming engineering into a scalable, intelligent process.

For decades, we've seen information technology advance at the pace of Moore's Law of exponential progress. With the rise of generative AI and large language models, that curve now appears to be steepening – but that's not the case in engineering.

Why does it still take months to design a heat exchanger or years to design a rocket engine? Why are some engineers stuck redesigning the same bracket over and over again, sometimes for their entire career? This is all in sharp contrast to a microchip, arguably one of the most complex 'machines' ever devised, which can be developed in a matter of months.

If I asked you to use a forty-year-old computer, you'd laugh, but you'd not think twice about taking a ride in a car or elevator from the 1980s – progress in engineering is painfully slow when seen through this lens.

This discrepancy has long frustrated me. Both fields are rooted in physics, logic, and manufacturability. Both ultimately produce physical hardware. So why hasn't engineering kept pace with computer hardware?

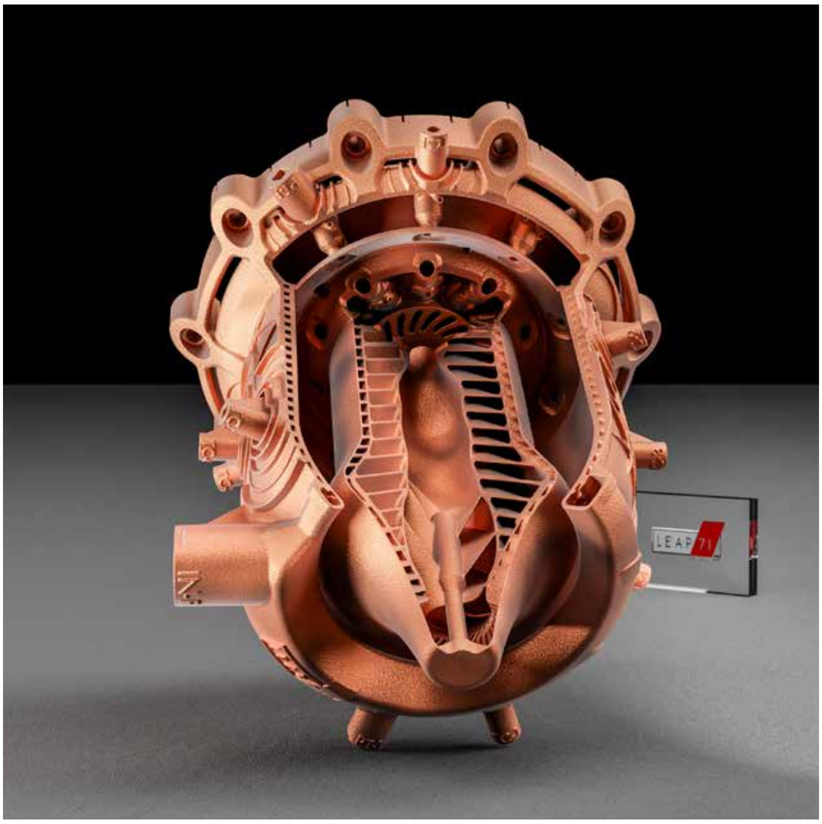

Fig. 1 The future is with us: a 5,000 Newton annular aerospike rocket engine, generated entirely using LEAP 71's Noyron software and additively manufactured by Aconity3D as a monolithic copper component. The engine was successfully hot-fired in December 2024 (Courtesy LEAP 71)

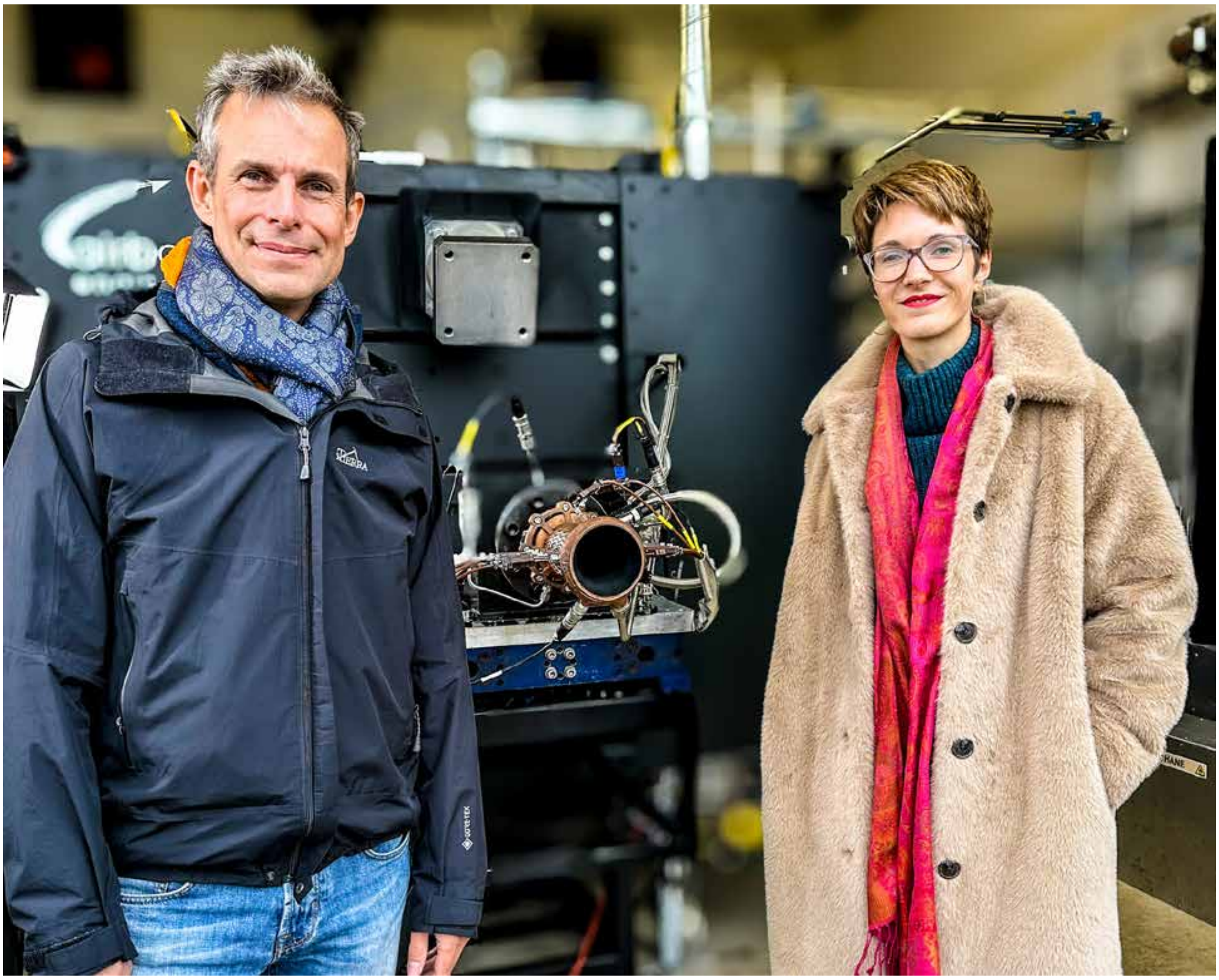

Fig. 2 LEAP 71 co-founders Josefine Lissner (CEO, right) and Lin Kayser (left) with the 7,000 N rocket engine generated by Noyron, following its successful hot-fire in December 2024 (Courtesy LEAP 71)

> ***"...when knowledge isn't preserved – when the intent behind a design's visual manifestation is undocumented – you can't question it, improve it, or rigorously test the logic behind it."***

We all live in the physical world. Why can't engineering accelerate to tackle humanity's grand challenges and opportunities more effectively? For the past decade, I have been attempting to get to the bottom of this question.

At the core of this issue lies a fundamentally different approach to engineering. Outside of IT, we remain trapped in a visual design paradigm that hasn't changed radically since ancient times. A Roman engineer created the blueprint for an aqueduct on a piece of paper; today, an aerospace engineer draws a spacecraft component in a Computer-Aided Design (CAD) tool. CAD only does what it says – it aids the engineer in sketching. But it doesn't preserve the intent, nor does it encode the logic; that all stays in the engineer's head.

I've said before that CAD is evil – not because it's malicious, but because it creates the illusion that you're using a computer for computation, when in fact you're just using it as a sketchpad – albeit a powerful one. The real algorithm runs in the engineer's brain, and the engineer's hands then translate it into geometry at an excruciatingly low bit rate.

This approach holds back innovation because it makes engineering tedious. And when knowledge isn't preserved – when the intent behind a design's visual manifestation is undocumented – you can't question it, improve it, or rigorously test the logic behind it. As the saying goes: 'Never change a running system.'

And this limitation becomes completely untenable when you consider the vast design space that Additive Manufacturing opens up. AM removes many traditional production constraints, enabling the creation of highly integrated, multifunctional, and geometrically complex structures. But to fully leverage that freedom, we must move beyond drawing. We must embrace Computational Engineering.

Computational Engineering is also the required prelude to AI engineering because, without understanding the physics, logic, and intent of a design decision, there is nothing to train a neural network on. Any attempt at AI engineering without that intermediate step is smoke and mirrors.

At LEAP 71, my partner Josefine Lissner and I have been progressing down the path of building Noyron, a large Computational Engineering Model (CEM) designed to encode engineering knowledge as computational logic. Some have called it 'the first AI that builds machines.' In a way, it is, and this catchy phrase surely aligns well with the current hype cycle. But in this article, I want to clarify what we actually built – and why 'AI' in engineering, at least as it's commonly understood, is often a dead end.

We'll look at what it really takes to bring engineering into the computational era, what role AI should play, and how Additive Manufacturing can unlock engineering at the speed of Moore's Law. Most importantly, we'll show how Computational Engineering is already producing real-world hardware – and why the next generation of machines won't be drawn: they'll be computed.

From commands to conversations: designing machines with AI collaboration

What would be the ideal process for designing a machine? Some imagine a black-box AI that magically produces a finished blueprint at the

Fig. 3 A pre-cooler concept for high supersonic and hypersonic flight. The challenge is preventing overheating of air at the jet engine intake by rapidly cooling the incoming air. The full-scale version is 1.60 m high (Render courtesy LEAP 71)

"...without understanding the physics, logic, and intent of a design decision, there is nothing to train a neural network on. Any attempt at AI engineering without that intermediate step is smoke and mirrors."

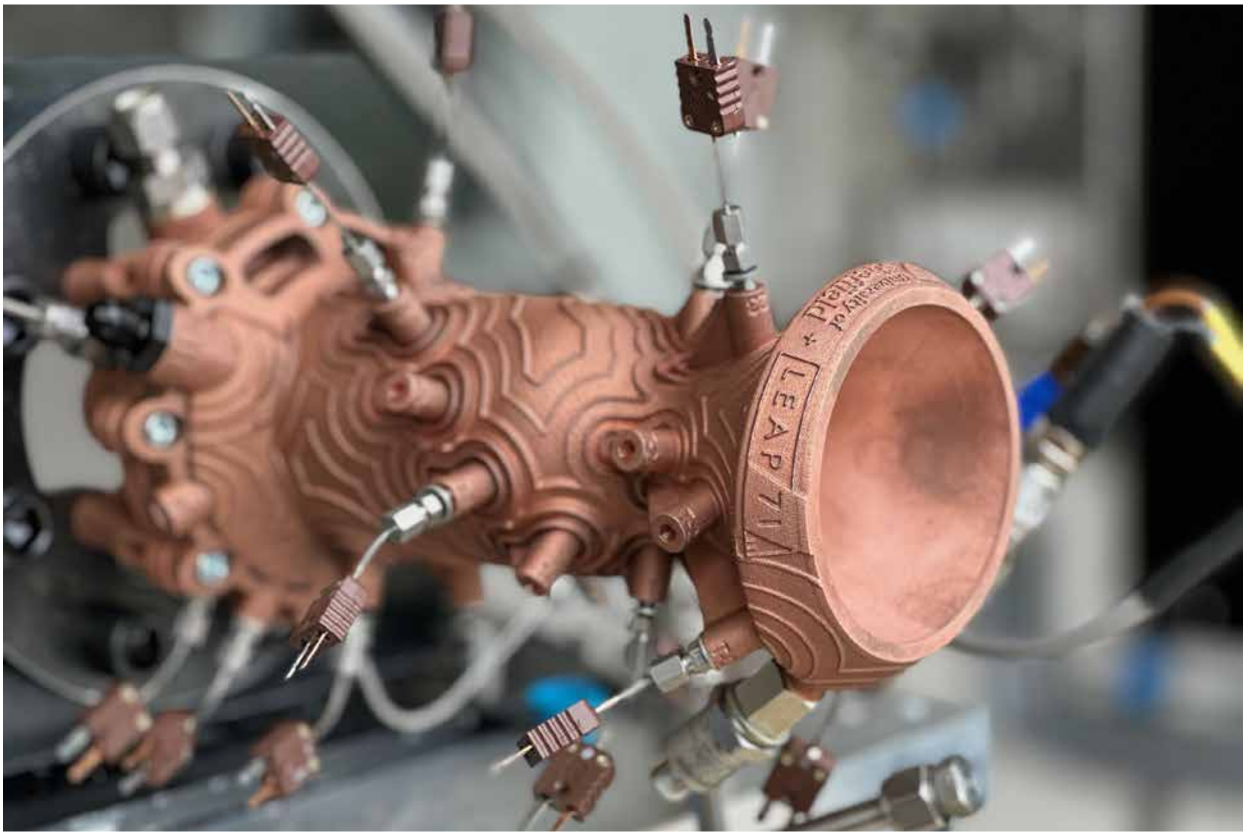

Fig. 4 Noyron TKL-5 thruster, producing 5,000 N of thrust and powered by kerosene and cryogenic liquid oxygen. Additively manufactured from CuCrZr by AMCM (Courtesy LEAP 71)

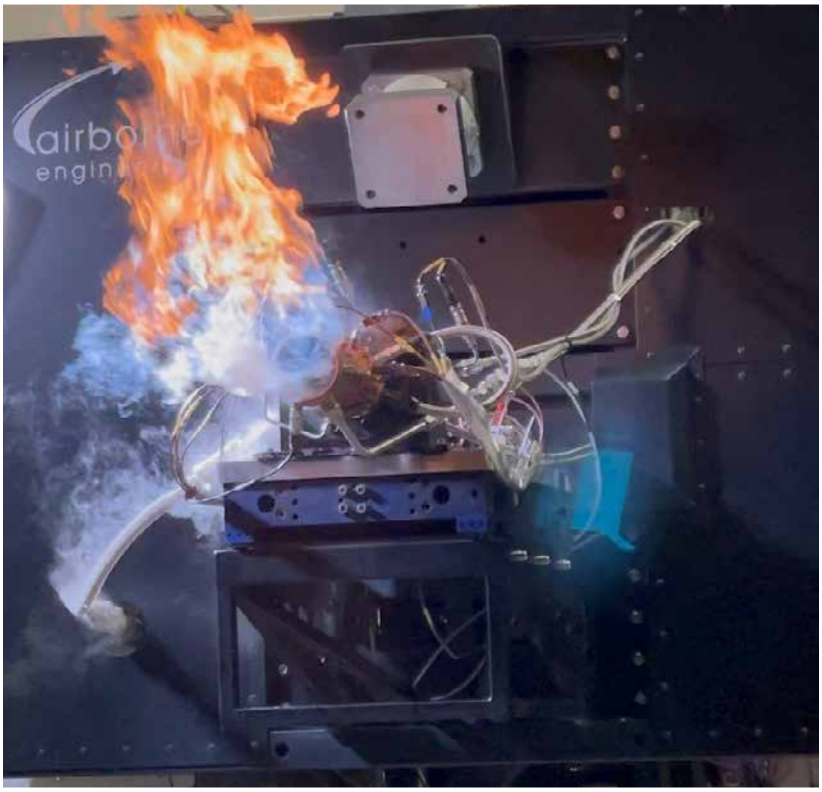

Fig. 5 The Noyron TKL-5 thruster was successfully hot-fired in June 2024 (Courtesy LEAP 71)

push of a button. Just feed in the specs of a new spacecraft, and out comes a complete, ready-to-build CAD model. But that's not how engineering works.

Engineering is exploratory. You rarely know exactly what you want, especially when you're venturing beyond established designs. Inventing something new means testing bold ideas, iterating, and learning along the way. As you experiment, you develop new insights, refine your objectives, and reshape the solution. It's not a spec., it's a conversation.

That's why J.A.R.V.I.S., the fictional AI assistant from Iron Man, is actually a far better metaphor for what we need. J.A.R.V.I.S. doesn't just output a finished design. It listens, suggests, and fills in blanks. It redesigns as new insights are found. It flags what's feasible and what's not. It supports an open-ended conversation that leads to a functioning machine, grounded in first principles and sound engineering.

Fig. 6 Production batch of 2,000 N rocket thrusters, manufactured by VulcanForms (Courtesy VulcanForms)

While J.A.R.V.I.S. is fictional, the approach is realistic. In a world with ChatGPT and generative code tools, a conversational human/AI design process is no longer far-fetched.

In our version, the output isn't a CAD file, but a Computational Engineering Model: an algorithm that creates the design. It can be modified, iterated on, and tested – because it's not a blueprint, but a living, logical system. Just like how, in nature, DNA encodes the algorithm that dynamically produces an organism, the computational model can create a three-dimensional shape as well as the data that directly drives the production process – slices, G-Code, and heat treatment instructions. This is because the model understands manufacturing and the constraints that come with each stage.

It's important to emphasise the difference between a computational model and the 'geometry tree' that conventional CAD creates. A computational model is a rich set of instructions, where even small adjustments to the algorithm can produce vastly different objects. A computational model runs physics models, logic checks, and manufacturing validation at any point during the process and directly changes the result.

At LEAP 71, we've built many of the logical building blocks that such a system requires. We manually encode engineering knowledge drawn from textbooks, existing designs, first-principle thinking, and practical experience. We encode fundamental physics and embed manufacturing constraints enriched through multiple production runs. We test real-world parts (for example, hot-firing rocket engines), collect data, and feed the insights back into the model.

"Just like how, in nature, DNA encodes the algorithm that dynamically produces an organism, the computational model can create a three-dimensional shape as well as the data that directly drives the production process."

Fig. 7 Cut-through render of the XRB-2E6 rocket engine, generated using the latest version of Noyron. This 2,000,000 N (2 Meganewton) engine features a full-flow staged combustion cycle and stands at approximately 2 m tall. It represents the most advanced current rocket technology, comparable to the engines powering SpaceX's Starship. At the top, the injector directs hot gaseous methane through dual side inlets and hot gaseous oxygen through the centre, injecting the mixture into the combustion chamber below. The chamber wall and nozzle are cooled by an intricate network of channels through which methane propellant flows before being fed into the turbopump. The engine is now moving into manufacturing validation, with hot-fire testing targeted for late 2028 (Render courtesy LEAP 71)

This large CEM, Noyron, is not a black-box neural network trained on unstructured data. It's object-oriented source code (in our case, written in C#) that explicitly encodes everything we've learned. It's deterministic: given the same parameters, it always produces the same result. It's traceable, explainable, and cannot hallucinate. Every assumption is documented. Even the rules of thumb that engineers often employ are eventually replaced by a formula once the underlying logic becomes clear.

In this sense, Computational Engineering might be the first time engineers have truly been forced to be scientific. Traditional engineering workflows tolerate a surprising amount of folklore, trial-and-error, and undocumented best practices – what we might call 'engineering intuition'.

In a computational model, every assumption must be explicit. Every step must be verifiable, and every design decision must be explained. The result is not just better machines, but a more robust, scientific foundation for engineering itself. A Computational Engineering Model requires a clear, algorithmic foundation for every feature it creates. It's engineering by logic, not intuition.

Over time, Noyron has grown to encompass a significant portion of the knowledge needed to design complex machines. It's still incomplete – knowledge is only added in the areas we actively work in – but many domains share the same logical scaffolding.

Rules we used to design capillary distributions in bioprinted vascular systems, for example, turned out to apply directly to aerospace heat exchangers. Those same principles that guide fluid routing in manifolds can be used to avoid crossing wires in electric motors.

Noyron has been used across a wide range of fields – from micromechanical systems and biological tissue to rocket engines, filtration systems, electrodes, heat

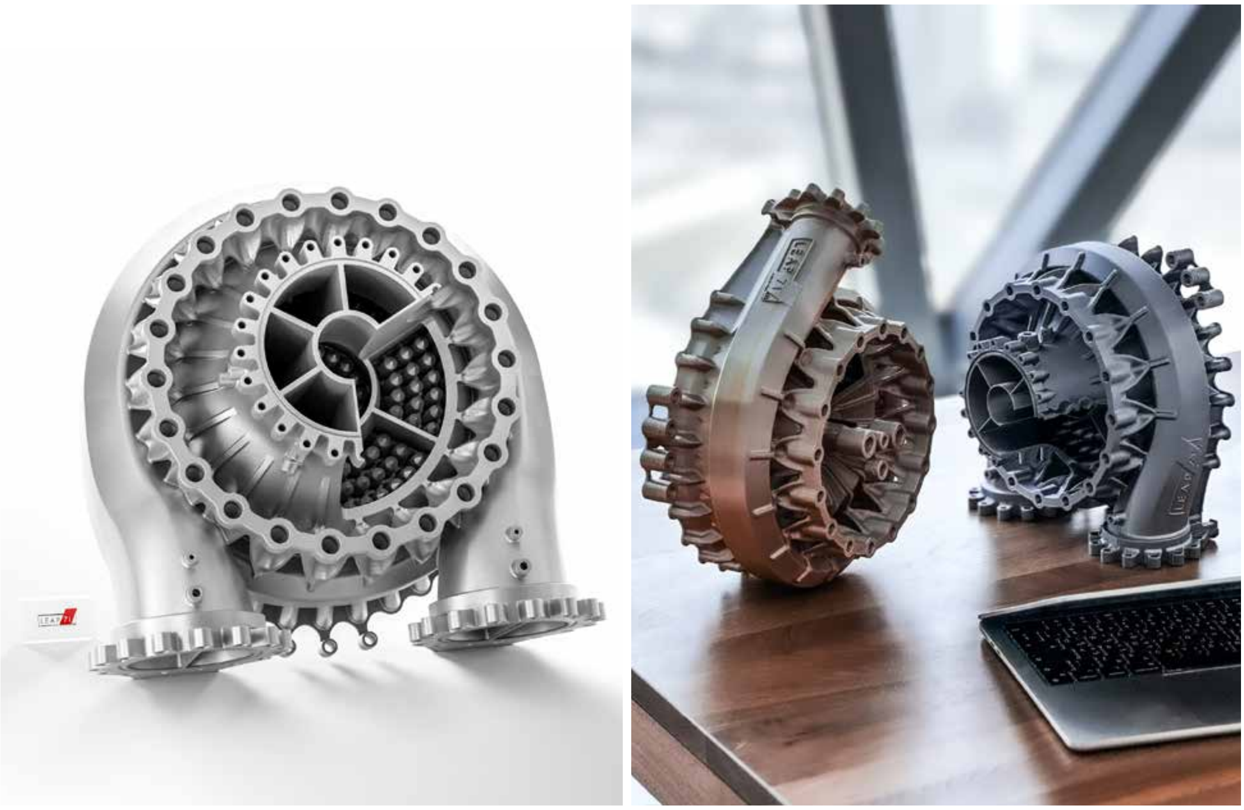

Fig. 8 Left: Render of the injector head for a 2,000,000 N (2 Meganewton) rocket engine featuring a full-flow staged combustion cycle. This advanced engine technology is comparable to the engines powering SpaceX's Starship. The injector directs hot gaseous methane through dual side inlets and hot gaseous oxygen through the centre before injecting the mixture into the combustion chamber. Right: Sub scale variants of the 2 MN engine injector head. Both support engines of 60,000 N. The left one is a gas-generator cycle engine, which takes in cryogenic liquid oxygen on the side before it mixes it with the methane coming from the regenerative cooling channels. The right injector supports full-flow staged combustion and takes in hot gaseous methane through twin inlets on the side and hot gaseous oxygen through a central inlet (Courtesy LEAP 71)

exchangers, and electric motors. In every case, the design emerges from the abstract engineering DNA encoded in Noyron, not a visual concept in an engineer's head.

Just like Tony Stark never touches a stylus in Iron Man, a computational engineer never draws geometry on a computer screen. The computational model does all the sketching. And it doesn't take long to recompute, so the engineering process, while not yet a verbal conversation, becomes almost playful. You can test ideas freely, because a new design takes minutes, not weeks. Innovation requires iteration, and, in this paradigm, iteration is no longer expensive.

"Computational Engineering might be the first time engineers have truly been forced to be scientific. Traditional engineering workflows tolerate a surprising amount of folklore, trial-and-error, and undocumented best practices – what we might call 'engineering intuition'."

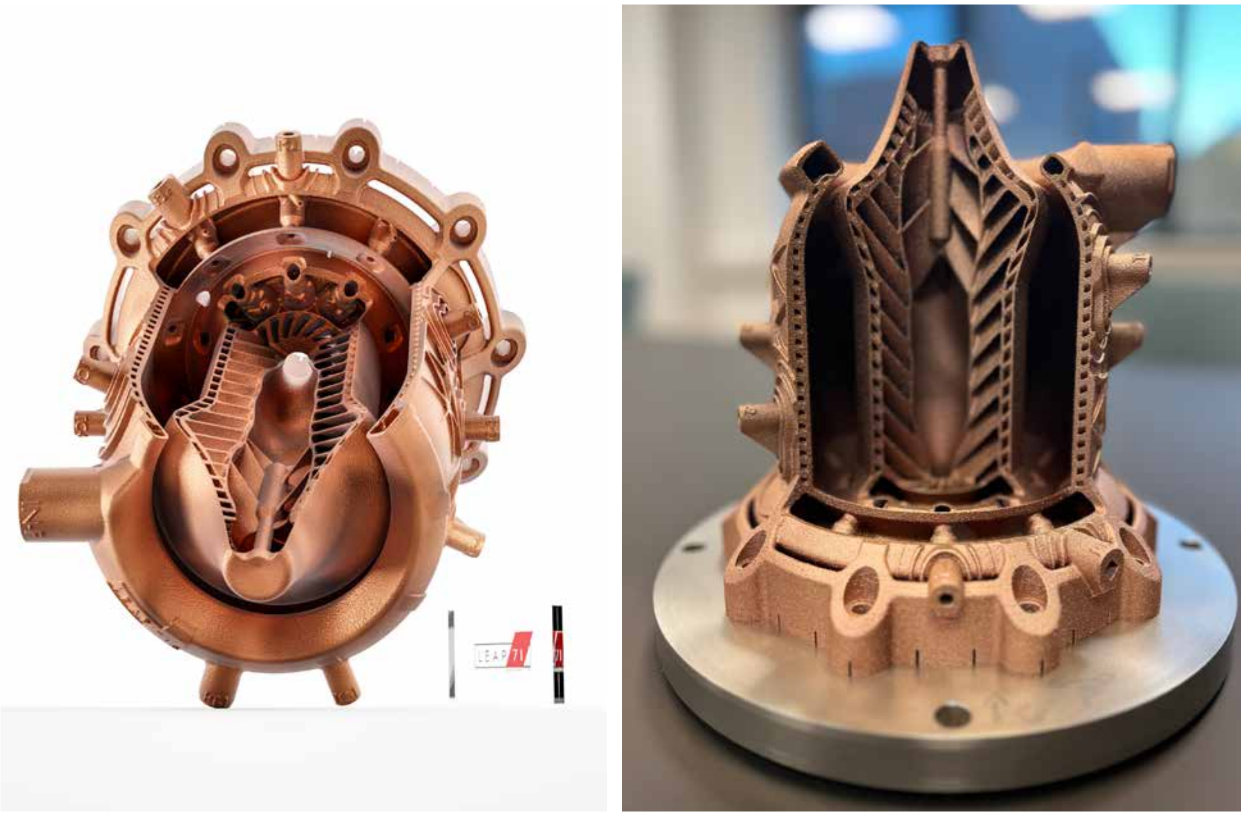

Fig. 9 A 5,000 newton annular aerospike rocket engine. The inner spike is regeneratively cooled using cryogenic liquid oxygen, while the outer jacket is regeneratively cooled with kerosene. Both hot propellants are then injected into the toroidal combustion chamber. Aerospikes offer greater efficiency than conventional bell-nozzle engines but are notoriously challenging to cool. The LEAP 71 engine was entirely designed using Noyron, additively manufactured by Aconity3D as a monolithic copper piece, and successfully hot-fired in December 2024. (Courtesy LEAP 71)

"A simple CEM can generate such output in seconds, whereas a human engineer might spend hours on this task. Once you have such a computational block, you fundamentally never have to think about this problem again, unless you encounter a situation where the algorithm fails or needs to handle a new challenge."

Why the future of engineering must be computational

Fundamentally, a Computational Engineering Model is an algorithm that deterministically, from the same set of inputs, produces the same result. How it arrives at this output depends on the class of objects you want to create. For a simple manifold, you may have a set of connection points in space that all need to be connected to another point, avoiding collisions. A simple CEM can generate such output in seconds, whereas a human engineer might spend hours on this task. Once you have such a computational block, you fundamentally never have to think about this problem again, unless you encounter a situation where the algorithm fails or needs to handle a new challenge. This means connecting all the complex piping in a heat exchanger is no longer a manual task; once encoded, the logic handles it automatically and consistently. Over time, you can add manufacturing constraints, preservation of mass flow, and many other aspects that are tedious for engineers to work on, given the current CAD design paradigm.

As these building blocks mature, the abstraction level increases. At some point, you can just say, 'I need a heat exchanger here, with a heat transfer capability of X', and the system will build one for you, fully manufacturable, and, ideally, already using the real-world testing data you established. Your heat exchanger needs to fit into a complex bounding shape? No problem, the algorithm will route or extend the pipes into this space. If this is not possible, it will tell you.

Noyron RP, our computational model for space propulsion systems, can autonomously produce fully functional rocket thrusters for completely different mission profiles. No CAD is involved; not even a visual sketch. If changes are needed because of feedback from the field, the algorithm is improved, for example, by adjusting coefficients that can only be found out in practice. Every future design generated by that CEM automatically benefits from the improvement.

Contrast that with human CAD engineering, where any insight needs to be communicated to the one person who happens to be designing that feature. It's easy to see how much information gets lost in this traditional way of working.

Computational Engineering speeds up progress enormously. For example, we validated Noyron through real-world testing and hot-firing multiple rocket engines. In total, over the course of five months, we tested eight individual rocket engines, including an aerospike, one of the most elusive and sophisticated engines to be hot-fired. An aerospike looks entirely different from traditional bell-nozzle engines, but shares 90% of their DNA. None of the rocket engines took longer than a few weeks

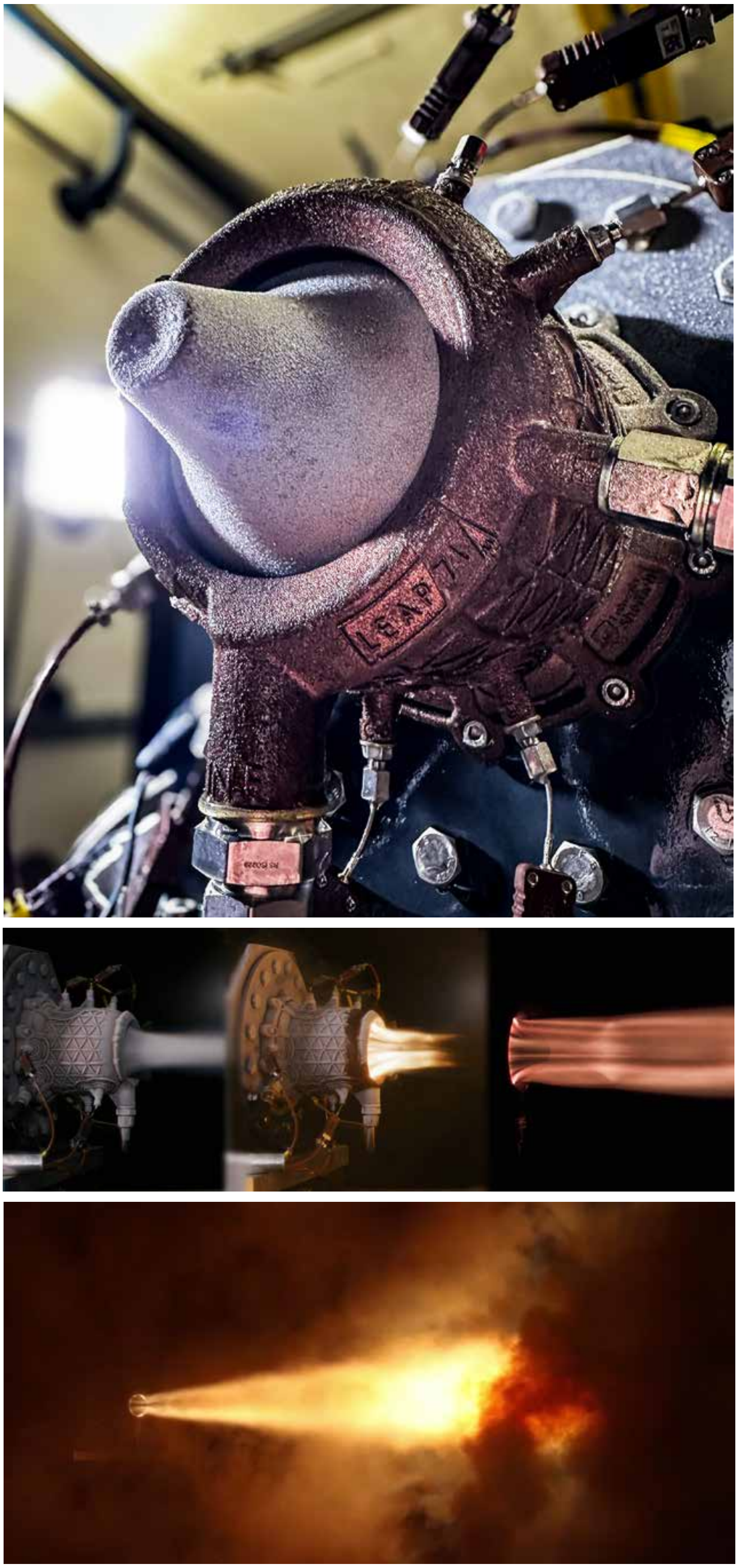

Fig. 10 Top: Aerospike rocket engine shortly before successful hot firing in December 2024. Middle: Aerospike rocket engine hot-fire sequence. Above: Aerospike rocket engine hot-fire (Courtesy LEAP 71)

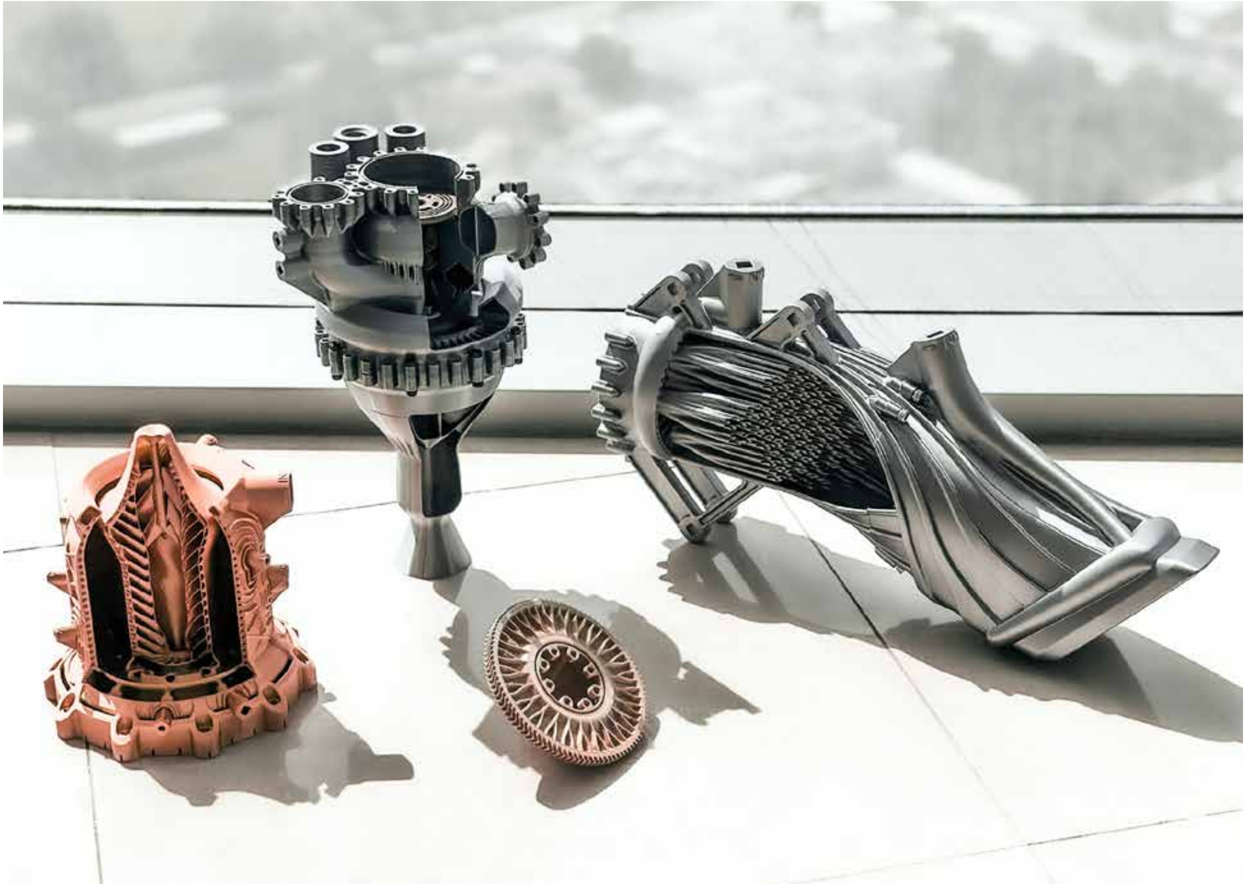

Fig. 11 Left to right: 5,000 N aerospike rocket engine, turbopump with preburner for 28,000 N rocket engine, and subscale pre-cooler concept – all generated by Noyron (Courtesy LEAP 71)

> *"Why can't we go from a spoken description or a sketch on a napkin to a functional 3D design using a neural network, the way we generate images with AI? Because 3D geometry, unlike images, must obey the laws of physics."*

from spec to manufacturing handoff. Each generation run took less than an hour on a regular laptop computer – and each worked the first time it was tested because it was based on practically validated physical models.

Noyron outputs a visual model to inspect, but it also generates the manufacturable files (for example, slices), provides performance predictions, documents all assumptions, and even creates fixtures that can be additively manufactured, along with helper geometry that can be loaded into CAM systems for post-machining, all automatically and every time it runs. This goes far beyond what a typical CAD workflow provides.

The Computational Engineering Model is a single source of truth, which, every time it's run, re-generates everything from visual model to manufacturing files and documentation.

Why most AI in engineering fails and how to fix it

As with all hype cycles, there is now a new trend to call everything 'AI', even when it isn't, and apply AI to things where it is not appropriate.

Let's get this out of the way: a Computational Engineering Model is an algorithm, not a neural net. It's closer in spirit to an expert system. Ironically, expert systems were once called 'AI' before neural networks redefined the term. At LEAP 71, we do use Large Language Models (LLMs) to summarise and extract information from vast amounts of engineering information. We've also connected the Noyron codebase to LLMs, aiming at building a system that synthesises new machinery by combining validated computational blocks with new insights from unstructured knowledge. This hybrid approach – combining structured logic with language-based synthesis – brings us closer to the J.A.R.V.I.S. vision.

But there is no question that without the algorithmic, logical, scientific underpinnings of Computational Engineering, you will not get to AI engineering.

People have tried attaching LLMs to a CAD tool, generating 3D files using neural nets, and calling topology optimisation 'AI.' These approaches may look interesting, but they are dead ends. While it's fun to talk to a CAD system, your communication bit rate is now even lower than using a mouse or stylus. Instead of pointing somewhere, you have to laboriously explain in words what you are trying to accomplish. Computational Engineering relies on the clear logic of a programming language, which was designed to communicate intent in a concise and structured manner. Natural language is ambiguous and not suitable for low-level description of geometry.

Why can't we go from a spoken description or a sketch on a napkin to a functional 3D design using a neural network, the way we generate images with AI? Because 3D geometry, unlike images, must obey the laws of physics. A sketch doesn't carry information about how a design functions. And even if you trained a neural net on billions of 3D shapes, the output would still be hit or miss, because a 3D mesh doesn't understand what it's for or how it works.

Topology optimisation is a useful tool in the CAD arsenal. You can draw something and then optimise it using underlying physics, and while it is useful, it works in reverse: starting from geometry and optimising it. In our paradigm, we start with a blank canvas and generate the object from scratch. Topology optimisation, of course, has nothing to do with AI; it's just applied physics.

Fig. 12 Top: Multi-material heat exchanger. Middle: Multi-material (~300+ mm diameter) aerospike rocket engine; Above: Electric motor concept (~300 mm) diameter. All are produced using Fraunhofer IGCV's dual metal process on a Laser Beam Powder Bed Fusion (PBF-LB) machine from Nikon SLM Solutions (Courtesy Fraunhofer IGCV)

Fig. 13 Eplus3D and LEAP 71 produced the world's largest additively manufactured rocket thruster, exhibited at Formnext 2024. Built in a single 354 hour run on the EP-M650H, the 650 x 650 x 1600 mm thruster features a fully integrated design enabled by LEAP 71's Noyron software (Courtesy LEAP 71)

> ***"True AI engineering will depend on a combination of computational systems (math, physics, logic) and new tools like PINNs. A J.A.R.V.I.S.-like system can interpret your intent and synthesise high-level building blocks that are pre-validated to build functional machinery."***

There is one area, though, where AI engineering and topology optimisation might shake hands. Most people assume LEAP 71's tech stack involves a lot of Computational Fluid Dynamics (CFD) or other simulation tech. That is not the case. CFD requires immense computing resources, so it is very slow. What's even more troubling is that it fundamentally only runs on the finished object. So it cannot give you an insight while you are generating a feature in your design. Noyron relies on heuristics, which are the direct evaluation of physics (for example, for heat transfer), which applies at the point of the design of a feature.

During the construction of cooling channels in our rocket engines, we evaluate fluid densities, chemistry of the propellant, pressures, thermal loads, etc., all while creating the channel itself, directly influencing cross section, curvature, wall thickness, etc. We are not waiting to simulate these things after a design is complete, as it would be hard to create actionable insights.

But if you could evaluate complex CFD physics instantly, we could make more informed decisions during the design phase. The emergence of Physics Informed Neural Networks (PINNs), which attempt to predict simulation results, is quite interesting, as they essentially provide instant results.

True AI engineering will depend on a combination of computational systems (math, physics, logic) and new tools like PINNs. A J.A.R.V.I.S.-like system can interpret your intent and synthesise high-level building blocks that are pre-validated to build functional machinery. This is how true AI engineering will develop.

After all, not only do you want a working machine, you also want to understand why it works. A Computational Engineering Model, even when a J.A.R.V.I.S. conversation generates it, is always traceable and deterministic.

A new foundation for engineering

Ten years ago, I embarked on this journey with a simple question: Why does engineering in the real world not follow the exponential trend of IT? The straightforward answer is that we have not been abstracting the underlying methodology, as other fields have done.

A person from the financial world would laugh at the thought of manually processing a company's sales projections using an old-fashioned calculator. Of course, all that data is fetched, recomputed automatically, and presented in a high-level format.

Microchips were designed using CAD until the 1970s. Then they became too complex, and the design moved to encoded rules and algorithms, rooted in physics and logic. A modern chip design is not drawn aided by a computer, but computed from high-level specs written in hardware design languages like Verilog.

"Leonardo da Vinci would be baffled by the process of microchip design – but he'd be reasonably familiar with the everyday work of a CAD engineer. Computational Engineering changes that."

Leonardo da Vinci would be baffled by the process of microchip design – but he'd be reasonably familiar with the everyday work of a CAD engineer.

Computational Engineering changes that. It moves engineering to that abstract level, to a system that can be re-run in seconds. But, like in microchip design, it forces engineers to learn how to code in order to express their intent. What we will see in the coming years is a split between engineers who will work on a much higher level, creatively interacting with an AI engineering system through accessible communication, perhaps through natural language or high-level visual interfaces. And then there will be the engineers who produce validated and robust components to create mechanisms that, today, we can only begin to imagine.

Working with my partner, Josefine Lissner, the architect of the Noyron system, for the past three years has been an eye-opener for me. How fast can we build and test complex systems? How can we finally take advantage of the awesome capabilities of Additive Manufacturing, and how can we functionally integrate machinery that would otherwise be manufactured from thousands of individual parts?

I have no doubt that it will move engineering under the exponential curve of Moore's Law, because I am already seeing it in our daily work.

Author

Lin Kayser
Co-founder

LEAP 71
Dubai, United Arab Emirates
leap71.com

Additive Manufacturing and European defence: a critical opportunity as the US and China accelerate ahead

As global threats mount, Europe is falling behind the US and China in deploying Additive Manufacturing as a defence capability. While these powers integrate AM to enhance readiness and resilience, Europe risks being outpaced by fragmented efforts and slow adoption. Calum Stewart, former Army Engineering and Logistics Officer and now Director of Defence Programmes at SPEE3D, draws on insights from Maj Gen Ed Dorman (Ret), former Commander of the US Army's 8th Theater Sustainment Command; Kieron Salter, CEO of the Digital Manufacturing Centre; and Michail Efthymiadis of General Dynamics European Land Systems.

The world today is marked by escalating conflict, and the bear is at the door. As Russia pushes the boundaries of European stability, we must confront a hard truth: deterrence only works if the equipment we rely on is fit to fight. At the recent AM Forum 2025 in Berlin, discussions made clear that while Additive Manufacturing technology is advancing, the required urgency of its integration into defence logistics is lacking. This lack of momentum is alarming. If nations, AM OEMs, and defence primes do not act decisively, NATO will fall behind faster-moving adversaries. Discussing AM's potential is no longer enough; action is needed to make it a core element of military sustainment and capability-building.

If 'peace through strength' is to be the foundation of deterrence, it must be backed by logistic systems capable of withstanding prolonged conflict. As it stands, the current pace of AM adoption in European-based defence falls far short of what the times demand. Simply put, time is running out and our adversaries are moving quicker than us.

The need for military readiness

Nowhere is the urgency of readiness more evident than on Europe's eastern flank. In Ukraine, the brutal war of attrition has exposed a fundamental vulnerability: Europe and NATO's ability to sustain prolonged military operations is deeply constrained by conventional supply chains. Whilst, on the other side, Russia's reliance on vast Soviet-era stockpiles has proven unsustainable

Fig. 1 A Portuguese Air Force fighter pilot taxis for take-off in an F-16 Fighting Falcon during a Baltic Air Policing Rotation in Estonia (Courtesy NATO)

Fig. 2 At the AM Forum 2025 in Berlin, Calum Stewart (the author of this article, and EMEA Director of Defence Programmes at SPEE3D), joined Mike Efthymiades, General Dynamics European Land Systems, and Jostein Olsen, Fieldmade AS, for a panel discussion moderated by Stephan Bayer on the role of Additive Manufacturing in defence logistics. Discussions made clear that while Additive Manufacturing technology is advancing, the required urgency of its integration into defence logistics is lacking (Courtesy AM Forum Berlin)

> ***"If we continue to debate rather than act, we will soon face a harsh reality: our deterrent capabilities will be hollow because our equipment is not combat-ready. While defenders hesitate, aggressors are accelerating."***

– neither side can claim that their logistic systems are what they would wish them to be. Ukraine, by contrast, has had to innovate at speed – integrating commercial manufacturing, distributed production, and advanced repair techniques to bridge the gap between need and availability. They are showing the world just how to do it right.

The Ukraine war is not an isolated case; conflict is intensifying worldwide. In Gaza, a humanitarian catastrophe is paralleled by logistical failures, with military and civilian infrastructure struggling to function amid dwindling resources. In Kashmir, heightened skirmishes between India and Pakistan strain military maintenance capabilities. In the Gulf of Aden, maritime security operations face constant disruption from insurgent attacks, stretching naval logistics. In the Indo-Pacific, rising tensions in Taiwan pose a massive logistical challenge for Western allies, with analysts predicting that any large-scale conflict in the region would exceed current military industrial capacity. And then, as this publication goes to print, the world is watching with one eye open to understand the impact of US involvement in the Israel/Iran war. With so much war across the entire globe, it is hard to believe that Western centralised manufacturing capability would be quick enough to respond.

Compounding this need is the long-term decline of traditional metalworking industries in the West. Once a cornerstone of wartime production, steel production, foundries and forging plants have all significantly diminished over the decades. The US steel industry, for instance, has seen its production capacity cut in half since the 1970s. This decline has left Western militaries in a precarious position, reliant on ageing infrastructure and stretched supply lines to maintain readiness.

If we continue to debate rather than act, we will soon face a harsh reality: our deterrent capabilities will be hollow because our equipment is not combat-ready. While defenders hesitate, aggressors are accelerating.

Nations, AM OEMs, and defence primes must recognise that today's threat environment is defined by persistent, multi-theatre conflict, from material support to Ukraine, to rising tensions in the Indo-Pacific. The clock is ticking for Europe's defence industry to embrace AM. Delays now mean an inability to defend later.

To understand how Additive Manufacturing is being positioned within modern defence logistics, I spoke with three leaders shaping this transition: Major General Ed Dorman (Ret) former Commander of the US Army's 8th Theatre Sustainment Command and now with S10 Consulting; Kieron Salter, CEO of the Digital Manufacturing Centre, Silverstone; and Michail Efthymiadis, Head of Product Digital Innovation at General Dynamics European Land Systems, Switzerland.

Their insights will show that AM is vital for faster, more resilient operations. Success means understanding defence procurement rules and meeting strict standards. Defence engineers must see AM's strengths: on-demand parts, rapid repair, and design freedom; governments need to tackle challenges such as certification, cybersecurity, and skills. Clear policies and strong collaboration are essential to unlock AM's full potential.

Fig. 3 Ukrainian soldiers learn how to maintain the Leopard 2A4 main battle tank during a training course held at the Polish Army's Combined Arms Training Centre (CAT-C) in Zagan, Poland. The rapid availability of spare parts for military vehicles is central to successful operations (Courtesy NATO)

The strategic divide: national vs regional approaches

NATO faces a choice that must be made now – we've reached what in military parlance we'd call a Decision Point (DP): pursue AM integration through individual national efforts, or work collectively to develop a robust, region-wide action plan. I say plan, because we don't have the time for more strategy. While national initiatives are essential, they must be harmonised to prevent duplication and inconsistency. The challenge is to balance national interests with the need for a unified European defence capability that is resilient, responsive, and strategically coherent.

The United States offers a model of coordinated, cross-branch integration that is perhaps worth modelling. The latest US Army's Transformation and Acquisition Reform allocated $35 million specifically to military AM initiatives, signalling a shift from research to operational deployment. The US legislation mandates that AM move from research settings into operational units by 2026, aiming to make advanced manufacturing an integral part of defence logistics. This proactive approach contrasts sharply with NATO's more cautious, fragmented stance.

The logical solution is to develop a NATO AM plan, aligning investment and standardisation across member states. Such a strategy would ensure effective integration, leverage collective expertise, and streamline the adoption process. Without this coordination, we risk repeating past mistakes of fragmented development, as seen in other critical technologies.

Fig. 4 SPEE3D's Expeditionary Manufacturing Unit (EMU) enables the rapid build, post-processing and validation of high-quality metal components exactly where they're needed (Courtesy SPEE3D)

"AM's primary value proposition lies in its ability to deliver parts of consequence directly to the soldier when the regular supply fails. During conflicts such as the war in Ukraine, traditional supply chains have proven insufficient..."

Fulfilling immediate logistical needs through capability

AM's primary value proposition lies in its ability to deliver parts of consequence directly to the soldier when the regular supply fails. During conflicts such as the war in Ukraine, traditional supply chains have proven insufficient: the constant demand for replacement parts – from vehicle components to field equipment – has outpaced the production capabilities of centralised manufacturing facilities.

Dorman summed up the challenge: "Defence logistics is performing under pressure – adapting rapidly but facing real strain. Today's environment is defined by persistent, multi-theatre conflict: from supporting Ukraine to sustained competition – which increasingly resembles conflict – in the Indo-Pacific, to NATO's heightened posture."

He highlighted that, while logistics systems remain broadly effective, they are increasingly challenged by political pressures, outdated practices, contested environments, extended supply chains, and limited surge capacity. Ideally, each stakeholder could focus on its own area of responsibility, but today's operational demands require far greater flexibility and coordination.

The most recent and tangible example of this has been the Ukrainian Armed Forces using advanced and digitised manufacturing equipment - including from SPEE3D - to reduce downtime and keep combat vehicles in the fight. But Ukraine had to take time to learn the new capability and to understand that in order to get 'bang for buck', the advanced manufacturing capability must be fully integrated into defence-wide frameworks.

This shift toward decentralised, forward production and partner-enabled logistics – exemplified in the US Department of Defense's Regional Sustainment Framework – places advanced manufacturing at the heart of modern sustainment. "Going forward, we need logistics that are digitally enabled, partner-integrated, and posture-flexible – and advanced manufacturing is central to that future," explained Dorman. "Digitised manufacturing – especially Additive Manufacturing – enables us to move production closer to the point of need. That's a game-changer."

Any strategy focusing on harnessing AM will require a laser-like focus on what 'AM Defence Capability' actually means. We will be required to address each of the 'military capability bricks' required when creating any military capability, whether that be an advanced manufacturing unit or an F-35 stealth fighter jet. These capability bricks are constant and are:

- Training
- Equipment
- Personnel
- Infrastructure
- Doctrine
- Organisation
- Information
- Logistics

At SPEE3D, we have spent the past five years developing these bricks to ensure that when we serve a military customer, we have addressed their needs associated with each brick. And whilst it isn't always self-evident as to what each brick requires as a solution, the good news is that, on the whole, AM companies are now able to offer a near full capability – but here's the catch: we don't want to! I'll say that again: whilst we have worked to ensure that our military customers are provided with a solution to each brick, we would much prefer to stay in our own lane as the 'equipment expert', and allow other companies to be the experts in training and information for example.

This is where the primes can add value: by bringing together the expert solution providers within our industry to build each brick.

Fig. 5 A Bradley Fighting Vehicle's transmission mount (before and after) manufactured using SPEE3D technology by US soldier with no prior Additive Manufacturing experience during U.S. Army Combat Capabilities Development Command (DEVCOM) Army Research Laboratory (ARL) advanced manufacturing demonstration at the University of Tennessee Knoxville (Courtesy SPEE3D)

"The defence customer wants speed, resilience, interoperability, and security. They're looking for solutions that deliver faster than traditional supply chains, work in austere, expeditionary conditions, can scale or surge in conflict, and are cyber-secure and digitally traceable."

This coordinated, ecosystem-based approach mirrors the qualities that defence customers are increasingly demanding. Dorman stressed, "The defence customer wants speed, resilience, interoperability, and security. They're looking for solutions that deliver faster than traditional supply chains, work in austere, expeditionary conditions, can scale or surge in conflict, and are cyber-secure and digitally traceable."

According to Dorman, digitisation enables real-time insight into system health and logistics needs: "Digital twins that model platforms and predict maintenance, and AI-enabled forecasting tools, allow us to anticipate requirements, reduce waste, and optimise

"Defence is willing to pay for solutions that reduce operational risk, shorten sustainment timelines, and improve readiness. It's not about the cheapest cost – it's about assured availability in a world where delay can cost lives [...] The defence community is looking for partners, not vendors."

throughput – all vital in contested environments."

Dorman emphasised that to succeed in this environment, AM firms must "engage early on qualification and certification pathways – partner with depots, OEMs, and standards bodies." He also highlighted the importance of developing dual-use applications that can serve both national and allied force structures, helping "increase interoperability in coalition operations."

"To improve AM adoption by primes, we must impact system design, provide government incentives, send clear demand signals, support workforce development, and reform the qualification process." This includes mechanisms such as tax credits, SBIR funding, and procurement strategies that reward digital twin integration and model-based engineering."

"Defence is willing to pay for solutions that reduce operational risk, shorten sustainment timelines, and improve readiness. It's not about the cheapest cost – it's about assured availability in a world where delay can cost lives."

This approach echoes the expectations of today's defence customers. "The defence community is looking for partners, not vendors," Dorman stated. Success in this space requires more than technical expertise – it requires operational understanding and a commitment to delivering outcomes that matter in theatre. AM firms must engage not as suppliers of equipment, but as collaborators capable of addressing mission-critical challenges alongside defence stakeholders.

"While Additive Manufacturing's impact on sustainment and logistics has been widely acknowledged, its potential to transform front-line capability – to build better, faster, more adaptive systems – is still under-realised in defence circles."

AM's role in next-generation defence technologies: building to fight, not just sustain

While Additive Manufacturing's impact on sustainment and logistics has been widely acknowledged, its potential to transform front-line capability – to build better, faster, more adaptive systems – is still under-realised in defence circles. The future of military readiness depends not just on keeping existing equipment operational, but on integrating AM into the development of the next generation of defence technology.

Kieron Salter stresses the importance of integrating Design for Additive Manufacturing (DfAM) principles from the outset, rather than retrofitting existing designs. Without proactive adoption, he warns, competitors will gain the upper hand. "I think the bit that they're missing is that it's not about rapid prototyping – that is one of the benefits. It's actually a future technology that will unlock future capability."

Fig. 6 The UK's Digital Manufacturing Centre (DMC) is working in partnership with NP Aerospace to deliver state-of-the-art metal engineering solutions as part of the UK Ministry of Defence's Project TAMPA. This Mastiff/Ridgeback patrol vehicle door latch was manufactured using Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing technology at the DMC (Courtesy DMC)

I posed the questions "Why AM, what do we wish the MOD understood about the value AM offers, what are the gaps in understanding, and how do we bridge these gaps?" Salter put it plainly: "I think the gap is the message, and the fact that we are hailing Additive Manufacturing as the objective, rather than the solution."

"There's nobody on the front line or in an actual procurement position saying they need to buy an Additive Manufacturing part. What they're going to say is I need it quicker. I need it to be more reliable. I need to have a more agile response and be able to adapt more quickly. All those sorts of things – well, those are the things that can only be unlocked with Additive Manufacturing."

This is why we need outcome-driven thinking at the highest levels. "In the UK, what the Defence Secretary should be doing is mandating the outcomes that are required – outcomes that will mean that only Additive Manufacturing can be a solution," added Salter. "So, for example, mandating that we improve response times, that we have distributed manufacturing capability, repairability, lightweighting, sustainability and advanced technology. If those outcomes are mandated, only AM will be able to achieve them, and so that will encourage Additive Manufacturing to get adopted."

The case is clear: AM is not just about spare parts; it is about designing better, lighter, and more efficient systems from the ground up. Whether it's drones with improved range and payload capacity or missile engines with enhanced propulsion through complex internal geometries, AM delivers benefits that conventional manufacturing cannot.

However, for this bridge between potential and practice to form, a broader recognition of AM's capabilities is required, both within government and across the supply chain. "There are two things," said Salter. "First, what are the real benefits of AM, and what should we be talking about? We should be saying: we need to achieve something, and only AM can do this. Second, there is a growing supply chain of motivated SMEs [Small and Medium-sized Enterprises] that want to help. They'll need support in terms of visibility of business opportunities, and funding gaps between R&D and production, but we need engagement from the primes, Tier 1s, and government to say 'we recognise that AM could be a solution for things we need in the future.'"

Fig. 7 Also manufactured by the Digital Manufacturing Centre (DMC), this Mastiff/Ridgeback patrol vehicle step assembly was manufactured using Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing technology (Courtesy DMC)

> ***"Funding is welcome, but where is it going? We're not asking for handouts – give us work. With real contracts, we can invest in capability and be part of your supply chain when the time comes. Right now, everything is staying in-house."***

"AM is already being widely adopted in the defence sector. Many SMEs are utilising it. AM is already a mainstream manufacturing process being deployed." However, this reality isn't always reflected in policy or procurement decisions. "I'm a big supporter of the TAMPA programme [2] [a UK Ministry of Defence initiative exploring how AM and other advanced tehnologies can support military readiness and forward-deployed sustainment] and we've done some strong work with primes as part of it," Salter noted. "But the demonstration products emerging from those efforts are still far removed from the real-world applications of drones – or even munitions – that are already being manufactured with AM today. It just needs to be more widely adopted and accepted."

I posed the question, "If you were the Defence Secretary, what would you instruct to happen?" Salter responded, "Firstly, invest in the supply chain. I made this point at an MOD event we held here at the DMC in March, as part of one of the TAMPA project working groups [...] All the primes were there; they're all developing their own capabilities in-house for rapid R&D and developing products that have AM as part of the solution. I said, 'If you don't invest in the supply chain now, we won't be here when you need us.' Because there's so much activity in defence – but where's the money? Where are the contracts?"

This call for action is echoed at the policy level. Fred Thomas, a UK Member of Parliament and member of the House of Commons Defence Select Committee, recently highlighted the need to unlock private capital in order to drive innovation in UK defence. In an interview shared on LinkedIn [1], he explained, "The tech that we need to integrate into our force is not going to be supplied realistically by large companies who deliver multi-year, million-pound platforms."

Instead, innovation is expected to come from small, venture-backed technology firms capable of rapid development cycles. Thomas added that enabling this shift requires the MOD to demonstrate that it can adopt and integrate technology quickly, sending a clear signal to the market. Only then, he argued, will venture capitalists have the confidence to back the kinds of companies that are developing critical, fast-moving defence technologies.

Recent government initiatives have pledged hundreds of millions to help SMEs access the defence supply chain. Yet, despite these efforts, the practical impact remains limited. "It doesn't solve the problem, either," Salter remarked. "Funding is welcome, but where is it going? We're not asking for handouts – give us work. With real contracts, we can invest in capability and be part of your supply chain when the time comes. Right now, everything is staying in-house."

Finally, there's the cultural side of AM adoption – how engineers and designers interact with the technology. Salter reflected: "I remember

Fig. 8 The Royal Danish Navy frigate HDMS Triton sailing in the waters around Greenland. Additive Manufacturing, in particular large format technologies such as Directed Energy Deposition, is becoming a core part of naval supply chains (Courtesy NATO)

when I started as an engineer designing parts, if you drew something that couldn't be manufactured using CNC machines, or fabricated, then you'd get severely told off. Now I've got the opposite problem – I can't get engineers to design things that are complex enough that they benefit from AM and truly exploit its advantages."

As we look to the future, the message is clear: mandate outcomes, fund capability, and empower the supply chain. Additive Manufacturing must not be treated as an end in itself, but as a critical enabler of a more agile, responsive, and combat-ready defence force. The opportunity now is not simply to sustain what we have, but to design and deliver next-generation systems that meet operational demands with speed, efficiency, and precision. These are the capabilities AM is ready to provide – if we have the will to embed them where they matter most.

The role of defence primes: integrators of AM

If Additive Manufacturing is to fulfil its potential (either for supply chains or DfAM), it must be fully integrated into defence logistics. Defence primes are uniquely positioned to lead this transformation. However, to do so effectively, they must embed AM at the core of their operational strategies.

Companies such as BAE Systems, Lockheed Martin, Raytheon, and General Dynamics already manage complex, multi-tiered supply chains

"I remember when I started as an engineer designing parts, if you drew something that couldn't be manufactured using CNC machines, or fabricated, then you'd get severely told off. Now I've got the opposite problem – I can't get engineers to design things that are complex enough that they benefit from AM and truly exploit its advantages."

Fig. 9 A wheel bearing cover produced in the field using SPEE3D's Cold Spray Additive Manufacturing technology being fitted to an M113 fully tracked armoured personnel carrier (APC) (Courtesy SPEE3D)

"At the end of the day, we're not selling steel on wheels – we're selling mobility. If we could deliver that without armoured steel, we would. For me, Additive Manufacturing is a way to increase that availability."

and are trusted as systems integrators for defence. But to realise AM's full potential, they must go further: embedding it at the core of their operational strategies, from design to field sustainment.

In practical terms, this means defence primes must embed AM across their core logistics operations – from hardware deployment and software interoperability, to training military personnel and securing digital manufacturing threads – acting as both innovators and standard-setters.

Central to enabling this level of responsiveness is the adoption of advanced manufacturing technologies – in particular, Additive Manufacturing – which offer the speed, flexibility and agility required to meet evolving defence needs. Michail Efthymiadis stressed that this shift requires a reframing of primes' delivery: "At the end of the day, we're not selling steel on wheels – we're selling mobility. If we could deliver that without armoured steel, we would. For me, Additive Manufacturing is a way to increase that availability."

"If you consider AM a product that increases the availability of military mobility, we need to be in a position where we know what exists in the market, we know the whole value chain, and we need to offer solutions, not technology. This means that we still have the role of system integrator for AM."

For primes, this means stepping up as coordinators of an AM ecosystem, bringing together capabilities across design, production, software, data security and supply chain management. Efthymiadis highlighted this integrative role clearly: "We are in a position where we need to bring all these pieces together and offer it to the customer... a product that stands by itself."

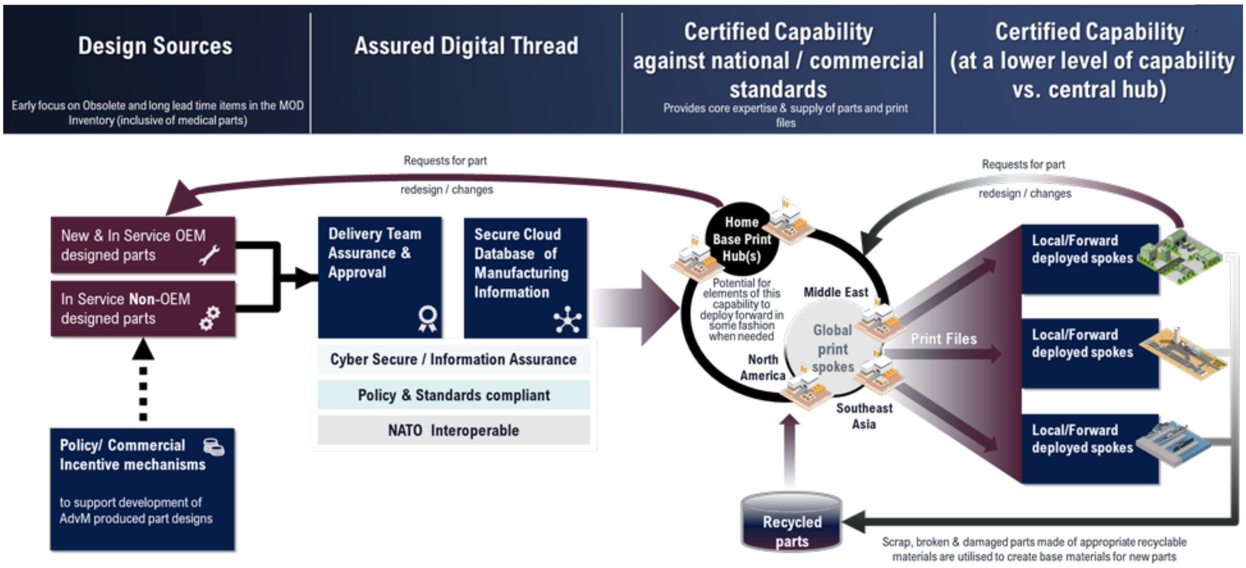

Fig. 10 The UK Ministry of Defence's AM vision, as published in its Defence Advanced Manufacturing Strategy (Courtesy UK Ministry of Defence)

However, this level of integration depends on a more strategic approach to partnerships and supply chain structure. Efthymiadis believes that AM's maturity will hinge on the strength of its ecosystem. "Stick to what you're good at – that's key as this technology takes hold. As customer requirements become more complex, we need suppliers who specialise. We don't need ten generalists; we need ten specialists who can work together."

This collaboration must underpin the next phase of AM in defence. The components exist: the machines, the materials, the software, and the skills. The challenge now is to align them, both strategically and at scale. "All the pieces are there. The only thing left is to combine them together as one package."

The barriers to integration

Integrating AM into defence logistics is not without its challenges. Barriers to adoption remain significant: high costs and uncertain return on investment, qualification and certification hurdles, intellectual property and cybersecurity concerns, gaps in digital engineering skills, and the lack of standardised design repositories and data protocols. The recent UK MOD's Defence Advanced Manufacturing Strategy, published in March 2025, echoes many of these issues, emphasising the need for stronger integration, digital security, and strategic partnerships (Fig. 10).

Intellectual Property Rights and licensing

One of the most persistent challenges in adopting AM for defence is navigating Intellectual Property Rights (IPR). The UK MOD policy document acknowledges this: "IPR is often cited as a blocker to AM. However, as with all types of manufacture, IPR can only prevent the MOD (or third parties working on its behalf) from manufacturing a part when it does not have the necessary rights in any extant patents or designs."

To overcome this, the MOD emphasises the importance of negotiating contracts that include explicit rights to manufacture critical components through AM. Defence primes must take a proactive stance in securing these rights during the procurement and development phases rather than retroactively addressing issues once they arise.

"Stick to what you're good at – that's key as this technology takes hold. As customer requirements become more complex, we need suppliers who specialise. We don't need ten generalists; we need ten specialists who can work together."

Fig. 11 A gunner's ratchet for the M242 Light Armoured Vehicle, additively manufactured in aluminium bronze using SPEE3D's Cold Spray technology (Courtesy SPEE3D)

> *"As the strategy notes, 'There are many solutions being used within industry and developed by nations and allies. It is easy to be distracted by the latest solution being offered, but what is needed is clarity over the design of a supply chain which exploits the advantages of AM.'"*

Interoperability and standardisation
The challenge of integration is often overlooked but remains critical for successful AM integration. The UK MOD's Project TAMPA revealed that even when the same AM process is used, different machines can produce varying results due to differences in hardware and software configurations. As stated in the MOD strategy, "Different vendors' machines produce different results, challenging repeatability. This will have a bearing on the design of a future supply network utilising AM."

Defence primes must work with AM OEMs to develop standard operating procedures and certification protocols to ensure that parts produced in different locations or on different machines maintain consistent quality. Investing in robust quality assurance systems and leveraging internationally recognised standards (such as ASTM) will be crucial for maintaining operational readiness.

Digital security: safeguarding AM data
The digital nature of AM introduces unique security challenges. The MOD's Defence Advanced Manufacturing Strategy highlights the need for a secure 'digital thread' linking AM production capabilities within defence units to central logistical networks. Without this secure infrastructure, the risks of cyber intrusion or data corruption increase significantly.

As the strategy notes, "There are many solutions being used within industry and developed by nations and allies. It is easy to be distracted by the latest solution being offered, but what is needed is clarity over the design of a supply chain which exploits the advantages of AM."

To address this, defence primes must collaborate with cybersecurity experts to develop encrypted data transmission methods and secure cloud storage solutions. Establishing a digital inventory with robust access controls will be critical to prevent the unauthorised manipulation of essential design files.

Strategic partnerships: building a unified AM ecosystem
Strategic partnerships are essential for creating a resilient AM ecosystem. The MOD strategy outlines the importance of collaboration between military units, OEMs, and industry leaders. This approach not only fosters innovation but also ensures that military units have the support needed to deploy AM solutions effectively. The document states, "Strategic partnering would see Front Line Commands, MOD units, and agencies team up with relevant industry colleagues to share learning, provide support and potentially develop 'trusted agent' status."

Defence primes must take the lead in forming these partnerships, facilitating knowledge exchange, and ensuring that innovations are rapidly translated into practical applications. By creating a network of certified AM hubs, primes can ensure that production is both scalable and standardised.

Unified voice for the AM industry: collaboration or stagnation

One glaring issue revealed during AM Forum Berlin is the fragmented voice of the AM industry. To influence defence policy and drive adoption, the AM sector must speak as one. Unlike aerospace or automotive industries, which often present collective positions, the AM industry remains disjointed.

To truly drive change, the AM sector needs a clear, unified narrative. This means speaking not just about the technology itself but about its strategic value in defence. Learning from the US and China, the European/NATO AM sector should foster alliances, create advocacy groups, and engage directly with defence policymakers. If we do not unify, we risk being marginalised while competitors build momentum.

Advanced manufacturing firms must prioritise operational validation, robust cybersecurity, and interoperability. Early engagement on qualification pathways, focus on

Fig. 12 A soldier sits atop a Leopard 2A4 main battle tank during a maintenance training course for Ukrainian personnel, held at the Polish Army's Combined Arms Training Centre (CAT-C) in Zagan, Poland (Courtesy NATO) (Courtesy NATO)

"One glaring issue revealed during AM Forum Berlin is the fragmented voice of the AM industry. To influence defence policy and drive adoption, the AM sector must speak as one."

Thanks to the following for their time and insight in the preparation of this article

Major General Ed Dorman (Ret)
Major General Ed Dorman (Ret) is Executive VP and COO at S10 Consulting, and Chair of the NDIA Contested Logistics Subcommittee. A former Commander of the US Army's 8th Theater Sustainment Command and senior logistics leader for US forces across the Middle East and South Asia, he brings deep expertise in contested logistics, large-scale combat sustainment, and defence transformation.

Kieron Salter
Kieron Salter, CEO of the UK's Digital Manufacturing Centre (DMC), leads the organisation's drive to integrate Additive Manufacturing into high-performance sectors, including defence. With a background in motorsport engineering and a focus on innovation and agility, Salter has become a prominent advocate for the adoption of AM at the systems level.

Michail Efthymiadis
Michail Efthymiadis, Head of Digital and Product Lifecycle Innovation at General Dynamics European Land Systems, focuses on integrating AM and digital tools into the lifecycle of next-gen land platforms. His work highlights how primes can act as system integrators to realise AM's full value across the defence ecosystem.

"Learning from the US and China, the European/NATO AM sector should foster alliances, create advocacy groups, and engage directly with defence policymakers. If we do not unify, we risk being marginalised while competitors build momentum."

dual-use cases, and alignment with coalition needs will be key to driving adoption. Above all, AM must be framed not just as innovation, but as a strategic enabler of resilient logistics. To succeed, AM adoption needs government backing: clear demand, faster qualification, and skilled people. Defence primes and AM suppliers must now deliver.

We cannot afford to hesitate while our adversaries are building capacity. Those who lead now will define the future of military sustainment. Those who hesitate will find themselves outmatched and unprepared.

Author

Calum Stewart
Director of Defence Programmes
SPEE3D
www.spee3d.com

Calum Stewart is a veteran of both the British and Australian Armies, where he served as an Engineering and Logistics Officer. For the past five years, Calum has been the Director of Defence Programmes at SPEE3D, a global leader in metal Additive Manufacturing technology. With a focus on deploying rugged, field-ready AM solutions for defence applications, Calum has been at the forefront of integrating AM into military logistics. His work has been instrumental in supporting defence forces worldwide, from rapid parts production on the battlefield to developing comprehensive training programmes for military engineers.

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A market analyst's view: Europe's opportunity as defence AM surges in the US and China

Drawing on insight from the *AMPOWER Report 2025*, this article examines how defence has become a key growth driver for metal Additive Manufacturing. While the US and China advance with coordinated, large-scale adoption, Europe risks falling behind. Matthias Schmidt-Lehr, Managing Partner at AMPOWER, offers a market analyst's perspective on the strategic role of Additive Manufacturing in global defence, and what Europe must do to translate its industrial potential into meaningful defence capability.

In a year marked by revenue declines and project delays across the Additive Manufacturing industry, defence emerged as a key driver of growth. According to the *AMPOWER Report 2025*, the global metal AM machine market saw a 3% revenue decline in 2024, despite an increase in units sold – a shift driven by falling average machine prices and mounting cost pressures on OEMs.

Against this backdrop, defence stood out as the fastest-growing vertical for metal AM machines, with equipment sales totalling €195 million – a year-on-year increase of more than 30%. Defence users now account for more than 15% of global metal AM equipment revenue and, when combined with the closely related aerospace sector, this figure rises to more than 36%.

This growth comes as conventionally strong sectors, such as medical and energy, have slowed. While industries like automotive and consumer electronics are beginning to explore high-volume production, broader momentum remains weak, with some companies reducing staff or scaling back their AM activities.

Amid this turbulence, defence adoption signals a shift in AM's strategic relevance – not just as a tool for prototyping, but as a critical enabler of readiness, innovation, and logistics flexibility. Powder Bed Fusion (PBF) and Directed Energy Deposition (DED) remain the dominant technologies, particularly in aerospace and defence, where Europe continues to hold a strong OEM base, including Nikon SLM Solutions, EOS, and MX3D.

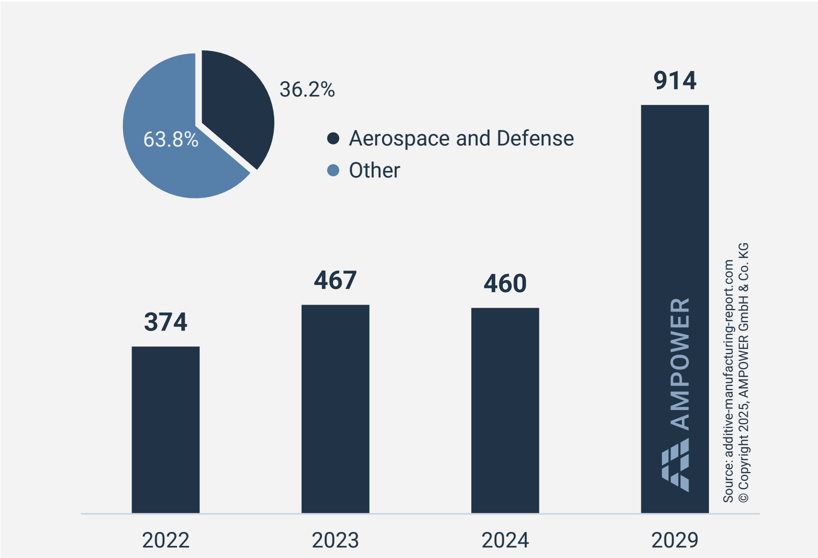

Fig. 1 Metal AM machine revenue for aerospace and defence 2022 to 2024, and forecast 2029 (€ million). Inset chart shows that, when combined, aerospace and defence account for 36% of the market (Courtesy AMPOWER)

Fig. 2 In the US, Lockheed Martin has expanded its metal AM operations to meet the demand for advanced capabilities, such as this guidance housing for the Mako hypersonic missile (Courtesy Lockheed Martin)

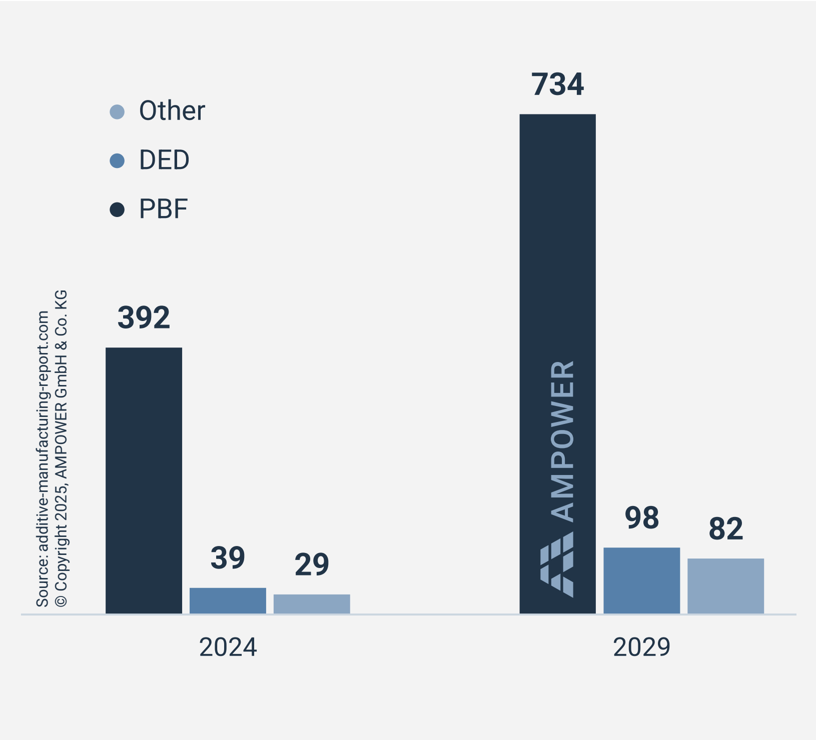

Fig. 3 Metal AM machine revenue in aerospace and defence by technology, 2024, and forecast 2029 (€ million) (Courtesy AMPOWER)

Global defence AM strategies: US and China surge ahead

Over the past decade metal Additive Manufacturing has evolved from an experimental tool into a strategic capability for the defence sector. Armed forces and contractors worldwide now use AM not only to sustain legacy systems but also to enable next-generation platforms such as hypersonic missiles and fighter aircraft.

The US: institutionalising AM at scale

In the US, defence-led procurement initiatives have driven a significant increase in AM adoption. The US Department of Defense has invested in PBF-LB and DED technologies in particular, fuelling a sharp year-on-year rise in both machine sales and consumables.

Metal AM plays a dual role in US defence strategy, supporting the readiness of current platforms and enabling innovation in future systems. The US Navy, for example, has institutionalised AM through its Additive Manufacturing Center of Excellence, developing digital part manufacturing data sets that will allow distributed production for submarines and surface ships. Replacing conventional casting with AM has cut lead times and supported the Navy's ambitious submarine production goals, including Columbia- and Virginia-class vessels.

At the development frontier, companies such as Lockheed Martin and Raytheon have scaled AM integration into advanced hypersonic missile programmes, achieving cost and lead time reductions of over 90% for some components. AM is no longer confined to pilot projects but is embedded across operational supply chains and mission-critical production. Startups such as Beehive Industries are also innovating with AM-based propulsion systems, demonstrating how even small firms can contribute to agile, distributed supply chains within the US defence ecosystem.

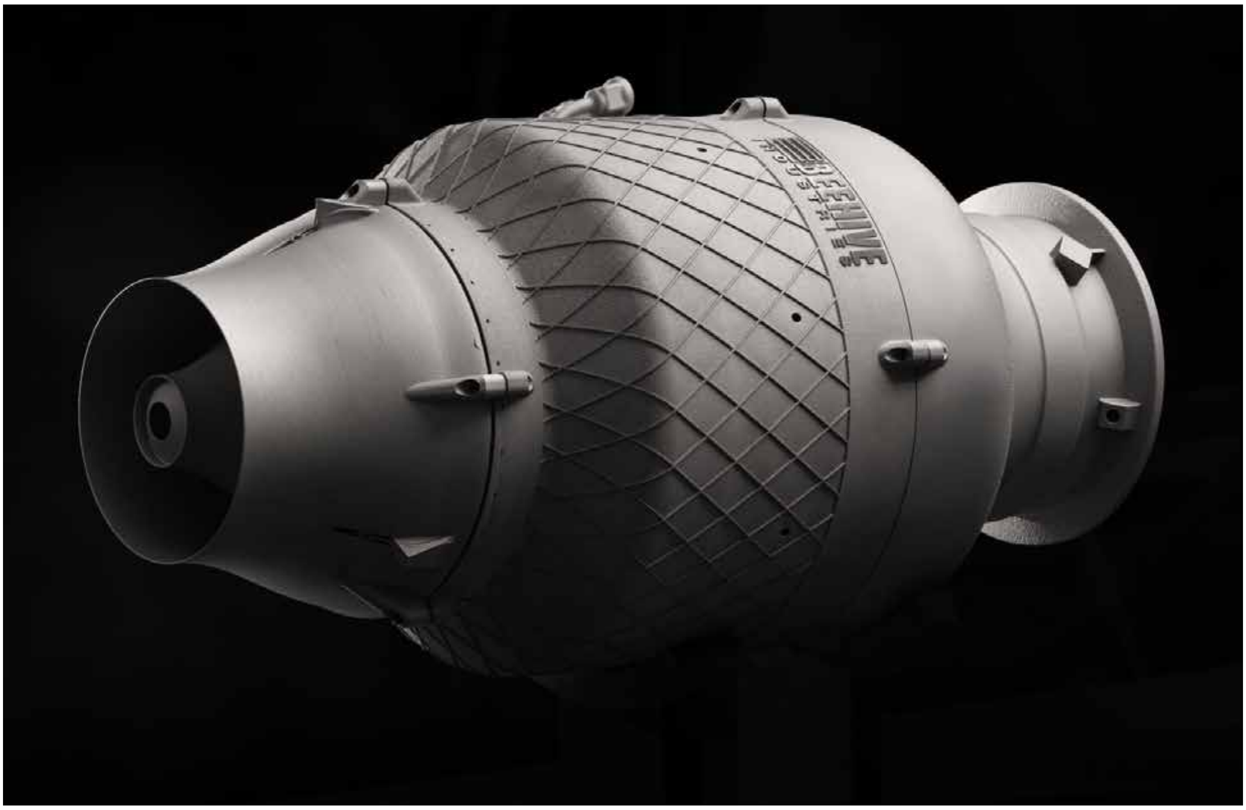

Fig. 4 US-based startups such as Beehive Industries are innovating with AM-based propulsion systems, demonstrating how even small firms can contribute to agile, distributed supply chains within the US defence ecosystem (Courtesy Beehive Industries)

The US model, with its coordinated infrastructure, digital qualification workflows, and public-private partnerships (such as America Makes), reflects a high level of organisational maturity.

"China's approach to AM in defence is both assertive and strategically aligned with its goal of military-technological self-reliance. AM is used to bypass traditional manufacturing bottlenecks and reduce dependence on foreign suppliers, enabling faster deployment of advanced capabilities."

China: accelerating AM through state-driven strategy

China's military industrial complex has pursued a similarly ambitious trajectory, albeit through a more centralised, opaque model. Although less publicly documented, major military research institutes and state-owned enterprises such as China Aerospace Science and Industry Corporation (CASIC) and AVIC have embedded AM into production lines for cruise missiles, UAVs, and advanced fighter aircraft.

For example, CASIC uses AM to produce components such as rudders and engine housings that were once reliant on casting and welding. These parts are now made in days, with reduced waste, fewer personnel, and improved performance through optimised geometries. Shenyang Aircraft Corporation has integrated AM into the manufacturing of aircraft – likely including the FC31 stealth fighter – with reports indicating significant use of AM for structural components that reduce weight while enhancing strength.

China's approach to AM in defence is both assertive and strategically aligned with its broader goal of military-technological self-reliance. AM is used to bypass traditional manufacturing bottlenecks and reduce dependence on foreign suppliers, enabling faster deployment of advanced capabilities.

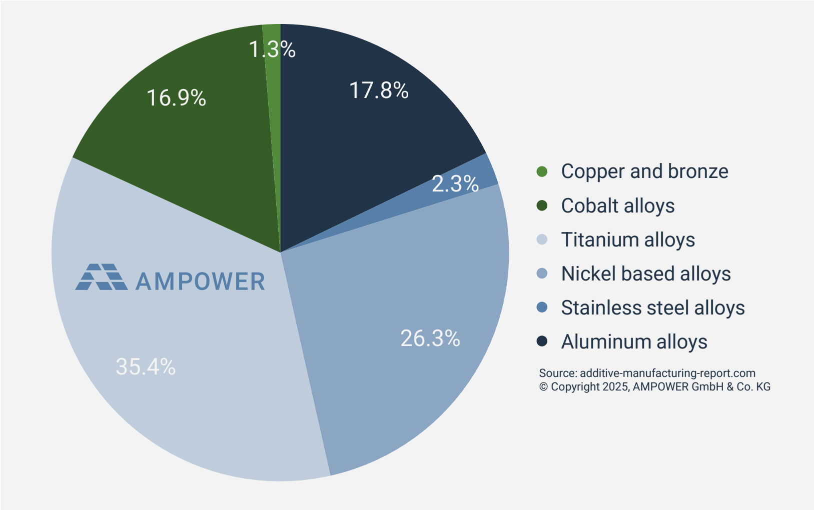

Fig. 5 Share of metal feedstock consumption in aerospace and defence by alloy, 2024 (Courtesy AMPOWER)

> *"AM in Europe is still too often viewed as a sustainability experiment or digital pilot project rather than a scalable production technology. There is little evidence of the kind of strategic coordination seen in the US or China – between defence ministries, OEMs, and AM technology providers."*

Material use in defence also reflects this strategic divergence. Aerospace and defence applications have a strong focus on high-value alloys such as titanium, nickel, and cobalt – materials that support weight reduction, strength, and performance under extreme conditions. In contrast, stainless steel, which accounts for nearly 17% of global AM powder demand across all sectors, makes up just 2% of material usage in these applications (Fig. 5). In China, this emphasis on high-performance alloys supports its drive to develop propulsion systems, airframes, and thermal shielding for next-generation platforms.

Europe's defence AM momentum: catching up or falling behind?

Because of their global operations, many leading AM companies do not routinely segment industry sales data by market within specific regions. As a result, no definitive data confirms that aerospace and defence companies in Europe invest less in AM compared with the US or China. However, most machine OEMs interviewed for the AMPOWER Report 2025 indicated that aerospace and defence spending in the US and China drove the majority of their growth in 2023 and 2024, whereas similar momentum has yet to materialise in Europe.

This is supported by numerous public announcements from machine OEMs, component manufacturers and materials suppliers, as well as public funding bodies such as the US Department of Defense. The volume of announcements from defence primes and their suppliers further suggests that AM activity, particularly in the US, has been growing significantly faster than in any other region globally.

Europe does have some promising activity in the defence AM space. The UK Ministry of Defence deployed Cold Spray AM systems during NATO's *Steadfast Defender* exercise. MBDA Systems has developed missile components using AM. Rolls-Royce is recycling titanium from decommissioned Tornado aircraft to print parts for the next-generation Orpheus engine under the Future Combat Air System (FCAS) programme.

However, these remain isolated rather than integrated into a broader ecosystem. Europe lacks a unified strategy for defence-related AM. Its industrial base is scattered across national borders and hampered by complex procurement systems and constrained budgets. Although companies such as Airbus Defence, Rheinmetall, and EOS have shown AM leadership, overall momentum is limited by a conservative innovation culture and risk-averse decision-making.

AM in Europe is still too often viewed as a sustainability experiment or digital pilot project rather than a scalable production technology. There is little evidence of the kind of strategic coordination seen in the US or China – between defence ministries, OEMs, and AM technology providers.

Can Europe catch up?

The US has taken a deliberate and highly coordinated approach to integrating AM across its defence ecosystem. Metal AM is now embedded in both sustainment and innovation pipelines, enabled by strategic infrastructure, digital qualification processes, and public-private

Fig. 6 European metal AM technology, from Nikon SLM Solutions, in a US Lockheed Martin AM facility. While Europe is still regarded as a technology leader, the region lacks a unified strategy for defence-related AM, with its industrial base scattered across national borders and hampered by complex procurement systems (Courtesy Lockheed Martin)

initiatives. This has positioned the US as a global leader in the defence adoption of AM, with results already visible in both operational readiness and platform development.

China's approach to AM in defence is equally assertive but structurally different. It follows a model of state-driven acceleration through tightly integrated government industrial complexes. Reports indicate that AM is widely used for engine components and large airframe structures across advanced military platforms. While transparency is lower than in the West, it is clear that China seeks to bypass conventional bottlenecks, reduce foreign dependence, and gain a leapfrogging advantage in military technologies. China's emphasis on vertical integration and self-reliance is evident across both prototyping and final part production.

"To stay competitive, Europe must shift from pilot projects to full platform integration. It should align procurement and certification processes to support AM and encourage cross-border collaboration."

By contrast, Europe's adoption of AM in defence remains cautious and disjointed. While promising efforts exist, these remain the exception rather than the rule. Without a cohesive industrial strategy and cross-border alignment, Europe risks falling behind in critical areas such as hypersonics, logistics agility, and digital part certification.

To stay competitive, Europe must shift from pilot projects to full platform integration. It should align procurement and certification processes to support AM and encourage cross-border collaboration. Without this shift, Europe could become strategically dependent on others for next-generation defence readiness.

Fig. 7 European metal AM technology, this time from EOS, on show at Beehive Industries during the opening of its new 5,500 m² headquarters in Centennial, Colorado (Courtesy Beehive Industries)

Realising AM's potential in European defence

Despite these challenges, recent geopolitical events have led to a rise in European defence spending. Tensions in Eastern Europe and the Middle East have prompted EU member states to increase defence budgets for 2025 and beyond. The European Defense Fund has allocated new multinational grants to support collaborative research in advanced manufacturing, including metal AM.

These developments show that defence spending is shifting toward digital and lightweight manufacturing, with metal AM positioned to benefit. As member states expand budgets, AM will capture a larger share of defence allocations, boosting demand for machines, feedstock, and software. European armies face a similar challenge to US forces, with ageing fleets and difficulties in the supply of spare parts.

"As member states expand budgets, AM will capture a larger share of defence allocations, boosting demand for machines, feedstock, and software. European armies face a similar challenge to US forces, with ageing fleets and difficulties in the supply of spare parts."

Strategically, higher defence budgets may accelerate the harmonisation of AM certification across Europe. Under the European Defense Agency, member states could adopt a unified Directive for AM Qualification. This would streamline collaboration and reduce barriers to entry for smaller OEMs. Such efforts could lead to a European Defense AM Consortium – promoting best practices, strengthening supply chain security, and enhancing the resilience of Europe's defence capabilities.

The broader economic impact will extend beyond defence. Innovations in alloys and certification from defence programmes will benefit civil aerospace and green energy. Stronger regional collaboration will improve supply chain resilience. In short, if Europe aligns its strategy with execution, it can narrow the gap with the US and China and reclaim a leadership role in AM for defence.

Europe already has a strong industrial base to build on. It is home to leading equipment OEMs such as Nikon SLM Solutions, EOS, and MX3D, which are at the forefront of Powder Bed Fusion and Directed Energy Deposition technologies. From a supply chain perspective, the capability to support defence programmes is already in place – what's needed now is strategic coordination and political will to fully activate it.

Author

Matthias Schmidt-Lehr
Managing Partner
AMPOWER GmbH & Co KG

additive-manufacturing-report.com

The *AMPOWER Report 2025* draws on insights from over 300 in-depth interviews with Additive Manufacturing managers and directors, offering a balanced view of both technical and commercial trends.

This year's data set includes more than 44,000 individual data points, with equipment OEMs representing around 90% of the global installed base. In addition to capturing supplier perspectives, the report places particular emphasis on user feedback, enabling a demand-driven evaluation of the market.

Complementing the data, a series of guest-authored articles explores regional developments across the global AM landscape.


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From Fixed Processes to flight parts: How REM's advanced surface finishing supports NASA JPL's AM innovations

REM Surface Engineering has worked with NASA's Jet Propulsion Laboratory (JPL) for decades to develop surface finishing processes for metal components used in space missions – more recently including those produced by Additive Manufacturing. Drawing on its aerospace and medical experience, REM has adapted its Isotropic Superfinishing (ISF®) and Chemical Polishing (CP) technologies to address the roughness and surface variability of AM parts. In this article, REM's Justin Michaud and Agustin Diaz trace the evolution of that work, culminating in the development of ultralight, crushable lattice structures for the Mars Sample Return mission.

REM Surface Engineering has been supporting NASA's Jet Propulsion Laboratory (JPL) missions since well before the lab turned to Additive Manufacturing for flight hardware. The company's ISF® Process – a chemically assisted, non-directional surface finishing technology – has been used in multiple Martian Rover programmes to finish extremely small, high-precision gears and components, such as the part shown in Fig. 1. Beyond the space sector, the ISF Process has been deployed for more than three decades in critical, high-performance gear applications across aerospace and other industries.

As one of the first – if not the first – non-tool-path-guided surface polishing processes applied to precision gears, the ISF Process is perhaps the most rigorously and comprehensively tested polishing method outside of traditional machining. It is essentially a chemically assisted tumbling approach, leveraging alloy-matched chemistries and controlled, typically self-limiting surface reactions to achieve precise material removal and surface refinement [1].

The benefits of the process – more generally referred to as isotropic superfinishing, a term REM coined to describe the ultra-low roughness, non-directional surface texture it produces – first attracted the interest of the aerospace industry in the 1990s for power transmission gears. Companies including Sikorsky [2] and

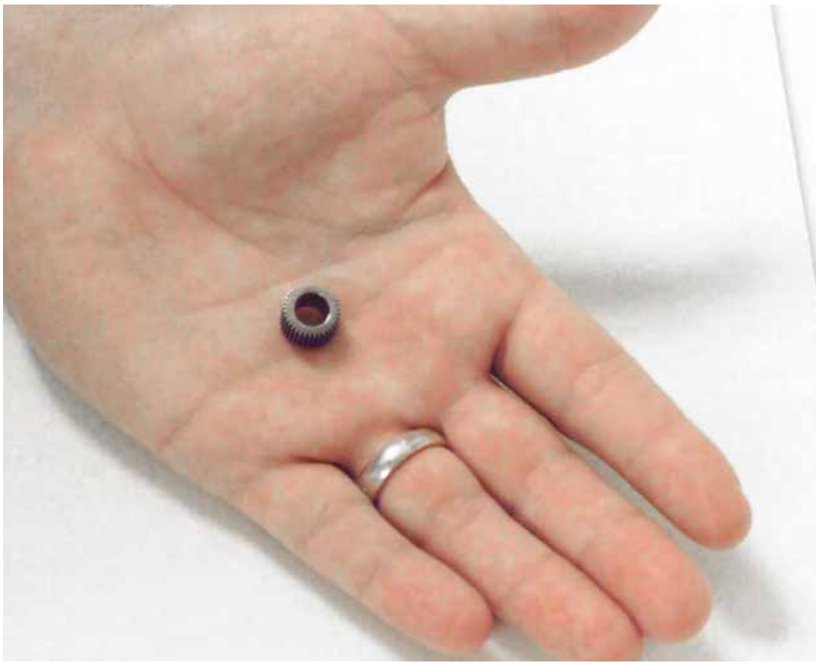

Fig. 1 Prototype Martian Rover gear from the early 2000s (Courtesy REM Surface Engineering)

Fig. 2 Future Advanced Rotorcraft Drive System (FARDS) main rotor gearbox (MRGB) gearshaft (publicly acknowledged as having undergone the ISF Process at AHS Forum 2017 [5])

Fig. 3 Traditionally manufactured Ti-6Al-4V compressor blade segment shown after REM's ISF Process (Courtesy REM Surface Engineering)

Fig. 4 Example of PBF-EB/Ti-6Al-4V components in their as-built condition (Courtesy REM Surface Engineering)

Bell Helicopter [3, 4] have publicly acknowledged their use of REM's technology for helicopter and vertical takeoff and landing aircraft (Fig. 2).

From aerospace to AM: Adapting surface finishing to meet unique challenges

This association with the aerospace sector led REM into the world of metal AM and, ultimately, into supporting JPL's metal AM programmes. However, this transition did not happen overnight. REM's journey from gear and machined component surface polishing technology provider to approved metal AM surface finishing supplier for JPL (and others) began nearly fifteen years ago. In 2012, CalRAM, Inc contacted REM about a programme it was undertaking with Northrop Grumman and UES Technology [6] focused on Ti-6Al-4V.

REM had worked with Ti-6Al-4V since the 1980s in support of medical applications and aero-engine compressor blades (see Fig. 3), so a titanium surface finishing project seemed straightforward. However, when the fatigue specimens and Mars Pathfinder components produced by Electron Beam Powder Bed Fusion (PBF-EB) arrived at REM's Texas location – the first metal AM components REM had ever seen – they looked nothing like the milled or machined parts the company was used to handling (see Fig. 4).

At the time, REM had been experimenting with alternative purely chemical processes to support various experimental left ventricle assist device (LVAD) components, whose geometries and material removal requirements were not fully suited to the ISF Process.

After recovering from the initial shock of the roughness and surface texture of the PBF-EB/Ti-6Al-4V components, REM began testing both its traditional ISF Process and its then-experimental chemical process. A two-step approach – chemical treatment followed by the ISF Process – was ultimately adopted. This combination significantly reduced surface roughness; however, the parts still retained a much rougher texture than the typical final components produced by REM, primarily due to elevated levels of residual waviness (see Fig. 5).

However, time constraints meant REM had to return the components to CalRAM so that testing and evaluation could proceed. To everyone's surprise, REM's specimens outperformed a competitive abrasive polishing process – which had achieved a much lower roughness value – in uniaxial high-cycle fatigue testing (see Fig. 6). REM's samples only underperformed compared to specimens that were additively manufactured as solid cylinders and then fully machined to final dimensions – an approach REM considers not directly comparable, given the substantial material removal from the gauge section of those samples.

This unexpected result marked REM's entry into the metal AM market. The experimental chemical process evolved into REM's Chemical Polishing (CP) technology, and the ISF Process was adapted from its original goal of minimising material removal (typically 5-15 µm per surface) while achieving ultra-low roughness (<0.1 µm Ra), to also accommodate more aggressive removal levels. This adaptation was necessary to address the inherent surface waviness of metal AM components.

To distinguish between the two approaches, REM began using the term Chemical-Mechanical Polishing (CMP) to describe this more AM-tailored variant of the ISF Process which was often used subsequent to REM's Chemical Polishing process. Ultimately, REM opted for the tradename Extreme ISF Process to refer to both methods, used either independently or in sequence.

From proof of concept to collaboration with JPL

In part due to the results of this earlier study, REM was contacted by JPL in July 2019 regarding the

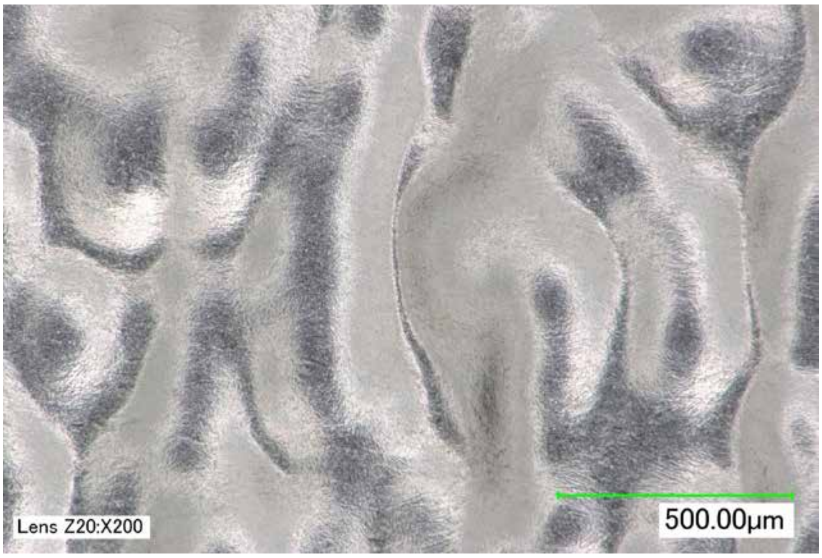

Fig. 5 Example of PBF-EB/Ti-6Al-4V micrograph showing high levels of residual waviness (Courtesy REM Surface Engineering)

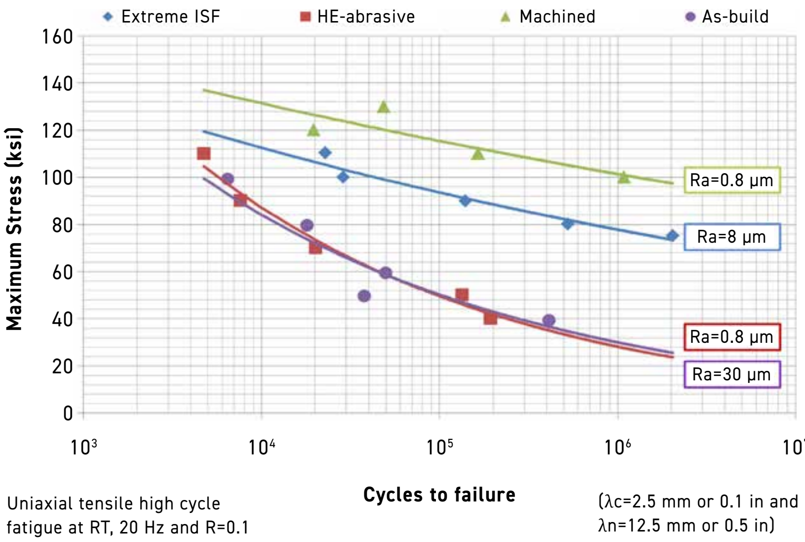

Fig. 6 Comparative high-cycle fatigue testing results for PBF-EB/Ti-6Al-4V specimens with different surface finishes and finishing processes applied (modified from data provided by Northrop Grumman, UES Technology, and CalRAM Inc [6])

> *"In part due to the results of this earlier study, REM was contacted by JPL in July 2019 regarding the processing of PBF-EB/Ti-6Al-4V components. The project yielded new and valuable data, as well as several potential flight components."*

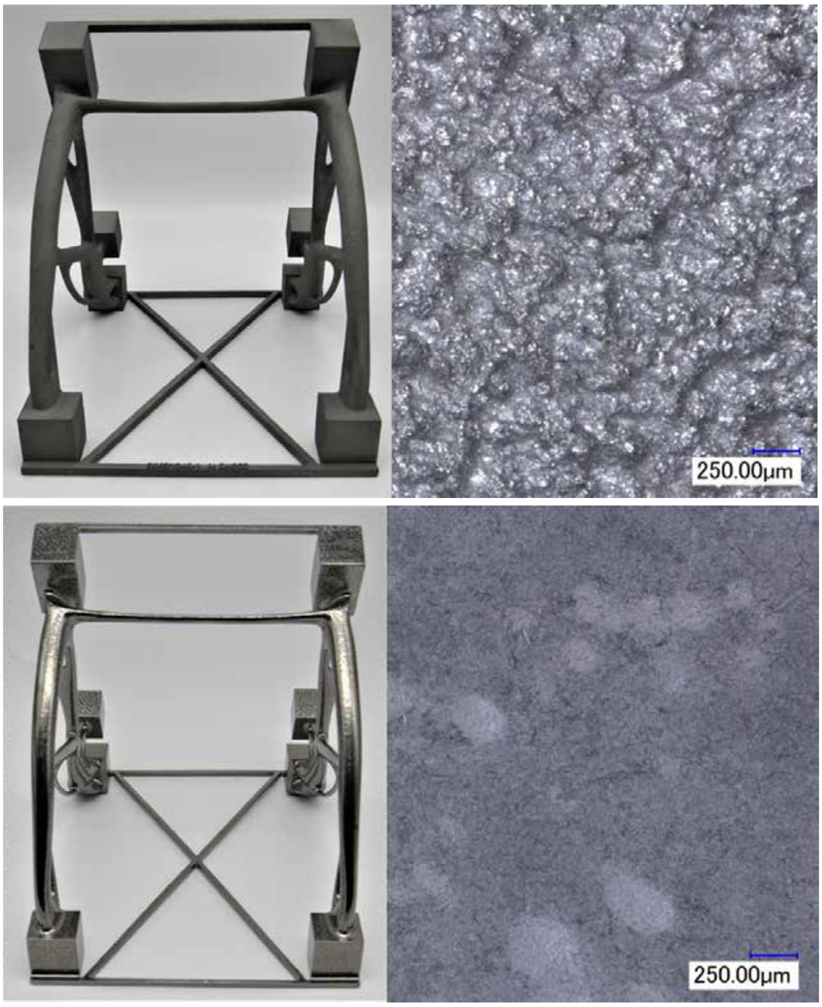

Fig. 7 PBF-EB/Ti-6Al-4V components for JPL, shown as-built and after surface finishing using REM's Extreme ISF Process [7]

processing of PBF-EB/Ti-6Al-4V components. The project yielded new and valuable data, as well as several potential flight components (see Fig. 7).

JPL sought to evaluate the effects, if any, of grit blasting and REM's Extreme ISF Process on thin wall tensile strength. In addition, REM was asked to produce three distinct levels of roughness reduction to assess the impact of surface roughness on mechanical performance.

The results were surprising. Grit blasting led to a slight increase in yield strength and ultimate tensile strength (UTS), but no statistically significant improvement in elongation compared to as-built specimens (see Fig. 8). By contrast, specimens processed using REM's Extreme ISF Process – first with CP, then CMP – showed significant increases in yield strength, UTS, and elongation relative to both the as-built and grit-blasted samples.

Notably, these specimens underwent a uniform 500 µm of surface material removal (SMR), as specified by JPL, yet showed no statistically significant differences in tensile properties across the three surface roughness levels tested (6.4, 3.2, and 1.6 µm Ra) [7].

The success of this initial tensile testing study led to increased engagement between REM and JPL. JPL began insourcing much of its metal Additive Manufacturing, shifting to Laser Beam Powder Bed Fusion (PBF-LB) technology and focusing primarily on Ti-6Al-4V and A6061-RAM2 – a specialised variant of aluminium 6061 developed by Elementum 3D to address the hot tearing issues common to alloys not suitable for AM [8].

As Ti-6Al-4V was REM's original and, at the time, primary metal AM material, this transition posed little challenge. Aluminium, however, was not a material REM frequently worked with in non-AM applications. The ISF Process typically excels on harder or more difficult-to-machine materials – hence REM's focus on gears and steels outside of AM.

"The results were surprising. Grit blasting led to a slight increase in yield strength and UTS, but no statistically significant improvement in elongation compared to as-built specimens. By contrast, specimens processed using REM's Extreme ISF Process – first with CP, then CMP – showed significant increases in yield strength, UTS, and elongation relative to both the as-built and grit-blasted samples."

While REM had some ability to process traditionally fabricated aluminium, its low hardness means many other polishing methods exist, and aluminium accounted for only a small part of REM's pre-AM business. As such, REM would have been poorly positioned to support JPL's emerging need for A6061-RAM2 surface finishing – if not for a stroke of good timing (and Air Force SBIR funding).

In early 2020, following the successful completion of its first NASA Phase 1 SBIR, REM applied for an Air Force Open Call Phase 1 SBIR. Although some preliminary work had been done with PBF-LB/AlSi10Mg, concerns about its as-built density persisted, and REM believed the Air Force was seeking a higher-performance aluminium. Aware of Elementum 3D's emerging A6061-RAM2 material, REM proposed and won the SBIR to develop CP and CMP capabilities for it.

The work yielded promising results, including insights into the importance of heat treatment and build parameters for achieving optimal bulk density. More importantly for JPL, it provided REM with a relatively mature surface finishing capability for A6061-RAM2 (see Fig. 9).

Developing fixed processes for flight-ready components

To apply REM's surface finishing capabilities to flight components, both REM and JPL needed a method to ensure consistent process control and repeatability. Since REM's work introduced a subtractive manufacturing step, a material offset strategy also had to be defined.

REM proposed an 'SMR [surface material removal] vs Roughness/Texture' study. This is a standard approach REM uses to help customers understand the expected surface condition for different SMR depths at given build angles. If the SMR intervals are sufficiently small, the study can also reveal any concentrations of subsurface porosity at specific depths.

"The work yielded promising results, including insights into the importance of heat treatment and build parameters for achieving optimal bulk density. More importantly for JPL, it provided REM with a relatively mature surface finishing capability for A6061-RAM2."

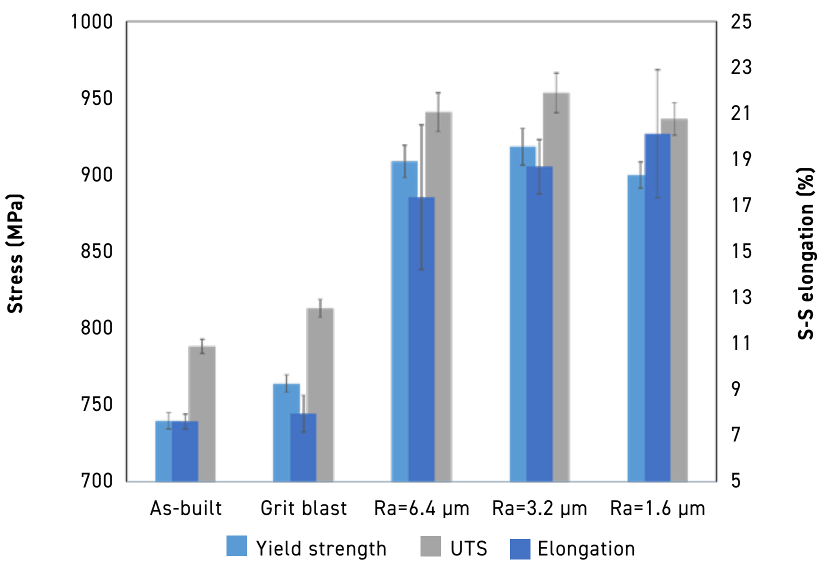

Fig. 8 Tensile testing results for PBF-EB/Ti-6Al-4V specimens with different surface finishes [7]

Fig. 9 PBF-LB/A6061-RAM2 specimens shown in as-built condition and after processing with REM's Extreme ISF Process (Courtesy REM Surface Engineering)

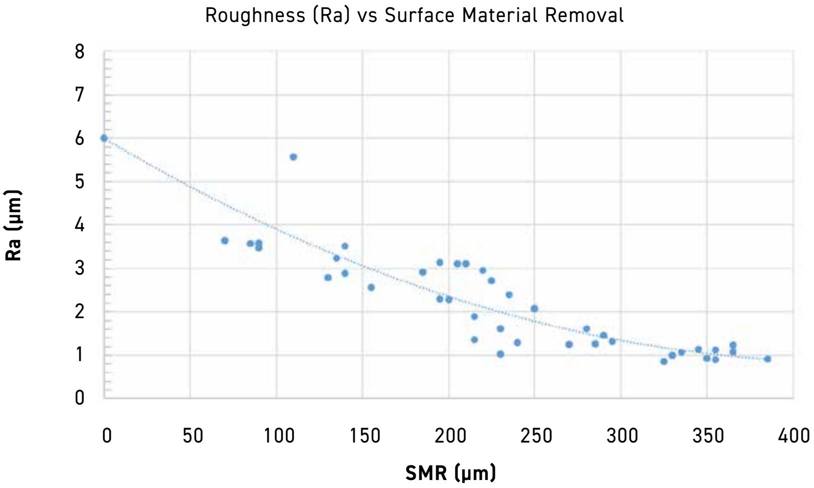

Fig. 10 Scatter plot with trendline showing roughness versus SMR data for JPL's A6061-RAM2 material offset study [7]

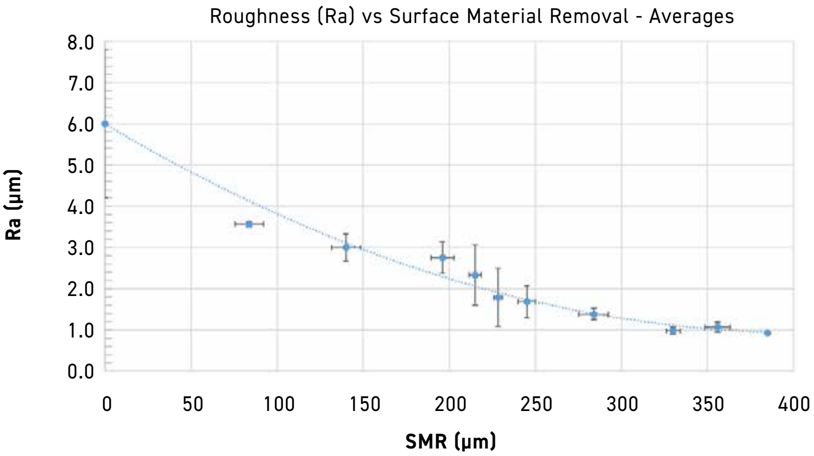

Fig. 11 Scatter plot with trendline showing average roughness and SMR data with standard deviations for JPL's A6061-RAM2 material offset study [7]

JPL provided simple test specimens for the study, and REM processed eleven SMR levels using its CP method, each in triplicate, while documenting the resulting surface roughness and texture. These tests confirmed a concentration of near-surface porosity between depths of approximately 200-250 µm (see Figs. 10 and 11, noting the cluster of data points and higher standard deviations).

Since porosity itself was not a critical concern for this application, JPL and REM agreed on a standard offset of 165 µm for A6061-RAM2, just above the porosity band. This depth was sufficient to eliminate granular roughness and reduce surface waviness. Lower roughness levels were possible but would have required offsets exceeding 300 µm.

With the material offset strategy defined, first for A6061-RAM2 and later for Ti-6Al-4V, REM began drafting Fixed Process documentation for both alloys.

Expanding CP to aluminium and high-performance alloys

Drawing on its experience with aerospace gears, gas turbine engines, and life-critical medical devices, REM created a structure tailored to the requirements of metal AM.

The goal of a Fixed Process is to define a repeatable and verifiable method, with the customer taking ownership of revision control. This ensures all parts supplied by REM are processed consistently and correctly, as documented in a Certificate of Conformance (C of C). For a Fixed Process to be effective, it must define:

- All parameters critical to part quality
- Acceptable process ranges
- Processing details – from high-level equipment specifications to detailed instructions for work-holding and inspection points

In traditional manufacturing, REM's Fixed Processes are often

> *"In traditional manufacturing, REM's Fixed Processes are often part-number or part-family specific. However, JPL rarely produces the same component more than once, making this approach impractical in terms of both time and cost. Instead, with JPL's agreement, REM developed alloy-specific Fixed Process documents."*

Step	Equipment	Product	Concentration (V/V %)	Temperature (Celsius)	Time (minutes)
Load	Lifting apparatus	N/A	N/A	N/A	N/A
Refinement	CP tank	Extreme ISF® XRP-10005	99+	<75[A] (optimal 50-70)	N/A
Rinse (1)[B]	Tank/Hose/Sink	DI water[C]	99+	N/A	>0.1
Neutralisation[B]	Neutralisation tank	Extreme ISF® XRB-10	1-10 (optimal 1-5)	N/A	>0.1
Rinse (2)[B]	Tank/Hose/Sink	DI water	99+	N/A	>0.1
Inspection[B]	N/A	N/A	N/A	N/A	N/A
Unload	N/A	N/A	N/A	N/A	N/A
Cleaning	Ultrasonic tank	Extreme ISF® XRB-10	1-20	15-50	>5
Rinse (3)	Tank/Hose/Sink	DI water	99+	N/A	>0.1

Table 1 Ti-6Al-4V process summary from JPL's Fixed Process document (Courtesy REM Surface Engineering)

part-number or part-family specific. However, JPL rarely produces the same component more than once, making this approach impractical in terms of both time and cost.

Instead, with JPL's agreement, REM developed alloy-specific Fixed Process documents. These define the most critical CP processing parameters for each alloy (see Table 1 for an excerpt from the Ti-6Al-4V Fixed Process summary table).

Given the wide range of part geometries JPL might send, these documents also include flexible application guidelines, offering multiple processing options and general advice on work holding. Specific details are confirmed with JPL on a job-by-job basis as required.

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Lattices and crush structures for Mars Sample Return

In parallel to the Fixed Process development efforts, REM was also working with JPL on several experimental AM programmes. In 2020, Dr Ryan Watkins of JPL initiated what would become a multi-year effort with REM to develop AM crush lattices.

Dr Watkins was exploring the use of AM to produce crushable structures with more complex, optimised lattice geometries – designs that legacy manufacturing methods could not readily support. While AM's geometric flexibility was key, challenges soon emerged, particularly around surface roughness and internal defects such as porosity.

Efforts within JPL to reduce roughness through build parameter modifications often led to an increase in internal defects. Additionally, despite the general geometric freedom of Powder Bed Fusion, Dr Watkins noted that AM ultimately struggles to achieve good length-scale separation at low relative densities due to limitations in minimum feature size. A different strategy was needed.

Drawing on REM's prior work with JPL's AM team, Dr Watkins reached out to trial REM's CP process. The aim was to reduce surface roughness and remove near-surface flaws, such as porosity, that would otherwise lead to degraded or highly variable mechanical performance.

The initial trials were encouraging. Dr Watkins soon identified an expanded opportunity: to use CP not only for surface finishing, but to thin

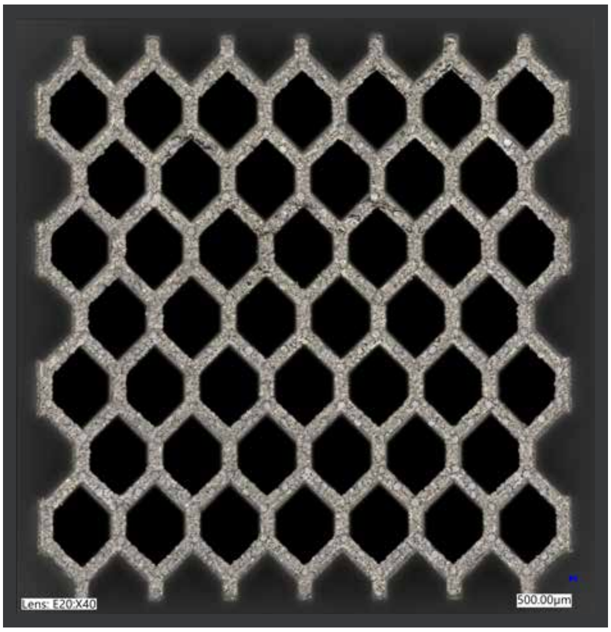

Fig. 12 As-built PBF-LB/A6061-RAM2 honeycomb lattice [9]

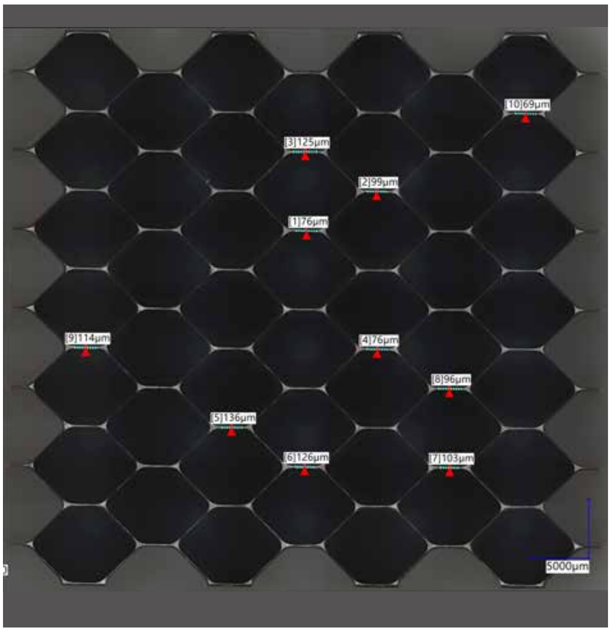

Fig. 13 A6061-RAM2 honeycomb lattice after REM processing for extreme wall thickness reduction [9]

Fig. 14 As-built PBF-LB/A6061-RAM2 reflector [10]

the lattice ligament diameters themselves. This would reduce component mass and relative density while also tuning the crush response, effectively using CP to overcome the inherent limitations of AM, including high surface roughness, poor near-surface quality, and limited resolution for fine features.

REM carried out multiple processing trials and coordinated part design modifications. The team ultimately succeeded in producing a honeycomb lattice additively manufactured in A6061-RAM2. The original ligament diameter was approximately 1.05 mm (see Fig. 12), which was reduced to below 0.15 mm (see Fig. 13) in the final ligament. These initial components achieved all performance targets set by Dr Watkins: reducing surface roughness by more than 50%, lowering relative density by over 75%, and improving crush strength and energy absorption efficiency by around 15% compared to traditionally manufactured honeycombs [9].

Following this success, the programme was expanded. Dr Watkins initiated a broader effort, shifting away from simple honeycomb designs to more complex lattice geometries and other component types.

Submillimetre reflectors and prototype wheels for the MSR mission

Another application of the combined AM and CP approach was the development of submillimetre wavelength reflectors. As with the lattice structures, conventional manufacturing methods for these components impose significant limitations, particularly in terms of geometry and weight.

To overcome these challenges, JPL was investigating methods for printing smaller, cm-scale reflectors, and, more specifically, ways to generate lightweight backing structures (see Fig. 14). Based in part on the success of the earlier honeycomb lattice programme, REM's CP process was trialled to remove as-built granular roughness and reduce component mass – and by extension, areal density, a key metric in space applications that expresses mass per unit surface area.

At the time, the state-of-the-art for reflectors under 20 cm in diameter was an areal density of approximately 14 kg/m². Using the AM + CP approach, JPL demonstrated a reflector with an areal density of around 13.4 kg/m², surpassing the existing benchmark. Notably, this result was achieved using only the standard 165 µm surface material removal (SMR) depth, suggesting that further reductions may be possible with more aggressive processing.

The reflector also featured a triply periodic minimal surface (TPMS) structure in its backing. This not only contributed to weight reduction, but also provided a useful test of material removal uniformity across a distinctly different geometry, further reinforcing JPL and REM's confidence in the process (see Fig. 15) [10].

Fig. 15 PBF-LB/A6061-RAM2 reflector after Chemical Polishing [10]

Lightweighting prototype wheels for the Mars Fetch helicopter

Another application that sought to apply Chemical Polishing to lightweight components was the development of prototype wheels for the Mars Sample Return (MSR) Fetch Helicopter. As part of the MSR mission, a vehicle is required to retrieve sample tubes from the Martian surface. One proposed concept is a small helicopter equipped with wheels to assist in sample collection (see Fig. 16). However, strict mission constraints dictated that each wheel must weigh no more than 20 g and measure less than 120 mm in diameter.

To meet these constraints, JPL trialled several fabrication strategies for the prototype wheels, including Additive Manufacturing using A6061-RAM2 and hybrid micro-waterjet cutting. Although the wheel

Fig. 16 Concept design for the Mars Sample Return (MSR) Fetch Helicopter [11]

"The reflector also featured a triply periodic minimal surface (TPMS) structure in its backing. This not only contributed to weight reduction, but also provided a useful test of material removal uniformity across a distinctly different geometry, further reinforcing JPL and REM's confidence in the process."

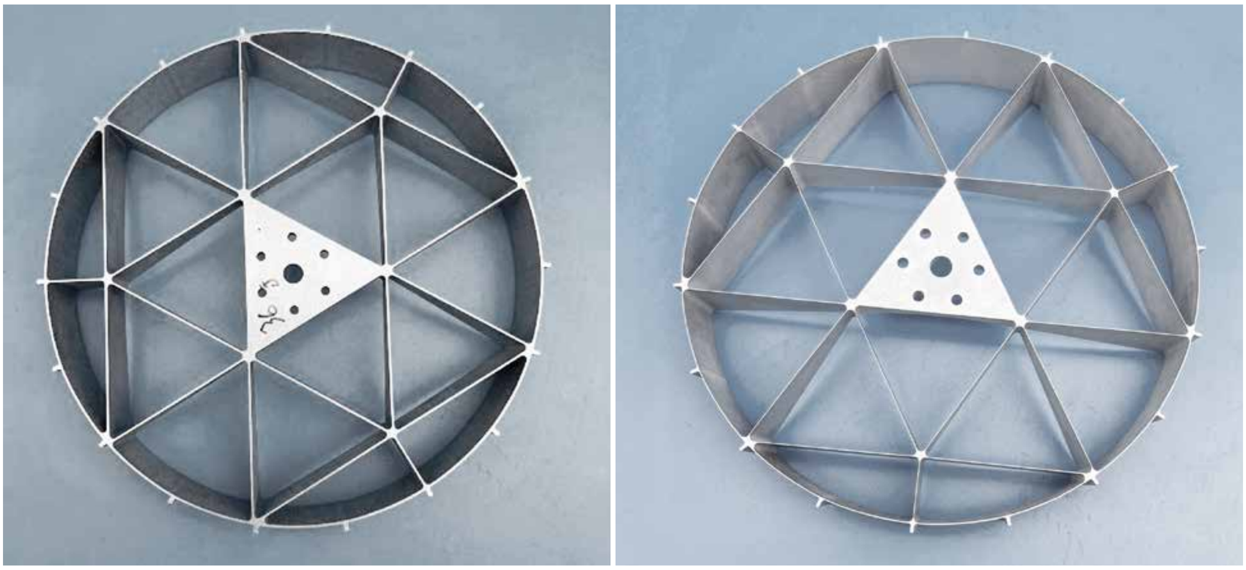

Fig. 17 Prototype MSR Fetch Helicopter wheels, shown as-built (left) and after Chemical Polishing (right) [11]

geometries were not as complex as other components, such as reflectors or lattices, they were still subject to demanding material and performance requirements. JPL evaluated multiple design variations, some of which could only be realised through AM.

Multiple AM wheel prototypes were provided to REM, where various wall diameter and mass targets were set (see Fig. 17). Using the AM + CP approach, wall thicknesses in the range of 200-250 µm were achieved, and wheel masses below the 20 g requirement were successfully delivered – representing, in some cases, a roughly 50% mass reduction, comparable to that seen in the honeycomb lattice programme. These technology developments were also fed directly into NASA's Cooperative Autonomous Distributed Robotic Exploration (CADRE) mission development effort [11].

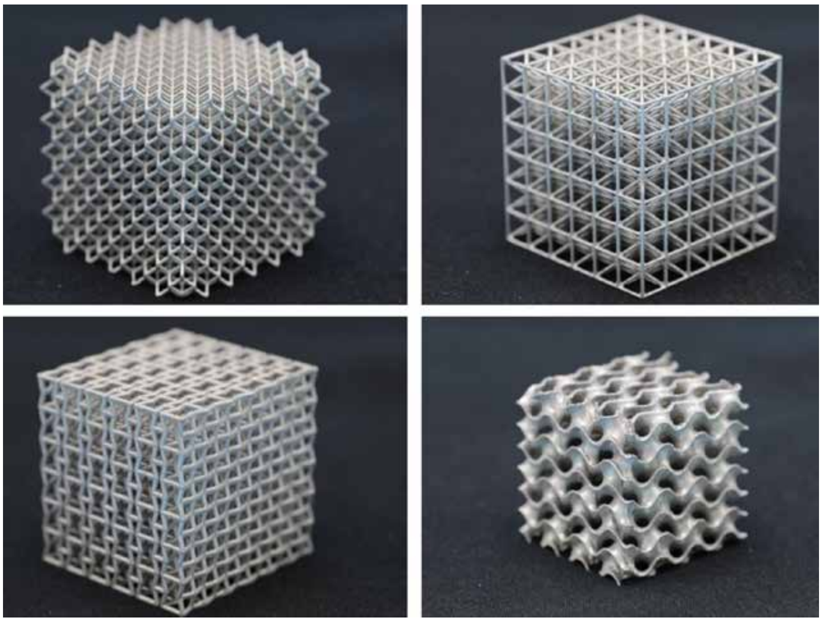

Fig. 18 Lattice design examples [9]

Work on the lattice programme continued, and REM learned that these AM lattices were under consideration for use in the MSR mission. Contrary to prior assumptions, the Mars Samples – if and when returned to Earth – would not land via an arrested descent, such as a parachute. Instead, these high-value specimens would have to survive a terminal-velocity crash landing.

It's worth noting that the work undertaken by Dr Ryan Watkins and the JPL team to enable this was significant. Beyond developing the lattices themselves, a web-based lattice design tool – Unitcell – was created to support the design effort. This tool, which has since been made publicly available, played a critical role in the project's success by enabling the evaluation of multiple lattice architectures and unit cell sizes (see Fig. 18).

Due to mission-specific requirements – including high temperature exposure – the lattice material was changed from A6061-RAM2 to Ti-6Al-4V. This shift introduced new challenges. Given the higher strength of Ti-6Al-4V, achieving the desired crush behaviour on impact required lattices with extremely low relative densities. As Dr Watkins explained at the 2025 Additive Manufacturing Users Group (AMUG)

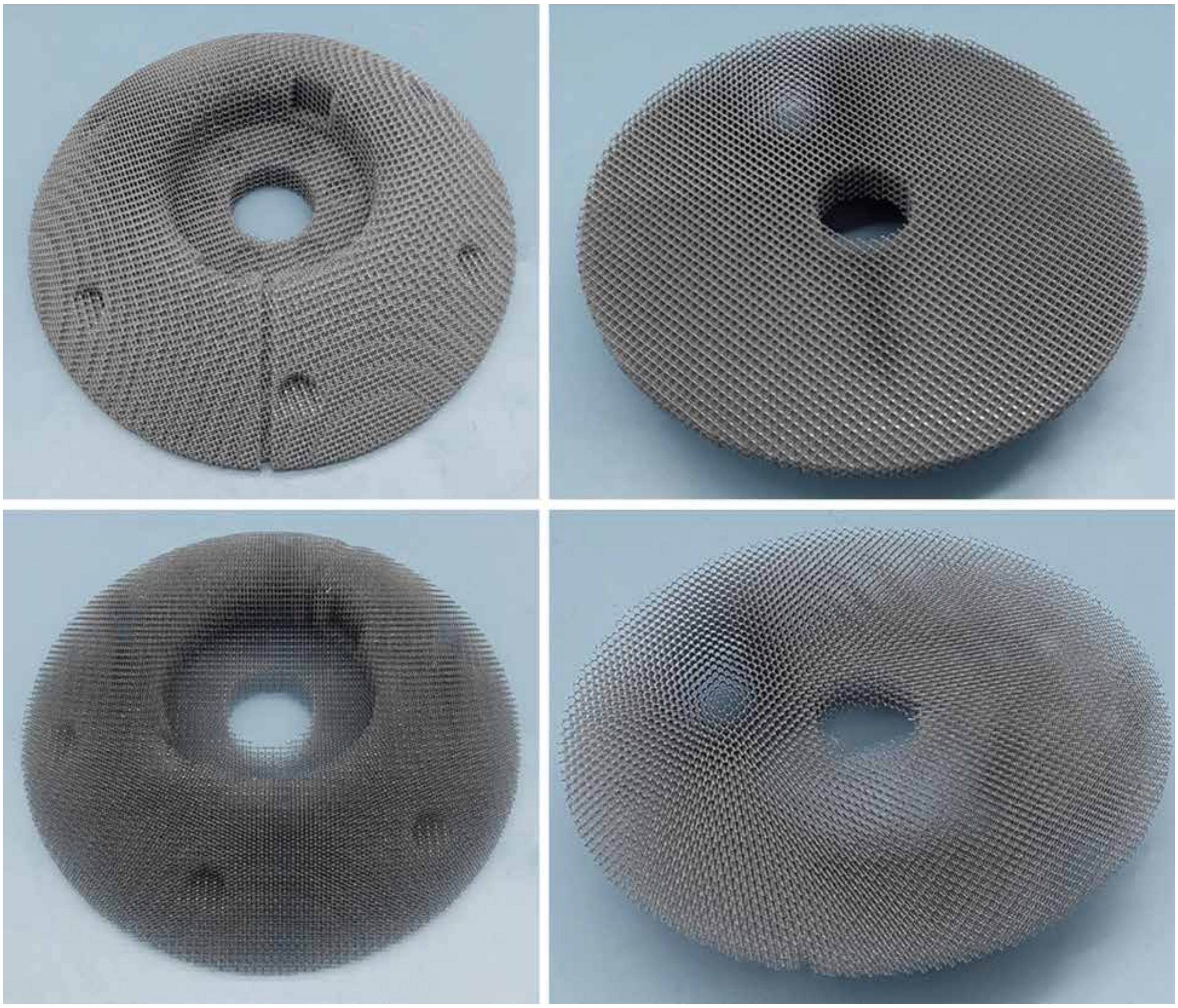

Fig. 19 Large MSR crush lattice component: as-built top view (top left); as-built bottom view (top right); processed top view (bottom left); processed bottom view (bottom right) (Courtesy REM Surface Engineering)

Conference in Chicago, the lattice structures are designed to crush at a lower impact force than the sample containers themselves, ensuring the containers remain intact, provided an adequate crush stroke (the distance over which the lattice structure can deform or compress) is available.

Building on earlier work with PBF-LB/A6061-RAM2, REM and JPL began adapting the AM + CP process to the new Ti-6Al-4V lattice components. Due to the mission-critical nature of the application, extremely tight mass tolerances were required, typically ±1 g. While this was achievable for smaller components, larger lattices demanded mass reductions of over 80%, meaning the ±1 g tolerance represented less than 0.5% of starting mass. Achieving this level of precision required further refinement of REM's process understanding and control systems.

Many chemical-based material removal processes are exothermic in nature. This is generally true for REM's CP process as well, though the amount of heat generated varies depending on both the material and the surface area of the component(s). Ti-6Al-4V tends to generate a fair amount of heat during processing. However, for 'typical' AM geometries, REM can maintain the optimal processing temperature using a combination of active chilling and the natural heat sink effect of the CP solution's working volume.

Lattice structures present additional challenges. Due to their high surface area, they generate significantly more heat during CP processing than non-lattice components occupying an equivalent 'build box.' As with many chemical reactions, the reaction rate – and by extension, the material removal rate – increases with temperature. In many ways, these Ti-6Al-4V crush lattices represented a 'perfect storm' of processing challenges.

Fortunately, JPL approached these challenges collaboratively. Over several months, progressing from small specimens to full-scale MSR components, REM and JPL refined the CP process to achieve repeatable

Fig. 20 Large MSR crush lattice component displayed at AMUG 2025 [14]

> *"This collaboration is an example of how partnerships between research institutions and industry can support the development of solutions where commercial offerings are not readily available. In this case, JPL's requirements led to the exploration of new processing capabilities that might not otherwise have been pursued."*

results (Fig. 19). Full-scale lattice components reached final relative densities in the 1-3% range, down from as-built densities of 20-30%. This required the implementation of multiple process optimisations to tightly control material removal rates and ensure precise outcomes in ligament diameter, relative density, and component mass.

The success of the AM + CP – additive plus subtractive – manufacturing approach for the MSR crush lattices reflects JPL's practical response to the limitations of current technologies. Where conventional options were insufficient, PBF-LB was used to produce components tailored to mission-specific requirements. However, limitations were discovered with the capabilities of PBF-LB, particularly in terms of resolution and material properties, such as surface roughness and near-surface density.

CP was identified as a potential means of addressing such challenges, and JPL collaborated with REM to adapt and scale the process for use with the crush lattice structures.

This collaboration is an example of how partnerships between research institutions and industry can support the development of solutions where commercial offerings are not readily available. In this case, JPL's requirements led to the exploration of new processing capabilities that might not otherwise have been pursued.

The much-deserved accolades that the MSR crush lattices have received through recent awards [12, 13], are a testament to the AM industry's recognition of both the significance of this achievement and the value of further collaborations and projects of this kind. A direct benefit of this collaboration for REM has been the ability to apply the more advanced process controls and deeper process understanding developed during the lattice programme to AM heat exchanger applications, particularly large-scale components incorporating TPMS geometries and multiple domains.

Without the experience gained from the latticework with JPL, it is unlikely that these heat exchanger surface finishing and cleaning projects would have been as successful. Hopefully, public policy will continue to support the kind of research being undertaken by organisations such as NASA JPL – work that contributes not only to the AM industry but to the advancement of manufacturing as a whole.

Conclusion

Additive Manufacturing holds significant potential, but those working within the industry are well aware that it also comes with its own set of challenges. This is not unique to AM; all manufacturing technologies have inherent strengths and limitations. As with traditional subtractive processes such as machining, additional steps are often necessary to realise a component's full performance potential.

If aerospace gears can achieve a 3-5× increase in contact fatigue life through post-machining surface finishing, there is every reason to explore how post-processing technologies might similarly enhance AM components [15].

Acknowledgements

The authors would like to thank Andre Pate (formerly of JPL, now of General Atomics), Samad Firdosy, Dr. Ryan Watkins, Adrian Cheng, Dr. Doug Hofmann and the rest of the JPL team for their support and collaboration.

Authors

Justin Michaud and Agustin Diaz
REM Surface Engineering
325 West Queen Street
Southington, CT 06489
USA

JMichaud@remchem.com
ADiaz@remchem.com
www.remchem.com

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The future of large metal parts: WAAMathon #2 showcases developments in Wire Arc Directed Energy Deposition

Wire Arc Directed Energy Deposition (DED-ARC/W), also known as Wire Arc Additive Manufacturing (WAAM), is gaining traction as a high-deposition-rate solution for large-scale metal parts. At WAAMathon #2 in Berlin, leading experts from industry and research explored the technology's rapid progress – from machine design and process automation to real-world applications. As Dr Joerg Lantzsch reports, the event highlighted DED-ARC/W's growing relevance across a wide range of sectors, with use cases spanning from turbine blades to underwater habitats.

WAAMathon #2, organised by Berlin. Industrial.Group. and held in Berlin, Germany, on 21 May 2025, brought together around 130 industry professionals to explore the latest developments in Wire Arc Directed Energy Deposition (DED-ARC/W). Over sixteen hours of content, twenty-eight speakers presented across two parallel stages, covering a wide spectrum of applications, supplier-led innovations, and academic research.

Opening the conference, Carl Fruth, CEO and founder of FIT AG, set the tone with a clear message: "When it comes to Additive Manufacturing, the motto should be 'faster, better, cheaper.'" He highlighted digitalisation, automation, and artificial intelligence as the key technologies driving AM forward – already enabling the competitive production of mechanical components in volumes below 1,000.

Founded by Fruth in 1995, FIT AG now employs more than 210 people and operates over fifteen different Additive Manufacturing technologies. Drawing on this breadth of experience, Fruth provided strategic guidance for companies considering machine investments. Among his key recommendations was the importance of risk diversification: maintaining a broad technology portfolio, he argued, can create long-term competitive advantages.

He also emphasised that early investment in emerging technologies can serve as a powerful branding tool. Success at this stage, he suggested, can be supported by innovation partnerships with leading research institutions and by tapping into available funding opportunities.

Fig. 1 Carl Fruth, CEO and founder of FIT AG, delivered the opening keynote at WAAMathon #2, held in Berlin on 21 May 2025 (Courtesy Studio vom Berg)

Fig. 2 Thomas van Glabeke, Chief Product Officer at MX3D, presented the company's turnkey solution (Courtesy Studio vom Berg)

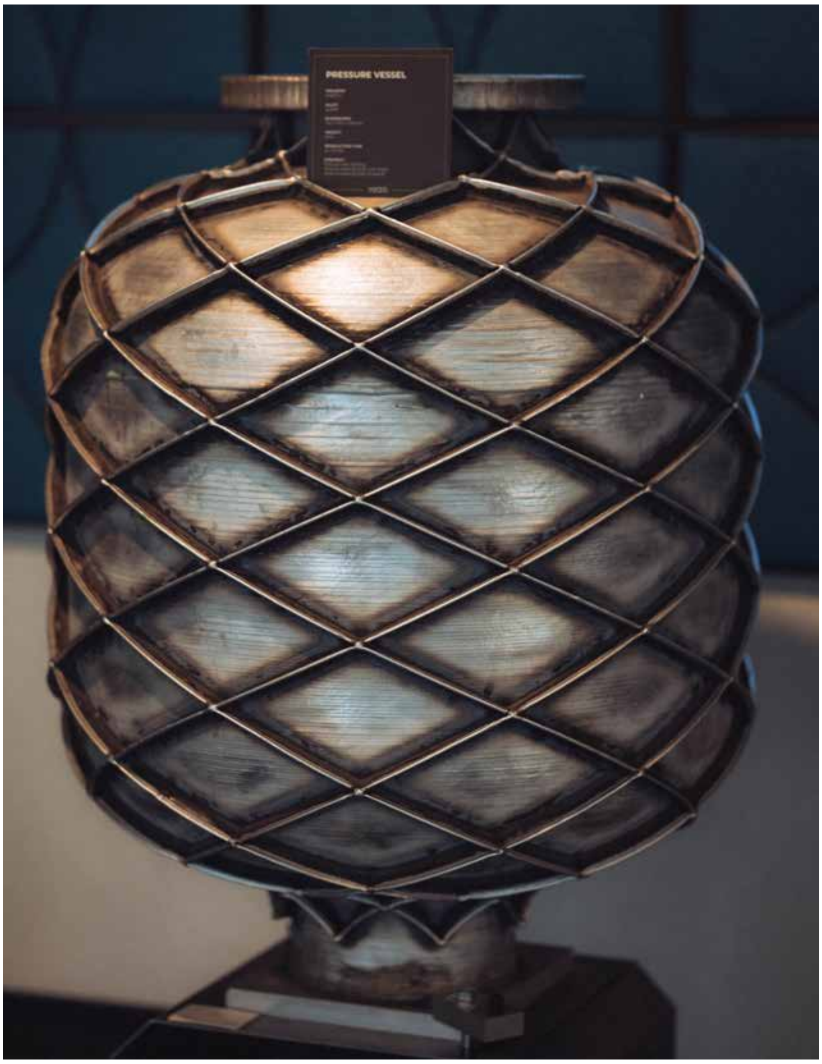

Fig. 3 Additively manufactured pressure vessel produced by MX3D on display at WAAMathon #2, produced using DED-ARC/W (Courtesy Studio vom Berg)

Despite these insights, Fruth stressed that all strategic decisions must still carefully balance risks and benefits.

Alternative manufacturing solutions: multi-axis systems or articulated arm robots

One of the conference's central topics was machine design. While system configurations vary, all DED-ARC/W system suppliers operate on a common foundation: arc welding and wire feedstock are used to construct parts, layer by layer.

Compared to other AM processes that use powder feedstock, this manufacturing technology offers several advantages: there is no need for complex powder handling, and most standard materials are available in wire form. However, the most significant advantage lies in the very high deposition rate. This makes it possible to additively manufacture large and heavy components at high speed. Since many standard alloys are available as welding wire at a relatively low cost, the process can also be significantly more cost-efficient than powder-based Additive Manufacturing. The DED-ARC/W process typically produces a near-net-shape blank, which can then be finished through surface machining or other hot and cold working processes, depending on application requirements.

In terms of machine design, there are two distinct approaches: software-controlled robotic arms, and conventional three- or five-axis machine setups. Articulated robotic arms use software-controlled welding heads to deposit weld beads along a planned path. Companies like MX3D showcased machines based on this approach.

In his presentation, MX3D's Thomas van Glabeke showed the company's turnkey solutions. He focused on his company's software and automation solution Metal XL, a dedicated DED-ARC/W-specific CAM software with a material library, opti-

Fig. 4 Sebastian Recke, Senior Key Account Manager at GEFERTEC, highlighted the benefits of DED-ARC/W, including significant reductions in material waste compared to conventional machining (Courtesy Studio vom Berg)

mised toolpath planning, real-time process monitoring, and visualisation.

The second approach, conventional three- or five-axis machine setups, is similar to those used in many Computer Numerical Control (CNC) machine tools. GEFERTEC, a German machine builder focused on DED-ARC/W technology, offers mature models in its arc series, which run on Siemens' Sinumerik control platform. The largest model in the series can produce components weighing up to eight tonnes in a build volume of 2 x 2 x 2 m.

A hybrid approach to the DED-ARC/W process was presented by Siemens in cooperation with VLM Robotics. These hybrid machines combine AM and subtractive finishing in a single cell. The foundation is CNC robotics, offering high precision for both additive and milling processes. Autonomous mobile robots are also deployed, enabling the machining of very large components. All manufacturing steps are again based on the Sinumerik platform.

"As Sebastian Recke, Senior Key Account Manager at GEFERTEC, explained at the conference, conventional machining processes can result in up to 80% material waste, whereas Additive Manufacturing with surface finishing cuts this to about 8%."

All approaches offer shared advantages over conventional subtractive manufacturing methods. For example, depending on the component, material efficiency can be significantly higher than with chip-removal processes. This is particularly important when working with costly materials such as titanium.

As Sebastian Recke, Senior Key Account Manager at GEFERTEC, explained at the conference, conventional machining processes can result in up to 80% material waste, whereas Additive Manufacturing with surface finishing cuts this to about 8%.

Fig. 5 Raven T Reisch, Siemens AG, reviewed the use of Digital Twins in the DED-ARC/W process (Courtesy Studio vom Berg)

Fig. 6 Robert Lau, Fraunhofer IAPT, presented research on surface structure in DED-ARC/W, focusing on how process parameters influence surface quality and post-processing requirements (Courtesy Studio vom Berg)

"Lau placed special emphasis on the potential energy savings – both from the use of DED-ARC/W versus subtractive manufacturing in general, as well as the reduced need for post-processing due to enhanced surface characteristics."

Process technology, components, and machine design

Regardless of machine approach, the most significant advancements in DED-ARC/W currently lie in process control and automation technology. Several presentations at the event focused on further developing the process to enable stable operations.

Within this context, Dr Amin S Azar of 3D-Components AS demonstrated how AI-powered process control tools can enhance stability and performance. With so many factors affecting the process – from machine architecture to materials and operator qualification – AI offers an effective way to stabilise and optimise control. The goal is to define the appropriate process parameters automatically and quickly.

Raven T Reisch of Siemens AG reviewed the use of Digital Twins in the DED-ARC/W process. The Digital Twin approach offers advantages along the entire chain, from design and process planning to actual manufacturing and quality assurance. The Digital Twin serves as a virtual counterpart to the physical manufacturing process, featuring a bidirectional data connection. This approach is especially valuable for in-process quality monitoring. The objective is to detect process anomalies and part defects during the process itself, enabling data-driven quality assurance.

A presentation by Robert Lau from Fraunhofer IAPT explored the topic of surface structure. The study investigated how various process parameters affect the surface of additively manufactured parts. Improved surface quality can reduce the subsequent milling effort and save material. Lau placed special emphasis on the potential energy savings – both from the use of DED-ARC/W versus subtractive manufacturing in general, as well as the reduced need for post-processing due to enhanced surface characteristics.

One company that has taken on a particular challenge is Compound Extrusion Products GmbH (CEP), which focuses on addressing the wear of contact tips through which the welding wire runs during the build process. These need periodic replacement depending on wear, interrupting production and requiring manual intervention. This not only involves time and cost, but can also impact the quality of the additively manufactured part.

CEP has developed contact tips composed of different materials on the inside and outside. According to the company's Eric Irmer, this modified material composition, along with an optimised geometry, now enables tip lifetimes of up to eighty-two hours. This significantly reduces maintenance and contributes to quality improvement. It also makes automated series production of components feasible in many applications.

One critical component in the DED-ARC/W process is the welding wire – the material from which the part is made. Dr Martin Schmitz-Niederau, from voestalpine Boehler Welding Germany, presented key insights into multi-material components. He discussed the production of holding rings for hydraulic power plants, manufactured using a DED-ARC/W robotic system, and emphasised the importance of an Environmental Product Declaration (EPD).

Diverse applications, proven impact

The application examples presented at WAAMathon #2 were impressively diverse. One of the most well-established use cases is the rapid production of urgently needed spare parts. Uwe Jurdeczka, Group Lead Innovative Technologies for Production at Alstom Transport, illustrated this using the example of a yaw damper for a commuter train – a replacement part for rail vehicles produced by the company.

Given the decades-long service life of rail vehicles, the availability of spare parts must be guaranteed over comparable periods. Meeting this commitment cannot rely solely

Fig. 7 Eric Irmer, Compound Extrusion Products GmbH (CEP), discussed extended contact tip lifetime in DED-ARC/W, a key enabler for automated, uninterrupted production (Courtesy Studio vom Berg)

Fig. 8 Dr Martin Schmitz-Niederau, Voestalpine, shared insights into multi-material components for hydraulic power plants and the role of Environmental Product Declarations (EPDs) (Courtesy Studio vom Berg)

Fig. 9 René Liers, Siemens Energy, explained that long delivery times and high costs were a factor behind the company's adoption of DED-ARC/W. To date, over 2,700 turbine blades have been produced using the technology (Courtesy Studio vom Berg)

Fig. 10 Dr Afif Batal, Deep Manufacturing, presented an ambitious project: underwater habitats made from very large DED-ARC/W structures (Courtesy Studio vom Berg)

on warehousing, especially given the longevity of rolling stock and the wide range of parts involved. Alstom has already used the DED-ARC/W process in several instances to ensure spare part availability. Notably, even chassis components subject to dynamic loads can be produced using this process. The AM parts passed all static and dynamic strength and fatigue tests.

Additive Manufacturing applications for serial production, such as turbine blades in steam turbines, have also been successfully implemented. René Liers, Project Lead WAAM at Siemens Energy in Goerlitz, presented the initial conditions under which his company chose the technology and the path toward series production.

Custom-designed turbines pose particular challenges for production planning. The two main hurdles are typically lead times and costs. The blank material used for turbine blade machining often originates from China. Due to global supply chain issues, lead times can stretch to several months. Moreover, material wastage from machining can reach 70%. These are compelling reasons to consider production via DED-ARC/W. In a dedicated project, Siemens Energy examined feasibility, tested the quality of the manufactured blades, and ultimately implemented series production in 2022. The arc403 machine from GEFERTEC was used. Further, thanks to CEP's above-mentioned contact tips with up to 82 hour durability, serial production now takes place around the clock and, to date, more than 2,700 turbine blades have been produced.

Another application presented at WAAMathon #2 was for industrial compressors, introduced by Elvir Murati, Head of Engineering-Aftermarket at Howden, a Chart Industries Company. The impellers used by Howden Turbo in industrial compressors are milled from forged disks for smaller models up to 900 mm in diameter. Larger impellers are made by welding blades onto a forged hub. For Howden Turbo, the DED-ARC/W process is suitable for

Fig. 11 Howden presented an impeller additively manufactured by GEFERTEC, This component has already gone from prototype to real application (Courtesy Studio vom Berg)

repairing damaged or worn impellers. The first pilot project involved an impeller with a 900 mm diameter, with approximately 25% blade wear. The existing blades were removed by machining, and new ones were produced via DED-ARC/W before being milled to final dimensions. The finished impeller then underwent quality inspection. The total time for replacing the impeller was reduced from around eight months to less than four weeks, and CNC machining time dropped from 150 hours to under forty hours.

Fig. 12 Elvir Murati highlighted that Howden utilises DED-ARC/W as a solution for repairing damaged or worn impellers (Courtesy Studio vom Berg)

A unique application was presented by Dr Afif Batal, Manufacturing Engineer at Deep Manufacturing, involving the production of underwater habitats. The British company plans to offer two types of additively manufactured underwater habitats by the end of 2027: Vanguard, which will accommodate three people for up to seven days at depths of 100 m, and Sentinel, designed for more than six occupants at depths up to 200 m. Scientists are expected to carry out research at these depths for over six months. The dimensions of the additively manufactured parts are enormous, with diameters reaching up to 6 m and heights of 3.2 m. At Deep, DED-ARC/W manufacturing is carried out using a system called Hexbot, in which six articulated-arm robots simultaneously produce large structures.

In his presentation, D Mark Douglass from Lincoln Electric showed applications from the energy

Fig. 13 Prof Dr Jonas Hensel presented on qualification in DED-ARC/W (Courtesy Studio vom Berg)

Fig. 14 Dr Mark Taylor of the University of Manchester explored martensitic transformation in steels produced by DED-ARC/W (Courtesy Studio vom Berg)

Fig. 15 William Priest of Kingsbury highlighted the complexity of DED-ARC/W production, despite the promise of 'Just Press Print' (Courtesy Studio vom Berg)

sector. The company produces a wide variety of components on twenty-two DED-ARC/W machines. These time-critical applications highlighted the speed advantage of AM, with one example being of critical spare parts made of Inconel for a refinery that were delivered within thirty days.

Research projects drive technological progress

Although arc welding has been used for decades, its application in Additive Manufacturing still requires substantial research. At the Institute of Joining and Assembly Technology at Chemnitz University of Technology, a group led by Prof Dr Jonas Hensel is conducting research on DED-ARC/W.

In his presentation, Hensel focused on the mechanical properties of components, with particular emphasis on part strength as a function of various process parameters. He also examined the impact of surface finishing, specifically whether parts were post-processed by machining or not. According to Hensel, the qualification of the process is crucial; unlike conventional welding, there is still a notable lack of standards and norms.

Dr Mark Taylor, from the University of Manchester, delved into the metallurgy of steels in DED-ARC/W. Specifically, he addressed the martensitic transformation that can occur during production. Ideally, the resulting grain sizes should match those in forged components. Among other findings, his results highlighted the influence of inter-layer temperature during the build process. The objective of the study is to establish recommendations for optimal process parameters.

Other presentations from academic and institutional research projects covered topics such as metallurgy, X-ray analysis, novel filler wires, and the challenges of using various aluminium alloys. The necessity of this breadth of research to move the industry forward was underscored by William Priest of

Fig. 16 Matthias Schmidt-Lehr, Managing Director of AMPOWER, presented on the state of the Additive Manufacturing industry, forecasting strong growth across polymer and metal technologies through 2029 (Courtesy Studio vom Berg)

the UK-based Kingsbury Additure, which focuses exclusively on Additive Manufacturing technologies. Although the title of Priest's presentation was 'Just Press Print,' he demonstrated that things aren't quite so simple.

Kingsbury (Additure) operates an application centre dedicated to contract manufacturing and feasibility studies. William Priest emphasised the importance of deep expertise in producing DED-ARC/W parts. In recent years, Additure has built significant experience in optimising process parameters, path planning, CAD/CAM integration, and other critical steps in the workflow.

Positive outlook

What lies ahead for this small, highly specialised sector? Matthias Schmidt-Lehr, Managing Director of AMPOWER, addressed this in his presentation on the findings of the latest AMPOWER Report. According to Schmidt-Lehr, the total market for all polymer and metal AM technologies was valued at €10.7 billion last year. By 2029, the report forecasts market growth to nearly €20 billion. The strongest growth is expected in DED technologies, with annual growth rates in the double-digit percentage range.

WAAMathon #2 offered a comprehensive insight into the current state and development potential of Wire Arc DED. The conference showcased a broad spectrum of innovations from process and equipment to applied industrial use cases and active academic research. Discussions around standardisation, quality assurance, and the integration of digital tools emphasised the challenges that remain as the technology advances. Continued collaboration between industry and research will be key to expanding the role of DED-ARC/W in metal Additive Manufacturing.

Author

Dr Joerg Lantzsch
Technical journalist
Wiesbaden, Germany

Contact

Berlin.Industrial.Group.
Tel: +49 30 912074-10
www.berlin.industrial.group

WAAMathon #3

Berlin.Industrial.Group. has announced that WAAMathon #3 will return to Berlin on 11 June 2026.

www.eventbrite.com/e/waamathon-3-berlin-tickets-1374141136129

Wire Electron Beam Directed Energy Deposition (DED): Advancing productivity and sustainability in metal AM

Wire Electron Beam Directed Energy Deposition (DED-EB/W) is gaining attention as a highly efficient metal Additive Manufacturing process. Offering high deposition rates, minimal thermal distortion, and excellent energy efficiency, the process addresses two major industry challenges: productivity and resource use. As sustainability regulations tighten and demand grows for large-scale, cost-effective components, DED-EB/W presents a compelling alternative to powder-based AM systems. In this article, Bernd Baufeld and Alejandro Zamorano Reichold of Pro-beam Additive GmbH review the technology and examine its technical foundations and potential for industrial-scale adoption.

Additive Manufacturing offers clear advantages – from cost savings in small series production to reduced machining and waste when compared to subtractive manufacturing processes. Further, AM processes offer an unrivalled design freedom. Yet barriers remain; in many cases, productivity and resource efficiency can fall short of industry's requirements. Addressing these gaps is not only a commercial priority but a strategic and environmental imperative.

One AM technology showing significant potential in this respect is Wire Electron Beam Directed Energy Deposition, abbreviated DED-EB/W by ISO/ASTM 52900 [1], which defines general AM terminology. The process is also referred to by Pro-beam Additive GmbH as Wire Electron Beam Additive Manufacturing (WEBAM), a proprietary name used for their implementation of the technology. This article explores how the process can drive greater resource efficiency and productivity in metal AM.

This is of particular relevance given evolving EU legislation that is sharpening the industry's focus on sustainability. The EU's Ecodesign for Sustainable Products Regulation (ESPR) aims to improve product lifecycle performance, including material efficiency and circularity, while the Corporate Sustainability Due Diligence Directive (CSDDD) places greater responsibility on manufacturers to address environmental and social impacts across their supply chains. These measures underscore the urgency of advancing Additive Manufacturing technologies like DED-EB/W that promise higher material efficiency, reduced waste, and lower energy consumption.

Fig. 1 A demonstrator rocket engine component post-machining. This was produced from copper using the DED-EB/W process and is 485 mm tall and 305 mm in diameter (Courtesy Pro-beam Additive GmbH)

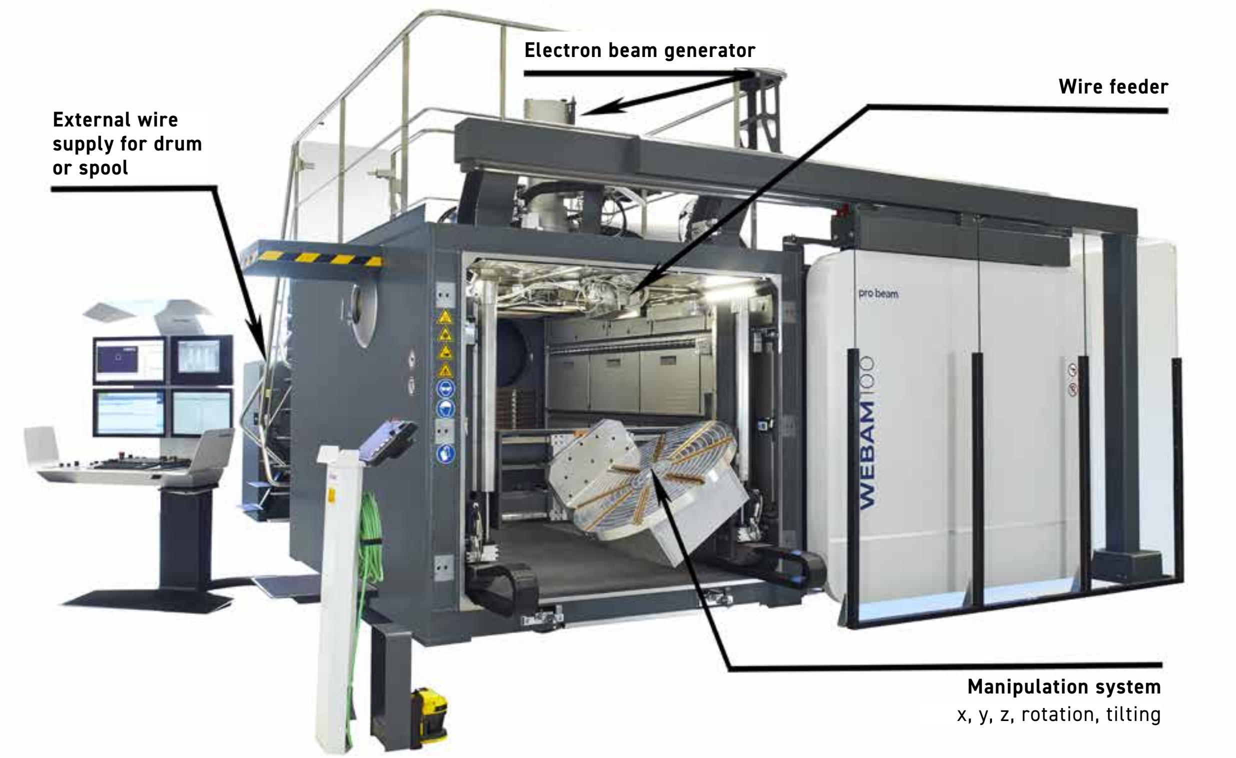

Fig. 2 The PB WEBAM 100 machine, equipped with a five-axis table manipulation machine, external mobile beam generator, internal wire feeder, and external wire supply for drum or spool (Courtesy Pro-beam Additive GmbH)

Process overview

For those less familiar, Wire Electron Beam DED is an evolution of electron beam welding, using a filler wire – a process that has long been proven in industrial applications [2]. Modern electron beam-based AM machines offer beam powers of up to 30 kW, with power densities exceeding 10^5 W/mm² at the beam focus [2]. Belonging to the broader family of DED processes [1, 3], it has been the focus of extensive industrial and academic research [4-11].

The process operates in a high vacuum at approximately 10^{-4} mbar [2], enabling the Additive Manufacturing of highly reactive metals without the need for additional shielding gas. For reactive metals such as titanium, local shielding gas is often insufficient for creating large AM parts, necessitating either a chamber filled with inert gas, or a vacuum chamber. Commercially available vacuum chambers for electron beam welding have a volume of 630 m³ [2], while chambers of similar size filled with protective gas can be expensive and difficult to operate.

During the DED-EB/W process, a wire is melted using an electron beam, resulting in a melt bead on a base. Part of the underlying material also becomes liquid during this process. By moving the process relative to a substrate, a three-dimensional structure can be built up layer by layer. This relative movement can be accomplished either by a robot or a gantry moving the electron beam generator with the attached wire feeder, or by a multi-axis table (x, y, z, possibly turn and tilt). A combination of both methods is also feasible. Fig. 2 shows an example of a DED-EB/W machine with a five-axis table manipulator. Multi-axis manipulation and computerised numerical control (CNC) enable the creation of complex three-dimensional components such as the rocket engine demonstrator shown in Fig. 1.

“For reactive metals such as titanium, local shielding gas is often insufficient for creating large AM parts, necessitating either a chamber filled with inert gas, or a vacuum chamber.”

Increased productivity through higher deposition rates

Electron beam technology provides an energy source with high power and high energy density. The machine shown in Fig. 2, for example, provides a maximum of 9 kW, which is generally sufficient for using a single wire feeder and exceeds the capability of many other DED technologies. Build envelopes of up to 1,400 x 1,300 x 1,100 mm are possible, enabling the production of large components.

With this level of power, it is possible to melt relatively thick wires (1.6 mm diameter) and create components at high feed rates. Table 1 summarises the maximum deposition rates achieved when building cylinders (Fig. 3). The limit in this case was the maximum wire feed rate available (12 m/min). Nevertheless, these values are very high compared to AM deposition rates commonly reported in the literature and give the opportunity to achieve improved productivity.

The mechanical properties of the high deposition rate Ni based alloy IN718 components meet application-relevant standards, showing parity with results from laser (DED-LB/W) [12] and arc (DED-ARC/W, also known as WAAM) processes [13], see Fig. 4.

No cracks or pores were reported in this IN718 DED-EB/W cylinder. The microstructure exhibits a fine dendritic structure with a nickel-based alloy face-centred cubic γ phase with presumably laves phase and carbides (Figs. 5a and b). The heat treatment changed the microstructure, possibly leading to γ'' (Ni_3Nb) precipitates in fine, coherent disc-shaped morphology within the γ matrix (Figs. 5c and d). These precipitates are responsible for the increase in strength by heat treatment.

Fig. 6 shows that the mechanical performance of a high deposition rate Ti6Al4V (DED-EB/W, component A) is similar to that of a lower deposition rate (component B). Both fulfil the requirements described in AMS4999 for DED Ti6Al4V components for the aerospace industry [14].

Material	Deposition rate [kg/h] max	Volume rate [cm³/h] max
Pure copper	13.0	
Inconel 718	11.9	1448
Ti64	6.4	

Table 1 The maximum deposition rate and volume rate achieved for different materials (Courtesy Pro-beam Additive GmbH)

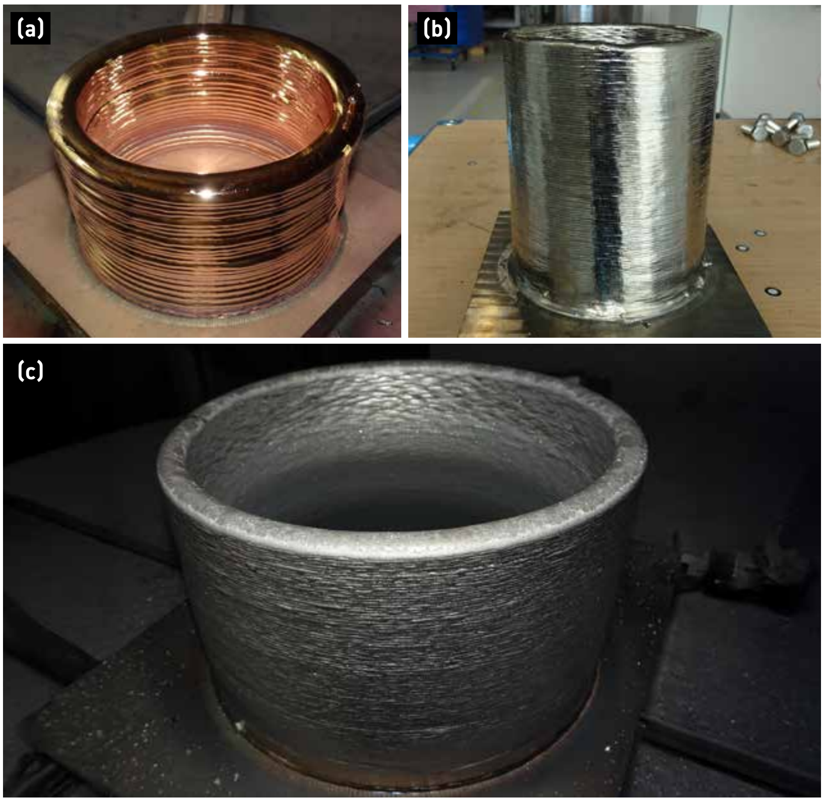

Fig. 3 DED-EB/W cylinder built at maximum deposition rates. a) pure copper (OD 121 mm), b) Ti64 (OD 116 mm) and c) IN718 (OD 220 mm) (Courtesy Pro-beam Additive GmbH)

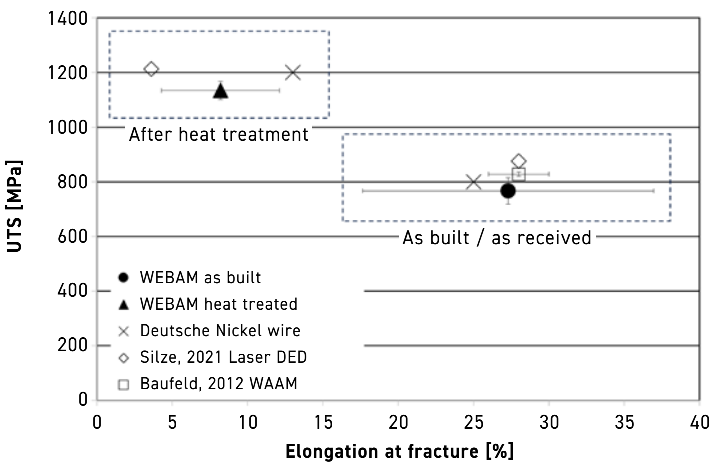

Fig. 4 Ultimate tensile strength versus elongation at fracture of IN718 DED-EB/W cylinder (11.9 kg/h), tested in vertical direction, in as-built and heat-treated condition, in comparison to data from literature for other wire DED processes [12, 13] (Courtesy Pro-beam Additive GmbH)

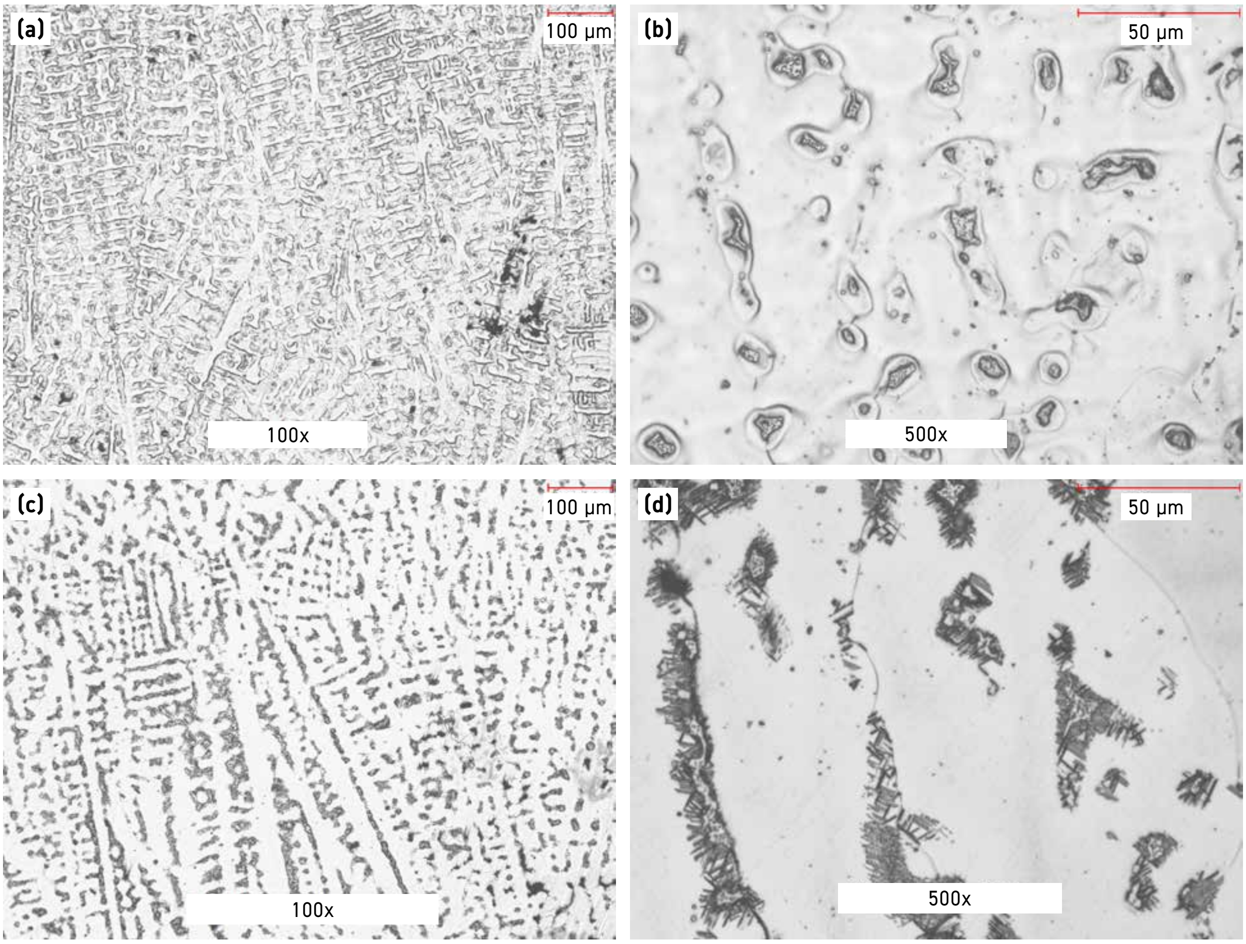

Fig. 5 Microstructure near the top of the cylinder in the as-built (a, b) and the heat-treated (c, d) state at low (a, c) and high (b, d) magnification (Courtesy Pro-beam Additive GmbH)

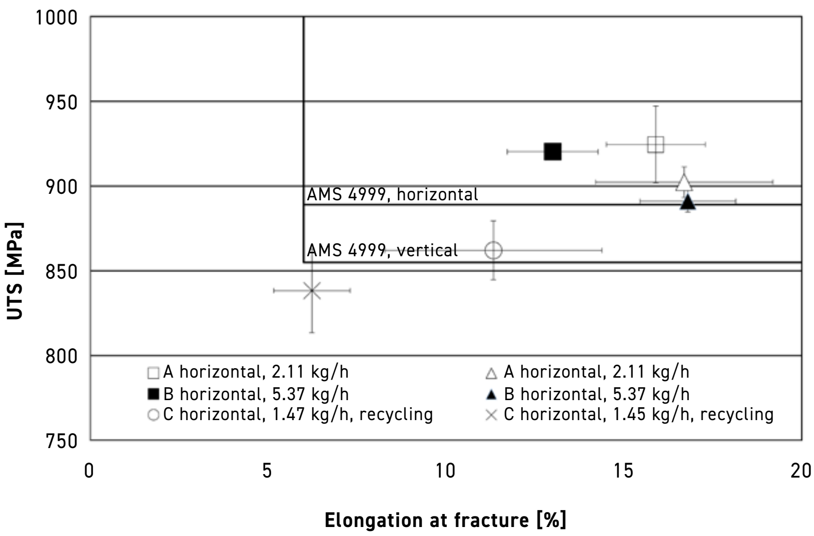

Fig. 6 Ultimate tensile strength versus elongation at fracture of Ti6Al4V DED-EB/W walls, tested in horizontal and vertical direction, at different deposition rates, using virgin (A, B) and recycled wire (C), in comparison to the minimum requirements described for DED Ti6Al4V components for the aerospace industry, AMS4999 [14] (Courtesy Pro-beam Additive GmbH)

Managing thermal distortion

One of the key challenges in Additive Manufacturing is the generation of thermally induced residual stresses, which can result in geometric distortion. To compensate, designers often oversize the build platform and component, anticipating warpage during production. A process that reduces residual stress and thermal distortion could significantly lower material consumption and post-processing requirements, particularly machining.

The most important distortion-determining parameters are the base plate thickness, the introduced beam power, wire feed rate and the production strategy (seam sequence), as well as the preheating temperature and the insulation of the base plate.

Fig. 7 DED-EB/W structural component (Ti6Al4V) for an application in the aerospace sector built on a 300 x 250 x 5 mm base plate, with a distortion of less than 2 mm. For comparison and highlighting the distortion, a 10 mm base plate is placed beneath (Courtesy Pro-beam Additive GmbH)

Taking these parameters into account, it is possible to minimise the thermal distortion. Fig. 7 shows a section of a structural component for an aerospace application. Despite the extremely thin base plate thickness of 5 mm, the resulting thermal distortion is less than 2 mm.

Another method to reduce thermal distortion is to utilise a flip frame where structures can be constructed on both sides of a base plate. Fig. 8a shows a component built on a base plate attached to a flip frame. The component was flipped in high vacuum after each layer. The flipping process took approximately 1 minute. This led to the sequential counteraction of thermal distortion by the following layer from the opposite side. By doing so, the sequential counteraction significantly reduced distortion, as shown in the side view (Fig. 8b).

Increased resource efficiency

Reducing thermal distortion enhances the DED-EB/W process's resource efficiency. Other process characteristics also contribute to improved resource efficiency. As previously mentioned, operating at high vacuum eliminates the need for shielding gas, conserving this resource. This not only benefits the environment but also reduces costs, particularly for large-scale components.

Another reason for DED-EB/W's improved resource efficiency is that, compared to blown powder laser DED, wire DED technology produces significantly less material waste. In the case of blown powder DED, a substantial portion of the powder either bounces off the part

Fig. 8 DED-EB/W structural component (Ti6Al4V) for an application in the aerospace sector built on a 500 x 400 x 10 mm base plate. a: Top view of the component fixed on a flip frame. b: side view demonstrating minimised thermal distortion (Courtesy Pro-beam Additive GmbH)

surface, is carried away by shielding or carrier gas, or lands outside the intended deposition area. Such waste does not occur in the case of wire-based DED.

However, the largest contributor to the overall cost and environmental impact of AM is often its energy consumption. The energy input from the electron beam into the work-piece, however, occurs with a high efficiency of 90-95% [15]. This technology is very efficient as the energy is absorbed directly in the workpiece by the transformation of the kinetic energy of the electrons into heat (no scattering by air or optical systems). Contrary to that, laser beam technology suffers energy losses due to reflection, scattering and optical losses. This leads to an efficiency in laser beam welding of ~30-50% [16]. Raute *et al.* [17] have compared DED-EB/W with blown powder laser DED and have shown a better performance of the electron beam process, which is primarily due to the significantly lower energy requirement of the machine, being only around a third of DED-LB. A direct comparison of the processes via the life cycle assessment shows that DED-LB generates approximately three times the emissions across all environmental indicators compared to DED-EB [17].

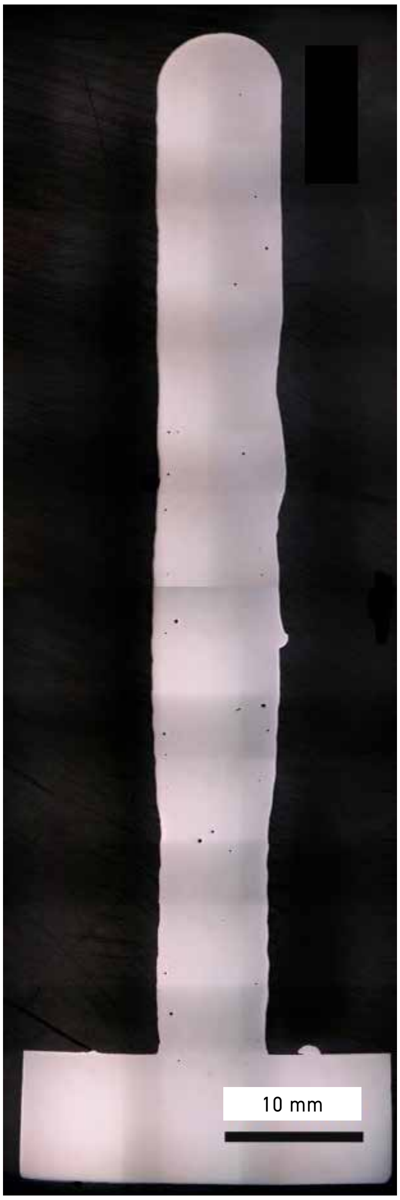

Fig. 9 Polished cross section of DED-EB/W wall, built using recycled wire (same component as C in Fig. 6) (Courtesy Pro-beam Additive GmbH)

In the case of materials with high light reflectivity, such as copper, DED-EB/W offers enhanced efficiency compared to DED-LB due to differences in energy transfer processes. In DED-EB/W, the kinetic energy of the electrons is converted into process heat, which is highly efficient [1]. Conversely, with a conventional infrared laser on pure copper, as much as 98% of the laser power is reflected and lost to the process [18]. Recent developments in lasers have reduced reflectivity to 45% for green lasers and 30% for blue lasers [19, 20].

Another way to enhance resource efficiency is to use wire produced from recycled materials. In wire-based DED, however, only virgin (or 'primary') wire is typically used. Substituting this with recycled wire could improve the environmental footprint of the process while also lowering material costs. One example investigated is a titanium alloy recycled wire, which was a cored wire that differed significantly in its structure from a standard homogeneous solid virgin wire. The recycled wire consisted of a laser-beam longitudinally welded outer skin made of virgin titanium and an inner filler material made of alloy powder from recycled stocks. The average composition of skin and filler material was Ti6Al4V.

The challenge of applying cored wire for DED-EB/W is that the trapped gases in the cored wire are released when the wire melts in the vacuum and expand extremely quickly, potentially leading to splatter in the process and pores in the component. With an appropriate process adaptation, however, it is possible to achieve relatively dense DED-EB/W components (Fig. 9). As also shown in Fig. 6, component C – built using recycled titanium wire – demonstrated comparable ultimate tensile strength and elongation at fracture. These positive results open up the hope of using DED-EB/W with recycled wire for certain applications in the future.

Conclusion

Wire Electron Beam Directed Energy Deposition (DED-EB/W) offers a high-potential path to more productive and resource-efficient metal Additive Manufacturing. With deposition rates up to 13 kg/h, energy efficiency nearing 95%, and the ability to process reactive and reflective metals without shielding gas, it

"A direct comparison of the processes via the life cycle assessment shows that DED-LB causes around three times as many emissions in all environmental factors as DED-EB."

outperforms many established DED technologies in both throughput and environmental impact. The potential to use recycled wire further strengthens its case. As sustainability regulations tighten and cost pressures rise, DED-EB/W aligns well with industry's evolving priorities and has the potential to reshape expectations for AM at scale.

Authors

Bernd Baufeld, Senior Expert
Alejandro Zamorano Reichold, R&D Engineer
Bernd.Baufeld@pro-beam.com

Pro-beam additive GmbH
Gilching, Germany
www.pro-beam.com/en

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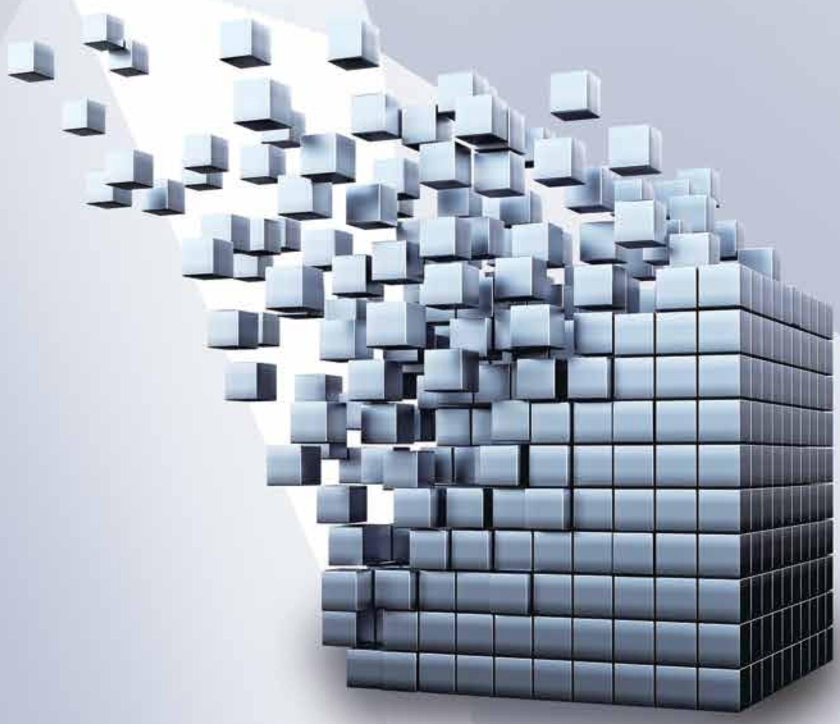

Building trust in AM: How Qualified AM GmbH is enabling regulated production at scale

Additive Manufacturing is gaining traction in regulated industries, but broader adoption depends on proven qualification frameworks. This article explores the methodology developed by Qualified AM GmbH, demonstrated through case studies in the semiconductor, rail, and remote manufacturing environments. Whether applying ISO/ASTM 52920, 52904, 52930, 52928, 52901 or industry standards such as ISO 9001, AS/EN 9100, and ISO 13485, Qualified AM supports industry with a scalable, standards-based approach to compliant and decentralised AM production.

Additive Manufacturing is increasingly being adopted in regulated industries due to its capacity for customisation, decentralisation, and faster development cycles. However, the lack of standardised qualification frameworks continues to hinder its full integration into critical supply chains – particularly in sectors where reliability and compliance are essential.

In this context, robust supply chain qualification is key to AM's success in regulated sectors. Qualified AM's adaptable methodology combines risk-based customisation, digital integration, and collaborative auditing. This helps companies navigate regulatory complexities, scale operations responsibly, and evaluate cross-domain applicability.

This article outlines Qualified AM's methodology and its implementation through three case studies: semiconductor manufacturing (ASML), rail operations (Deutsche Bahn), and decentralised AM for remote and regulated environments (Fieldmade).

Despite progress in AM, harmonising sector-specific requirements – particularly in balancing speed, compliance, and documentation – remains a significant challenge. Growing adoption shows the need for professionals who understand both technical and regulatory dimensions. Qualified AM approaches these challenges with a framework that aligns international standards with sector-specific requirements. Supported by training programmes tailored to engineers, quality professionals, and compliance teams, the methodology offers a structured route to achieving both certification and scalability in the production of AM parts.

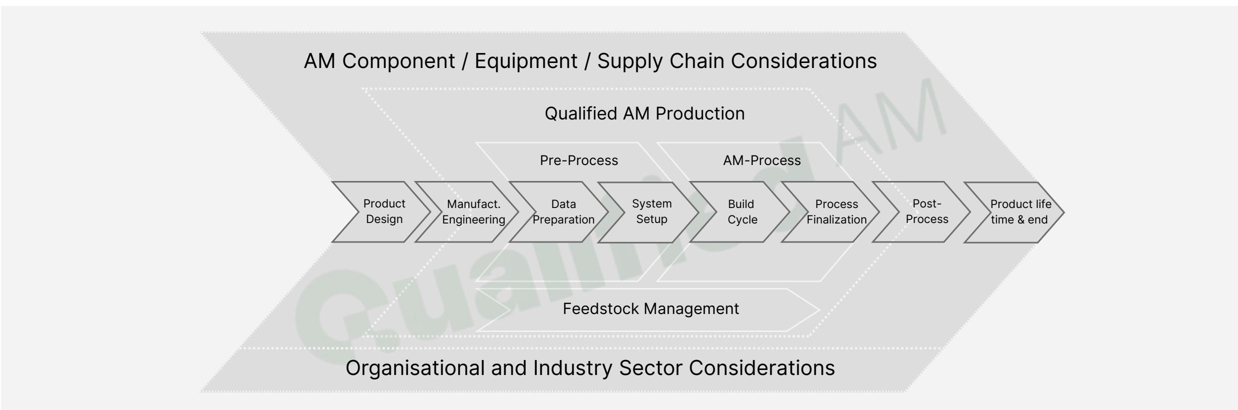

Fig. 1 AM component, equipment and supply chain considerations (Courtesy Qualified AM)

Fig. 2 The Qualified AM team at Formnext 2024 (Courtesy Qualified AM)

> *"Today, Qualified AM's process is structured into four key phases, designed to guide organisations through the qualification process and ensure that AM systems are scalable, compliant, and adaptable across various industries..."*

Background and methodology

Qualified AM's solutions stem from the EU-funded DILAPRO project. Short for Digital Laser Production, the project was a Horizon Europe/Horizon2020 initiative aimed at advancing laser-based manufacturing, in particular Additive Manufacturing. The project sought to develop the following tools:

DILAFACT – Digital Laser Factory
A software platform using digital twins to simulate and optimise laser-material interactions – whether additive, subtractive, or thermal. It was designed to enhance planning, real-time monitoring, and efficiency, reducing waste and energy use significantly.

DILACERT – Digital Laser Certification
A complementary tool to digitise and semi-automate certification, aligning with ISO/ASTM standards and the International Additive Manufacturing Qualification System (IAMQS) framework. This enables in-process quality verification and faster compliance uploads – critical for high-spec industries.

DILACERT combines automated data validation, machine learning algorithms, and adherence to ISO/ASTM standards to maintain regulatory consistency across multiple industries. Further, the software provides real-time monitoring and feedback mechanisms, aiding manufacturers in maintaining compliance and optimising processes.

Its modular architecture ensures scalability and is suitable for both small-scale operations and large decentralised networks. The software adapts to evolving regulations, upholds robust validation protocols, and offers transparent reporting features.

Today, Qualified AM's process is structured into four key phases, designed to guide organisations through the qualification process and ensure that AM systems are scalable, compliant, and adaptable across various industries:

Phase 1: Scope definition
Establishes the required certification level, categorising parts based on their criticality – from development-stage prototypes to components subject to full regulatory compliance.

Phase 2: Process mapping and risk assessment
This stage maps production processes and identifies potential risks, using ISO/ASTM 52954 and Process Failure Mode and Effects Analysis (PFMEA).

Phase 3: Process qualification
Installation, Operational, and Performance Qualification (IQ/OQ/PQ) procedures are carried out to ensure that equipment, processes, and outputs meet established standards.

Phase 4: Certification and maintenance
The final stage uses SPC and continuous improvement initiatives to ensure long-term compliance and adaptability.

Complementing its digital tools, Qualified AM strongly emphasises collaborative audits. Rather than relying on one-off evaluations, the audit process involves multiple stakeholders in iterative gap-closure activities. This approach facilitates early identification and resolution of issues, aiding in the refinement of the process and ensuring that it continues to meet evolving industry standards.

Fig. 3 ASML NXE:3350B photolithography machine used for advanced semiconductor manufacturing (Courtesy ASML)

ASML: first qualified AM supply chain for the semiconductor industry

ASML, a global leader in photolithography, partnered with Qualified AM to qualify its AM supply chain for high-precision components. This collaboration resulted in the first qualified supply chain for the semiconductor industry, establishing a robust framework for ensuring consistent, high-quality AM production across multiple suppliers.

ASML's NXE:3350B photolithography machine plays a key role in semiconductor production, where precision is vital. Ensuring that components used in ultra-clean environments comply with strict quality and traceability requirements presents a significant challenge.

Qualified AM focused on surface contamination control. Ultrasonic cleaning protocols were implemented to mitigate contamination risks, particularly in mixed-material depowdering environments where even minor contamination can disrupt the photolithography process. These protocols were fine-tuned to meet stringent cleanliness standards for semiconductor manufacturing.

A further key focus was the challenge of traceability and validation. In cases where post-processing, such as milling, removed the original serial numbers from parts, Qualified AM implemented digital twin documentation. Each part was linked to a comprehensive digital profile that preserved its manufacturing history, including material batch numbers, process parameters, and post-processing details.

Fig. 4 An ASML demonstration part produced by Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing (Courtesy ASML)

> ***"This collaboration resulted in the first qualified supply chain for the semiconductor industry, establishing a robust framework for ensuring consistent, high-quality AM production across multiple suppliers."***

Fig. 5 The rail industry is increasingly adopting Additive Manufacturing to enhance maintenance operations and production efficiency. AM is utilised for creating spare parts, maintenance tools, and specialised components, effectively addressing challenges with obsolete parts and significantly reducing lead times. As adoption grows, ensuring high quality and safety becomes ever more critical. AM parts undergo extensive mechanical testing and validation to meet the stringent performance standards of the industry, such as the EN 45545-2 and DIN SPEC 17071. Standards such as ISO/ASTM 52920, which provides requirements for establishing quality-assured AM processes regardless of the AM technology used, and to guide manufacturers in maintaining consistency and reliability (Courtesy Deutsche Bahn)

"Given the complexity of railway components, data integrity was a critical focus. Qualified AM worked with DB to standardise mesh quality, CAD fidelity, and file-sharing protocols, ensuring accuracy throughout production."

Geometric fidelity was also ensured through archived 3D models, and semi-finished parts were delivered with their original CAD files and metadata, ensuring compliance with ASML's internal Additive Manufacturing General Specifications Agreement (GSA) and the SPC approach.

Deutsche Bahn: railway industry

Deutsche Bahn (DB) partnered with Qualified AM to qualify Additive Manufacturing processes for spare parts, using Powder Bed Fusion-Laser Beam (PBF-LB) systems, such as the Formlabs Fuse 1 and materials such as PA12 and TPU 90A. The railway sector requires components that can withstand mechanical stress and variable environmental conditions, so DB worked with Qualified AM to validate the digital production pipeline for AM parts.

Simulation models were validated before physical production to confirm throughput reliability. This digital twin process helped address potential issues with mechanical integrity or dimensional accuracy early on. Design and manufacturing reviews were integrated into the contract workflow, reducing rework and waste. These reviews also encouraged closer collaboration between DB's design engineers, procurement officers, and quality assurance teams.

Given the complexity of railway components, data integrity was a critical focus. Qualified AM worked with DB to standardise mesh quality, CAD fidelity, and file-sharing protocols, ensuring accuracy throughout production. This standardisation not only reduced inconsistencies but also ensured parts met the mechanical and dimensional specifications required for reliable railway components. Additionally, it improved communication across departments and with external partners, streamlining the production process.

The collaboration helped DB establish a scalable and repeatable qualification model for AM, which can be applied across various depots and maintenance hubs, ensuring consistency and quality in spare parts production.

Fieldmade's mobile AM units pass audit for field deployment

Fieldmade, a Norwegian technology company, has developed mobile micro factories designed to bring AM capabilities to remote and mission-critical environments. Each NOMAD unit is a mobile, climate-controlled facility equipped for metal, polymer, and composite Additive Manufacturing, designed to operate without reliance on fixed infrastructure.

In collaboration with Qualified AM, Fieldmade's systems underwent a Stage 1 audit based on ISO/ASTM 52920 and 52901, with a focus on spare parts production using a DMG Mori LaserTec 30 SLM machine. The audit scope included risk-based process mapping, machine validation, and documentation of traceability for metal PBF-LB processes. It confirmed that Fieldmade's deployable AM units meet baseline requirements for regulated production in sectors such as energy and defence.

Fieldmade's NOMAD units have already seen operational deployment, including at Aker Solutions' Stord yard alongside the Johan Castberg FPSO. This demonstrates the maturity of the system for field-based, on-demand manufacturing. This case highlights the potential to qualify decentralised AM systems to international standards without compromising on quality, traceability, or compliance.

Fig. 6 Top: Offshore personnel involved in Fieldmade's NOMAD deployment for the Johan Castberg FPSO project (Courtesy Qualified AM). Above: Fieldmade NOMAD containers in a remote, cold-weather deployment scenario (Courtesy Fieldmade)

Conclusion

These case studies demonstrate the flexibility and robustness of Qualified AM's framework across diverse industries. Risk-based customisation was a key enabler, allowing each organisation to adjust the qualification depth according to part criticality. For example, a prototype for educational use might follow a simplified qualification route, while components for semiconductor or medical use require a more rigorous approach.

Qualified AM's supply chain model provides a grounded, standards-aligned framework for integrating AM into regulated production. The ASML, Deutsche Bahn, and Fieldmade examples show its cross-sector applicability and support its role in enabling decentralised, compliant, and resilient manufacturing operations.

As AM adoption scales, frameworks like this will be essential to ensure that production keeps pace with innovation while meeting the growing demands of quality assurance, regulatory compliance, and operational scalability.

Author

Gregor Reischle
Founder and CEO
Qualified AM GmbH
Zugspitzstr, 24, Wielenbach,
Deutschland 82407, Germany
www.qualifiedam.com
Gregor.reischle@qamx.io

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HI-AM Conference – Holistic Innovation in Additive Manufacturing
July 23–24, Waterloo, Canada
hiam.uwaterloo.ca/2025/

America Makes MMX
August 5–6, Canfield, OH, USA
www.americamakes.us/events/mmx/

Formnext Asia Shenzhen
August 26–28, Shenzhen, China
www.formnext-shenzhen.com

The Vicenza Symposium for Jewellery Technology & Fashion Makers
September 2–4, Vicenza, Italy
www.thevicenzasymposium.com

Euro PM2025 Congress & Exhibition
September 14–17, Glasgow, Scotland
www.europm2025.com

The European Additive Manufacturing Congress
September 14–17, Glasgow, Scotland
www.euroam2025.com

T.I.C.'s 66th General Assembly 2025
September 14–17, Cape Town, South Africa
mmta.co.uk/event/t-i-c-s-66th-general-assembly-2025/

4th International Conference on 3D Printing & Additive Manufacturing
September 15–17, Rome, Italy
www.3dprintingevents.com

Course on Atomisation for Metal Powders
September 18–19, Glasgow, Scotland
irp.cdn-website.com/25ba6e5f/files/uploaded/2025_Press_Release_Website.pdf

Formnext Asia Tokyo Forum 2025
September 25–26, Tokyo, Japan
formnextforum.jp.messefrankfurt.com/tokyo/en.html

The Advanced Materials Show USA
September 30–October 1, Columbus, OH, USA
www.advancedmaterialsshowusa.com

RM FORUM: Innovation and Generative Design with 3D Printing
October 1–2, Arese MI, Italy
www.rmforum.it

ICAM25 - ASTM International Conference on Advanced Manufacturing
October 6–10, Las Vegas, NV, USA
amcoe.org/event/icam2025

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Merryl Le Roux,
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Fraunhofer IFAM 6th Workshop on Sinter-based Additive Manufacturing
October 8–9, Bremen, Germany
www.ifam.fraunhofer.de/en/Events/sinter-based-additive-manufacturing-workshop-2025.html

EPMA – Use of Powder Metallurgy Technologies in Medical
October 14–15, Saint-Etienne, France
seminars.epma.com/event/use-of-powder-metallurgy-technologies-in-medical/

APMA 2025 7th International Conference on Powder Metallurgy in Asia
October 19–22, Qingdao, China
apma2025.scimeeting.cn

Smart Manufacturing Aerospace & Defense
October 28, Chicago, IL, USA
www.amg-world.co.uk/smart-manufacturing-aerospace-defense/

Advanced Engineering
October 29–30, Birmingham, United Kingdom
www.advancedengineeringuk.com

Formnext 2025
November 18–21, Frankfurt am Main, Germany
www.formnext.com

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Merryl Le Roux,
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January 27–28, Nice, France
www.worldbigroup.com/advanced-aerospace-manufacturing

Military Additive Manufacturing Summit & Technology Showcase (MILAM)
February 3–5, Tampa, FL, USA
www.militaryam.com

MIM 2026 International Conference on Injection Molding of Metals, Ceramics and Carbides
February 23–25, Jacksonville, FL, USA
www.mim2026.org

Additive Manufacturing Strategies 2026
February 24–26, New York, NY, USA
www.additivemanufacturingstrategies.com

10th AM Forum 2026
March 10–11, Berlin, Germany
en.am-forum.de

AMUG 2026
March 15–19, Grand Sierra Resort, NV, USA
www.amug.com

AM China 2026
March 24–26, Shanghai, China
www.amatex.cn

PM China 2026
March 24–26, Shanghai, China
en.pmexchina.com

RAPID + TCT 2026
April 14–16, Boston, MA, USA
www.rapid3devent.com

WorldPM 2026 | AMPM 2026 | Tungsten2026
June 25–29, Montreal, Canada
www.worldpm2026.org | www.ampm2026.org
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