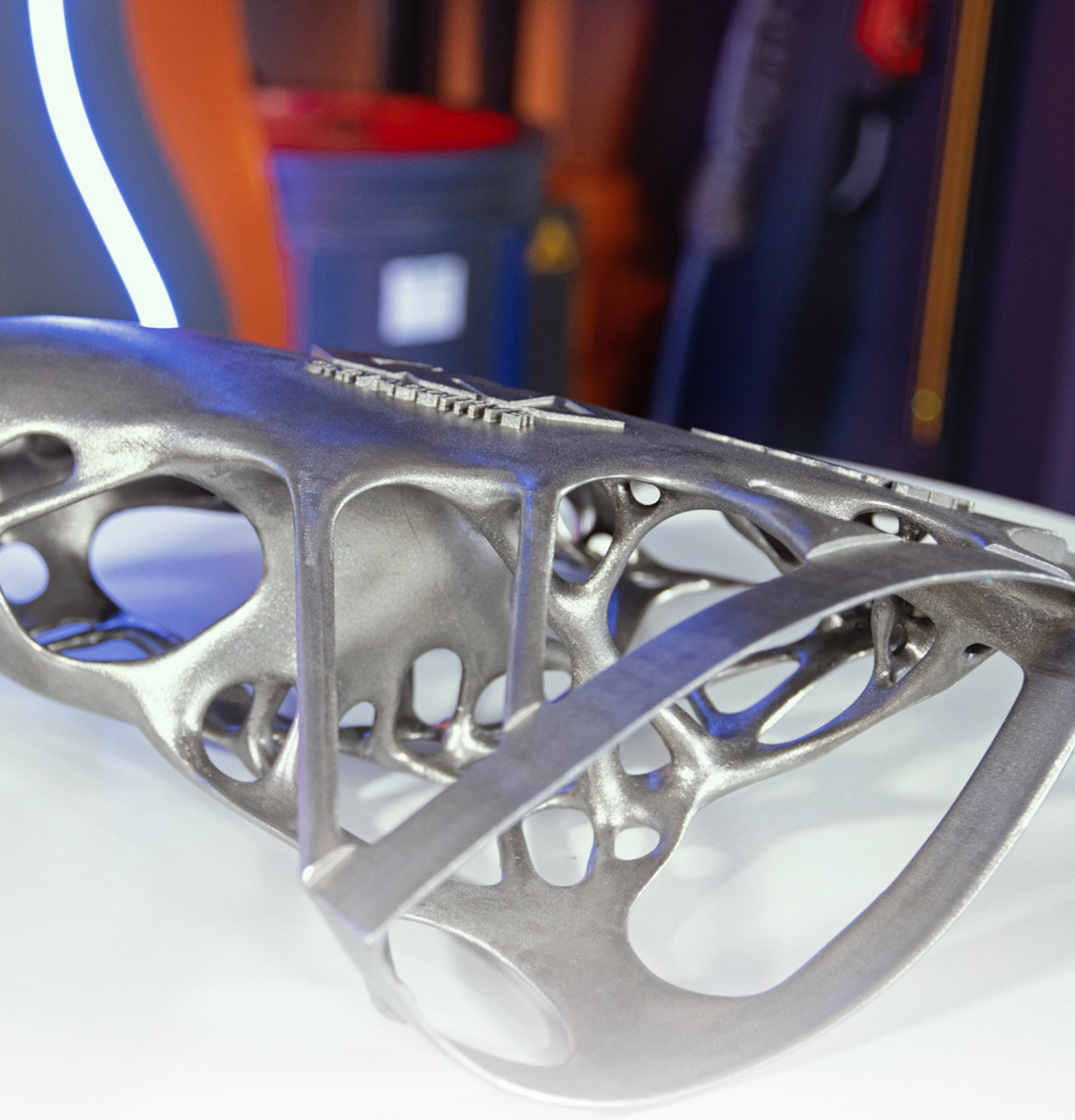


SPOTLIGHT

How GKN Additive is broadening metal AM's horizons with DPLA steel

First DP600-like low alloy steel for L-PBF has tunable properties

3dpbm × GKN ADDITIVE

Image: GKN Additive

GKN Powder Metallurgy and GKN Additive division have positioned themselves strategically at the forefront of laser powder bed fusion industrialization through their participation in the ongoing IDAM project. The initiative, which stands for Industrialization and Digitalization of Additive Manufacturing, is led by a consortium of 12 partners who share the goal of creating a highly automated, end-to-end production line for laser powder bed fusion. With the participation of leading automotive manufacturer BMW, the IDAM project has put a particular emphasis on the automotive industry as an end-user.

We've followed the ongoing IDAM project closely since it launched in 2019, and like others in the metal AM industry have felt hopeful at its continued progression. Today, the project is nearing its conclusion, which means that the two automated pilot lines that the 12 IDAM partners set out to establish (one at BMW's Munich facility, the other at GKN's facility in Bonn) are in their test phase.

Besides the production line itself, one of the most notable innovations born out of the IDAM project's framework has been the development of a low alloy steel powder for additive manufacturing. The material—which is actually two materials, DPLA (Dual Phase Low Alloy) for LPBF and FSLA (Free Sintering Low Alloy) for binder jetting—was developed by GKN Powder Metallurgy. The DPLA powder, which we will explore in more depth in this article, brings something new and interesting to the table and expands the potential for metal AM applications in the automotive industry and beyond.

Developing DPLA

The story of DPLA begins at BMW. The automotive manufacturer, which has increasingly been integrating AM for part development and production, reached out to GKN with something of a pain point. One of the most commonly used metals in automotive production, a low alloy steel called DP600 (HCT600X/C), had no equivalent for additive manufacturing. Traditionally, sheet metal fabrication is used to form DP600 parts, and the material's high strength and impact resistance make it suitable for many critical components in vehicles, like floor panels and outer body parts.

Leveraging its extensive experience in powder metallurgy and AM powder development, GKN set to work to adapt the low alloy steel for AM. "The development was not easy, we encountered several issues, but we have the background for it—we are one of the world's leading powder manufacturers," said Eduard Ulrich, Business Development Manager at GKN Additive. "DP600 is only easy to manufacture using conventional methods, so we needed to make certain changes to the powder for AM."

These changes to the automotive-grade steel resulted in the development of two materials: DPLA for LPBF and FSLA for binder jetting. DPLA is a dual-phase/complex phase steel powder with excellent ultimate tensile strength (UTS) and low yield strength. The material has also been optimized for the laser powder bed fusion process, with good spreadability and laser absorption. (FSLA has similarly been optimized for binder jetting with good sinterability.) What is most interesting about DPLA, however, is that its properties can be tuned by adjusting heat treatment parameters. "For example, we can achieve three different material properties with a single material," explained Jochen Wagner, Business Development Manager at GKN Additive. "This is really one of the key successes of this material."

Technically speaking, an as-built DPLA 3D printed part has a tensile strength of x>850 MPa UTS/Rm. If the same part undergoes a heat treatment with parameters set for medium strength, it will result in a significant change of $\Delta x > 300$ MPa UTS/Rm and a beneficial effect on elongation. Other properties, like yield strength, fracture elongation, hardness, and young's modulus can also be adjusted by changing heat treatment parameters.

“It is the perfect fit for additive manufacturing. With the right material like DPLA, you don’t need any tooling and you can save a lot of money.”

In short, this means that end users can produce parts with different properties without having to validate different powders. To date, GKN Additive has validated the steel powder for the EOS M300-4 quad-laser system through the IDAM framework. This validation marks an important step in the ultimate goal to prepare the AM production line for high-volume DPLA part production.

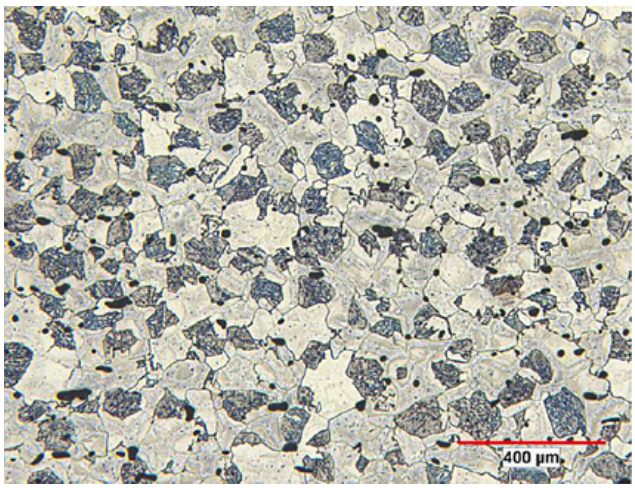
A new material for automotive AM

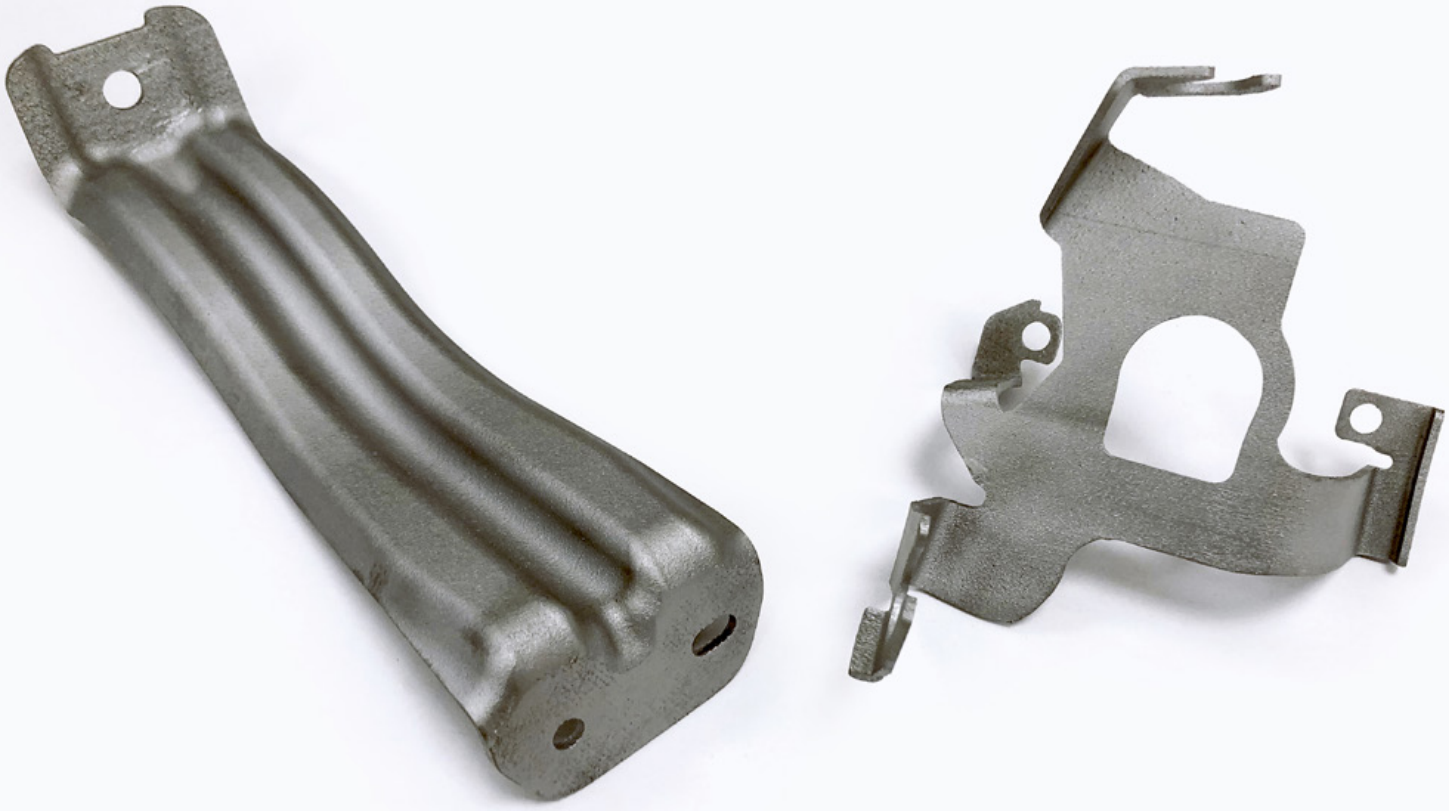
A 3D printed automotive roof node made from DPLA showcases how the low alloy steel and additive manufacturing can strategically be used in combination to meet the stringent requirements of the automotive industry. On the one hand, AM enables the redesign of parts to optimize weight and performance—as seen with the roof node’s bionic structure. “This design is only possible with AM,” said Wagner. “You cannot cast it, forge it, machine it.”

On the other hand, DPLA offers higher mechanical properties compared to other metal AM materials such as aluminum, making it more viable for structural parts that must meet crash test requirements. Notably, because the metal powder is comparable to the widely used DP600, it eases the transition from conventional manufacturing to additive manufacturing for certain applications.

Within the automotive sector, customers like BMW and others will benefit from using DPLA for the production of functional prototypes to streamline product development, as well as for the serial production of small components. Wagner and Ulrich also point to the rapidly growing hypercar market, in which many companies are leveraging AM to produce low-volume end-use components and structures for vehicles. “It is the perfect fit for AM,” Wagner said. “With the right material like DPLA, you don’t need any tooling and you can save a lot of money.”

The FSLA dual phase microstructure after undergoing heat treatment.
Image: GKN Additive





Automotive 3D printed serial parts made on the EOS M300-4 as part of the IDAM project.
Image: GKN Additive

Another area where the two GKN managers see a potential opportunity for DPLA is in the cycling industry, particularly in the production of cargo bikes designed to carry loads. Because these bikes are built to carry more than just their rider (for instance, children, groceries, etc.), they must be built from a high-strength material like steel. 3D printing DPLA could therefore provide lightweight optimized steel components without the weight of solid steel parts.

GKN Additive, at your service

GKN Additive is also exploring other application areas for its new material and is looking forward to speaking with customers and potential customers about other industries and ideas. Naturally, Formnext 2021—where GKN is exhibiting at booth 12.1/C41—will be a key gathering for making these connections. "The good thing about Formnext is that you have every kind of industry coming to Frankfurt," Ulrich says. "You can learn from visitors: what industries they are from, what projects they have, and then you can brainstorm and say 'hey, maybe this material is a good fit'."

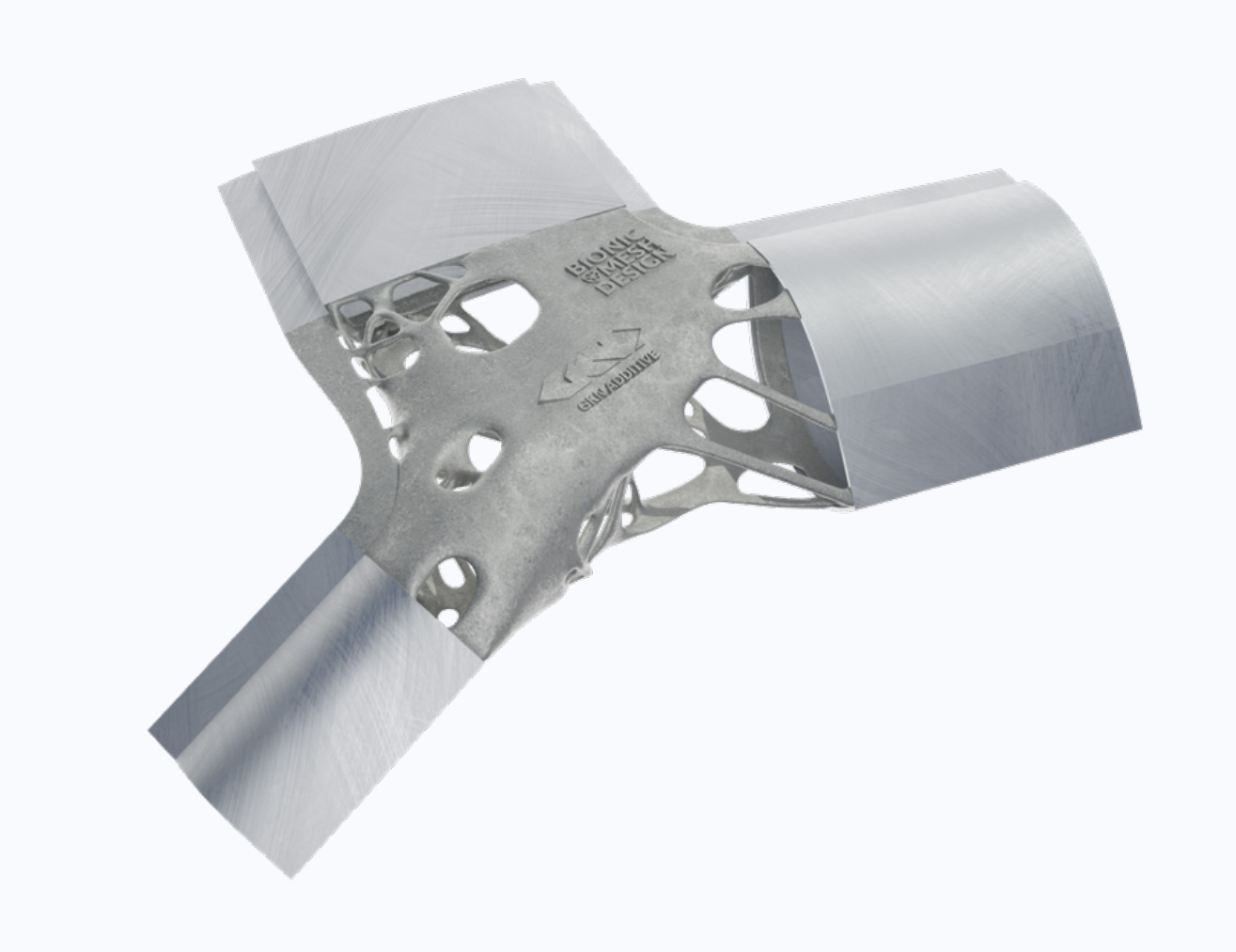
Ulrich and Wagner also emphasize that DPLA is a fine example of the company's overall mandate. That is, GKN develops powders to meet the needs of its clients when no existing products do. When BMW highlighted a need for an automotive-grade low alloy steel, GKN delivered. And that material will now benefit metal additive manufacturing adopters more broadly.

Beyond the low alloy steel, GKN is also continually working on developing other materials for AM. Presently, the company says it has a strong focus on new materials for binder jetting. GKN is the first manufacturer to implement large-scale production using the metal binder jetting process. Since mid-2021, the first series parts are running with 316L; and the ramp ups of FSLA, which has already been fully validated, are currently taking place.

"Under development are tool steels (like M2 / 1.3343) as well as aluminum and copper alloys," the company adds. "Furthermore, we are developing special materials like a nickel-free stainless steel. Due to the fact that GKN produces the AM powder by itself, we are totally flexible and we can respond quickly to the needs of our customers."

Ultimately, DPLA and GKN's broader additive manufacturing material development competency are helping to drive new applications and uses for AM in automotive and beyond. Moreover, as evidenced by the IDAM project, GKN's strengths—such as a global production presence, Industry 4.0 capabilities and many powder metallurgy certifications—are bolstering the industrialization of metal AM. ◆

An automotive rood node redesigned for additive manufacturing and GKN's new DPLA material.
Image: GKN Additive



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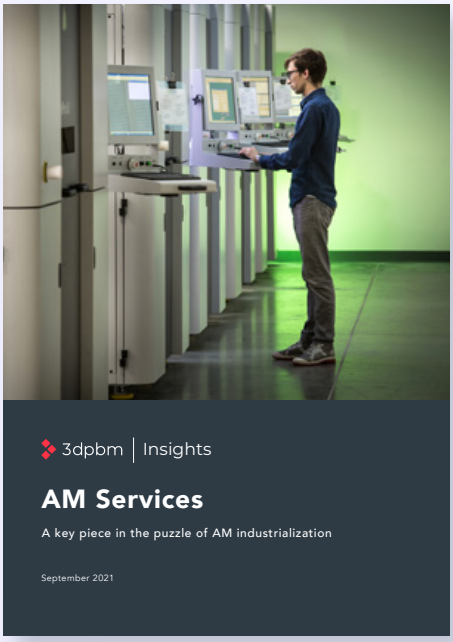

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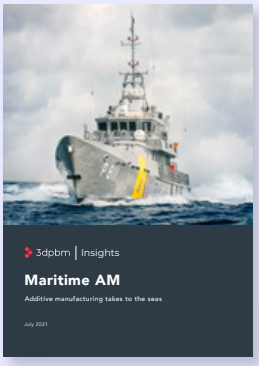

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