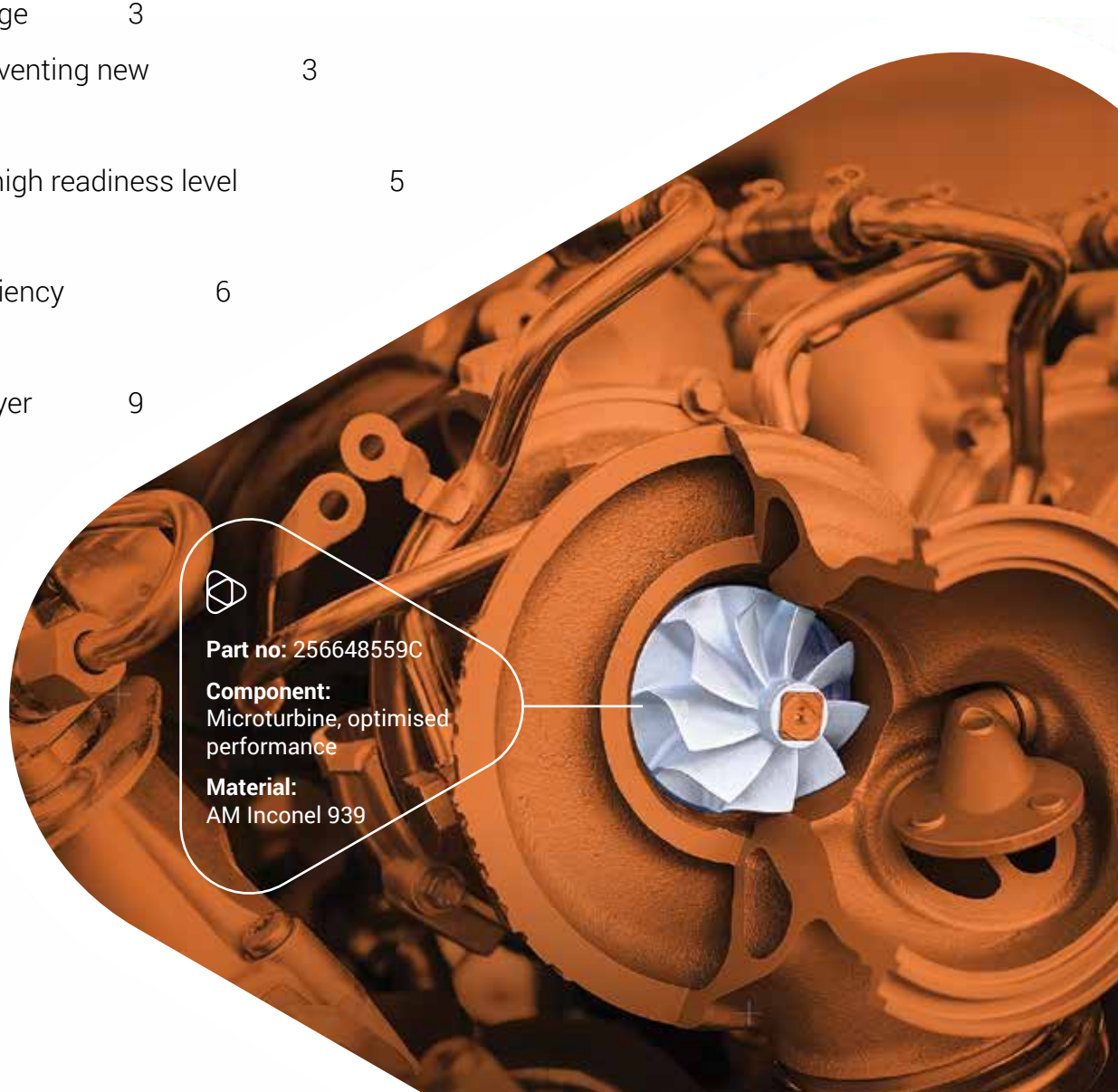
Metal 3D printing is a mature production technology that boosts competitivness

Delva

Content



Foreword

Metal additive manufacturing (AM), called also metal 3D printing, is a rapidly growing industry on its way to being widely integrated with conventional manufacturing technologies. It is even predicted that additive manufacturing will to a certain extent, lead the way for disrupting manufacturing as we know it. Metal 3D printing adds a new dimension to the range of manufacturing technologies and enables entirely new structures and solutions. It is an enabler to make things with less, more wisely, and more efficiently.

Additive manufacturing (AM) is a technology that gives businesses a competitive edge. In the EY report of AM from 2019, 70% of the companies assessed AM technology as an essential strategic topic and part of their daily business. In addition, 18% of the companies surveyed reported that they already use the technology to manufacture end-use products. The percentage of companies reporting to have applied the technology rose to 65%, compared to the previous report from 2016, where this figure was 24%. One in two of the companies predicted that they would make products additively by 2022. Maybe it is worth noting that a vast number of the Asian companies surveyed, four out of five (78%-81%), reported that they already used 3D printing. The global metal 3D printing market is estimated to reach USD 15.28 billion by 2028. The market is expected to register a Compound Annual Growth Rate (CAGR) of 22.9% from 2021 to 2028.

Industrial metal 3D printing is here and now and suitable for tough use. That is why the most important takeaway from this guide should be that metal 3D printing is not only the future, but a production technology of today that produces consistent, high-quality output that will power large-scale production alongside conventional techniques like milling, turning, and casting. If not yet done, it is time to get to the already fast-moving train.

New opportunities are opened for the manufacturing industry, so do not hesitate, embrace this mature technology, and improve your competitiveness with improved efficiency, growth, and transformation.

We hope that this guide will answer some questions and awaken your interest in metal AM, giving you some insight into the technology and the possibilities it enables.

Delva Oy

Metal 3D printing is fast becoming an essential strategic advantage

Strategy is about winning; it is about defining why we are better than others. In this fast-changing environment, we need to quickly recognise significant new technologies, trends, and other forces and realise their impact - in good and bad - on our business. We may adjust to the changes, be forerunners changing the environment by ourselves, or even choose another utterly new business area to enter. But we cannot step aside and believe the change does not concern us.

Printing and conventional manufacturing methods are not competitors but complement each other.

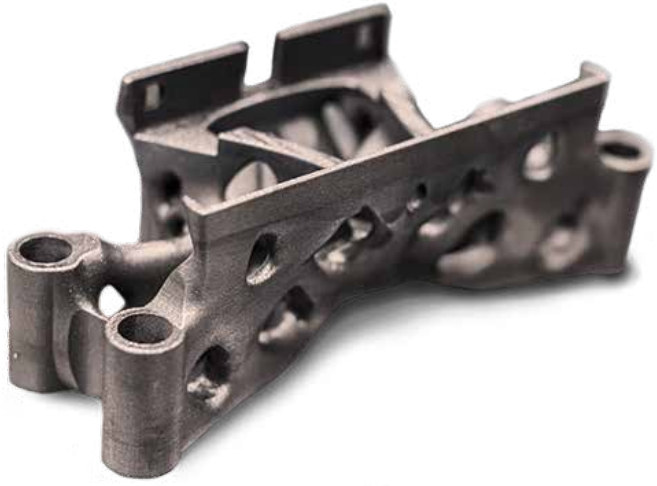
There are many ways on the strategic level we can consider metal 3D printing benefiting us. In the following, we describe how metal 3D printing helps any company design and manufacture better machines and equipments, bringing competitive advantage through more efficient processes and supply chain and saving cost. We also emphasise how metal 3D printing helps us enhance sustainability, which is our common goal in the world.

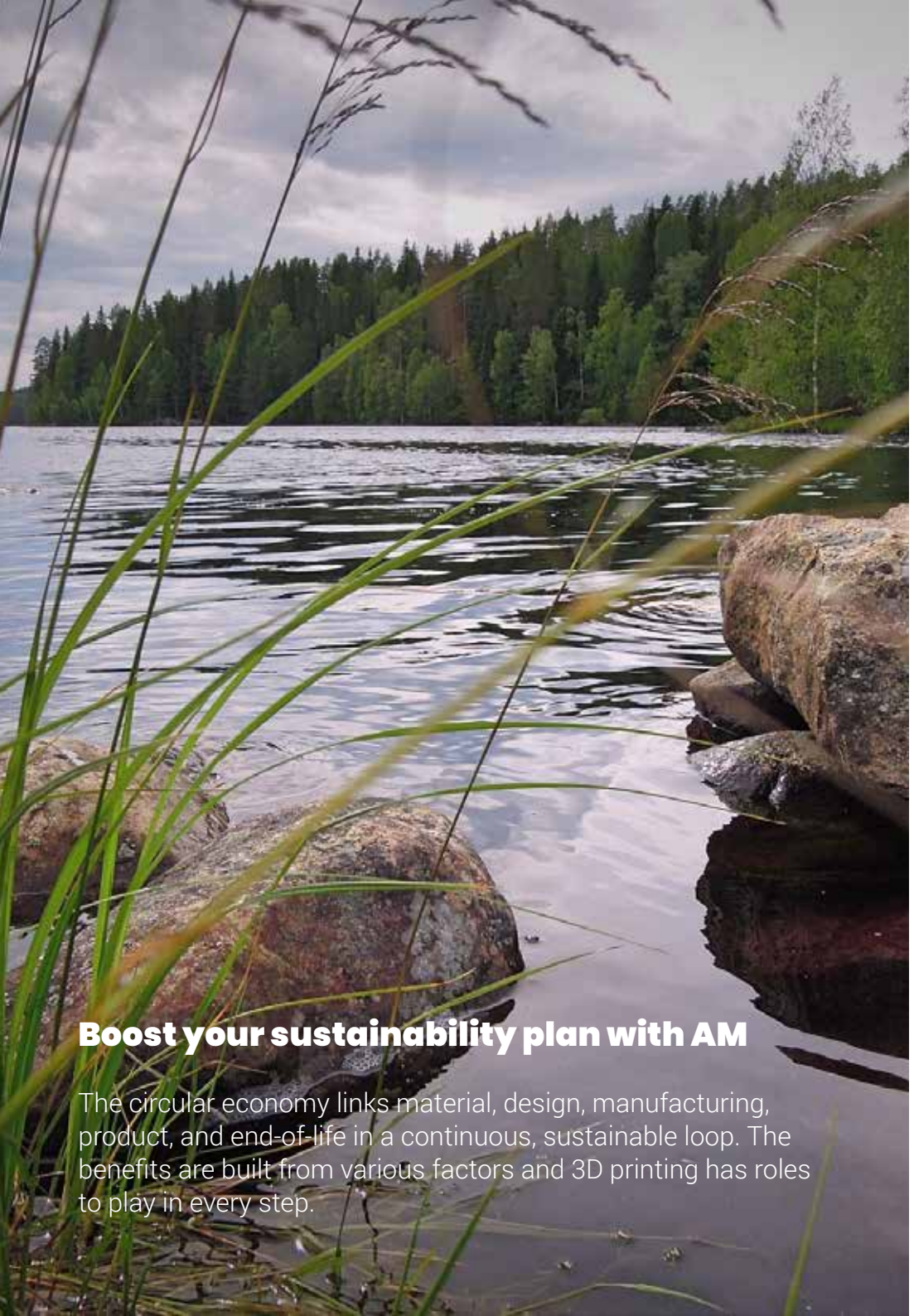
Maximum freedom of design, optimisation of components and inventing new

Metal 3D printing is a technology that allows companies to design and produce components and structures that are much more complex and solution-oriented than ever before. Metal 3D printing makes it possible to design and print repeatedly metal components that are fully dense, high-quality, and consistent, even when the application requires highly complex geometry. You can create different types of demanding geometrical structures that meet specific needs, lighten the weight of the component significantly with bionic structures and optimised material choices and produce one-piece parts that earlier had to be assembled from multiple components. Changing the currently used conventional manufacturing method to metal 3D printing would, in many cases, save time and money. In addition to the new machine elements, also spare parts are an excellent example of this. 3D printing does not require expensive molds or more extensive series. Manufacturing of single units is of reasonable cost, and even if a drawing does not exist, scanning the broken part works as a basis.

- **Create a new business with new solutions**
- **Streamline your supply chain, save money and time**
- **Create better performing solutions**

Maybe the component needs to precisely direct fluids or gases, enhance cooling, increase power, or heat resistance, reduce pressure drop and thus develop process efficiency, and in addition to these functionalities, be lighter and have more robust structures. The list of where industrial metal 3D printing has delivered significant competitive advantages to applications could go on. You can even design internal structures to previously inaccessible spaces.





Boost your sustainability plan with AM

The circular economy links material, design, manufacturing, product, and end-of-life in a continuous, sustainable loop. The benefits are built from various factors and 3D printing has roles to play in every step.

Sustainable success by printing

As we strive for solutions to achieve a sustainable future, businesses are looking for ways to optimise their manufacturing processes to reduce material and energy consumption and waste – an approach is known as sustainable manufacturing.

3D printing helps industries reduce their environmental footprint and even grow their environmental handprint, especially when integrated into the overall sustainability strategy. Optimally designed structures and carefully selected materials decrease the use of materials, lower weight and improve durability. Replacing multi-part assemblies with 3D printed single components, called consolidation, brings a technical lead, helps protect product rights, and brings savings throughout the supply chain.

Optimised printed metal components are high-performance in use. In terms of sustainability, the benefits come from multiple factors. In addition to weight and space savings, printed parts, e.g., improve efficiency by enhancing gas mixing in combustion processes. Unprecedented channel structures significantly reduce process time through enhanced cooling. Streamlined channels in hydraulic components increase energy efficiency and reduce leakage risks.

Existing component designs with a complex structure that are time and material-consuming to produce with conventional methods can often be time- and cost-efficient to metal 3D print. For example, when printing a complex part with an existing design, scrap material can, in some cases, be reduced massively from 95% down to even 1%. Also, components designed for conventional manufacturing techniques can often be printed with a lower price tag. This is due to lower scrap rate, faster production and better performing materials.

The prints are very accurate in dimensions. Minimal post-processing

reduces material consumption, printing time, and machine time for finishing. Reducing work steps saves time and money. The need for logistics decreases as the manufacturing steps are fewer, and the production is closer to the end-use destination of the part. All this decreases costs, environmental impact, and additionally, the piece is quickly ready for use. We can also see local manufacturing as a means to increase supply and transparency security in the manufacturing chain.

Recycling materials is an integral part of the manufacturing process: unmelted powder is filtered locally and reused. Nothing gets thrown away as you only use what is needed. However, energy consumption in printing powders and the large-scale utilisation of recycled metals in the production of powders still have research and development potential.

Additive manufacturing is considered to empower the transition from mass production to mass customisation in several leading sectors.

Powder bed fusion technology (PBF) – a secure technology with high readiness level

At Delva, we print metal 3D components with powder bed fusion technology (PBF). PBF is considered the leading metal technology and one of the industry's most established metal 3D printing technologies.

It is easy to get lost in the terminology jungle of additive manufacturing. Machine manufacturers have licensed the commercial abbreviations differently, even if the technologies are the same. For example, SLM (Selective Laser Melting), DMLM (Direct metal laser melting), and DMLS (Direct Metal Laser Sintering) are Laser-based powder bed fusion (L-PBF) technologies. Delva uses EOS L-PBF machines, and EOS calls their technology DMLS.

PBF has come a long way and has evolved into the leading metal 3D technology since its preliminary technology, Selective Laser Sintering (SLS), from the year 1988. The PBF technology is today widespread and used in many applications for various industries.

The Technology Readiness Level (TRL) was developed in the early 1970s by NASA and is nowadays commonly used in many industries. The system measures a technology's maturity from Level 1 to Level 9 and demonstrates the level of the technology's development. The European Commission advised EU-funded research and innovation projects to adopt this scale in 2010.

Kuva: TWI Ltd

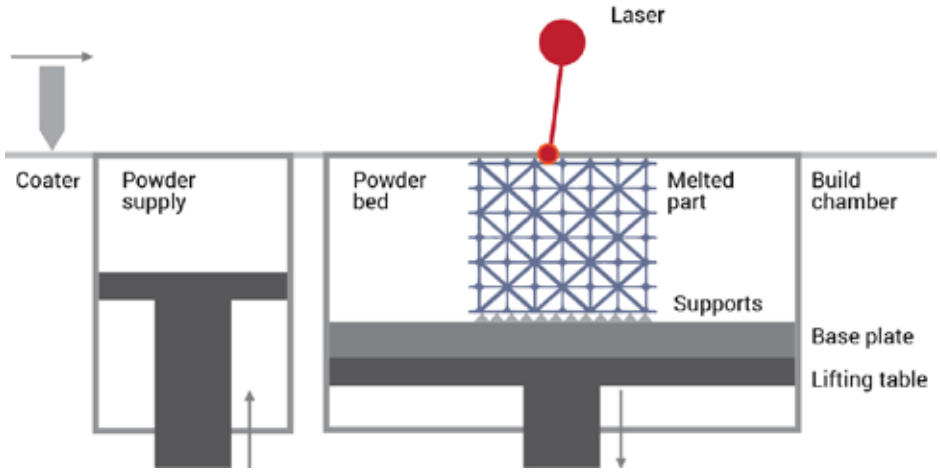
Laser Powder Bed Fusion has a technology readiness level of 8, touching 9, indicating that the technology has proven itself successful under normal operating conditions and is on a fast track towards integrating the widespread international manufacturing ecosystem.

It is easy to demonstrate the strengths and possibilities of this method, keeping our thought on various space programs implementing this technology. Do not be discouraged with these extravagant examples, but rather encouraged. This technology is not anymore only an agile tool for solely prototyping but a heavy-duty production technology, ready for tough use. The PBF technology has already for years proven its excellence in various demanding applications and revolutionised traditional applications. Additive manufacturing is widely acknowledged to deliver several benefits to industries implementing this technology.

How the Laser Powder Bed Fusion does its magic

No magic here. Metal 3D printing is an industrial process. With 3D printing, you produce parts that have highly detailed geometry with complex and unique shapes. The printed components most often have more advanced mechanical properties as parts manufactured with traditional methods. With various post-treatments, the properties can be modified further.

Due to the strong reactivity of metallic powders, the whole process takes place in a protective atmosphere, and the chamber is filled with inert gas before the actual printing can begin. The metal powder is applied by a levelling blade, in a predefined layer thickness, on the build platform. Between each layer, the laser beam selectively melts the powder according to the 3D model. When a layer is done, the build platform is lowered, and the next layer of metal powder is applied. This process is repeated until the component is completed. After this, the



Schematic of Laser Powder Bed Fusion. Image: Delva Oy

excess metal powder is removed. Worth noting that unexposed powder is reusable for other prints. Now the build plate can be removed from the printer and is ready for stress-relieving. Heat treatment finalises the microstructure and mechanical properties of the component and is, therefore, a necessary delicate part of the metal 3D printing process. Lastly, the printed parts are sawed off the plate and are now ready for use or various available post-processing treatments.

Hybrid printing is a cost-effective way to improve production efficiency

Impressive and highly cost-effective hybrid components are created by printing new structures to a traditionally manufactured machined base. In several customer cases, we have successfully repaired worn and broken parts by printing new geometries on top of the basic form. One does not exclude the other. This is a good example where combining the strengths of conventional manufacturing methods and additive manufacturing maximises the benefits.

Maybe you already have some innovative ideas springing up in your mind? The cost advantage is most often undisputed.

Molds wear out in use. Hybrid printing is a fast and cost-effective way to turn an old mold into a new one. The worn part is substituted with 3D printed structures. When remodelling older molds, optimisation of channels may be considered with the aim of streamlining the process.

Tool Steel 1.2709 is easy to polish to a level of A2 and next to A1. With a hardness of around 57 HRC, it is particularly suitable for mould inserts, tooling production, and other end-use components requiring extra strength.

Polished Tool Steel 1.2709 examples. Image: Delva Oy

It is possible to produce optimally performing metal components of better-performing materials in the same price range as traditional subtracting methods with additive manufacturing. Therefore it is often worth considering an optimally performing material already at the design table. With DfAM (Design for Additive Manufacturing), your component and process performance will be undoubtedly superior. Please read more about available materials and their benefits on our web pages and in our material guide.

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Rosendahl Nextrom already does what many have just envisioned

Rosendahl Nextrom is the world's leading supplier of optical fiber and optical cable production technologies. Core competencies include optical glass manufacturing solutions, fiber drawing, fiber coating, and fiber optic cable production. The company takes the possibilities that metal 3D printing enables seriously, and the development work is already producing results.

Read the article here >

Image: Rosendahl Nextrom

How to begin your AM journey?

But before the fun can begin. Is your company ready for this ride? Does your company's leadership recognise AM? Maybe department leaders already have started investing, testing, learning, and understanding the possibilities this technology offers. You are on your way to identifying how your company could benefit from metal AM and what applications. If you are at this point, you are well on your way.

Image: Delva Oy

Every company has its specific way of implementing AM to the range of manufacturing technologies. However, a common factor in companies who have successfully integrated AM is that they have established a climate that encourages new ways of doing things, exploring, and enabled a culture of innovation. An experiment, training, or a strategic decision can ignite the AM journey. It is essential to realise the impressive potential additive manufacturing has to offer to the industry when integrated with conventional manufacturing capabilities. At the same time, every level of the organisation must see the benefits AM offers and be empowered to enhance them.

Image: Delva Oy

By working closely with an expert despite your company's AM maturity level, you will ensure the optimal outcome of metal 3D printing. Working with an AM expert is the fastest and most efficient way to get a highly functional, implementable, and valuable result.

The early majority is already using AM for end-use parts. At this stage, AM is implemented as a strategic application across the organisation and deliver steady and measurable result supporting the company's competitiveness.

After identifying the parts viable for metal 3D printing, there is the need to balance the design between design for additive manufacturing (DfAM) and modify or adapt for additive manufacturing (MfAM) (AfAM).

Replicating a component with AM might not always be considered cost-effective due to the existing component's efficiency or weight. By solely replicating a current component, you will also miss out on the proven benefits that AM continuously has shown to deliver to the industry. As AM enables multiple possibilities to improve efficiency in various ways, the aim should always be to add value by applying DfAM or MfAM.

Delva's Chief Technology Officer raises the importance of experimenting. "It's not always worth trying to make perfect right away, but to start iterating," says Lindqvist. "Printing is a great way to do something new, even if the test phase is satisfied with a solution that implements the mounting dimensions of the old part. From this, it is easy to proceed to fully optimised components."

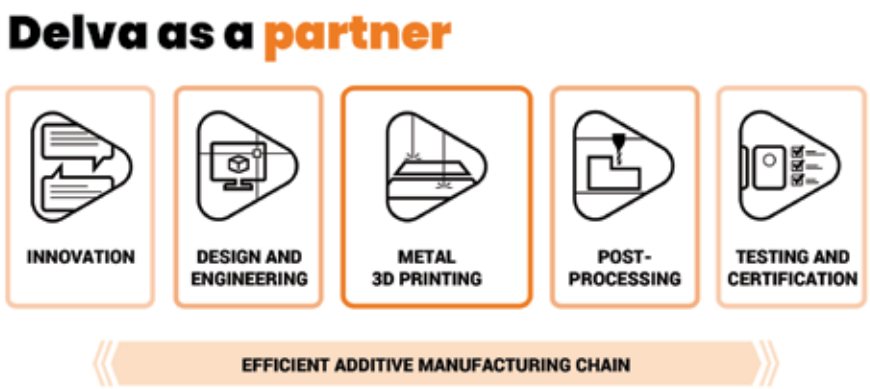
Image: Delva Oy

To step up to successful DfAM or MfAM, you need to not only look at the bare-bone function of the part and its current assembly techniques but address how to produce the component with industrial 3D printing equipment and materials. This way, it is possible to gain efficiency on all the fronts possible.

May we help you with our metal 3D printing expertise – layer by layer

Delva is your experienced expert in industrial metal printing. As your partner, we offer co-development that goes deeper than the surface to find optimal solutions to our customers' individual needs. We ensure quality results by combining the customer's knowledge of the requirements and possibilities of the components with our expertise in Metal AM.

Delva offers you the whole additive manufacturing process as a service.



With our leading technical expertise, extensive metal 3D printing material portfolio, and insight into the possibilities, we have significantly maximised the benefits of industrial 3D printing for our customers. Delva supports companies from the very beginning to finished components.

Maybe you already have the first thought you would like to examine further, a more mature one, or a bold new idea of where you would like to apply metal 3D printing. Delva helps customers identify new applications for the technology and to increase their overall AM maturity.

Delva is your skilled partner in industrial metal 3D printing. We are tirelessly interested in the details and pave your way to stay ahead of the AM game.

Feel free to contact us to discuss further how metal 3D printing can support your organisation's competitiveness.

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Metal 3D printing technology is developing and moving forward at a fast pace. Embrace this mature technology and improve the competitiveness of your company.

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