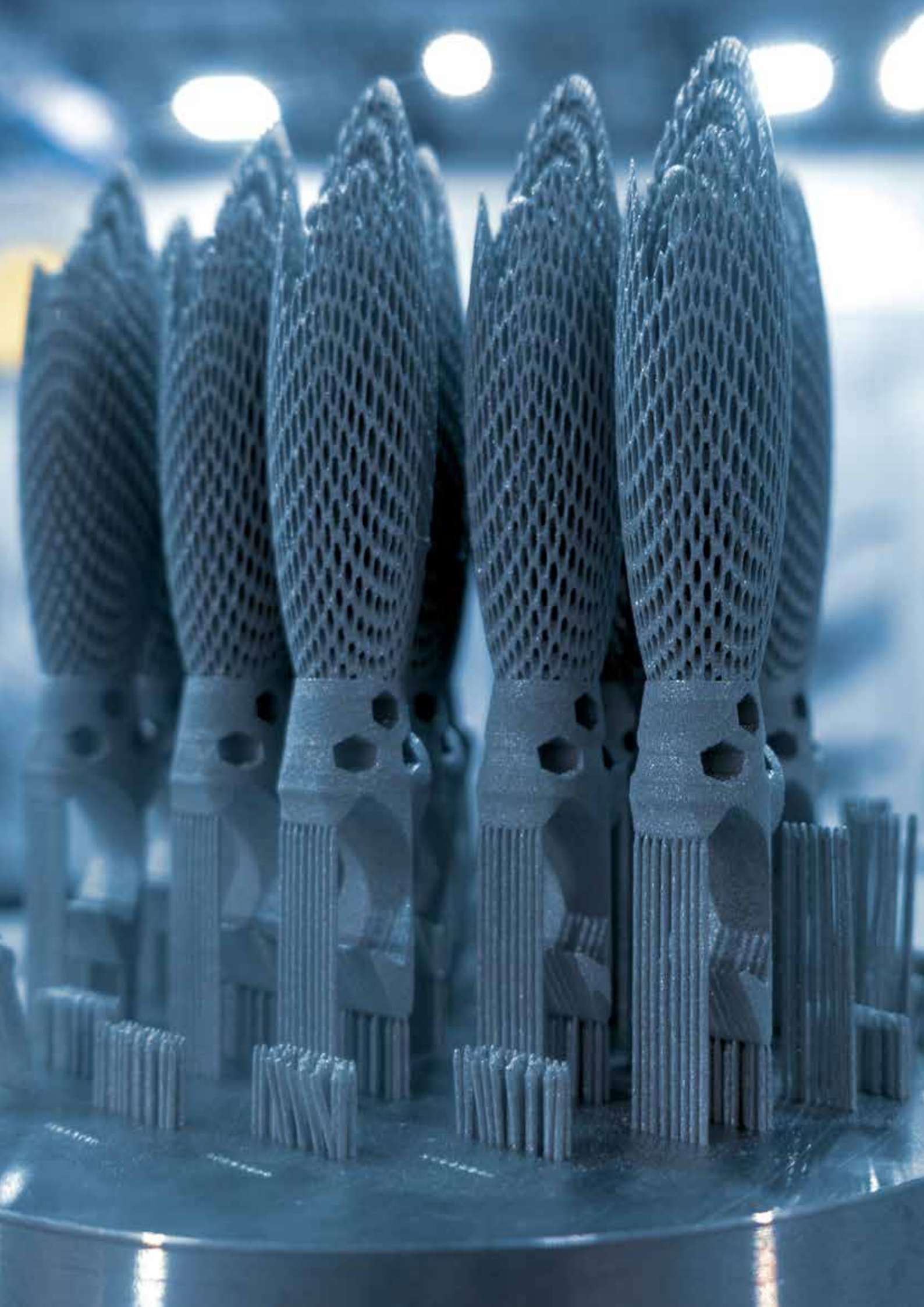
UNIVERSITY OF TWENTE. | FRAUNHOFER INNOVATION PLATFORM FOR ADVANCED MANUFACTURING

WHITE PAPER

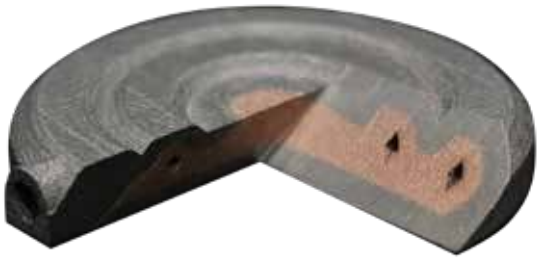
SIX REASONS FOR ADDITIVE MANUFACTURING AND WHY YOU NEED TO INVESTIGATE



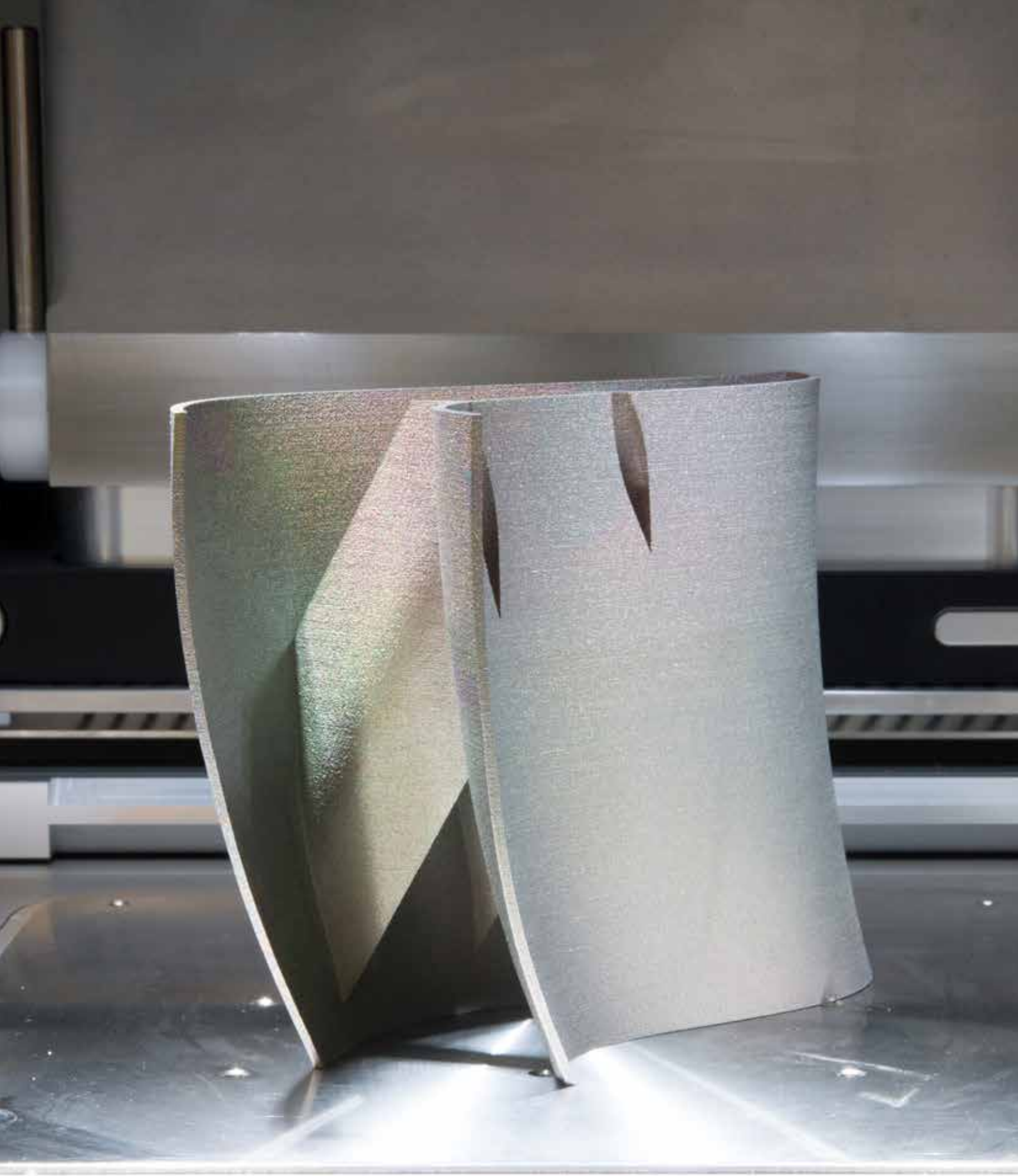
MULTI-MATERIAL ADDITIVE MANUFACTURING

Additive Manufacturing (AM) as we currently know it is starting to reach a key maturation point. Manufacturers are taking an increasing amount of interest in the technology and we can expect machines to become increasingly widespread over the coming years. This in turn will lead to evolutionary development of AM, gradually improving performance and quality whilst simultaneously reducing costs.

Whilst this is happening, one question that needs to be asked is “what is next for AM?”. There are probably a range of answers to this question, the majority of which focus on increasing the range of products that can be made using an additive approach. A lot of these answers also focus on increasing the range of materials that can be combined into a single part in order to provide increased functionality. Let’s face it, we only make parts from more than one material when we need multiple functionality.



A multi-metal part printed using an Aconity 3D printer combined with the Aerosint multi-powder feed system. Photo via Aerosint.



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INTRODUCTION

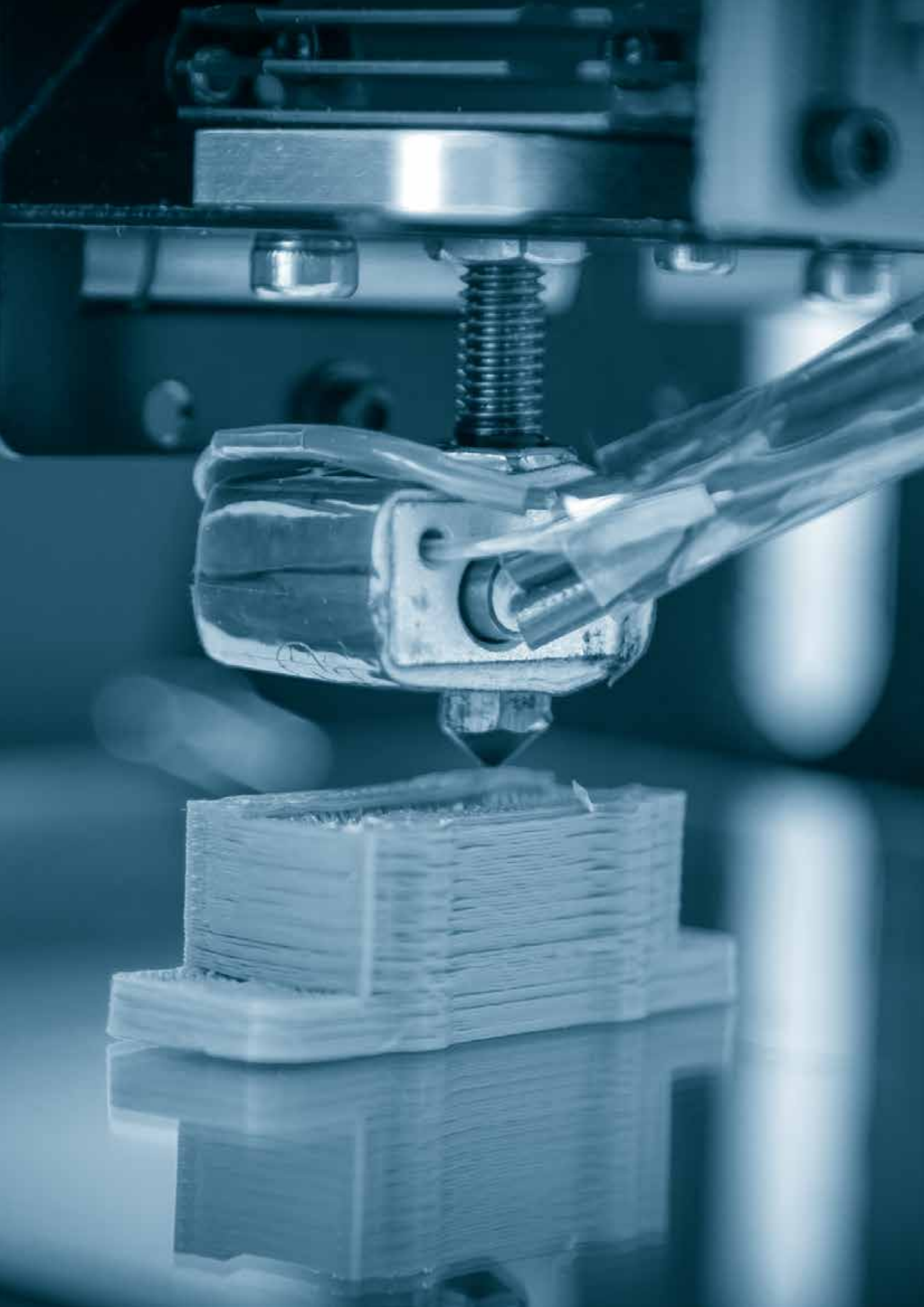
In contrast to what you might think, considering the hype around additive manufacturing in the last decade, 3D printing has been around for more than 40 years. However, a lot has changed since the first commercial material printers were introduced in the late 1980s and early 1990s. The market has been growing continuously, more often than not by double digits. Although growth was down considerably, compared to the average annual increase of 27.4 percent over the previous 10 years, the 3D industry didn't suffer as much from the Covid crisis as other industries did.

Also, on the equipment side there has been huge developments. The cheapest 3D printer in the early 1990s might have cost a quarter of a million US dollars. Nowadays, you can buy a machine with pretty much the same functionality for about 300 dollars. Moreover, the printing processes are very much under control and have sped up tremendously. So much so that 3D printing has evolved from its original use in prototype production and DIY projects to mainstream industrial applications. Automotive and aerospace manufacturers such as BMW, Mercedes and GE build on the technology to produce lightweight components for their cars and airplanes. And from teeth implants to customised insoles, also the medical industry can no longer do without AM.

According to the renowned Wohlers Report, the industry expansion was 7.5 percent in 2020, despite the pandemic, reaching a total market value of nearly 12.8 billion US dollars.

Therefore, some analysts predict that the AM market will grow exponentially in the years to come. The main reason for this is that, year by year, the biggest hurdles to implement 3D technology are lowered. The reliability of the machines has approached the level necessary for an industrial environment. From plastics to metals, and even ceramics and concrete, the range of available materials is increasing rapidly. And the initial costs and the costs per part are dropping dramatically.

Those trends mean that AM is challenging traditional manufacturing techniques such as injection moulding and casting. However, not in every industry and for every application or component. Whether or not additive manufacturing is for you, depends on the volume you are producing and on customer demands. To help you evaluate the possible implementation of 3D printing in your organisation, we have compiled a list of 6 key reasons why you should consider AM and how you can benefit from the technology.



SIX KEY DRIVERS FOR AM

1. VOLUME OF PRODUCTION

As said, the success of 3D printing in your production process is largely determined by the number of components you want to produce. Extremely high volumes are not yet suited for AM. So, when you operate in that category and all your products are completely identical, you are probably better off with other options. But when the volume is relatively low, you should seriously look into the technology. A rule of thumb is a couple of thousands of products per year. However, when you have your act together and all systems and personnel lined up, you could go as high as tens of thousands.

It is precisely that scalability that makes AM such an interesting alternative. When you have an idea for a new product, you can set up the manufacturing process very quickly and start producing within days, since you don't have to wait several months for the development of tooling for your injection moulding machine. And with AM, you can start with small volumes to get a feel for the market and accelerate immediately when demand is raising. 3D printing systems are ideal tools for bridging manufacturing, as first steppingstones on the route to mass production.

Moreover, it is very easy to extend your AM capacity through one of the many 3D network communities. There, you can rent additional print capacity, either because that is their business model, like Shapeways, or because they don't fully sustain their own machines. Indeed, you could make an extra buck yourself by renting out your AM systems when you decide to invest and have spare capacity available.

Although extreme high volumes are not the current strength of AM systems, many equipment builders are pursuing that goal. The Dutch company Additive Industries is a good example. It builds industrial metal printers with one thing in mind: productivity. And also, 3D Systems, one of the largest machine builders in the field, is preparing its printers for life on the manufacturing shop floor.

2. FLEXIBILITY

Closely related to the volume of production, is the flexibility AM has to offer. Since you don't have to wait for any specialized tooling, the technology enables rapid production modifications and swift product alterations. This gives you the crucial benefit of a shorter time to market. Start quickly, ramp up and adjust according to consumer demands and business opportunities. The adaptability to change is a feature that would have been useful to many companies during the Covid crisis. For example, suppliers to the automotive industry saw demand plummeting. They looked for new customers, but often lacked the flexibility to adjust to their needs. 3D printing capability would have made a world of difference for those organisations.

Another lesson learned from the pandemic is that supply chains can be disrupted in an instant. As many other companies, you might consider buying a 3D printer, not to use it, but as an alternative source for production just in case something somewhere in the supply chain goes awry.

3. CUSTOMISATION

The flexibility of AM systems allows for the production of multiple versions of products. You can customize the design and create a part that is specific for a certain individual or client. That starts with personalisation, such as putting a name on the product or incorporating a specific design into it. But it goes much further. The medical applications mentioned earlier - dental implants and insoles – are great examples of how you can benefit from the batch-size-1 feature of AM and how you can easily create unique objects at high volumes.

4. COMPLEXITY

It is often stated that with additive manufacturing, you get complexity for free. That is not quite how it works, but for a 3D printer it doesn't matter too much how complex the geometry of the part is. Compared to other production techniques, AM is much less bound to design constraints and incredibly versatile. With topology optimisation tools, you can set the boundary conditions of your design and automatically generate the best possible structure. The result will probably have a more natural look, and a shape you may never have imagined yourself. That design freedom also enables you to incorporate channels and intricate internal structures into your design.

5. MULTI-PHASE MATERIALS

Maybe still a more developmental driver, but the potential of multi-phase materials in AM could be precisely what you are looking for. With the growing availability of materials suited for 3D printing, you can pick and choose what is best for your application. But you can also combine materials with different characteristics within one design. For instance, you could use a porous, lightweight material internally and a strong and rigid material for the skin. Or you can merge soft and hard materials, elastic and brittle materials, heat conductive or insulative materials, et cetera. More than enough options to tickle your innovative brain.

With the blend of different materials, you are talking about highly specialized features and applications. As an example of what can be done, consider the Australian company Fusetec. They have developed an anatomically correct model of a human nose, including soft skin, flexible cartilages and hard bone. Great for training surgeons and doctors.

6. SUSTAINABILITY

The last characteristic to discuss, is sustainability. Since you need to consider the full lifecycle of your product when you determine its carbon footprint, it is difficult to make bold statements here. With 3D printing, there are arguments pro and con. Let's say, you are making millions of parts using old-fashioned injection moulding and you have a market for all of them, without high costs for logistics, storage and material waste. Then you would be a fool to change since it will almost certainly be the cheapest and most sustainable option.

AM, however, gives you the possibility to print to order. That way, you only produce the parts you actually need or have sold. Also, with print capacity potentially distributed around the world, additional costs as well as environmental impact will diminish significantly. In the right circumstances, and with the right conditions, additive manufacturing can be the more sustainable approach.

When you are using high-value metals like titanium or Inconel, it's easier to justify the adoption of 3D printing. Conventional machine tools remove material, sometimes as high as 90 percent of the original chunk. That mounts up to a heap of expensive waste that cannot easily be recycled. AM on the other hand, only uses the material required. With systems based on powder or filaments, you can even reuse the unused material with minimal impact.

TO PRINT OR NOT TO PRINT

The benefits of additive manufacturing for industrial applications are undeniable. But still, 3D printing might not be of interest to your company. When none of the advantages discussed above are relevant to your business, why would you invest in an expensive printer? The simple answer is: you probably shouldn't.

However, many companies are buying or considering AM systems to future-proof themselves. They are implementing 3D printers in their production process not because they absolutely need them at the moment, but because they know that at some point in the future they will.

An inspiring example comes from the American company Stryker. It makes hip implants, amongst other things. Although it could effectively produce them with more traditional techniques, Stryker favours 3D print technology. Admittedly, many countries and hospitals don't allow customized implants at the moment, but Stryker is prepared for when insurance companies lift that ban. Overnight, it can switch to patient-specific implants and trump its competitors.

USE CASE

Aeronamic

Aeronamic is an aerospace company that provides a variety of machining tasks on high-standard castings. The Dutch company chose FIP@UT as a technology partner in a project aiming to acquire knowledge of the development processes in AM.

The castings provided by the company are generally top notch, but sometimes casting pores occurred in regions that were only unveiled after numerous machining tasks. Aeronamic wanted a solution that would reduce the reliance on an outside supplier in a critical stage of their supply chain. Furthermore, the company wanted to control the quality of the near- net shape of the part to be machined. It was considered that this would be an ideal opportunity to explore the use of AM to replace the casting process.

Aeronamic worked with Fraunhofer Innovation Platform for Advanced Manufacturing to develop significant in-house knowledge of AM that would allow them to prepare for future possibilities. Through the partnership with FIP, Aeronamic was able to achieve its objectives and solve its problem. The solution included:

- Determining best build parameters for the desired quality
- Understanding required mechanical and material properties by using a hot isostatic pressing
- Running a series of laboratory tests to ensure quality improvement, including process parameters studies to optimise throughput

The key deliverable included an in-house system providing greater control of their supply chain. Through this, Aeronamic can control and ensure the quality and reliability of its products. The in-house system also makes the company ready for additional improvements in the redesign process that takes full advantage of AM technology.

ABOUT THE FRAUNHOFER INNOVATION PLATFORM FOR ADVANCED MANUFACTURING

Originally known as the Fraunhofer Project Center at the University of Twente, the Fraunhofer Innovation Platform for Advanced Manufacturing emerged in 2022, continuing the strong collaboration between the Fraunhofer Institute for Production Technology IPT in Aachen and the University of Twente in the Netherlands.

The Fraunhofer Innovation Platform for Advanced Manufacturing at the University of Twente (FIP-AM@UT) is a research centre that collaborates with manufacturers to develop innovative and integrated solutions to serve and strengthen the industrial manufacturing community and benefit society as a whole.

FIP-AM@UT's primary goal is to strengthen and diversify the manufacturing sector in the Netherlands to ensure ongoing adaptability, competitiveness and efficiency. This can be accomplished by bringing highly skilled researchers and supporting staff to the region.

Their secondary goal is to source and develop innovative thinkers by engaging them in cutting-edge applied research for both industrial and public clients, and by promoting technology transfer through the joint exploitation of results. FIP-AM@UT is part of the University of Twente (UT), the only campus university in the Netherlands. Divided over five faculties, it provides more than fifty educational programmes. In addition, UT has a strong focus on personal development, aiding and encouraging talented researchers to conduct groundbreaking research.

HOW WE CAN HELP YOU

Fraunhofer Innovation Platform for Advanced Manufacturing at the University of Twente is in the ideal position to translate the theoretical knowledge at the academic level to the real-world operation at the factory floor. Bridging the gap between research and practice is our core competence. We can help you get underway, finding the right track, guide you from a push to a pull in your digital metamorphosis.

To start, we will evaluate your current situation together, and assist you in defining your end goal and the road to take. Then, we help you to create the best use cases, build proofs of concept and get to the first results. Those success stories will show the added value of the transformation and will motivate your people to join.

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