

# 3D printing: hype or game changer?

A Global EY Report 2019



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# What is additive manufacturing?

Additive manufacturing (AM), commonly known as 3D printing (3DP), is a digital manufacturing process that involves slicing three-dimensional digital designs into layers and then producing additively, layer by layer, using AM systems and various materials.

AMM  
3DP

A person's hands are shown typing on a silver laptop keyboard. To the right, a black mouse is on a white desk. In the background, a white 3D printer is visible. The letters 'AMM' and '3DP' are overlaid in large, dark grey font across the image.



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# Foreword



## Glenn Steinberg

EY Global and EY Americas  
Supply Chain Leader

In the three years since EY published first 3DP report, additive manufacturing (AM) has grown up.

The technology has attracted such exposure that almost two-thirds (65%) of the businesses we surveyed this year have now tried the technology – up from 24% in 2016. Any early skepticism that predictions of 3DP’s transformative potential were just hype have been laid to rest. AM has joined the armory of production technologies, with 18% of companies already using it to make end-use products for customers and consumers. This means that the crucial “early majority” – whose buy-in is essential to the success of any new technology – have been won over.

This moment in AM’s evolution is comparable to the point, a century ago, when industry moved from steam power to electricity. Then, those that hesitated in the transition were swept away. The question is, will businesses that resist AM face the same fate – while those that embrace the technology, as users or vendors, become the new industry leaders?

Only time will tell. But we can be sure that manufacturing will never be the same again. With almost one in two surveyed companies expecting to make products additively by 2022, the industrial landscape is facing a rapid metamorphosis. Manufacturing and product design will be transformed, a fresh supply chain will develop and new, innovative business models will emerge.

The chasm to acceptance of AM has been crossed; to avoid being left behind on the wrong side of history, businesses should now consider taking the leap themselves. You can’t sit this one out!

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# Key findings

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▶ **3DP use is escalating.**

65% of businesses surveyed have experience of additive manufacturing (AM) – up from 24% in 2016. Four out of 10 have in-house systems in place.

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▶ **The West is losing ground.**

Germany, which had the highest exposure to 3DP in 2016, has become one of the countries with the least experience. The US has the third-lowest experience of AM.

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▶ **Asia is surging ahead.**

More than four out of five (81%) South Korean and 78% of Chinese firms have used 3DP – up from 24% in 2016.

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▶ **Aerospace tops sector use.**

More than three out of four (78%) aerospace companies apply 3DP – more than any other industry.

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▶ **Businesses adopt exploration mode.**

39% of companies are at maturity Level 2 with AM; experimenting, testing, and identifying how it could benefit them and via which applications.

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▶ **The “early majority” – the cohort crucial to a technology’s success – are now using AM for end-use parts.**

18% of companies currently apply AM for this purpose, 46% expect to do so by 2022.

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▶ **Cost is holding back adoption.**

90% say the high cost of AM materials is inhibiting them, with 87% citing high machine costs.

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▶ **AM is boosting competitiveness.**

43% say it helps better meet customer needs. By 2022 this number is expected to rise to 56%.

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▶ **Production is moving closer to customers.**

65% expect to move manufacturing downstream with AM.

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▶ **The 3DP market is expanding fast.**

Player numbers are spiraling, as traditional industrial players and numerous start-ups enter the arena, and annual CAGR hits 29%.

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▶ **M&A activity is strong.**

42% of recent transactions involved AM companies buying competitors, 28% saw strategic players entering the market. Activity is set to remain robust with 11% of all surveyed companies intending to enter the market.

# About this study

Additive manufacturing (often called 3D printing or 3DP) has been attracting attention for decades, but it is now firmly in the C-suite spotlight. M&A activity, increasing numbers of new vendors and the evolution of the existing sub-technologies, and the development of new ones has elevated additive manufacturing (AM) from being a technology earmarked for prototyping to one that is increasingly production-ready. Its time has finally come, and AM is being hailed as a game changer for the 2020s.

## A game changer for the 2020s

However, the technology has not yet reached its zenith, with innovation showing no signs of slowing down. Dozens of sub-technologies, using fresh materials and offering additional applications, have emerged under the AM banner in recent years, often driven by new players. Such development has made the industry ever more attractive for new entrants and investments, injecting further dynamism into both the demand and supply sides of the industry. This has created a very diverse market with many different types and sizes of business.

Figure 1  
Surveyed companies per country.



Source: EY

Such diversity has, however, created a fragmented marketplace. This can make it challenging to get a clear picture of the industry: to gauge, for example, how much manufacturing companies know about the technology, what applications are being used, what challenges companies are experiencing with AM and how the technology – and market – will evolve.

### Informed perspectives on an evolving market

This publication aims to answer such questions and provide a full and informed viewpoint about today's AM market. It builds on the first global EY 3D printing report of 2016, capturing the unprecedented change that has transformed AM in the three years since then. In providing an up-to-date view of the industry and informed insights into its future development, this report again draws on both continuous EY research and the perspectives of 900 executives from 13 countries and nine industries. To reflect the varied applications and use of 3DP, these 900 decision makers come from:

- ▶ **Different-sized companies:**  
319 small businesses (with revenue of less than \$US100m), 407 medium-sized businesses (with revenue between \$US100m and \$US1b) and 174 large businesses (with revenue of more than \$US1b)
- ▶ **Companies from 13 countries:**  
Austria, Belgium, Canada, China, France, Germany, Italy, Japan, South Korea, Spain, Switzerland, the UK and the US
- ▶ **Businesses from nine industries:**  
Aerospace, Automotive, Chemicals, Construction, Consumer Packaged Goods, Electronics, Industrial Products, Life Sciences, Logistics and Transportation

We hope the findings help create a better understanding of the industry and provide companies with ideas for their AM journey irrespective of their current stage of AM maturity.



174

Asia

87

China

44

Japan

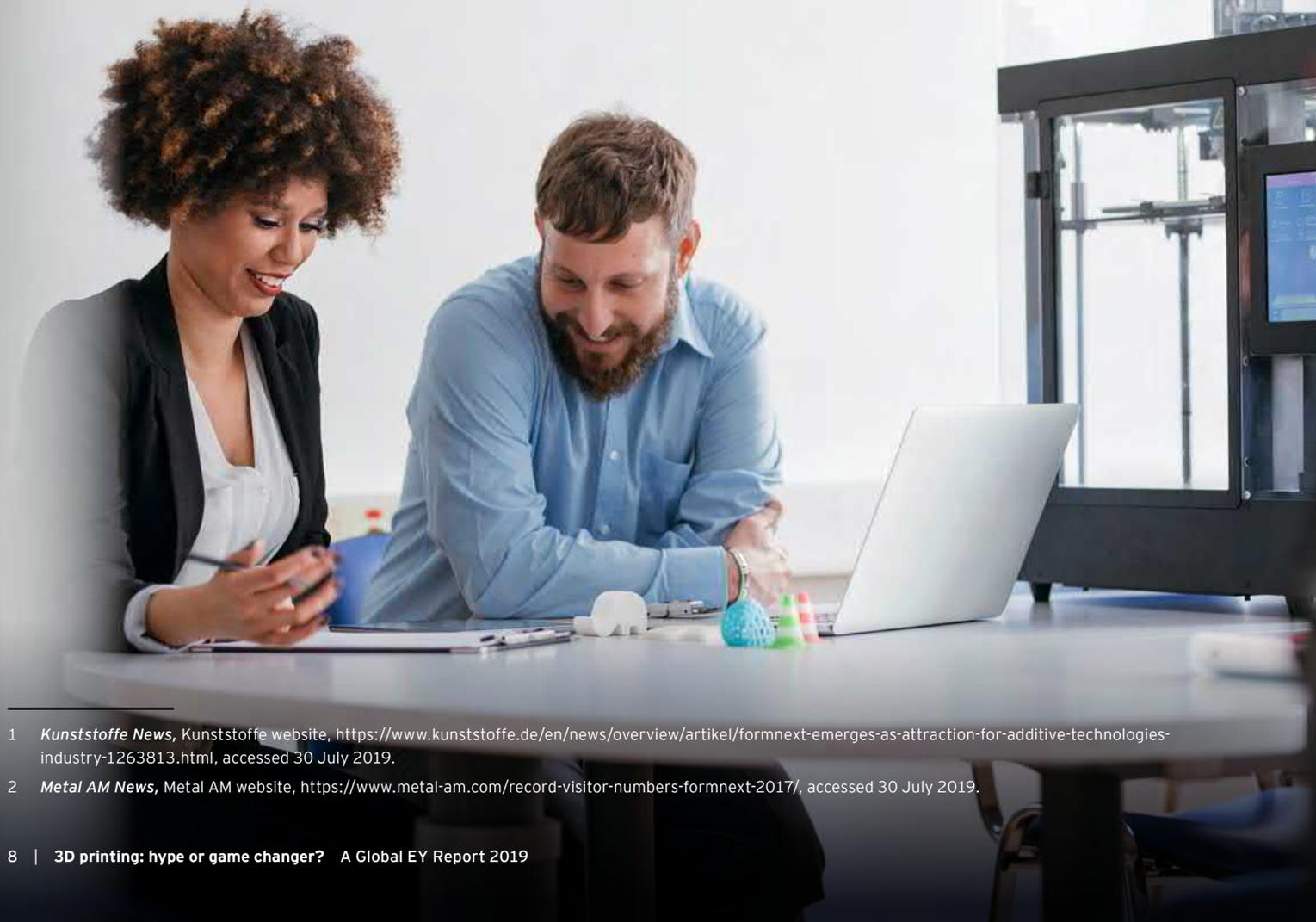
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South Korea

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# 3DP moves into the operational mainstream

To understand how far AM has been integrated into modern organizations, the first step is to assess levels of awareness and adoption among individuals and businesses. Coverage of 3DP has risen steadily in recent years with growing numbers of case studies on use posted daily on social media. Furthermore, AM meeting points such as fairs and conferences no longer exclusively attract small groups of enthusiasts. The world's premier annual fair on industrial 3DP, Formnext in Frankfurt, Germany, for example, attracts more visitors and exhibitors every year. Between 2015 and 2018 the number of visitors tripled from 8,982<sup>1</sup> to 27,000 and between 2017 and 2018 the number of exhibitors increased by 34% from 470 to 632<sup>2</sup>. Another factor serving to improve the visibility of 3DP is the fact that it is often seen by companies as an essential part of wider industrial trends, such as the digitization of manufacturing.



1 *Kunststoffe News*, Kunststoffe website, <https://www.kunststoffe.de/en/news/overview/artikel/formnext-emerges-as-attraction-for-additive-technologies-industry-1263813.html>, accessed 30 July 2019.

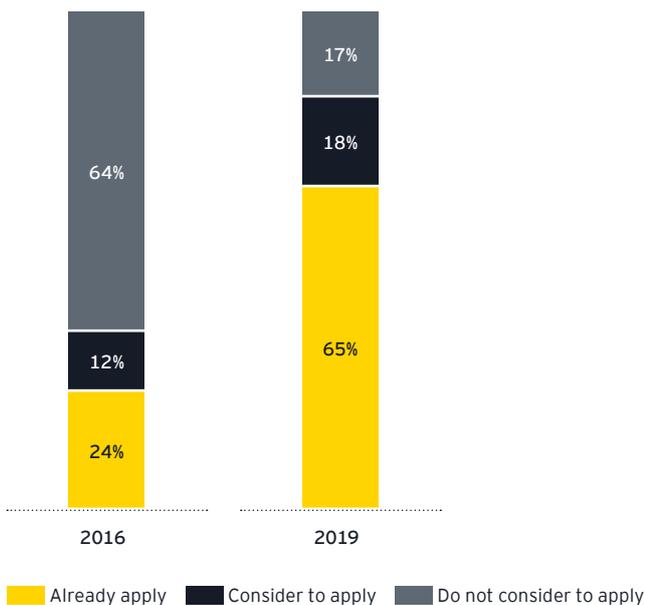
2 *Metal AM News*, Metal AM website, <https://www.metal-am.com/record-visitor-numbers-formnext-2017/>, accessed 30 July 2019.

## Business use escalates

The 2016 EY survey found that 24%<sup>3</sup> of companies had some experience with AM. This cohort ranged from companies that had just started testing the technology or were experimenting with it to businesses with a high awareness of 3DP and a clear application path. In the past three years, there has been a significant increase in the number of companies, across different industries, that have gained experience of AM. The percentage of businesses that have applied the technology rose to 65% in 2019, from the previous figure of 24%. One in four (25%) of all surveyed companies are in the very early stages of their AM journey, still testing or experimenting with the technology. However, there is a huge increase in the number that claim that AM is strategically important to them and that have a clear plan for integrating it in their business – up from 4% three years ago to 20% in 2019.

While awareness and use of 3DP technologies increased globally, enthusiasm and interest vary significantly between different regions and countries. In 2016, German businesses exhibited the highest level of experience with AM at 37%. Today, although that percentage has risen to 63%, Germany has become one of the three countries with the lowest level of experience. On other hand, exposure to the technology among Asian businesses has spiraled upwards, especially in South Korea and China. Of the South Korean and Chinese companies surveyed, familiarity with AM grew from 24% in 2016 to 81% and 78% respectively in 2019, making them the nations with the most 3DP experience.

**Chart 1**  
Awareness about AM technologies,  
2016 and 2019 (%)\*



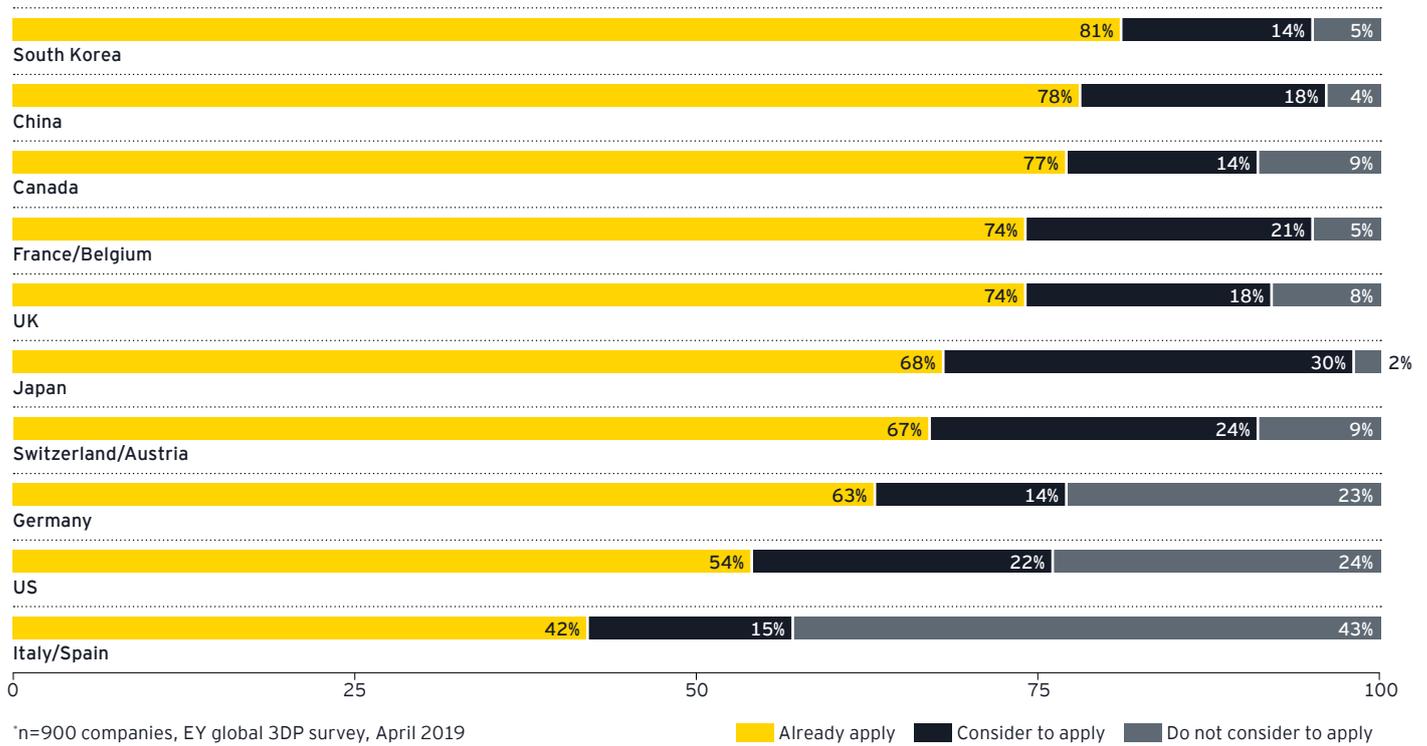
\*n=900 companies, EY global 3DP survey, April 2016 and April 2019

The percentage of businesses that have applied the technology rose to 65% in 2019, from the previous figure of 24%.



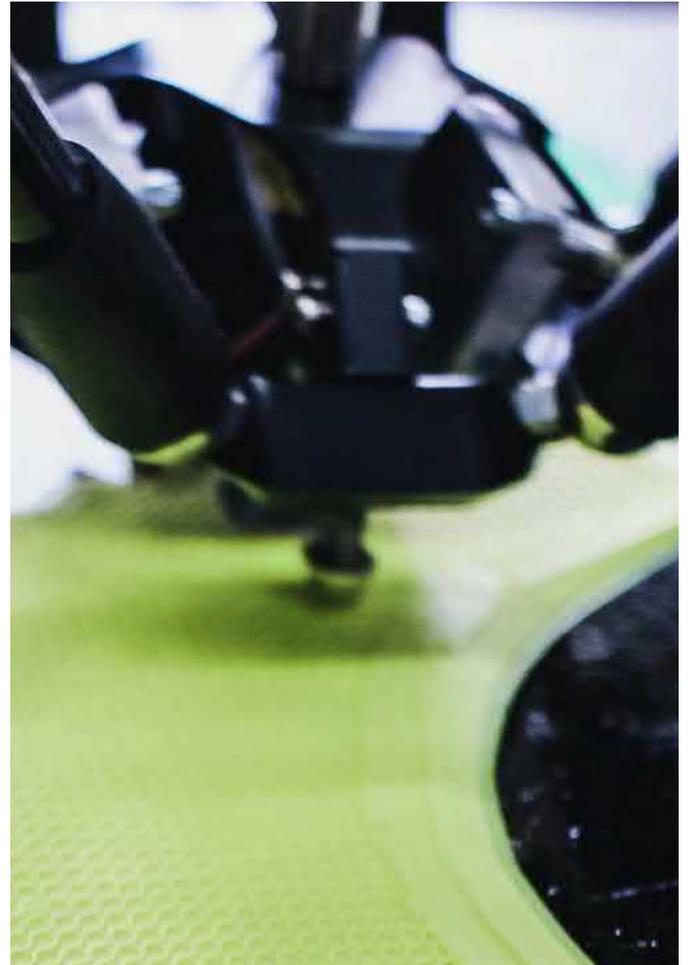
<sup>3</sup> EY's global 3D printing report 2016, Ernst & Young, 2016.

**Chart 2**  
Experience of AM technologies per country 2019 (%)\*



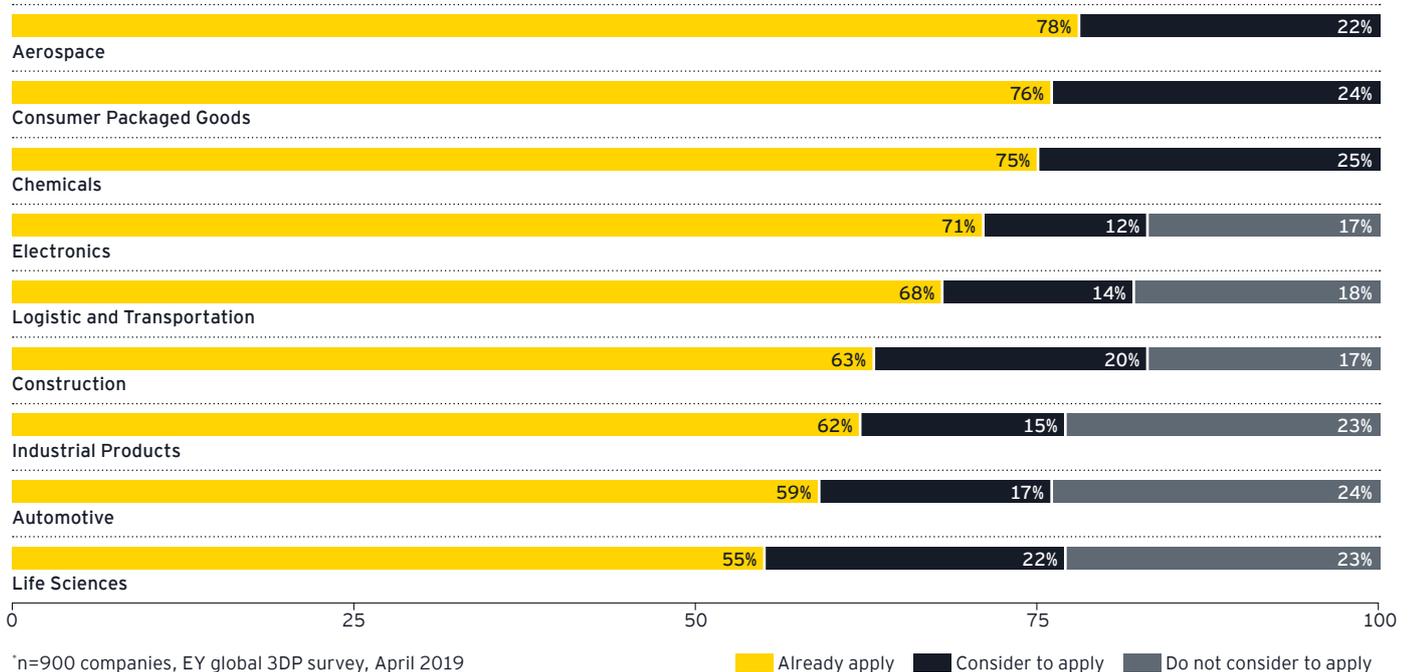
## Spiraling Asian AM reflects government support

The extraordinarily rapid growth in AM adoption in South Korea and China could reflect their more dynamic economic development in recent years, compared with that of the mature economies of Western Europe and the US. Asian businesses may also have recognized the potential in using emerging technologies to build a new competitive advantage, in place of their previous dependence on cost leadership. The business focus on emerging technologies, as in China, has been enhanced by a government tendency for market intervention. China's high-tech manufacturing plan initiative, for example, includes an emphasis on advancing a Chinese AM sector. This encompasses massive funding of pilot projects, the fostering of innovation and the construction of the right industrial ecosystem to develop a large Chinese 3DP industry.<sup>4</sup>



<sup>4</sup> *3Dprintingindustry News*, 3Dprintingindustry website, <https://3dprintingindustry.com/news/china-action-plan-3d-printing-3-billion-2020-126119/>, accessed 30 July 2019.

**Chart 3**  
Experience of AM technologies per industry 2019 (%)\*

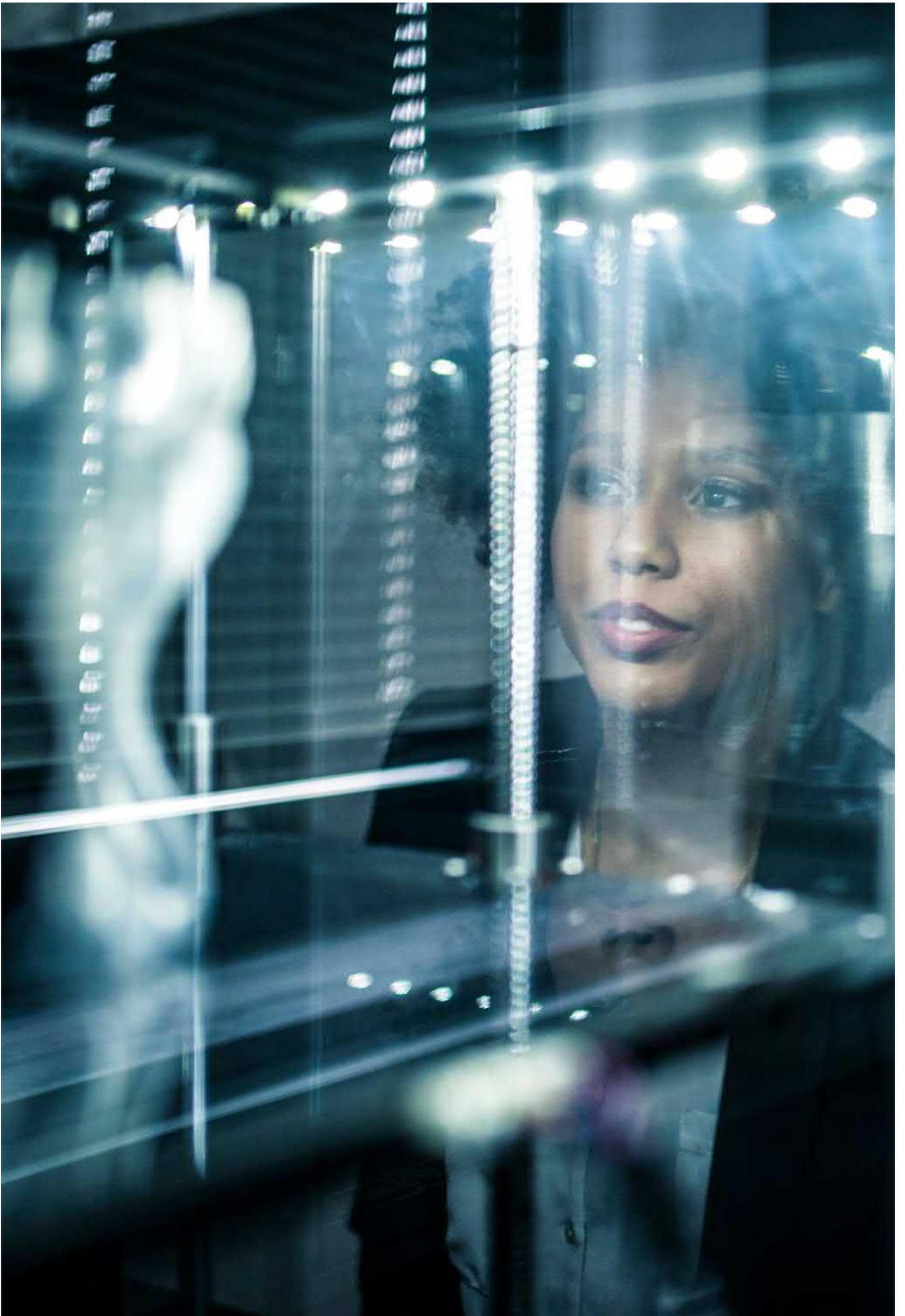


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## Aerospace sector builds on early AM adoption

The aerospace industry has the highest AM experience of all sectors with 78% of companies claiming they have used the technology. Most of the aerospace players have already identified early-winning 3DP applications and made the industry a first mover toward AM. However, 3DP interest hasn't only increased among sectors where it was already widely in use. Industries with limited use of AM, and in which its application would mean whole new business models, such as logistics and transportation, or construction, demonstrate high awareness of the technology. The interest in and experience of AM among logistics and transportation companies, for example, is now six times higher than in 2016.

In summary, nearly triple the number of companies have experienced AM since 2016, as they bid to create a competitive advantage. This has helped businesses to identify new applications for the technology and to increase their overall AM maturity.



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# From the lab to the shop window: AM serial production takes off

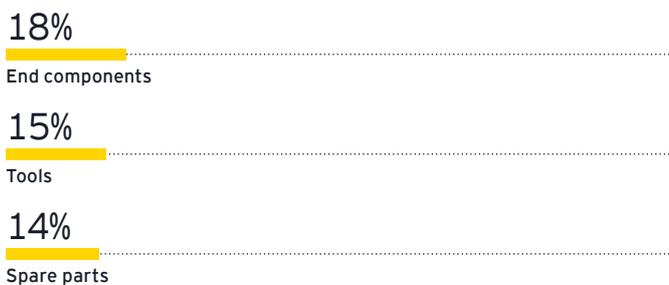
Using AM for prototyping yields benefits, but the real breakthrough comes when companies apply AM for functional parts.

There are three main types of functional parts that AM can deliver:

- ▶ End-use components and final parts used by the ultimate client or consumer
- ▶ Tools, molds, etc., for use in traditional manufacturing
- ▶ Spare parts made on demand from digital warehouses

Understanding that AM has evolved beyond prototyping and can be used to make functional parts is often a key step toward its adoption.

**Chart 4**  
Companies' use of AM to make functional parts (%)\*



\*n=900 companies, EY global 3DP survey, April 2019

## Direct AM accelerates

There has been a sharp increase in the use of AM for functional parts. Almost one-third of surveyed companies apply 3DP to produce one or more of the three types of functional parts outlined above. Eighteen percent use the technology to make end components; indicating that AM encompasses far more than a spare parts manufacturing technology. Airbus, for instance, has been installing 3D-printed titanium alloy brackets in serial production aircraft since 2017<sup>5</sup>, along with latch shafts for A350 XWB doors.<sup>6</sup> For Airbus, AM delivers improved lightweight structures at a lower cost than traditional manufacturing.

Nevertheless, AM is increasingly being used to directly manufacture tools and spare parts too, by 15% and 14% of companies respectively – almost double than in 2016. Indeed, our survey shows that almost 17% of all automotive companies now apply the technology for tooling because 3DP offers the potential for enormous cost savings.

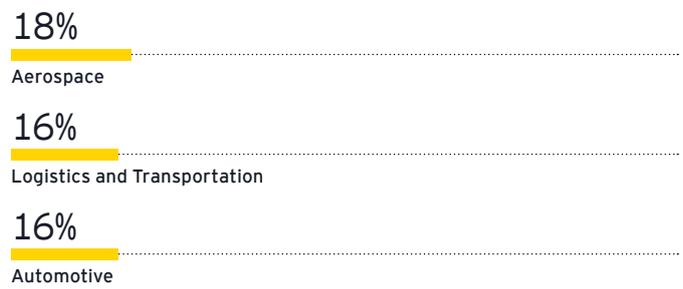
When it comes to spare parts production, AM addresses several major aftersales and repair cost drivers: high inventories, older spare parts that become special request items, outdated or non-mover parts in warehouses, and transportation. It is therefore unsurprising that, as indicated above, 14% of all companies take advantage of these savings by directly manufacturing spare parts with AM. Heading this trend is Aerospace, at 18%, followed by the Automotive, and Logistics and Transportation sectors, both with 16%. Railway company Deutsche Bahn, for instance, has been using AM for its spare parts since 2015.

5 **Airbus Media**, Airbus website, <https://www.airbus.com/newsroom/press-releases/en/2017/09/first-titanium-3d-printed-part-installed-into-serial-production-.html>, accessed 30 July 2019.

6 **Airbus Media**, Airbus website, <https://www.airbus.com/newsroom/press-releases/en/2018/09/airbus-helicopters-to-start-large-scale-printing-of-a350-compone.html>, accessed 30 July 2019.

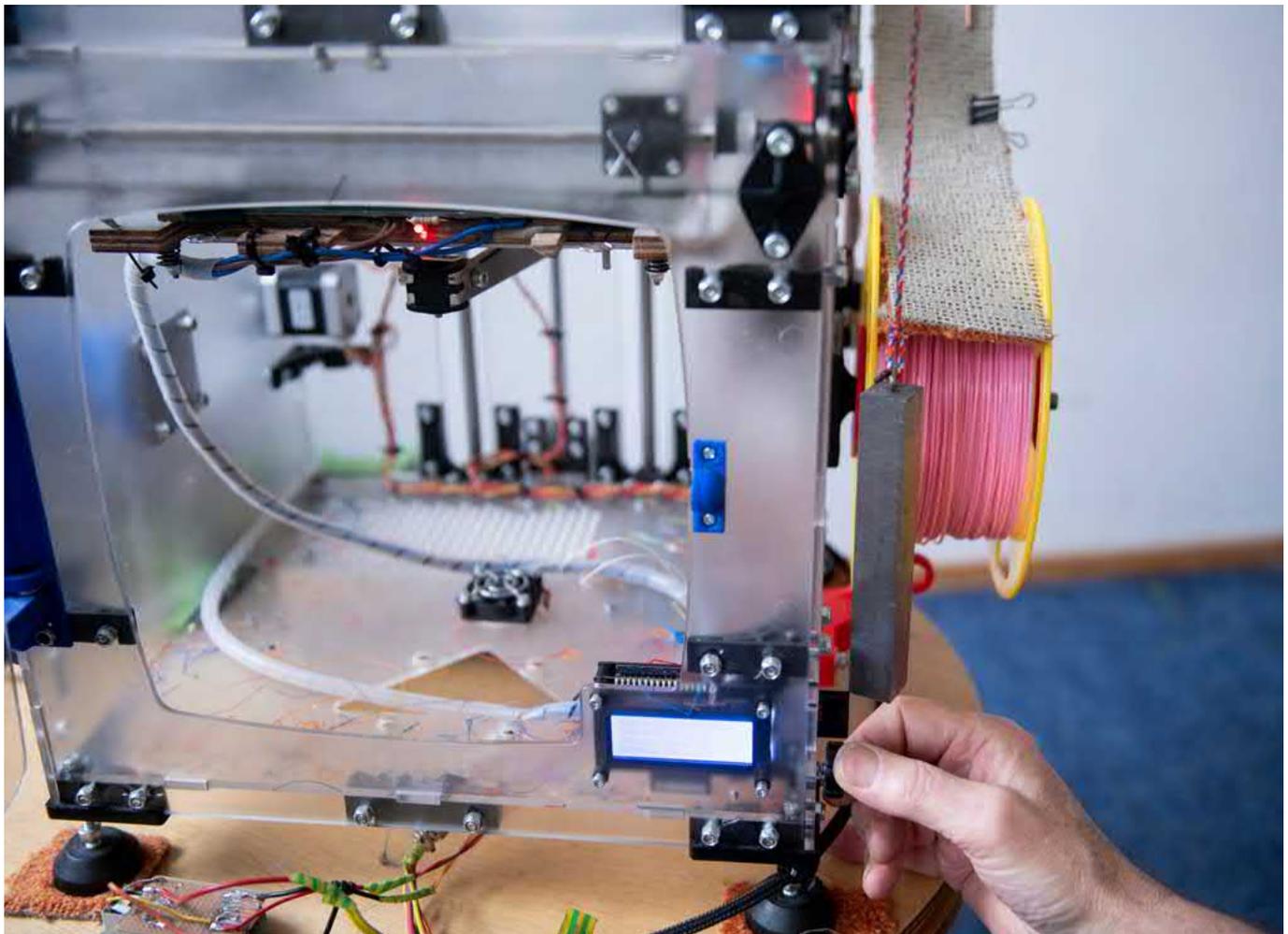
The company has built a network of more than 80 AM players, consisting of research institutions and systems manufacturers, to leverage the knowledge to apply the technology efficiently.<sup>7</sup>

**Chart 5**  
Top three industries that apply AM to make spare parts (%)<sup>\*</sup>



<sup>7</sup> *3D natives News*, 3D natives website, <https://www.3dnatives.com/de/3d-druck-deutsche-bahn-110420181/>, accessed 30 July 2019.

<sup>\*</sup>n=900 companies, EY global 3DP survey, April 2019



## Reaching the early majority

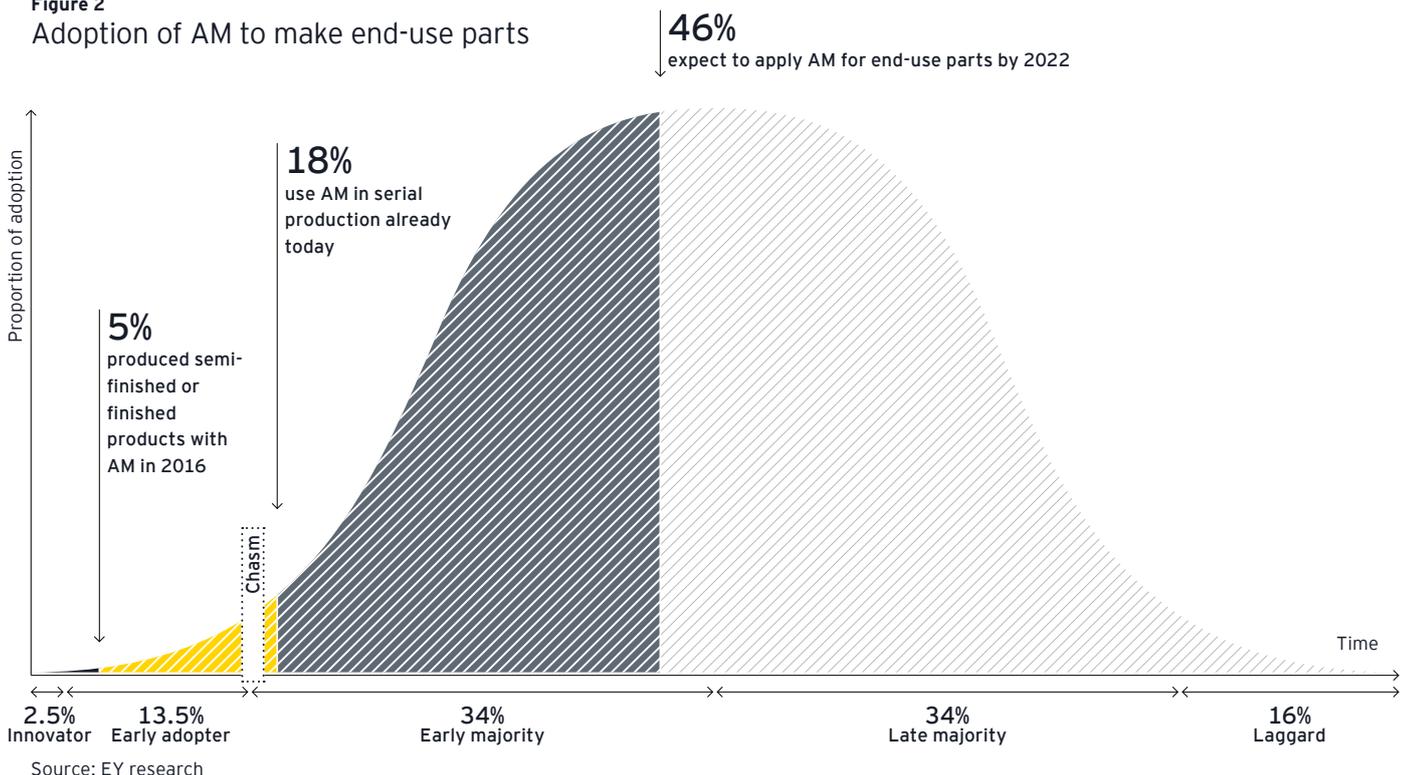
AM technology is reliable and mature enough to produce end parts and components, but the question arises how many companies actually use it for this purpose. Understanding the current level of adoption will help identify when AM will break through and be used to its full potential. To quantify how far AM has been accepted, we applied our survey results to the technology adoption life cycle model.<sup>8</sup> This model assesses the penetration of new technologies via their progression with different types of customers, with the population being divided into innovators, early adopters, early majority, late majority and laggards. While innovators and early adopters appreciate the advantage of being first movers, the early majority wishes to obtain a degree of certainty about a technology's potential and solid evidence of its reliability and benefits before adopting it.

Convincing this group is crucial for sustainable growth of a technology and is known as 'crossing the chasm'. According to this theory, a technology has been accepted by a critical number of companies when it has penetrated more than 16% of the full cohort.

In 2016 we found that AM was being applied for end parts and components by 5% of companies, across all surveyed industries and countries; this year, that figure rose to 18%. This means that AM has reached – and exceeded – the crucial tipping point, from being the focus of enthusiasts and visionaries to becoming a technology with broad applications. In other words, adoption of AM has reached another level, which is likely to lead to even more activity and growth in the market.

<sup>8</sup> Geoffrey A. Moore, *Crossing the chasm* (3rd edition, p.14., 2014).

**Figure 2**  
Adoption of AM to make end-use parts



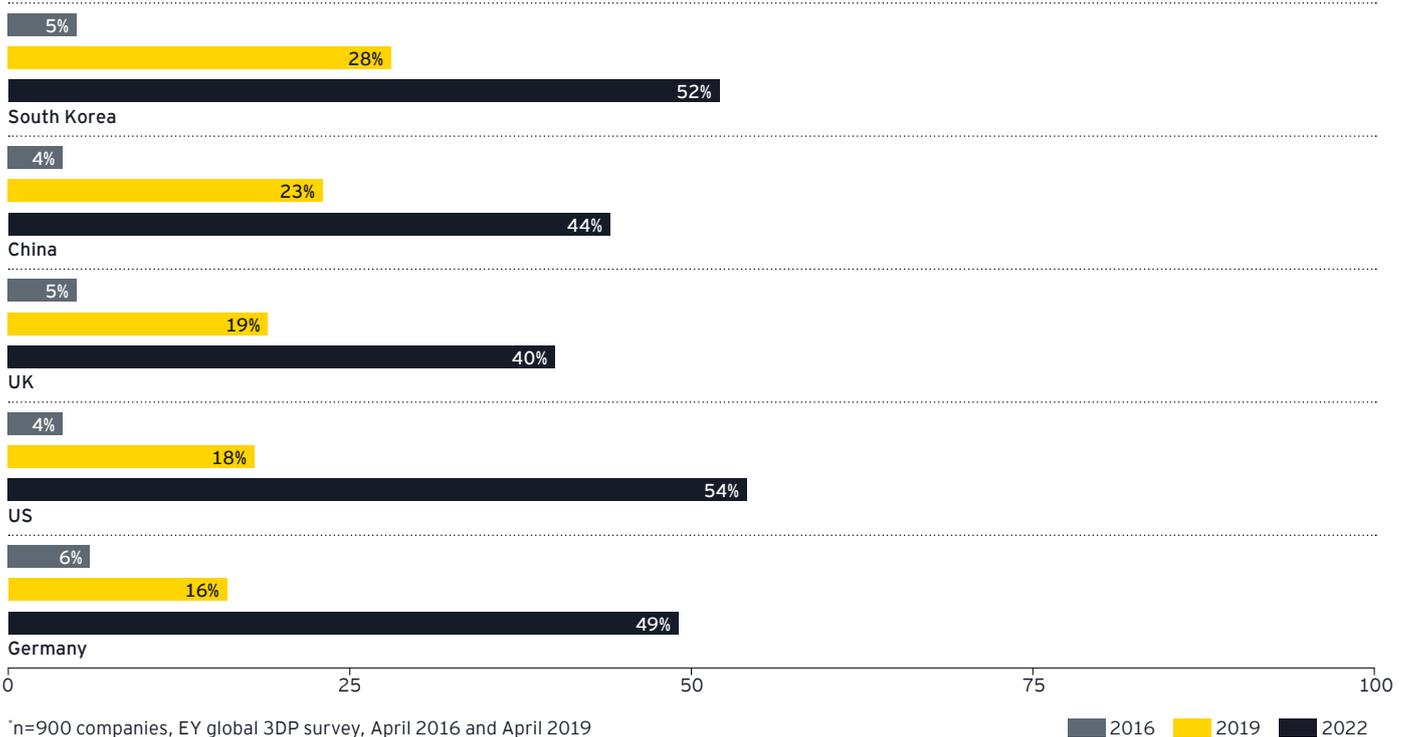
## Serial AM production: Asia again sets the pace

This adoption and growth trend appears set to continue: 46% of surveyed companies expect to apply the technology for their serial products by 2022. However, the current level of adoption and expected growth varies significantly among regions. Asia is setting the pace and the region's countries are the leading adopters of AM and among the most optimistic in planning to use the technology within the next three years. This marks a major shakeup in the ranking of countries. Three years ago, although there was significant interest among Asian companies, they lagged behind others such as Germany and the United States.

Asian countries have now left everyone else behind. In doing so, they were supported by a rising number of Asian AM systems manufacturers offering cheaper alternatives to established powder bed fusion systems, and by governmental initiatives such as China's high-tech manufacturing plan.



**Chart 6**  
Use of AM for making end products 2016, 2019 and 2022 (forecast) (%)\*



## AM maturity boosts sector growth

When it comes to industry penetration, Life Sciences and Chemicals lead the field. More than one in five (22%) surveyed companies in both sectors use AM to make end products. Aerospace comes next at 18%.

Life Sciences' strong showing is perhaps predictable. The increasing maturity of AM technologies has boosted the sector as spin-offs such as state-of-the-art implants, hearing aids and other personalized medical devices offer a clear competitive advantage. Even the pharmaceuticals market is now yielding numerous examples of personalized medicines approved by the US Food and Drug Administration.

Chemicals players include producers of chemical raw materials and of semi-finished or finished goods such as plastics. They have taken advantage of the technology both to produce parts for themselves and to become vendors of AM materials to other companies. This is well showcased by BASF, which set up a dedicated AM business unit both to produce its own machine parts, such as heat exchangers,<sup>9</sup> and to target external customers, by developing materials and processes and offering 3DP engineering services.<sup>10</sup> The German company's successful entry into the additive market saw it both leverage its own in-house knowledge and acquire Dutch AM materials supplier, Innofil3D.<sup>11</sup>

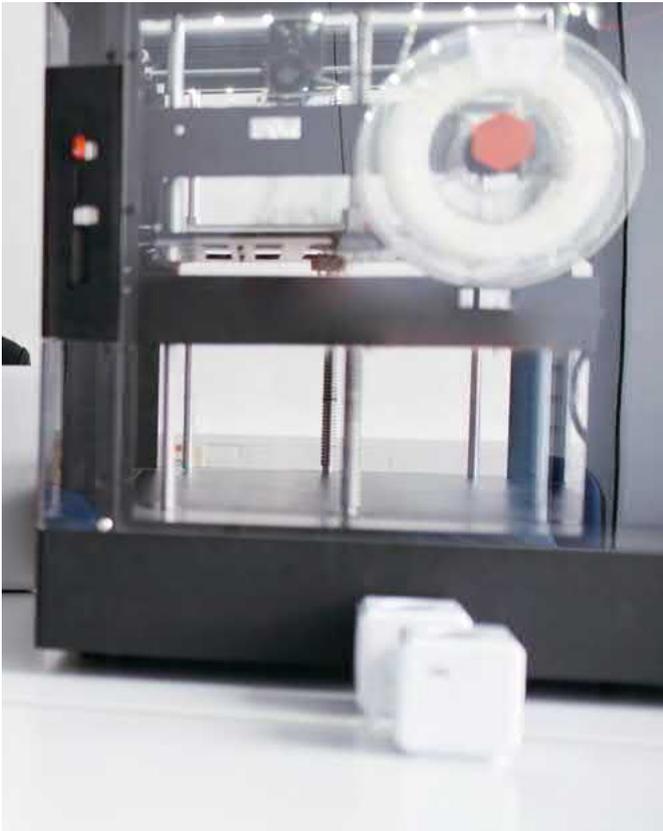
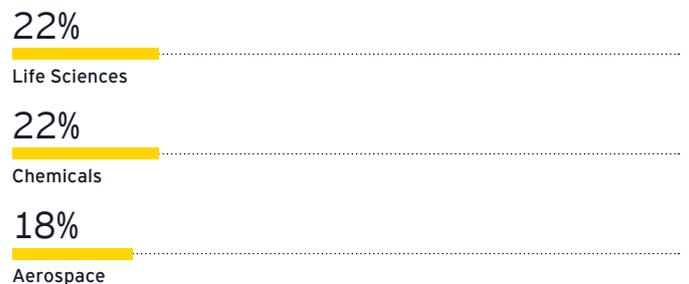


Chart 7  
Use of AM for making end products (%)\*



\*n=900 companies, EY global 3DP survey, April 2019

9 *BASF uses 3D-printed parts at site facilities*, BASF YouTube channel, <https://www.youtube.com/watch?v=S6MaRBTTVDY>, accessed 30 July 2019.

10 *BASF Organizations*, BASF website, [https://www.basf.com/global/en/who-we-are/organization/locations/europe/german-companies/BASF\\_New-Business-GmbH/our-solutions/3d-printing.html](https://www.basf.com/global/en/who-we-are/organization/locations/europe/german-companies/BASF_New-Business-GmbH/our-solutions/3d-printing.html), accessed 30 July 2019.

11 *Innofil3D News*, Innofil3D website, <https://www.innofil3d.com/basf-acquires-filament-producer-innofil3d/>, accessed 30 July 2019.

## How will AM serial production evolve?

By 2022, 46% of the surveyed companies expect to use AM as a production technology for their end-use products. We see two different scenarios: that AM will replace traditional manufacturing technologies or that it will become an additional production technology.

If AM were to replace other technologies, it is likely to be because it enables more economic production or, on the other hand, validates more expensive production processes by delivering added value to products that better meet customer needs. If, alternatively, AM was to continue to co-exist with other production technologies, this would probably be an application-driven decision.

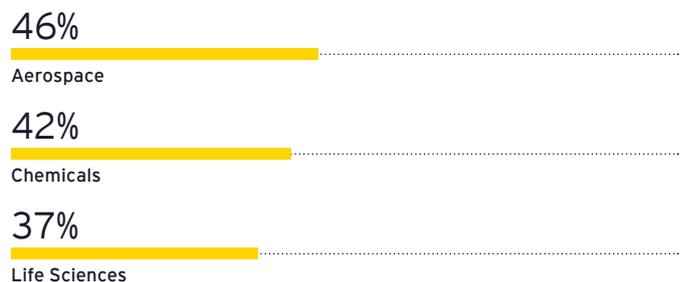
The EY survey shows that 34% of all companies believe that AM will become an additional production technology, with only 12% thinking it will replace other technologies. From an industry perspective, aerospace companies are most inclined to think that AM will become an additional technology, followed by chemicals and life sciences businesses respectively. This reflects the aerospace sector's long-held conviction of and its demonstration of the advantages of AM. Aerospace pioneered the use of AM for making end-use parts, redesigning and improving their utility through functional integration and with lightweight and internal structures. It continues to work on identifying new applications. The chemicals sector's strong opinion may reflect its close connection to the AM market with almost every global Chemicals player having shown interest in the technology including BASF<sup>12</sup>, Dow<sup>13</sup>, Sabic<sup>14</sup> and Solvay<sup>15</sup>. Chemicals businesses are well informed about 3DP because of their core business as polymer providers and due to their existing customer base.

**Chart 8**  
Expected future use of AM (%)\*



The application of the technology for serial production will drive increased demand for AM materials, creating another revenue stream for chemicals companies. The enthusiasm of 37% of life sciences companies for AM as an additional production method can be explained by the strong aptitude of 3DP technology for personalization across many applications.

**Chart 9**  
Top three industries: AM as a future additional production technology (%)\*



12 **BASF Organizations**, BASF website, [https://www.basf.com/global/en/who-we-are/organization/locations/europe/german-companies/BASF\\_New-Business-GmbH/our-solutions/3d-printing.html](https://www.basf.com/global/en/who-we-are/organization/locations/europe/german-companies/BASF_New-Business-GmbH/our-solutions/3d-printing.html), accessed 30 July 2019.

13 **Dow News**, Dow website, <https://corporate.dow.com/en-us/news/press-releases/dow-3d-printing-evolv3d>, accessed 30 July 2019.

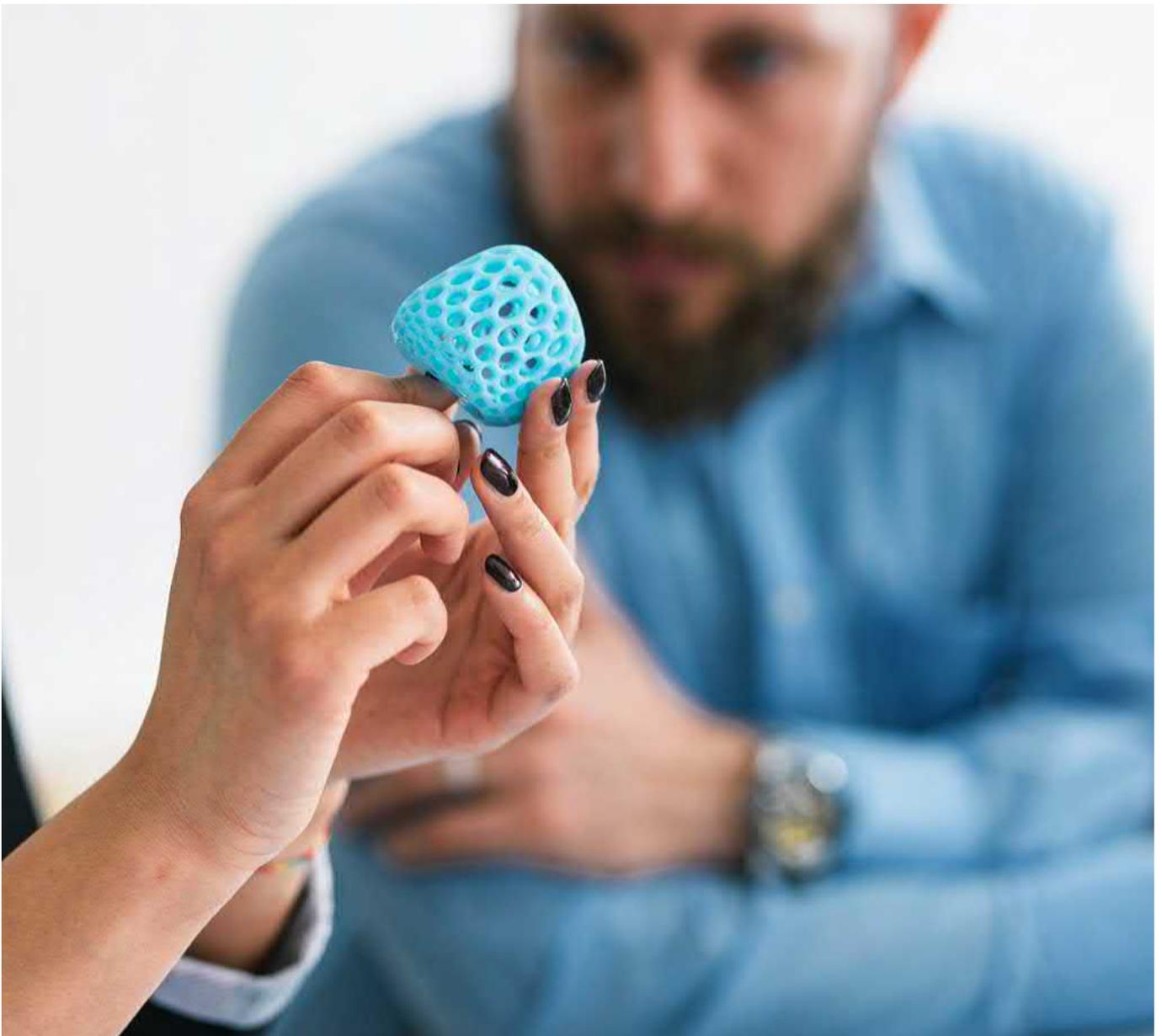
14 **Sabic Products**, Sabic website, <https://www.sabic.com/en/products/specialties/additive-manufacturing>, accessed 30 July 2019.

15 **Solvay News**, Solvay website, <https://www.solvay.com/en/press-release/solvay-specialty-polymers-takes-additive-manufacturing-next-level>, accessed 30 July 2019.

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The alternative view, that AM could replace traditional production technologies, is held particularly strongly by logistics and transportation companies. If – as we suggest above – AM might replace conventional processes if it delivered economic benefit or added value, the industry is likely to back this scenario because of 3DP's logistical benefits. Manufacturing closer to customers can have

a huge financial impact since it saves handling and transportation costs and reduces potential customer downtime. As companies rethink their business models in the context of AM's future development, such factors are likely to shape logistics companies' views on the best way to apply the technology.



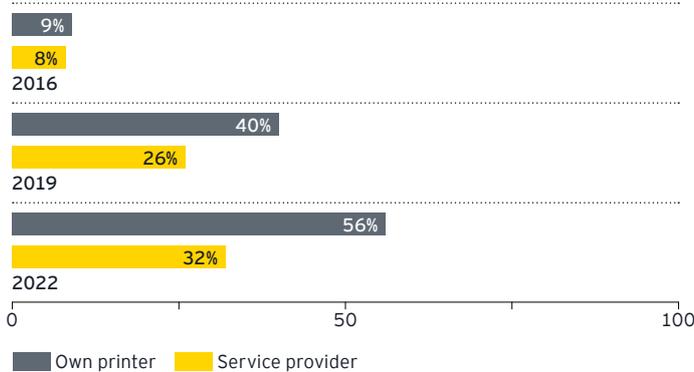
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# Choosing the right 3DP operating model

To what extent should companies use their own resources to drive their adoption of 3DP and to what extent should they rely on external experts and systems? This is the key question facing firms as they look to integrate AM into their operations.



**Chart 10**  
The level of companies using their own AM systems/external service providers (%)\*



\*n=900 companies, EY global 3DP survey, April 2016 and April 2019

The survey suggests that both 3DP operating models will remain relevant, with each attracting rising numbers of companies. The number of surveyed organizations with AM systems in house more than quadrupled in the past three years, leaping from 9% to 40%. There has also been a significant increase in the percentage using service providers, which more than tripled to 26%. Reflecting the predicted rise in the use of AM technology, these figures are likely to continue accelerating. By 2022, 56% of surveyed companies expect to have invested in their own systems, while nearly one-third (32%) expect to design and produce their AM parts via service providers.

For those wishing to own their system, another pressing question is what sort they should buy. There are two broad types: desktop models and industrial systems. Desktop systems are mainly aimed at the consumer market, with companies primarily using them only for testing. Costs start from less than \$US5,000. Professional industrial systems, on the other hand, fall within the range from \$US20,000 to over \$US1m. Of the companies that intend to own an AM system by 2022, more than two thirds (67%) predict they will have a desktop 3D-printer compared with the 29% that plan to own an industrial-scale system. Four percent assume they will have both.



## Why do companies use 3DP service providers?

Organizations collaborate with service providers for three main reasons:

### I. They are at the beginning of their AM journey and don't want to invest in industrial systems or capabilities before they are clear about what they will use 3DP for and what its impact will be.

Around four out of five (81%) of those that predict they will work with service providers in the future say they will do so because they don't want to invest in their own systems. Of this number, 75% either have no experience with AM or are at the experimenting phase (Level 1 and 2 of maturity). With systems' and materials' costs so high, companies that are not yet committed to 3DP are clearly wary about taking the financial leap.

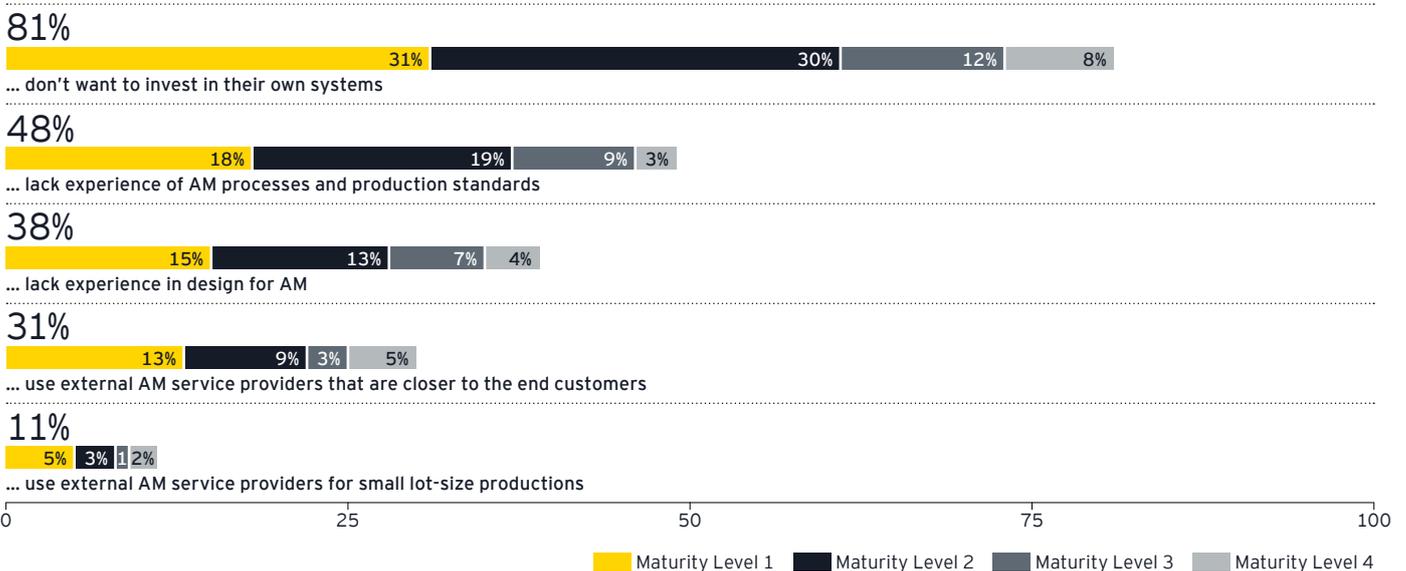
Limited in-house experience is another factor inhibiting companies from going it alone: 48% say they will work with service providers because they are unfamiliar with AM processes and standards, with 38% citing their uncertainty around AM design.

### II. Service providers usually offer systems using various AM sub-technologies. Companies wishing to use different applications at low volume find it cheaper to use providers' technology and skills than investing in their own.

### III. Companies that make products on demand close to the point of use can deliver added value. For example, factory downtime can be reduced if spare parts are just a short journey away. It can therefore make sense to transfer production to a local service provider.

Almost one-third (31%) of companies say they will work with service providers in the future to manufacture close to the point of use.

Chart 11  
Companies would use AM service providers, because they... (%)\*



\*n=120 companies that would use AM service providers, EY global 3DP survey, April 2019

## How will AM shape future operations and supply chains?

Company supply chains will experience dramatic reshaping under the impact of AM. The entry of service providers into the supply chain and a likely exponential increase in the use of AM for end parts and products will radically transform the status quo.

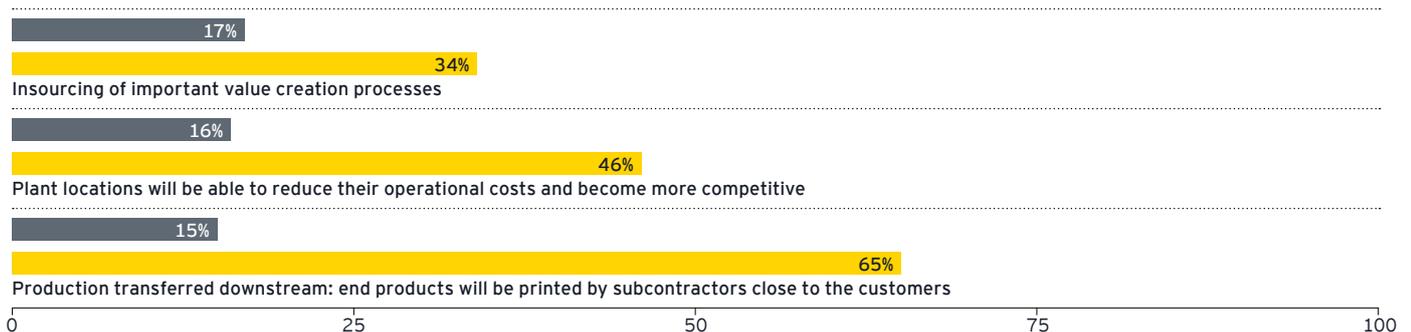
This transformation will open up both opportunities and challenges for companies across different sectors. For example, moving production closer to the point of use will radically reduce haulage distances, with a seismic impact on logistics firms. Downstream manufacturing will also shrink inventories, thus reducing the working capital required to keep items in stock. Rather than accumulating parts and products in physical stores, they will be able to keep virtual stock in 'digital warehouses', to be printed on demand by service providers. This is already reaping particular benefits in bespoke production, as seen in dentistry and life sciences. In 2020, New York's Hospital for Special Surgery (HSS), a leading orthopedic hospital, will join the list of leading healthcare providers with an onsite 3D printing unit following a joint project with Italian medical implant company LimaCorporate. The facility will design and produce titanium patient-specific orthopedic implants made by Arcam, a GE Additive company. The venture will act as a test bed for LimaCorporate to roll out 3DP services to hospitals across the US.<sup>16</sup>



16 *3Dprintingindustry News*, 3Dprintingindustry website, <https://3dprintingindustry.com/news/limacorporate-to-open-implant-3d-printing-facility-at-hospital-in-new-york-146661/>, accessed 30 July 2019.

**Chart 12**

Due to AM, companies expect the following changes to their current value chains (%)\*



\*n=900 companies, EY global 3DP survey, April 2016 and April 2019

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## 3DP on the high street

As both demand for personalization, and the 3DP industry itself, grows apace, AM production looks likely to become embedded in more commonplace locations. Almost two thirds of survey respondents can now foresee producing close to customers – up a massive 50 percentage points from 2016 (15%). Consumer goods companies have even higher expectations with 70% forecasting this evolution. So, it might not be long before individuals can step into their local copy shop to buy a pair of unique personalized shoes in their bespoke size made with their preferred materials and customized with the, patterns and colors of their choice.

Nearly one in two (46%) companies expect AM to help them reduce operational costs in factories and to boost their competitiveness. This figure has risen a striking 30 percentage points in just three years. This cost containment expectation could refer to both applying 3DP to produce parts at a lower overall cost – as with smaller lot sizes, reduced tooling and change-over costs and faster delivery times – and to using the technology to improve existing operations, as with better tools, jigs/ fixtures, spare parts, etc. Reflecting their early adoption of AM, aerospace companies have the highest expectations in this regard at 62%.

Additionally, more than one-third of companies (34%) – double the 2016 figure – think AM could boost their competitiveness by enabling them to value creation processes back in house. This view is most strongly held by logistics and transportation companies at 44%.





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# Growing up with AM

To demonstrate the different stages of a company's additive manufacturing journey, EY teams have developed the following AM maturity model. This ranks organizations according to key factors across four different levels of maturity. These include how companies perceive and assess the relevance of AM and how – and to what extent – they apply it.

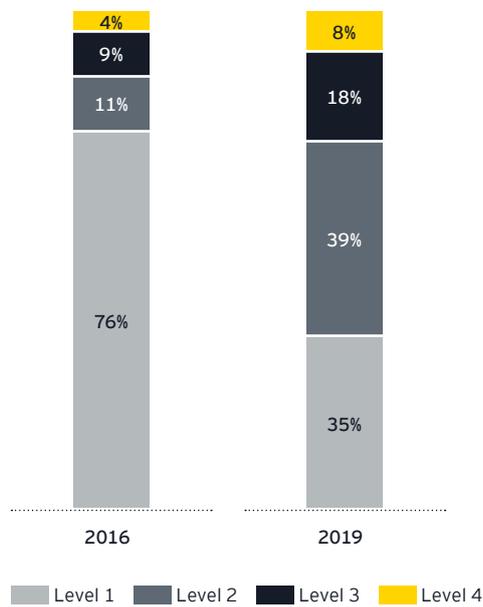
**Figure 3**  
Definition of AM maturity levels.

Maturity level	Strategic direction	Organization and processes	Technology enablement	Value and performance management
<b>4</b> Strategic application across company	<ul style="list-style-type: none"> <li>▶ Application of 3DP embedded in company's strategy</li> <li>▶ C-level sponsorship</li> </ul>	<ul style="list-style-type: none"> <li>▶ 3DP embedded in relevant operational areas with clear organization and process</li> </ul>	<ul style="list-style-type: none"> <li>▶ Own or joint ventures 3DP production locations</li> <li>▶ Own or joint 3DP research centers</li> </ul>	<ul style="list-style-type: none"> <li>▶ Embedded measurement of how applying 3DP improves efficiency</li> </ul>
<b>3</b> Application in "champion" departments	<ul style="list-style-type: none"> <li>▶ Clear direction on application of 3DP in a certain area</li> </ul>	<ul style="list-style-type: none"> <li>▶ "Champion" departments have integrated 3DP into operations</li> <li>▶ First cross-functional teams</li> </ul>	<ul style="list-style-type: none"> <li>▶ Own systems from relevant technology</li> <li>▶ Established collaborations</li> </ul>	<ul style="list-style-type: none"> <li>▶ Measurable results within specific departments or areas of application</li> </ul>
<b>2</b> Experimenting and testing	<ul style="list-style-type: none"> <li>▶ Department leaders start to invest, test and understand the technology</li> </ul>	<ul style="list-style-type: none"> <li>▶ Teams of enthusiasts test 3DP technology</li> <li>▶ No structured processes for application of 3DP</li> </ul>	<ul style="list-style-type: none"> <li>▶ Testing different technologies with service providers, research group or own cheap systems</li> </ul>	<ul style="list-style-type: none"> <li>▶ First own use cases with measurable results</li> </ul>
<b>1</b> No experience	<ul style="list-style-type: none"> <li>▶ Leadership has no or low awareness about 3DP and application in the company</li> </ul>	<ul style="list-style-type: none"> <li>▶ Eventually, first evaluation and consideration of possible</li> </ul>	<ul style="list-style-type: none"> <li>▶ Eventually first considerations of form of application (own system, cooperation)</li> </ul>	<ul style="list-style-type: none"> <li>▶ No own experience. Eventually, review of experience from other companies</li> </ul>

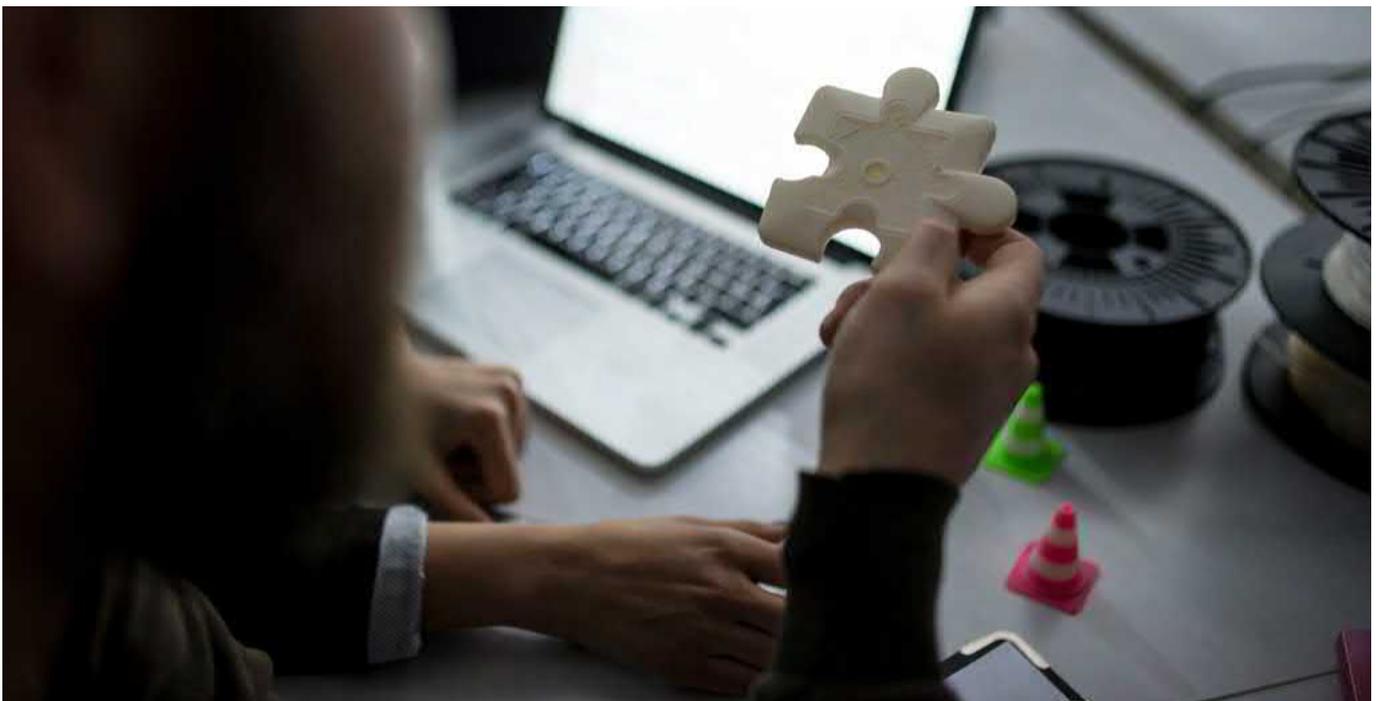
Source: EY

The model includes characteristics of companies at all stages of AM experience. These range from Level 1 organizations which have no experience of 3DP to Level 4 companies that deploy AM company-wide typically with C-level sponsorship and a clear strategic direction of where and how to use it. The latest EY survey reveals that there are twice as many businesses (8%) at the top maturity level than there were in 2016. Although some general improvement is to be expected over three years, closer examination of patterns within individual sectors and of the reasons why companies are at certain levels provides valuable insight as discussed below.

**Chart 13**  
Maturity levels of the surveyed companies (%)\*



\*n=900 companies, EY global 3DP survey, April 2016 and April 2019



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## Level 1: no experience

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The amount of companies at Level 1, without AM experience, has almost halved since 2016 – falling from 76% to 39%. Although those businesses are still 3DP novices, the survey shows that this does not mean they are unaware of the technology or its benefits. Two-thirds intend to gain some experience but have not identified the benefits or could not yet apply the technology, while the remainder see AM as irrelevant to them. The high cost of AM systems and materials is the main reason why organizations are holding back. Companies at all maturity levels see high systems' costs as a barrier to implementing AM, but this sentiment is three times higher among Level 1 businesses than any of the others. This may be because companies that are not able to identify the right winning application or are still assessing the business case for AM are simply comparing costs with traditional manufacturing technologies.

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## Level 2: initial experience and testing

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Level 2 companies are the largest of the four groups, representing 39% of respondents and up 28 percentage points from the 2016 figure. The significant increase in organizations beginning to invest in 3DP over the past three years underscores the huge expansion of interest in the technology. Level 2 companies have just started their AM journey and gained their first experiences. They might use their own equipment, usually a desktop printer, for testing activities. However, many will seek help from service providers as they don't want to invest much money in systems and lack in-house knowledge. The aerospace sector has both the highest share of Level 2 companies and the lowest portion of those at Level 1. This serves to demonstrate the high maturity of this sector as almost every company has, at the very least, tested AM technologies. Nevertheless, at this stage there is still a gap between the testing environment and having a structured approach to implementing and utilizing the technology. Almost half of Level 2 companies say they could not yet assess the relevance of AM for their business. These companies require the greatest support in the technology's benefits into their business case.

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## Level 3: utilizing AM in selected departments

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Level 3 companies have identified first use cases and generated measurable results of AM in their organizations. They are working to transfer the knowledge gained to other departments, to identify further applications and fully integrate the technology into existing processes. For more than 70%, the technology is an important or strategic topic and part of their daily business. South Korean and Chinese respondents represent the highest share of Level 3 companies, a large increase on our 2016 report results. From a sector perspective, there is a significantly large proportion of life sciences companies at Level 3 (25%). The growing demand for personalized and customized medical products, enabled by AM, has made the technology a competitive necessity in this industry. In the dental sector, for instance, custom-fit prosthesis is now an integral part of the offering.

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## Level 4: evolving business models to leverage AM

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A strategic approach to implementing AM and an assessment of its importance and implications for the whole organization, is the crucial factor that sets Level 4 companies apart. Such organizations understand clearly how AM can generate efficiencies, growth opportunities, and possibly a business model realignment in their organization. When these companies apply AM in their own operations, they oversee the technology and many have direct manufacturing 3DP applications. Even more than at Level 3, these organizations are aware of the product-specific benefits and the inherent changes to their supply chains. As a result, many Level 4 companies not only apply AM for their own businesses but also become 3DP providers to the external market. The increasing use of AM for operations, affecting many of their business models, will have prompted them to take this step even if it requires them to adapt their business models and markets.

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# How AM can give businesses a competitive edge

Companies increasingly recognize that AM is not just another way to make the same old parts. They appreciate that the technology allows them to design and produce parts that are much more complex and enabling than ever before. They can, for example, create different types of geometrical structures honed to meet specific needs, make lightweight products with bionic structures, and produce one-piece parts that were formerly assembled from multiple pieces – even integrating internal structures that were previously within inaccessible spaces.



## AM could deliver three ascending levels of benefit for businesses:

- 1. Efficiency** – AM is applied within the existing supply chain and operations to improve efficiency (for example, with better prototypes, molds and machine parts, or as a production strategy for lot size one parts). Products are not redesigned at this level.
- 2. Growth** – AM enables the (re)design and creation of end-use products with improved functionality or ones that could not be made previously, so satisfying unmet customer needs and winning new markets.
- 3. Transformation** – AM provides the opportunity for companies to extend or change their business models, reposition themselves in the value chain, or even gain competitive advantage from the technology by becoming an AM vendor.

Figure 4  
How AM can give businesses a competitive edge.



### COMPANY



New business models



Value chain repositioning



Users become suppliers



**Business transformation**

### PRODUCT DESIGN AND CUSTOMERS' ADDED VALUE



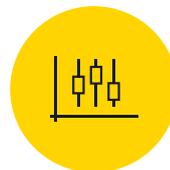
New clients and markets



New structures and geometries



Customization and personalization



Functional integration



**Growth**

### SUPPLY CHAIN AND OPERATIONS



Cost-effective product development and fast go-to-market



Efficient manufacturing processes and high utilization



Low-cost engineering and maintenance



Low inventories and reduced transportation



Digital spare parts and flexible after-sales market



**Operational efficiency**

Source: EY

## Meeting customer expectations

These capabilities give companies a competitive edge: 43% of those surveyed claim that AM helps them to better meet customer expectations. This has undoubtedly contributed to the rise in the number of organizations now using the technology to produce end-use components. And the figure seems destined to rise even further, as by 2022 more than half (56%) of those surveyed expect to better fulfill customer demands via AM. Moreover, by this date, over one-third (34%) expect to be using the technology to manufacture complex products that they could not make in the past.

Logistics and transportation companies have the highest future expectations that AM will enable them to better meet customer requirements. They realize that AM will create the possibility – and raise customer demand – for lower costs and shorter waiting times. With production likely to move downstream, many foresee a time when they will not only be delivering a part but also producing it with AM, from a design stored in their digital warehouse.



## Improved operations

AM's original value, as a prototyping technology, is still relevant for many businesses. Thirty-eight percent of companies surveyed see faster and more efficient R&D processes as a benefit of the technology and over half (54%) believe this will still be the case in 2022. Of the different sectors, almost one in two automotive companies have already experienced this advantage.

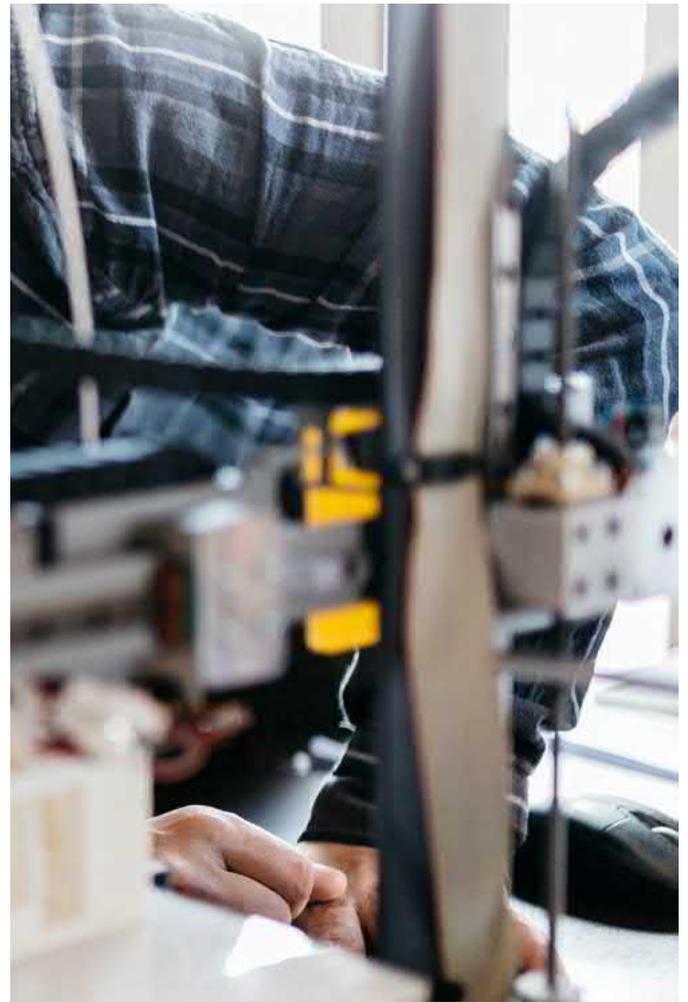
The after-sales and spare parts market is seen as clear beneficiary of AM. Almost one-third of respondents say they have already experienced a 3DP-related boost and a further 15% expect to do so within three years. Reflecting the high margin that industrial products (IP) companies generate from after-sales and spare parts, and the strong focus they place upon them, it is not surprisingly that 56% of sector companies surveyed emphasize to have already experienced this benefit. After IP companies, electronics businesses are the most likely to expect to enhance their after-sales and spare parts market with AM.

Besides prototyping, companies traditionally used AM to improve existing production processes. By enabling them to make dies and molds with internal structures and customized tools and machine parts, jigs and fixtures, the technology enhanced their traditional manufacturing and maintenance systems. This is still a major draw: almost one-third (32%) of businesses surveyed cite this as one of the primary benefits of AM. Of the various sectors, consumer products companies most recognize this potential, at 39%. Looking ahead to 2022, 48% of surveyed companies – especially those in the aerospace and chemicals industries – believe this improvement of existing production processes will remain a relevant benefit of AM.

The ability to manufacture products wherever and whenever they are needed will significantly impact company logistics, enabling organizations to reduce their warehouse inventories, handling efforts and transportation. More than one-quarter (26%) of those surveyed claim to have already experienced these benefits. Looking forward to 2022 – after manufacturing products that better meet customer needs – the reduction in logistics and transportation efforts is the AM benefit cited by the

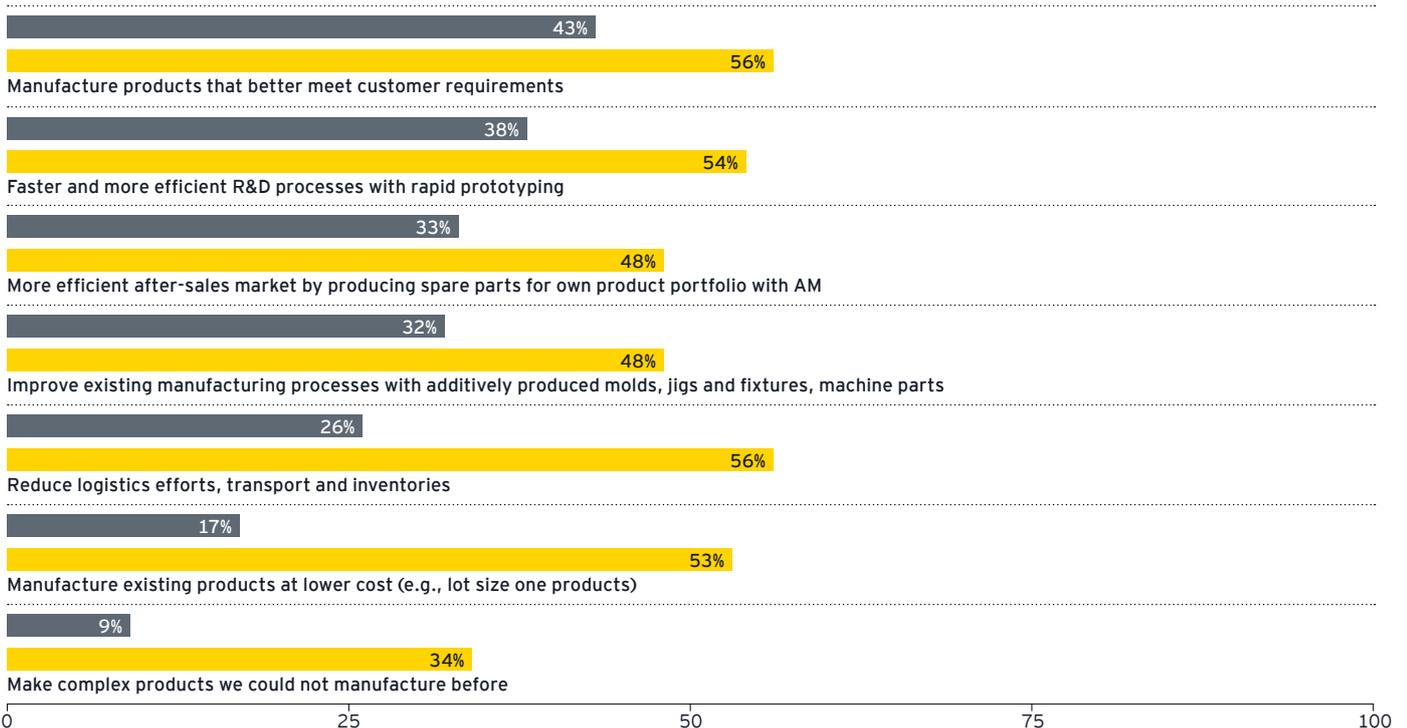
highest number of all businesses. As one might expect, logistics and transportation companies are affected most heavily by this trend.

AM production does not need to be done in batches to be economically feasible, as it does not require tools and forms. Companies can therefore make lot size one/small lot production of functional parts – indeed 17% of those surveyed are doing so already. And more than half (53%) expect to experience this benefit of AM by 2022 with companies from the aerospace and consumer products industries, where customization is in great demand, leading the pack.



**Chart 14**

What are the greatest benefits that companies expect from applying AM, both now and in three years? (%)\*



\*n=900 companies, EY global 3DP survey, April 2019

■ 2019 ■ 2022

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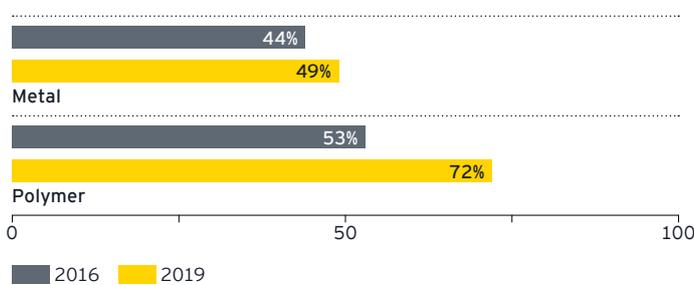
# The evolution of 3DP technologies and materials

The AM market is in a transformation phase. As 3DP systems' manufacturers strive to make machines faster, cheaper and smarter, technologies and materials are evolving rapidly.



This change is not always explicit. The seven sub-technologies that first established AM's strong market position do still dominate. This core of seven, including material extrusion, binder jetting and powder bed fusion, continue to underpin most 3DP applications. Likewise, the long-established manufacturers, such as 3D Systems and Stratasys, which – like the sub-technologies – date back more than 30 years, still lead the market. But neither the major products nor the big players are standing still. Every year, improved, bigger, and faster versions of high-performing models appear – either from the 3DP-systems market leaders or via companies exploiting the expiry of winning patents.<sup>17</sup>

**Chart 15**  
Top AM systems that companies use, by material 2016 and 2019 (%)\*



\*n=582 (214) companies 2019 (2016) with AM experience, EY global 3DP survey, April 2016 and April 2019

## Disruptive newcomers

However, as in many other industries, the real disruption comes from new market entrants. Desktop Metal, which launched in 2015 to 'advance metal 3D printing to be faster, less complex and more affordable for use within an office-environment'<sup>18</sup>, is one such disruptor. The business says its Single Pass Jetting technology makes metal parts more than 100x faster than traditional laser metal printers and 4x quicker than binder jetting equivalents, delivering higher throughput, simpler use and far lower costs.<sup>19</sup> Carbon, founded in 2013, uses Digital Light Synthesis technology and it claims that this not only delivers higher processing speeds but also creates a layerless structure with superior surface quality.<sup>20</sup>

Such innovations are transforming the AM industry and its customer base. By enabling reliable and sophisticated 3DP products to be produced quickly, simply, and more cheaply, they are making the technology attractive to a much wider population of potential buyers and investors. And – as the survey shows – companies are now buying machines from both these industry newcomers and the dominant players. When it comes to the type of materials processed, of the two most common – metal and polymer – it is much more likely to be polymer. Seventy-two percent of survey respondents – 19 percentage points up on 2016 – currently use a polymer system, compared with the 49% (2016: 44%) that access a metal one. This preference is largely price-driven, as the wide availability of low-cost desktop polymer systems means they are much more affordable. However, the less complex processing of polymer parts and their wider application may also be a factor.

17 *TechWatchNow 2019 – Plug in to the Future of Tech Innovation*, Ernst & Young, 2019.

18 *Desktop Metal Press Kits*, Desktop Metal website, <https://www.desktopmetal.com/company/press-kits>, accessed 30 July 2019.

19 *Desktop Metal Products*, Desktop Metal website, [www.desktopmetal.com/products/production](http://www.desktopmetal.com/products/production), accessed 30 July 2019.

20 *Carbon3D technology*, Carbon3d website, [www.carbon3d.com/our-technology/](http://www.carbon3d.com/our-technology/), accessed 30 July 2019.

## Metal tops AM wish list

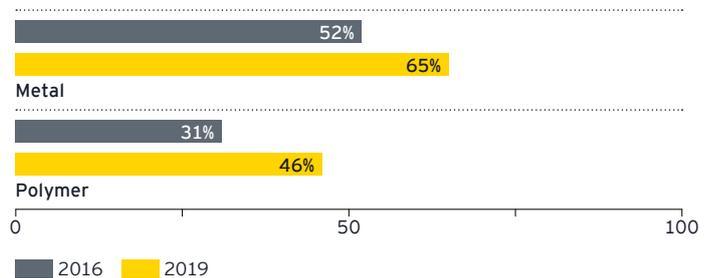
Despite the prevalence of polymer systems, most companies aspire to apply a metal printer (65%) – either their own or a service provider’s – although the attractiveness of both types has risen sharply since 2016. Metal also tops the list of the materials that most respondents would like to use for their next AM application, with 40% of all companies opting for standard alloys, while 31% cite high-performance alloys. High-performance polymers are the cross-industry population’s second choice, at 35%, with ceramics also on 31%.

Industries differ markedly, however, in the preferred material for their next AM job. Standard alloys, reflecting their relatively low cost, broad application and straightforward processing, are the top choice of five sectors, led by Logistics & Transportation (53%), Electronics (50%), and Aerospace (46%), which print metal objects for such uses as spare parts, machine parts and electroconductive parts.

Reflecting the strong penetration of 3DP in Aerospace and Electronics, these industries are also the greatest proponents of high-performance polymers, which resist heat and chemicals better than standard variants. Ceramics are cited mainly by the Automotive, Aerospace and Industrial Products sectors, where the material is used to withstand high pressure and temperatures.

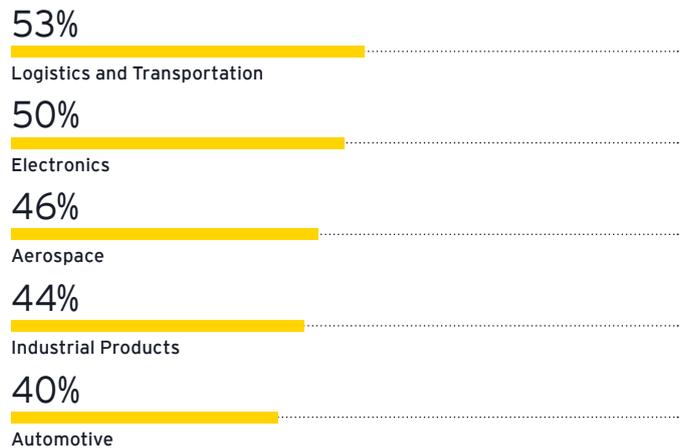
The growth in AM niche materials demonstrates manufacturers’ ability to leverage 3DP applications across a wider spectrum. More than one in five (21%) survey respondents aim to apply construction materials in their next AM process, while 10% want to use food and 7% opt for tissues and live cells. This widening material pool is likely to expand even further when 4D printing moves from the R&D lab to the factory floor.<sup>21</sup>

**Chart 16**  
Companies’ wish to apply AM for metal or polymer materials, 2016 and 2019 (%)\*



\*n=900 companies, EY global 3DP survey, April 2016 and April 2019

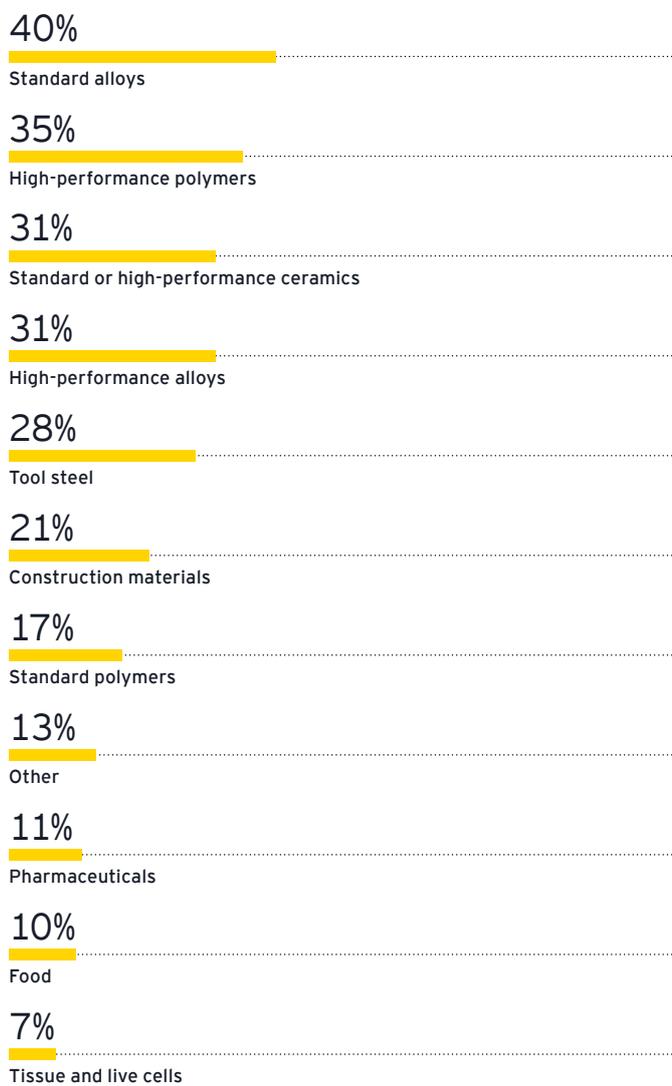
**Chart 17**  
Sector commitment to applying AM using standard alloys (%)\*



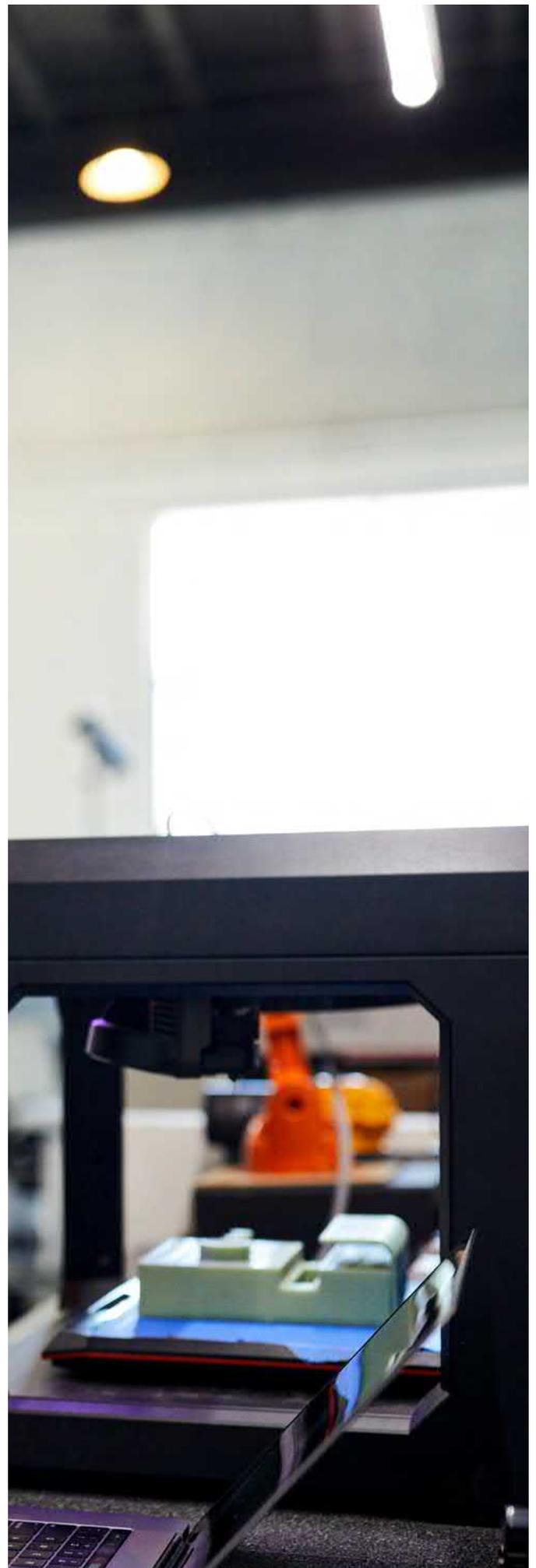
\*n=688 companies, EY global 3DP survey, April 2019

21 *TechWatchNow 2019 – Plug in to the Future of Tech Innovation*, Ernst & Young, 2019.

**Chart 18**  
Materials that companies wish to apply with AM (%)\*



\*n=688 companies, EY global 3DP survey, April 2019



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# What holds companies back from adopting 3DP?

Acceptance and adoption of AM has increased dramatically in recent years, to the point that even the cautious 'early majority' cohort has started to incorporate it in production. However, despite AM's high potential, many companies still hesitate to introduce or extend application of the technology, meaning that adoption levels are not sustainable and growth rates remain unclear.

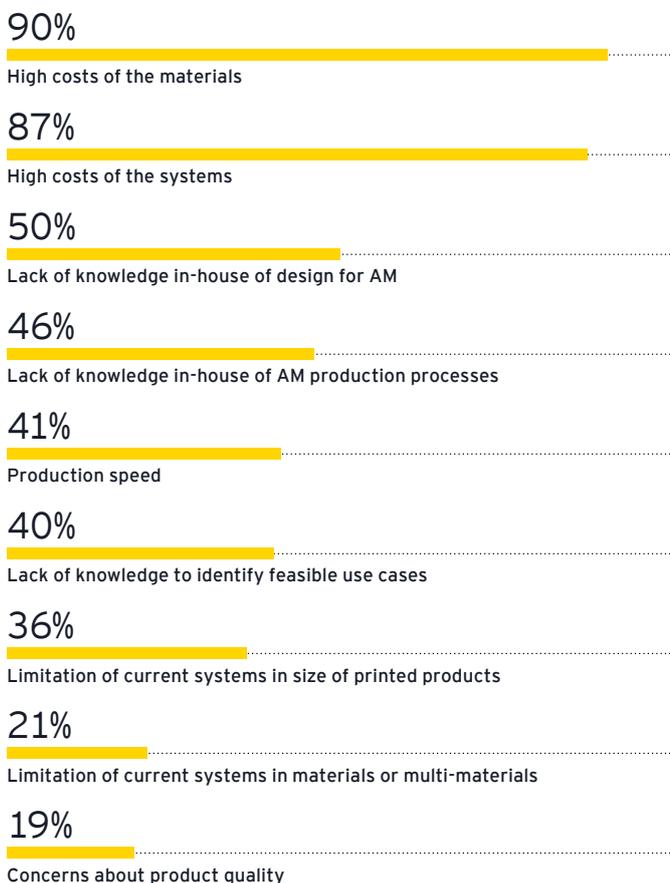


The perceived barriers can be clustered into three groups:

- I. High prices and investments**
- II. Lack of capability and know-how**
- III. Technological limitations**

The cost of AM is the chief roadblock to adoption, while limited in-house capability to identify and design related applications, oversee manufacturing and maintain machinery are also inhibiting. Technological limitations seem less of a concern.

**Chart 19**  
What are the hurdles to implementing AM? (%)\*



\*n=900 companies, EY global 3DP survey, April 2019

## I. High prices and investments

Applying AM technologies to make functional parts is undeniably costly. Industries under high margin pressure will find it particularly pressing to access AM systems and materials at competitive rates.

Ninety percent of all surveyed companies say the high cost of materials is the key hurdle to introducing and expanding the use of, AM. This reflects the fact that AM polymers and metals are still five times more expensive than the non-3DP equivalent. The limited amount of industrial AM open-system equipment is still the barrier here since systems manufacturers tend to remain dominant and retain their strong position in the value chain. Yet, open-systems would drive liberalization of materials supply, create opportunities for stronger competition, deliver new applications and positively impact material prices.

The survey demonstrates that chemicals and aerospace companies are particularly vocal about the prohibitive cost of AM materials. This reflects their strong mutual interest in the 3DP market as discussed above. Most chemicals companies intend to become AM materials suppliers or to extend their existing 3DP product offering, while aerospace companies, with their high level of direct manufacturing applications and ambition for further growth, could be the customers they need.

Similarly, 87% of companies see high systems' prices as a critical hurdle to expanding AM use. This percentage has more than doubled since 2016 from 40%, reflecting the increased interest from companies in the early stage of their AM journey. The high cost of systems means that companies which are still exploring the potential of AM prefer to work with service providers, rather than investing in their own equipment. Lower systems prices could especially boost use of AM in developing countries with strong enthusiasm for the technology. In China, for example, 95% of surveyed companies say that the cost of AM systems is the key barrier to wider use of the technology.

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## II. Lack of capability and know-how

The sustainable integration of AM into contemporary operations is only partially dependent on its benefits and limitations. Its wider use also depends on companies' ability to apply the advantages of AM design to product design, identify technologically and economically feasible use cases, and operate and maintain 3DP machinery.

Lack of knowledge about design for AM presents a key barrier for one in two surveyed companies, followed by a limited understanding of production processes, which is an additional hurdle for 46%. Effective integration of AM requires the (re)qualification of engineers, so they understand the benefits of the technology and can transfer these into product design and finished products. There remains a disconnect between company demand and the (re)skilling of experts. Some universities and institutes have now introduced AM into their curricula but they are in the minority and there is a clear need for decisive action. Furthermore, making AM an integral part of the university curriculum is just one step. The next generation should learn about the technology during primary education so they grow up as AM natives.

Forty per cent of companies also find that identifying feasible AM use cases is a significant challenge. As most of these organizations have no experience with AM, or are still experimenting with the technology, finding the right use cases and quantifying the benefits is essential for its adoption. However, this is often a time-consuming manual task rather than the structured and automated process it would ideally be.

## III. Technological limitations

AM technologies are mature production technologies yet that offer room for improvement, a factor seen as a hurdle to adoption by some companies.

For 41%, speed is an issue when considering AM as a production technology. Additionally, in most AM processes production speed is directly linked to product quality, which is a concern for 19%. With material extrusion or powder bed fusion technologies, for instance, increasing layer thickness enables a higher production speed but affects quality.

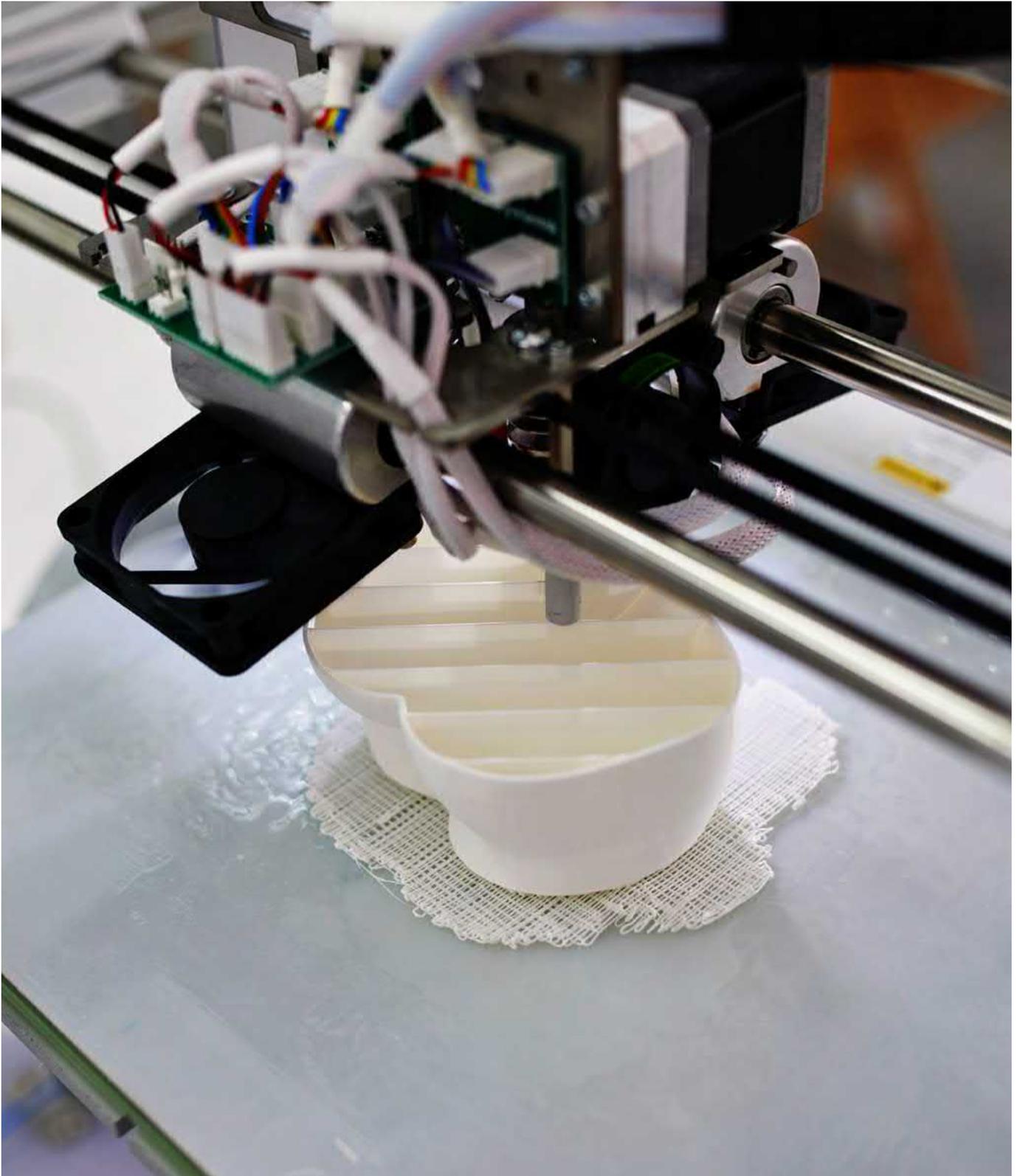
Product quality is already very high across the various sub-technologies, especially powder bed fusion processes, which are attracting strong attention from industrial users. Nevertheless, powder bed fusion systems are still relatively slow and hence not ideal for producing large volumes quickly. Therefore, various companies launched innovative sub-technologies that combine fast production speeds and good product quality. Powder bed fusion is itself experiencing major developments, as shown, for example, by the latest four-laser-system from GE Additive<sup>22</sup> which accelerates the speed of printing metal parts while lowering costs due to increased productivity.

As AM technologies constantly evolve, the increase in quality of "prints" goes hand-in-hand with the development of larger machines: Portuguese company Adira's addcreator system, for example, has a 500-liter building envelope.<sup>23</sup> More than one in three of all companies that took part in our survey want 3DP machines to be able to make bigger parts.

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<sup>22</sup> *GE Additive Systems*, GE website, <https://www.ge.com/additive/additive-manufacturing/machines/project-atlas>, accessed 30 July 2019.

<sup>23</sup> *Aniwaa 3D printers*, Aniwaa website, <https://www.aniwaa.com/product/3d-printers/adira-addcreator/>, accessed 30 July 2019.



AM technologies offer a wide range of applications for producing large parts made with other materials. Many of these are based on material extrusion processes, for example, concrete printers for making whole houses or polymer extrusion systems to produce car bodies.

However, the technological capabilities of multi-material processes have not changed significantly in the past three years and industrial end-users are increasingly

asking for special single-material applications. Existing AM materials meet the demands of many users. However, some uses require engineered and customized materials to ensure the properties of certain parts, or to achieve ideal processing. This is especially for metal materials since special alloys, for instance those that are titanium-based, can require particular treatments.

# AM trends, developments and challenges

The AM market is expanding fast, with annual market revenue growth topping 29% during the financial years between 2015 and 2018. The number of industry players also exploded in that period, increasing from around 600 to more than 1,300 and offering all types of AM products and services. And the tally is increasing every day, as more and more start-ups enter the arena.



## What kind of companies are in the market?

We classify players into three main groups:

### ► **Established AM "incumbents"**

Founded between 1980 and 2010, these pioneering companies grew by inventing or commercializing core AM sub-technologies. They still generate a significant portion of sector revenue and retain strong market positions. Notable businesses include Stratasys, 3D Systems, EOS and Materialise.

### ► **Industrial companies**

Traditional industrial companies with no AM heritage. Well positioned in sectors such as chemicals, industrial products and metallurgy, these businesses moved into AM to extend their offering/product portfolio. They entered the market as suppliers (either organically, as strategic investors, or in joint ventures). Having experienced the potential of AM as users, they are now shaping the technology of the future. Notable businesses include GE Additive, OC Oerlikon, DMG Mori, BASF, Solvay and Sandvik.

More than one in 10 (11%) of all industrial companies surveyed seek to enter the AM market, most of them from the industrial products, chemicals and electronics

Chart 20

By entering the AM market, companies plan to become: (%)\*

30%

a provider of 3DP services (design, contract manufacturing)

28%

a provider of 3DP/AM systems

24%

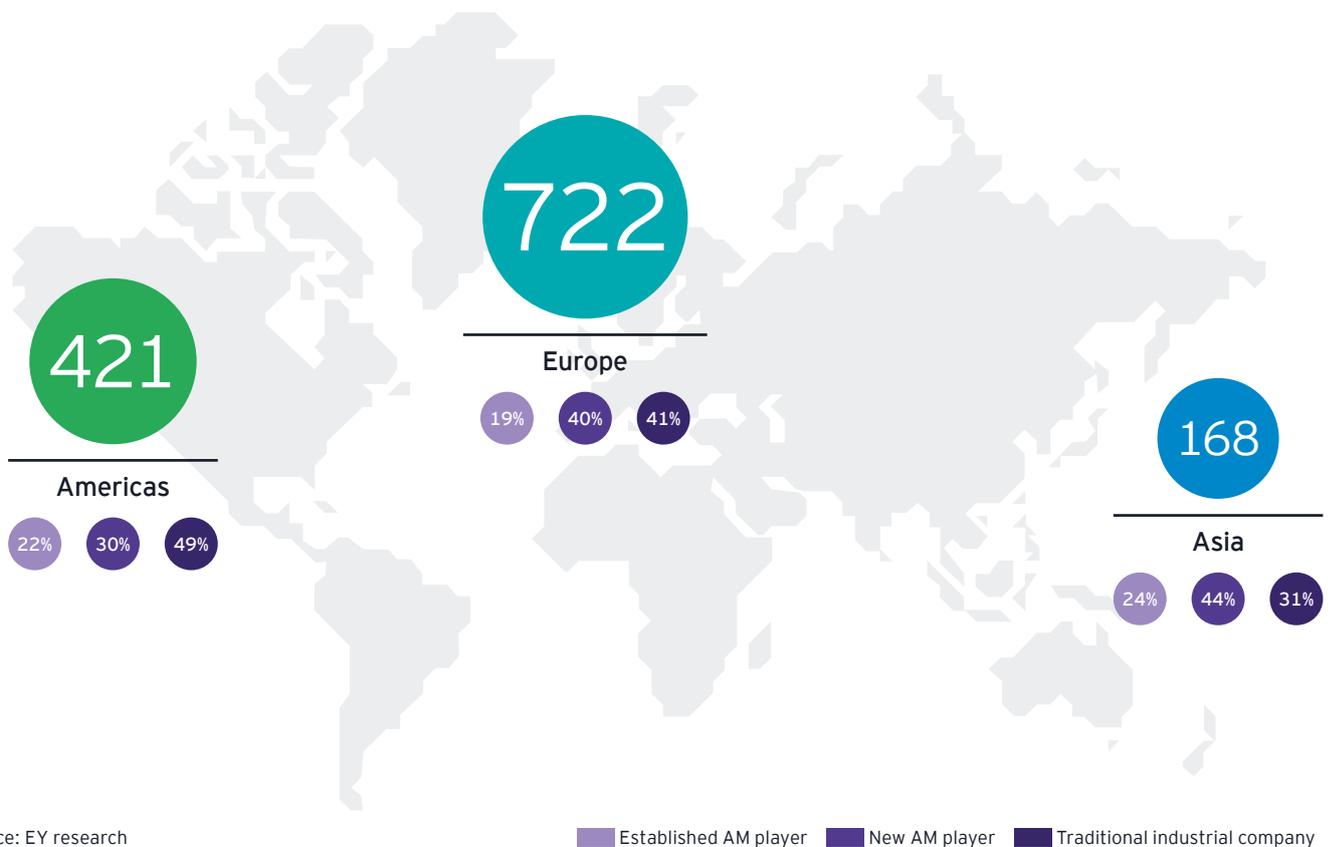
a provider of materials

23%

a provider of 3DP/AM-related software

\*n=102 companies, EY global 3DP survey, April 2019

**Figure 5**  
Overview of global AM players.



industries. Of those seeking to become AM players, 30% aim to be service providers and 28% systems manufacturers.

► **New AM vendors**

Companies established since 2010 that are mostly still at the start-up stage. They usually focus on one type of service or product, delivering innovative solutions that address customer needs, for example, around speed, price or new materials. Their dynamic approach has enabled them to attract attention from prominent industrial companies, gain major funding and grow swiftly. Notable businesses include Carbon, Desktop Metal and Markforged.

Around 20% of all AM businesses are established players, about 42% are traditional industrial companies, and the remainder (38%) are new to the market.

Europe is the region with the most (55%) AM firms, followed by the Americas with 32%, and Asia with 13%. At a country level, the US has the highest number with 29% of all companies, while Germany is second with 24%.

# AM value chain: Who's who

## Systems manufacturers

Primarily original equipment manufacturers (OEMs) of AM machines. Most also offer related software, materials and services.

## Materials producers

Providing raw materials for 3DP, ranging from chemicals players offering polymer to metallurgical companies supplying metal.

## Software developers

Mainly developers of AM-related software, such as for design, process simulation, workflow and CAD-model slicing, as well as for digital platforms.

## 3D scanning and reverse engineering companies

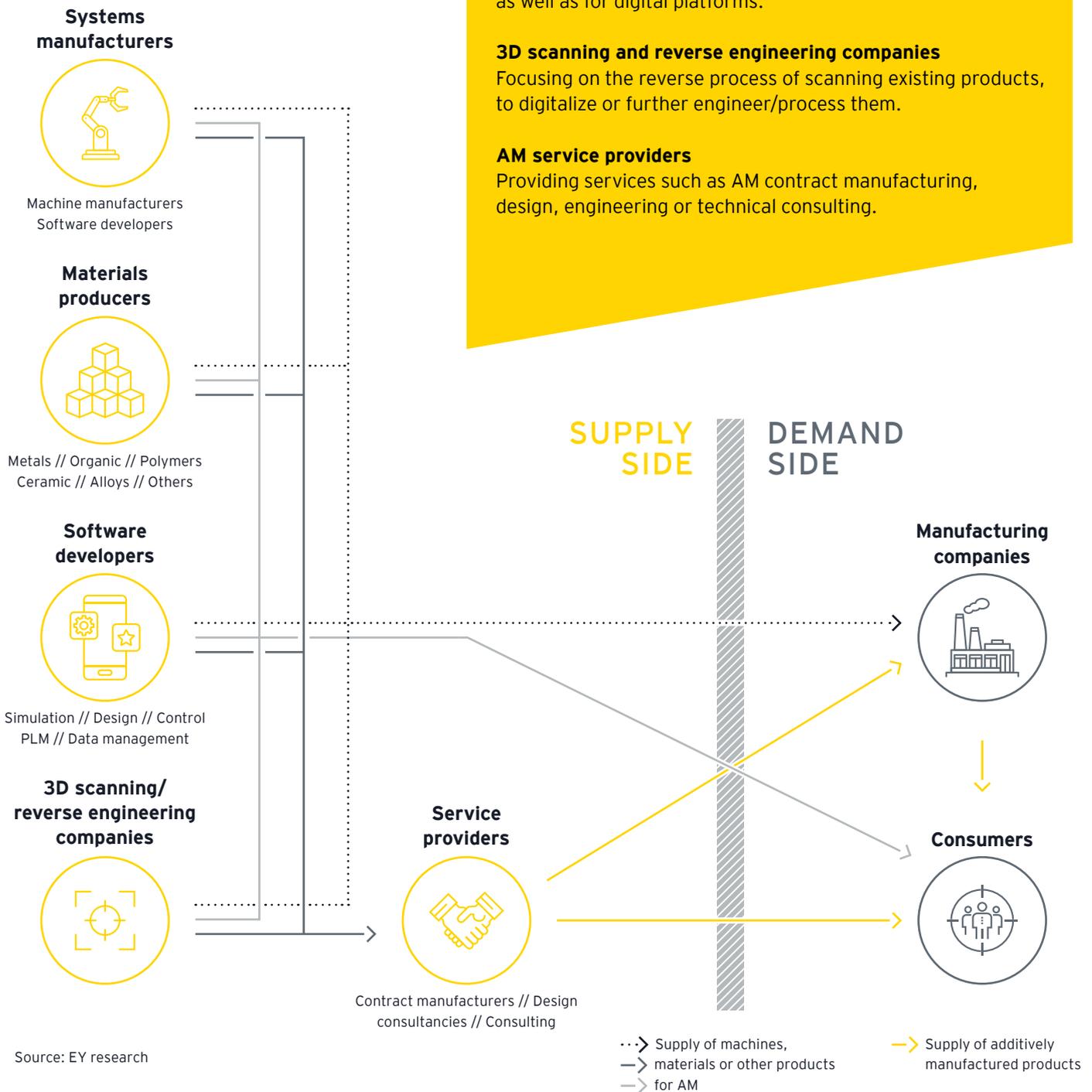
Focusing on the reverse process of scanning existing products, to digitalize or further engineer/process them.

## AM service providers

Providing services such as AM contract manufacturing, design, engineering or technical consulting.

## Which role do these companies play in the AM market?

Figure 6  
AM Value chain



Source: EY research

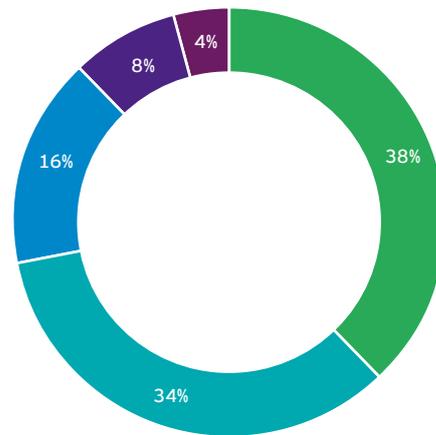
The AM market, as one might expect, is made up of companies that supply 3DP machines, materials or services. Based on the number of players, systems manufacturers make up the biggest group (38%) although the number of service providers has risen dramatically, reaching 34%. (For more details see the AM value chain graphic and the 'Who's who' box above.)

Although we distinguish between system manufacturers, service providers, materials providers and software producers, vendors often have several roles. Such multiple offerings are crucial for helping users to identify new applications.

Reflecting this need for a broad offering, major AM players are maneuvering themselves to access different capabilities. There are two marked trends:

**All-in-one suppliers** – companies are extending their portfolios to incorporate more of the must-have capabilities. This trend is uppermost among materials producers from traditional manufacturing backgrounds – such as chemicals and metallurgy – that became service providers to tap into application ideas that they can build on to secure new markets.

**Chart 21**  
Global AM players landscape (%)\*



- Systems manufacturers
- Service providers
- Materials producer
- Software producers
- 3D scanning

\*n=1,311 companies, EY global 3DP survey, April 2019

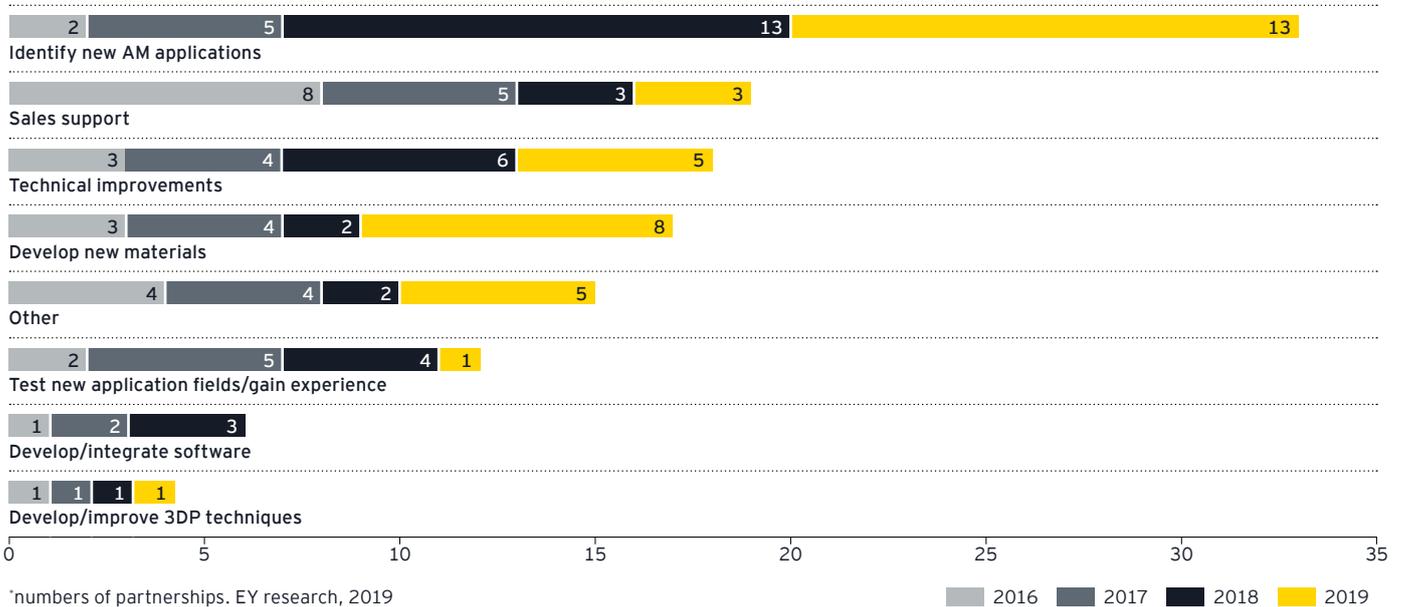


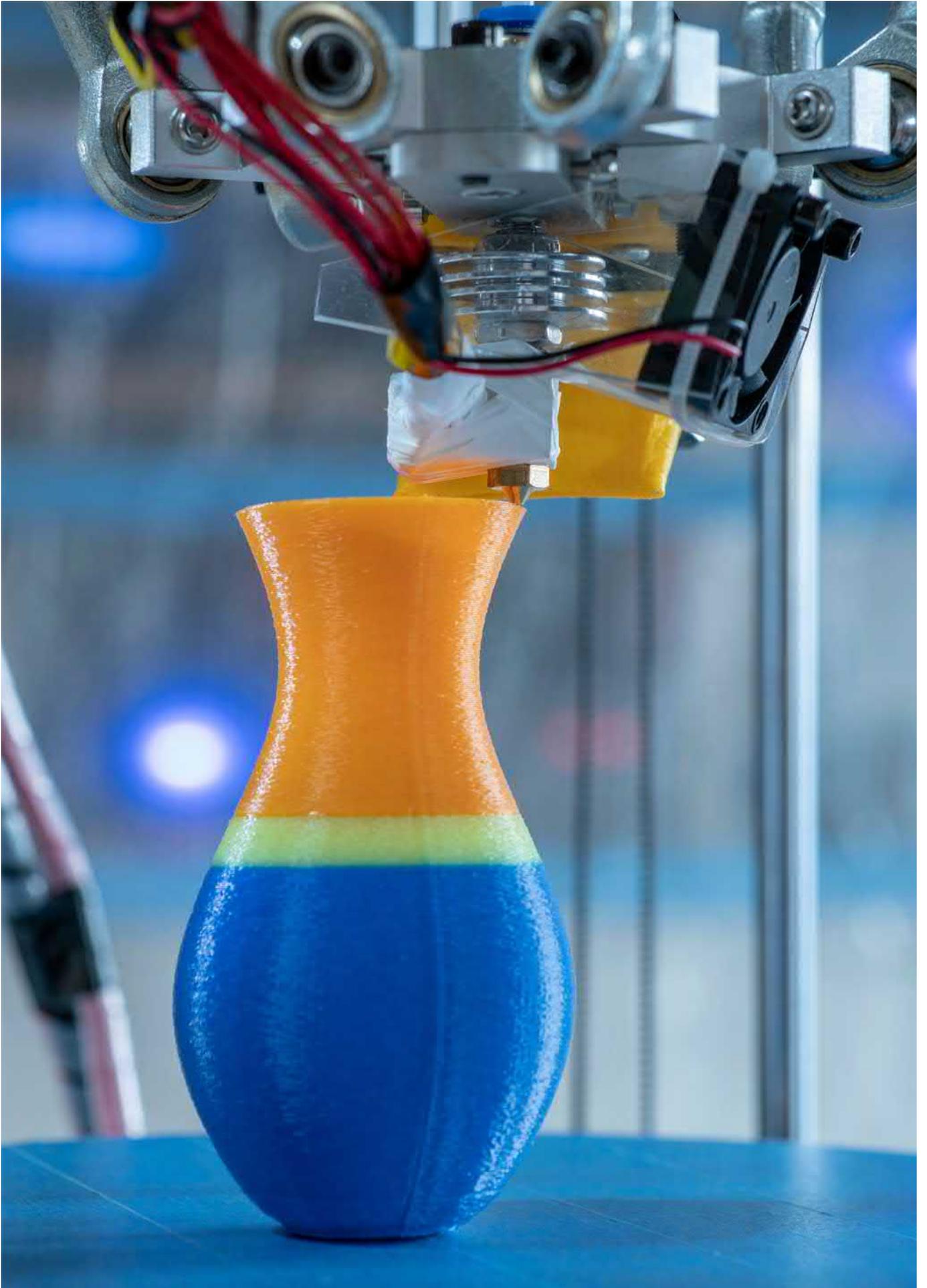
**Partnerships** – companies are also seeking to drive innovation and create new applications by joining forces. Between 2016 and 2019, more than 120 partnerships and collaborations were entered into in the AM market. Systems manufacturers led the way by linking up with materials producers and large industrial corporations.

Companies established partnerships for three main reasons which are to:

- ▶ Innovate and identify new applications, chiefly for end use products
- ▶ Achieve technical improvements as in machine speed or product quality
- ▶ Develop new materials that enable them to more quickly identify new applications

**Chart 22**  
Primary reasons for establishing AM market partnerships between 2016 and 2019\*





# M&A activity in the 3DP market

There has been a significant number of M&As in the AM arena since our 2016 survey, as strategic players strive to expand in the growing marketplace, either entering as a sector newcomer or enlarging established businesses. The industry's attraction to investors was demonstrated clearly during the 2017 to 2018 period when, following a slow 12 months, the market accelerated to deliver a rise of 117% in disclosed transactions.



**Chart 23**

Share price development and transaction rationale for major 3D printing companies (2015-2019)\*



\*Source: Mergermarket, Capital IQ, EY research as of 12 June 2019

1. Stock chart index includes median share prices of Stratasys Ltd, Materialise NV, 3D Systems Corporation, FARO Technologies Inc, The ExOne Company, SLM Solutions Group, Proto Labs Inc

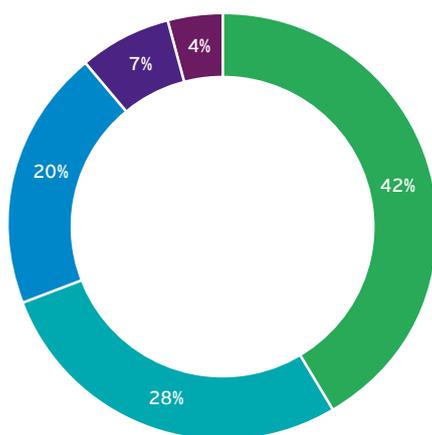
## What's driving deals?

Three factors are driving the buoyant 3DP M&A market:

- I. Manufacturing businesses from outside the sector are acquiring 3DP companies to access new technologies and knowledge
- II. AM companies are enhancing their position along the value chain by expanding their offering via acquisitions and collaborations
- III. AM equipment manufacturers are buying smaller players to absorb innovative technologies

These drivers are underpinned by a desire to increase market share that is common to both existing players and aspiring sector entrants. Forty-two percent of transactions in this period involved AM companies buying direct competitors, while a further 28% of deals saw strategic players buying into the market for the first time.

Chart 24  
AM transaction motivation\*



- Market share
- Market entry
- Product expansion
- Geogr. expansion
- PE takeover

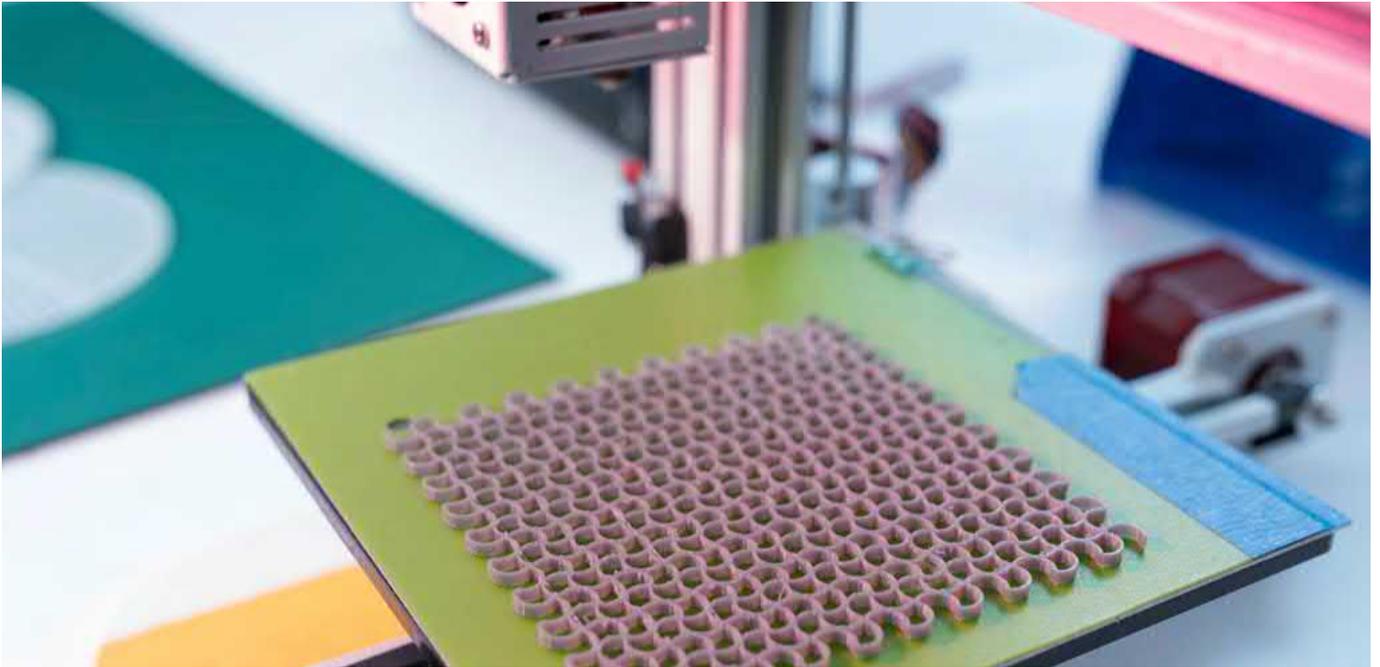
\*Source: Mergermarket, Capital IQ, EY research

## Who are the buyers?

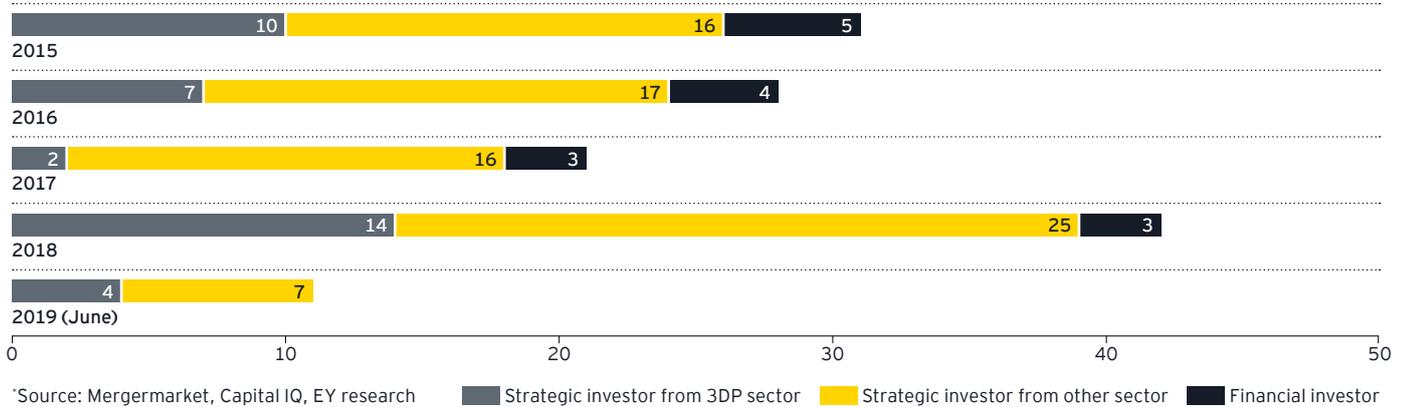
Strategic players from other sectors are the most significant pool of investors. They are looking to change their production processes or extend their offering either through AM technology or by entering the new high growth market. This group's slice of the deals increased from 42% in 2015 to 56% in 2018. Large industrial conglomerates that have identified AM's disruptive momentum and seek access relevant technologies dominate the field. General Electric<sup>32</sup> is a notable role model given its transformation from a 3DP end user to a solution provider by acquiring relevant companies including printer manufacturers, raw materials suppliers and service providers.

Beside acquisitions from outside the sector, there has also been a significant increase in deals from within the AM industry, which rose by 40% from 10 to 14 between 2015 and 2018.

Financial investor interest also remains high, although only 8% of all 2018 AM transactions came from this source. This was mainly due to the intensely competitive nature of the deal environment with strategic bidders paying high premiums for assumed synergies and strategically important 3DP technology. As a result, average transaction multiples reached high double-digits. In reality, not all buyers have managed to leverage expected synergies; major 3DP vendors have disappointed investors with the actual synergies generated from tech acquisitions, contributing to a fall in stock prices since September 2018.



**Chart 25**  
AM transactions by investor type (absolute numbers)\*



**Table 1**  
Selected transaction multiples in the AM area

Date	Buyer	Target	Revenue Multiple	EBITDA Multiple
16 April 2012	Stratasys, Ltd	Objet Limited	4.8	29.2
24 November 2014	3D Systems Corporation	Cimatron Ltd.	1.8	11.2
6 September 2016	General Electric Company	Arcam AB	9.5	74.7
27 October 2016	General Electric Company	Concept Laser GmbH	8.0	48.2
24 October 2018	Carpenter Technology Corporation	LPW Technology Ltd.	4.5	43.5

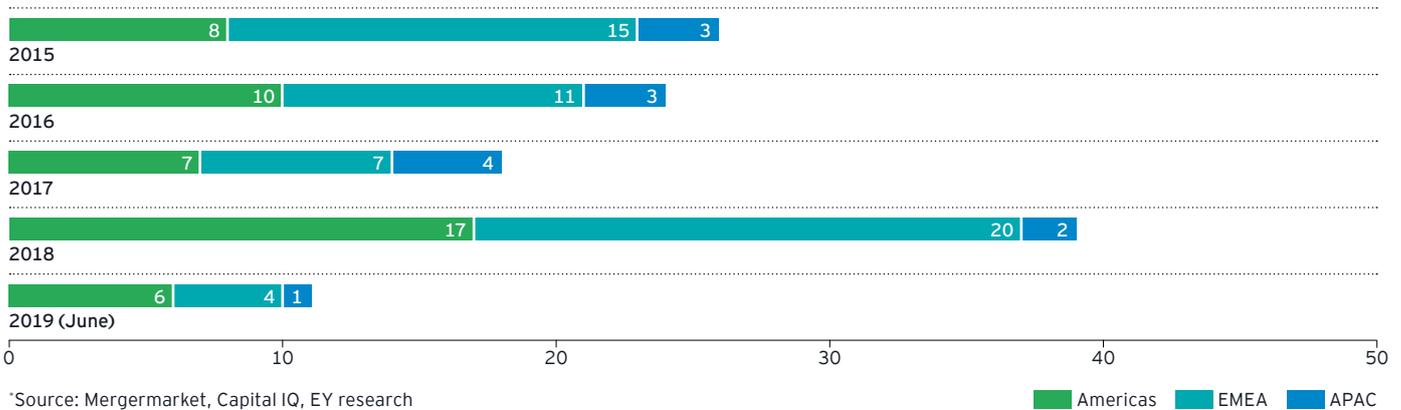
\*Source: EY research

## Regional deal hotspots

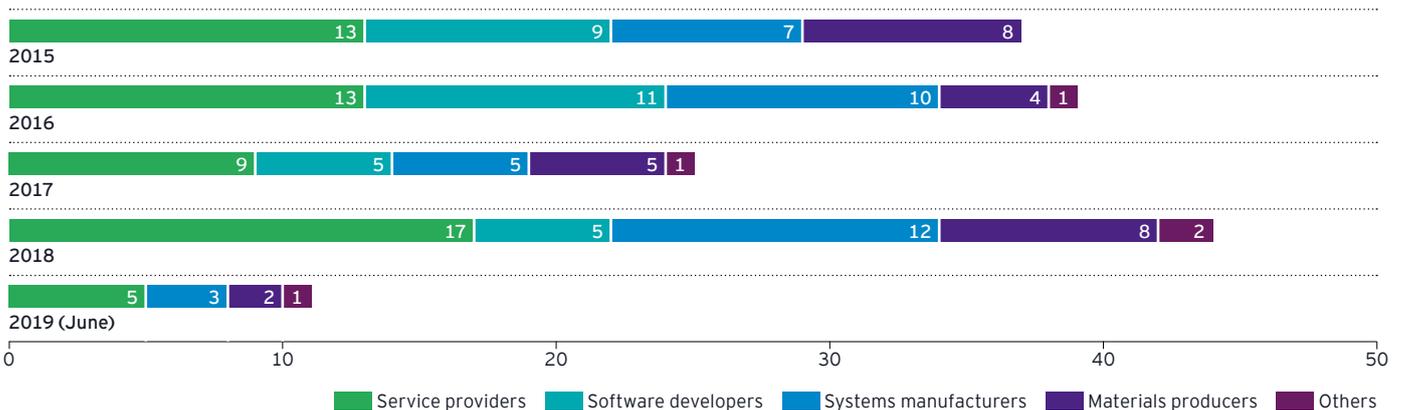
In 2018 most AM transactions occurred in Europe (51%) and the US (44%), reflecting the superior technology offered by companies in these regions. Although deal activity in the Asia Pacific region remained low, Asian players are expected to increasingly expand their market share due to support from national governments, especially China, and growing AM adoption rates.



**Chart 26**  
Geographic background of target companies (absolute numbers)\*



**Chart 27**  
Volume of AM-related transactions per business type (absolute numbers)\*

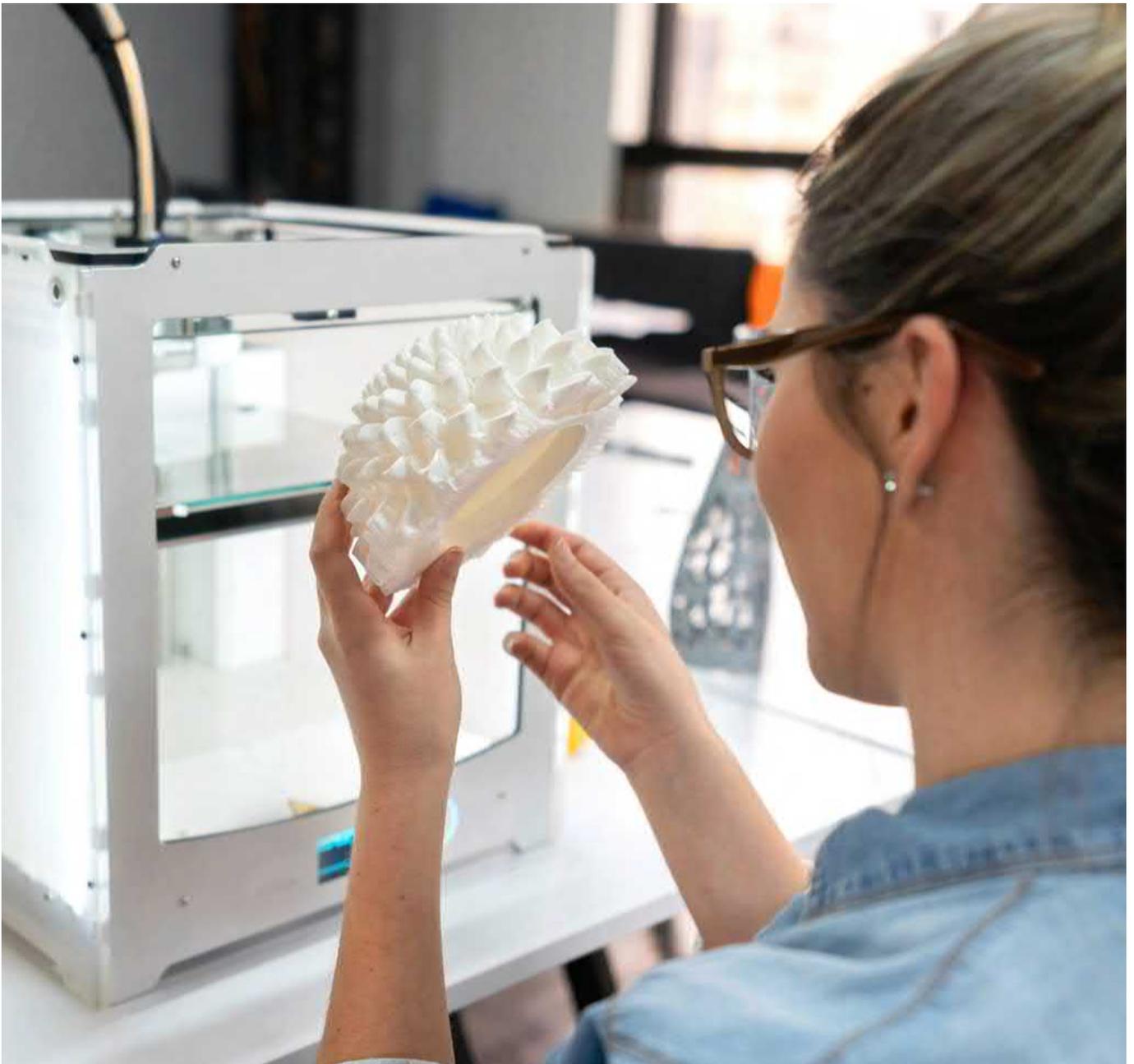


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## Sub-sectors of targets in 3DP-related transactions

3DP service providers were the most prized targets across all market sub-sectors. They represented more than half of all acquisitions (51%), compared with systems manufacturers which made up 21% and raw materials producers at 15%. This supports the assumption that

existing 3DP players are trying to build value by conducting forward and backward integrations. This is particularly true for printer manufacturers, which are aiming to increase their customer touchpoints by adding services and materials to their product portfolio.



## Survey results reinforce trends

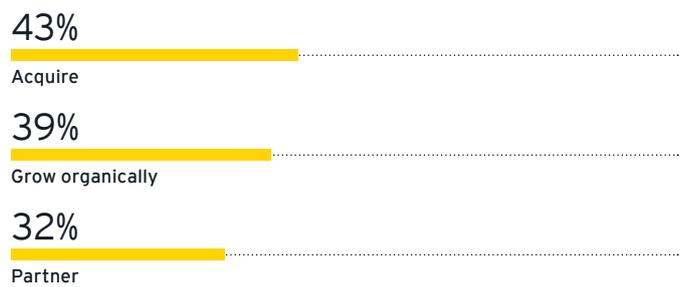
The survey shows that many companies surveyed are so keen to enter the growing market that they are interested in buying any strong sector business irrespective of what it produces or sells. More than one in 10 (11%) are interested in becoming any type of AM vendor, whether they supply systems, materials, hardware or 3DP-related services such as contract manufacturing or design.

Of the available routes to becoming an AM vendor, acquisition is the preferred way. Forty-three percent of our survey respondents cite this strategy, which serves as further proof that M&A activity is likely to continue to thrive. Despite acquisition being the preferred entrance strategy, organic growth was highlighted by 39% of respondents. Partnership with other organizations was also a strongly backed option, chosen by nearly one-third (32%).

The level of acquisition enthusiasm varies between different sub-sectors: almost half of the 17% of surveyed industrial products companies seeking to enter the market as a supplier of AM products or services intending to do so via acquisition.

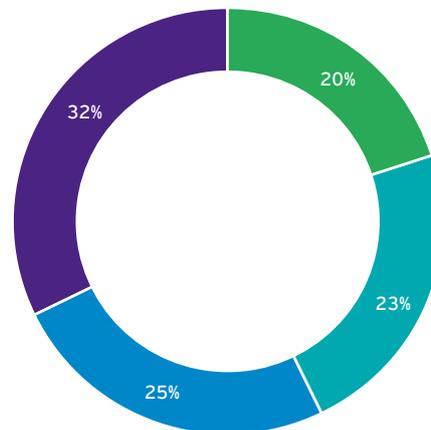
The survey results suggest that the acquisition focus on 3DP service providers will continue. Almost one-third (32%) of non-sector respondents that intend to acquire to build an AM business say their rationale for entering the market is to become a 3DP service provider. However, the whole arena is attractive, with the other three primary sub-sectors being the leading choice for at least one in five surveyed companies: software (25%), systems (23%), and services (20%).

**Chart 28**  
AM market entry strategies: (%)\*



\*n=102 companies that seek to enter the AM market, EY global 3DP survey, April 2019

**Chart 29**  
Desired AM vendor type: (%)\*



- a provider of materials
- a provider of 3DP/AM systems
- a provider of 3DP/AM related software
- a provider of 3DP services (design, contract manufacturing)

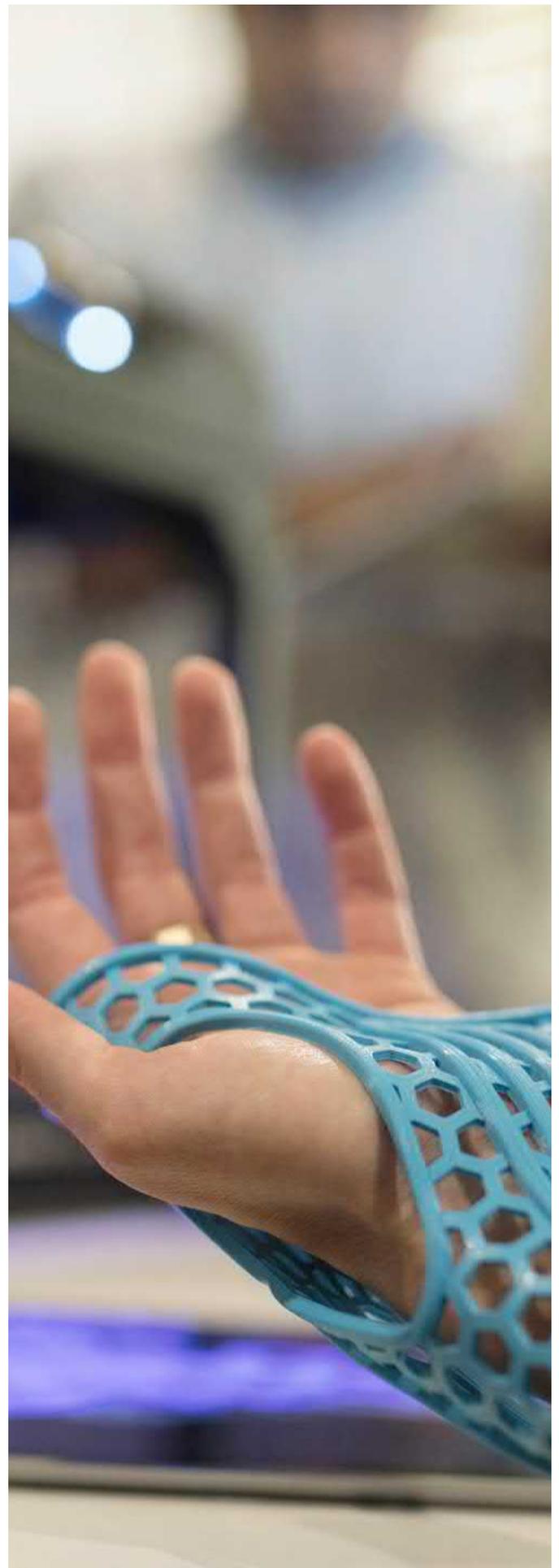
\*n=44 companies that plan to become AM vendors by acquisition, EY global 3DP survey, April 2019

## Looking ahead

The AM market remains quite fragmented despite having experienced previous consolidation waves. We therefore expect the high level of deal activity to continue in the short-term to mid-term, as almost all niche players – including equipment manufacturers, raw materials suppliers and service providers – cater to customer-tailored needs and applications.

We also expect transaction multiples to remain high in the short-term to mid-term. This confidence reflects both the technology's favorable outlook and the fact that this already expanding market is likely to grow even further as higher adoption rates bring costs down. As a sign of possible things to come, quickly growing recent market entrants have already achieved multi billion dollar post-money valuations. Formlabs, for example, has been priced at \$US1.06b, Desktop Metal at \$US1.5b and Carbon at \$US2.4b.<sup>24</sup>

The behavior, as well as the value, of these rising AM companies is likely to shape the future M&A market. They have begun to break down the boundaries between industry stakeholders and to transform the market into an open system where all parties interact in a network. For example, this had led to raw materials suppliers selling directly to end customers instead of via an intermediary. Such activity will change the rationale, intensity and targets of future M&As.

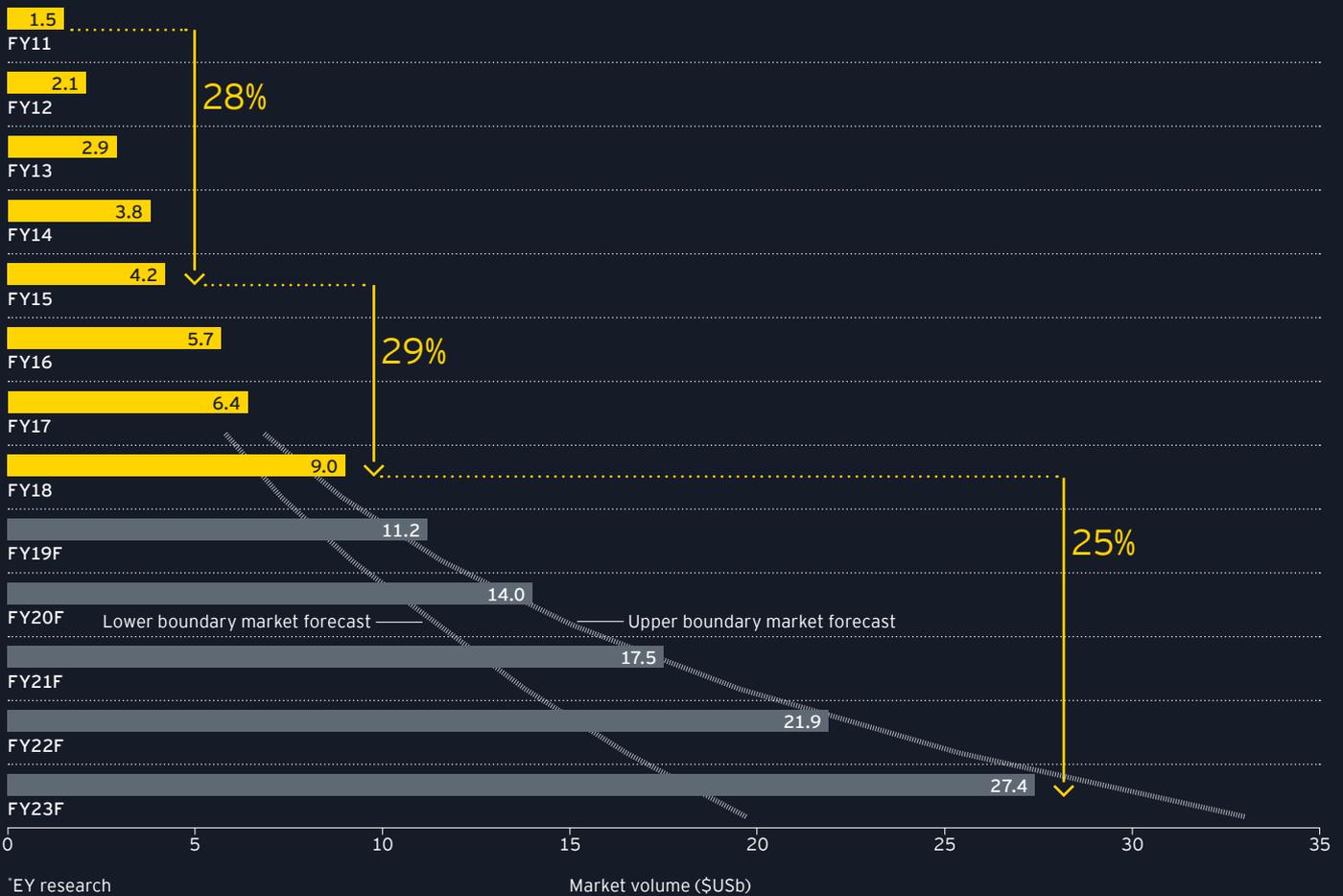


<sup>24</sup> *Pitchbook Newsletter*, Pitchbook website, <https://pitchbook.com/newsletter/3d-printing-startup-carbon-now-worth-24b-dDN>, accessed 30 July 2019s.

# What's next for AM?

The AM market has grown continuously since 2011, when it began developing in its current form with the entry of industrial players and related systems manufacturers between 2011 and 2015. It has continued to grow at a CAGR of 29% since 2016, mainly driven by the production of industrial systems for metal AM and service providers.

Chart 30  
Global AM market size: actual and forecast\*



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We believe this growth trend will continue over the next five years with the 3DP market expanding by about 25% annually, resulting in a total market value of \$US27.4b by 2023. Within this band, companies with established technologies are likely to grow at a different rate than new players.

These estimates reflect historical data, analyst consensus reports and the different types of company and varying maturity levels within the industry. However, despite basing our forecast on such solid intelligence, variable factors could lead to growth as low as 18% or as high as 30%, with the potential overall 2023 market value ranging from \$US20.7b (the lower boundary in the graph) to \$US33.3b (the upper boundary). Such variables include the pace and impact of key anticipated developments such as the use of AM in serial production, the development of new technologies and materials, price reductions, and the introduction of a more systematic approach to identifying new applications.

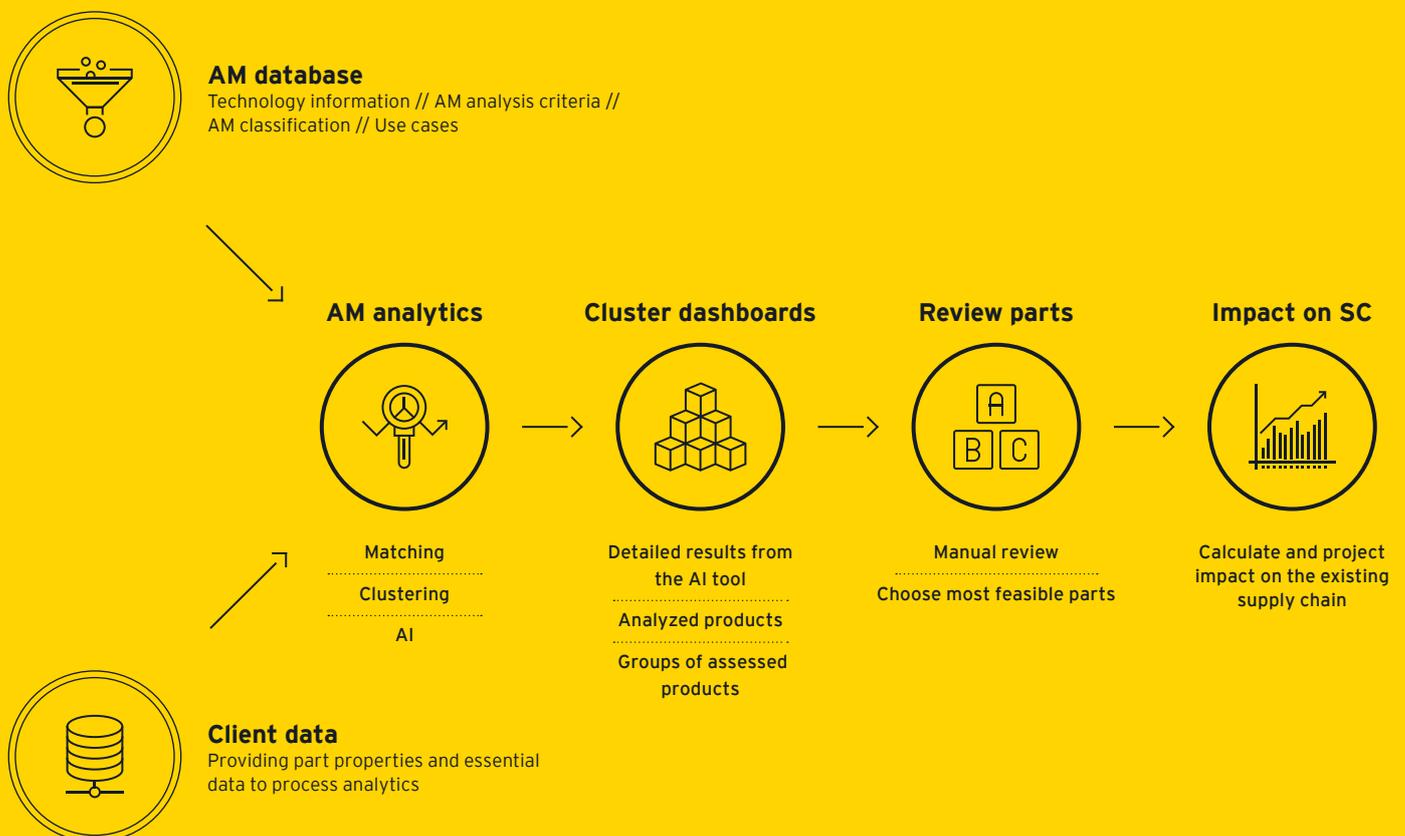
The key growth drivers are likely to be

- ▶ Expansion in 3DP applications for end-use products. This will have the greatest effect on businesses in the aerospace, medical and dental sectors, which are experiencing a strong demand for personalized products, and companies that have a significant focus on spare parts, such as those in industrial products
- ▶ Development of new materials in response to the increase in new end-use applications. This will inevitably lead to an expansion in materials suppliers' share of market revenue
- ▶ Strengthening role of service providers at the heart of the AM value chain as a point of contact for new users and for companies that wish to utilize AM production in close proximity to customers
- ▶ Continuing evolution of technology, as innovative start-ups address the key challenges of price, speed, and enabling software, and strategic investors drive the further development of the industry
- ▶ Creation of new business models as companies seek to generate and support new revenue streams

# How EY teams support companies on their 3DP journey

Companies with no experience in additive manufacturing often struggle to understand if, and how, they can benefit from the technology. Businesses that have experienced AM, on the other hand, are often looking for ways to unlock its potential for their entire organization.

Figure 7  
EY Additive Manufacturing Diagnostics approach.



Source: EY

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EY teams offer companies at all levels of AM maturity the support they need to gain the maximum benefit from the technology. Depending on their 3DP maturity and business needs, we can help them to:

- ▶ Gain a better understanding of AM technology and the market
- ▶ Understand how 3DP can transform their operations and supply chain and even their entire business
- ▶ Identify concrete applications and quantify their impact on the company
- ▶ Shape an AM strategy and plan its execution
- ▶ Deliver a planned AM transformation

EY professionals have amassed knowledge and insights on each side of the value chain, having worked with both vendors and users. Such knowledge underpins two EY Additive Manufacturing Solutions: “Additive Manufacturing Diagnostics” and “Nucleus 3DP”. We combine these two offerings with the traditional consulting services – for supply chain and operations, strategy and transactional services – to provide the best possible support for clients on their AM transformation journey.

**Additive Manufacturing Diagnostics** Identifying the right AM applications and quantifying their impact remains one of the biggest challenges for businesses. We developed Additive Manufacturing Diagnostics (AMD) to facilitate and structure this process. AMD is a structured analytics approach for classifying components and identifying groups of components with high potential for AM, based on technological and economic criteria. To identify component clusters, we use an EY AM database with information about the technical limitations and benefits of AM. Having identified parts and components with high AM potential, we will calculate a business case for switching to 3DP. This can help to both justify the comparatively high investment and demonstrate the impact that the technology will have on the customer and value chain.

**Nucleus 3DP** is a digital knowledge platform focused on the AM market. It is built around a constantly expanding database of vendors, with extensive information about the services and products that they provide. The platform, which currently contains information about more than 700 AM vendors, is an invaluable resource for clients. For example, we use it to help newcomers to AM to assess potential providers of the sub-technology, products and services that would best suit their preferences and location. While, for clients interested in entering the AM market, we draw on platform knowledge to identify and assess future partners and potential M&A targets.

## Imprint

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