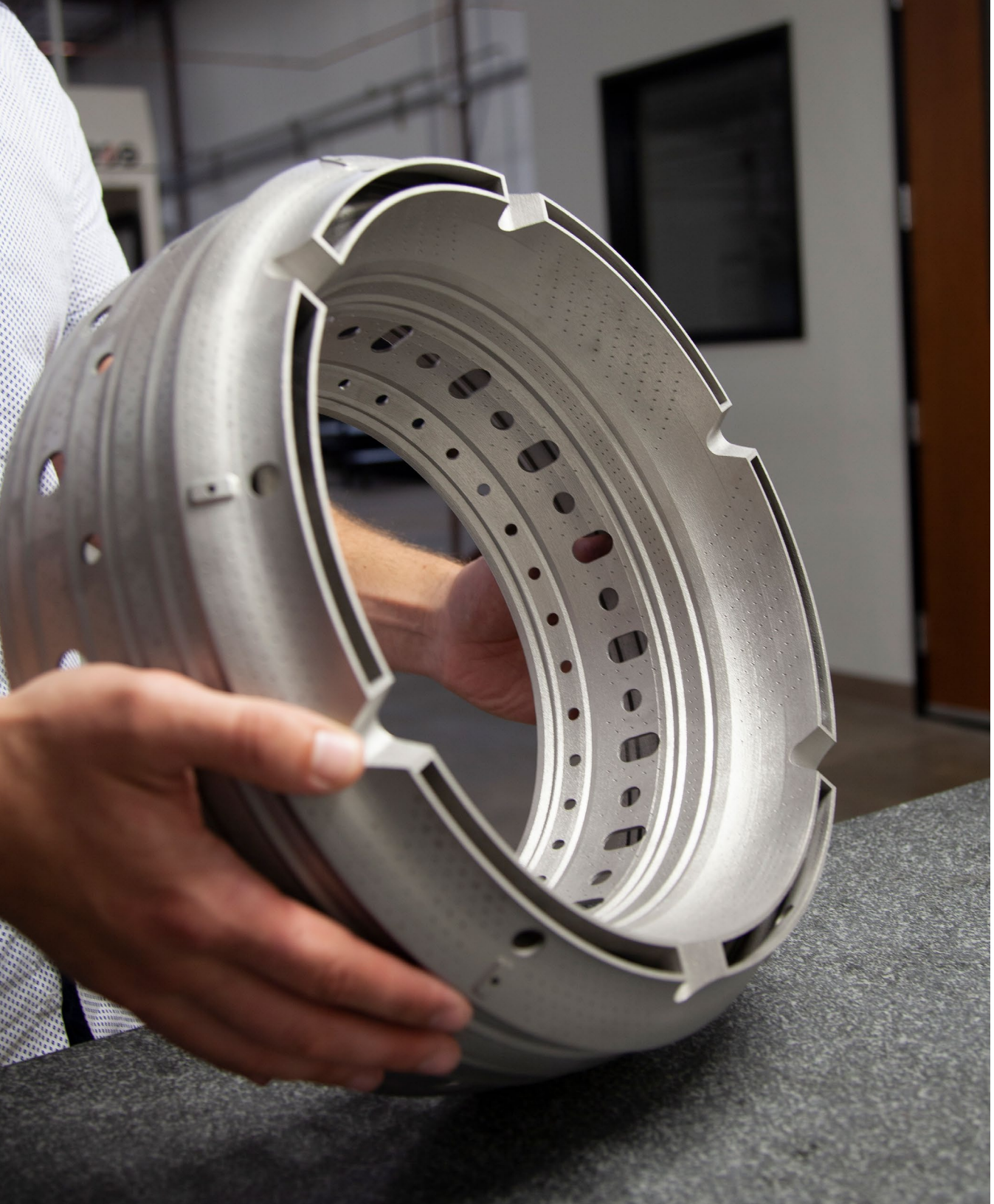

Looking Forward: Additive Manufacturing in 2020

A report from 3D printing users

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Survey Methodology

DATA COLLECTION

Survey administrator: Stratasys Direct Manufacturing & SME Media

Methodology: Online

Timeframe: September 24 to October 31, 2019

Survey length: 12 questions

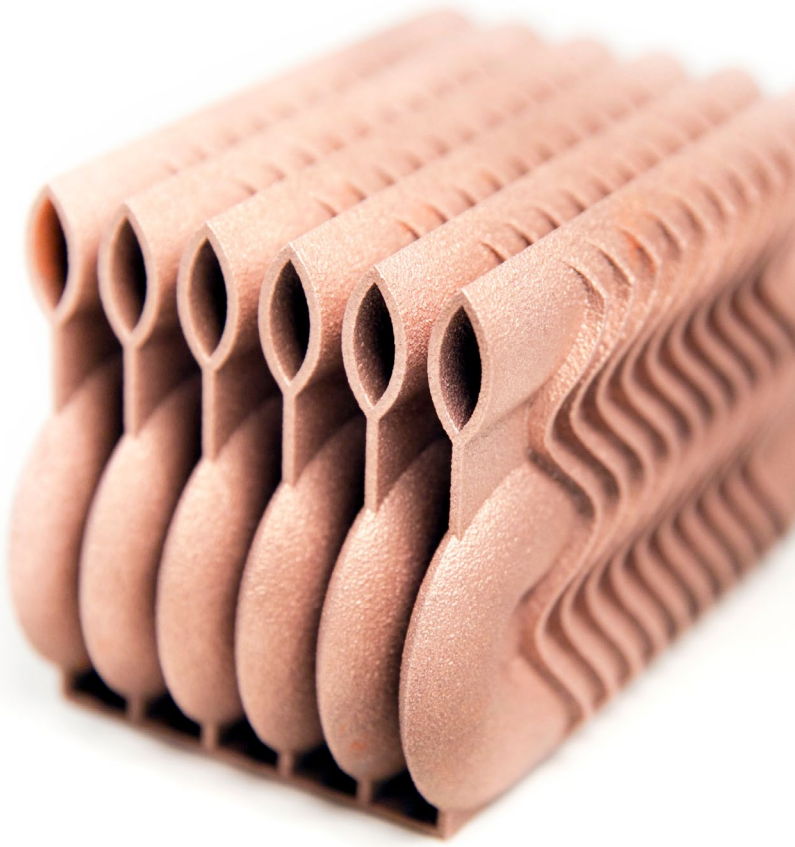
Completed interviews: 686

QUALIFIED RESPONDENT

- Currently uses or is considering using additive manufacturing
- Uses or foresees using at least one additive or traditional manufacturing process

**Note: The terms additive manufacturing (AM) and 3D printing are used interchangeably in this study.*

**Note: Percentages are rounded up in most cases.*



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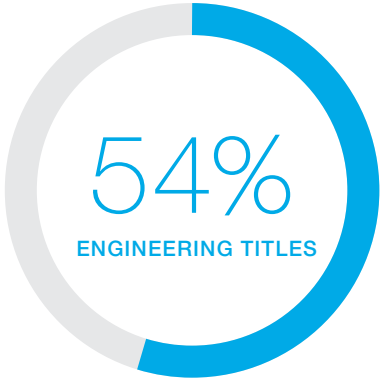
Profile of Survey Respondents

This survey's participants were aggregated from multiple sources. These respondents are leading advanced manufacturing in their companies by utilizing 3D printing across a wide range of applications. A significant number of the nearly 700 participants are engineers and designers (Figure A) that have first-hand experience with additive manufacturing, making this report a well-rounded look at its impact on the industry today and where it will grow in 2020.

The responses of this survey represent a range of business sizes from small design shops to some of the largest companies in the world, including Airbus, Bell Helicopter Textron, Walt Disney Company, Ford, GE, Google, Honda, Nestle Purina, Nissan, Siemens, Johnson&Johnson, NASA and Honeywell International.

FIGURE A

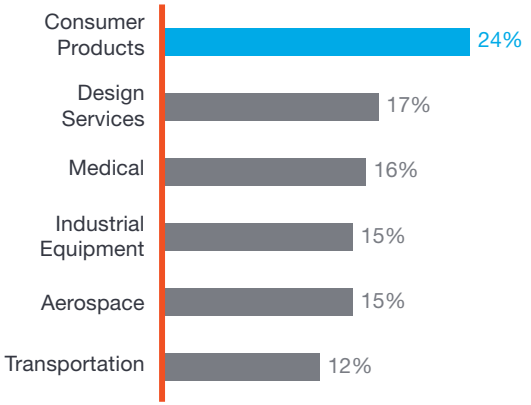
Titles of Respondents 2019



Additional titles included designer, executive/owner and project manager

FIGURE B

Top Industries of Respondents 2019



The survey respondents represent key industries, displaying the wider adoption of 3D printing.

A significant number of respondents manufacture consumer and commercial products, displaying the wider adoption of the technology beyond aerospace and medical industries (Figure B).

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Comparing Past Respondents

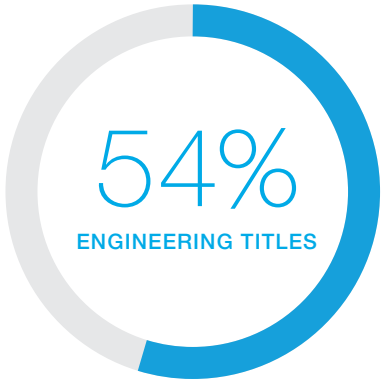
It's important to note that this audience was similar in industry make up and participant numbers to a similar survey we reported on in 2015 (700 participants in 2015 vs 686 participants in 2019).

The respondents in 2015 primarily had engineering titles (Figure C) and worked at businesses in the consumer products industry (Figure D). An additional field represented in the 2019 data was design and engineering service providers.

In order to understand the ways additive manufacturing has changed in perception in the last five years, we asked the same or similar questions to our audience in 2019 and compare them on the following pages.

FIGURE C

Titles of Respondents 2019



Titles of Respondents 2015

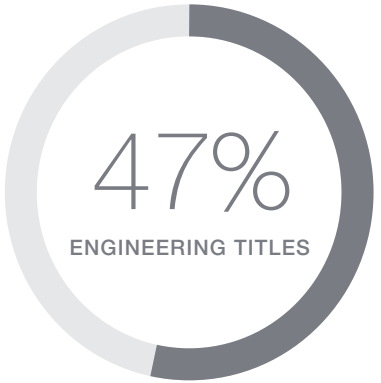
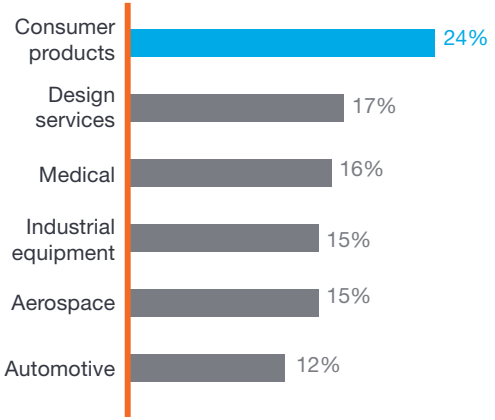
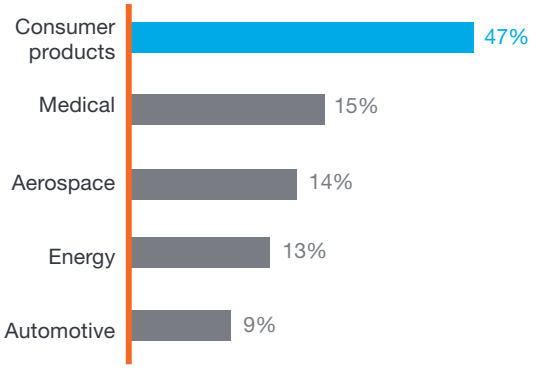


FIGURE D

Top Industries of Respondents 2019



Top Industries of Respondents 2015



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How Respondents Use 3D Printing

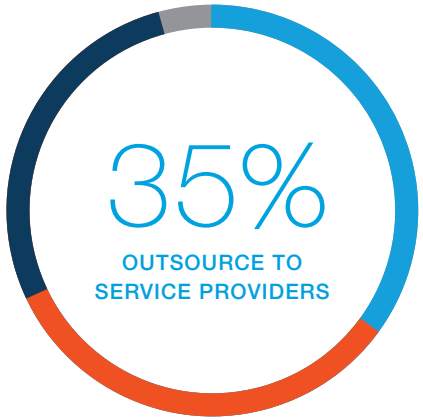
To further understand our survey respondents, we drilled into how they are utilizing 3D printing technology (Figure E) and specifically which additive manufacturing technologies they use to make parts. While outsourcing to a 3D printing service provider was the most common answer (35% of respondents), 28% own industrial 3D printers and 32% own desktop printers.

Participants from the aerospace (38%) and transportation (39%) industries (Figure F) were more likely to own industrial 3D printers, while consumer product (38%) and medical (35%) industry respondents were more likely to own a desktop 3D printer.

Respondents from the transportation industry primarily own industrial 3D printers and also outsource to a service provider.

FIGURE E

How respondents utilize AM



35% Outsource to service provider

32% Owner of desktop 3D printer(s)

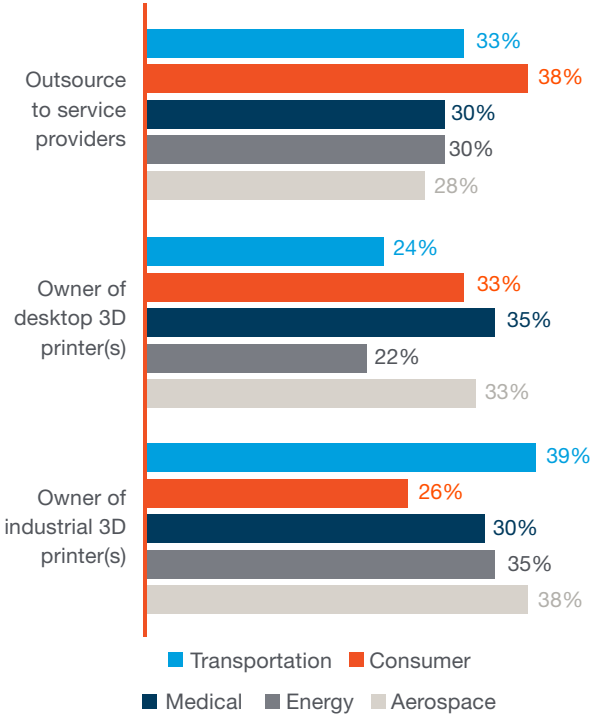
28% Owner of industrial 3D printer(s)

4% Not currently utilizing AM

The survey respondents represent an even ratio of machine owners and companies that outsource.

FIGURE F

How industries utilize AM



Respondents from the consumer products industry primarily outsource their 3D printing and own desktop printers.

3D Printing Technologies Used

Material Jetting (25%), which includes PolyJet™ technology, and Photopolymerization (25%), which includes Stereolithography (SLA), were the two most popular types of technologies (Figure G) utilized by the respondents, followed by Plastic Powder Bed Fusion (19%), aka Laser Sintering (LS, SLS).

The industry breakdown (Figure H) highlights how respondents from the energy sector utilize material extrusion (31%) and photopolymerization (23%) 3D printing technology.

As we reference on page 9, our respondents are primarily utilizing 3D printing for functional prototyping and concept modeling. Because 3D printing technologies like Photopolymerization and Material Jetting are fast and produce parts with very fine resolution, it could be that the two are correlated data points.

Material Jetting and Photopolymerization are the most popular 3D printing technologies and are represented in both industrial and desktop 3D printers.

FIGURE G

Most frequently used 3D printing technology

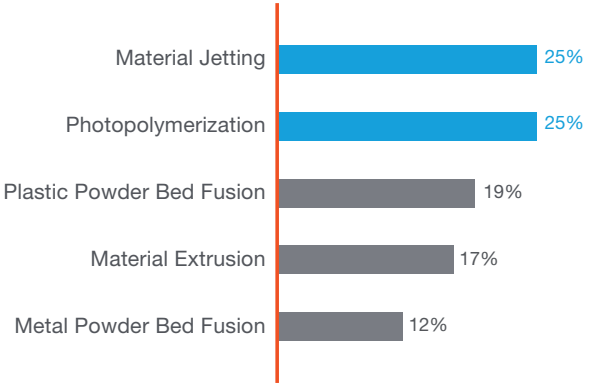
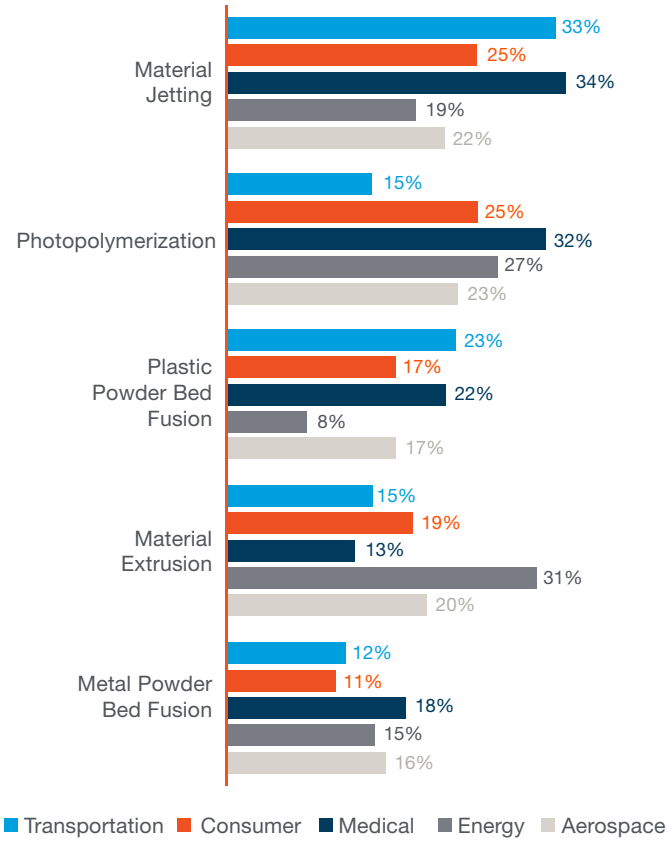


FIGURE H

Industry breakdown of use of technologies



> “One of our products would be very expensive to manufacture through injection molding or traditional outlets. AM has allowed us to produce that part at a much lower cost.”
>
> **- Jacob Marino, Product Engineer**
> **Barsplice Products Inc.**

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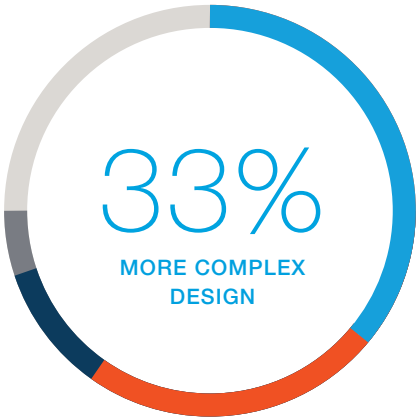
Benefits of 3D Printing

We asked respondents what they see as the most significant benefit of using AM. The most common responses were (Figure I): Freedom of design complexity (33%), speed (26%) and freedom for customization (10%). Of the respondents from aerospace companies, freedom of design complexity (28%) and speed (25%) were especially key. For other industries including medical (25%) and consumer products (32%) respondents, speed continued to be a top benefit.

FIGURE I

The most significant benefit of using AM



33% More complex design

26% Speed

10% Freedom for customization

6% Manufacturing efficiency

While lead times can be significantly reduced when utilizing 3D printing, design freedom for complex design was the top response.

WE ASKED SPECIFICALLY,

How has your company benefited from using AM?

"Speed. Gaining access to shortened product development cycles is the most significant benefit, though there are others."

– CHRIS WERNER, SENIOR PROGRAM MANAGER, PHILIPS HEALTHCARE

"We have significantly improved our development pace for racing. We've also been able to reduce our composite production costs through printed tooling and jigs/ fixtures, which has been our biggest area of growth."

– ANDREW MILLER, TEAM PENSKE

"We have been updating molds and patterns that were done by hand for over 30+ years."

– CHRIS POHLMAN, NASCO HEALTHCARE

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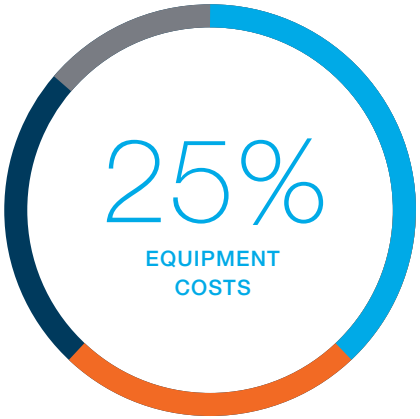
Top Challenges

While many of our respondents have utilized 3D printing for years, there are still challenges inherent with the technology that can inhibit growth in use. We asked respondents to weigh in on what they consider to be the top challenge their company faces using AM now and will face in the future. (Figure J)

Part quality (19%), production consistency and reliability (13%) were high on the list for companies, especially those in the aerospace and consumer products industries. Cost of operations (16%) and balancing pricing and operational costs (14%) were also top concerns.

FIGURE J

Top challenge companies face using AM



25% Equipment costs

16% Limited materials

16% Manufacturing costs

9% Post-processing requirements

WE ASKED SPECIFICALLY,

Are there other challenges your company faces that prevent future growth with AM?

> "For production parts with any significant volume, the speed of manufacturing needs to increase by an order of magnitude. AM technology won't be interesting for production until parts can be made in minutes rather than hours. Material properties (overall strength, and layer-to-layer strength, especially) need to get a lot better before we can start really considering AM for anything beyond prototypes."

– BRYAN SHORTALL, DESIGN ENGINEER
ELECTROLUX HOME PRODUCTS

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Impact on the AM market

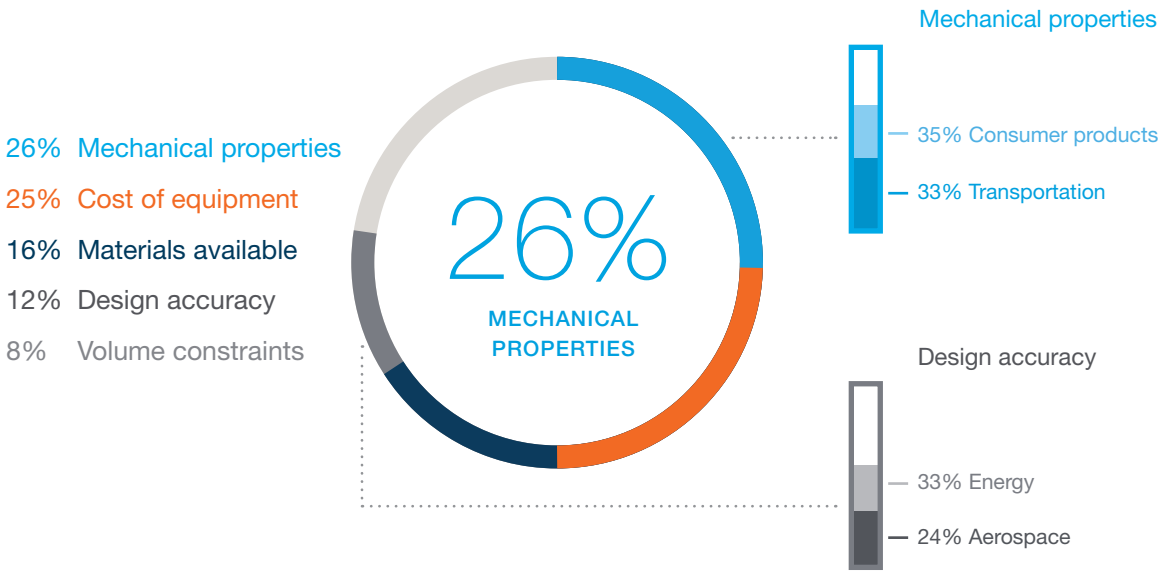
Speaking to the future of 3D printing adoption, we asked respondents what one issue they would consider to be the most significant benefit of using AM. (Figure K)

Acknowledging the top challenges on page 11, respondents chose the issues that will most impact the AM market. Similar to the respondents polled in 2015 (20%), the cost of equipment (25%) remains a top challenge for companies to embrace further adoption of AM in the future. However, in 2020 another concern has risen to the top challenge for the future of AM: engineers are concerned about the mechanical properties (26%) of 3D printed parts meeting the standards and needs of an application.

Particularly, respondents from the consumer products industry (35%) and the transportation industry (33%) choose cost of equipment as the key issue they feel will impact AM. Respondents from the energy (33%) and aerospace (24%) industries also chose design accuracy as the top issue.

FIGURE K

Top issues that impact on the AM market



Similar to 2015, the cost of equipment remains a top concern in the future of additive manufacturing.

Preparations for the Future

Despite the challenges associated with AM adoption, 98% of our respondents anticipate that they will use 3D printing in 2020. Of those 98% respondents, 75% anticipate they will use it more than 2019. Aerospace (79%) and consumer product (72%) industry respondents are especially focused on utilizing AM more in 2020.

In 2020, how do you predict your company will utilize AM?

75%
Utilize 3D printing more than in 2019

24%
No change in 3D printing utilization

1%
Utilize 3D printing less than 2019

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Steps for the Future

So how do they plan to counter the challenges of AM adoption? We asked respondents, “What steps is your company taking to incorporate AM in future projects?”

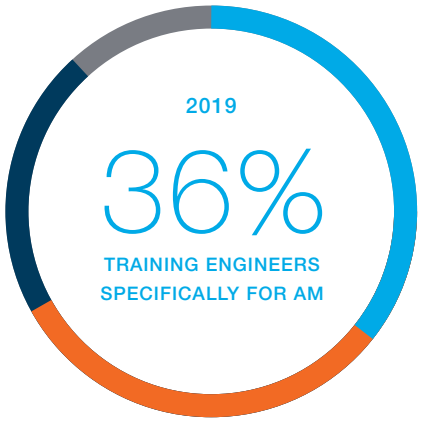
In 2019 (Figure L) and 2015 (Figure M), training designers and engineers specifically for additive manufacturing (40% 2015 vs. 36% 2019) and partnering with additive manufacturing service providers are considered the key strategies for growth (40% 2015 vs. 31% 2019).

Additional insights from respondents included mastering effective design for AM, growing overall awareness and knowledge of 3D printing’s benefits company wide, in house R&D, and identifying applications that could benefit from utilizing AM.

36% of respondents plan to train engineers specifically for AM

FIGURE L

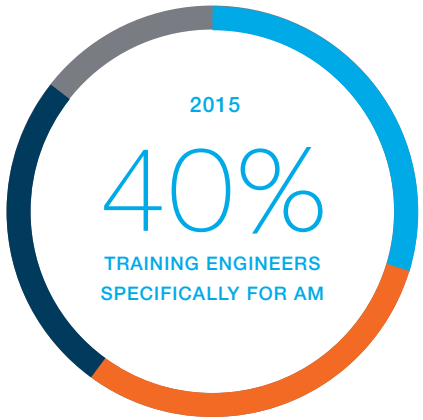
2019 responses: Top steps to incorporate more AM



36% Training engineers for AM
31% Partnering with service providers
21% Funding research/development
12% Recruiting employees with AM experience

FIGURE M

2015 responses: Top steps to incorporate more AM



40% Training engineers for AM
40% Partnering with service providers
34% Funding research/development
19% Recruiting employees with AM experience

Training and hiring employees specifically for AM accounted for more than 50% of responses in 2015 and 2019.

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“In most cases, the ones who can benefit most from AM lack the technical skill to develop designs from scratch or to generate printable models from surface data. Old school thinking prevents taking full advantage of AM opportunities.”

- Craig Freese, Engineer Associate
Honda Manufacturing of Alabama

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Material Development

Metal materials for AM are the most highly-coveted across industries.

Another key factor in further adoption of AM is the development of materials. The availability of materials was the third largest challenge identified by respondents (15%). We asked respondents what specific materials they would like to see further developed for AM. (Figure N)

Similar to 2015, metal materials are the most highly-coveted across industries, with 55% of respondents interested in seeing more metal materials developed for use in AM. High-temperature plastic materials are also in high-demand at 22%.

With more materials coming on scene, the "other" category (13% of respondents) brought to light the demand for ceramic materials, glass and glass-enforced plastics, polypropylene and additional options for transparency.

Additionally, there is a growing interest in materials with properties similar to injection molding thermoplastics and greener materials that biodegrade.

Filter through mechanical characteristics to learn more about 3D printing materials.

FIGURE N

Top material desired for AM

55%

2019 respondents interested in seeing more metal materials

56%

2015 respondents interested in seeing more metal materials

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Current Use of 3D Printing

To better understand how our respondents utilize 3D printing at their companies, we asked about them to identify specific applications they are currently using AM to produce. (Figure O)

30% of respondents, across all industries, utilize 3D printing to produce functional prototypes, a tried and true use of the technology since its commercialization.

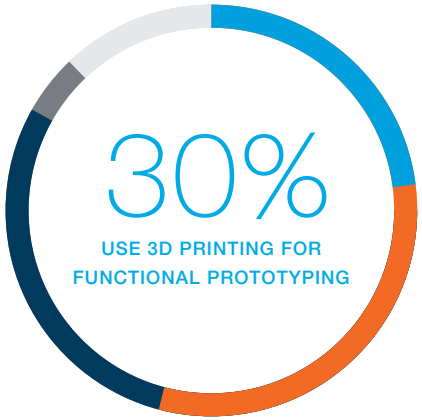
There is also significant use of 3D printing for development of concept models (28%) and manufacturing aids (22%), an application that has been rising in popularity in the last five years.

Particularly, respondents in the consumer products (24%), energy (24%) and aerospace (24%) industries are utilizing AM for manufacturing aids. (Figure P)

FIGURE O

Top applications produced with AM

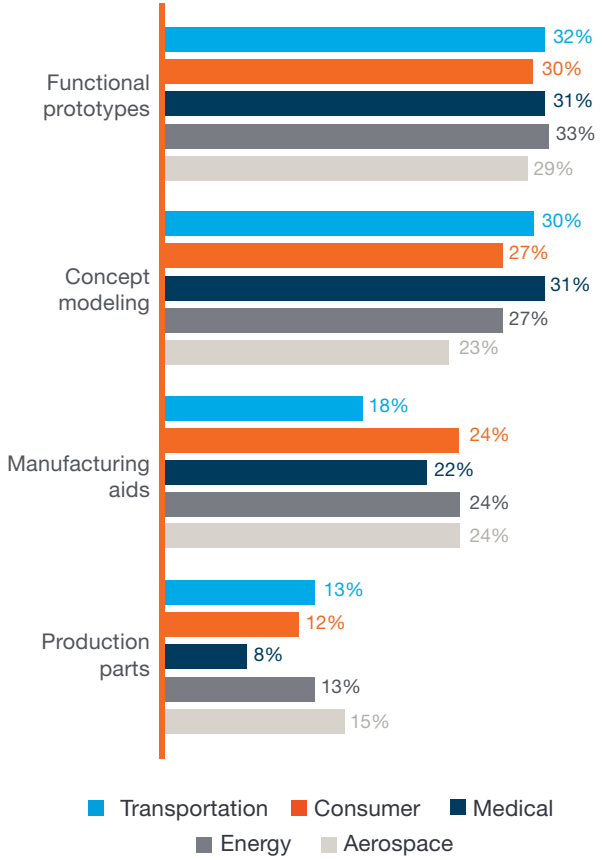
30% Functional prototyping
28% Concept modeling
22% Manufacturing aids
12% Production parts
4% Bridge production



Functional prototyping and concept modeling combined account for more than 50% of the responses.

FIGURE P

Industry breakdown of top responses



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Growth of Application Types

The 2015 anticipated growth in AM by application types aligns with 2019 results in one key application: manufacturing aids.

An interesting comparison of data from the last five years is the anticipated application growth in 2015 versus the actual use of 3D printing in 2019.

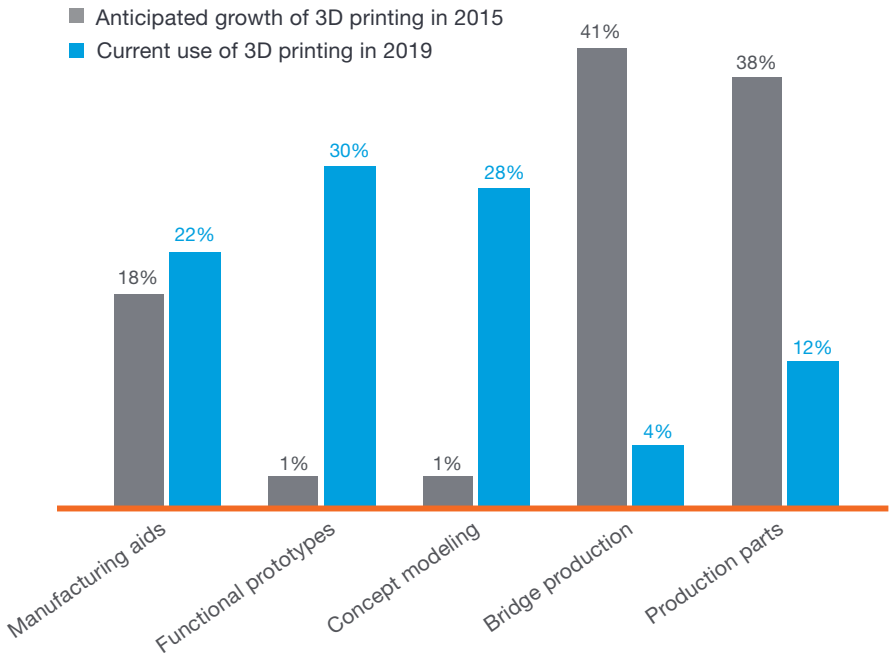
In 2015, survey takers were asked, “What applications do you anticipate growth in the next three years?” (Figure Q)

The expectation by 2018 was to see growth spurts in tooling, trial and end-use production applications. The results from the 2019 survey are consistent with one key application: manufacturing aids.

Despite anticipating growth in production parts and bridge production parts, the fact remains that those two segments received only marginal growth. Functional prototypes and concept modeling continue to dominate AM applications.

FIGURE Q

2015 anticipated growth vs. 2019 current use



This chart shows anticipated growth in AM by application type by 2018 in gray, and actual use of 3D printing by application in 2019 in light blue.

Anticipated Growth in Application Type

When asked “Which application do you anticipate your company will see the most AM growth in the next 3 years?” (Figure R), manufacturing aids was the most popular application (39%).

While seen as a viable application of growth in 2015 (18% anticipated growth), it appears that the development of AM manufacturing aids has gained traction as valuable in the last five years.

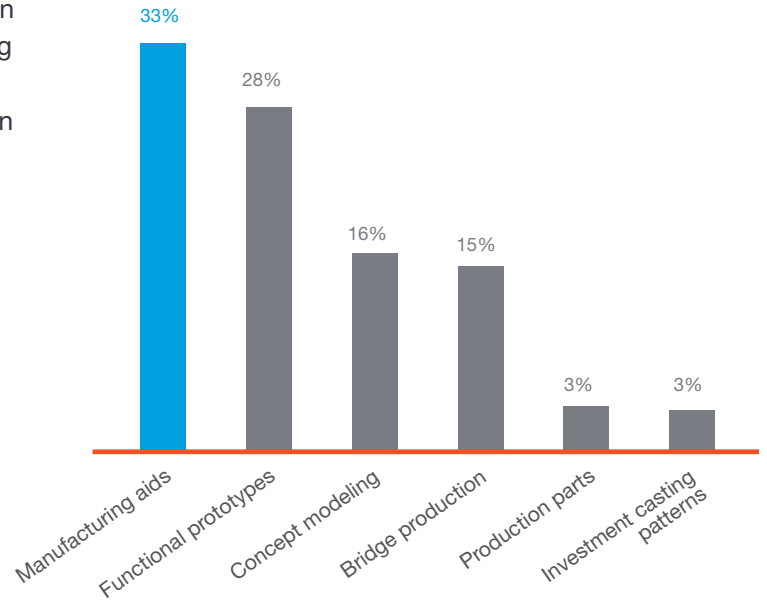
While some of the respondents are using 3D printing for production and bridge production parts currently (12% and 4%), less than 16% think it is an area of growth in their company in the next three years. This might reflect the new realistic use of 3D printing, anticipating advancement, but utilizing it where it brings real business value.

When you look at the industry breakdown of these results, aerospace is maintaining growth in functional prototypes (42%), manufacturing aids (18%) and production parts (27%).

Manufacturing aids are anticipated to experience the greatest amount of growth in the next 3 years

FIGURE R

Anticipated growth in AM by applications in the next 3 years



Learn more about manufacturing aids by reading about TS Tech Co’s 3D printed fixtures.

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> “3D printing has been around for a bit, and people will be doing more of it. I’ve seen it grow here, and I want to use it more.”

- Ryan Norton, Supervisor, Mattel

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The Future of Additive in 2020

Kent Firestone, CEO of Stratasys Direct Manufacturing

What do these survey findings say about the future of additive manufacturing for current and future users? I've identified five key takeaways that are not only helpful for our customers and the wider user base of 3D printing, but Stratasys Direct Manufacturing as a key provider of 3D printing services.

Manufacturing aids are being recognized as a growth opportunity

In 2015, only 18% of survey respondents expected manufacturing aids to be a growing application in the following three years. Five years later, 22% of survey respondents are utilizing additive manufacturing for manufacturing aids, and 33% see it as the biggest area of growth in the new decade. At Stratasys Direct we've seen this reflected in the increase in demand for jigs and fixtures among transportation, consumer products and aerospace customers.

The return on investment from a 3D printed manufacturing aid is high, and AM can deploy jigs and fixtures where they previously could not exist due to several key advantages. As recognized by nearly 50% of respondents, 3D printing is free from the design constraints of traditional manufacturing, opening opportunities for complex, ergonomic manufacturing aids. 3D printed manufacturing aids can be light weight, printed as-needed, customized for specific employees with less lead time than traditional parts.

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The Future of Additive in 2020

Functional prototyping is here to stay as a major application

Halfway through the decade, 3D printing entered a new era of self-awareness, moving away from the “printer in every home” dream and slipping into the more realistic understanding of the technology’s capabilities and place as part of the value chain. Now, 30 years since its commercialization, AM is still considered a key rapid prototyping solution, with 58% of respondents currently utilizing AM for prototyping, and 54% intending on using 3D printing for that purpose in the future.

While 3D printed parts are being successfully utilized in production and bridge production applications, the advancements of technologies and materials have also opened up more opportunities for robust functional prototypes. 3D printed parts are currently being put to the test underwater, in wind tunnels, on prototype vehicles, in high-temp, high-impact space test environments. Having quick access to reliable prototypes for testing remains a top benefits of AM across industries.

Metal continues to be the most coveted area of material growth

Similar to the survey 5 years ago, metal materials are still in high-demand. As more metal AM technologies emerge onto the scene, the diversity of metal alloys has increased significantly. Still, there’s a hunger for more options; several of our respondents called out tungsten, 6000 & 7000 series aluminum, additional stainless steel options and beryllium. A cursory search online will show you that some of these materials are already being explored for AM processes.

Processes that utilize powder bed fusion technology like Direct Metal Laser Melting (DMLM) and Electron-Beam Melting (EBM) have the widest range of metal materials. The future is bright for this technology simply because of the sheer number of companies making systems and developing new materials for the process. The availability aids in adoption and generates a sustainable solution for production AM metal parts.

The Future of Additive in 2020

Companies need knowledgeable, trained champions of 3D printing in order to gain traction and see results

What do these survey participants see as the most important step toward continued AM growth at their company? Training employees for additive manufacturing according to 36% of respondents and recruiting employees who already have experience with AM according to 21%. More than half of the responses are focused on developing AM champions in their company that they can rely on to utilize it efficiently. In my decades of experience in the additive manufacturing industry, I've concluded that AM adoption is most-effectively advanced by those that see its value for their businesses and utilize their skills and creativity to assess its place in the value chain.

For smaller companies, a fully-trained, dedicated team of AM engineers isn't realistic. It makes sense then that 31% of respondents see the future growth of AM in their company will mean partnering with a 3D printing service provider. The value of an AM parts provider is the range of technologies and materials available, post-processing and finishing services, and experts with passion for each person's project and how AM fits into their product development.

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The Future of Additive in 2020

The appetite for continued process AM improvements is ever growing across industries

Finally, it's clear that users are excited for the advancements the additive manufacturing industry will bring in the coming years. As more materials become available and processes become more reliable, the more companies will utilize 3D printing as a tool in their manufacturing methods. The larger the user base, the higher the demand for improved technologies and development of more materials.

In the 2015 survey, Joe Allison, the previous CEO of Stratasys Direct, concluded with this statement: "Today 3D printing is still perceived as a technology solution, but the future of 3D printing is a business solution." It is my belief that we're seeing that reality as many companies, no matter size or industry, are experiencing the long-term business benefits of additive manufacturing and are embracing the technology more year by year.

Now, entering the new decade, Stratasys and Stratasys Direct Manufacturing are committed to continuous process improvements and great accessibility to the latest advancements for our customers. To date Stratasys Direct has devoted 1.7m hours of engineering time to pushing the boundaries of advanced manufacturing.

Whether it's technological solutions that allow for better parts, standardization solutions that help qualify components for high-requirement applications, or resources that help engineers and designers educate and champion additive manufacturing in their company, we are focused on how we can help you excel into the future of manufacturing.

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