

# TREND FORECAST

## 3D Printing's Imminent Impact on Manufacturing

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# I FOREWORD



3D printing's greatest value is not as a technology, but as an enabler to derive greater business value



# FOREWORD BY JOE ALLISON



**stratasys**  
DIRECT MANUFACTURING

## CEO OF STRATASYS DIRECT MANUFACTURING

For those of us working in, around and with 3D printing, it's an incredibly exciting time. Today, we're putting production parts on commercial aircraft. Within 10 years, every commercial airplane will have 3D printed parts on it. That's just one example that you can apply across a multitude of industries – medical, energy, automotive, etc. The magnitude of change 3D printing will bring, and has already brought, is powerful. We at Stratasys Direct Manufacturing believe 3D printing is revolutionizing manufacturing: It's literally changing how products are being manufactured.

To get a more complete sense of 3D printing's imminent impact on manufacturing we needed to look beyond our factory walls. So we sponsored an independent survey of serious, professional users of 3D printing, many of them working for companies with over \$50M in revenue. We asked: How will they use 3D printing over the next three years? What do they see as the greatest benefits of and hurdles to 3D printing adoption? What is the business value? How will product development evolve? Who will invest in owning the technology and what role will service providers play?

The pace of change in this industry is so rapid you could argue a 3D printing industry research report is almost futile because the findings will quickly need updating once completed. While the data may only be accurate for a short period of time, it's the insights we can glean from them that hold the greatest value. With this research project, Stratasys Direct Manufacturing set out to uncover the common themes among companies who are on the

spectrum of larger-scale adoption and integration of 3D printing into their manufacturing process. We're most interested in discovering how they will do it and their latent needs. What do they see as barriers to getting there, and what resources and support will they need along the way? We're sharing this information with the industry to help advance adoption and help manufacturers maximize the business benefits of AM.

The findings indicate what materials, applications, services, equipment and business benefits are capturing the attention of 3D printing's most committed users, and where their companies will invest. Respondents expect their companies to expand their use of AM – most will increase in-house capabilities to meet the demand, yet many also express the need for a partner that will not only augment their internal manufacturing capacity, but also guide them through the expansion of internal capabilities, providing technical support and design consulting. 3D printing's greatest value is not as a technology, but as an enabler to derive greater business value.

If your company is a committed user of 3D printing, these findings will provide assurance that you are headed down a similar path of your peers and face many of the same challenges to adoption. If you're still dipping your toe in the water, the results may serve as a wake-up call to take swifter action. Using 3D printing to manufacture products may just be emerging as a competitive advantage today, but companies that don't initiate investment soon will quickly be at a considerable disadvantage.



# " METHODOLOGY



# HOW WE CONDUCTED THE SURVEY

## Data Collection

**Survey administrator:** SMS Research Advisors

**Methodology:** Online

**Timeframe:** April 10 to May 1, 2015

**Survey length:** 36 questions

**Sponsor:** Stratasys was NOT identified as the study sponsor, so as not to bias results

**Database:** Industry list of approx. 40,000 email addresses aggregated from multiple sources

**Completed interviews:** 700

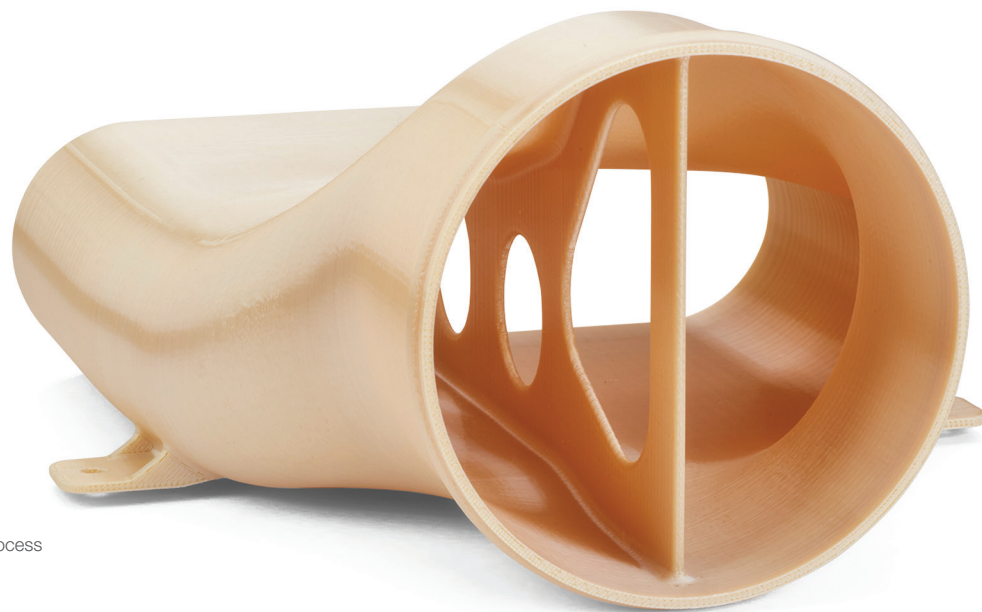
**All statistically significant results are reported at the 95% confidence level**

**Statistical accuracy:** +/-3.8%

## Qualified Respondent

- Currently uses or is considering additive manufacturing in the next 3 years
- Has some role in either the selection or management of manufacturing service providers
- Uses or foresees using (within the next 3 years) at least one additive or traditional manufacturing process

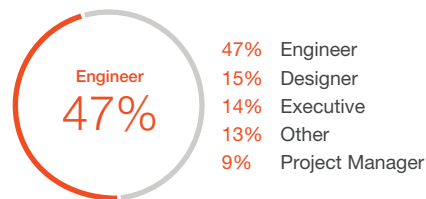
\*Note: The terms additive manufacturing (AM) and 3D printing were used interchangeably in this study.



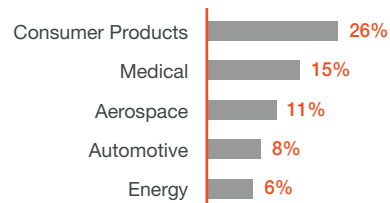
# PROFILE OF SURVEY RESPONDENTS

FIGURE A

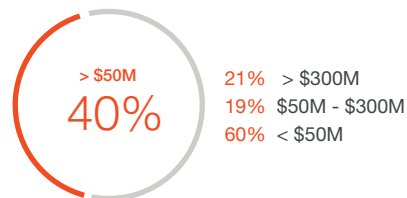
## Top 5 Titles / Positions



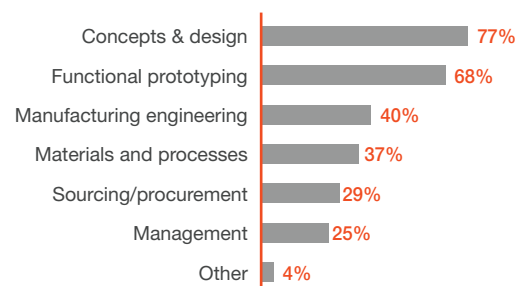
## Top 5 Industries



## Annual Revenue



## Top 6 Production Roles

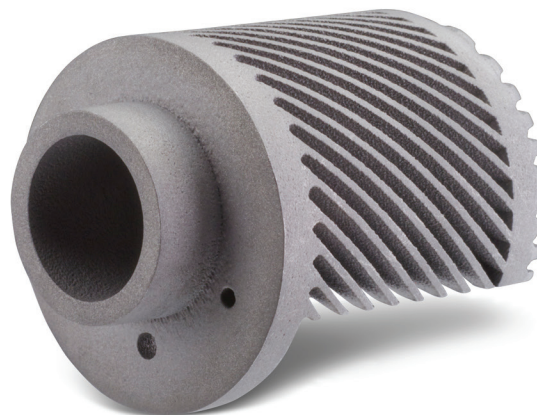


Survey respondents ranged from engineers and designers to executives and project managers, 40% of whom work for companies with more than \$50 million in revenue. They serve in a variety of production roles and work across a number of industries.

The survey's respondents are serious users. Each one of the 700 engineers, executives, designers and project managers who participated are already using 3D printing in their manufacturing processes or plan to do so in the next three years, making this one of the most comprehensive industry surveys of professional 3D printing users.

40% of participants were employed by companies with over \$50M in revenue in 2014, as noted in Figure A. Many of them are decision-makers in the selection of 3D printing services and processes for their companies. Industries represented include consumer products, medical, aerospace and automotive, among others. Geographically, respondents are based in North America.

We are not comparing survey findings to *The Wohlers Report*, the 3D printing industry's comprehensive and undisputed source of trends, analysis and forecasts. Though different in their scope and scale, we see the two reports serving a similar purpose: to further advance the resources, expertise and knowledge available within the 3D printing sector. By delivering knowledge to the greater manufacturing community, we can help accelerate adoption and influence public perspective for the greater good of designers, engineers and those in production.





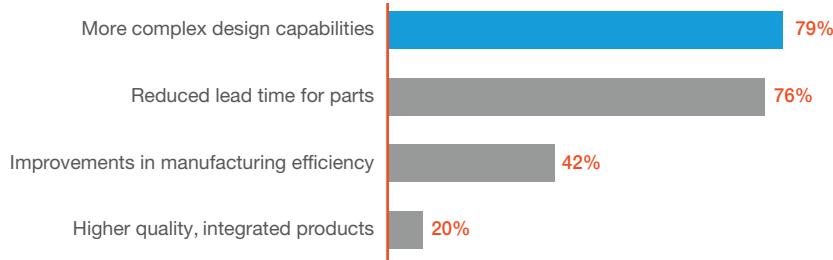


# CURRENT STATE OF 3D PRINTING

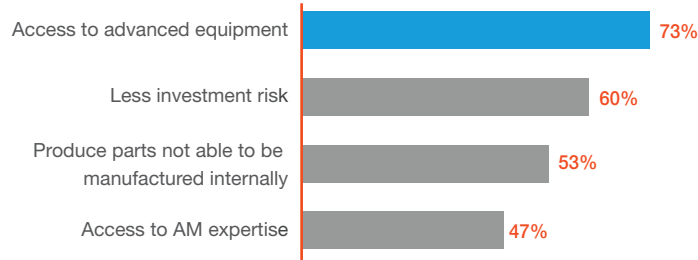
# BENEFITS

FIGURE B

## Top 4 Benefits of AM



## Top 4 Benefits of Outsourcing AM

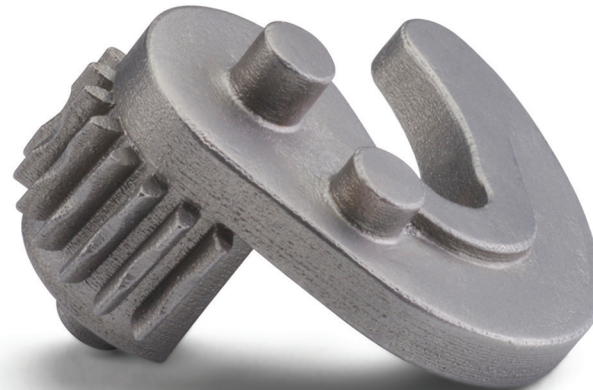


Respondents were asked what they perceive to be the top 3 benefits of both AM in general and outsourcing AM. The 4 most popular responses are highlighted here.

We asked respondents what they see as the most significant benefits of using AM. The most common responses were: more complex design capabilities (79%), reduced lead time for parts (76%) and improvements in manufacturing efficiency (42%).

We also asked what they believe to be the top benefits of outsourcing AM. The most common responses were: access to advanced equipment and materials (73%), less investment risk (60%), produce parts not able to be manufactured internally (53%), and access to AM expertise (47%).

The responses validate that AM users find the benefits essential to product development and manufacturing because the process creates complex parts in a way that increases manufacturing efficiency and gets them to market faster. Regardless of whether companies own AM machines, respondents indicated outsourcing part production is valued as a way to minimize risk and compensate for resources or expertise that doesn't exist internally.



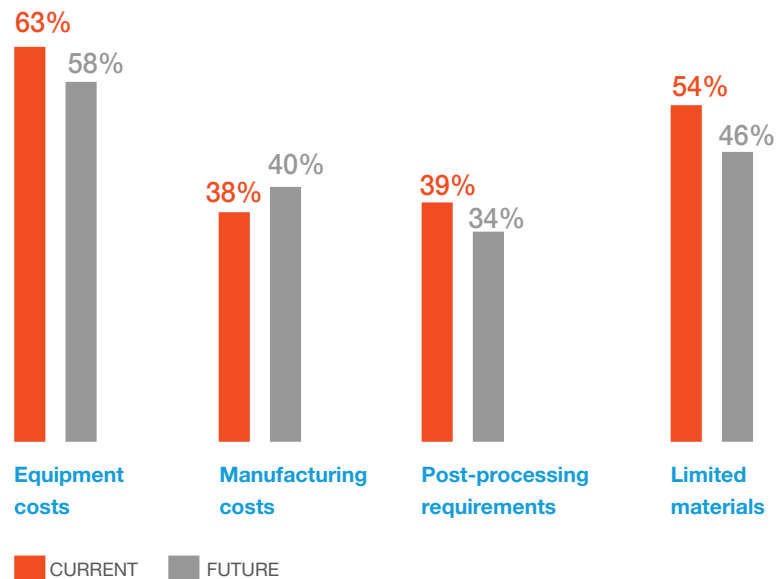




The industry must change the conversation from emphasizing AM's technical benefits to its overall business value.

## CHALLENGES

FIGURE C



Respondents were asked what they perceive as the top challenges their company faces in using AM now and will face in the future. The 4 most common responses are shown in this graph.

An analysis of the current state of 3D printing would not be complete without being realistic about the challenges to implementation. We asked respondents to weigh in.

As noted in Figure C, two of the top four challenges are financially-based, indicating that cost remains a notable barrier to implementation. In order to overcome these challenges, Stratasys Direct Manufacturing believes the industry must change the conversation from emphasizing AM's technical benefits to its overall business value.







# ATTITUDES

Some survey questions were developed specifically to allow us to compare and analyze the difference in attitudes held by decision-makers and influencers whose companies are currently using AM against those that are considering using AM within the next three years. Our hypothesis was the attitudes would vary depending upon where companies are along the spectrum of AM adoption, which the findings proved to be true. Here are the most interesting differences between the two groups:

- Businesses currently using AM are more likely to say they have started to rethink product design to fully leverage the design capabilities of AM than those who are considering AM.
- When compared to those already using AM, people who are considering AM are more likely to believe manufacturing service providers will play an increasingly important role in the future of manufacturing.
- Other significant attitudinal differences are highlighted in Figure D.

FIGURE D

25% / 45%	If the benefits of AM were better understood by our company, I believe we would be doing more of it.
32% / 49%	I do not believe my company is fully leveraging the advantages of AM today.
40% / 7%	We are now doing more AM in-house that we used to outsource in the past.
40% / 28%	We have already started to rethink product design to fully leverage the design capabilities of AM.
50% / 61%	I believe that manufacturing service providers will play an increasingly important role in the future of manufacturing.

■ USING AM   
 ■ CONSIDERING AM

The attitudes of respondents towards 3D printing varied based on whether they currently use AM or plan to use AM in the next 3 years.



## PREPARATIONS FOR THE FUTURE

We wanted to know what steps companies are taking to prepare for transferring from traditional manufacturing to AM in the future. The top responses, presented in Figure E, are shared by companies who are already using AM today as well as those who are planning on using AM in the future.

FIGURE E

40%

Training designers and engineers specifically for additive manufacturing

40%

Partnering with additive manufacturing service providers

34%

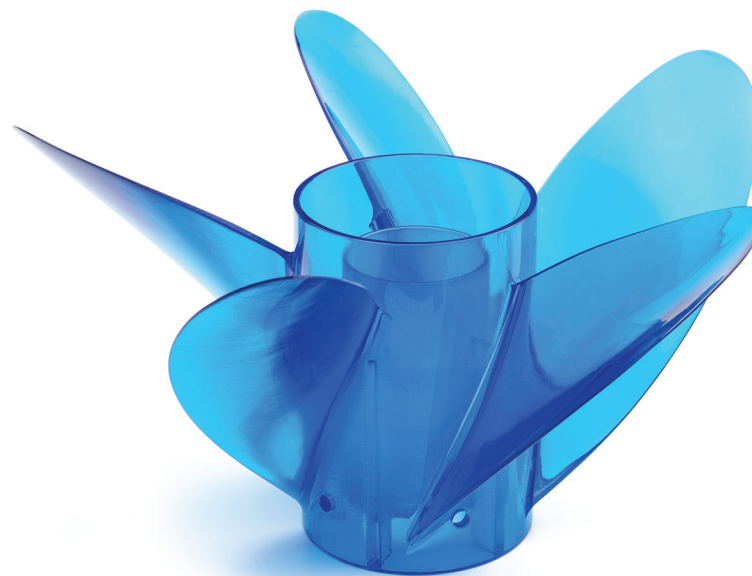
Funding research/investing in the development of additive manufacturing

19%

Recruiting employees experience/familiar with additive manufacturing

Companies are taking a number of steps to prepare for an increase in their 3D printing output.

The most common steps taken include: training designers and engineers specifically for AM (40%) and partnering with AM service providers (40%). Based on these responses, it's clear companies have been focusing on shoring up gaps in internal expertise. Companies are investing in the future by training employees specifically for AM and encouraging professional development through educational classes and seminars. Partnering with a service provider not only gives users access to equipment and materials they may not have experience with, but also consultative expertise.



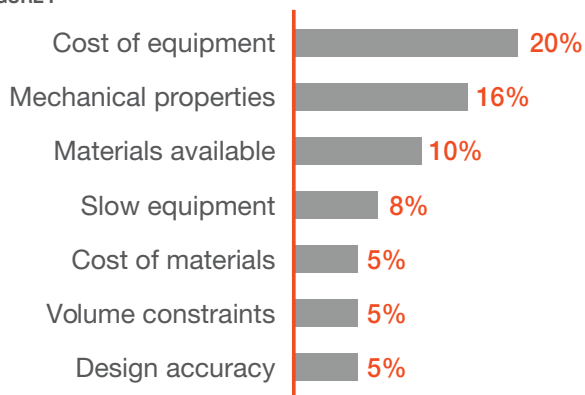


IV

# FUTURE STATE OF 3D PRINTING

# ISSUES OF GREATEST FUTURE IMPACT

FIGURE F



Respondents were asked what one issue they feel will have the greatest impact on the AM market. Interestingly, no one issue stands out significantly more than another.



We asked respondents what issues they see as having the greatest impact on the AM market. As you can see, responses range from cost of equipment and mechanical properties to materials available and design accuracy. Interestingly, employee training and education did not come up high on the list. This may be because, per the findings on Preparations for the Future (page 14), some respondents said they've already invested in training designers and engineers specifically for AM, and recruiting employees who are experienced or familiar with AM.

Among the top 7 responses (Figure F), no one issue stands out more than another. We believe this indicates users are looking to industry thought leaders – AM companies, analysts and members of the media – to tell them what issues will impact them most, so they can focus their efforts on those one or two issues.

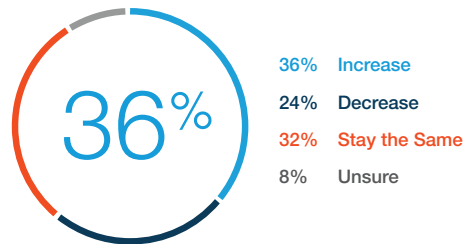


# SCALING CAPABILITIES & THE ROLE OF THE SERVICE PROVIDER

According to *The Wohlers Report 2015*, use of AM services grew nearly 40% from 2013 to 2014. With this survey, we were interested in learning how companies intend to expand their use of AM in the future – will they acquire and expand internal capabilities, rely on an external partner, or both?

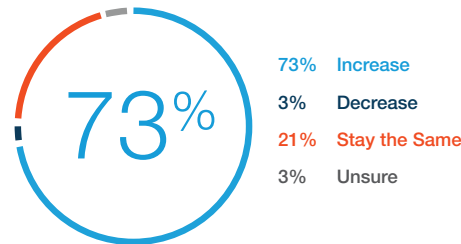
FIGURE G

## Change in Outsourced Production

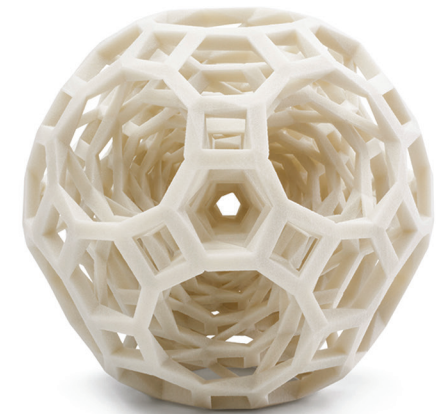


Consumer and Energy industries are most likely to grow outsourced AM

## Change in In-House Production



Aerospace and Medical industries are most likely to grow in-house AM



We asked respondents whether they expect their company's in-house AM production to increase, decrease or stay the same over the next 3 years. We asked the same question relative to their company's outsourced AM production.

It stands to reason that in-house AM capabilities are expected to grow as more companies invest in equipment, specifically those in the aerospace and medical industries. Nearly half of those who already have in-house equipment use it for the vast majority of their total AM needs.

The majority of respondents said that regardless of their company's in-house AM capabilities, they believe there will always be value in partnering with an AM service provider to augment internal capabilities.

Companies are choosing to outsource AM projects not because they have to, but because they want to. Respondents are especially attracted to outsourcing technologies that require more post processing, particularly Direct Metal Laser Sintering and Laser Sintering. Not only does outsourcing help companies meet production shortfalls, but service providers may have experience with a company's application type and may be better suited to help them realize AM's full

potential. The interest in ongoing access to expertise, spanning across the entire spectrum of product development and technology adoption, helps explain why respondents expressed interest in working with service providers even after they've purchased AM equipment.



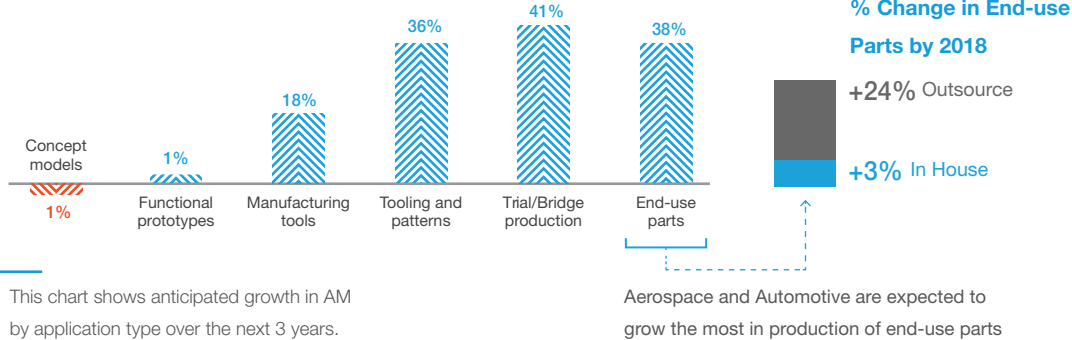
The majority of respondents – both current and future users over the next 3 years – strongly believe that more end-use parts will be designed specifically for AM in the future.



# APPLICATIONS

FIGURE H

% Change in AM Applications by 2018

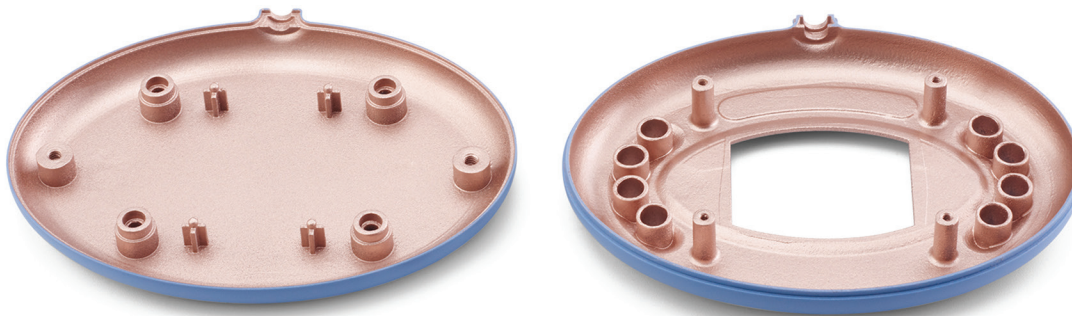


This chart shows anticipated growth in AM by application type over the next 3 years.

By 2018, AM can expect growth spurts in tooling, trial and end-use production applications, and stability in early stages of product development. Respondents' investments in AM and designing specifically for AM has helped expand their use of the technology for end-use part production.

Aerospace and automotive industries will expand their end-use part production the most. This is not surprising because these industries were among the first to explore end-use part production and, therefore, are further along in validating designs and materials to fit application needs.

A higher percentage of new end-use part production will be outsourced to service providers rather than done in-house. Survey results show there will be a 24% increase in end-use parts produced via outsourced AM by 2018 (Figure H), indicating respondents believe AM service providers have the expertise, materials and/or processes to meet their company's AM end-use part production needs better than their own internal capabilities. This augmented support helps those who are new to end-use production with AM navigate uncharted territory.

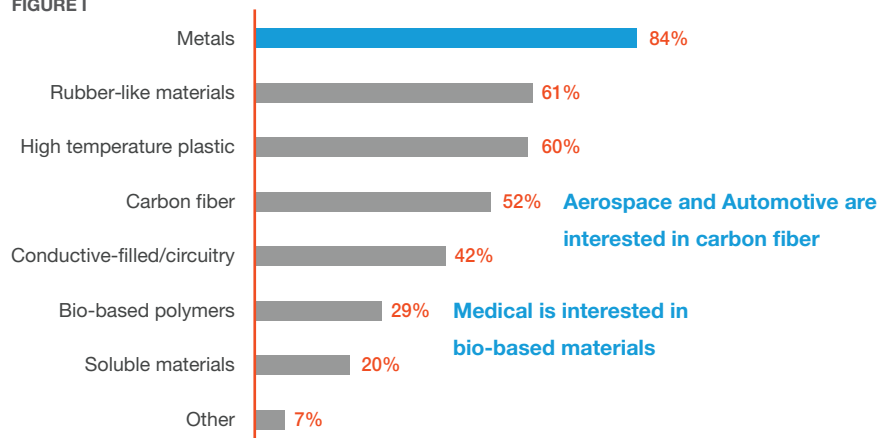




Metals are most highly  
coveted across all industries.

# MATERIALS

FIGURE I



Respondents were asked which materials they'd like to see further developed for AM in the future. Metals is the clear leader.

We asked respondents what materials they would like to see further developed for AM. Future material interests and needs are focused on properties.


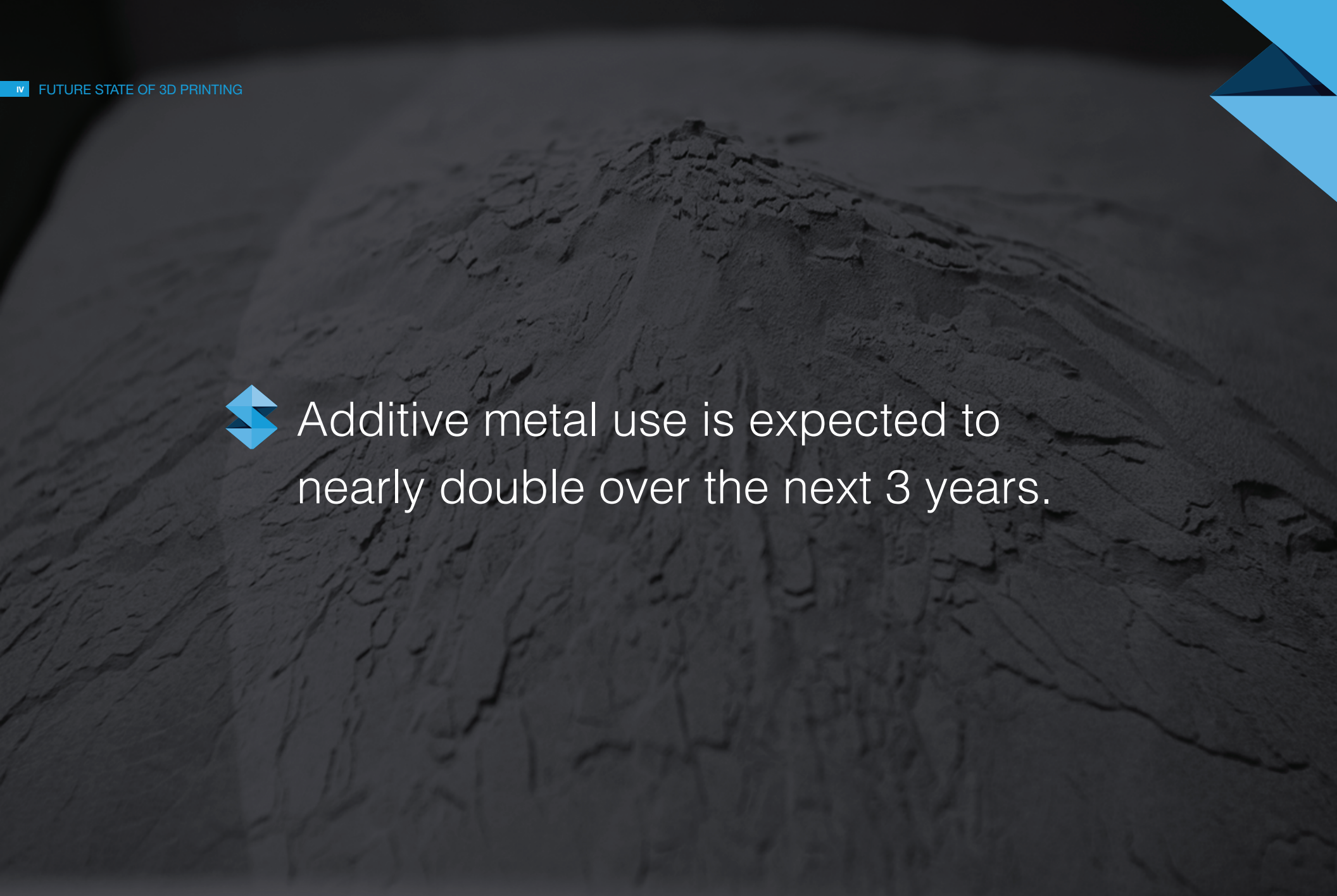
Decidedly, metals are most highly-coveted across all industries, with 84% of respondents interested in seeing more metal material developments (Figure I). Rubber-like materials and high-temperature plastics are in high demand for future use as well. Past these top 3 materials, property needs are very industry-specific. For example, respondents in aerospace and automotive sectors are more interested than other industries in carbon fiber, while respondents in the medical industry are more interested in bio-based materials.

There's a perception that metals are more highly sought-after in the aerospace sector than other industries, but this survey indicated the demand is equal across all sectors.

Stratasys Direct Manufacturing believes materials development will lead to new AM applications and solutions, giving companies opportunities to expand into new markets and multiply product lines. Thanks to their increased strength, durability and other beneficial properties, these materials will create – and already are creating – parts that are indistinguishable from conventional manufacturing methods materials and engineers, developers and manufacturers will progressively rely upon them.



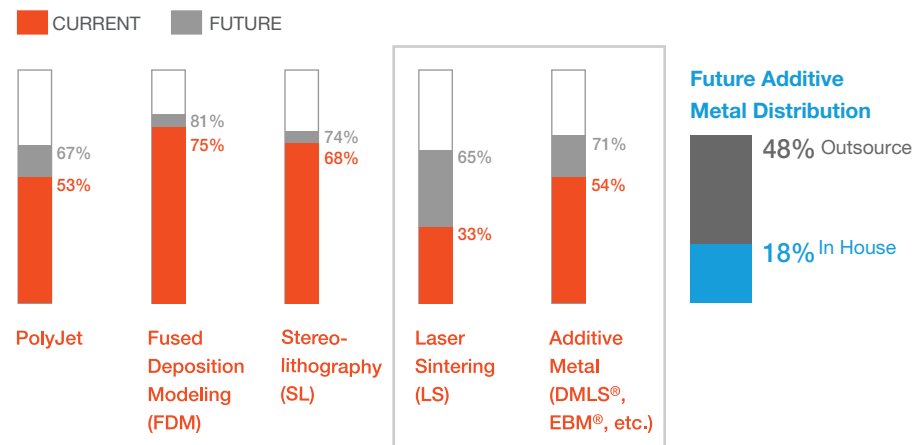




Additive metal use is expected to nearly double over the next 3 years.

# PROCESSES

**FIGURE J**  
**% Change in AM Processes by 2018**



Here you see current vs. anticipated future usage of several AM processes among respondent companies.

Respondents were asked to describe their companies' current and future usage of several AM processes, including photopolymer, thermoplastic and additive metal processes. The chart in Figure J depicts both current and future usage of each process, making it easy to see that Laser Sintering and additive metal processes are prime for future growth. In fact, additive metal use is expected to nearly double over the next 3 years.

The market is more likely to turn to service providers for access to additive metal technologies rather than buy equipment and build the required team and skills. It can be difficult to implement these processes in-house since they're messy, can require additional equipment (like CNC machines) and necessitate a team for post-processing. They can also be expensive for one-off parts, depending on the geometry.

Stratasys Direct Manufacturing is seeing the greatest interest in additive metals in the medical, oil & gas, and aerospace industries.







# v WHAT'S NEXT





BY JOE ALLISON,  
CEO OF STRATASYS DIRECT  
MANUFACTURING

So what do the survey's findings reveal about the future of 3D printing for serious, professional users? They confirm that growth over the next three years will largely come in end-use production, with an emphasis in metals. These two trends combine to drive the third trend: a demand for expertise and know-how. Companies need help identifying new additive applications to determine the technology that can best fulfill those needs. For end-use part production, they need support in optimizing 3D printing processes to bring cost down, while fully leveraging 3D printing's benefits and its business value.

It won't surprise you to hear that Stratasys believes the future is bright for 3D printing and manufacturing service providers—a view realized in its acquisitions of Solid Concepts and Harvest Technologies to combine with its parts business, RedEye, in 2014 and form Stratasys Direct Manufacturing. It's an exciting time to be in this challenging and rewarding industry. While the future holds incredible potential, I like to remind people that expanded adoption of 3D printing for end-use parts does not happen in the blink of an eye—it happens one application at a time. It's our job to take customers' amazing new ideas for products and technologies and champion them into real applications, one-by-one, by identifying ways additive can bring them to life faster and easier. While it doesn't happen overnight, it's something we at Stratasys Direct Manufacturing are uniquely and exceptionally good at. We get to know each part and project at a level that transcends the customer's company or industry needs, allowing us to create unique solutions using a variety of tools.

It's also not a shock that additive metal is the future of manufacturing services because the market has long yearned for a method to create complex metal parts. Service support is necessary because, as one of the newer additive technologies, additive metal still needs evaluation and qualification. Partners with experience and know-how will be sought-after. At Stratasys Direct Manufacturing, we remain focused on growth and research in additive metal technologies and supporting processes.

One of the questions about the 3D printing industry that I hear often in the press and within the investor community is: When will end-use part production go beyond the early adopters and become "mainstream"? No survey can tell us whether we've reached the inflection point; only time will tell. But make no mistake: 3D printing is here and now. We're building real production parts in every field you can think of, across a wide range of applications today. For any manufacturers out there that haven't started using 3D printing, they better start looking at it now, or they'll fall behind and it will be difficult to catch up.

The last thought I'll offer is that today 3D printing is still perceived as a technology solution, but the future of 3D printing is as a business solution. Stratasys Direct Manufacturing and Stratasys are committed to evolving the conversation because technology is a tool that enables innovation, not defines it.



For any manufacturers out there that haven't started using 3D printing, they better start looking at it now, or they'll fall behind and it will be difficult to catch up.





# TREND FORECAST

## 3D Printing's Imminent Impact on Manufacturing