3D Printing comes of age in US industrial manufacturing

pwc

Introduction

Has 3D printing (3DP) finally come of age? It's become clear that the technology, also known as additive manufacturing, is crossing from a period of hype and experimentation into one of rapid maturation. 3D-printed parts and products are quickly making their way into end products—from a printed car to athletic shoes to a printed NASA rocket engine. Industrial 3D printers, once almost exclusively used for prototyping, are now, on some of America's factory floors, being rolled out on production lines. Manufacturers of all stripes are building 3DP programs and are likely to continue to expand those programs as advancements in 3D printers, software and printing materials (or "inks") make adoption easier and more cost-effective.

The adoption of 3D printing—both desktop and industrial—continues to rise, with global spending on printers hitting about $11 billion in 2015 and forecast to reach about $27 billion by 2019, according to IDC[1]. A proliferation of new-entry printer makers are offering faster, cheaper and more sophisticated 3D printers on both the personal desktop and industrial printer markets. And, as printers expand the portfolio of inks that can be used—most notably metal, ceramics and graphene—3D printing will likely continue its march to compete with conventional manufacturing technologies, especially as the expectations and needs for just-in-time and customized products rise. Quite simply, 3D printing is becoming mainstreamed as we witness the technology cross the threshold from "advanced" to "conventional".

Two years ago, PwC published results from its first "Disruptive Manufacturing Innovations Survey" in which we sought to take a snapshot of how—and to what extent—US manufacturers were adopting 3DP into their operations and how they expected the technology to play out in the future. In this report, we share findings from a second survey posing the same questions to see what's changed over two years. Not surprisingly, manufacturers are still very much at the vanguard of 3D printing adoption and innovation. While desktop printers and entrepreneurs may grab the headlines, manufacturers are also pushing 3D printing to its limits and are prime movers in ushering the technology to higher maturity levels.

According to our new survey, we find some interesting shifts in how 3D printing is being applied by manufacturers from just two years ago. These include:

- **More making, less tinkering** While roughly the same percentage of US manufacturers are currently adopting 3DP in some way (roughly two-thirds) a higher percentage (51%) are using it for prototyping and final-products than two years ago (35%); meanwhile, fewer are simply "experimenting" to determine how they may use the technology (17% vs 29% two years earlier).

- **Expectations rise for 3D printing for high-volume production in the future** More manufacturers (52%) expect 3D printing to be used for high-volume production in the next 3-5 years, compared to two years ago (38%). Meanwhile, those expecting 3D printing to be used for low-volume, specialized products in the next 3-5 years slipped slightly to 67% from 74% two years ago.

- **3D printing seen to disrupt supply chain, threaten intellectual property** Manufacturers are equally split on what will be 3DP's most disruptive effect, with 22% saying it will be in restructuring supply chains, and another 22% that it will be threats to intellectual property, and 18% believe that it will be changed relationships with customers. Two years ago, the stand-alone, number-one concern was supply chain disruption.

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1 "Worldwide spending on 3D printing forecast to grow at a compound annual rate of 27% to more than $26 billion in 2019, according to IDC", IDC press release, January 21, 2016.

7 ways 3D Printing is disrupting US manufacturing: findings from PwC's 2016 Disruptive Manufacturing Innovations Survey
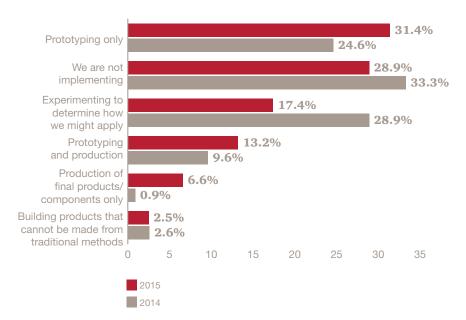
Below are main findings of our 2016 Disruptive Manufacturing Innovations Survey on 3D printing. For purposes of comparison, relevant results carried out in our 2014 survey are also included.

1. More than two-thirds of US manufacturers are using 3D printing in some way—chiefly in prototyping

71.1% of US manufacturers are applying 3D printing technology in some way, up slightly from 67% in 2014. But, when we look at how the technology is being used, we see some important shifts. A higher percentage of manufacturers, compared to two years ago, are using it for prototyping (31.4%), the production of end-products (6.6%)—or both (13.2%). At the same time, fewer (17.4%) are merely "experimenting to determine" how the technology may be useful to their operations—down from two years ago when 28.9% said they were in the tinkering phase.

Printing end-products on the rise

Q. How is your company currently applying 3D technology? Please select one.

Legend:
- 2015
- 2014

	2015	2014
Prototyping only	31.4%	24.6%
We are not implementing	28.9%	33.3%
Experimenting to determine how we might apply	17.4%	28.9%
Prototyping and production	13.2%	9.6%
Production of final products/components only	6.6%	0.9%
Building products that cannot be made from traditional methods	2.5%	2.6%

Number of respondents: 121
Source: PwC analysis of Zpryme Research survey data, "2015 Disruptive Manufacturing Innovations Survey," conducted in October 2015.
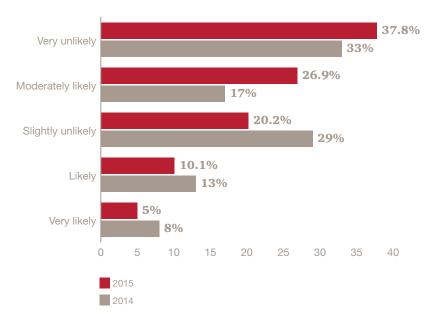
2. Manufacturers anticipate greater use of 3D printing for high-volume production

More manufacturers (42%) now believe that, in the next 3-5 years, 3D printing will likely be primarily used for high-volume production, up slightly from two years ago, when 38% felt that that was the case. Most manufacturers still believe that 3D printing will be used primarily low-volume, specialized products (67%)—although that percentage slipped slightly from 74% in our survey two years ago.
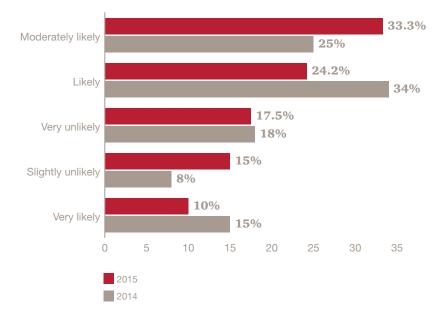
Is 3D printing approaching a mass-production tipping point?

Q. 3D applications will be used for high-volume production.

Category	2015	2014
Very unlikely	37.8%	33%
Moderately likely	26.9%	17%
Slightly unlikely	20.2%	29%
Likely	10.1%	13%
Very likely	5%	8%

■ 2015
■ 2014

Number of respondents: 119
Source: PwC analysis of Zpryme Research survey data, "2015 Disruptive Manufacturing Innovations Survey," conducted in October 2015.

Q. 3D printing will be used mostly for low-volume, specialized products.

Category	2015	2014
Moderately likely	33.3%	25%
Likely	24.2%	34%
Very unlikely	17.5%	18%
Slightly unlikely	15%	8%
Very likely	10%	15%

■ 2015
■ 2014

Number of respondents: 120
Source: PwC analysis of Zpryme Research survey data, "2015 Disruptive Manufacturing Innovations Survey," conducted in October 2015.
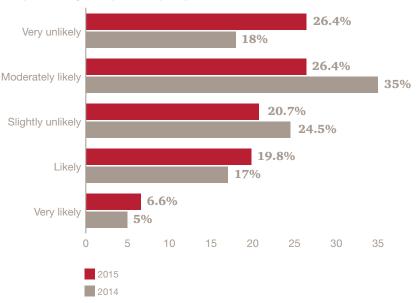
3. Most manufacturers believe 3D printing will be more useful in producing after-market parts than newly developed products

Manufacturers are evenly split on 3D printing's role in after-market parts production. Just over half of US manufacturers (52.8%) believe that, in the next 3-5 years, 3D printing will be more useful in producing after-market parts or products, slightly down from 57% two years ago.

After-market parts: 3D printing's sweet spot?

Q. 3D applications will be more useful in producing after-market parts rather than for producing newly developed products.

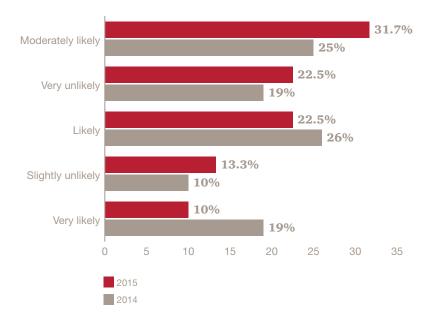| Category	2015	2014
Very unlikely	26.4%	18%
Moderately likely	26.4%	35%
Slightly unlikely	20.7%	24.5%
Likely	19.8%	17%
Very likely	6.6%	5%

Number of respondents: 121
Source: PwC analysis of Zpryme Research survey data, "2015 Disruptive Manufacturing Innovations Survey," conducted in October 2015.

4. 3D printing seen useful to produce obsolete parts

64% of manufacturers expect that, in the next 3-5 years, 3D printing will be used to produce older, obsolete parts—down slightly from 2014, when 70% believed that would be the case.

Making old parts new

Q. 3D applications will be used to replace obsolete parts.

Category	2015	2014
Moderately likely	31.7%	25%
Very unlikely	22.5%	19%
Likely	22.5%	26%
Slightly unlikely	13.3%	10%
Very likely	10%	19%

Number of respondents: 120
Source: PwC analysis of Zpryme Research survey data, "2015 Disruptive Manufacturing Innovations Survey," conducted in October 2015.
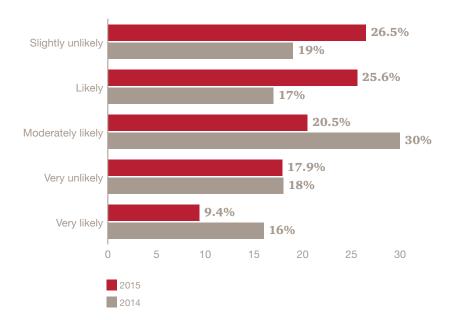
5. Most manufacturers see majority of all manufacturers in the US adopting 3D printing technology

As mentioned earlier in this report, roughly two-thirds of US manufacturers we surveyed are already using 3D printing in some way (i.e., prototyping, finals products production and experimenting). Yet, when asked if they feel it is likely that more than half of their peers in the US will adopt 3D printing in the next 3-5 years, just 56% believe that that would be the case. Perhaps this suggests that adopters of emerging technologies assume that they are further ahead in the adoption curve than their manufacturing counterparts are. In any case, two years ago, 63% of manufacturers we surveyed believed that at least 50% of manufacturers in the US would adopt 3D printing in the next 3-5 years.

Widespread adoption of 3D printing seen on horizon

Q. 3D applications will be adopted by more than 50% of manufacturers.

Slightly unlikely — 26.5% (2015), 19% (2014)
Likely — 25.6% (2015), 17% (2014)
Moderately likely — 20.5% (2015), 30% (2014)
Very unlikely — 17.9% (2015), 18% (2014)
Very likely — 9.4% (2015), 16% (2014)

■ 2015
■ 2014

Number of respondents: 117

Source: PwC analysis of Zpryme Research survey data, "2015 Disruptive Manufacturing Innovations Survey," conducted in October 2015.

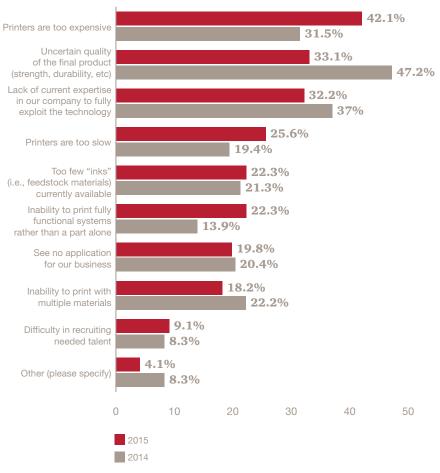*3D Printing comes of age in US industrial manufacturing*

6. Cost and quality lead adoption barriers

The most commonly cited barriers to adopting 3D printing among manufacturers are cost and lack of talent and current expertise (41.3% and 42.1% respectively), followed by uncertainty of quality of the final product (33.1%) and printer speed (25.6%). [Note: survey participants could choose any barriers that applied them; therefore, percent totals of all choices add up to greater than 100%].

Interestingly, manufacturers from our 2014 survey cited quality of the final product by far as the greatest barrier (at 47%), followed by lack of talent and expertise to exploit the technology, followed by cost concerns.

3D printing non-adopters still waiting for speedier, cheaper printers

Q. What are the barriers to your company's adoption of 3D printing? Please select all that apply.

Barrier	2015	2014
Printers are too expensive	42.1%	31.5%
Uncertain quality of the final product (strength, durability, etc)	33.1%	47.2%
Lack of current expertise in our company to fully exploit the technology	32.2%	37%
Printers are too slow	25.6%	19.4%
Too few "inks" (i.e., feedstock materials) currently available	22.3%	21.3%
Inability to print fully functional systems rather than a part alone	22.3%	13.9%
See no application for our business	19.8%	20.4%
Inability to print with multiple materials	18.2%	22.2%
Difficulty in recruiting needed talent	9.1%	8.3%
Other (please specify)	4.1%	8.3%

■ 2015
■ 2014

Number of respondents: 121

Source: PwC analysis of Zpryme Research survey data, "2015 Disruptive Manufacturing Innovations Survey," conducted in October 2015.

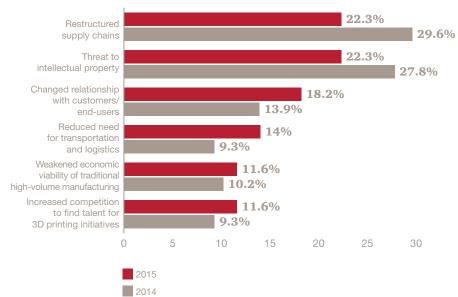*3D Printing comes of age in US industrial manufacturing*

7. Supply chain restructuring and intellectual property threats top list of 3D printing disruptions

When asked which aspects of their business 3D printing could potentially disrupt the manufacturing industry if, or when, the technology is widely adopted, the two most highly cited were: restructured supply chains and threat to intellectual property (both at 22%)—which were also the top-two selected in our 2014 survey, though more vehemently (at 30% and 28% respectively).

Interestingly, US manufacturers now see other areas vulnerable to disruption than they saw two years ago, including: changed relationship with customers; reduced need for transportation and logistics; and talent concerns to exploit the technology.

3D printing seen to disrupt supply chains, IP security

Q. If and when 3D printing is widely adopted, what will be the most disruptive effect on US manufacturing?

Category	2015	2014
Restructured supply chains	22.3%	29.6%
Threat to intellectual property	22.3%	27.8%
Changed relationship with customers/end-users	18.2%	13.9%
Reduced need for transportation and logistics	14%	9.3%
Weakened economic viability of traditional high-volume manufacturing	11.6%	10.2%
Increased competition to find talent for 3D printing initiatives	11.6%	9.3%

Number of respondents: 121
Source: PwC analysis of Zpryme Research survey data, "2015 Disruptive Manufacturing Innovations Survey," conducted in October 2015.

Embracing disruption: Are you ready for the 3D printing revolution?

Manufacturers big and small are assessing how to shape or expand a 3D printing program. Doing so is becoming easier, as more 3D printing hardware, software products are entering the market and as costs of the technology are falling swiftly. As with any disruptive technology adoption, businesses take different directions and wade in at different speeds—as evidenced by our findings in this report.

No matter the trajectory of 3D printing adoption a company may be on—from mulling to aggressively expanding--there are probing questions all manufacturers ought to be asking themselves to exploit the technology in ways that both expand their business and make them more competitive.

Some questions that could help such a "3DP self-assessment" include:

- How can 3D printing be an integral part of your research and development (e.g., through rapid prototyping)?
- Can 3D printing help improve the design and performance of your existing products made through conventional manufacturing processes?
- Are there any new products in your portfolio that can be partially or even whole 3D printed to help go to market faster or with greater latitude for customization?
- Do your product lines lend themselves to 3D printing? And which 3D technology would you need?
- At what point does it become economically attractive to use 3DP over traditional manufacturing (i.e., injection molding, casting, subtractive manufacturing, machining, milling, and turning), and in which parts of the business (e.g., R&D, testing and custom-production)?
- What opportunities do you see to "hybridize" (i.e., combine 3DP and traditional subtractive processes)?
- Is 3D printing economically viable now? Have you considered experimenting with a desktop printer before considering purchasing or leasing an industrial 3D printer?
- Have you assessed the barriers of 3DP for your company (e.g., limited ability to use multiple materials printing one object, process quality process speed, feedstock availability and price, the right talent and skill sets)? Does your company have a plan to adopt 3DP when or if those barriers drop?
- Does your organization have the talent and resources to launch a 3D printing program, or does it make more sense to outsource to a third-party service specializing in all facets of the technology (3D scanning, prototyping, reverse engineering, etc.)?
- Has your company identified the best vendors/suppliers that could help you wade into 3DP adoption?
- Can 3DP be used to help your business customize products, or does it make sense to print products on demand in the "lot of one" model?
- Could 3DP present opportunities for your company to diversify into new products and bid on jobs that presently you cannot?
- Could your business take advantage of the growing global network of 3D printers in ways that could simplify your supply chain?
- Would it make sense to "buy into" 3DP through an acquisition, joint venture or other business combination in order to acquire the expertise instead of developing it internally?

***To have a deeper conversation about how this subject may affect
your business, please contact:***

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About the research survey:

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in an online survey of 120 US manufacturing professionals in 2015.