Tech-Clarity

How Top Manufacturers Are Planning for the Future

What You Need to Know about 3D Printing and How It Will Change Product Development

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Executive Overview

As companies strategize to improve their competitiveness amidst the growing pressures of a global economy, they will make critical decisions about the future of their products. For many companies, new technologies will play a significant role. Some of these new and emerging technologies will fundamentally change the way we develop and manufacture products. Those companies who successfully adapt to these new technologies, and turn them into a competitive advantage, will be well positioned to achieve market success and enjoy greater profitability. The risk is making the right decisions around what to adopt and how.

Top Performing companies tend to be visionary and consequently enjoy higher revenue growth and profit margins. Their plans can be a leading indicator of what you should consider as you develop product and production strategies. Which technologies are leading companies adopting? What steps do they take to be successful? What should you consider for your company? To understand these questions, Tech-Clarity surveyed 200 manufacturers.

Over the next five to ten years, to stay competitive, 95% of Top Performers will change the way products are designed and engineered.

The research finds that Top Performers maintain their competitive edge by focusing on how to continue to keep customers happy, after they have made the purchase. They are 2.6 times more likely than peers to improve their competiveness by reducing the cost of ownership for their customers. What's most striking is that that over the next five to ten years, to stay competitive, 95% of Top Performers will change the way products are designed and engineered.

89% of Top Performers will look at new ways to design to take advantage of 3D printing.

Interestingly, 3D printing will play a big role in helping companies achieve a competitive advantage. Respondents report it will be a top technology to help companies execute strategies to improve competitiveness. In fact, 89% of Top Performers will look at new ways to design to take advantage of 3D printing. To support 3D printing, Top Performers are 2.1 times more likely than peers to work with scan data to design parts for 3D printing. In addition, 60% of companies will use scan data or will increase its use if it becomes easier to work with because it will improve their design efficiency.

This report explores how 3D printing will help companies become more competitive. It also identifies best practices to adopt it so that you can make it a success at your company.

Identifying the Top Performers

With so many exciting new and emerging technologies, it can be difficult identifying what's hype versus what will really make a difference. Studying the plans of the most successful companies can provide good guidance on what to prioritize. Tech-Clarity defined Top Performers as those who exceed their competitors. To identify them, survey respondents rated themselves against their competitors, using a scale of one to five, with five meaning significantly exceeding competitors. We defined the top 20% as Top Performing companies. Table 1 shows the metrics used to define success and the respective average scores for each group.

Ability to:	Top Performers	Average Performers
Develop products efficiently	4.5	3.3
Develop high quality products	4.7	3.7
Develop innovative products	4.7	3.5
Meet product cost targets	4.3	3.0

Table 1: Definition of Top Performers

As you would expect, Average Performers rate themselves about a three, meaning they are doing about average compared to competitors. On the other hand, Top Performers significantly exceed their competitors.

As a result of their better performance, Top Performers enjoy higher profitability. Figure 1 shows the financial benefits they enjoy.

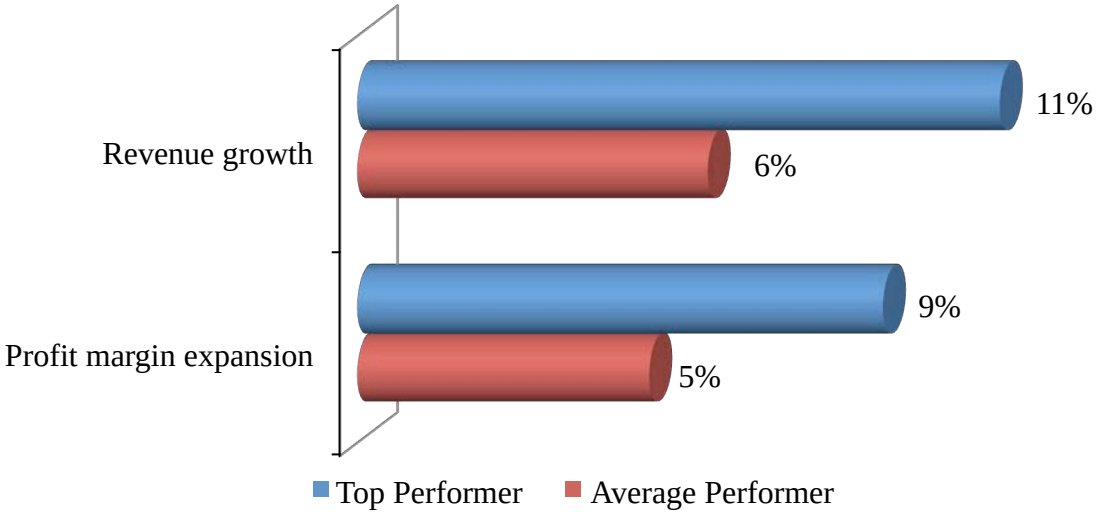

Figure 1: Financial Advantages of Being a Top Performer

Figure 1 shows that Top Performers make decisions and take approaches that lead to greater revenue growth and larger increases in profit margins. Let's look at their plans for the future.

Consider the Product Strategies that Are Important to Success

There are many product strategies companies can take to improve the competitiveness of their products. Figure 2 shows the top ones.

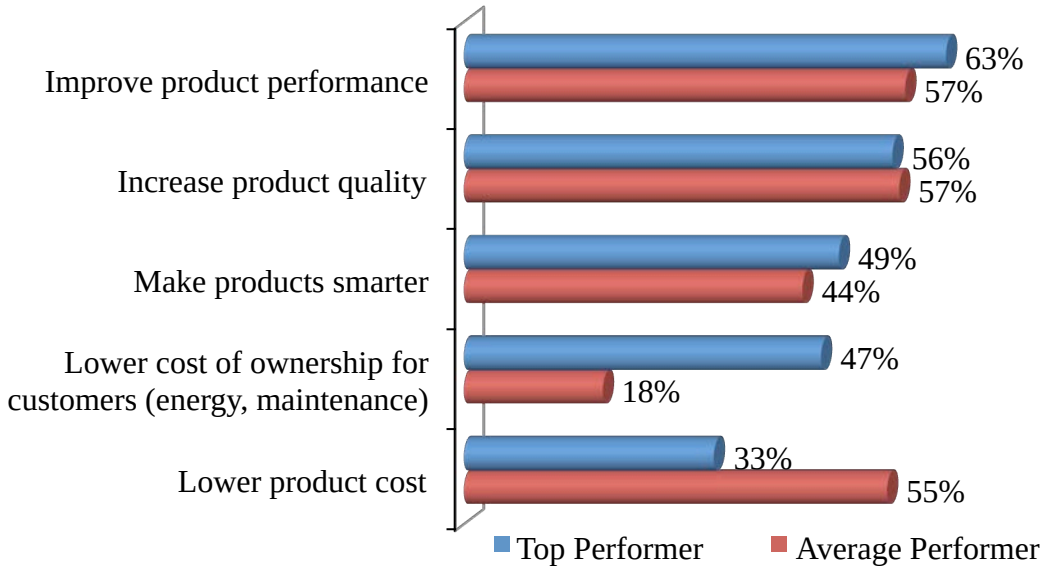

Figure 2: Strategies to Improve Competitiveness

To become more competitive, Top Performing companies focus on customer needs. They implement product qualities that will win loyalty through improved product performance, quality, and making products smarter. Average companies look at this as well, but Top Performers stand out by focusing on the total cost to the customer. Beyond just the product cost, Top Performers also look at the cost over the product lifecycle. They consider factors like better energy efficiency and lower maintenance costs. Average companies focus more on product cost. While this helps with profitability in the short term, competing on just cost and pricing becomes less sustainable over time. It also does less to offer customers long-term value.

Top Performers stand out by focusing on the total cost to the customer.

When exploring the technologies that will help them execute on these strategies, 3D printing comes out on top (Figure 3).

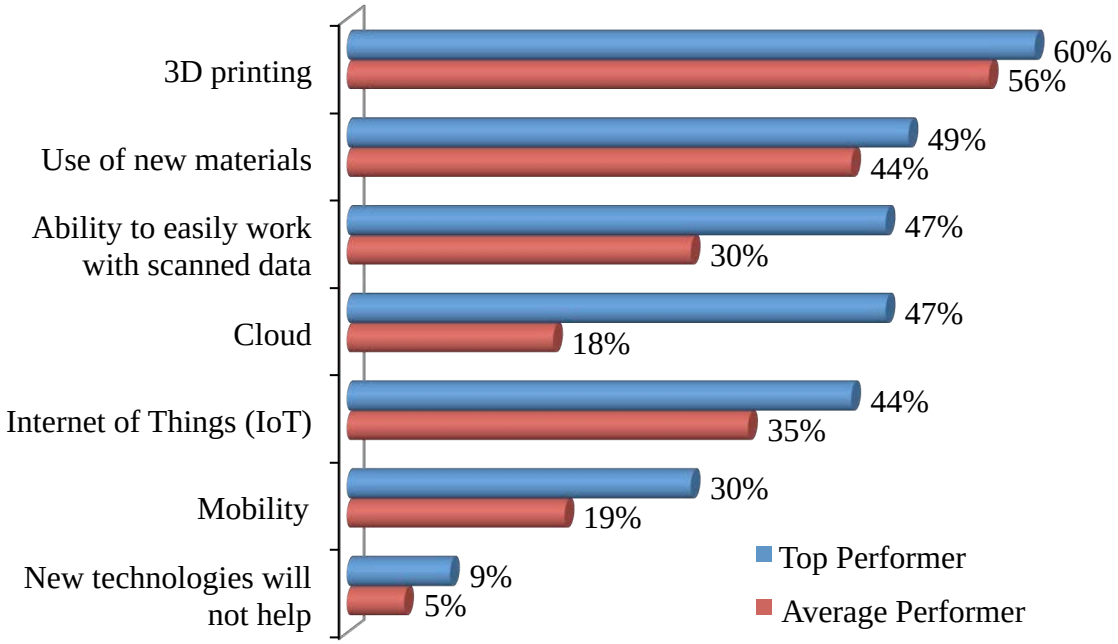

Figure 3: Technologies That Will Help Execute Strategies to Improve Competitiveness

The combination of 3D printing, new materials, and scan data will play a role in lowering the cost of ownership. These technologies can help reduce part weight, which will lead to better fuel efficiency. In addition, rather than stocking spare parts, companies can just scan existing parts or use CAD models to 3D print them. Since you avoid waiting for spare parts, you minimize downtime. Plus, you lower inventory costs. While the survey data may have a slight 3D printing bias, it is clear that new technologies will play a critical role in the future and 3D printing will be an important component.

The combination of 3D printing, new materials, and scan data will play a role in lowering the cost of ownership.

What's especially striking is that as companies adopt these new technologies, they will need to make changes. In fact, 95% of Top Performers anticipate that to stay competitive, they will need to change how they design and engineer products over the next five to ten years (Figure 4).

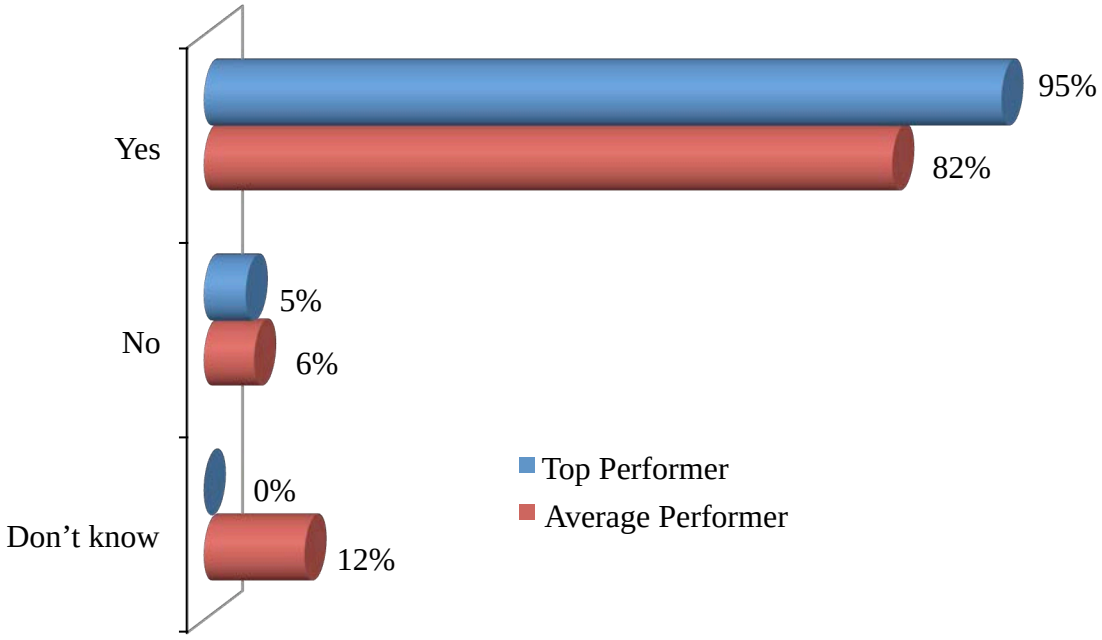

Figure 4: Over the Next 5 to 10 Years, to Stay Competitive, Will Your Company Change How Products Are Designed and Engineered

Clearly, status quo is no longer enough to remain competitive. The pressures from global competition require new approaches to maintain a competitive advantage. Plus, taking full advantage of the innovations enabled by new technologies means rethinking existing practices. It is also interesting that there are not any Top Performers who don't know if there will be changes. This likely indicates that plans for changes are already underway.

95% of Top Performers anticipate that to stay competitive, they will need to change how they design and engineer products over the next five to ten years

Pay Attention to 3D Printing Adoption

Considering how important 3D printing will be for future competitiveness, let's look at the current state of adoption. Figure 5 shows company adoption plans and current use of 3D printing for prototyping and production.

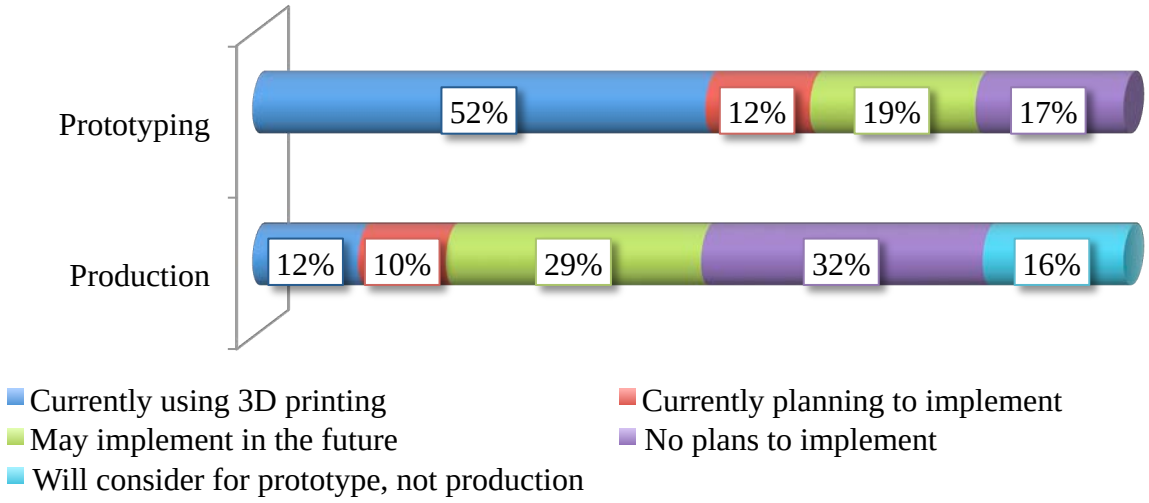

Figure 5: 3D Printing Adoption for Prototypes and Production

Figure 5 shows 3D printing is more commonly used for prototyping. Fifty-two percent (52%) use it for prototyping, while only 12% use it for production. However, wider production use is not far away. Thirty-nine percent (39%) are in the process of planning to implement for production or may implement in the future.

When looking at adoption timeframes, Top Performing companies lead the way. They are more likely to have been using 3D printing longer and they use it for a greater percentage of parts. In addition, of those planning to implement it, Top Performing companies plan to implement it sooner (Table 2).

	Prototyping	Production
When Top Performers plan to implement	2 years	2.5 years
When Average Performers plan to implement	3 years	3.1 years
Timeframe Top Performers have used	6.7 years	2.8 years
Timeframe Average Performers have used	4.4 years	3.9 years
Of those using 3D printing, percentage of parts Top Performers 3D print	46%	43%
Of those using 3D printing, percentage of parts Average Performers 3D print	34%	39%

Table 2: Adoption of 3D Printing for Prototypes vs. Production

Consider Options Enabled by 3D Printing

The reasons driving 3D printing adoption reveal how it helps improve competitiveness (Figure 6).

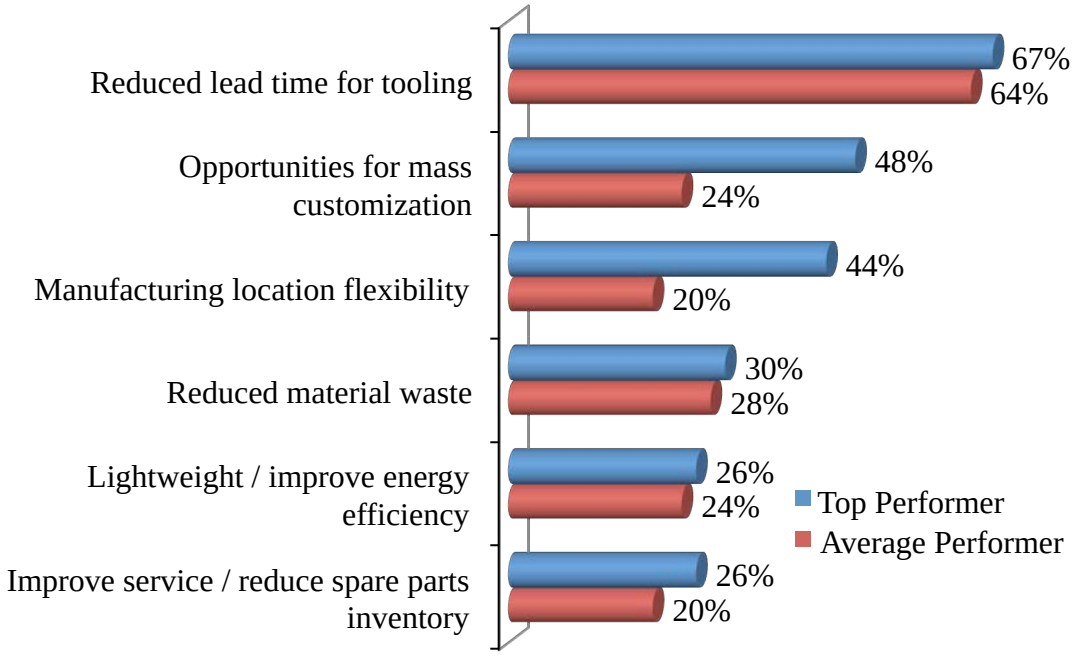

Figure 6: Reasons Companies Adopt 3D Printing

While the actual production process for 3D printing may be slower than traditional manufacturing, you save time by not waiting for tooling to be designed and produced. This cuts down on lead-time considerably. With this in mind, it makes sense why 3D printing is such an attractive option for prototyping. Reducing the prototype stage means you produce revenue-generating parts that much sooner.

While the actual production process for 3D printing may be slower than traditional manufacturing, you save time by not waiting for tooling to be designed and produced.

Because 3D printing doesn't require new tooling for each version of a part, it also offers a very economical way to produce "one-offs" or parts that have been customized for an individual. This can be especially powerful for applications such as medical or dental because manufacturers can produce products that have been custom-fit to the unique needs of a person. Enabling this is another way for Top Performers to meet customer needs in exceptional ways.

Because 3D printing doesn't require new tooling for each version of a part, it offers a very economical way to produce "one-offs."

Manufacturing location flexibility is another driver that is bigger for Top Performing companies compared to peers. With 3D printing, production no longer depends on the facilities that have the mold or the right capital equipment. Decisions around where to produce parts can be driven by proximity to the customer, lowering shipping costs and getting it to them sooner. There is also more flexibility to adjust production locations based on the capacity of an individual facility. The volume of work can then be more evenly distributed across facilities.

Since 3D printing only adds material where it is needed, there is less material waste. Also, geometry limitations imposed by traditional manufacturing processes no longer apply. You do not have to worry about things such as tool clearances or how the part will eject. This opens doors to new geometries that are lighter weight and thus more fuel-efficient. Finally, with the capacity to produce parts on-demand, you can stock fewer spare parts, releasing money that was formerly tied up in inventory.

Understand the Business Impact and Opportunities

The business impact of 3D printing shows that manufactures realize the benefits they expected when they adopted 3D printing (Figure 7).

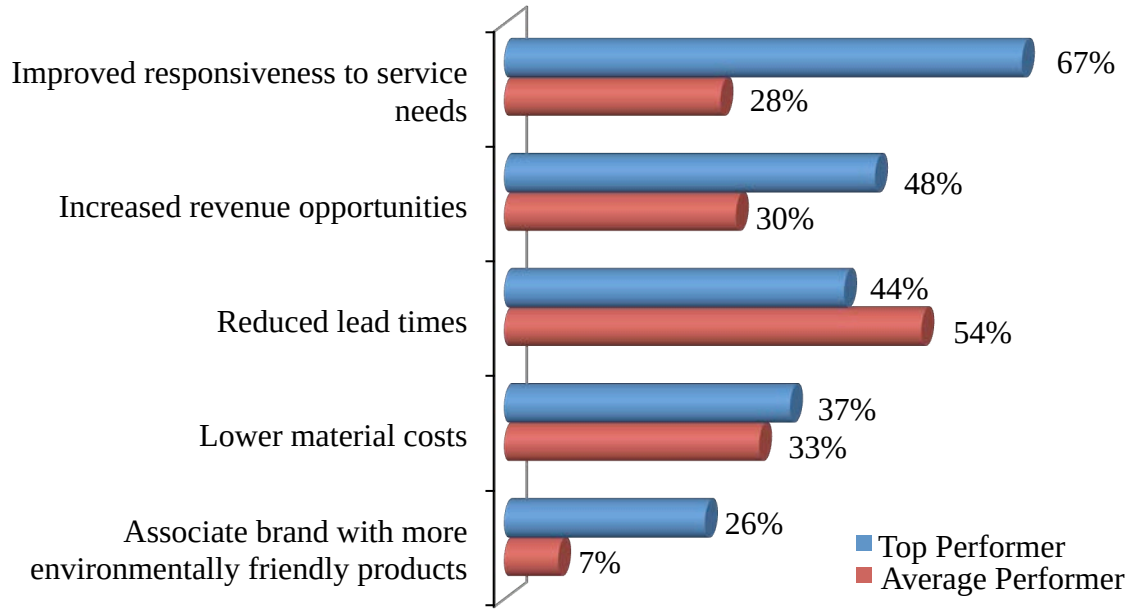

Figure 7: Business Impacts of 3D Printing

Consistent with the focus on customers, Top Performers report that 3D printing has allowed them to be more responsive to customers. The ability to produce parts without waiting for tooling allows companies to deliver parts that much faster. Service technicians don't have to rely on stocked inventory of spare parts or guessing which parts they will need. They can print parts as needed, reducing down time.

Consistent with the focus on customers, Top Performers report that 3D printing has allowed them to be more responsive to customers.

3D printing also opens doors for new business opportunities. For example, the ability to economically customize parts creates new opportunities to provide customers with exactly what they want. Products can be tweaked for individualized tastes or customized for a precise fit.

Consider Updates to the Design Process

As discussed, 3D printing overcomes many barriers created by traditional machining. In addition, there are opportunities and potential to create new business models. Because of this, companies who have adopted or plan to implement 3D printing are looking at new ways to design (Figure 8).

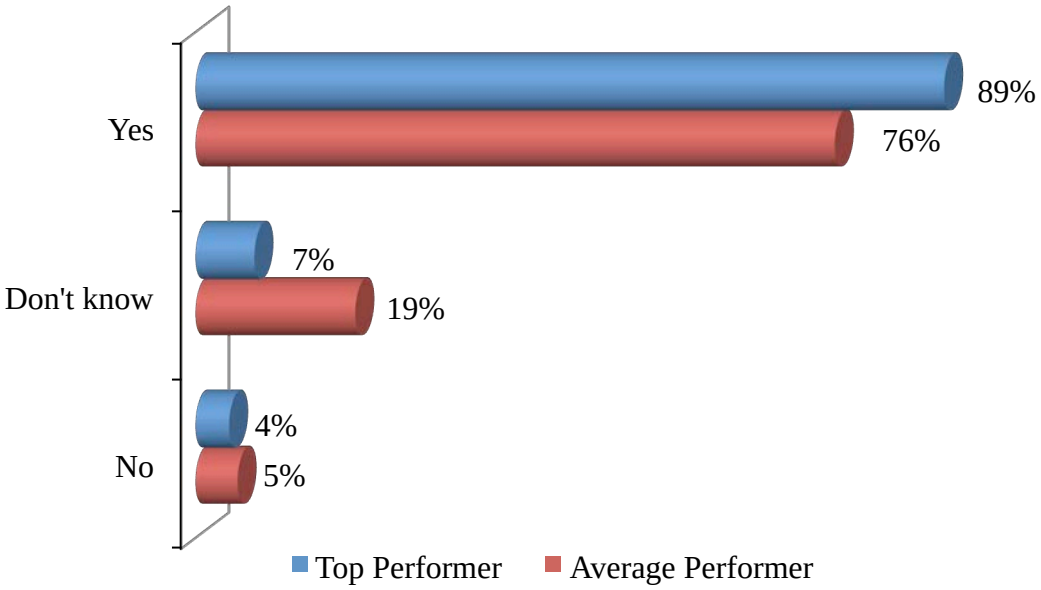

Figure 8: Will Your Company Look at New Ways to Design to Take Advantage of 3D Printing?

Interestingly, 89% of Top Performers will look at new ways to design to take advantage of 3D printing. This will allow them to take even more advantage of the opportunities offered by 3D printing.

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So when designing for 3D printing, when should you start thinking about 3D printing (Figure 9)?

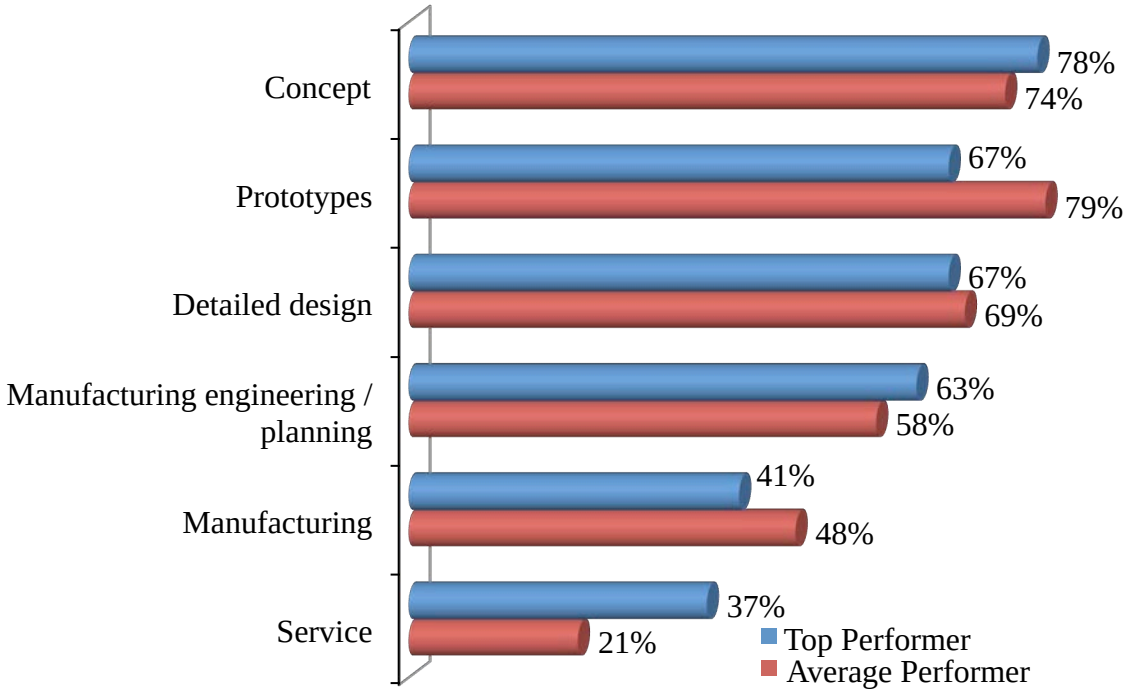

Figure 9: When Should 3D Printing Be Considered

Companies agree that you should really think about 3D printing from the very beginning, during the concept phase. This is when you have the most flexibility to rethink the design and consider possibilities that may not have been possible with traditional machining. Furthering that idea, Top Performers also believe you should redesign parts that will be 3D printed (Figure 10). They are more likely to take this approach than to print parts as designed.

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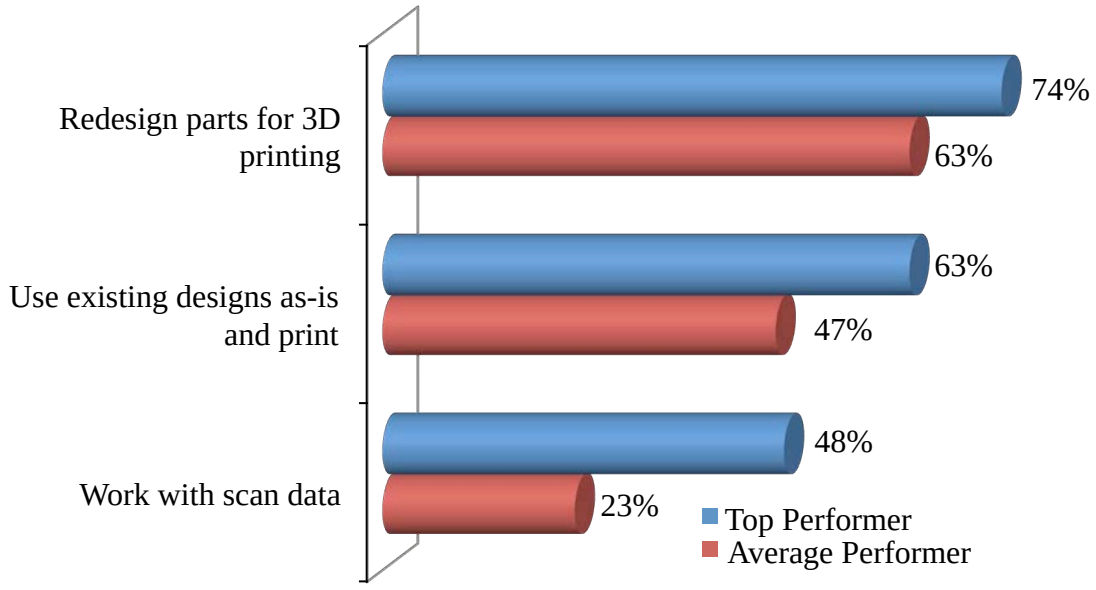

Figure 10: What Will be Your Approach to Designing Parts that Will Be 3D Printed

By redesigning, you can consider new geometries that for example, optimize strength and weight. Complex shapes and lattice structures are now possible with 3D printing. You can also combine several parts into one.

What's also interesting is that Top Performers are 2.1 times more likely than Average Performers to work with scan data to design parts for 3D printing. This opens options such as custom fit medical applications. For example, you can customize prosthetics based on the scan of an individual's limb. This can be especially valuable for growing children who need to be refit regularly.

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Validation is another important part of design, especially during the early stages of 3D printing adoption. By understanding how closely the as-manufactured part matches the as-designed one, continuous improvement becomes possible to ensure part quality. There are a variety of ways to validate 3D printed parts, but CMM is the more common one (Figure 11).

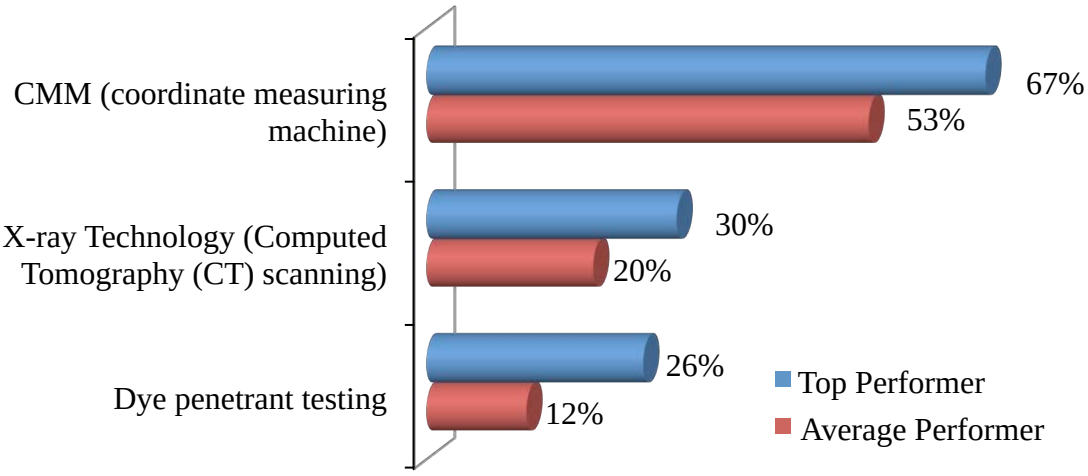

Figure 11: How Do Validate 3D Printed Parts?

Validation is another area where scanned or polygon data can be especially useful. You can take the output from the scan to compare with the CAD model and identify differences.

Be Strategic When Selecting Parts to 3D Print

When starting with 3D printing adoption, companies agree you should start with prototyping (Figure 12).

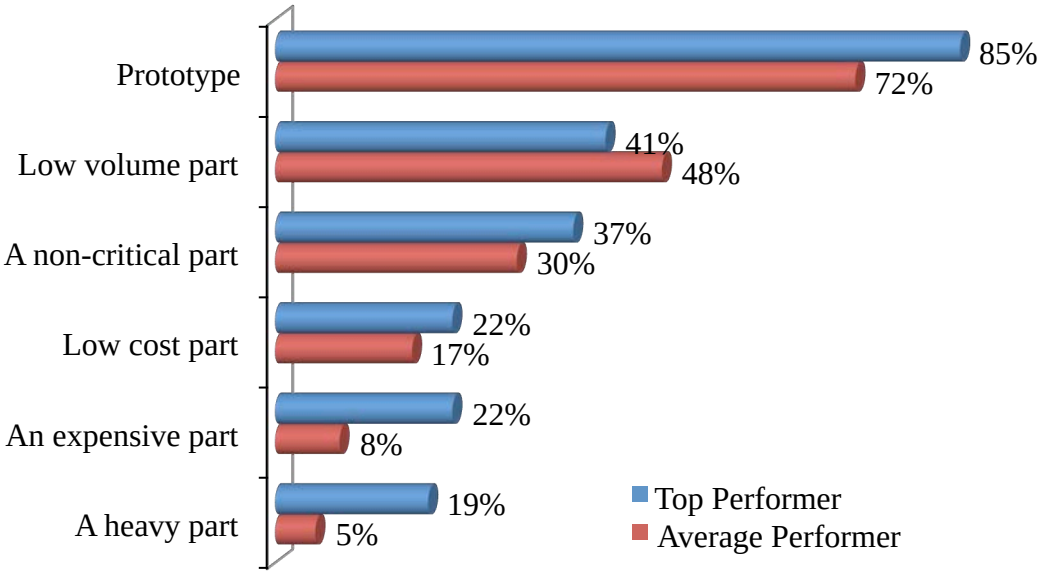

Figure 12: What Type of Part Should You Start with When Adopting 3D Printing?

By starting with prototypes, you can develop expertise and become familiar with processing requirements, without impacting the production schedule. There is also less pressure to meet the quality requirements expected of a production part. Prototypes offer more flexibility to explore and experiment with 3D printing capabilities so that you can develop guidelines.

By starting with prototypes, you can develop expertise and become familiar with processing requirements without impacting the production schedule.

With 3D printing, you can usually start producing parts sooner than traditional manufacturing because you do not have to wait for tooling. However, because the printing process for 3D printing can take longer, a low volume part can be a good candidate to start with.

A non-critical or low cost part may also be a good starting point for many of the same reasons one would want to start with prototyping. On the other hand, a part with complex geometry may also be a good candidate. Complex geometry may require several different operations with traditional manufacturing, making it very expensive to produce. In this case, it may be more economical to 3D print it.

3D printing opens doors to create complex topology optimized shapes and lattice structures that are very strong, yet light weight.

3D printing opens doors to create complex topology optimized shapes and lattice structures that are very strong, yet light weight. If light weighting is important, redesigning a heavy part to take advantage of the geometry flexibility available with 3D printing can be a good way to quickly realize value from 3D printing.

After identifying where to start, the next step is to develop the knowledge and expertise to make 3D printing successful (Figure 13). Experimentation is the most common way to improve knowledge and understanding of 3D printing. Top Performers are 67% more likely than peers to recommend guidance from software tools to develop best practices. Design tools can automate geometry optimization based on design criteria. Since the "rules of thumb" for traditional manufacturing no longer apply with 3D printing, software can suggest geometries that would not have been considered previously.

Top Performers are also 87% more likely to use an industry resource such as America Makes (https://www.americamakes.us/). This is a public-private partnership with member organizations from industry, academia, and government that focuses on the advancement of 3D printing. For a similar resource in Europe, LZN Laser Zentrum Nord GmbH has developed a training program to transfer the gained knowledge of research and industrial

projects into the market. In addition the Light Alliance network of LZN offers a platform for companies to inform and exchange best practices regarding 3D printing on a regular basis.

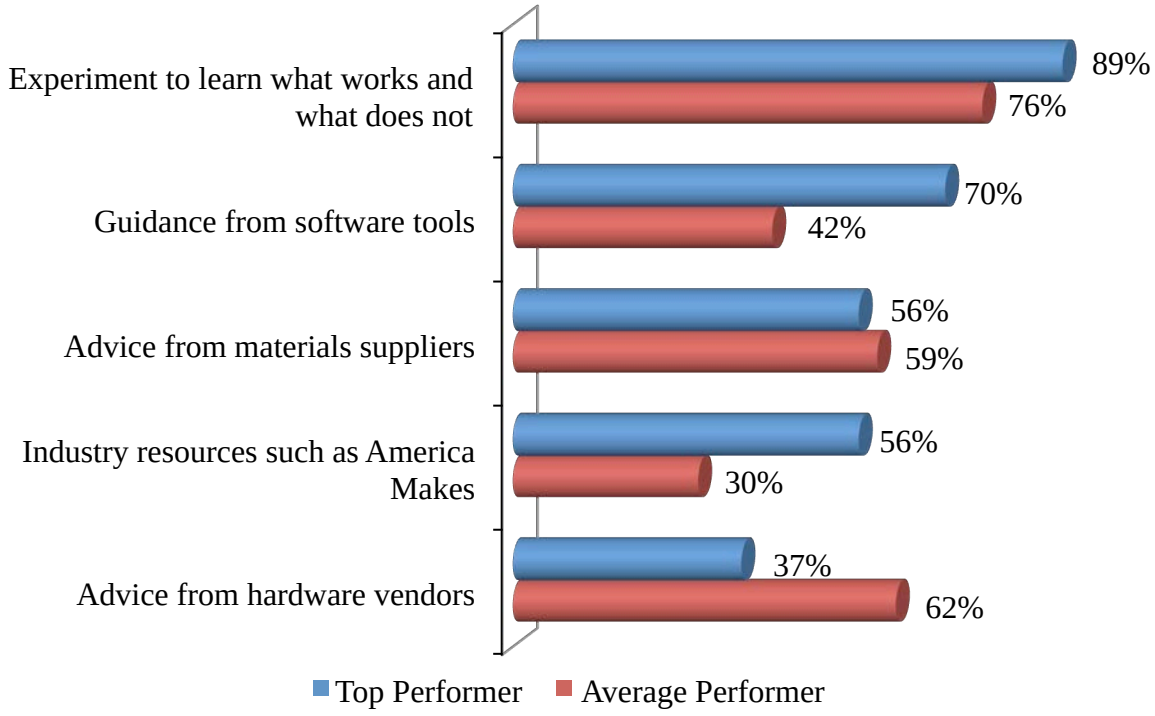

Figure 13: How to Improve Knowledge of 3D Printing

Given the uncertainty around materials, companies recommend relying on material suppliers for advice, regardless of their performance band.

Top Performers are 67% more likely than peers to recommend guidance from software tools to develop best practices.

Getting the support to develop 3D printing knowledge also means picking the right partner. Figure 14 shows the top qualities companies look for in a vendor.

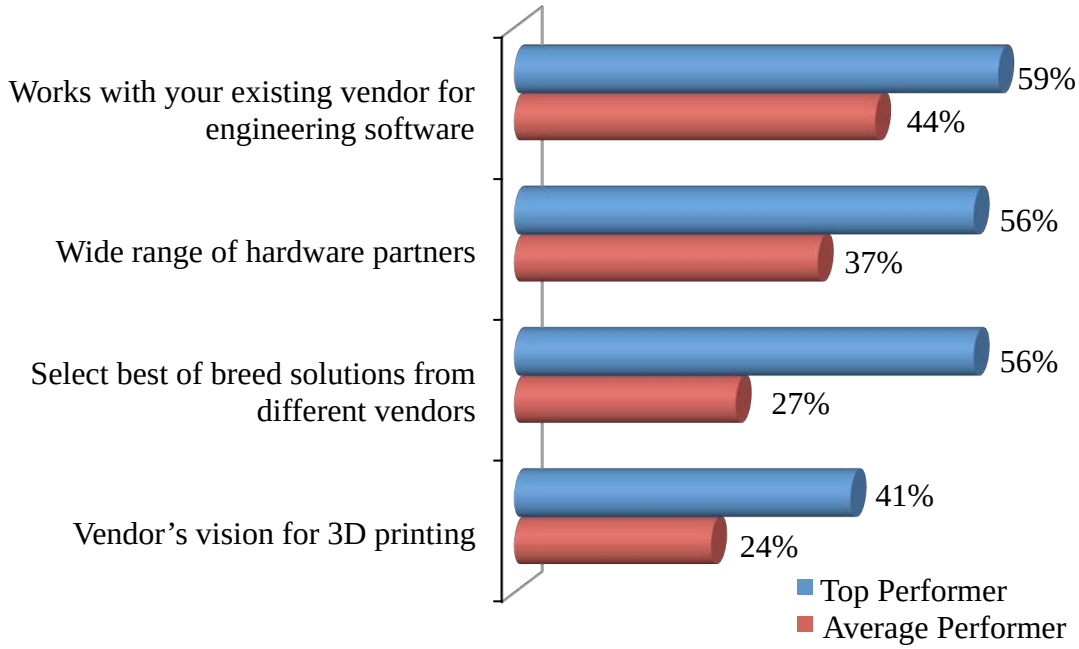

Figure 14: Important Qualities in a Vendor to Support 3D Printing

3D printing requires an ecosystem of vendors to support it, including both hardware and software. Top Performers recommend selecting vendors who are open to working with your existing engineering software vendor and have a wide range of hardware partners.

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Consider Applications for Scan / Polygon Data

To support 3D printing, there were several areas where Top Performers found scanned data helpful. Top Performers are also more likely to use it (Figure 15).

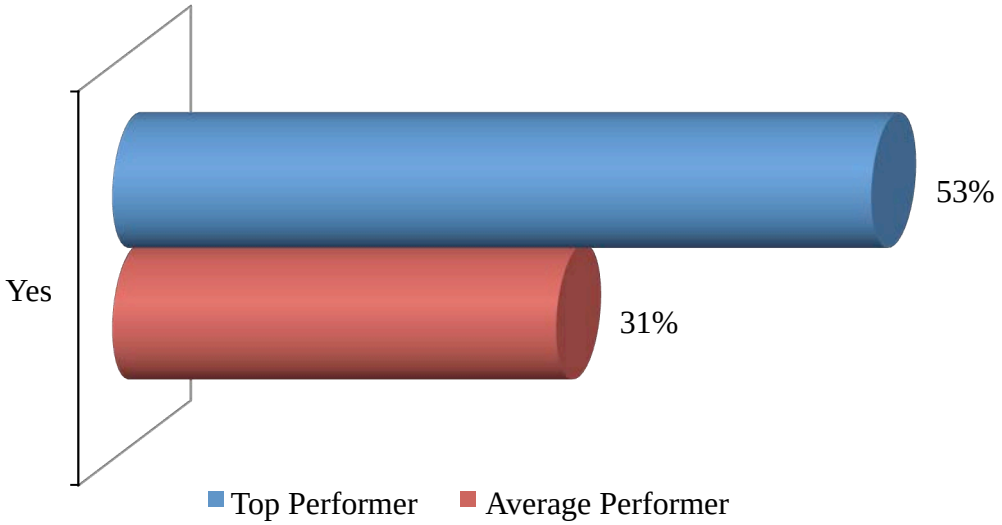

Figure 15: Do You Use Scan Data?

There are several applications for scan data. Figure 16 shows the top ways companies use scan data.

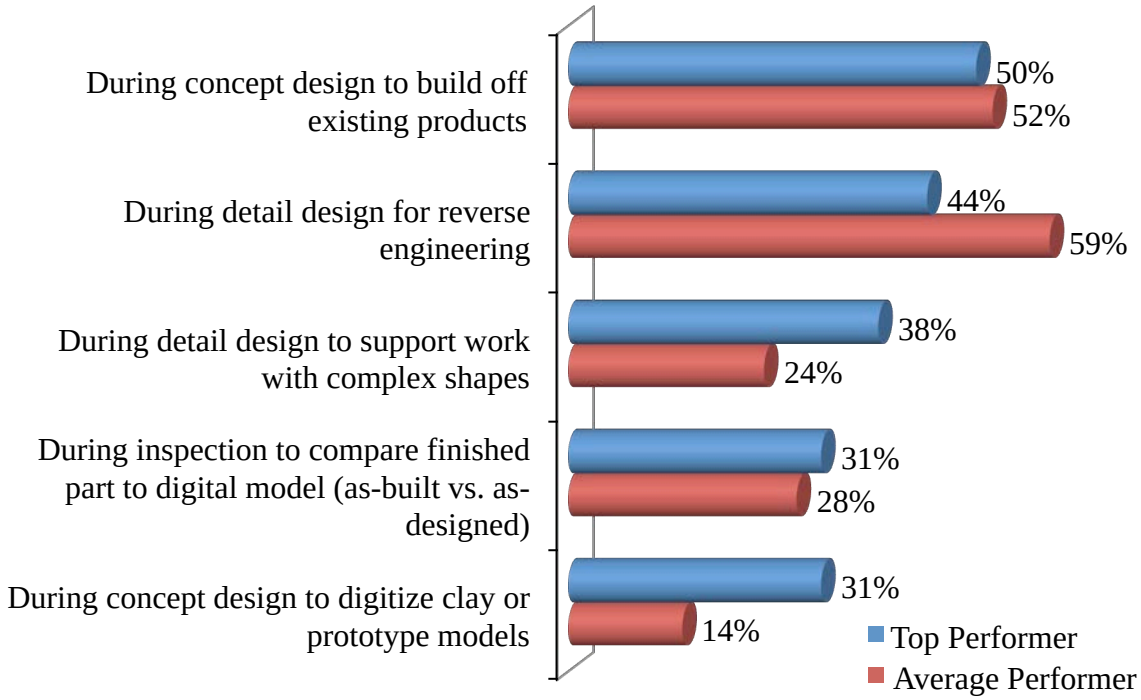

Figure 16: Top Ways Scan / Polygon Data Is Used

The most common uses for scan data is for reverse engineering and during concept design to build off existing products. While it is useful to use and reference scan data, traditionally it has not been easy to work with. Figure 17 shows the top reasons it can be difficult to work with.

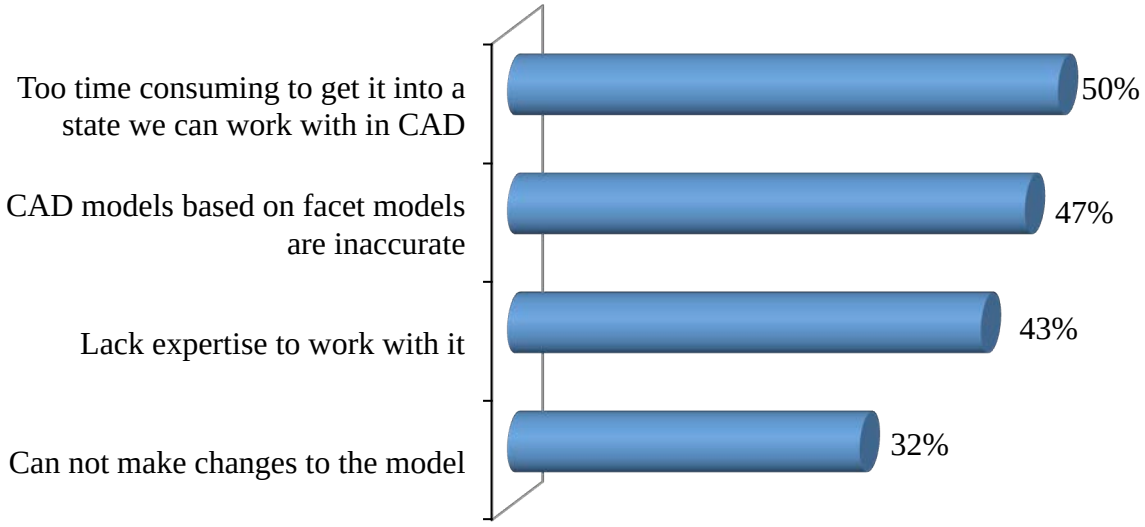

Figure 17: Top Challenges of Working with Scan / Polygon Data

The time required to get the scan data into a workable state in CAD is the biggest challenge. In fact, respondents report it takes 4 hours to convert scan data to a usable CAD model. However, if it was easier to work with, more would use it (Figure 18).

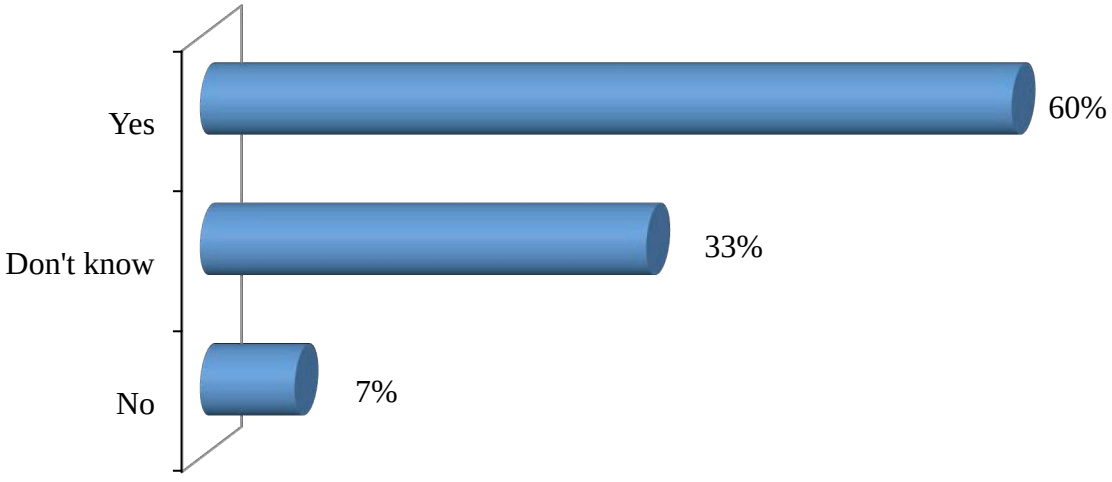

Figure 18: If It Was as Easy as Pressing a Button to Get Scan Data Usable in CAD, Would You Use It?

Sixty percent of both Top and Average Performers report they would use scan data or increase its use if they could use it more easily. They were also in agreement with how it would help their business (Figure 19).

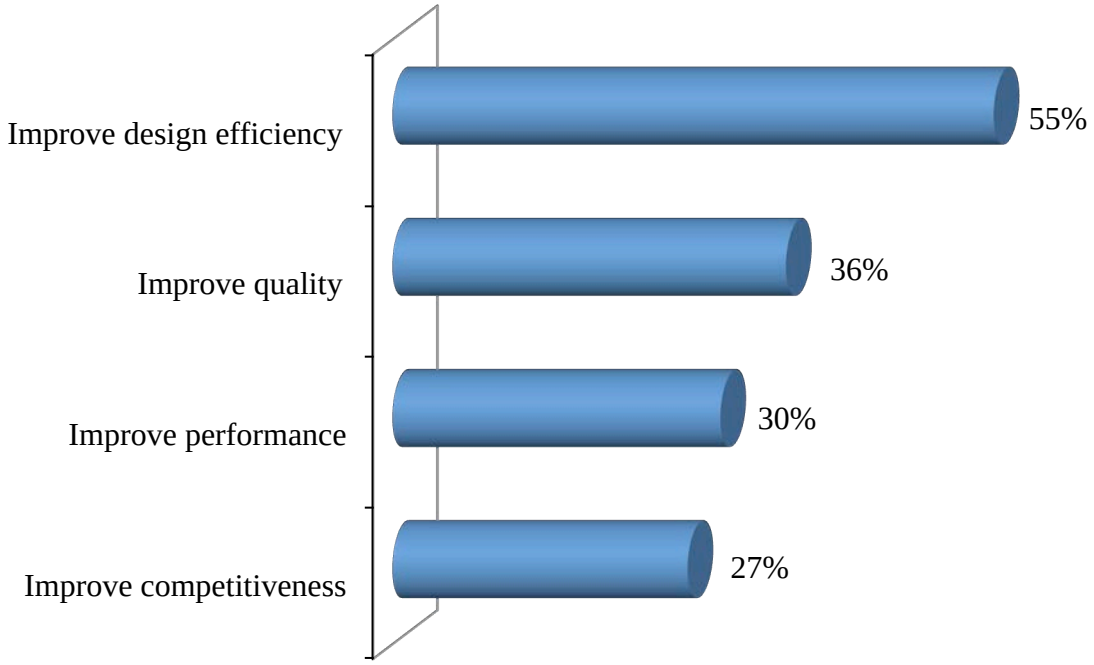

Figure 19: Business Impacts if Scan Data Was Easier

Companies report that if they could use scan data more easily, it would improve design efficiency, quality, and performance. All of these would help make products more competitive by giving customers more of what they want. This is also inline with how Top Performing companies become more competitive.

Companies report that if they could use scan data more easily, it would improve design efficiency, quality, and performance.

Conclusion

For many companies, new technology will plan a key role in keeping their products competitive. To take advantage of these new technologies, development processes will evolve as well. A remarkable 95% of Top Performing companies expect that they will need to change the way they design and engineer products over the next five to ten years so that they can stay competitive.

Many companies are looking at how new technologies can help them improve product performance and quality as well as make products smarter. What makes Top Performers a bit different is they are also looking to lower the cost of ownership for their customers. To help them with this, Top Performing companies are looking at a combination of 3D printing, new materials, and scan data. Together, these technologies enable them to offer customers increased energy efficiency, reduced spare parts management costs, faster delivery times, better responsiveness, and greater flexibility to customize products to their specific needs. This puts them in the powerful position to earn customer loyalty, which should lead to higher revenue and increased profitability.

To realize the greatest benefits from 3D printing, 89% of Top Performers expect to change the way they design products. They also agree that 3D printing should be considered at the very beginning of design, during the concept phase.

Scan data can play an important role to support 3D printing adoption.

Scan data can play an important role to support 3D printing adoption. It can offer methods to validate printed parts match the as-designed version or create a custom fit for medical or dental applications. Companies report that if scan data was easier to work with, it would help them improve design efficiency, quality, and performance.

Companies can expect technologies such as 3D printing to have a significant impact on products and how they are developed and serviced.

In summary, looking forward to the next five to ten years, companies can expect technologies such as 3D printing to have a significant impact on products and how they are developed and serviced. Those who are taking the right steps now to prepare, will be well positioned to be the Top Performing companies of the future.

Recommendations

Based on industry experience and research for this report, Tech-Clarity offers the following recommendations:

- Implement product strategies that will offer customers a superior experience with better performance, higher quality, smarter with a lower cost of ownership.
- Consider 3D printing, new materials, and scan data as ways to lower the cost of ownership.
- Create a competitive advantage by rethinking how products are designed and engineered.

- Evaluate 3D printing as a way to improve customer responsiveness and create new revenue opportunities.
- Realize the full potential of 3D printing by redesigning parts for 3D printing, starting at the concept phase.
- Look at scan data as a way to start concept designs as well as validate 3D printed parts.
- Support 3D printing adoption by starting with prototypes and be strategic about which part to start with.

About the Author

Michelle Boucher is the Vice President of Research for Engineering Software for research firm Tech-Clarity. Michelle has spent over 20 years in various roles in engineering, marketing, management, and as an analyst. She has broad experience with topics such as product design, simulation, systems engineering, mechatronics, embedded systems, PCB design, improving product performance, process improvement, and mass customization. She graduated magna cum laude with an MBA from Babson College and earned a BS in Mechanical Engineering, with distinction, from Worcester Polytechnic Institute.

Michelle began her career holding various roles as a mechanical engineer at Pratt & Whitney and KONA (now Synventive Molding Solutions). She then spent over 10 years at PTC, a leading MCAD and PLM solution provider. While at PTC, she developed a deep understanding of end user needs through roles in technical support, management, and product marketing. She worked in technical marketing at Moldflow Corporation (acquired by Autodesk), the market leader in injection molding simulation. Here she was instrumental in developing product positioning and go-to-market messages. Michelle then joined Aberdeen Group and covered product innovation, product development, and engineering processes, eventually running the Product Innovation and Engineering practice.

Michelle is an experienced researcher and author. She has benchmarked over 7000 product development professionals and published over 90 reports on product development best practices. She focuses on helping companies manage the complexity of today's products, markets, design environments, and value chains to achieve higher profitability.

About the Research

Tech-Clarity gathered and analyzed 200 responses to a web-based survey on the impact of future technologies and 3D printing. Survey responses were gathered by direct e-mail, social media, and online postings by Tech-Clarity. Tech-Clarity also interviewed leaders from leading manufacturers in order to share their experience and knowledge.

The respondents were comprised of about one-half (51%) who were individual contributors. Another one-third (32%) were manager or director level, and the remaining 17% were VP or executive levels.

The respondents represented a mix of company sizes, including 37% from smaller companies (less than $100 million), 16% between $100 million and $1 billion, 21% over $1 billion. 26% chose not to disclose their company size. All company sizes were reported in US dollar equivalent.

The responding companies were a good representation of the manufacturing industries, including Industrial Equipment and Machinery (34%), Automotive (19%), Consumer Products (15%), Life Sciences and Medical Devices (14%), Aerospace and Defense (14%), High-tech and Electronics (13%), and others including federal government. Note that these numbers add up to greater than 100% because some companies indicated that they are active in more than one industry.

The respondents reported doing business globally, with most companies doing business in the North America (90%), about one-third doing business in Asia (31%), a little less than one-third doing business in Western Europe (28%), Eastern Europe (12%), Latin America (9%), and Australia (8%).

Respondents included manufacturers who were considered to have direct involvement in designing and developing products and the report reflects their experience. Respondents who did not were removed from the analysis.

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