Tech-Clarity

Composites State of the Market

Using Composites as a Competitive Advantage

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Executive Overview

Today's products are growing in complexity and new materials are a significant source of that complexity. Composites, in particular, are getting a lot of attention. In fact, the use of composites is growing and is expected to increase over the next 15 years. With this growth, the number of engineers working with composites should also increase by 15% over the next five years. Complicating this, even engineers currently working with composites rate their knowledge of composites as average. The combination of complexity, growth in composite use, and increase in the number of engineers using composites means companies will need better ways to supplement their engineering knowledge of composites.

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Composites have been key for helping many companies differentiate their products by reducing weight, improving performance, and lowering the cost of ownership. However, with the expense of composite material, companies must find ways to make better decisions to optimize the amount of composite material used to achieve performance requirements, without over-engineering and maintaining profitability.

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To understand best approaches, Tech-Clarity surveyed 244 companies to identify their goals for composites, best practices, and top selection criteria for technology. Further analysis identified how Top Performing companies address the top challenges of designing and producing composite parts. Top Performing companies are those who are more successful than their competitors. Compared to competitors, they are more efficient, faster, produce higher quality products, and do a better job meeting cost targets. When compared to peers, some of the things Top Performers do to achieve this success includes:

- 2.2 times more likely to optimize the part design to improve consistency during production
- 59% more likely to use tools that automatically link design and analysis data
- 2.5 times more likely to use tools that automatically update the composite definition as changes are implemented

This report examines the state of the market for composite design and production and provides guidance on best practices. These practices will help companies leverage the benefits of composites to improve the competiveness of their products, while managing cost, quality, and efficiency.

Identify the Meaning of Complexity

There are a lot of existing opportunities for innovation in today's products. However, as companies seek to take advantage of new innovations, products often become more complex. There are a variety of sources for this complexity. Figure 1 shows the top five:

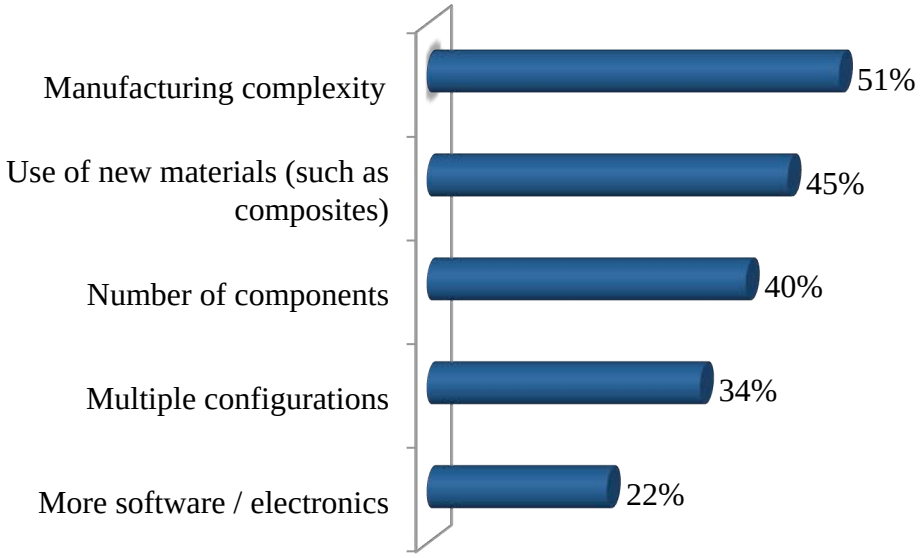

Figure 1: Top 5 Drivers of Product Complexity

As companies innovate and incorporate new technologies, there is a direct impact on design and production. More components, complex geometry, new manufacturing techniques, and globally distributed manufacturing centers all create additional complexity. New materials are also a large contributor to manufacturing complexity, but also mean more complexity during design. Uncertainty around material behavior and properties, understanding the impact of the manufacturing process, and staying on top of the latest advancements in materials all introduce complexities. The use of new materials also opens up new options for geometry and topology. Finally, the increasing number of components, multiple configurations for different market needs, and the increasing amount of software and electronics add further complexity.

Complexity makes the already difficult jobs of designing and manufacturing that much harder. For a company to grow and improve its business, it must find ways to address this

complexity. Those who are better positioned to manage complexity will find themselves at a competitive advantage.

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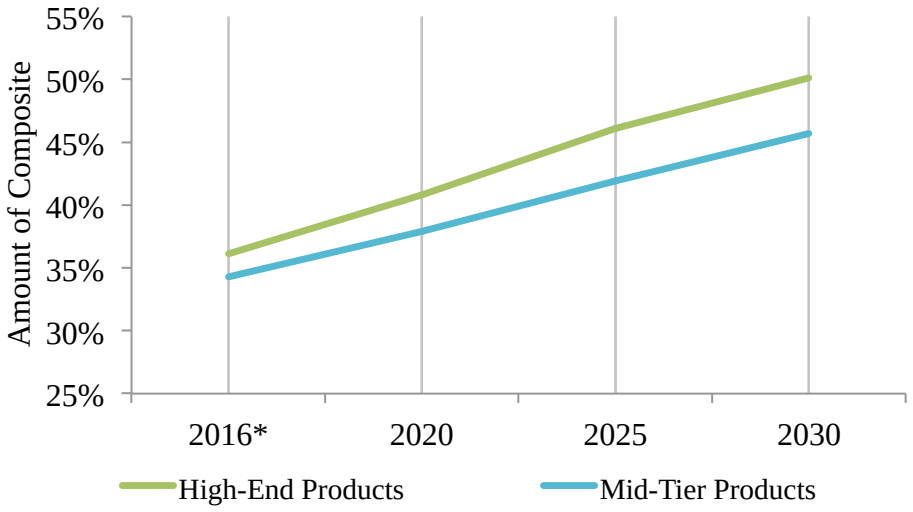
Prepare for Growth in Composites

Despite adding complexity, new materials offer lots of opportunity for innovation. Composites in particular are growing in importance. In fact, 58% of manufacturers report using composites, while another 16% plan to start using them. In addition, those using composites report that on average, five to six programs currently use composites. On top of that, nearly half, 47% expect that to grow every year. The 47% is made up of 26% who anticipate adding several programs every year and another 21% who plan to expand the use composites to at least one new program a year.

Despite adding complexity, new materials offer opportunity for innovation.

In addition to the number of programs using composites, the amount of composite material used will also grow. Over the next 15 years, those using composites anticipate the amount of composite material will continue to grow for both high-end and mid-tier products. Figure 2 shows the percent of composite material currently in products and how manufacturers report it will grow over the next 15 years.



* Extapolated

Figure 2: Growth in Composite Material

With this anticipated growth, companies also anticipate the number of engineers working with composites will increase by15%. However, those working with composites rate their composite knowledge a 3.4 on a scale of 1 to 5. This means engineers feel they have a basic working knowledge of composites, but most would not rate themselves as very knowledgeable or as experts. Considering the lack of expertise, combined with expected increase in both the use of composites and the number of engineers involved, companies will need to find better ways to work with composites. They will need methods for supplementing their existing engineering knowledge.

Manufacturers will need methods for supplementing their existing engineering knowledge.

Realize Opportunities with Composites

So what is driving this growth in composites? By far the top reason is to reduce weight, with 73% saying this is why they use composites. When looking at goals for light weighing, it is primarily about making products more competitive (Figure 3).

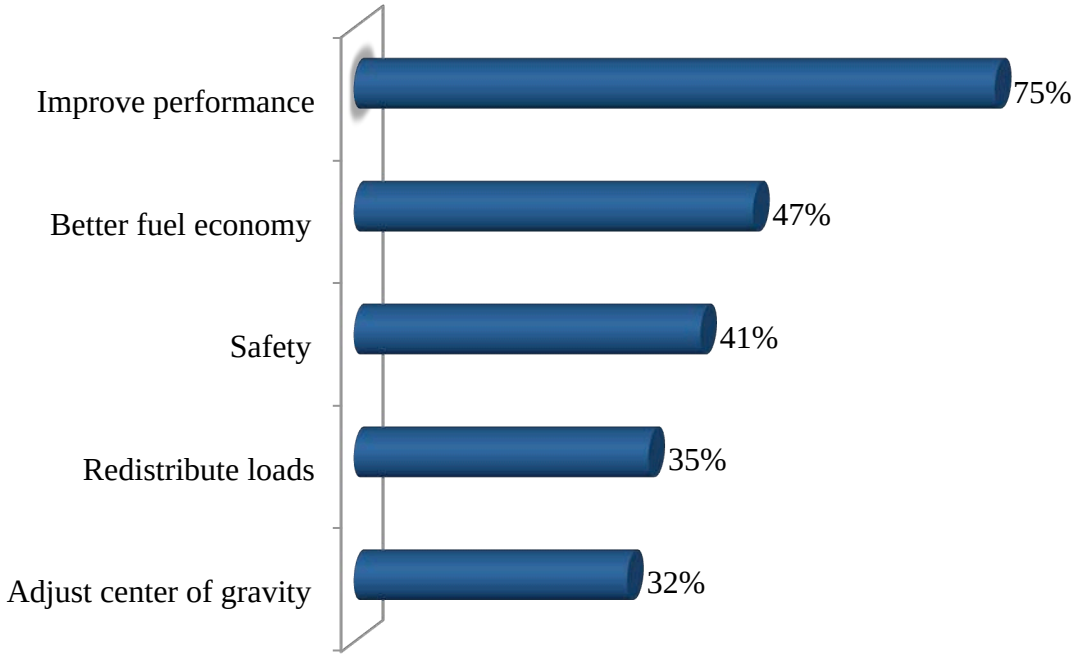


Figure 3: Top 5 Light Weighting Goals

When looking at goals for light weighing, it is primarily about making products more competitive.

Improving product performance is by far the top goal for light weighting, followed by improving fuel economy, and then improving product safety. This shows that companies are relying on composites as a key way to improve products in ways that will improve differentiation.

Address Challenges

While composites offer many opportunities to improve products and make them more competitive, there are also some challenges companies should be aware of. Companies looking to use composites should be aware of these challenges and look for ways to manage them. The biggest cost drivers of composites can be seen in Figure 4.

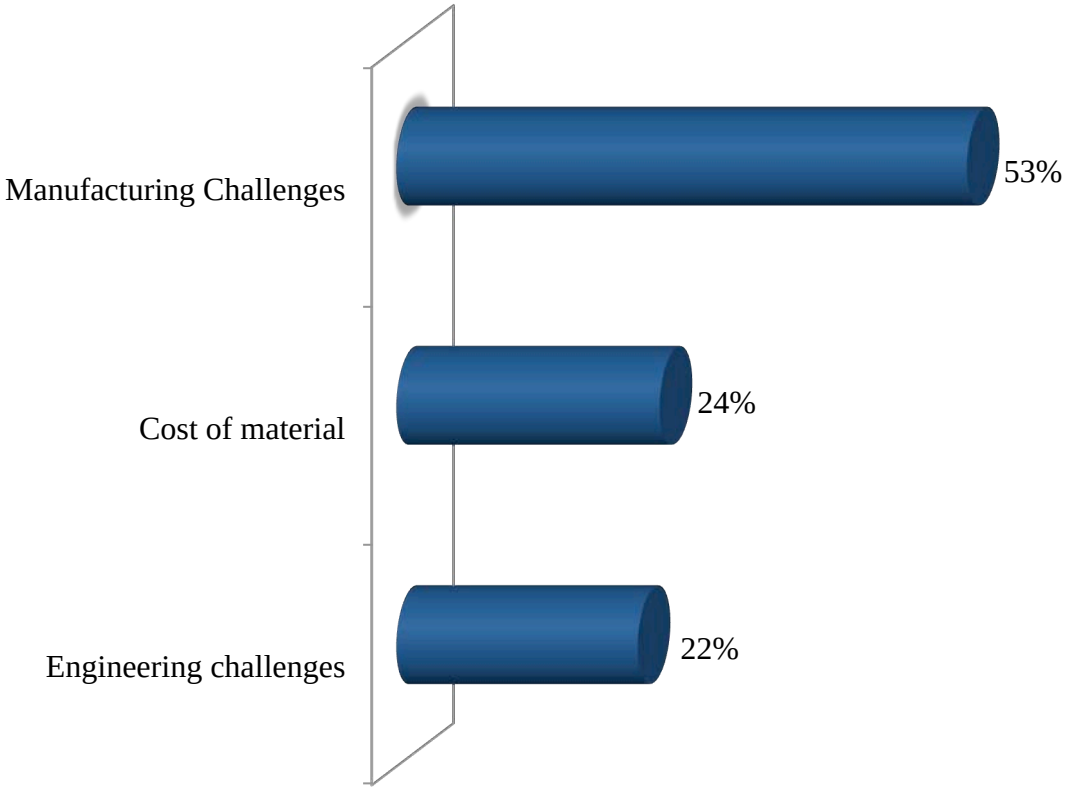


Figure 4: Top Cost Drivers of Composites

Manufacturing challenges are the biggest cost driver. These include slower production and wasted material and scrap. This is followed by the cost of composite material and engineering challenges, which are nearly equivalent. Engineering challenges include poor communication between design engineers and manufacturing, poor communication

between design and analysis, and over-engineering. Interestingly, addressing the engineering challenges will help the manufacturing challenges as well. By improving communication between the different groups, and giving engineers better insight into manufacturing, they can make better design decisions to improve production and reduce scrap. Also, limiting the amount of over-engineering will reduce material costs.

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With only a basic working knowledge, engineers need supporting resources to make better decisions to optimize their use of composites. With this help, products can benefit from the use of composite materials while keeping costs more manageable.

Identifying Top Performers

To understand best approaches for working with composites, Tech-Clarity researchers identified Top Performers. Survey respondents were asked to rank their performance in relation to their competitors on four key metrics that are important to product development. Respondents used a scale of one to five, with five being significantly above average and one being significantly challenged. The top 20% performing companies were defined as the Top Performers. Table 1 shows the metrics used to define success and each group's respective performance.

	Top Performers	Average Performer
Design and produce high quality products	4.7	3.9
Design and produce products quickly	4.4	3.3
Design and produce products efficiently	4.6	3.3
Meet product cost targets	4.5	3.2

Table 1 – Defining Top Performers

Top Performers successfully beat their competition, while their peers rate around an average score of three. Since companies have started working with composite material, Top Performers have seen greater improvements compared to their peers (Table 2).

	Top Performers	Average Performer
Cycle times of composite parts	15% Faster	6% Faster
Number of mechanical components	13% Fewer	7% Fewer
Material costs	10% Less	0.3% Increase
Amount of rework	11% Reduction	1% Reduction

Table 2 – Benefits when Working with Composites

After gaining experience with composites, all companies see improvements, but Top Performers see about twice the improvement their competitors do.

After gaining experience with composites, all companies see improvements, but Top Performers see about twice the improvement their competitors do. Clearly the practices Top Performers follow help them realize more success with composites. What is also interesting is that Top Performers have also done a better job addressing their engineering challenges. Only 5% rate engineering challenges as a cost driver and this has likely contributed to their success (Figure 5).

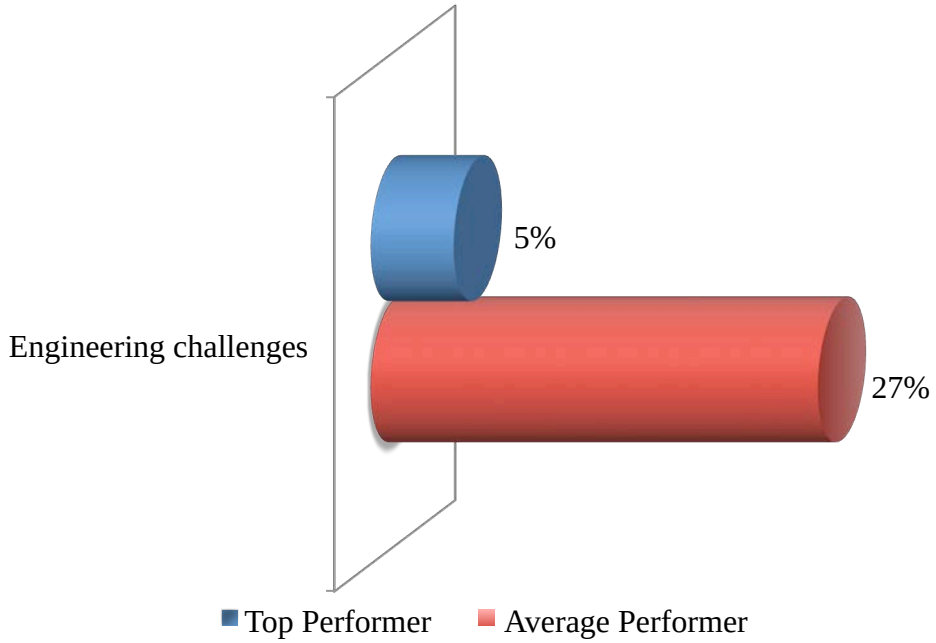

Figure 5: Fewer Top Performers Report Engineering Challenges as Cost Driver

Only 5% of Top Performers rate engineering challenges as a cost driver and this has likely contributed to their success.

Interestingly, the industry with the most experience using composites, Aerospace and Defense, makes up the largest percentage of Top Performers (Figure 6).

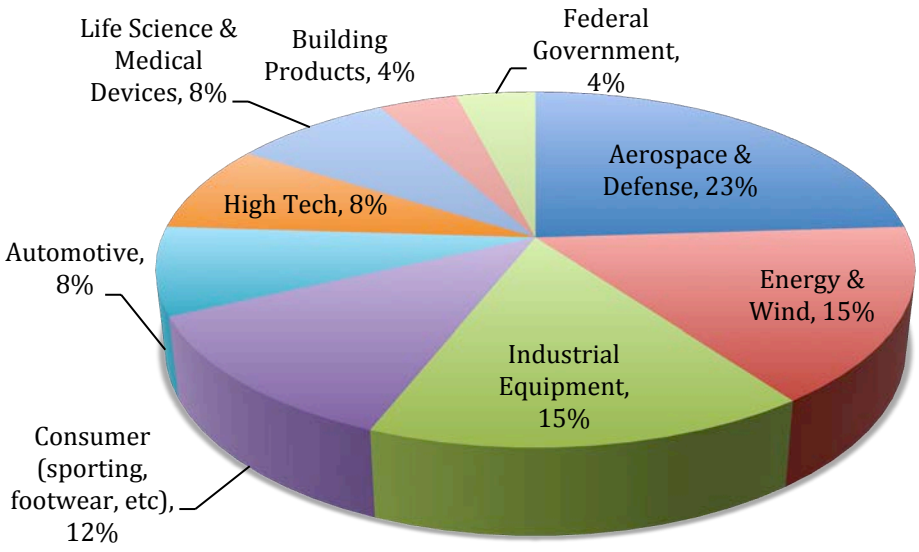

Figure 6: Industry Breakdown of Top Performers

This indicates that as an industry, Aerospace and Defense may be a good indicator of best practices.

Understand Production Requirements

As Figure 4 shows, manufacturing challenges are the biggest cost driver of using composites. Figure 7 shows the top challenges of producing composite parts.

Manufacturing challenges are the biggest cost driver of using composites…Top Performers optimize production by focusing on design.

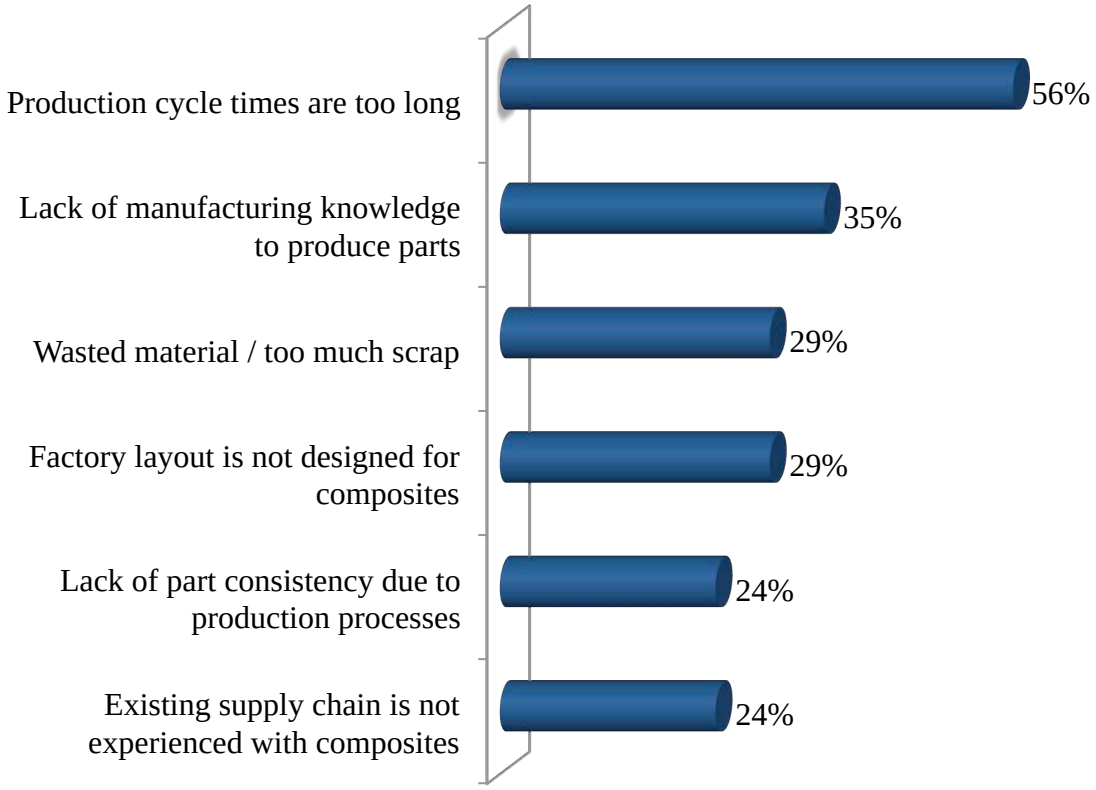

Figure 7: Top Challenges Producing Composite Parts

Top Performers are 2.2 times more likely than their competitors to optimize the design to improve production consistency.

With these challenges in mind, Top Performers optimize production by focusing on design (Figure 8). In fact, they are 2.2 times more likely than their competitors to optimize the design to improve production consistency.

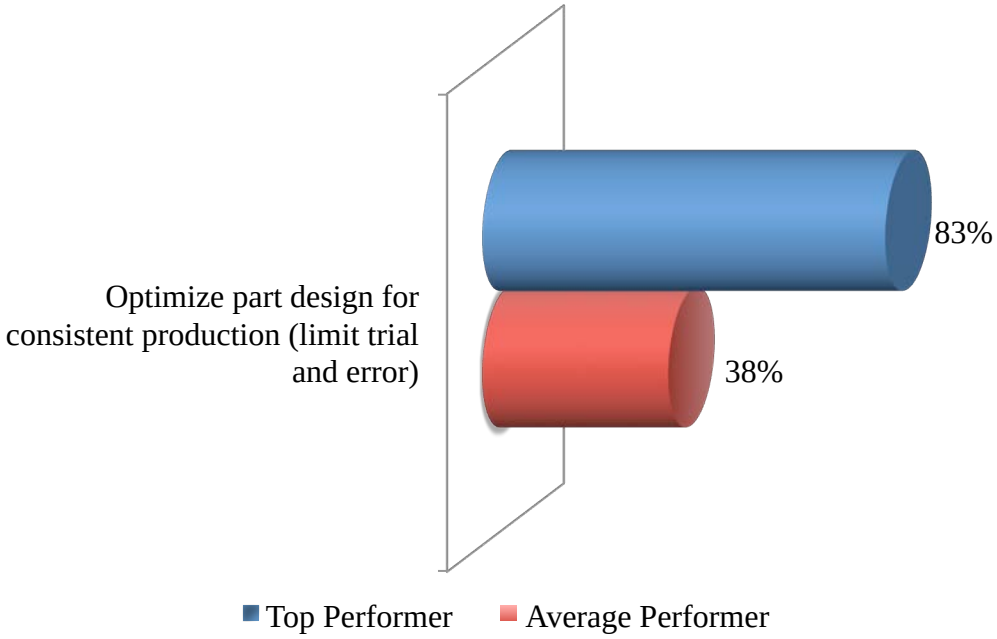

Figure 8: How to Optimize Production

Support Design Decisions

Considering that optimizing part design is the top way Top Performers reduce manufacturing challenges, we will now look at design best practices. To identify these practices, it is helpful to start with what makes designing with composites difficult (Figure 9). These challenges largely come down to the need for additional resources to support knowledge gaps.

Optimizing part design is the top way Top Performers reduce manufacturing challenges.

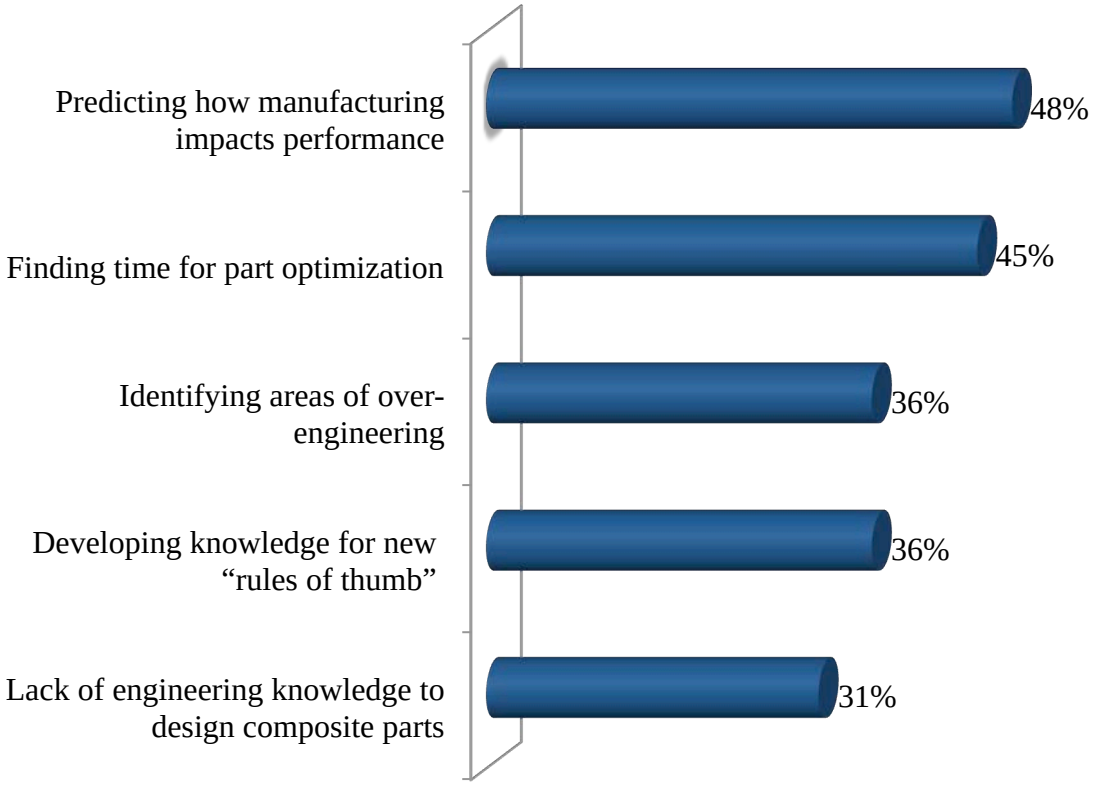

Figure 9: Top 5 Challenges Designing Composite Parts

During design, engineers need better methods for predicting what will happen during production. The orientation of fibers has a significant impact on the strength of the composite material. To offset this uncertainty, products are over-engineered with additional material, which drives up cost and slows down manufacturing. If engineers could better predict what will happen during manufacturing, they could avoid over-engineering due to this uncertainty. The lack of insight also means it takes longer to optimize parts.

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These challenges, when not addressed, have a negative impact on the business (Figure 10). The inability to make the right design decisions means higher cost, additional time, and poor quality. No wonder Top Performers, who do a better job of addressing these challenges, have a competitive advantage.

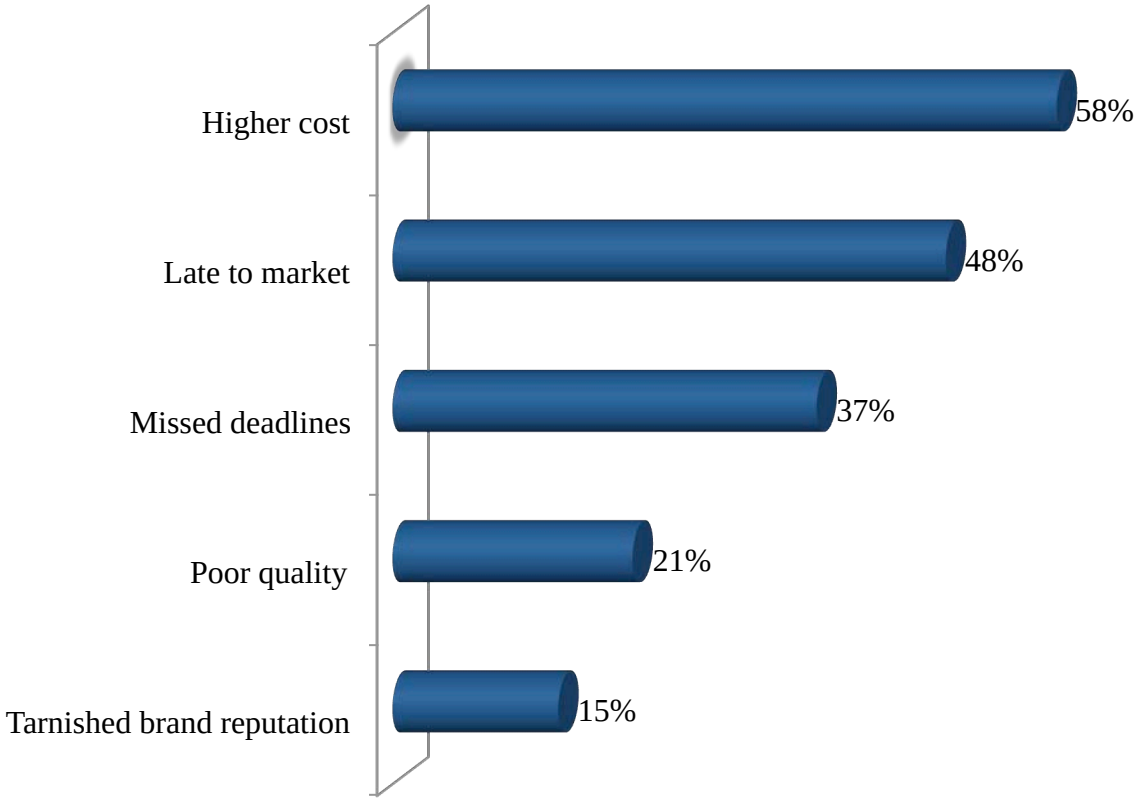

Figure 10: Business Impact of Design Challenges

Top Performers, who do a better job of addressing these challenges, have a competitive advantage.

Figure 11 shows best practices Top Performers are more likely to adopt than their competitors. As such, these are the practices that contribute to their success.

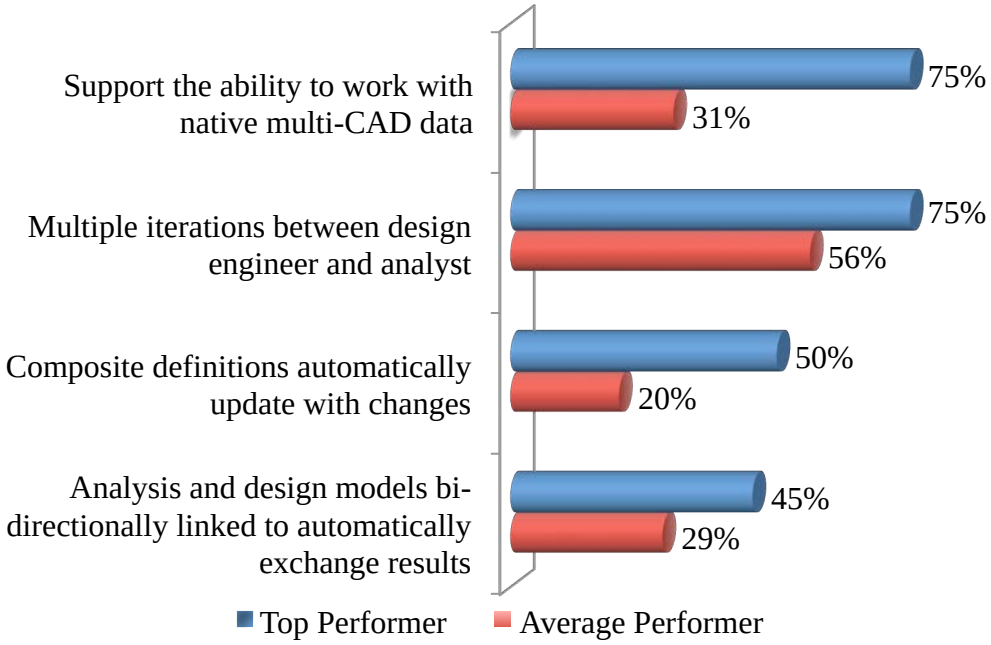

Figure 11: Design Best Practices

To minimize bottlenecks and improve efficiency, Top Performers are 2.5 times more likely than peers to use a composite design tool that supports multi-CAD data. This way they do not waste time recreating CAD information. They are also 2.5 times more likely to use tools that automatically update the composite definition as changes happen. This automation saves time and improves quality.

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To make better decisions that avoid over-engineering and improve optimization, Top Performers also enable better collaboration between design engineers and analysts. They are 59% more likely to use tools that automatically link the design and analysis information. This way design engineers benefit from the analysis results right away and analysts are aware of changes as they happen, saving time for both groups. With this process, they can evaluate multiple iterations so that they arrive at a more optimal design.

Top Performers are 59% more likely to use tools that automatically link the design and analysis information

Select the Right Technology

To enable these best practices, Top Performers need the right technology tools. Table 3 shows the top technology selection criteria Top Performers are more likely to consider compared to peers. Survey respondents were asked to rank selection criteria for solutions to support the design and production of composites, based on a scale of 1 to 5, with 5 being most important.

	Top Performers	Average Performer
Breadth of solution (capabilities)	4.3	3.7
Integration with primary CAE	4.2	3.8
Complete solution from single vendor	4.2	3.5
Integration with manufacturing	4.2	3.8
Academic partners	4.0	3.0

Table 3 – Selection Criteria for Composite Design and Production Solution

Top Performers value the breadth of the solution, but also want to make sure it integrates with both CAE tools and their manufacturing environment. Top Performers also find it more important to get the entire solution for working with composites, design, analysis, and manufacturing from a single vendor. Finally, considering the ongoing advancements in composites, Top Performers also value academic partners.

Top Performers value the breadth of the solution, but also want to make sure it integrates with both CAE tools and their manufacturing environment.

Conclusion

Composites offer great opportunities to reduce weight and improve product competitiveness. This is driving an increase in the amount of composites used. However, composites add complexity to both design and manufacturing. To make their use of composites more successful, Top Performers, those who are beating their peers, optimize the part design for production. They have also implemented several design best practices and enabled those practices with the right technology. By implementing best practices followed by Top Performers, companies can expect to see improvements such as faster cycles times, lower material costs, and reduced scrap.

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Recommendations

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

- Understand sources of complexity and invest in ways to manage it
- Assess the growth of composites and identify how adopting more composite material will impact your products and your market as competitors adopt composites
- Focus on design optimization to improve production consistency of composite parts
- Empower your growing engineering staff by supplementing their composite knowledge and giving them access to tools that will enable them to make better decisions
- Understand the challenges associated with designing composite parts
- Enable better collaboration between design engineers and analysts working with composites
- Ensure your composite design tools support the CAD data you work with
- Select a solution that integrates with both CAE tools and your manufacturing environment

About the Research

Tech-Clarity gathered and analyzed 244 responses to a web-based survey on material trends. Survey responses were gathered by direct e-mail, social media, and online postings by Tech-Clarity, Siemens PLM, and Composite World.

The responding companies were a good representation of the manufacturing industries, including Automotive (34%), Aerospace and Defense (30%), Industrial Equipment and Machinery (20%), Consumer Products including Sporting Goods (17%), Building Products and Fabrication (14%), Energy and Wind (14%), Electronics and High-tech (9%), and others including Life Sciences, Marine, and more. 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 represented a mix of company sizes, including 30% from smaller companies (less than $100 million), 19% between $100 million and $1 billion, 16% between $1 billion and $5 billion, and 14% greater than $5 billion. 21% chose not to disclose their company size or did not know. All company sizes were reported in US dollar equivalent.

The respondents were comprised of various roles. A little less than one-half (45%) were individual contributors. Another one-third (36%) were manager or director level, and 20% were VP or C-level executives.

The respondents reported doing business globally, with most companies doing business in North America (66%), a little over one-third doing business in Western Europe (37%), about one-third doing business in the Asia-Pacific regions (33%), Eastern Europe (15%), Latin America (12%), and Africa (6%).

Respondents included manufacturers as well as service providers and software companies, but responses from those determined not to be directly involved in designing or producing products were not included in the analysis. The majority of companies were considered to have direct involvement in designing and producing products and the report reflects their experience.

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.