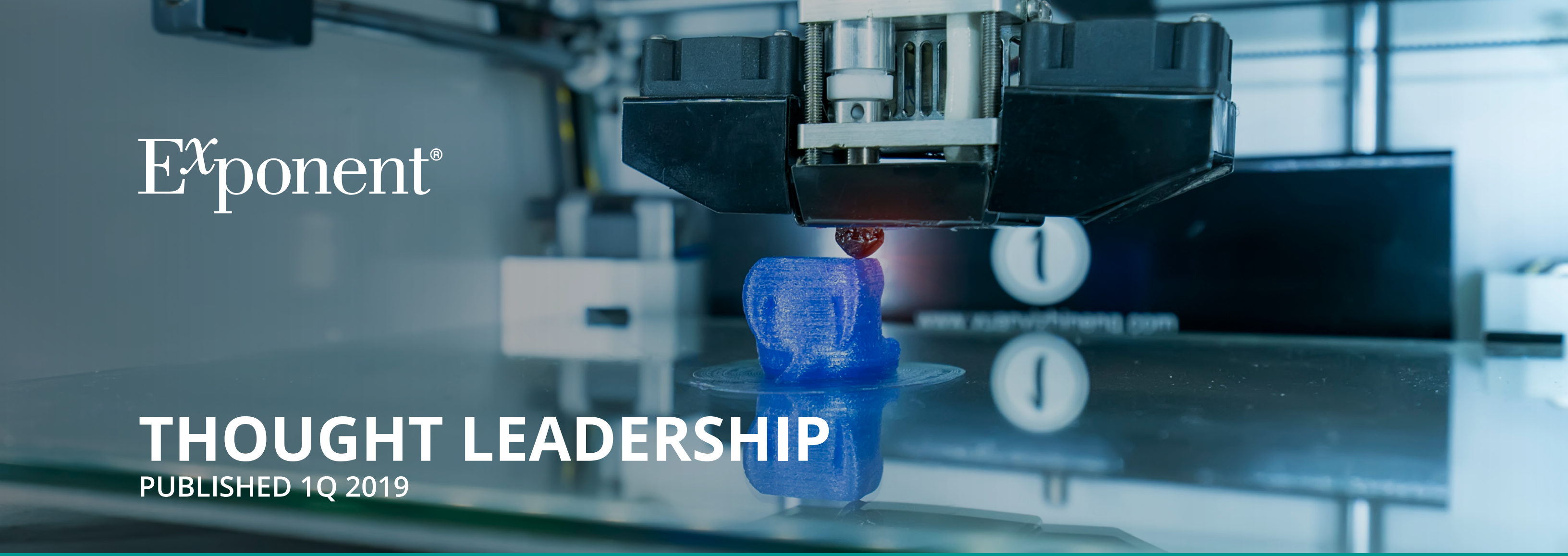

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Considerations for the Reliability, Safety and Performance of 3D Printed Parts and Products

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While additive manufacturing began as a method of making show-and-tell prototypes nearly thirty years ago, actual use cases and applications have only gained traction in the last five to ten years. Today, manufacturers can leverage over a dozen additive manufacturing or 3D printing technologies to help increase the speed of product development; minimize the risk associated with investing in production prototypes or tooling; and reduce the cost of manufacturing. Additive manufacturing can also enable manufacturers to enhance product design without the limitations that come with traditional manufacturing methods like CNC machining or injection molding. A common example is leveraging lattice structures or rotated square channels to increase heat or fluid flow and deliver an improved design at a reduced cost. While all of the above are welcome advancements, experts caution that potential performance and/or safety risks can occur if individuals use additive manufacturing to take a product to market without possessing foundational product development expertise or fully understanding the intricacies of additive manufacuturing technology. Manufacturers can help ensure the reliability, safety and performance of 3D printed parts and products by maintaining supply chain and process quality and by understanding the limitations of the technology.

It is important for manufacturers to maintain supply chain and process quality when using addititive manufacturing. Variability in incoming materials adds variability to the end result. The same idea applies to process. Additive manufacturing is a layering process with ample opportunity for one step to unknowingly falter and ruin the part. Our team at Exponent recently examined a metal printer that had recently been converted from a nickel-based alloy to an aluminum-based alloy. The operators failed to adequately clean out the nickel powder which resulted in nickel contamination and significant strength reduction of the printed aluminum parts. This example illustrates the importance of having strong understanding and tracking of the additive manufacturing process and a robust feedback loop to identify and address concerns.

In addition, manufacturers should take steps to characterize a material in the application in which it is going to be used. Well-established material data exists for CNC machined and cast titanium, for example, but not for 3D printed titanium. Manufacturers who seek to 3D print this metal must first characterize the material to understand how it will affect the performance of the specific part. It is also important for manufacturers to be mindful of the limits to manufacturing reliability (e.g., the consistency of the print and the material properties over a large batch). Due to the inherent layering process of additive manufacturing, more opportunity exists for one step to falter and compromise the part as compared to traditional manufacturing processes. More importantly, due to the automated nature of additive manufacturing, more risk exists for an unknown error to occur that may affect the reliability of the part.

Finally, manufacturers should understand that just because a part or product prints successfully does not necessarily mean that it has maintained the design intents of reliability, fatigue, chemical resistance, etc. Additive manufacturing is unlike CNC machining, injection molding, and other traditional manufacturing technologies that require a trained operator to assist in the design-for-manufacture iteration of the product design. With additive manufacturing, the person who designed the part or product can also manufacture it. This can be a welcome benefit, but only if steps are taken to ensure that the part or product is both manufacturable and holds true to the design intent. For this reason, many manufacturers benefit from maintaining teams of engineers that can perform a series of checks and balances on characteristics such as the geometry and mechanical properties of a part or product before going to print.

It is important to note that while regulatory standards for additive manufacturing are currently in development, they are still catching up to the technology. To date, ASTM has published twenty standards, most of which are two to three years old and do not cover the full spectrum of additive technologies, materials or applications. For example, the standard for design requirements, guidelines and recommendations was published in 2018. Coupled with new additive manufacturing technologies, materials and applications that introduce additional unknowns, it is more important than ever for manufacturers to perform due diligence to ensure the safety, performance, and commercial viability of their 3D printed parts and products. Due to the complex nature of additive manufacturing, manufacturers can often benefit from having eyes on several different technological verticals, such as mechanical engineering, materials science, electronics, quality and statistics, and polymer science (for plastic production).

Exponent's multidisciplinary team has expertise in each of the above technological verticals, and many others, specific to additive manufacturing. We help manufacturers across all industries avoid common pitfalls and optimize the reliability, safety, and performance of 3D printed parts and products.

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