A New Way of Thinking—The AM Journey

Navigate critical points and ensure engineering success

By Bill Herman, *President, New Era Assessments, LLC*

The allure of additive manufacturing (AM) is deeply rooted in its inherent possibilities to transform an established manufacturing process into a disruptive powerhouse by lowering costs, enhancing product performance and elevating quality. However, achieving such lofty goals begins with a deep analysis of every stage of the AM process.

Once a place where science and science fiction were legitimately co-mingling for decades, AM has moved beyond the dream stage while still searching for legitimate manufacturing uses that would unleash its potential.

This white paper will outline the reasons so many businesses employing AM processes struggling to make a profit?

The CHALLENGE

For each AM operation I assess, my first challenge is getting leadership to understand that adopting an AM model means also adopting a new way of thinking. The first question they should ask themselves is: Am I ready to re-evaluate everything I think I know?

In my experience, there's three things that make an AM process a success:

- Business
- Culture
- Product application

Business

Few technologies since World War II has been as disruptive as AM. There are no executives who can claim to have been through something as revolutionary as AM. The automotive industry was using AM technology in fuel pumps 30 years ago, printing out the impellers through stereolithography (SLA) techniques.

Three decades later, the expectation was that AM would be far more integrated into a wide array of industries. Only recently have we seen significant steps forward in plastics, composites, and metals. Yet, steady progress has been a challenge.

Culture

The importance of culture for a business cannot be overlooked. Observing AM advancing faster than the ability of most companies to fully utilize it is rooted in traditional manufacturing cultures that cannot find that "new way" of thinking.

Aerospace and medical industries have always been quick to adopt new technologies. Their AM success is well documented, but their willingness to embrace innovation comes as much from their adoption of new tech as it does from their success adapting the wholly new engineering approaches required to get there.

Product Application

One of the biggest mistakes made creating an AM business model is a lack of focus on the application of the technology to create a specific product. Many businesses make the mistake of purchasing a machine and then trying to adapt it to their existing product in some stage of the existing process. With the variants of quality AM machines available, there's no reason to not acquire the perfect machine for a specific product.

Best practices in the implementation of AM are to start small and focus on each of the specific operational silos required for the manufacturing process. Many problems originate with a lack of understanding for what AM operations require. The process should begin with an organic design approach.

There is a saying when it comes to AM organic design: 'Let the part be what it wants to be.' The premise suggests each individual application requires a thorough understanding of the best material to use and the process to follow for optimal results. It's critical to identify vendors who will set realistic AM throughput expectations and can transform inefficient AM business models into viable manufacturing processes.

Businesses employing an AM process have had to endure the constant noise associated with this technology, while trying to decipher many regarding its use.

Myth #1:
AM is for every company and every product.

AM is not for every company. Many successful companies have deeply rooted, traditional manufacturing processes. It takes a special culture to be open-minded and flexible enough to adopt AM.

Myth #2:
Material costs are how you control your expenses.

Material costs for a project are less than 5%. Understanding what material best suits a process in AM – as opposed to traditional manufacturing—is critical. In some cases, aluminum is not especially practical in AM—not because of cost but because of the dynamics associated with AM. In many cases titanium may perform much better.

Myth #3:
If you buy it, they will come.

There is a preconceived notion that you can do anything with AM, but transforming the theoretical to a practical purpose is very difficult. If a line of customers simply formed as soon as you purchased a machine, there would be significantly more companies using AM.

The SOLUTION

Having established a traditional approach to manufacturing does not work for AM, the solution lies in finding a balance between analytical and creative thought. From a design engineering standpoint, a traditional approach is a hindrance to seeing the AM process capabilities and what it takes to develop an effective process. A successful approach to AM design engineering requires the collaboration of an entire team.

At New Era, we see three primary stages for any AM process: Business Planning; Design Planning/Part Building; and Post Processing. Critical for all three stages is the ability to nurture collaboration across each distinct process. The AM process has its own nuances, blending technical with creative thinking, taking an approach that is decidedly not conventional. Establishing and monitoring collaboration throughout the process ensures all segments are in alignment.

Business Planning

Many companies' AM process fails at the very start when they hire traditional resources and lack the proper culture to think differently. Ultimately, every company wants a return on their investment, but the reality is the additive materials and machine are 40-50% of an AM project's cost, while the remaining 50-60% supports the process.

The ROI for AM, compared to conventional manufacturing, is a completely different road map. Securing funding for an AM project is easier in most cases than getting the right people onboard. Whether it's process or design engineers, you must determine 'do I have what I need' or 'do I need to train?' It is at this determining stage for training that many clients engage New Era to bridge the training gap.

A project's ROI can be enormous if you can reduce the engineering time up front. If a part costs $50,000 to produce in a 12 to 16-month period, what could ROI be if that same part could be produced in 3 to 4 months? That is where the impact of the AM model really can pay dividends.

The customizable manufacturing capabilities of AM are the antithesis of conventional manufacturing. Consider a family of parts—conventional thinking would require each being engineered, tooled, forged, and produced. With AM, you can dedicate a little more time on front-end engineering and that cost equates to the ability to produce a range (or family) of similar parts/sizes that are customized and available on demand, as needed.

Design Planning & Parts Building

The biggest challenge for the design stage of an AM process is to allow thinking and designing to happen organically. Employing conventional planning, software or design techniques for AM will create failure. Unlike a conventional manufacturing process, design and process engineering must be in complete alignment for AM.

Today's best AM parts builders understand collaboration between the engineers is critical to determine when and where key design elements, such as structural appointments, must appear. Attaining this level of collaboration optimizes AM's core capabilities while promising maximum ROI.

Post Processing

When parts emerge from the AM machine, they are not in a finished material state. The stress relieving process in AM is achieved through different types of heat treating or curing processes. It is essential for optimal parts performance that excess material and powder is effectively removed prior to the curing stage. Once cured, the stability of the part has been advanced to more secure stage.

The machining process in AM is achieved differently than in conventional processes. Datum structures, the central points

that an AM part is created from, are almost the reverse of conventional machining or the traditional casting processes.

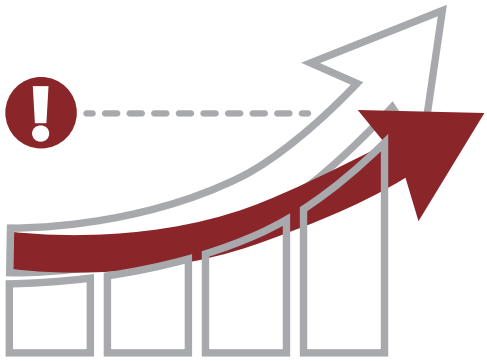
Both the internal and external inspection of organic parts occurs during the final stages of production. This is a challenging aspect of the AM process that requires use of high-level vision systems including lasers, white and blue lights, x-rays, and computer typography/CT scanners. The inspection process ensures every part is dimensionally correct.

Trends & Technology

It is clear that AM will never completely replace machining. However, one of the more interesting trends in AM technology is the creation of a hybrid approach that complements an existing machining process. The best way to see this trend growing is to track the increasing number of CNC machine tool builders introducing additive to their subtractive equipment platforms.

While the previously described inspection process for AM-produced parts is a critical aspect of getting the job done effectively and efficiently, new technology is proving that real-time process monitoring and validation can be implemented.

In the case of metal AM, the inability to analyze part structure during the manufacturing process has been a primary factor for mainstream manufacturers who are interested in AM technology—not to adopt it.



New technology is now giving manufacturers the ability to monitor and analyze key metal AM processes. Real-time identification of melt pool disturbances and other discontinuities provides a newfound level of confidence to adopt an AM metal process. This early-stage identification and elimination of potential problems provides immediate impact for the bottom line and ROI.

In the same category as real-time validation, Artificial Intelligence (AI) has also shown great promise but been just a slow for adoption by manufacturers. New software technology is elevating solutions for adaptive manufacturing—a process that entails adapting to the myriad variables that affect 3D printing through each step of a part's design, printing and post-processing.

When companies use 3D scanning to map data points against a part's original CAD or STL file, deviations between the two often require going back to the original file for adjustment—a time-consuming, inexact science for the best engineers.

By creating a loop between AI, design tools and 3D scan data, new software promises to enhance the ability of the base of AM printers to self-correct against variations throughout the printing process. This means that printing a part right the first time will become more likely after the part—or more accurately, after geometry similar to that of the part—has been printed hundreds or thousands of times.

The real promise is simple. Over time, if the AM machine deviates, or something in the environment/process changes, the machine can detect that and either create an alert or correct itself in real-time.

As is the case with any new technology, you cannot address a challenge if that challenge itself is not well defined. It is imperative that when adopting an AM approach there is also an equal adoption of a new way of thinking about the process. AI technology is only as good as an organization's ability to identify the problem they wish to solve and how are they going to source the specific type of data that is required to solve that problem?

Research shows that manufacturers that have been able to define a clear strategy have leveraged AI for quality checks, oversight in smart factories, creation of more reliable designs, and achieved a notable reduction of environmental impact.

The SHIFT

The shift happening today across the manufacturing industry involves some of the industry's largest players. Based on available resources, these notable giants should be enjoying the benefits offered by AM, but due to internal vertical structures and cultural indifference, they have been stymied time and again.

Up until now, the entities who have been prospering from AM technology have been the additive machine and software manufacturers instead of those who purchase the technology and try to implement it into an existing, conventional approach.

Faced with owning a powerful "round peg" – representing the potential of AM—companies continually try to force it into their existing "square hole" conventions. After repeated attempts, many companies grow weary of expending countless resources to change the round peg to fit into their comfortable square hole.

In the past, larger OEM manufacturing companies might decide to absorb smaller AM outfits in order to quickly assimilate the technology into their process, only to realize that the technology is only as good as the insights, experience, and people who run it. You can purchase the technology, or the entire company, and still miss the boat by not investing, or not the knowledge and employees who understand the culture and how to effectively apply AM.

CONCLUSION

While the incredibly appealing future promised by AM decades ago has not been achieved by the wide-ranging industries once projected to benefit most, it has not been due to a lack of technology—or even access to expert insights. On the contrary, technology and insights are abundant and quite impressive. What has plagued the implementation of AM is based more on inflexible corporate cultures, a lack of inclination to pivot from established processes, and a reluctance to adopt a new way of thinking when it comes to effective AM application.

With the varied selection of quality AM machines available, most requiring millions of dollars to simply power up, there's no reason to not acquire the insights and the brain trust to ensure the perfect machine has the perfect path laid out for production.

Manufacturers who are willing to let a proven technical authority like New Era show them how they can adopt a successful AM manufacturing process will have access to the insights necessary to meet their specific needs and business goals. Geared to market growth, profit, quality, ROI, ideal energy consumption, and efficient transportation costs, the New Era approach assesses a manufacturing process that extends both up and downstream from suppliers to distributors. It all starts with a willingness think differently.

About the Author:

Bill Herman is the President at New Era Assessments, LLC.

Based in Cincinnati, Ohio, in addition to a strong quality and test engineering background in traditional manufacturing, Bill has extensive experience in the additive manufacturing/3D printing industry with specialized expertise managing additive development and lean manufacturing for companies in the aerospace, medical, automotive and energy sectors. His professional experience includes Section Manager at GE Aviation and Vice President of Operations at Morris Technologies.

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New Era Assessments, LLC is an additive manufacturing/3D printing assessment firm specializing in innovative, comprehensive additive manufacturing consulting — providing expert insights and recommendations in design engineering, education, prototype parts development, production process and parts development.

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