ADDRESSING PRODUCTION CHALLENGES AND GO-TO-MARKET LIMITATIONS WITH ESTABLISHED ADDITIVE MANUFACTURING SERVICE PROVIDERS

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How Technological Advances in Wire Arc Additive Manufacturing Have Created New Opportunities for Prototyping and Legacy Part Production

INTRODUCTION

Industrial operations and manufacturers who depend on reliable, large-format metal parts are under more pressure than ever to exceed customer expectations for product quality and turnaround times. But they face several obstacles during research and development, product testing and production that negatively impact supply chains, go-to-market timelines and profits.

While advances in automated processes and lean manufacturing have helped manufacturers achieve more consistent part quality and increased production efficiencies, there are still significant limitations. Chief among those are the timely production of

In this white paper, we will:

- Identify the common challenges large-format metal part manufacturers and end users face in such applications as aerospace, automotive, heavy industry and the oil & gas industries.
- Examine how current wire arc additive manufacturing processes can be applied to various stages of production.
- Explain how working with an industry leader with vast experience in the manufacturing of arc welding products, automation technology and related processes can provide several advantages for manufacturers.

ADDRESSING PRODUCTION CHALLENGES AND GO-TO-MARKET LIMITATIONS

parts needed for tooling, low volume production, prototypes and maintaining a cost-effective stock of replacement parts.

Much has been said about additive manufacturing (also referred to as 3D printing) and the benefits of greatly improved lead times. Until now, this emerging technology has mostly been limited to plastics and smaller-sized parts made with metal powders. However, recent breakthroughs in the field of wire arc additive manufacturing are providing aerospace, automotive, heavy industry, oil & gas and other industrial equipment manufacturers with new ways to overcome common production challenges.

COMMON INDUSTRIAL MANUFACTURING CHALLENGES

There are four significant challenges all heavy industrial equipment manufacturers and end users face that can negatively impact production pipelines – causing production delays, downtime and increased costs. They include:

Malfunctioning or failing machine parts
that are challenging to replace or difficult to repair.

Long lead times for castings and forgings
of new parts, tooling or prototypes.

High cost of materials and shipping
for heavy equipment and parts.

Product testing and industry regulations
that cause delays and/or require redesigns or re-manufacturing of parts.

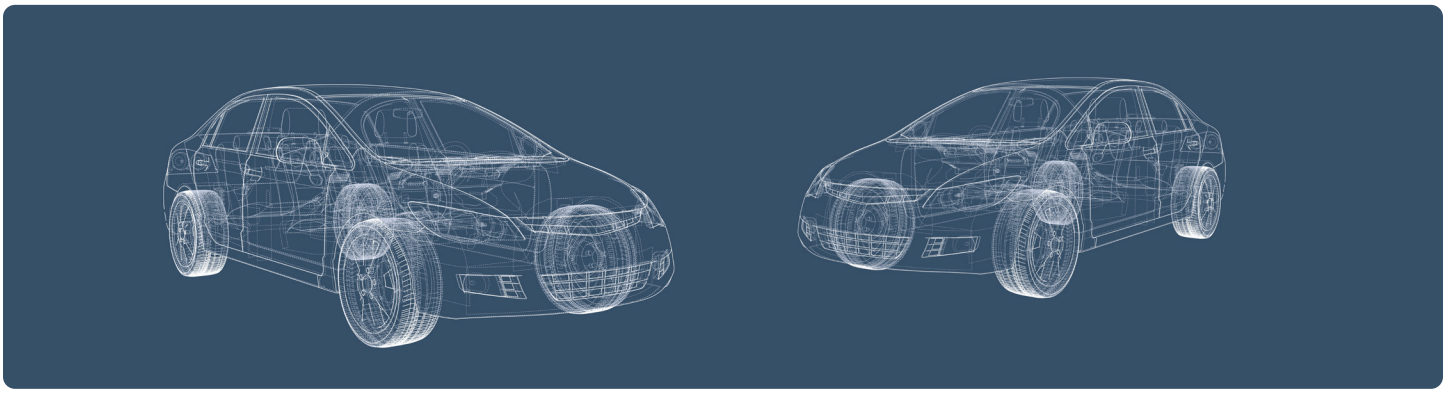
Let's examine how some of these challenges manifest in the four previously mentioned industry segments.

AEROSPACE

In the aerospace industry, weight reduction is critical to increasing energy efficiency and reducing fuel consumption. As a result, manufacturers are producing lighter composite materials which are being used in greater frequency in spacecraft and aircraft, from gliders and hot air balloon gondolas to fighter planes, space shuttle and passenger airliners.[1]

The problem is, the tooling used to produce these components can take months to manufacture. In addition to the extended lead times for acquiring raw materials, the fabrication and machining required to produce large, complex-shaped metal tools can cause further production delays. For major airline manufacturers, production delays can cause significant problems and add up to tens of billions of dollars in direct costs and lost sales. [2]

AUTOMOTIVE



According to an automotive industry trends survey by the manufacturer Jabil Circuit, although most automotive product development cycles have been shortening, all companies are facing challenges in reducing their product development cycles when it comes to testing, supply chain management and manufacturing.[3]

Research and development is often the principal reason for longer go-to-market timelines. Other obstacles that must be addressed include lengthy testing timelines and meeting government and safety regulations, as well as procurement cycles and the changing competitive environment.[3]

In addition, regulations for meeting increasingly stringent fuel economy and greenhouse gas targets add additional stress on automakers to make significant product changes in less time. [4]

HEAVY INDUSTRY

Heavy industry manufacturers responsible for the production of equipment such as excavators, backhoes, wheel loaders, bulldozers, dump trucks, cranes, and farm and mining equipment have faced considerable cost challenges in recent years.

The steel and aluminum tariffs of recent memory impacted the ability for manufacturers to satisfy customer demands, with some suppliers noting increased lead times on steel orders from 6-8 weeks up to 12-14 weeks.[5] International market growth is also fueling a need to remain competitive. According to a Global Market Insights report, the earth moving and road building machinery market is forecast to drive a compound annual growth rate of 4% in the construction machinery industry by 2024.[6] Agricultural equipment makers will experience similar growth, with a CAGR of 5% over the next four years, according to Market Research Engine. There are also pressures for manufacturers to keep up with new designs to satisfy changing global emissions standards, which further increases variability and R&D costs. [7]

OIL & GAS

In the oil & gas industry, operators require a smaller number of more expensive spare parts for replacement on equipment used in various stages of the supply chain – from extraction and storage, to processing and delivery.

The lack of spare parts has the potential to cause significant production loss due to extended repair times. On the flip-side, having to manufacture more parts than necessary raises operating costs. Over time, substantial amounts of unused or obsolete inventory translates to waste and loss.[8]

THE SOLUTION

Fortunately, experienced wire arc additive manufacturing service providers are now available to help alleviate manufacturers' pain points. They can help large-format metal part manufacturers accelerate projects by eliminating production bottlenecks, shortening delivery times and reducing prototype design and test cycles.

Among current and emerging manufacturing technologies, wire arc additive manufacturing provides several advantages concerning the production of large metal components, namely:

- Faster turnaround time and prototype testing
- Greater design freedom and part consolidation
- Reduced inventory costs and material waste

Manufacturers often have to compromise on size, material and even quality. Wire-based metal additive technology eliminates those trade-offs and delivers advantages over traditional manufacturing processes.

What is Wire Arc Additive Manufacturing?

Wire arc additive manufacturing combines gas metal arc welding (GMAW) with sophisticated automation. The process involves the use of 3D CAD software and the application of a robotic arm with a GMAW torch, which puts down successive layers of melted wire feedstock onto a multi-axis positioner to form a single, fully formed part. The process is ideal for parts larger than a basketball and can be readily scaled to several meters.

Faster Turnaround Time

By utilizing additive manufacturing, what would normally take months to produce a casting or forging can be reduced to weeks. This significantly reduces lead times for prototypes and finished

products. In one case involving the production of a mold tool for aerospace composites, the application of additive manufacturing was found to shorten delivery times by as much as 60% compared to traditional manufacturing.

More Design Freedom

The combination of layered manufacturing and flexible automation gives engineers the freedom to design complex geometries without the constraints of traditional manufacturing processes. For example, more complicated, multipart structures can be reduced to a single part. This means it is not only less time-consuming to build, but can also reduce supply chain risk from having to source parts from multiple vendors. End users can also tailor material properties by using multiple materials in the same build or improve product performance by optimizing designs, e.g. conformal cooling channels in molds or dies. In addition, parts can be made with hollow or structured interiors without sacrificing strength or structural integrity, allowing for weight reduction benefits.

Less Waste, Virtual Inventory

Compared to subtractive processes, such as lathes, mills and routers, additive manufacturing generates less material waste, reducing the amount of costly material that needs to be machined away. And because parts can be designed and made on-demand, companies can take advantage of the "digital inventory" afforded by additive, which makes it possible to achieve a more balanced part inventory and solve problems more expediently when replacement parts do not currently exist or are obsolete.

KEY BENEFITS OF WIRE ARC ADDITIVE MANUFACTURING

Reduction in lead times from months to weeks

Greater design freedom and part consolidation

Faster prototype testing

Lighter weight parts and less waste

CONCLUSION

Wire arc additive manufacturing has reached a maturity and quality level that provides faster turnaround times than traditional manufacturing processes for most low-volume parts (within certain size restrictions). These benefits in combination with enhanced design freedom makes further exploration of additive manufacturing a must for industries involved in the production and use of large metal parts.

However, the investment and research required to establish an in-house wire arc additive solution can be prohibitively expensive for most operations. In addition, the time and resources necessary for training and developing the expertise needed to run the process reliably and with high quality can also be beyond the capabilities of most industrial operators.

Therefore, manufacturers should make sure to partner with a vendor who has considerable knowledge and capabilities in additively manufacturing high quality parts in compressed time frames. Manufacturers need a partner with industry-leading technology in the entire additive value chain with the financial stability and manufacturing experience to provide high-quality parts long into the future.

Unlike other additive manufacturing service providers, Lincoln Electric has amassed 125 years of welding expertise and related manufacturing processes. Our latest service offering in additive manufacturing represents the culmination of this knowledge and pioneering research in the field. Further, no other provider has as much control over the entire additive value chain: slicing software,

robotic automation, power sources, wire feedstock and controls, and yes, even machining capabilities to provide fully-finished parts and assemblies. Lincoln Electric's extensive capabilities and long history of supporting manufacturing with quality products provides customers with a world-class option for large-format metal additive services that yields greater quality, dependability and peace of mind.

SOURCES

1. AZO Materials "Composites Used in the Aerospace Industry" **https://www.azom.com/article.aspx?ArticleID=8152**
2. "A Major Aerospace Concern: Manufacturing Delays and Ways to Solve Them" **https://www.manufacturing.net/aerospace/article/13057531/a-major-aerospace-concern-manufacturing-delays-and-ways-to-solve-them**
3. "Automotive Industry Life Cycle – Shorter Timelines" **https://www.jabil.com/blog/automotive-industry-trends-point-to-shorter-product-development-cycles.html#scroll-download-the-Managing**
4. "Automotive Product Development Cycle and the Need for Balance with the Regulatory Environment" **https://www.cargroup.org/automotive-product-development-cycles-and-the-need-for-balance-with-the-regulatory-environment/**
5. "How Heavy Equipment Manufacturers Can Conquer Cost Challenges" **https://blogs.sw.siemens.com/thought-leadership/how-heavy-equipment-manufacturers-can-conquer-cost-challenges/**
6. Global Market Insights "Construction Equipment Market Size By Product, Industry Analysis Report, Regional Outlook, Growth Potential, Competitive Market Share & Forecast 2018-2024" **https://www.gminsights.com/industry-analysis/construction-equipment-market**
7. Market Research Engine "Global Agriculture Equipment Market By Product Type Analysis and By Regional Analysis – Global Forecast by 2018-2024" **https://www.marketresearchengine.com/Agriculture-Equipment-Market**
8. "12 Best Practices of MRO Inventory Optimization for Oil & Gas Companies" **https://www.oilandgasiq.com/integrity-hse-maintenance/whitepapers/12-best-practices-of-mro-inventory-optimisation-fo**

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Lincoln Electric is the world leader in the design, development and manufacture of arc welding products, robotic arc welding systems, plasma and oxy-fuel cutting equipment and has a leading global position in the brazing and soldering alloys market. Headquartered in Cleveland, Ohio, Lincoln has 60 manufacturing locations, including operations and joint ventures in 19 countries and a worldwide network of distributors and sales offices covering more than 160 countries. For more information about Lincoln Electric and its products and services, visit the Company's website at https://www.lincolnelectric.com.

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