



Image from www.eos.info - Sintering additive manufacturing powder bed production.

Understanding Additive Metal Manufacturing in 3D Printing

Successful Additive Manufacturing Relies on Critical Planning at Earliest Stages

By Bill Herman, *President, Arete Innovative Solutions, LLC*

The world has seen the additive manufacturing and 3D printing processes evolve from something that was more likely to appear in a science fiction setting than a report in a science journal. Like many of the innovations that have fueled global growth in countless industries, the additive manufacturing process is evolving every day.

The global market for 3D printing, materials and related services is projected to reach 16.2 billion dollars by 2018. This number accounts for all materials used in the process, typically plastic and metal. The number of the specialized machines required to apply additives during the manufacturing process has grown from an estimated 355 printers in 2008 to more than 23,000 printers in 2013.¹

The industries likely to find the most immediate benefits of additive manufacturing innovations are a virtual who's who of industry giants that thrive on the edge of technological breakthroughs. The medical, military, aerospace, energy and automotive industries have all found great opportunity in the further development of additive manufacturing.

Aerospace experts believe that additive manufacturing can reduce the lead-time in the development cycle by 80 percent, compared with conventional manufacturing methods.² This may allow aerospace manufacturers to redesign a part up to five times more during a standard component development cycle, leading to significant performance improvements of the components.

While additive manufacturing does allow for the printing of parts in plastic and metal, it is different from conventional manufacturing because the process adds materials, typically in layers, to create the new part.

Successful author and motivational speaker Denis Waitley once said "Imagination plus Innovation equals Realization."³

His audience was a group of businesses and he was trying to push them to exceed the expected norms of their industry. When it comes to additive manufacturing, one could easily have imagined Waitley was speaking directly to those companies trying to harness the potential of 3D printing.

To have been brought up in a lifetime where conventional manufacturing was the only way to generate parts requires enormous imagination. Development of the technology and interface with the 3D printer, creating a working part from continuous layers of additives, is the definition of game-changing innovation. And with the commitment to bringing many variables together in the hope of creating a new process — a new reality is born.

This white paper will focus on the evolution and adaptation necessary for companies hoping to tap into the metal additives manufacturing process.

Today's AM Technologies

There are two primary components of the metal AM process: First, the type of raw material used; and second, the energy source incorporated.

There are three main AM technology categories:

- **Powder bed fusion:** Fine layers of powdered plastic or metal are melted into solid objects using a laser
- **Laser powder injection:** Used to produce a metallurgically bonded deposition layer
- **Free form fabrication (FFF):** Without using lasers, this process builds near-net-shape parts requiring less raw material and finish machining than traditional manufacturing

Most commonly preferred AM formats incorporate powder bed fusion. The two most prevalent are:

- **EBM - Electron Beam Melting**
- **DMLM - Direct Metal Laser Melting**

THE CHALLENGE

When something is designed with a specific purpose in mind, it has a much better chance of succeeding. It all starts with designing a process that is focused on growing the intended part.

The palm tree and the oak tree are in fact both trees; however, if you asked an oak tree to survive in a loose, sandy soil environment with hurricane winds, it could not survive. The palm tree has evolved and thrived in sandy soil and it can sustain hurricane winds because it's designed for that specific environment. Takeaway: Don't ask the oak tree to do what the palm tree was designed to do.

The story of the palm and oak trees illustrates the plight of the additive manufacturing company that is attempting to design a product that was originally intended for process A, and must somehow try to find success performing process Z.

Too often, additive manufacturing projects will begin by employing conventional thought. This makes little sense when you consider the 3D printing process is wholly unconventional. In the 3D printing arena, where the technological boundaries are constantly expanding, there can be unrealistic expectations. The truth is that there are limitations, but they are limits in a new, unconventional sense.

Bumps in the Road

- **Process:** Try to have a complete plan from design through production to the final product.
- **Many Machines:** There are many machines out there with varying degrees of capability and different limitations. You must have the right machine for the part.
- **Qualification:** Still in its infancy, additive manufacturing has very few standards in place. Industry pioneers are forging new boundaries in the field and setting the standards as they gain expertise.
- **Training & Education:** It is critical to gain a complete understanding of the process. Too often, additive manufacturing operators do not possess the necessary insights and big-picture understanding. Proper training is essential.
- **Executive Overview:** Understanding the financial investment and the variables in the production process helps ensure realistic expectations.

The conventional manufacturing process, which can involve thousands of parts produced by countless companies, has a standard potential for problems realized from more than 100 years of manufacturing experience. When you consider many companies have machines but do not understand the additive manufacturing process, it is not hard to believe that a new project could take more than 20 months to start up. Some projects never manage to start up.

Many additive manufacturing project planners are unable to predict potential problems before they occur. Likewise, if you have no contingency plan for problems, you likely have no source for a specialist who can provide a solution. After all, you cannot plan for problems you never knew could be problems. The adage "We don't know what we don't know." applies to the additive manufacturing segment when it comes to understanding the process. Resourcing the proper expertise is critical to success.

THE SOLUTION

The unconventional additive manufacturing operation requires an unconventional thought process. Arete Innovative Solutions, LLC is a pioneer in the metal additives manufacturing process and a specialist in creating custom-designed solutions that deliver the intended results.

With more than 44 years of manufacturing experience, and more than 7 in additive manufacturing, Arete brings a diverse skill set and approach to projects and a commitment to quality that make them especially effective in the evolving 3D print arena. Offering essential manufacturing know-how and critical partnerships with skilled innovators in the metal additives segment, Arete approaches each build-out with a focus on connecting the many variables that can overwhelm a project.

Arete provides a holistic approach to additive manufacturing projects by being available from day one through the build-out and into production. While getting called into an existing project for problem-solving on product quality or machine set-up is normal, Arete prefers to be involved from the very beginning stages of planning.

Common Consulting Scenarios:

- Solving product problems
- Machine set-up challenges
- Consulting from day one
- Executive overview (business feasibility, evaluation and planning)

With a holistic approach to metal additive manufacturing projects, Arete can advise on every aspect of a project. From initial machine set-up and additive choice/use to final quality control, wherever a potential challenge exists, Arete can often see it in the planning stages and avoid the time lost and expense of mid-flow changes.

Being in a position to connect all the dots from planning through production, Arete approaches every project by reviewing the complete strategy from engineering and parts to metallurgy. Arete's approach is to be part of the process from the beginning while remaining a partner well beyond the build-out.

Education is a primary focus for Arete. As consultants who advise at every point in the manufacturing operation, their philosophy is to teach each company how to effectively use additive manufacturing technology so clients are able to optimize and maintain manufacturing momentum into the future.

Key Project Questions:

- **Engineering:** How to design/build it?
- **Parts:** Can it be built?
- **Metallurgy:** Will it work?

Going back to the palm tree story, there cannot be enough emphasis put on designing an additive manufacturing process that avoids the pitfalls awaiting those who approach a project in a conventional manner. The benefits of working with Arete start with a new way of thinking: Adding simplicity through complexity. This reflects the relative simplicity created by producing one consolidated part instead of 10 separate components, while recognizing the achievement of such a goal requires an intrinsically complex process.

A New Way of Thinking:

- Reduce the design curve
- Compress the development cycle
- Simplicity through complexity
- Less time/expense

Embracing an unconventional approach to additive manufacturing, provides benefits that can extend far beyond what conventional thought might have allowed. A metal part made with additive manufacturing could ultimately weigh less, use less materials, generate less scrap and be at start-up in six months rather than the 20-plus months it may take other projects to ramp up.

While conventional thought would require estimating the cost to produce and assemble 10 parts, additive manufacturing would be able to consider potentially producing all 10 parts in one process. The upside is that while a complex part has been created, a more simplified assembly process has emerged. Materials like aluminum, which may be chosen in a conventional approach that must take into account material costs and waste, could give way to better options like titanium. These are the benefits of an unconventional additive manufacturing approach.

Arete Innovative Solutions, LLC adheres to the saying: "It's not just about building a great part." Every plan involves a commitment to helping at the executive, design and engineering levels. From cost analysis and technical support for build-out and day-to-day operations, to the most critical aspect — educating and training the team so they can handle the day-to-day challenges into the future, Arete is there every step of the way.

ARETE HOLISTIC PROCESS

Design Engineering

- Design for additive process
- Understanding possibilities and limitations of additive
- Education and training

Part Building

- Technology selection
- Inspection and control
- Extensive additive experience

Post-Processing

- Support removal
- Heat treat
- Non-destructive testing

Part Finishing

- Surface finishing
- Analysis
- Design feedback

Aligning with strategic and tactical partners to provide solutions at all phases of the development process.

CONCLUSION

If you can believe that Imagination plus Innovation equals Realization, then the imagination part begins with thinking in an unconventional sense. Whether it is an old or still-unrealized manufacturing model, the goals are always the same — profitability.

When considering metal additive manufacturing, start-up costs can scare many potential players away. It is easy to look at the build time and initial costs and be surprised — only if you approach it wearing the dark glasses of conventional thinking.

If you allow yourself to step outside the box and consider the potential behind starting a project that is designed from day one to take full advantage of the newest technology in 3D printing, you are halfway there. Having access to the industry's top additive manufacturing specialists who provide day-to-day guidance, you will find that healthy bottom line is more attainable than ever.

Sources:

1. *Additive Manufacturing In Aerospace: Strategic Implications*, 2014, white paper
2. *The Psychology of Winning*, 1986, Denis Waitley
3. Statista: *The Statistics Portal*, 3D Printing and Additive Manufacturing

About the Author:

Bill Herman is the President at Arete Innovative Solutions, LLC.

Based in Cincinnati, Ohio, in addition to a strong quality background in traditional manufacturing, Bill has extensive experience in the metal additive manufacturing/3D printing industry with specialized expertise managing additive development and lean manufacturing for companies in the aerospace, medical, automotive and energy sectors.

Bill can be reached at bherman@areteisllc.com

Arete Innovative Solutions, LLC is an additive manufacturing/3D printing company specializing in innovative, comprehensive additive manufacturing solutions through design engineering, education, prototype part development, and production process and part development.

**Contact Arete Innovative Solutions, LLC
to build your success today.**



Bill Herman, President
513.503.2712
bherman@areteisllc.com
www.areteisllc.com

Additive Manufacturing | Consulting | Training

