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Additive Manufacturing in Aviation

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Abstract

Technology advancement has resulted in changes in the way products are produced. Therefore, additive manufacturing emerged as a transformative event in the manufacturing industry. Although no one would foresee its revolution, it is currently gaining awareness and acceptance in sectors. The implementation allows companies to make products that are viewed as complex and use minimum time and capital. The aviation industry is vastly affected by Additive Manufacturing because materials such as propellers and engine parts are made by adding materials until an anticipated structure is obtained. The purpose of this paper is to examine if 3D-printed components meet or exceed the quality standards of traditionally made components. Although 3D-printed parts are flexible, can build complex components, and ensure products arrives in the market early, they have challenges that limit the implementation, including quality consistency and the inability to produce large parts.

Additive Manufacturing in Aviation

The aviation industry is adopting advanced technology in its manufacturing process. Additive Manufacturing is one of the technologies adopted in making certain parts because it impacts the designs in the aerospace industry and the repair procedures of the aircraft in the future. Therefore, Additive Manufacturing (AM) technology will result in significant variation in the future of the aviation industry. Moreover, AM has attained substantial achievement in the end-part manufacturing, measured by the product enhancements and the decreased lead time related to the old-style process. This paper will examine additive manufacturing, how it has revolutionized the aviation industry, and review its benefits and the challenges that limit its capabilities.

Additive Manufacturing

The concept of AM is not new because it has been in existence for several years now. Abdulhameed et al. (2019) stated that AM was presented in 1983 when some defense aviation started implementing the technology in aircraft manufacture. Therefore, as time continued to pass, more companies and organizations adopted the technology in their practice across the world. Additive Manufacturing (n.d) defined AM as the technologies used to develop 3D objects by adding a layer of materials despite plastic, concrete, or metal. The most well-known AM technology is the utilization o computer, three-dimension modeling software such as computer-aided design, and layering material. The same source added that once the computer-aided design plan is generated, the AM device reads in data from the computer-aided design file and places down succeeding materials to manufacture a 3D object.

Moreover, the term AM comprises several technologies containing subsets such as three-dimension printing, additive production, and rapid prototyping. Additive Manufacturing (n.d) claimed that AM application is immeasurable because its initial use was in the design of rapid prototyping, concentrating on the preproduction visualization models. However, currently, AM is utilized in the production of end-use aircraft products and other fields such as medical implants and automobiles. Several reasons allow an extensive adoption of AM in the aviation industry, including its flexibility in producing complex parts. The present aviation industry needs to make geometrically intricate parts of development using the past manufacturing procedures. Since AM can create both simple and complex objects in the aviation industry, for instance, some of the intricate parts AM can make in the aviation industry are propellers and engines.

How AM is Revolutionizing the Aviation Industry

The aviation industry is progressively utilizing three-dimension printing for functional aircraft parts. Previously, AM was used by the aviation industry to make prototypes parts rapidly; however, it is significantly being used to develop in-flight elements for the aircraft. Nathan (2015) emphasized that General Electric (GE) will start printing fuel nozzles for the LEAP engine. Therefore, printed nozzles are expected to be twenty-five percent lighter and durable than the current one. Furthermore, the same source added that the production company for the nozzles would be set in Alabama and will be the largest company to develop 3D printed aero-engines parts massively.

Three-dimension printing provides a high potential of decreasing the cost and weight of the aircraft parts and enhancing the capacity of engines to design components specifically for their ultimate roles. Consequently, the technology allows the design and development of huge pieces. For instance, Boeing has many 3d printing elements flying on their aircraft (Nathan,

2015). The airplanes that are using the printed components comprise both commercial and military. Moreover, through additive layer manufacturing for the front bearing, significant knowledge was obtained, which aided in the design and development of the elements. This enabled them to evade the struggle of fixing the design early to offer the extended lead time for tooling.

GKN Aerospace creates, develops, and supplies advanced aerospace parts, systems, and sustainable technologies has invested in AM. Nathan (2015) stated that the GKN utilizes electron beam melting, where metal elements are built up through a layer-by-layer process. The metals are developed using the metal powder liquefied by an electron beam to generate small and medium-sized titanium elements, including furnishings and brackets. Nevertheless, when companies concentrate on developing operational aircraft elements using AM, more concentration is placed on building titanium elements to replace the parts produced conventionally. Also, Nathan (2015) claimed that as the AM continues to advance, manufacturers gradually adapt by designing their parts to benefit from the available opportunities.

Moreover, GKN company has initiated a research program supported by the Aerospace Technology Institute to create titanium powders explicitly for AM. Titanium Powder for net-shape component manufacture intends to make powders articulated and mixed to meet the requirements of AM (Nathan, 2015). furthermore, considering that the materials are produced as the elements are being developed, Aerospace manufacturers will start modifying the features of the material in various regions of the elements. Therefore, this function loading can be utilized to adjust the microstructure and texture of the parts in different stages to ensure they attain various loads or needs.

Benefits of Using AM in Aviation

AM plays a critical role in the manufacture of aircraft parts. The aviation industry can make parts by utilizing the design such as the internal cavities and lattice structures that aid in the decrease of aircraft components weight with no interference on the mechanical performance. Moreover, the AM system provides a little scrap as equated to the traditional approaches in the aviation industry (Abdulhameed et al., 2019). AM benefits are seen in its capacity to break present performance trade-offs in different ways, including decreasing the capital needed to gain economies of scale and enhancing flexibility, which reduces the capital required to attain the set of scope (Volen, 2019). The deliberations of the lowest reliable scale forms of the supply chain are contained in the capital and scale segment. AM can reduce the amount of capital required to attain the least efficient scale in production hence decreasing the barriers to entry in the manufacturing sector.

A high percentage of the aviation industry comprises various conventional strategies created that aim to influence the AM for modeling, tooling, prototyping, and short-run production with no considerable variations in the supply chain. Therefore, AM decreases the time of the product entering the market because the aviation manufacturing companies can develop prototypes to ensemble and measure functionalities, resulting in quick design cycles (Abdulhameed et al., 2019). The faster design ensures that the aerospace parts will be developed early, decreasing the time to take the plane in the market and providing manufacturers with a competitive advantage. Nevertheless, the move from traditional methods to AM will depend on how the manufacturers utilize their strategies. For instance, the Defense Advanced Research projects Agency (DARPA), which is accountable for developing emerging technologies used by

the military, was requested to enhance the designs of all VTOL aircraft. DARPA used a more extended time because Boeing developed a prototype that used thirty days less.

AM provides flexibility in creating an exceptional design. For instance, manufacturers can place the product into tests for uniqueness as many times as possible. Therefore, this will aid aerospace to reduce the risks and uncertainties that might have occurred when using the traditional approaches. Furthermore, flexibility intensifies the operations that operate at inexpensively available services related to the old-style manufacturing procedures. The modifications of the software design files can make the organizations effectively participate in more than one design at a time with an economic retooling tactic. Volen (2019) emphasized that another advantage of AM is tooling at lower charges. It allows manufacturers to design and test products quickly and decreases the total cost of creating the tools.

Challenges that Limit AM Capabilities

Although AM is gaining gradual adoption, several challenges limit its adoption capabilities. Coors (2018) stated that only thirty-four percent of the manufacturers in the United States had executed AM. Nevertheless, the same source noted that the low implementation of AM is different within companies depending on the size of the organization and product developed. Also, AM was first recognized because of rapid prototyping; however, it is now known for producing final parts because manufacturers can now make components that were thought to be complex. One of the limits is financial factors since the cost of installing the machines and facilities needed to sustain SM are high. Therefore, manufacturers will weigh between the traditional approaches and AM. Volen (2019) claimed that companies need to realize the best time to invest in AM by considering where the costs will appear in the process.

This will be evaluated to recognize volume as well as type of components made to justify transition.

Another challenge that limits AM adoption is the size restrictions of parts made. Coors (2018) stated that AM cannot manufacture significant and odd-sized components now, which creates regulations in the aviation industry. Nonetheless, some AM providers and research institutions are working to deal with the issue, including the United Kingdom organization BAE systems that manufactured one-meter titanium using the technology (Volen, 2019). Another challenge is quality consistency because AM faces a problem in producing complete dense metal elements. The strength in the aerospace of layers is not even. Thus Coors (2018) said that AM needs to ensure steadiness in quality and dependability of products generated through the procedure. Finally, AM is not adopted fast because of the issues of repeatability. Volen (2019) claimed that manufacturing suppleness is an asset because it allows the process to produce reliable components steadily. AM challenges because similar settings can result in production of various products. Also, there is an issue with output speed because it places restrictions on mass production possibilities.

In summation, AM is vital in the aviation industry because it offers a method of developing complex designs and creating lightweight and robust structures. AM explains the technologies that develop three-dimension objects by adding a layer on another layer. Therefore, AM is supple in the development of intricate elements geometrically that are complex to construct. AM revolutionizes the aerospace industry because they are using parts that are created by 3D printers. AM has significant benefits, including the reduction in capital required, a decrease of time the product arrives in the market, the flexibility of design iterations, and complex designing tools. Nevertheless, are several challenges facing AM that limit its

capabilities. For instance, AM cannot produce large parts of the plane and is facing problems in quality consistency. Therefore, the research goal is attained because the 3D printed parts still need attention and improvement to meet quality standards.

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