International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 7 ǁ July 2022 ǁ PP. 43-45

3D Printing In Aerospace and Its Long-Term Imperishable

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Abstract:
Bewildering 3D printing has excited the world of aerospace. Additive manufacturing (AM) has become a serious and potential game-changing method of manufacturing over the years since the first commercial technology for "Rapid Prototyping"in 1988. Even though we are advanced, the current accomplishments are still farfrom the level which can be expected in the future. Innovative approaches toward design are required to capture the full potential o f this technology. This paper describes the advantages and possibilities of AM technologies, and how they can be used in varioussectors (e.g., engineering, automotive, aerospace, medical, and consumer products, etc.) as alternative methods for manufacturing energy efficient parts with fewer raw materials.Additive manufacturing processes take the information from a computer-aided design (CAD) file that is later converted to a stereolithography (STL) file. In this process, the drawing made in the CAD software is approximated by triangles and sliced containing the information of each layer that is going to be printed.There is a discussion of the relevant additive manufacturing processes and their applications. The aerospace industry employs them because of the possibility of manufacturing lighter structures to reduce weight.It also reports how engineers need to change their thinking pattern to be able to use the full potential of the AM technologies. Engineers should be aware of the capabilities of the AM technologies and the available material selections to make the right decisions at the beginning of a design process.
Keywords: *additive manufacturing, rapid prototyping, 3-Dimensional printing; material selection; layer manufacturing technologies*

Date of Submission: 18-06-2022 Date of acceptance: 02-07-2022

I. Introduction:

3D printing, also known as Additive Manufacturing (AM), is 'a process of joining materials to make objects from 3D model data, usually layer upon. The product is designed in CAD software, which is then exported to a 3D. 3D printing provides a lot of customisations in product design and can even print parts, which cannot be manufactured by any traditional manufacturing processes. Complex and intricate components can be manufactured with substantial reduction in manufacturing time, costs, and material wastage. AM, colloquially known as "Rapid Prototyping" or "3D printing," is a process of making a three-dimensional solid or hollow-core object of virtually any shape from a digital model. AM is achieved using an additive process, where successive layers of material are laid down in different shapes following the specifications in a digital computer aided design (CAD) file. AM is distinct from traditional machining techniques, which mostly on the removal of material by methods such as cutting or drilling (subtractive processes). The key concept here is the difference between "additive" and "subtractive" manufacturing. The technology and its 3-D multiplastic material printing or metal laser/electron beam sintering/melting1 capabilities provide the means to develop truly industry-changing product-design and manufacturing processes. It allows the building of parts with verycomplex contours, cavities, and complicated lattice structures.

Cost and Time Savings:

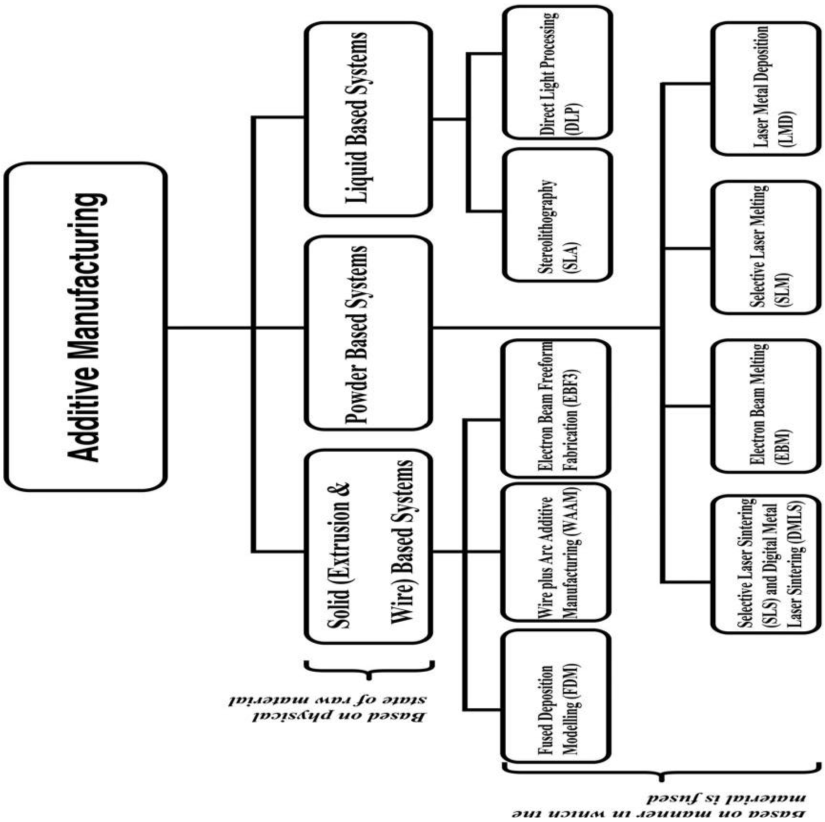
Obviously cost and time-savings are a large factor driving the rapid growth in manufacturing components and parts through additive processes rather than traditional manufacturing processes. A real life example would better illustrate.

Weight Reduction:

One of the potentials of AM that is still nearly untapped is the possibility of fabricating hollow-core structures that still retain adequate stability and performance. The ability to reduce product weight or change its mechanical properties offers significant energy and cost savings in the aerospace, automotive and consumer products industries. In the area of medical applications, the ability to build cavities in models allows, for example, the model to imitate bone structures. The obstacles in these fields are a lack of conceptual design methods to aid designers in defining and exploring design spaces enabled by AM. In addition, a new foundation for computer-aided design systems is needed to overcome the limitations of existing solid modeling in representing complex geometries. The first steps in the right direction have been taken. Now on the market are new software programs or modules to support the modeling of light weight products.

Popular 3D Printing Process in Aerospace Industry:

3D printing can be divided into two classes, namely (i) by the physical state of the raw material, that is, liquid-, solid-, or powder-based processes (Chua and Leong 2015) and (ii) by the manner in which the matter is fused on a molecular level, that is, thermal, ultraviolet light, laser, or electron beam (Hopkinson et al. 2006). The most commonly applied 3D printing processes are shown in Figure 1.



Among the many different AM processes, the ones that meet the aerospace industry requirements are Selective Laser Sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM), and Wire and Arc Additive Manufacturing (WAAM) (Kobrynet al. 2006, Wood 2009, Lyons 2012). These processes can produce extremely dense components without any post-processing with comparable mechanical and electrochemical properties to other conventional manufacturing methods . SLS and DMLS are in essence the same process. While SLS is used to produce parts using a variety of materials, such as plastics, ceramics, and metals, DMLS can only be used to produce metal alloy parts. SLM can be used to manufacture with any material. It uses a high-energy laser beam to heat and melt the powdered material. The material oxidation and degradation is minimised by carrying out the process in protective environment . EBM uses a very high-energy density electron beam, produces dense, void-free parts, but can process onlymetals. It is emerging as a high-quality substitute to laser melting and is being used to manufacture and repair turbine blades . Friction Stir Additive Manufacturing (FSAM) is another AM technique and a study has shown that FSAM did not only improve the mechanical properties, but the properties attained were also different from those manufactured by conventional methods.

3D Printing materials for aerospace applications:

A lot of research is going on into using different types of metals and metal alloys for AM. Polymers, ceramic composites, alloys of aluminium, steel, and titanium objects can be printed with a minimum layer thickness of 20– 100 μm, depending on the AM technique used and the physical state of the material . But from the aerospace industry point of view, more importanceis given towards Ti- and Ni-based alloy.Nickel-based alloys preferred in aerospace due to their tensile properties, damage tolerance, and corrosion/ oxidation resistance Using AM for these alloys results in high cracking tendency, hence to improve its mechanical properties generally a Hot Isostatic Pressing process is employed.

Specific adoption of AM in the aerospace Industry:

In early 2015, the Federal Aviation Administration (FAA)
qualified the first 3D-printed commercial jet engine part from GE. The part was printed of silver to house the compressor inlet temperature sensor inside the jet engine. GE Aviation is working with Boeing to retrofit GE90–94B jet engines with more than 400 3D-printed parts. The next generation LEAP jet engine from GE, which has 19 3Dprinted fuel nozzles (Tadjdeh2014, Richard 2015), is being currently flight tested. Their target use is to power the Boeing 737MAX and the Airbus A320neo aircrafts . GE Aviation plans to produce over 100,000 AM parts for its LEAP and GE9X engines by 2020 . It is also aiming to replace the forged and machined titanium leading-edge blades cover with 3D-printed ones.

Challenges with 3D printing in space:

In space, the feedstock used for 3D printing metals cannot be in the powder form, as it would float everywhere. Researchers at NASA's Langley Research Centre say that using EBF3 could solve this problem . This technique uses an electron beam gun to melt two strands of wire into a 3D shape one layer at a time. 3D printing 3D printing works by spraying thin layers of a material one-by-one that builds up to form a complete 3D part. But due to the little gravity in space, the material does not get held down, which results in unevenly thick layers of print . Additionally, thermal issues could be tricky as the microgravity affects heat flow. While printing, this could potentially mean that the plastic parts will get either too hot or too cold, thus impacting the part quality.

Applications:

With additive manufacturing technologies it is possible to manufacture lightweight parts.

In the automotive and aerospace industry the main goal is to make the lightest practical car or aircraft while securing safety. Additive manufacturing technologies have enabled the manufacture of complex cross-sectional areas like the honeycomb cell or every other material part that contains cavities and cut-outs which reduce the weight-strength relation. It is possible to create lightweight structures; they are methods to get a shape that have a minimum weight.

Additive manufacturing techniques have been shown to help reduce cost and lead times and also for reducing the mass of components aboard spacecraft and aircraft. Many popular publicized examples of AM applications in aerospace boast mass reductions, among many other benefits. The main applications of AM in the aerospace industry are rapid prototyping, rapid tooling, and repair, as well as direct digital manufacturing (DDM) of parts made of metal, plastic, ceramic, and composite materials. Currently, the fastest growing application is DDM (final part manufacturing).

II. Discussion and Conclusion:

In this paper is discussed the early versions of additivemanufacturing for making fast prototypes that was initiated by the necessity of speeding the process in model development and shortening the time between product development and market placement. Additive manufacturing processes take the information from a CAD file that is later converted to an STL file. In this process, the drawing made in the CAD software is approximated by triangles and sliced containing the information of each layer that is going to be printed. There is also a discussion of the relevant additive manufacturing processes and their applications and a review of how the parts are made using these additive manufacturing processes. The continuous and increasing growth experienced since the early days and the successful results up to date, there is optimism that additive manufacturing has a significant place in the future of manufacturing.

References:

[1]. Sunil C. Joshi & Abdullah A. Sheikh "3D printing in aerospace and its long-term Sustainability"

[2]. KaufuiV.Wong and Aldo Hernandez " A Review of Additive Manufacturing"

[3]. S. Ashley, "Rapid prototyping systems," *Mechanical Engineering*, vol.113

[4]. A. D. Taylor, E. Y. Kim, V. P. Humes, J. Kizuka, and L. T. Thompson, "Inkjet printing of carbon supported platinum 3- D catalyst layers for use in fuel cells," *Journal of Power Sources*, vol. 171, no. 1, pp. 101–106, 2007

[5]. H. Kim, C. Jae-Won, and R. Wicker, "Scheduling and process planning for multiple material stereolithography," *Rapid PrototypingJournal*, vol. 16, no. 4, pp. 232–240, 2010