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Additive Manufacturing

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Abstract: Additive manufacturing is a recent trend in manufacturing processes due to its many advantages. It can be defined as the process of manufacturing parts by depositing materials layer by layer. It has been a subject of intense study and examination by many scholars. The development of additive manufacturing as a leading technology and its different stages will be discussed. The importance of partial orientation, construction time estimates and cost calculations were also discussed. A notable aspect of this work was the identification of problems associated with different additive manufacturing methods. Due to the imperfections of additive manufacturing, its hybridization with other methods, such as subtraction manufacturing, has been highlighted.

I. INTRODUCTION

The development of industries depends on advanced and innovative research activities associated with manufacturing processes, materials and product design. In addition to the usual demands for lower prices and higher quality, market competition in today's manufacturing industries is associated with the need for complex products, with shorter life cycles, shorter lead times, and more. Shorter delivery, involves customization, and requires fewer skilled workers. In fact, the current product line is very complex and difficult to design. Manufacturing processes can be classified into five categories, namely subtraction, addition, assembly, division and transformation, as shown in Figure 1.[1]

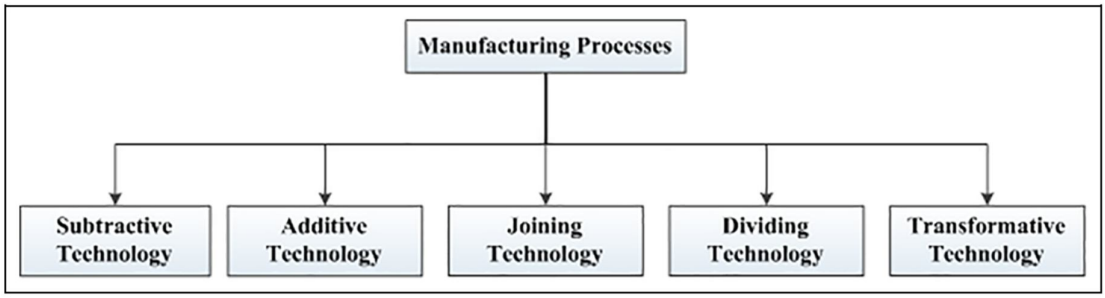

Figure 1. Classification of manufacturing process

- Refraction technology can be defined as a method in which layers of material are removed to produce a desired shape. In the past 20 years, subtraction technologies have undergone a major change. The advent of software for modeling complex three-dimensional (3D) surfaces has replaced traditional code generation, such as G and M codes.
- Additive technology based on adding material layers material to create the desired part shape.
- Combining technologies such as welding involves physically joining two or more parts together to create the required shape.
- Partitioning technology such as sawing is the reverse of the joining process.
- Processing technology, for example, forming, heat treating and freezing cold, using one part to make another, keeping the same mass.

II. ADDITIVE MANUFACTURING

Amplitude Manufacturing (AM) can be described as a method of mixing materials by melting, bonding, or solidifying materials such as liquid resins and powders. Build parts layer by layer using 3D CAD modeling. Describes the AM process using terms such as 3D printing (3DP), rapid prototyping (RP), direct digital manufacturing (DDM), rapid manufacturing (RM), and solid freeform fabrication (SFF). I can do it. The AM process uses 3D computer data or STL (Standard Tessellation Language) files that contain information about the geometry of objects to manufacture components. AM is very useful when production is low, design is complex, and frequent design changes are required. AM has many advantages, but its application is still limited due to its lower accuracy and longer build times than CNC machines. It does not have the same limitations as CNC machining because it divides the part into sections with a resolution that matches the resolution of the process. 2

Still, using the right part orientation can improve accuracy and build time. Optimized component orientation improves accuracy, reduces build time and support, and minimizes component manufacturing costs. Moreover, in contrast to traditional

manufacturing processes, AM consists of additional controllable process parameters and more active interactions between material properties and process parameters. There are different types of AM processes, depending on material preparation, layer formation techniques, phase change phenomena, material types, and application requirements. The AM process contains three main phases: the design phase, the processing phase, and the testing phase, as shown in Figure 2.[3]

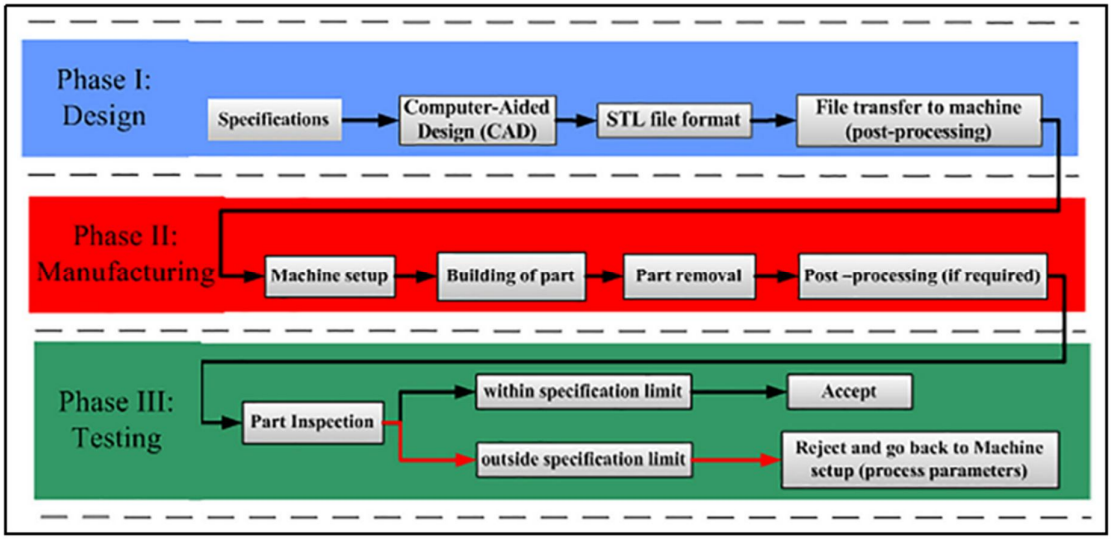

Figure 2. Phases in AM process [3]

III. CLASSIFICATION

A. AM processes or machines can be classified by machine size, nozzle size, nozzle speed and workspace size. AM can be classified in several ways based on the functional framework of the material. Although classification methods may also include prototyping energies, primitive geometries, the nature of the materials used, and the supporting process.[4,5] Figure 3 summarizes available methods for AM based on material type.

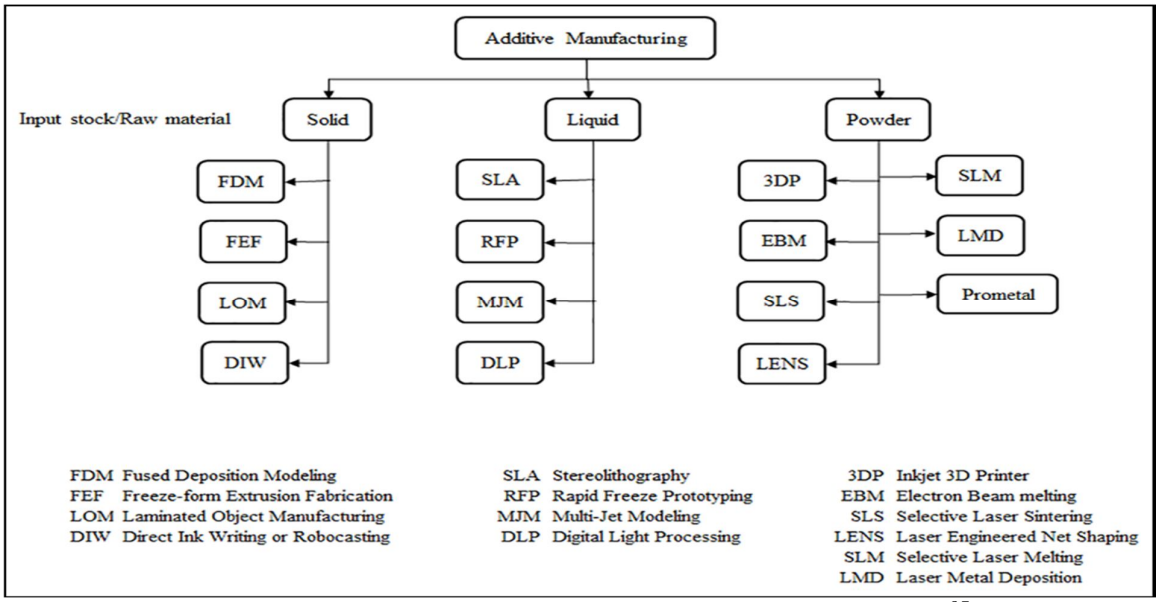

Figure 3. Classification of AM depending on the state of raw material.[6,7]

B. Solid-based AM

AM technology in which the input raw material is solid state has been discussed in this subsection. Among the many solids-based AM technologies available, FDM, Frozen Extrusion Manufacturing (FEF), Laminated Object Manufacturing (LOM), and Direct Ink Capture (DIW) are the most popular.

C. FDM

The operation of FDM, as shown in Figure 4, is based on the principle of layered manufacturing technology.[8] In this technology, the plastic material (in the form of fibers) is extruded through a nozzle, which is heated to melt the material. . Nozzle head moves along the tool path, generated for each layer.

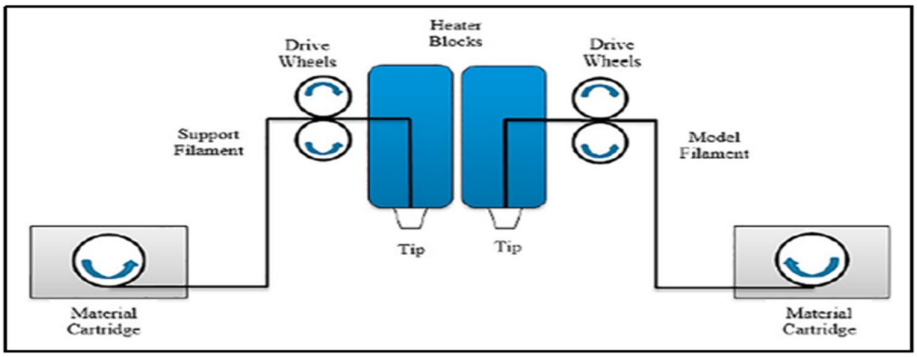

Figure 4. Schematic of FDM

D. FEF

The process was developed at the University of Missouri-Rolla, Rolla, Missouri[9] and works by extruding an aqueous ceramic powder. In this technology, the dough is extruded layer by layer in a building chamber, which is kept at below room temperature to obtain the solids of the dough.

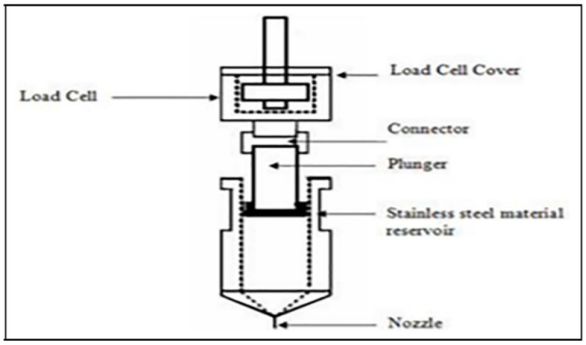

Figure 5. FEF process

IV. CONCLUSION

Progress in manufacturing depends on cutting-edge research tied to manufacturing processes, materials, and product design. As product complexity increases, new and innovative manufacturing processes are needed. AM is a recent trend in the manufacturing process due to the many benefits it offers as well as the challenges it has to overcome. In this work, a comprehensive assessment regarding AF was performed. The importance of partial orientation, construction time estimates and cost calculations were discussed in detail.

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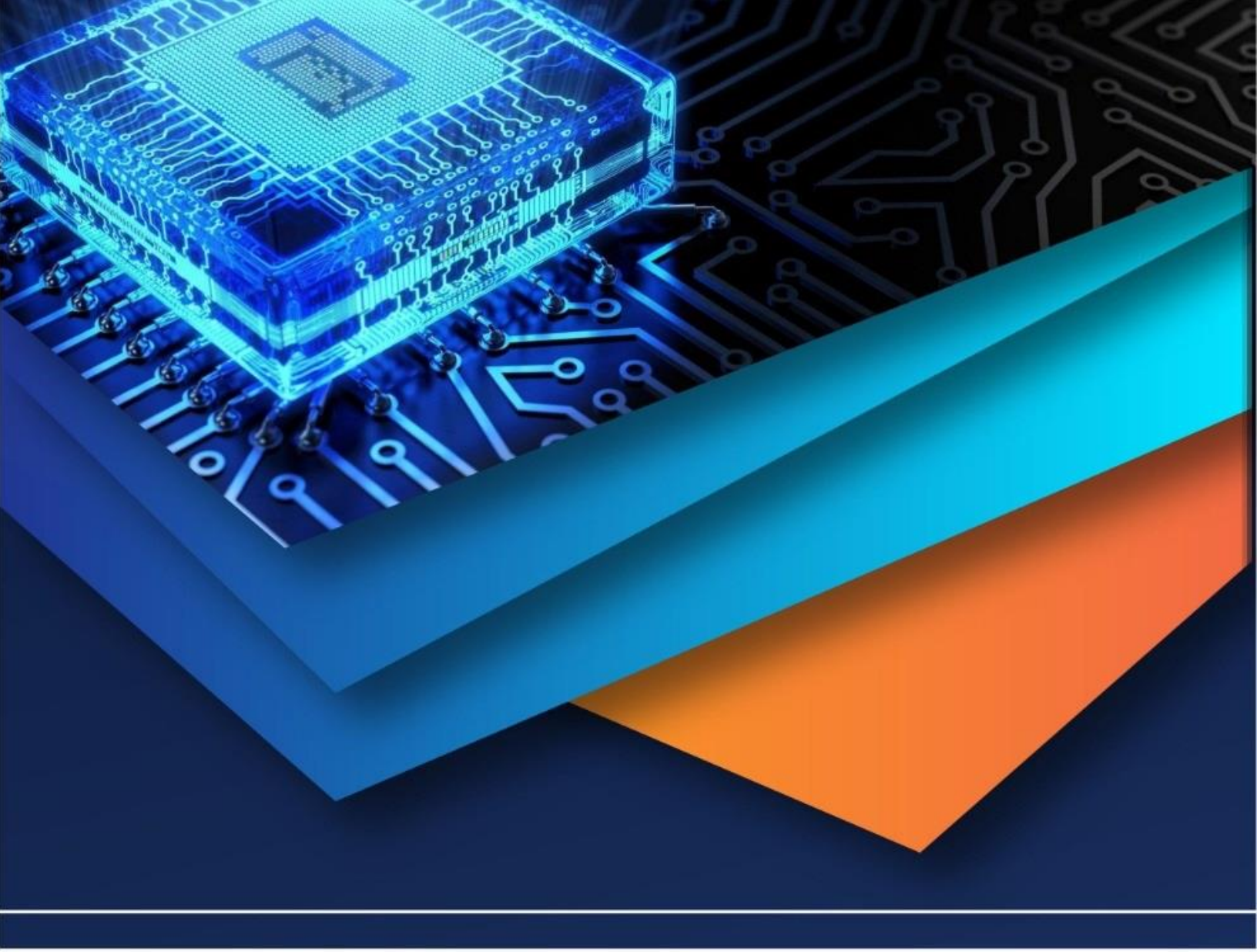

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