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WHAT IS ADDITIVE MANUFACTURING? AND IS IT BETTER THAN CONVENTIONAL MANUFACTURING

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ABSTRACT

This Research paper describes what additive manufacturing is and whether is it any better than conventional manufacturing. This paper represents what additive manufacturing is and it will differentiate between both manufacturing processes. This paper also reviews when each of the manufacturing processes are best suited.

Keywords: Addictive manufacturing; Traditional Manufacturing; Manufacturing; Processes.

INTRODUCTION

Addictive Manufacturing refers to a process which uses 3D design to create the desired part or component. The first additive manufacturing system available was the SLA-1 by 3D Systems[1].3D Printing is also a synonym for Additive manufacturing and is increasingly used term, however the latter is more accurate in that it describes a professional production technique which is clearly differentiates it from conventional methods of material removal[2]. Additive manufacturing makes the component by joining materials layer by layer by using material such as plastic, metal and other composite materials which are in fine powder form. Models with moving part can also be printed such that the pieces are already assembled [1]. Depending on the material used, components can be manufactured using several techniques of which 2 are listed below and explained;

Stereolithography

It's a technique which creates a 3D object layer by layer from bottom to top using photopolymerization, a process which uses light to bond chains of molecule forming polymer which make up the body of a three-dimensional solid [3].

Laser sintering

The technique uses a very powerful laser to sinter powder material (usually metal), targeting at point defined by three-dimensional model, binding the material to form a complete three-dimensional structure.

Addictive Manufacturing has many application ranging from producing models, prototypes to been used in Industries subsectors, including for motor vehicles, aerospace, machinery, electronics and medical products. Technological advances have even resulted in a 3D-Bioprinter that one day might create body parts on demand [1].

Although 3Dprinting allows the manufacturer to make customized and complex parts, slow print speed of the process limits their use of producing large number of parts but then it has allowed the replication of real objects without using expensive molds. It present Original Equipment Manufacturers with an opportunity nearly in all industries sectors to create a

distinctive profile for themselves based on new customer benefits, cost-saving potential and the ability to meet sustainability goals. With many markets turning toward to additive manufacturing, it is little surprise that General Electric (GE) has forecast annual growth of 14 percent for the additive manufacturing until year 2017[4].

Functional Principle and Processes

The Functional Principle starts by spreading a narrow of the powder material to the construction platform. A robust Layer beam then fuses with the powder at the exact location which is defined by the computer and then the platform is lowered and another layer is been applied. Once more the material is fused so as to bond with the layer below at the predefined points by the computer. Addictive Manufacturing processes are divided into 7 classifications which are listed below, each with a different purpose, advantage and disadvantage. These classifications are formulated by a American Society for Testing and Materials (ASTM) group [5].

Material Extrusion

Material is force out of a die where it is heated which is then deposited layer by layer where nozzle can move horizontally and platform can move up and down.

Material Jetting

The working principal is similar to ink-jet printer where the material is jetted onto a construction platform [6].

Binder Jetting

This process need two input material, a binder which usually a liquid and powder based material. The printer head move horizontally in x and y axes of machine where it deposits alternating layers of binder and powder based material.

Sheet lamination

Sheet lamination processes include ultrasonic additive manufacturing (UAM) and laminated object manufacturing (LOM). The Ultrasonic Additive Manufacturing process uses sheets or ribbons of metal, which are bound together using ultrasonic welding [5].

Vat photo polymerization

This process uses vat of liquid polymer resin where it is to construct the model layer by layer and UV light is used to harden the resin. The platform move downward as the object being constructed after each new layer is cured.

Powder bed fusion

It uses laser sintering technique to either melt or fuse material powder together. It requires a vacuum where it could be used with metal or alloys to create functional part. The part is made layer over layer.

Direct Energy Deposition

It one of the most complex printing processes which is usually used to repair or add additional material to existing part or model. It typically consists of nozzle and which could move in multi-axes which deposits melted material over specific surface where it solidifies. A layer or electron beam is used to melt the material.

ADDITIVE MANUFACTURING BENEFITS

Addictive manufacturing has taken over the news for its massive potential in almost every market, including automotive, aerospace, robotics and even toys and it has streamlined traditional manufacturing. Variety in Addictive Manufacturing is free and very simple like for example if something is needed to be changed in the design, the change can simply be made on the original CAD file and the new product can be printed immediately. It also produces very less waste since it only uses material that is required. Moving parts can be easily being printed without any assembly required. Efficiency is one other benefit of Addictive Manufacturing which takes speed, effort, process delay and process step into the consideration. It holds on to its efficiency when production volume is low, changes are frequent and complexity is high [7]. Despite this, many industries are just started to grasp the concept to exactly how transformative the technology will be to the future of manufacturing. It's cheaper and quite fast then other processes. There are very few constrains in Addictive Manufacturing, anything you can imagine and design in CAD Software, can be created with this manufacturing process. Addictive Manufacturing also supports the green manufacturing initiative as this process equates to a smaller environmental footprint [8]. Since it relies on electricity, a very small amount is needed to produce the parts. In fact, parts made using this manufacturing processes like Fused Deposition Modeling, allow many engineers to make solid parts with a semi-hollow honeycomb interior which have very good strength to weight ratio that is almost equal to a solid part. As the technology evolves and becomes more sophisticated and the familiarity develops among mold manufacturers, the additional advantages will further soon reveal themselves.

Into to Conventional Manufacturing

It's one of the oldest manufacturing process known to the mankind. In earlier days, manufacturing was usually carried out by a single skilled craftsman with assistants. Training was through apprenticeship. In most of the pre-industrial world, the guild system was used to protect trade secrets of urban artisans.

Before the Industrial Revolution, most manufacturing occurred in rural areas, where household-based manufacturing served as a supplemental subsistence strategy to agriculture (and continues to do so in places). Entrepreneurs organized a number of manufacturing households into a single enterprise through the putting-out system. Conventional Manufacturing refers to machining, casting and powder metallurgy which provides the highest part quality level and good surface finish with geometrical and dimensional accuracy. Conventional Manufacturing can manufacture metal products as well as wood, plastic, ceramic and other composite products. Conventional Manufacturing is best suited for Mass production. Part of any size and shape can be manufactured by Conventional Manufacturing. Secondary machinery may be required to provide the final shape and size with tighter control on dimensions and surface characteristics.

Comparisons

Products manufactured by addictive manufacturing have poor mechanical properties when compared to Conventional manufacturing since layering in addictive manufacturing might cause defects in the product. It also can produce limited size component whereas conventional manufacturing isn't limited to the size of the component. Addictive manufacturing production process is discontinuous when compared to Conventional manufacturing since parts can only be printed one at a time, preventing economics of scale. Most of the time parts can be made faster than using conventional manufacturing process saving lots of money and lowering the production cost. Addictive manufacturing builds at a very slower rate when compared to Conventional manufacturing since many printers lay down at a speed of one to five cubic inch

per hour, depending on the part needed. One of the major advantage of Conventional manufacturing is Mass production.

CONCLUSION

Addictive Manufacturing is better than conventional Manufacturing in some region while conventional manufacturing is better in the other region. Addictive Manufacturing is cheap but it is not suited for bulk manufacturing since quite slow compared to the conventional manufacturing. For now, Addictive Manufacturing is best suited for prototyping or modeling purposes.

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