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RAPID PROTOTYPING - A NEW CHANGE IN MANUFACTURING TECHNOLOGY

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Abstract —*Due to the continues growth in the manufacturing technology, Additive manufacturing process is one of* the greatest revolution in the world. Since lot of work has already been done and some work is in progress that is *related to3D printing and in same way it is going to bring lot of changes in industries as well in societies. To this statement this review paper or report shows that the rapid prototyping have high caliber to bring changes in manufacturing technologies and its process. Additive manufacturing is simply a method to manufacture 3D object by adding layer upon layer of a particular material with the help of 3Dprinting machine. In other way it can be said that 3D printing is the method of creating 3D object with in quick time and in good manner. Rapid Prototyping machine receives stl format file from the CAD software to make prototype of any object. With the help of Rapid Prototyping machine any kind of complex as well as dense object can be made with in time limit.AM features include designing any object freely, reduce in weight and material wastage, reducing complexity, and many more characteristics in positive manner. Here is a review paper presents the study of 3D printing technology, material used in it ,major software used, applications, and some advantages as well as disadvantages.*

Index Terms—*3D Printing, Materials, Software used, examples, advantages and disadvantages*

I. INTRODUCTION

In 1980's the large scale of 3D printer were used in various flat printing tasks in full and established its status in printing industry. As per the continuous change in printing technology and the development of the computer 3D simulation more and more 3D printing requirement became at large scale. The inkjet equipment were only able to print on the plane material but the printing technology of 3D model is at the exploratory stage. However there are some reports for the theoretical issues in 3D printing research. Flat printer were only able to print on different flat materials like PVC, marble, glass. Also a 5 axis robot was developed by Gazeau Jean Pierre and his partner for printing high resolution pictures from media on vertical wide surfaces. In 3D printing mechanical design and printing control faces from complex challenges. At present there are various device commercially available that are capable to print 3D objects.

II. DEFINATION

Printing can be defined as the task of reproducing text and images typically with ink on paper by a printing press. It consists of only 2D image that can be defined in only two dimensions that is x and y. But 3D printing is the process where 3 dimension are well defined that are x, y, and z axis. 3D printing can be defined as the process of printing or creating any object layer by layer from digital file using filament material.

III. HISTORY

3D printing technologies was came to notice in 1980 by the name of Rapid Prototyping technologies. In 1984 the first printer was developed by Charles Hull and named it as Stereo lithography (SLA). Later Hull cofounded a 3D System Cooperation. 3D System was first commercial rapid prototyping system and SLA 1 was introduced in 1987. The first of this system was sold in 1988. Later in 1987 Carl Deckard was working at the University of Texas made a patent for Selective Laser Sintering (SLS) rapid prototyping process. This patent was issued in 1989. In 1989 Scott Crump a cofounder of Stratasys. Inc filed a patent for Fused Deposition
Modelling. The FDM patent was issued to Stratasys in 1992. Ballistic Particle Manufacturing was patent by William Master, Laminated Object Manufacturing was patent by Michael Feygin, and Solid Ground Curing (SGC) was patent by Itzchak Pomerantz et al. In 1993 MIT used 2D inkjet printing to develop 3D printers and named it as 3D printing techniques. Z Corporation obtained license from MIT in 1995 and started to develop 3D printers. In 2005 Z Corporation launched first high definition color 3D printer. In 2006 RERAP the first open source 3D printer was introduced by Cornell University. The first 3D printer that could produce parts was introduced and UEBEE was great achievement of that. It was first 3D printed car with three wheels and two seats. In 2014, Organovo the pioneer in biological 3D printing company demonstrated that its Human Liver can detect the toxicity of drugs. There are many more inventions the proved 3D printing as most successful technology in present era.

IV. 3D PRINTING METHODS

Stereo Lithography (SLA): - With the help of SLA solid, plastic 3D objects can be created from CAD drawing in few hours. Its uses Vat of liquid UV curable photopolymer resin and a UV laser is used to build parts layer by layer at a time. Each layer is traced by laser beam a part cross-section on the surface of liquid resin. The maximum size of part produced in SLA is 20"x20"x24". Prototypes made are strong enough to be machined and can be used as master patterns for injection molding, thermoforming, blow molding and also in various casting processes. There are no limitations of SLA but this process is expensive. An SLA machine can cost up to $10000 to $400000.

Material Type	Liquid (Photo Polymer)
Material	Principally photo curing polymers which simulate polypropylene, ABS, PBT, rubber; development of ceramic-metal alloys.
Maximum particle size	59.00 x 29.50 x 19.70 in
Min feature size	0.004 in
Min layer thickness	0.0010 in
Tolerance	0.0050 in.
Surface finish & Build speed	Surface finish is smooth and build speed is Average
Applications	Rapid tooling patterns, Snap fits, Very detailed parts, Presentation models, High heat applications

➢ **Fused Deposition Method (FDM)**:- FDM is a solid based rapid prototyping method that extrudes material layer by layer and model is build. In this method thread of filament is fed in to an extrusion head where one end of filament is kept in nozzle that is heated and a semi- liquid state of filament is extruded through a very small hole on to the previous layer of material on bed. And the process continues till the object is completed. The size of part build is 10"x10"x10" and material used are ABS, Casting Wax etc...

Material type	Solid (Filaments)
Material	Thermoplastics such as ABS, Polycarbonate, and Polyphenylsulfone; Elastomers
Maximum part size	36.00 x 24.00 x 36.00 in.
Min feature size	0.005 in.
Min layer thickness	0.0050 in.
Tolerance	0.0050 in
Surface finish & Build speed	Surface finish is rough and build speed is slow
Applications	Rapid tooling patterns, Small detailed parts, Presentation models, Patient and food applications, High heat applications

➢ **Selective Laser Sintering (SLS)**:- SLS is the technique that uses a laser to fuse small particles of thermoplastic, metal, polyamides, ceramic or glass filled with nylon. The size of single made part is 13.3"x13.3"x12". The thickness of individual SLS layer is 0.15 to 0.2mm layer. This process is quite simple. The internal system internal system is heated to lower the melting point of substance that is being used. When heat is applied by the CO2 laser the material get melted and sintered. Two system like platform, a roller, an optical sensor and material is used to form a part.

Material type	Powder (Polymer)
Material	Thermoplastics such as Nylon, Polyamide, and Polystyrene; Elastomers; Composites
Maximum part size	22.00 x 22.00 x 30.00 in.
Min feature size	0.005 in.
Min layer thickness	0.0040 in.
Tolerance	0.0100 in
Surface finish & Build speed	Surface finish is average and build speed is fast
Applications	Rapid tooling patterns, Less detailed parts, Parts with snap-fits & living hinges, High heat applications

➢ **Laminated Object Manufacturing (LOM)**:- LOM uses thin sheets of film. And the laser only cuts the periphery of each layer of sheet. In this process the build material is stretch from the roller one side and the heated roller passes over the paper to fix it to the platform. The laser keeps on cutting the one thickness of paper profile of the layer and the object is created. The

object made using LOM technique are durable , multilayered structures which can be machined, sanded, polished, coated and painted.

Material type	Paper, plastics (Sheets)
Material	Thermoplastics such as PVC; Paper; Composites
Maximum part size	32.00 x 22.00 x 20.00 in.
Min feature size	0.008 in.
Min layer thickness	0.0020 in.
Tolerance	0.0040 in
Surface finish & Build speed	Surface finish is rough and build speed is fast
Applications	Less detailed parts, Rapid tooling patterns

V. METHODOLOGY OF AM

1. A 3D solid model is created with the help of CAD software in computer. Any 3D image can also be downloaded from internet and can be edited as per our requirement and can be used as 3D solid model.
2. CAD file format is later on converted into STL format because AM machine accepts only STL file.
3. Later on STL file is send to AM machine.
4. Machine should be properly setup before the building process starts.
5. Further manufacturing process start and it fully automated process.
6. Once the part is complete it is removed from machine and send for post processing.

VI. SOFTWARE USED IN 3D PRINTNG

1.BLENDER	9. ZBRUSH	17.SCULPTRIS
2.SKETCHUP	10. CINEMA 4D	18. GRASSHOPPER
3.SOLIDWORKS	11.123D DESIGNS	19.FREECAD
4.AUTOCAD	12.RHINOCEROS	20.OPEN SCAD
5.MAYA	13.MODO	21.MOL3D
6.3DS MAX	14.FUSION 360	22.3DTIN
7.INVENTER	15. MESHMIXER	23.WINGS 3D
8.TINKERCAD	16.LIGHTWAVE	24.K-3D and BRL-CAD

VII. MATERIALS USED IN 3D PRINTING

All kind of materials can be used for manufacturing with 3Dprinting techniques; from sand to metals, ceramics, food, living cells and plastics. Especially plastics are used in the 3D printers at home (extrusion process) and may have their origin from either a fossil fuel or a bio-based feedstock (see next chapter for an overview).
In 3D printing a whole range of (bio) plastics is under development combined with (bio) additives to create special properties. For 3D printing, the main characteristics of interest are melting temperatures, melting viscosity and coagulation time.

VIII. ADVANTAGES OF AM

1. Any complex geometry part can be manufactured with in short period of time.

2. Variety of object can be printed using this technology.

3. Lead time to make any part is very less as comparison to other technology.

4. Even students in school can print their own complex objects way having little knowledge of this technology.

5. Wastage of material is very less.

IX. DISADVANTAGES OF AM

1. Production cost is very high.

2. Require post processing that increases cost.

3. It is discontinuous production process since the part can be built at once.

4. Larger machines are required to build large part that may require costly setup.

5. Printing speed is slow since printers may lay down material at a speed of 1 to 5 cubic inches per hour.

X. CONCLUSION

3D printing technology is a big revolution in manufacturing industry and can reshape the world. It can widely change the way of manufacturing products and method worldwide. It has lots of benefit to society and there is decrease in product development cycle and its costs. Every technical information about 3D printing couldn't be possible to share under this topic. 3D printing is solution to every problem in manufacturing industry and it is limit less technology.

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