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Overview of 3d Printing Technology for Rapid Prototyping

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Abstract: ***3D printing is a form of additive manufacturing technology where a three dimensional object is created by laying down successive layers of material. It is also known as rapid prototyping, is a mechanized method whereby 3D objects are quickly made on a reasonably sized machine connected to a computer containing blueprints for the object.3D printing is the process of being able to print any object layer by layer. The current generation of 3d printers typically requires input from a CAD program in the form of an STL file, which defines a shape by a list of triangle vertices. The vast majority of 3d printers use two techniques, FDM (Fused Deposition Modelling) and PBP (Powder Binder Printing).FDM works on an "additive" principle by laying down material in layers. One advanced form of 3d printing that has been an area of increasing scientific interest the recent years is bio printing. Cell printers utilizing techniques similar to FDM were developed for bioprinting. These printers give us the ability to place cells in positions that mimic their respective positions in organs.3D printing can speed up production. Prototypes can be made quickly this way. Prototypes can also be made in a less expensive way with 3D printing. By applying3D printing of structural electronics to expedite prototyping, the development cycle was reduced from weeks to hours.***
Keywords: ***Rapid Prototyping, 3D printing, additive manufacturing, CAD program***

I. INTRODUCTION

3D printing is a form of additive manufacturing technology where a three dimensional object is created by laying down successive layers of material[3]. In contrast to abrasive processes such a milling, drilling, grinding eroding etc. in which the form is shaped by material removing, in 3D printing the part is formed by joining volume elements[2]. It is also known as rapid prototyping. It is a mechanized method whereby 3D objects are quickly made on a reasonably sized machine which is connected to a computer containing blueprints of the object. A new device idea is initially prototyped in order to evaluate the fit and finish of the final part as well as to optimize the fabrication process to identify difficulties in manufacturing. These are time-consuming and expensive process. In addition to prototypes, RP techniques can also be used to make tooling (referred to as rapid tooling) and even production-quality parts (rapid manufacturing). 3D printing is a revolutionary method for creating 3D models with the use of inkjet technology.

II. LITERATURE SURVEY

The author P. F. Jacobs[1] describes the Rapid Prototyping (RP) is a new forming process which fabricates physical parts layer by layer under computer control directly from 3D CAD models in a very short time. In contrast to traditional machining methods, the majority of rapid prototyping systems tend to fabricate parts based on additive manufacturing process, rather than subtraction or removal of material.
The author D. T. Pham & et al.[2] describes an overview of the current technologies and comments on their strengths and weaknesses. Data are given for common process parameters such as layer thickness, system accuracy and speed of operation.
The author D. King & et al.[4] describes Rapid prototyping techniques are capable of producing prototypes of very complex part geometry directly from three-dimensional CAD software in a wide variety of materials such as polymer, wax, and paper without the benefit of specially designed tooling or fixturing. Rapid tooling is enabling art to production of quality parts and accelerating time to market by concentrating on the tool rather than the part.

III. RAPID PROTOTYPING TECHNIQUES

Rapid prototyping is the fabrication of parts from CAD data sources. Several rapid prototyping methods have been created to produce objects of complex geometries in a relatively short amount of time. These systems are beneficial to engineers by

allowing them to better understand the products that they are designing and by providing them with a way to create a visual aid to communicate with others. Following are the techniques used in 3D printing.

A. *Stereo Lithography*

Stereolithography is the very first technique that started the rapid prototyping revolution. The technique builds three-dimensional models from liquid photosensitive polymers that solidify when exposed to ultraviolet light [1]. The model is built upon a platform situated just below the surface in a vat of liquid epoxy or acrylate resin. A low-power highly focused UV laser traces out the first layer, solidifying the model's cross section while leaving excess areas liquid[2]. Then an elevator incrementally lowers the platform into the liquid polymer. A sweeper re-coats the solidified layer with liquid, and then the laser traces the second layer atop the first [6]. This is repeated until the prototype is completed.

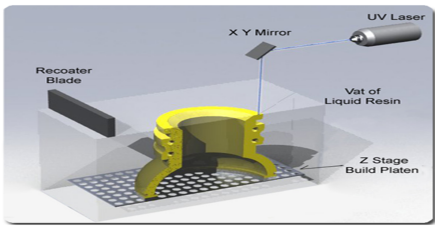

Fig: Stereo lithography

B. *Fused Deposition Modelling*

In this technique, filaments of heated thermoplastic are extruded from a tip that moves in the x-y plane. The controlled extrusion head deposits very thin beds of material onto the build platform to form the first layer[3]. The thermoplastic quickly hardened by maintaining the temperature of platform. Then extrusion head deposits second layer atop of first layer and so on. This process is continued till the model is completed.

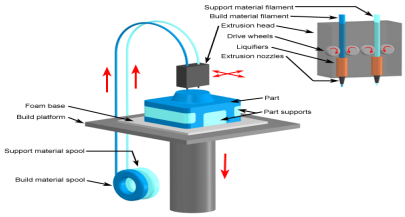

Fig : Fused deposition modelling

C. *Selective Laser Sintering*

This technique uses a laser beam to selectively fuse powdered materials. The materials are used in this techniques are nylon, elastomer, and metal etc. [4] Parts are built upon a platform which sits just below the surface in a bin of the heat-fusable powder. A laser traces the pattern of the first layer, sintering it together. The platform is lowered by the height of the next layer and powder is reapplied [2].This process continues until the part is complete. Excess powder in each layer helps to support the part during the build.

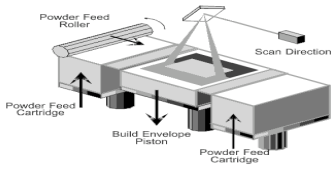

Fig : Selective Laser Sintering

D. Electron Beam Melting

This technique manufactures parts by melting metal powder layer per layer with an electron beam in a high vacuum [6]. Unlike some metal sintering techniques, the parts are fully dense, void-free, and extremely strong. The EBM machine reads data from a 3D CAD model and lays down successive layers of powdered material. These layers are melted together utilizing a computer controlled electron beam

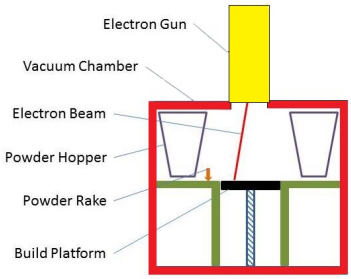

Fig : Fused deposition modelling

IV. THE BASIC PROCESS OF 3D PRINTING

Create a CAD model of the design
Convert the CAD model to STL format
Slice the STL file into thin cross-sectional layers
Construct the model one layer atop another
Clean and finish the model

V. ADVANTAGES OF RAPID PROTOTYPING

A. Speed

The time spent using rapid prototyping techniques has decreased by as much as 90% compared to other prototype methods. Conventional prototyping processes can take days but with rapid prototyping, the same model parts can be made within hours.

B. Time To Market

The faster a prototype is created, the quicker designers and engineers can analyse it for design flaws and make necessary adjustments. The next step after making these adjustments is manufacturing. A 60 to 90 percent reduction in prototype creation has a direct impact on how quickly companies can release their products to market.

C. *Cost Savings/Reduction*

Creating the tooling for injection molding prototypes is not only laborious, but expensive. In addition, tooling can only be used for creating that particular part. Rapid prototyping systems build parts in an additive, layer-by-layer manner. These systems can be used over and over again to build a variety of different parts within their build size.

VI. DISADVANTAGES OF RAPID PROTOTYPING

Current 3D printing materials for investment casting tend to yield sporadically rough surfaces.
It may not be suitable for large sized applications.
3-D printers are still expensive.
Although 3-D printers have the potential of creating many jobs and opportunities, they might also put certain jobs at risk
3D printed parts have a ribbed and little rough appearance due to layering beads of plastic.
May it seems to be a slow process for large build volume parts.

VII. APPLICATION OF 3D PRINTING

A. Art

3D printing allows artists to create objects that would be incredibly difficult, costly, or time intensive using traditional processes.

B. Jewelry

Jewelry makers were some of the first to use 3D printing in their manufacturing process

C. Prototypes

Prototyping in product development is currently the biggest use of 3D printing technology. These machines allow designers and engineers to test out ideas for dimensional products cheaply before committing to expensive tooling and manufacturing processes.

D. Models

we can build complicated models with the help of 3D printing in order to illustrate it more effectively.

VIII. CONCLUSION

Rapid Prototyping is one of the fastest growing new technologies of manufacturing the various products by adding the material in layer by layer and directly from the 3D CAD model connected with the automated machine. This paper provides a platform for researchers, new learner to create an awareness of rapid prototyping and manufacturing technology for creating the complicated and different contour products in various field of applications

IX. FUTURE SCOPE

The future for 3D printing seems very promising; it is the fastest growing part of the rapid-prototyping industry. Many industries are showing huge amounts of interest and are seem great potential in different applications where they could utilize three dimensional printing. Also NASA has requested a high resolution machine to manufacture crucial parts in space. One ultimate goal is printable organic parts, for example replacement organs, identical skin grafts and even limbs, to combat victims of illness, disease and war. 3D printers may also be used to make future buildings.

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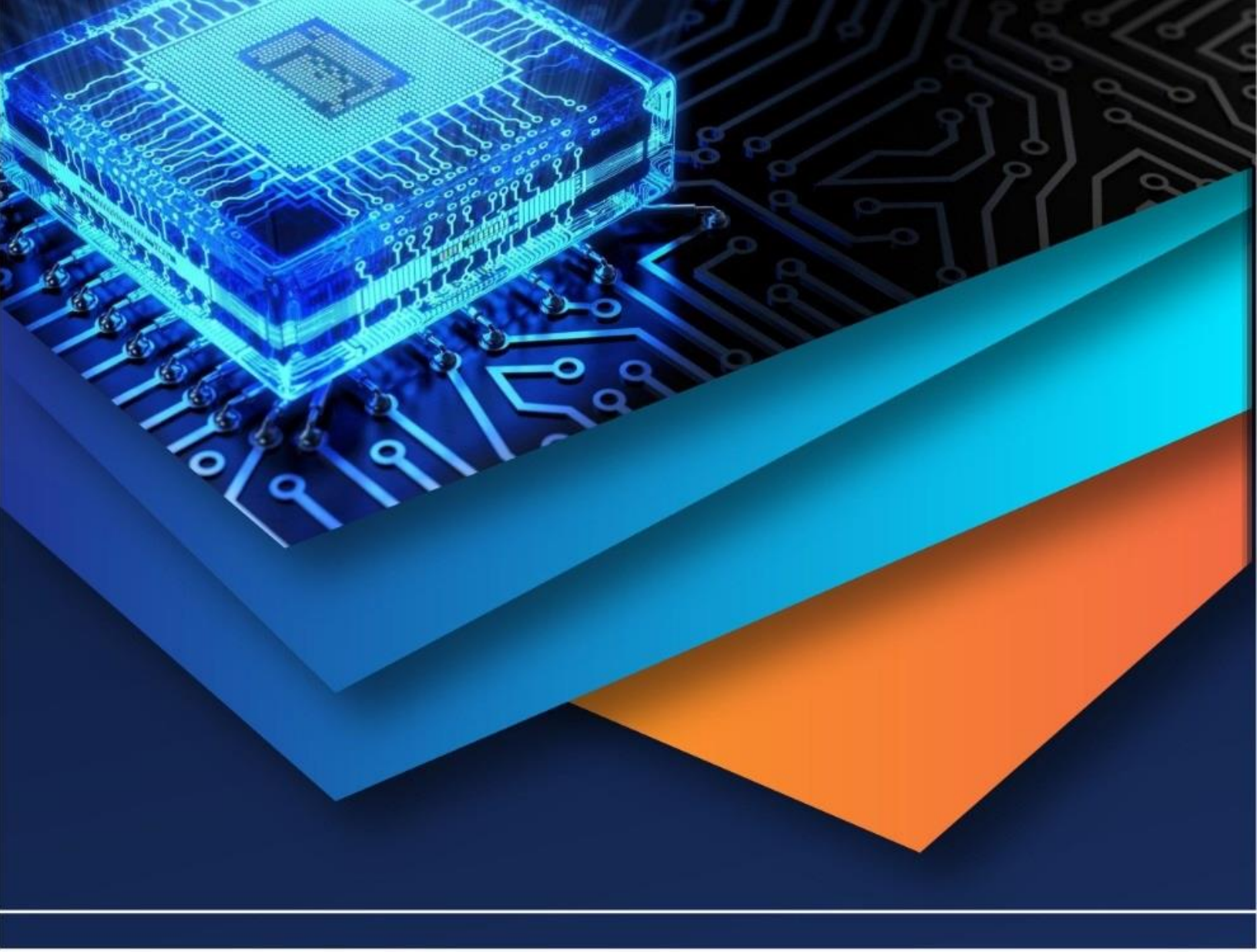

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