Rapid Manufacturing Process- 3D Printing Technology Advantages, Disadvantages and Applications

Suryavanshi Akash Vijay[1] Maner Shadab Shakil[2] Mr. Prashant. M. Patil[3]
[1,2]Student [3]Lecturer
[1,2,3]Department of Mechanical Engineering
[1,2,3]Sanjay Ghodawat Polytechnic, Atigre, India

Abstract— 3D Printing is a modern manufacturing technology. There are various types of manufacturing processes like casting, rolling, forming, molding, machining etc. In which machining process of material removal from raw material and obtaining the required shape. But 3D printing technology works on principle of material addition. 3D printing is also known as additive manufacturing process (AM). This technology is mainly used for making prototypes. It is a type of rapid manufacturing processes therefore production rate is fast in 3D printing.
Key words: 3D Scanners, 3D Printing Technology

I. INTRODUCTION

This method is a type of Rapid manufacturing processes. 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file.

The creation of a 3D printed object is achieved using additive processes. In which an object is created. Each of these layers can be seen as a thinly sliced horizontal cross-sedative process an object is created by laying down successive layers of material until section of the eventual object.

A. How does 3D Printing Work?

It all starts with making a virtual design of the object you want to create. This virtual design is for instance a CAD (Computer Aided Design) file. This CAD file is created using a 3D modeling application or with a 3D scanner (to copy an existing object). A 3D scanner can make a 3D digital copy of an object.

B. 3D Scanners

3D scanners use different technologies to generate a 3D model. Examples are: time-of-flight structured/ modulated light, volumetric scanning and many more. Recently, companies like Microsoft and Google enabled their hardware to perform 3D scanning, for example Microsoft's Kindest. In the near future digitizing real objects into 3D models will become as easy as taking a picture. Future versions of smartphones will probably have integrated 3D scanners.

C. 3D Modeling Software

3D modeling software also comes in many forms. There's industrial grade software that costs thousands a year per license, but also free open source software, like Blender, for instance. When you are a beginner and the amount of choices are a bit overwhelming, we recommend starting with Tinkercad. Tinkercad has a free version and it works in browsers that support WebGL, for instance Google Chrome. They offer beginner lessons and have a built in option to get your object printed via various 3D printing services. When you have a 3D model, the next step is to prepare it in order to make it 3D printable.

D. From 3D model to 3D Printer

You will have to prepare a 3D model before it is ready to be 3D printed. This is what they call slicing. Slicing is dividing a 3D model into hundreds or thousands of horizontal layers and needs to be done with software.

Sometimes a 3D model can be sliced from within a 3D modeling software application. It is also possible that you are forced to use a certain slicing tool for a certain 3D printer. When the 3D model is sliced, you are ready to feed it to your 3D printer. This can be done via USB, SD or Wi-Fi. It really depends on what brand and type 3D Printer you have. When a file is uploaded in a 3D printer, the object is ready to be 3D printed layer by layer. The 3D printer reads every slice (2D image) and creates a three dimensional object.

II. MATERIAL USED FOR 3D PRINTING

A. FDM Thermoplastics

FDM technology works with production grade thermoplastics to build tough, durable parts that accurate, repeatable and stable over time.

B. Poly Jet Thermo polymers

Poly jet polymers offer fine details along with the final products realism surpassing all other 3D printing technologies. They exhibit a chameleon like ability to simulate clear, flexible and rigid material and engineering plastics and even combine many colors and material properties into one model. Specifically materials include bio-compatible and dental.

III. PROCESSES AND TECHNOLOGY

Not all 3D printers use the same technology. There are several ways to print and all those available are additive, differing mainly in the way layers are built to create the final object. Some methods use melting or softening material to produce the layers. Selective laser sintering (SLS) and fused deposition modeling (FDM) are the most common technologies using this way of 3D printing. Another method is when we talk about curing a photo-reactive resin with a UV laser or another similar power source one layer at a time. The most common technology using this method is called stereo lithography (SLA).

To be more precise: since 2010, the American Society for Testing and Materials (ASTM) group "ASTM F42 – Additive Manufacturing", developed a set of standards that classify the Additive Manufacturing processes into **7** categories according to Standard Terminology for

Additive Manufacturing Technologies. These seven processes are:

- Vat Photo polymerization
- Material Jetting
- Binder Jetting
- Material Extrusion
- Powder Bed Fusion
- Sheet Lamination
- Directed Energy Deposition.

A. *Process*

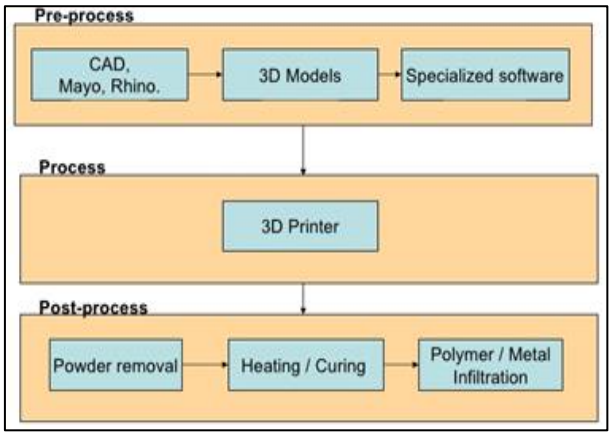

Fig. 1: Work Flow

A virtual design of the object is created. CAD (Computer Aided Drafting) uses a 3D modeling program or 3D scanner for virtual design. The software slices the final model into hundreds or thousands of horizontal layers. The printer creates the object layer by layer, resulting in one three dimensional object.

B. *Material Extrusion Method*

It is an additive manufacturing technology used for modeling, prototyping and production applications. In this method material injecting nozzle is used for applying successive layers of material. Here bed (saddle) is provided for required direction, while manufacturing.

This process is very similar to cake designing by cone which is filled with cream. Here by applying pressure on cone, we obtain layers of cream. Exactly this principle is used in material extrusion method.

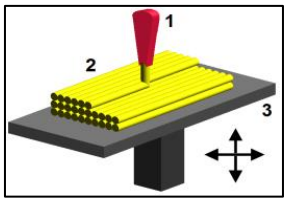

Fig. 2: Process of 3-D Printing

- Nozzle ejecting plastic
- Deposited material (modeling part)
- Controlled movable table

In above fig shows plastic injecting nozzle, this produces successive layers of plastic.

For manufacturing the job moving bed (saddle) is provided, which can move as required. Here height of the job built by applying successive layers, therefore at the time of manufacturing vertical movement of bed is not required.

IV. Applications of 3D printing

Applications include rapid prototyping, architectural scale models & Marquette, healthcare (3D printed prosthetics and 3D printing with human tissue) and entertainment (e.g. film props).

Other examples of 3D printing would include reconstructing fossils in paleontology, replicating ancient artifacts in archaeology, reconstructing bones and body parts in forensic pathology and reconstructing heavily damaged evidence acquired from crime scene investigations.

A. *Industrial 3D Printing*

In the last couple of years the term 3D printing has become more known and the technology has reached a broader public. Still, most people haven't even heard of the term while the technology has been in use for decades. Especially manufacturers have long used these printers in their design process to create prototypes for traditional manufacturing and research purposes. Using 3D printers for these purposes is called rapid prototyping.

B. *Aerospace & Aviation Industries*

The growth in utilization of 3D printing in the aerospace and aviation industries can, for a large part, be derived from the developments in the metal additive manufacturing sector. NASA for instance prints combustion chamber liners using selective laser melting and as of march 2015 the FAA cleared GE Aviation's first 3D printed jet engine part to fly: laser sintered housing for a compressor inlet temperature sensor.

C. *Bio-Printing*

As of the early two-thousands 3D printing technology has been studied by biotech firms and academia for possible use in tissue engineering applications where organs and body parts are built using inkjet techniques. Layers of living cells are deposited onto a gel medium and slowly built up to form three dimensional structures. We refer to this field of research with the term bio printing.

D. *Medical Industry*

The outlook for medical use of 3D printing is evolving at an extremely rapid pace as specialists are beginning to utilize 3D printing in more advanced ways. Patients around the world are experiencing improved quality of care through 3D printed implants and prosthetics never before seen. This technique was invented in 1986 by Charles Hull, who also at the time founded the company, 3D Systems.

1) *Advantages of 3D Printing*

- This technology is tool- less which reduces the maintenance cost.
- Sustainable / environment friendly.
- Quick production.
- Less waste of raw material.
- Better quality.
- Less manufacturing cost.

2) *Disadvantages of 3D Printing*

- Limited materials like non-metals only can be used.
- Size limitations are in 3D printing.
- Manufacturing limits are there. Such as every 3D printed object cannot be used in real applications.

V. CONCLUSION

3D printing is one of the fastest manufacturing methods available in engineering field. 3D printing is mainly used for prototype making. Due to 3D printing technology various designs of jobs can be manufacture in less time. But we can use only non-metals for 3D printing technology, therefore large size components cannot be manufacture by this technology.

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