

Role of 3D Printer in Additive Manufacturing

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Abstract - Additive Manufacturing is the process in which the material is added layer by layer to make the final prototype/product. Additive manufacturing (AM) is the latest technology that could improve the manufacturing process by building up thin layers of materials from digitized three-dimensional (3D) designs virtually constructed using advanced CAD software. This technique offers the creation of new types of objects with unique material properties. A massive media and public interest in the technology has led to the latest state of the art of exploring the technology for applications beyond the scope of the traditional engineering industry.

Key Words: Additive manufacturing processes, prototype, 3D printing, rapid manufacturing, Material extrusion, STL file, slicing.

1.INTRODUCTION ADDITIVE MANUFACTURING

In additive manufacturing, an object is made by building it layer by layer, which is different from subtractive manufacturing, which involves cutting away a solid block of material to create a finished product. Although technically, this process can be used to create various types of products, such as molds, it is mainly referred to as 3-D printing. During the 1980s, additive manufacturing was used to develop prototype products, which were usually not functional. This process was referred to as rapid prototyping, as it allowed individuals to create a scale version of their finished product in just a couple of hours. The rise of additive manufacturing led to the development of rapid tooling, which enables the creation of molds for final products. By the 2000s, it had become widely used to create functional goods. Some of the companies that have started using this technology include General Electric and Boeing.

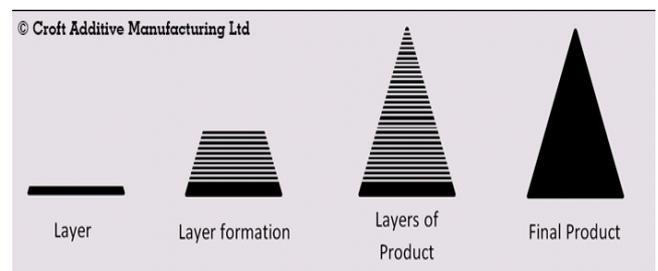


Fig - 1: Layers of Additive Manufacturing

1.1 Types of Additive Manufacturing Processes

1. Binder Jetting.
2. Directed Energy Deposition (DED)
3. Material Extrusion.
4. Powder Bed Fusion (PBF)
5. Sheet Lamination.
6. Vat Polymerization.
7. Material Jetting.



Fig - 2: Types of Additive Manufacturing Processes

2. INTRODUCTION TO MATERIAL EXTRUSION

Using the additive manufacturing (AM) technique of material extrusion, a spool of material (typically thermoplastic polymer) is driven through a heated nozzle and selectively positioned layer by layer to create a 3D object. Fused filament fabrication (FFF) and fused deposition modelling (FDM) are two examples of material extrusion processes. Material extrusion is frequently slower and less accurate than other types of additive manufacturing. However, the technology for material extrusion and the relevant raw materials, including nylon and ABS plastic, are readily accessible and inexpensive. As a result, material extrusion is the approach that home 3D printing hobbyists most frequently employ. In manufacturing and industrial settings, material extrusion is widely used to produce inexpensive, rapid prototypes for various versions of the same thing.

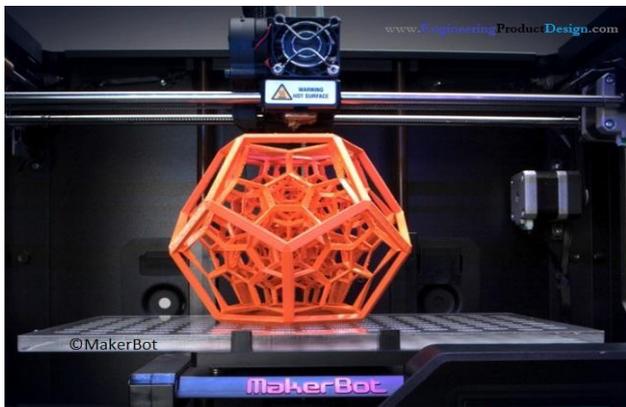


Fig - 3: Material Extrusion

Advantages

- A wide selection of print media.
- A straightforward printing procedure.
- A straightforward and user-friendly technique of switching materials.
- Low startup and recurring costs.
- An equivalent decrease in print time for tiny and thin items.
- A +/- 0.1 (+/- 0.005") tolerance for printing errors.
- No supervision is required.
- The equipment is smaller than other AM processes.
- The process temperature is comparatively low.

Disadvantages

- Apparent layer lines
- If the extrusion head stops moving, the material will bump.

- Supports could be needed.
- Z-axis component strength is subpar (perpendicular to build platform)
- Print time is increased by greater area and finer resolution.
- Prone to delamination and other problems caused by temperature fluctuations
- Hazardous print media

3. ACTUAL WORKING

In the process of additive manufacturing, a 3D picture is first created using software like CAD, Catia, etc. After that, this file is transformed into an STL file. Stereolithography is referred to as an STL file or Standard Triangle Language. A set of connected triangles 3D models or an object's surface geometry is described in each file. More triangles are employed, and the resolution is higher as the design becomes more complicated. We enter the image into the slicer after obtaining the surface geometry. Slicer is a go-between for a 3D CAD model and a 3D printer.

The 3D CAD model will be stored in one of the file formats, typically STL. A slicer does what its name implies: it slices the 3D model. It specifies the tool path that the printer should use to properly print each layer of the sliced model and how each layer should be produced. A slicer is a component of 3D printing software that connects virtual and physical models. The digital model is converted into G-code, the printing instructions, via the 3D printing slicer software. The printer receives these instructions and, in response, until the object is finished.



Fig - 4: Working Process

4. INTRODUCTION TO MACHINE

4.1 What is 3D Printing?

Additive manufacturing, sometimes known as 3D printing, creates solid, three-dimensional objects from digital files. 3D-printed things are made possible through additive manufacturing technology. An additive process produces an object by gradually adding components until the desired

result is achieved. A cross-section of the object that has been thinly cut can be imagined in each of these layers. For example, a milling machine can be used to hollow out or cut out a piece of metal or plastic. Subtractive manufacturing is the alternative to additive manufacturing. When compared to conventional production techniques, 3D printing uses less material to create complicated designs.

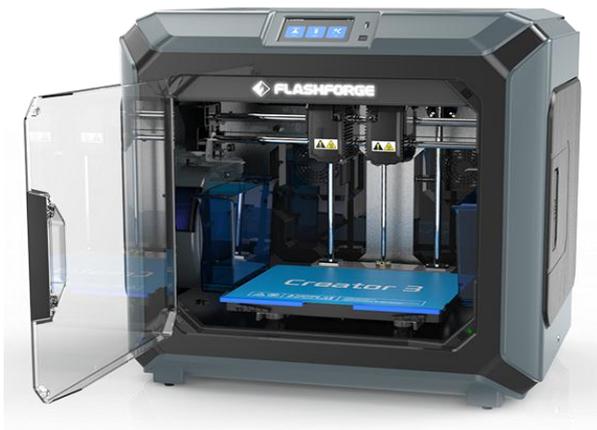


Fig – 5: 3D Printing Module



Fig – 6: Touch Screen



Fig – 7: Heatable Build Plate

4.2 How Does 3D Printing Work?

- A 3D model is where it all begins.
- A 3D model can be downloaded or developed totally from scratch.

4.3 3D Software

Software instruments come in a wide variety, ranging from open source to commercial quality. On our page for 3D software, we have a summary produced. Tinker pad is a common place where we advise beginners to start. You don't need to install Tinker Cad on your computer because it is free and operates in your browser. Tinker Cad features built-in functionality to export your model as a printable format, such as an STL or OBJ, and it also gives introductory lessons. The following step is to get the printable file ready for your 3D printer. We refer to this as slicing.

Slicing: From printable file to 3D Printer

With the use of slicing software, a 3D model is basically divided into hundreds or thousands of layers. Your file is ready to be sent to your 3D printer after it has been sliced. Through USB, SD, or Wi-Fi, you can send the file to your printer. Now that it has been divided into layers, your file is prepared for 3D printing.

5. MATERIALS

ABS (acrylonitrile butadiene styrene)

- Tough and durable
- Heat and impact resistant
- Requires a heated bed to print
- Requires ventilation

PLA (polylactic acid)

- The easiest FDM materials to print
- Rigid, strong, but brittle
- Less resistant to heat and chemicals
- Biodegradable
- Odorless

PETG (polyethylene terephthalate glycol)

- Able to print at lower temperatures for quicker output
- Humidity and chemical resistant
- High Transparency
- Can be food safe

Nylon

- Strong, durable, and lightweight
- Tough and partially flexible
- Heat and impact resistant

- Very complex to print on FDM

TPU (thermoplastic polyurethane)

- Flexible and stretchable
- Impact resistant
- Excellent vibration dampening

PVA (polyvinyl alcohol)

- Soluble support material
- Dissolves in water

HIPS (high impact polystyrene)

- The most typical soluble support material for ABS
- Dissolves in chemical limonene

Composites (carbon fiber, kevlar, fiberglass)

- Rigid, strong, or extremely tough
- Only a few pricey industrial FDM 3D printers are compatible.

6. APPLICATIONS

- Aerospace
- Medical
- Transportation
- Energy
- Consumable Products

7. CASE STUDY

1. Stroke IC Engine



Fig – 8: Stroke IC Engine

Engine is the machine used for converting any form of energy into motion and mechanical force. The engine has connecting rod, piston, crankshaft, cylinder, flywheel, spark plug, inlet and outlet ports. 2 stroke engine has 4 strokes known as Suction, Compression, Expansion, Exhaust. It is the engine which completes its cycle in 2 revolution and has its 1 stroke of 90 degree. A two-stroke (or two-stroke cycle) engine is a type of internal combustion engine that performs two piston strokes (up and down movements) throughout a power cycle, which is finished in one crankshaft revolution. A power cycle in a four-stroke engine involves four piston strokes over the course of two crankshaft revolutions. In a two-stroke engine, the intake and exhaust (or scavenging) activities happen simultaneously at the end of the combustion stroke and the start of the compression stroke.

Due to the power being accessible in a constrained range of rotational speeds known as the power band, two-stroke engines frequently have a high power-to-weight ratio. Two-stroke engines have fewer moving components than four-stroke engines.

2. Impeller



Fig – 9: Impeller

A centrifugal pumps impeller is a revolving part that accelerates fluid away from its center of rotation, transferring energy from the pump's motor to the fluid being pumped.

A part of pump or compressor known as an impeller rotates quickly and serves as a propeller to increase a fluid's pressure and flow rate. Impellers are made of plastic and other metals, such as steel, iron and bronze. Because of the fluid's energy transfer from the impeller as it travels through the pump, the fluids velocity raises at the discharge outlet.

There are three types of impellers:

- Open impeller
- Closed impeller
- Semi-open impeller

The rotational speed of an impeller is commonly expressed in revolutions per minute (rpm). A fluid (a liquid or a gas) is driven down a tube at an increased pressure, and an impeller increases the velocity of the fluid. Fluids and gases are frequently transported over great distances in pipes by pumps and compressors that include impellers.

3. Jaw Chuck



Fig – 10: Jaw Chuck

A specific type of clamp known as a "chuck" is made to hold radially symmetrical items, most notably cylinders. A chuck holds the revolving tool in a drill, mill, and transmission; in a lathe, it holds the rotating workpiece.

Jaws are frequently used by chucks to grip the tool or workpiece. The jaws, which are often referred to as "dogs," are typically organized in a radially symmetrical arrangement similar to a star's points. Some jawed chucks, which offer convenience at the sacrifice of gripping force, can be tightened or loosened by hand force alone. Certain jawed chucks, however, may require the use of a wrench-like tool called a chuck key. Certain lathes' chucks include jaws that can move independently, enabling them to grasp objects of odd shapes. More jaws, more jaws, or quick-release mechanisms are examples of more sophisticated designs.

Collets, which are flexible collars or sleeves that wrap snugly around the tool or workpiece and grab it when squeezed, may be used in place of jaws in a chuck instead of magnetism, vacuum, or collets.

8. FAILURE

When we were preparing the assembly of 2 stroke IC engine we failed many times. As it is a sectional view while printing it needs the support. While making layer, if the circle is vertical, it needs the support, and if it is horizontal, it doesn't need support.

While printing cylinder vertically the support needed to it, because of that support there is a chance to get gap between

the layers. If G codes are not generated properly the problem may occur in printing.



Fig – 11: Jaw Chuck

9. CONCLUSION

One of the most modern technology in manufacturing by which the product is built layer by layer. While studying about the 3D printer we made some of the prototypes like 2 stroke engine, Impeller and 3 jaw chuck. By making the prototypes we also come to know about the working of 2 stroke engine and mechanism of 3 jaw chuck. We are fortunate to have the 3D printer available in our college. As there was ANNUM NATIONAL LEVEL PAPER PRESENTATION competition because of 3D printer we have come to know the actual 3D printing process. As the other colleges students had no chance to recognize or to get chance to work on it. We are more fortunate to have the actual 3D printer in our college.

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