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3D Printing (Rapid Prototyping)

1) Introduction:

General explanation of 3D Printing: A method of manufacturing known as 'Additive manufacturing', due to the fact that instead of removing material to create a part, the process adds material in successive patterns to create the desired shape.

Main areas of use:

· Prototyping

· Specialized parts – aerospace, military, biomedical engineering, dental

· Hobbies and home use

· Future applications– medical (body parts), buildings and cars

3D Printing uses software that slices the 3D model into layers (0.01mm thick or less in most cases). Each layer is then traced onto the build plate by the printer, once the pattern is completed, the build plate is lowered and the next layer is added on top of the previous one.

Typical manufacturing techniques are known as 'Subtractive Manufacturing' because the process is one of removing material from a preformed block. Processes such as Milling and Cutting are subtractive manufacturing techniques. This type of process creates a lot of waste since; the material that is cut off generally cannot be used for anything else and is simply sent out as scrap.

3D Printing eliminates such waste since the material is placed in the location that it is needed only, the rest will be left out as empty space.

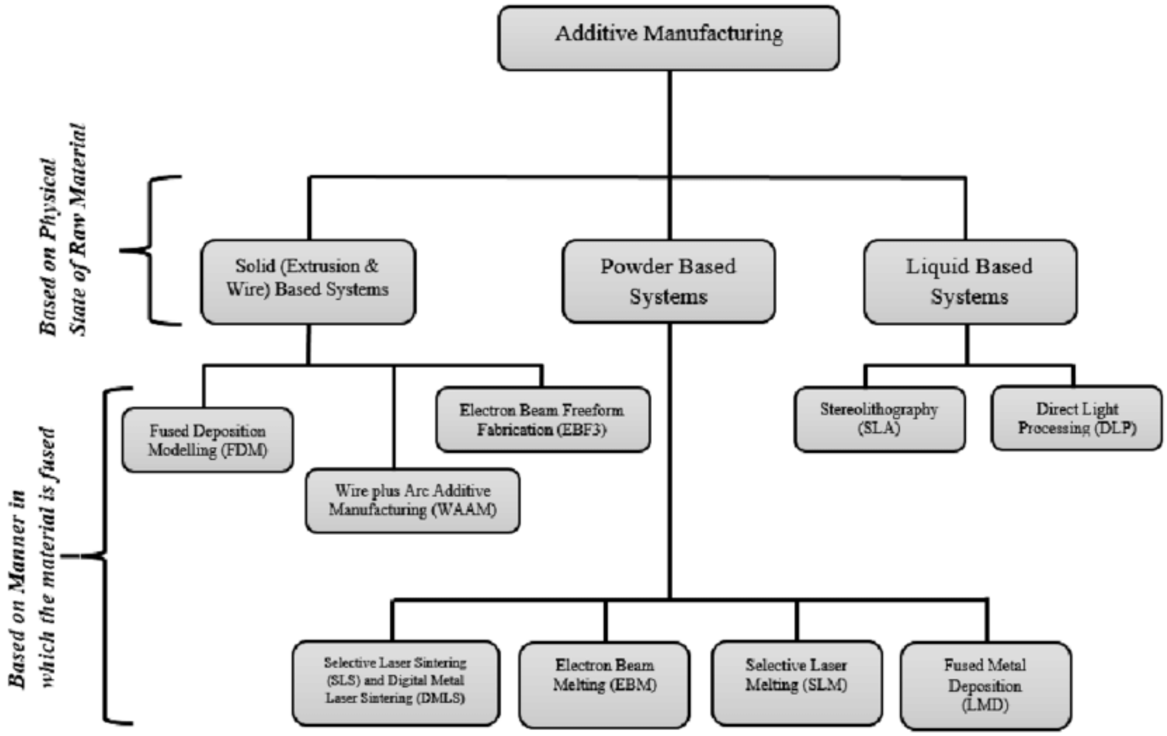

Fig.01Classification of Additive Manufacturing processes

2) Advantages and Limitations:

Layer by layer production allows for much greater flexibility and creativity in the design process. No longer do designers have to design for manufacture, but instead they can create a part that is lighter and stronger by means of better design. Parts can be completely re-designed so that they are stronger in the areas that they need to be and lighter overall.

3D Printing significantly speeds up the design and prototyping process. There is no problem with creating one part at a time, and changing the design each time it is produced. Parts can be created within hours. Bringing the design cycle down to a matter of days or weeks compared to months. Also, since the price of 3D printers has decreased over the years, some 3D printers are now within financial reach of the ordinary consumer or small company.

The limitations of 3D printing in general include expensive hardware and expensive materials. This leads to expensive parts, thus making it hard if you were to compete with mass production. It also requires a CAD designer to create what the customer has in mind, and can be expensive if the part is very intricate.

3D Printing is not the answer to every type of production method; however its advancement is helping accelerate design and engineering more than ever before. Through the use of 3D printers designers are able to create one of a kind piece of art, intricate building and product designs and also make parts while in space.

We are beginning to see the impact of 3D printing many industries. There have been articles saying that 3D printing will bring about the next industrial revolution, by returning a means of production back within reach of the designer or the consumer.

3) FDM – Fused Deposition Modeling-

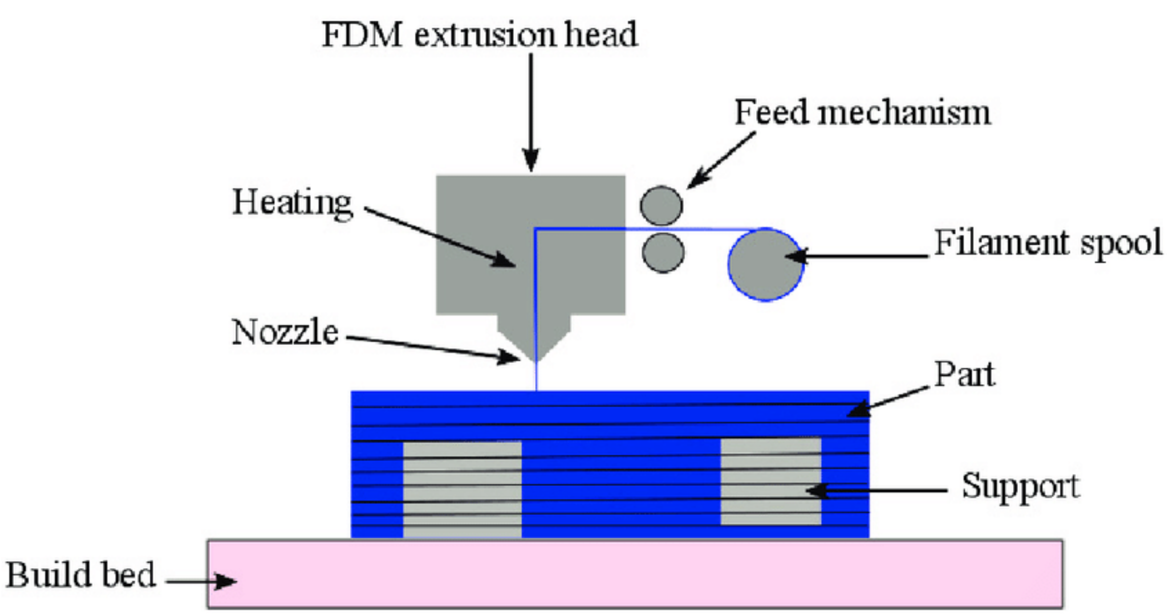

Fig.2: Schematics of FDM Process

Fused Deposition Modeling, is an additive manufacturing technology commonly used for modeling, prototyping, and production applications.

FDM works on an "additive" principle by laying down material in layers. A plastic filament or metal wire is unwound from a coil and supplies material to an extrusion nozzle which can turn the flow on and off. The nozzle is heated to melt the material and can be moved in both horizontal and vertical directions by a numerically controlled mechanism, directly controlled by a computer-aided manufacturing (CAM) software package. The model or part is produced by extruding small beads of thermoplastic material to form layers as the material hardens immediately after extrusion from the nozzle. Stepper motors or servo motors are typically employed to move the extrusion head.

FDM, a prominent form of rapid prototyping, is used for prototyping and rapid manufacturing. Rapid prototyping facilitates iterative testing, and for very short runs, rapid manufacturing can be a relatively inexpensive alternative.

Advantages: Cheaper since uses plastic, more expensive models use a different (water soluble) material to remove supports completely. Even cheap 3D printers have enough resolution for many applications.

Disadvantages: Supports leave marks that require removing and sanding. Warping, limited testing allowed due to Thermo plastic material.

Applications:

This technology is used to manufacture direct parts for a variety of industries including aerospace, dental, medical and other industries that have small to medium size, highly complex parts and the tooling industry to make direct tooling inserts. With a build envelop of 250 x 250 x 185 mm, and the ability to 'grow' multiple parts at one time, SLS is a very cost and time effective technology. The technology is used both for rapid prototyping, as it decreases development time for new products, and production manufacturing as a cost saving method to simplify assemblies and complex geometries.

4) Ultimaker 2+ Connect technical specifications-

A) Dimensions of 3D printing machine and workspace:

Sr.No	Area of Specification	Details
1.	Built Volume	223 x 220 x 205 mm (8.7 x 8.6 x 8 inches)
2.	Assembled Dimensions	342 x 460 x 580 mm (13.5 x 18.1 x 22.8 in)
3.	Print technology	Fused filament fabrication (FFF)
4.	Compatible filament diameter	2.85 mm

5.	Weight	10.3 kg (22.7 lbs)
6.	Power Input	100 - 240 VAC, 50 - 60 Hz
7.	Maximum Power Output	221 W

B) Printer Properties:

Sr.No	Area of Specification	Details
1.	Layer resolution	0.25 mm nozzle: 150 - 60 micron 0.4 mm nozzle: 200 - 20 micron 0.6 mm nozzle: 400 - 20 micron 0.8 mm nozzle: 600 - 20 micron
2.	XYZ resolution	12.5, 12.5, 5 micron
3.	Feeder Type	Geared feeder
4.	Display	2.4-inch (6 cm) TFT color touchscreen
5.	Print Head	Single extrusion with swappable nozzle and dual cooling fans
6.	Nozzle Diameter	0.25, 0.4, 0.6, 0.8 mm

C) Operational Parameter:

Sr.No	Area of Specification	Details
1.	Build Speed	< 24 mm³/s
2.	Nozzle temperature	180 - 260 °C
3.	Nozzle Heat up time	< 2 minutes
4.	Operating Sound	< 50 dBA

5.	Build Plate Leveling	Assisted leveling
6.	Build Plate	20 - 110 °C heated glass build plate
7.	Operating Ambient Temperature	15 - 32 °C (59 - 90 °F)
8.	Non-Operating temperature	0 - 32 °C (32 - 90 °F)
9.	Air Manager Filter technology	Replaceable EPA filter