

# \* Additive Manufacturing Technologies \*

01

## UNIT-1

### \* Introduction :

- The term "Rapid Prototyping (RP)" is used to describe a process for rapidly creating a system or part representation before final release or commercialization.
- A recently formed Technical Committee within ASTM international agreed that new terminology should be adopted. Recently adopted ASTM consensus standards now use the term "Additive Manufacturing".
- The basic principle of this technology is that a model, initially generated using a 3D Computer Aided Design (3D CAD) system, can be fabricated directly without the need of process planning.

### \* Prototyping fundamentals :-

At its most basic level, prototyping is the process of creating a lower fidelity representation of an end design. The early stages of prototyping involve open collaboration b/w our team and the client.

Prototyping is the process of building a model of a system. This helps the analysts develop an initial set of system requirements. Prototyping can augment this process because it converts these basic, yet sometimes intangible specifications into a tangible but limited working model of the desired information system.

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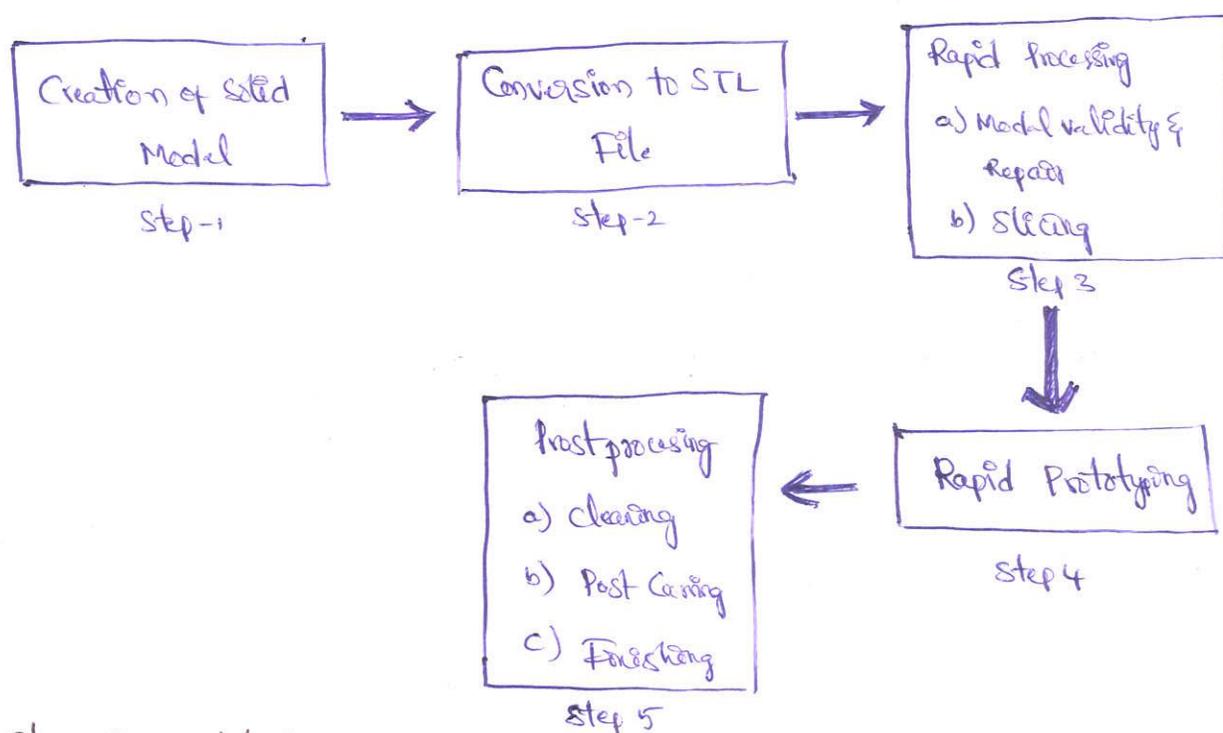
Types of Prototype	Typical Purpose	General Characteristics	When to Use
Concept Prototype	Analyze system approaches	High-level, overall vision	Concept Definition Stage.
Feasibility prototype	Determine feasibility of various solutions	Proof of concept for specific issues	Concept Definition Stage.
Horizontal prototype	Clarify scope and requirements	Demonstrates outer layer of human interface only, such as windows, menus, and screens	Function Definition Stage.
Vertical Prototype	Refine database design, test key components early	Demonstrates a working, though incomplete, system for key functions.	Later portion of function Definition Stage
Functional Storyboard ring	Determine useable sequences for presenting information	Demonstrates the typical order in which information is presented.	Function Definition Stage.

- Feasibility prototype. This type of prototype is usually developed to determine the feasibility of various solutions.
- Horizontal prototype.
- Rapid prototype.
- Simulations.
- Storyboard.
- Vertical Prototype
- Wireframe
- Animations.

## \* Rapid Prototyping :

It is the fast fabrications of a physical part, model or assembly using 3D Computer aided d/n (CAD). The creation of the part, model or assembly is usually completed using additive manufacturing, or more commonly known as 3D printing.

In manufacturing, rapid prototyping is used to create a three-dimensional model of a part to product. In addition to providing 3-D visualization for digitally rendered items, rapid prototyping can be used to test the efficiency of a part or product design before it is manufactured in large quantities.



## \* Steps in prototyping :

- Step-1 : Requirements gathering and analysis. A prototyping model starts with requirement analysis.
- Step-2 : Quick design.
- Step-3 : Build a prototype
- Step-4 : Initial user evaluation
- Step-5 : Refining prototype
- Step-6 : Implement product and maintain.

### \* Need for additive manufacturing:

Implemented properly, additive manufacturing can significantly reduce material waste, reduce the amount of production steps, inventory being held, and reduce the amount of distinct parts needed for an assembly... Additive manufacturing (AM) has the potential to completely redefine manufacturing in certain areas.

### \* Historical Development :-

1770 - mechanisation

1946 - 1st Computer

1952 - 1st CNC machine tool

1960 - 1st Commercial laser

1961 - 1st Commercial Robot

1968 - 1st Interactive graphic system

1988 - Rapid prototyping system.

### \* Fundamentals additive manufacturing: (Rapid Prototyping)

Unlike casting, forming or powder processing, rapid prototyping does not require a mould or tool to shape the surfaces of an object. Unlike cutting, AM techniques do not involve removal of material.

### \* Advantages and limitations of Rapid prototyping:

#### • Advantages:

- The Cost of Entry Continues to Fall.
- You'll Save on material waste and Energy.
- Prototyping Costs much less.
- Small production runs often prove faster and less expensive.
- You Don't Need as much on-Hand Inventory.
- It's Easier to recreate and optimize legacy parts.

### \* Disadvantages:

- It's almost always Cost-prohibitive. Just like metal injection molding (MIM), metal prototype manufacturing is rarely the most Cost-effective path to an end product.
- No Mixing Allowed.
- It's slow, and niche.

### \* Commonly used terms:

- Additive fabrication (AF)
- Desktop manufacturing (or) personal fabrication
- Direct Digital Manufacturing
- Electron Beam melting (EBM)
- Fused Deposition Modeling (FDM)
- Laminated Object manufacturing (LOM/LOM)
- Low-volume Injection molding
- Low-volume Layered Manufacturing
- Photopolymer
- Selective Laser Sintering (SLS)
- Solid Free form fabrication (SFF)
- Stereo lithography
- STL File
- Subtractive Fabrication
- 3D printing.

### \* Fundamentals of RP:

- (1) Input
- (2) Material
- (3) Method
- (4) Application

(1) Input refers to the electronic information required to describe the physical object with 3D data

→ There are two possible starting points

(i) Computer model

(ii) physical model

→ The Computer created by a CAD (Computer Aided Design) system, can be either a surface model or a solid model.

→ On the other hand 3D data from the physical model is not at all straight forward.

→ It requires data acquisition through a method is known as reverse engineering.

→ In reverse engineering a wide range of equipment digitizes the data points of the physical model and reconstructs it in a CAD system.

(2) Method - Method with them are currently more than vendors RP system. The method employed. each vendor can be generally classified into the following categories.

(i) photo curing

(ii) Cutting and joining

(iii) Melting and Solidification / fusing and joining / binding.

(3) Material:

→ The initial state of material can come in either solid, liquid and powder state. In solid state it can come various form such as wire or laminate.

→ Current range material include paper, nylon, wax and Ceramics.

(4) Applications are the most of the RP parts are finished or touch pad used before they are used for their intended applications.

→ Applications can be grouped into,

(i) D/M - Engineering analysis & planning.

(ii) Tooling / Manufacturing.

\* Classification of RP process :-  
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- (1) Liquid Based
- (2) Solid Based
- (3) Powder Based

(1) Liquid Based :-

→ Liquid Based RP System have the initial of its material in liquid state. Through a process commonly known as Curing.  
→ The liquid is converted into the solid state. The following rapid prototyping system fall into this category.

- (i) 3D system [ Stereolithography (SLA) ]
- (ii) Cubital's [ SGC ] [ Solid ground Curing ]
- (iii) CMET's - Solid object ultra violet laser printer.
- (iv) Sony's - SCS (Solid Creation System).

→ The single laser beam methods most widely used and includes all above RP systems.

(2) Solid Based :-

→ Solid Based Rapid prototyping system are meant to encompass all forms of material in the solid state.

(3) Powder Based :-

→ Powder is by largely solid state. However, it is intentionally created as a category outside the solid based rapid system. To mean powder in green like form.

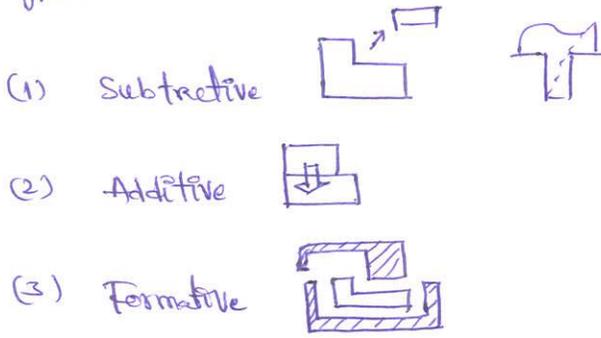
Limit :-  
Range - 250 x 250 x 250 mm<sup>3</sup> to 1000 x 800 x 500 mm<sup>3</sup>

accuracy - 0.05 mm

Cost - 2000 \$ to 60000 \$

\* Fundamentals of RP process :-

→ 3 types.



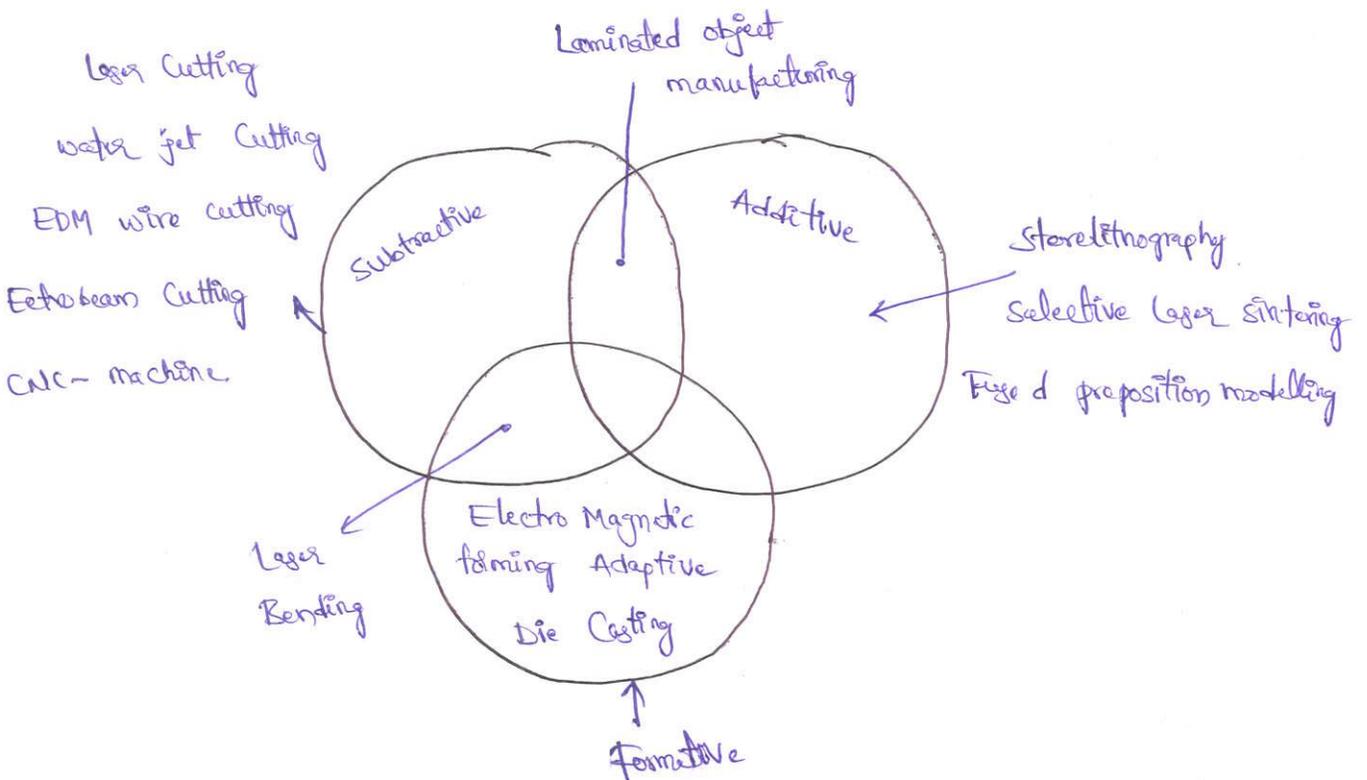
(1) Subtractive RP provides the ability to prototype in end used material since milling (or) machining removes material from a large piece of material. The finished part has a solid composition rather than a layered composition seen

in additive rapid prototyping with 3-D printer.

(2) Additive RP used out 3D printers to create plastic part and components by building in layer form CAD model.

(3) Subtractive we fabricate metal or plastic part and components by removing with our manually and CNC machine tools.

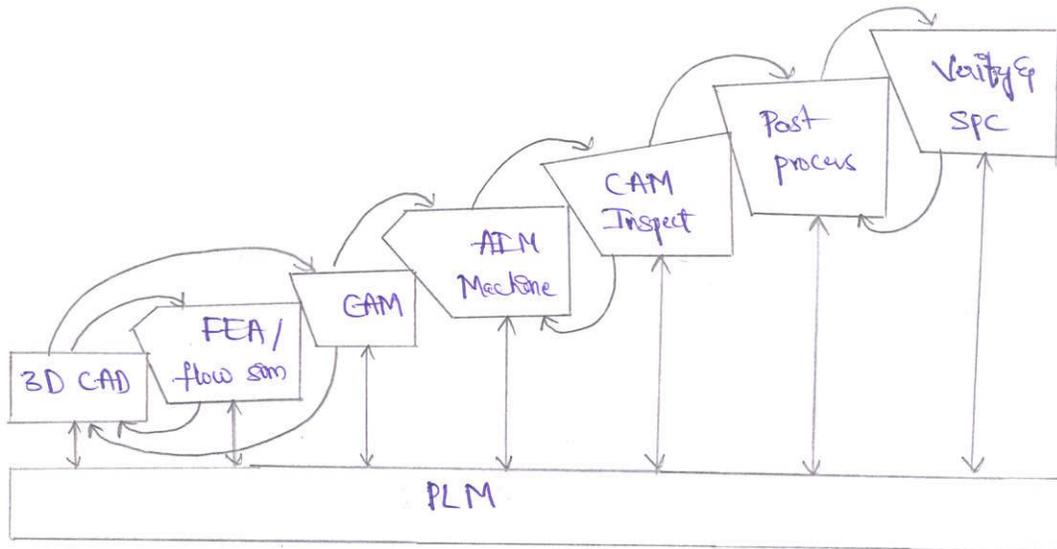
\* Material types :-



→ Additive fabrication process are able to produce parts in plastics, metals, Ceramics, Composites and even paper with properties similar to wood.

→ Some process can be build parts from multiple materials and distribute the materials based on the location in the parts.

\* Rapid prototyping process chain :-



Every product development process involving an additive manufacturing machine requires the operator to go through a set sequence of tasks. Easy-to-use "desktop" (or) "3D printing" machine emphasizes by the simplicity of this task sequence. These desktop machines are characterized by their low cost, simplicity of use, and ability to be placed in an office environment. For these machines each step is likely to have few options and requires minimal effort. However, ease also means that there are generally fewer choices, with perhaps a limited range of materials and other variables to experiment with.

General steps,

- (1) CAD
- (2) STL Convert
- (3) File transfer
- (4) machine setup
- (5) Build
- (6) Remove
- (7) post process
- (8) Applications.

\* Tessellation:

→ The developed 3D CAD model is tessellated and converted into STL file.

That are required for RP process. Tessellation is piece wise approximation of

Surface of 3D model CAD model using series of Triangles.

STL - Standard Triangulation Language.