



Reverse Engineering & Rapid Prototyping



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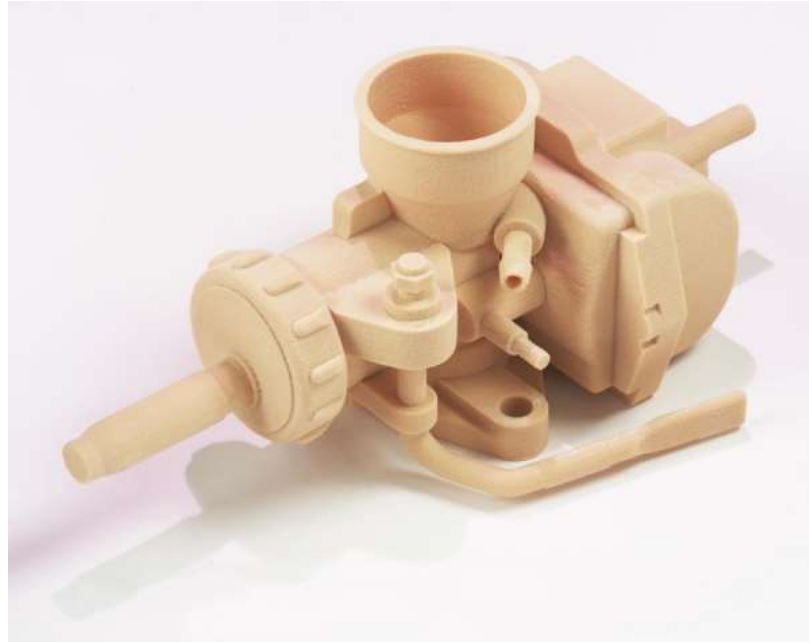
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Lecture No 1

Introduction to Rapid Prototyping

RAPID PROTOTYPING



Outlines



1. Fundamentals of Rapid Prototyping
2. Rapid Prototyping Technologies
3. Applications and Benefits of Rapid Prototyping
4. Material of RP
5. Process sequence of RP
6. Method of manufacturing of RP

Rapid Prototyping (RP)



A family of fabrication processes developed to make engineering prototypes in minimum lead time based on a CAD model of the item

- **Traditional method is machining**
 - Can require significant lead-times – several weeks, depending on part complexity and difficulty in ordering materials
- **RP** allows a part to be made in hours or days, given that a computer model of the part has been generated on a CAD system

Why is Rapid Prototyping Important?



- Product designers want to have a physical model of a new part or product design rather than just a computer model or line drawing
 - Creating a prototype is an **integral step** in design
 - A **virtual prototype** (a CAD model of the part) may not be sufficient for the designer to visualize the part adequately
 - Using RP to make the prototype, the designer can see and feel the part and assess its merits and **shortcomings**

RP – Two Basic Categories:



- 1. Material removal RP** - machining, using a dedicated CNC machine that is available to the design department on short notice
 - Starting material is often wax
 - Easy to machine
 - Can be melted and resolidified
 - The CNC machines are often small - called desktop machining
- 2. Material addition RP** - adds layers of material one at a time to build the solid part from bottom to top

Starting Materials in Material Addition RP



1. Liquid monomers that are cured layer by layer into solid polymers
2. Powders that are aggregated and bonded layer by layer
3. Solid sheets that are laminated to create the solid part

Additional Methods

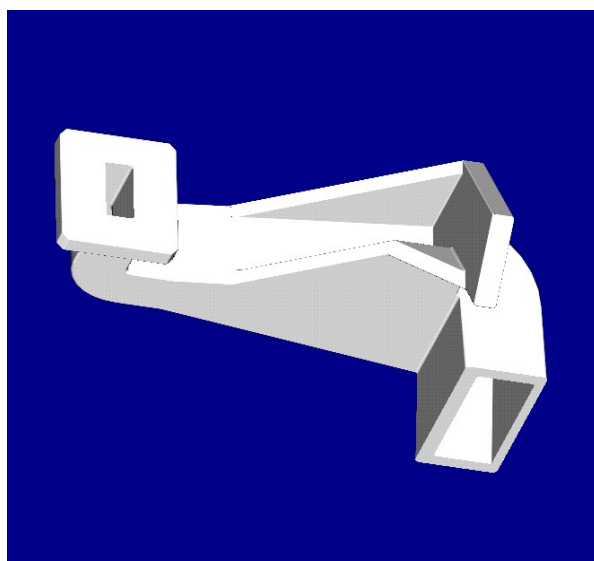
- In addition to starting material, the various material addition RP technologies use different methods of building and adding layers to create the solid part
 - There is a correlation between starting material and part building techniques

Steps to Prepare Control Instructions

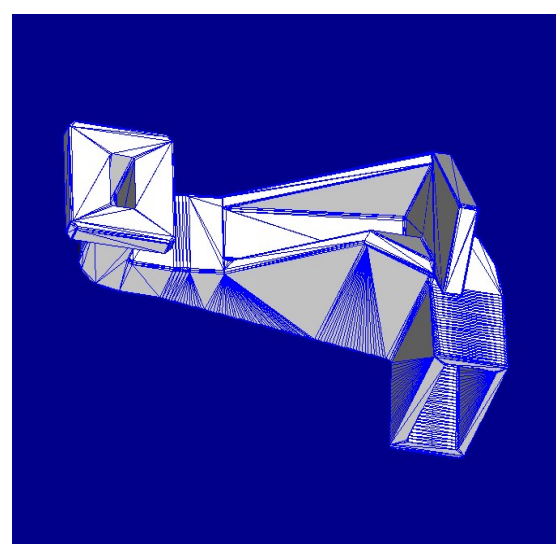


1. **Geometric modeling** - model the component on a CAD system to define its enclosed volume
2. **Tessellation** of the geometric model - the CAD model is converted into a computerized format that approximates its surfaces by facets (triangles or polygons)
3. **Slicing of the model into layers** - computerized model is sliced into closely-spaced parallel horizontal layers

CAD Part and Tessellation



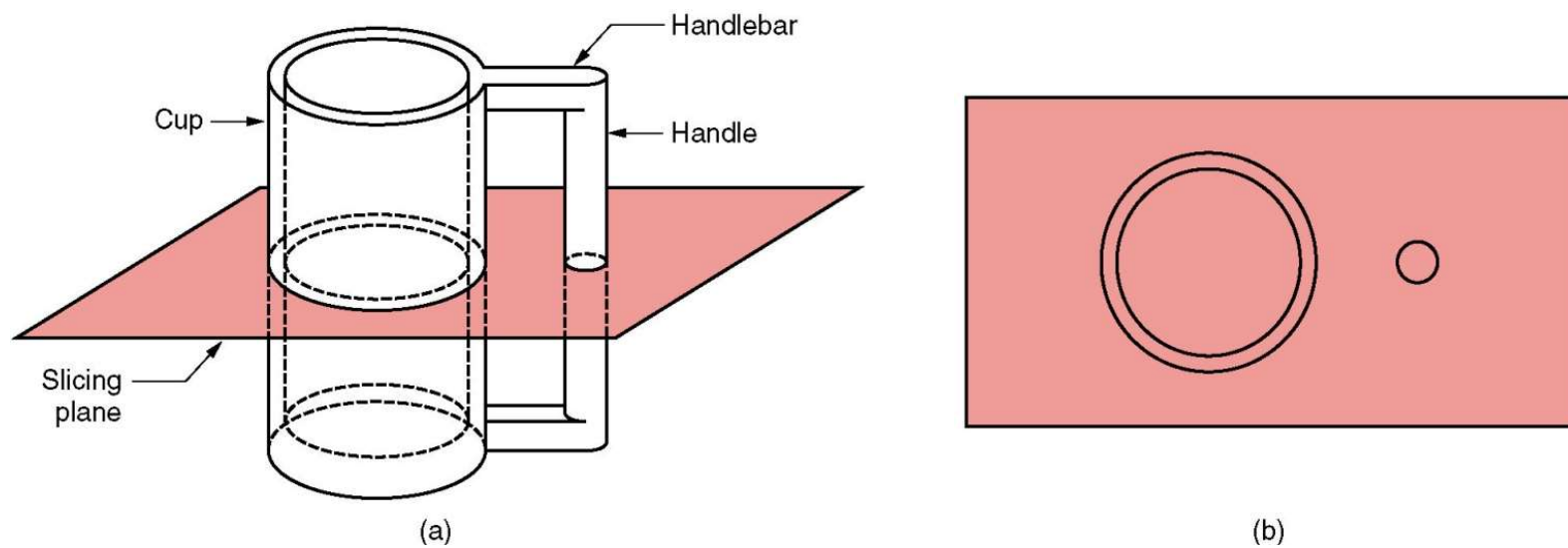
CAD Part



Tessellation



Solid Model to Layers



Conversion of a solid model of an object into layers (only one layer is shown).

More About Rapid Prototyping



- Alternative names for RP:
 - Layer manufacturing
 - Direct CAD manufacturing
 - Solid freeform fabrication
 - Rapid prototyping and manufacturing (RPM)
- RP technologies are being used increasingly to make production parts and production tooling, not just prototypes

Classification of RP Technologies



- There are various ways to classify the RP techniques that have currently been developed
- The RP classification used here is based on the form of the starting material:
 1. **Liquid-based**
 2. **Solid-based**
 3. **Powder-based**

1- Liquid-Based Rapid Prototyping Systems



- Starting material is a liquid
- About a dozen RP technologies are in this category
- Includes the following processes:
 - 1.1 **Stereolithography**
 - 1.2 **Solid ground curing**
 - 1.3 **Droplet deposition manufacturing**

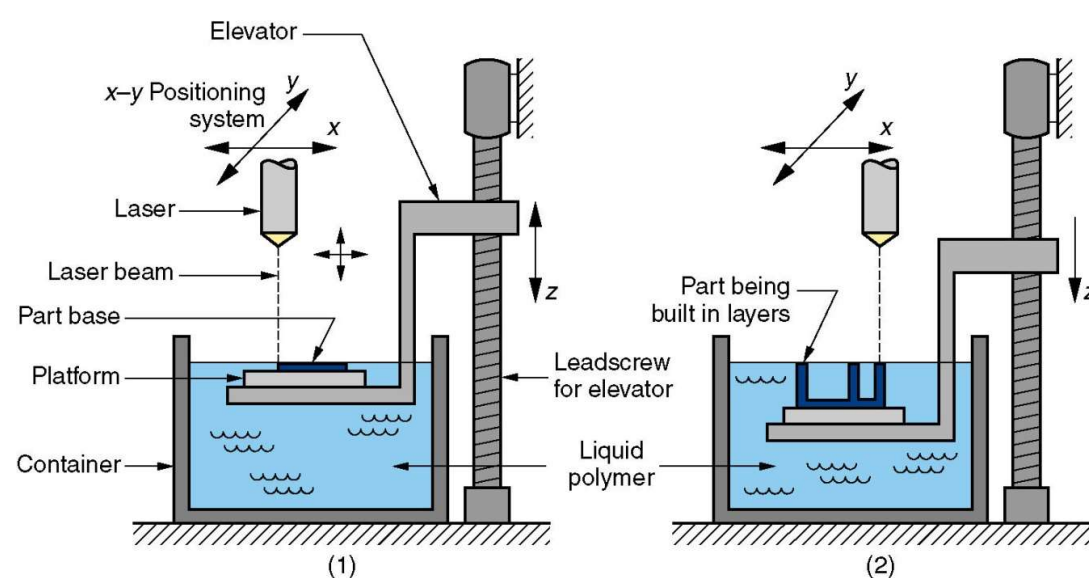


1.1-Stereolithography (STL)

RP process for fabricating a solid plastic part out of a photosensitive liquid polymer using a directed laser beam to solidify the polymer

- Part fabrication is accomplished as a series of layers - each layer is added onto the previous layer to gradually build the 3-D geometry
- The first addition RP technology - introduced 1988 by 3D Systems Inc. based on the work of Charles Hull
- More installations than any other RP method

Stereolithography



Stereolithography: (1) at the start of the process, in which the initial layer is added to the platform; and (2) after several layers have been added so that the part geometry gradually takes form.



A part produced by stereolithography

Facts about STL



- Each layer is 0.076 mm to 0.50 mm (0.003 in to 0.020 in.) thick
 - Thinner layers provide better resolution and more intricate shapes; but processing time is longer
- Starting materials are liquid monomers
- Polymerization occurs on exposure to UV light produced by laser scanning beam
 - Scanning speeds ~ 500 to 2500 mm/s