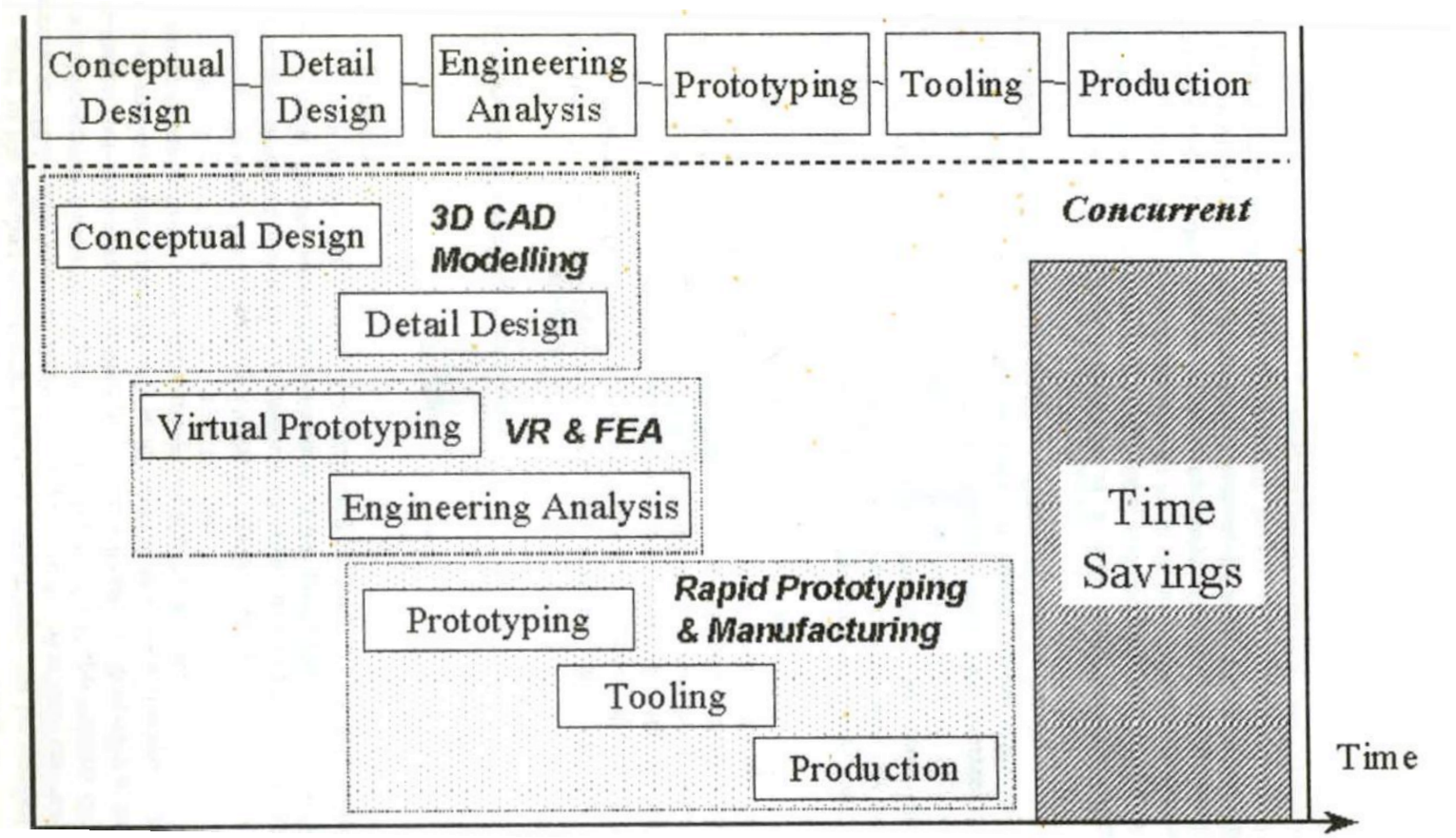
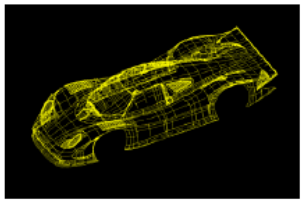
Rapid Prototyping

What is Prototyping?

- **Prototype** is the first or original example of something that has been developed; it is a model or preliminary version.
- **Need for a prototype:** It is a tool for a designer to validate his design before starting the actual production of the component.
- **Methods of making prototypes:**
  - Manual prototyping (Traditional practice)
  - Machining/CNC method (Recent practice)
- **Issues: Time consuming and costly**

Product Development





What is Rapid Prototyping????

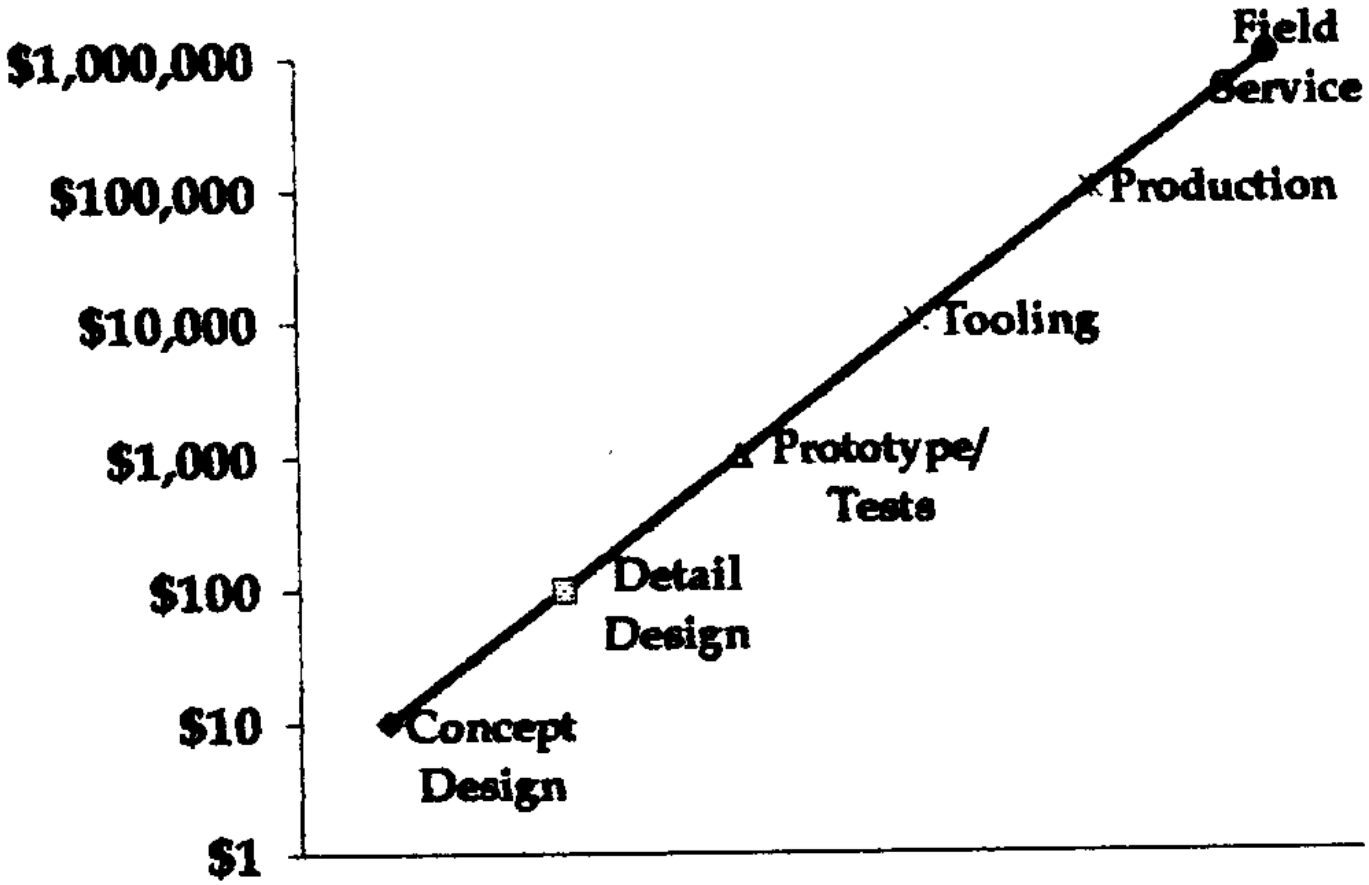
- A technology that produces models and prototype parts from 3D computer-aided design (CAD) model data, CT and MRI scan data, and model data created from 3D object digitizing systems.

- Direct fabrication of parts, components, or models from 3D CAD drawings WITHOUT part-specific tooling or human intervention".

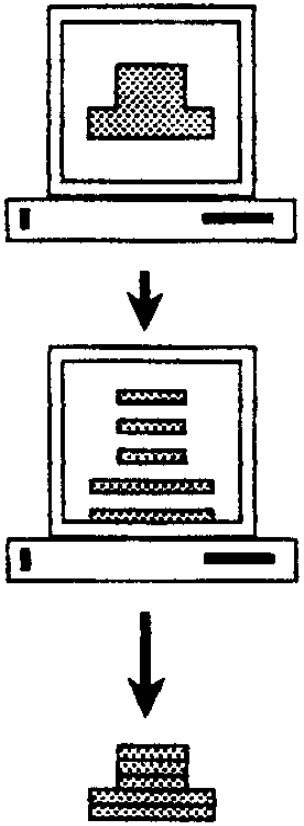
Benefits of Rapid Prototyping

- Reduced lead times to produce prototyped components
- Improved ability to visualize the part geometry due to its physical existence
- Earlier detection and reduction of design errors
- Increased capability to compute mass properties of components and assemblies
- Eliminates waste and costly late changes

Design change costs during Product Development



Principle of Rapid Prototyping



1. CAD Model
2. Sliced Model
3. Layered Manufacturing

Step 1: Creating CAD Model

- The first step in RP is the creation of a CAD solid model
- RP requires that we make a fully closed, water-tight model such that even if we were to pour water into the volume of the model, it would not leak
- Solid models can be created using a CAD softwares/tools

Step 2: Conversion of CAD Model into STL

- Since various CAD software packages use different algorithms to represent solid objects, STL file format has been selected as the de facto standard in the RP industry
- The STL file represents a 3D surface of an assembly as planar triangles
- The file contains the coordinates of the vertices and the direction of the outward normal of each triangle
- The STL file format is the best file format to represent all surfaces, in preparation for the ***slicing*** algorithm

Step 3: Slicing the STL file

- Slicing the STL file using a proprietary software program, provided by the manufacturer of the RP machine in which the model is to be produced
- The software imports the STL file and lets the user orient the part and adjust the size and slice thickness (0.01 to 0.7mm) of the model
- The software also generate support structure, these are necessary for creating features such as overhangs, internal cavities and thin-walled sections
- It also provides information about how much time and material will be required to make the prototype

Step 4: Growing the prototype

- It involves the actual making of the prototype
- Once the STL file is processed and saved, it is sent to the RP machine
- At this time, the RP machine acts as a printer
- Building the prototype one layer at a time
- Most of the modern RP machines can operate unattended once the initial setup is completed

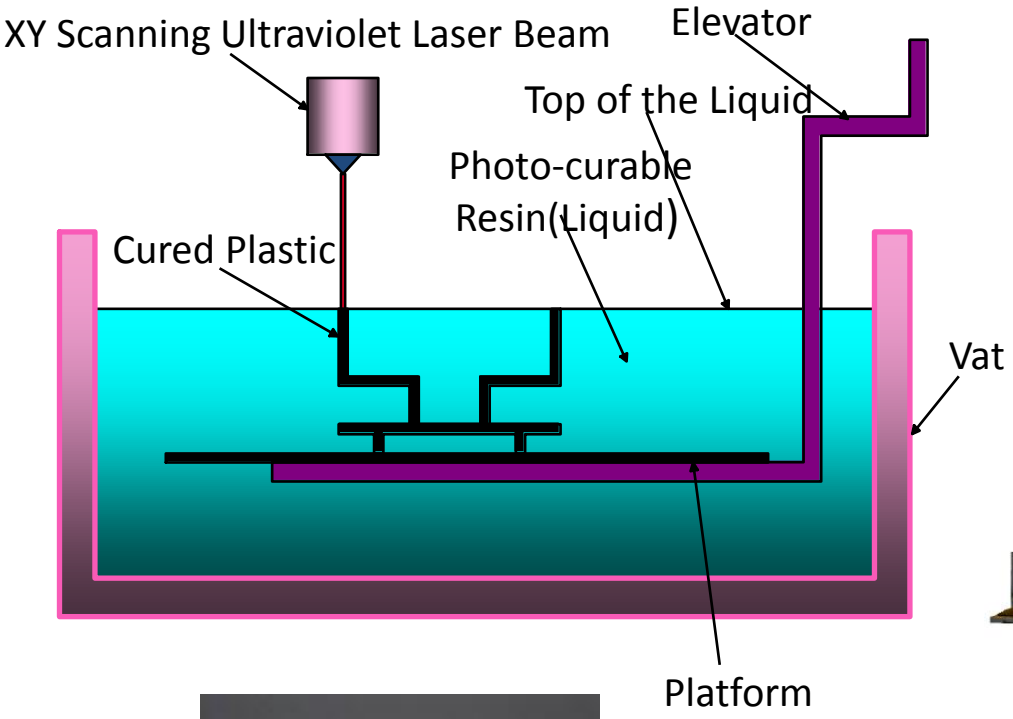
Step 5: Postprocessing

- The final step is removing the part from the machine and cleaning it before use
- It also involves post curing of photosensitive materials, sintering powder materials, and removing the support materials
- Some prototypes are also subjected to surface treatment, such as sanding, scaling or painting to improve their appearance and durability

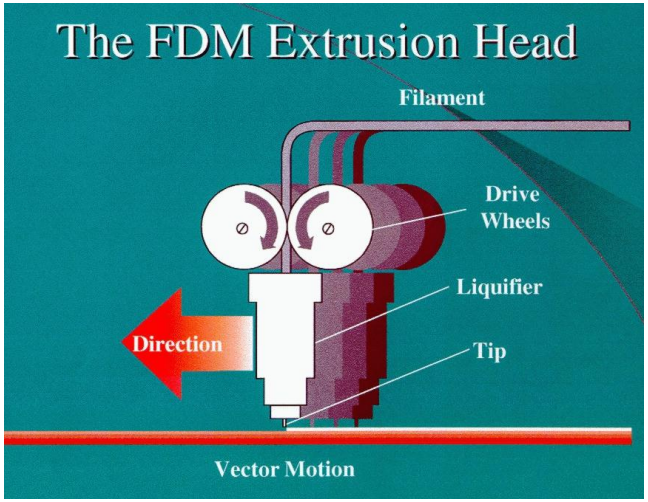
Classification

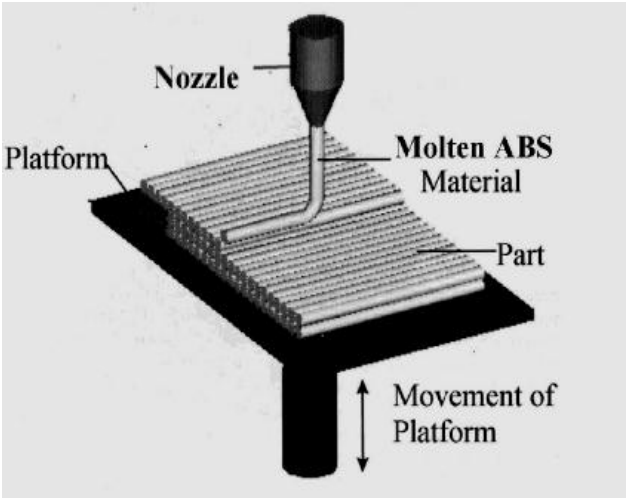
- RP systems can be classified in a variety of ways depending on the ***physics of the process***, the ***source of energy***, ***type of material***, ***size of prototypes***, and the like
- Classification based on the initial form of the material
    1. **Liquid-based (SLA)**
    2. **Solid-based (FDM)**
    3. **Powder-based (SLS, LENS,3DP)**

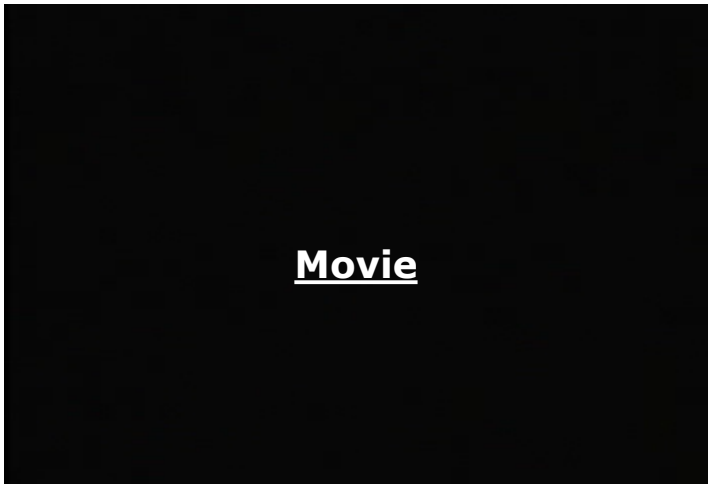
Stereolithography (SLA): RP Process



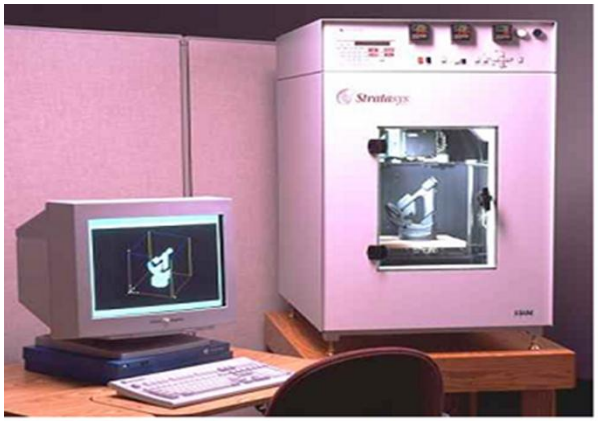
Fused Deposition Modeling: RP Process



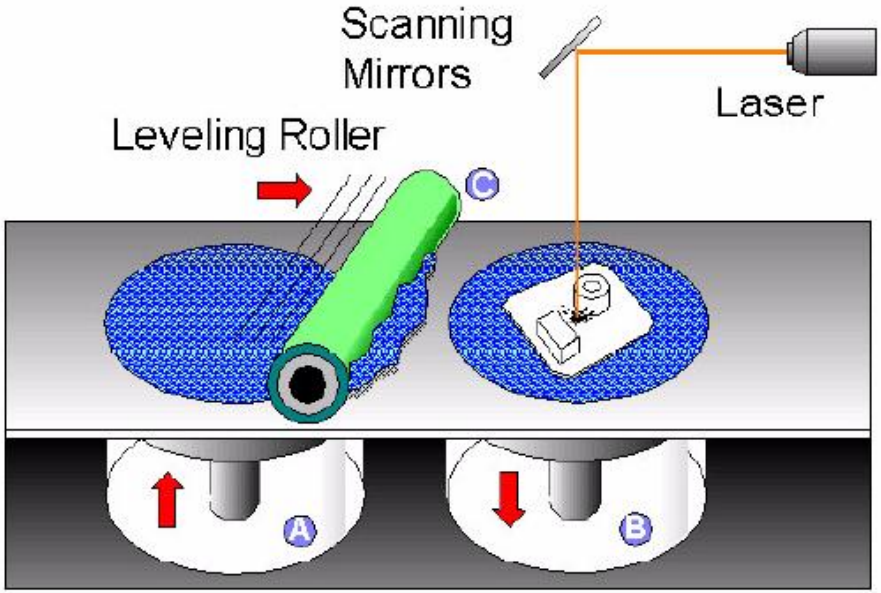




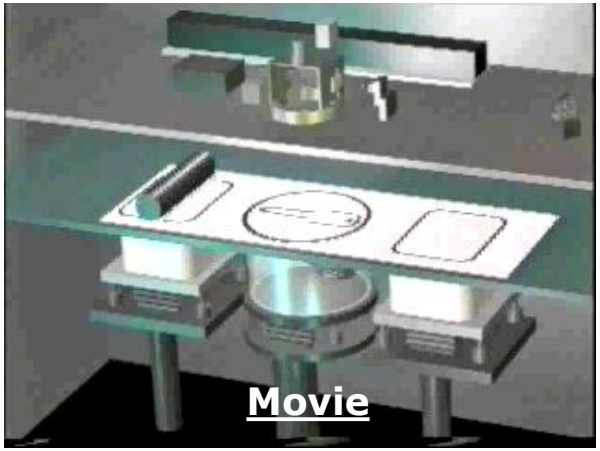
Stratasys' Fused Deposition Modeling (FDM): Systems

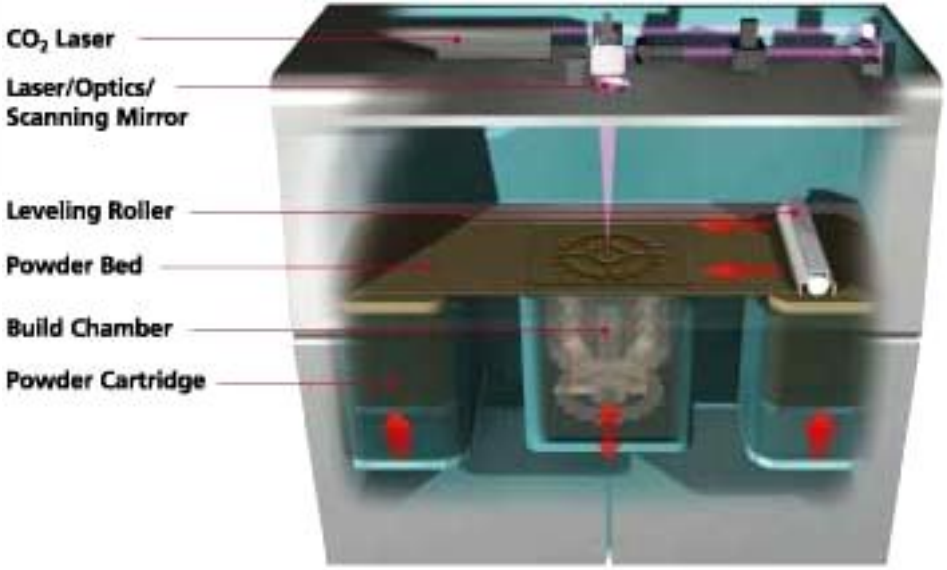


3D Systems Selective Laser Sintering(SLS): Process



EOS Movie



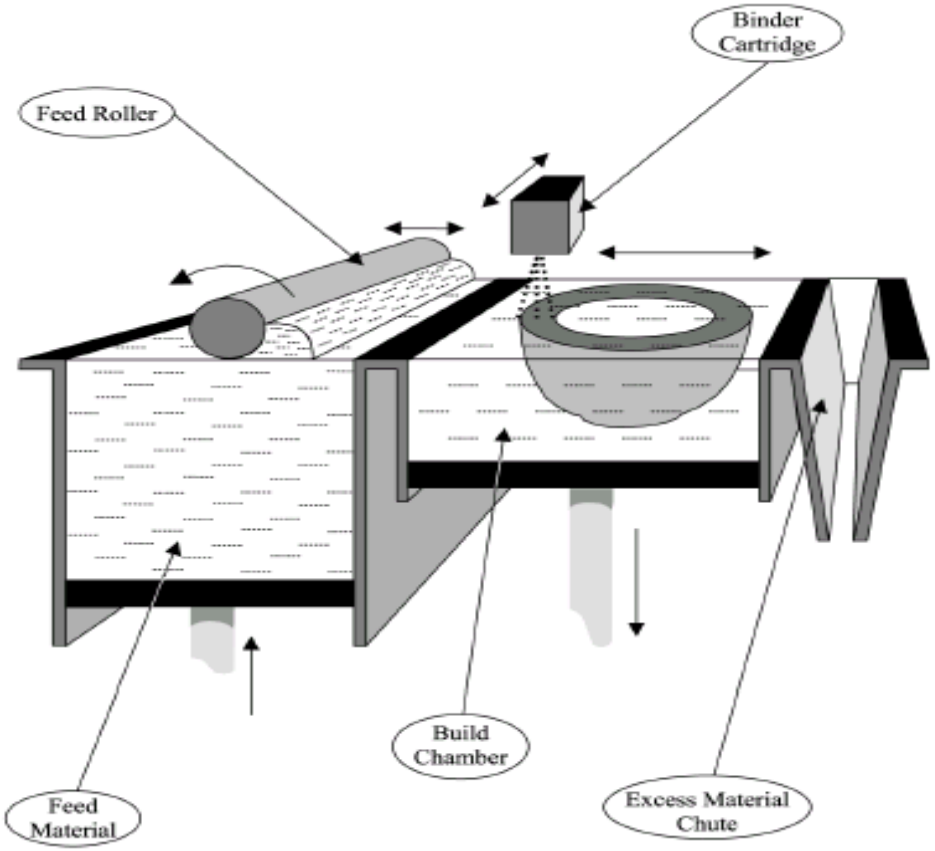


Build Chamber Dimensions
(W) 381mm x (D) 330mm x (H) 457mm

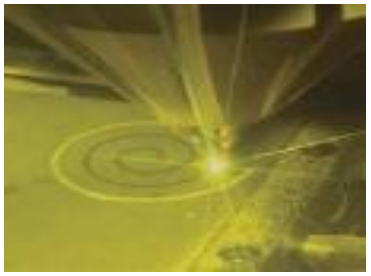
3D Systems Selective Laser Sintering(SLS): Products

- Sinterstation HiQ Systems
- Sinterstation 2500^{plus}
- Sinterstation Pro

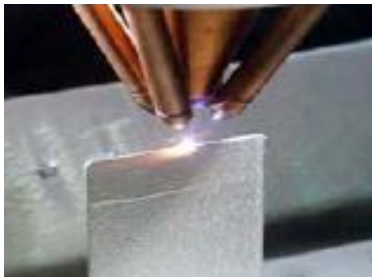
Z Corporation's 3 Dimensional Printing (3DP): RP Process



Movie



LENS Process

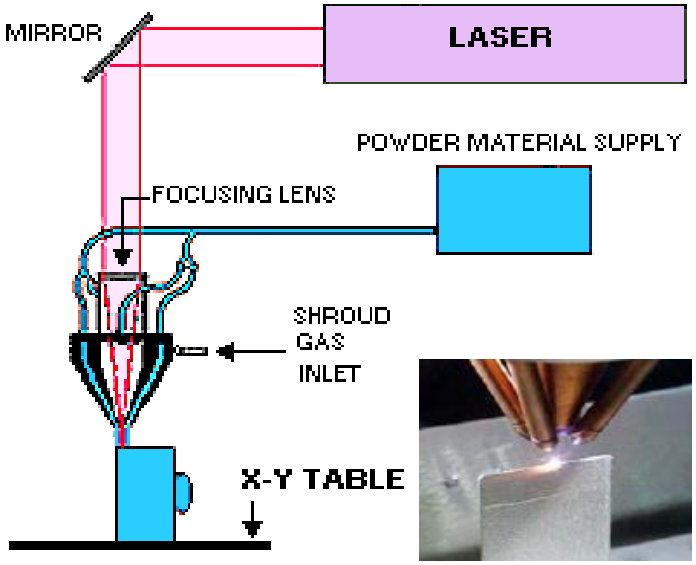


- LENS process was developed by David Keicher at Sandia National Laboratories (SNL), USA.
- Licenced to Optomec Inc., USA in 1997.
- It fabricates metal parts directly from a CAD solid model by using a metal powder injected into a molten pool created by a focused, high-powered laser beam.

LENS Process

Design

Process



Part

- 3D CAD Model
- Convert to STL file
- Process Set UP

- A high power laser is used
- Laser beam through a deposition head
- It travels through the center of the head
- The X-Y table is moved in raster fashion
- The head is moved up vertically as each layer is completed
- Metal powders are delivered by using a pressurized carrier gas
- An inert shroud gas is used to shield the molten pool

- Near Net Shape
- Fully Functional

Applications of RP