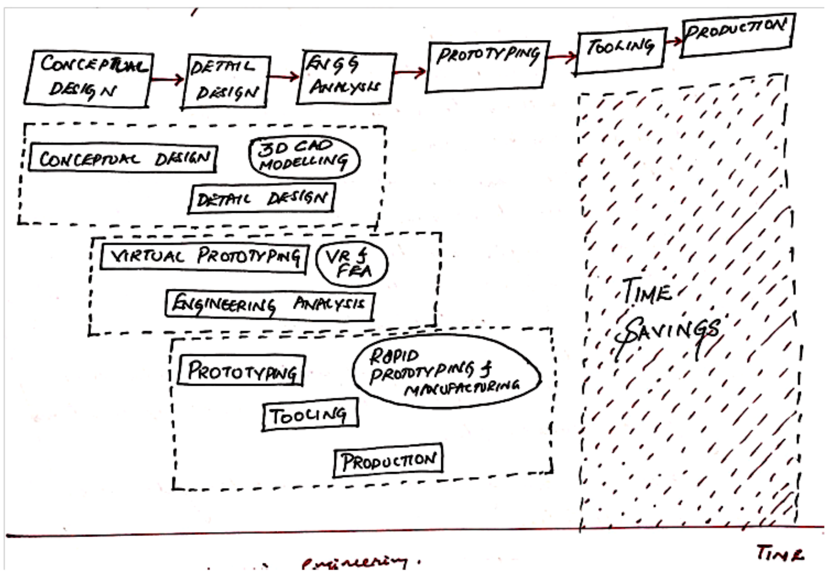
Academic Year 2017-18/ 8th Semester
Internal Assessment Test – 1
Sub Code: 10ME837 **Solution Key**
Subject: Rapid Prototyping 14.03.2018

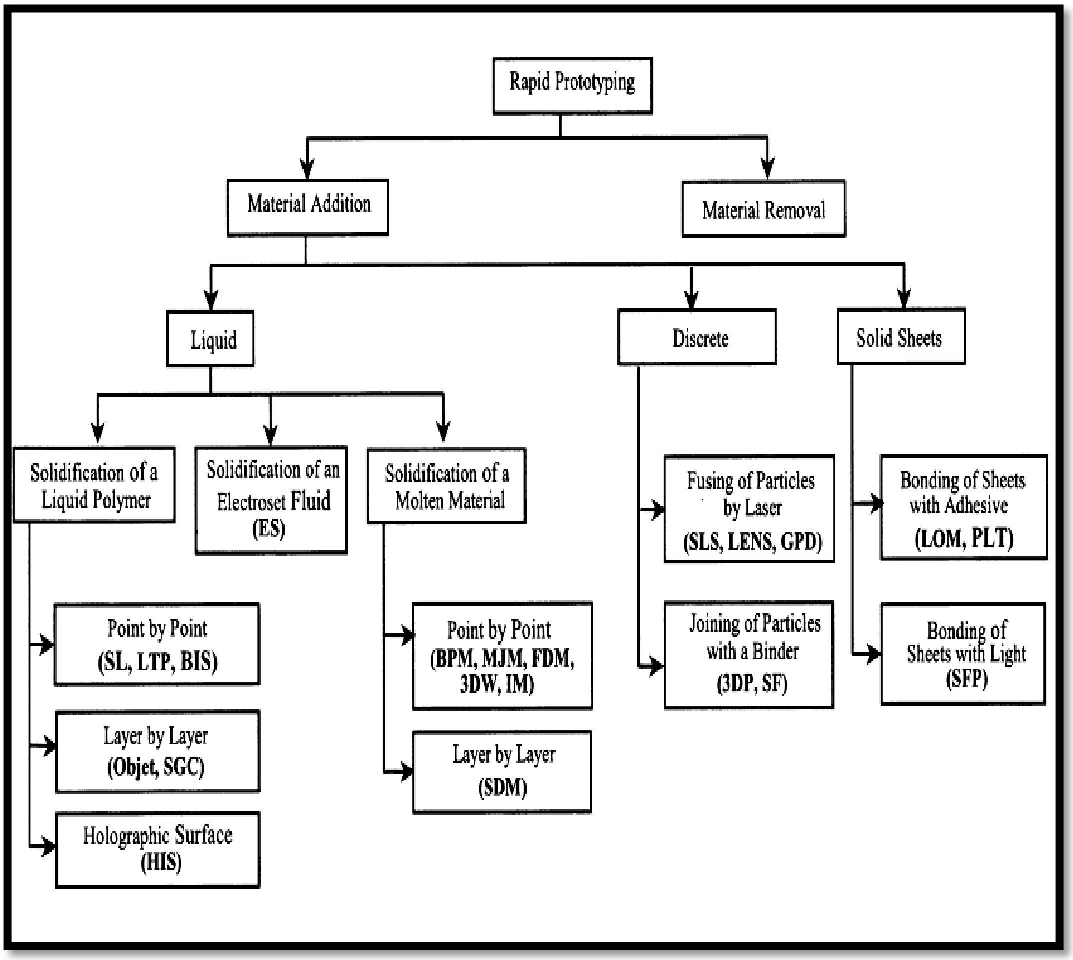
1. Need of Time compression in Engineering



History of RP Systems:

Year of Inception	Technology
1770	Mechanization [4]
1946	First Computer
1952	First Numerical Control (NC) Machine Tool
1960	First commercial Laser [5]
1961	First commercial Robot
1963	First Interactive Graphics System (early version of Computer-Aided Design) [6]
1988	First commercial Rapid Prototyping System

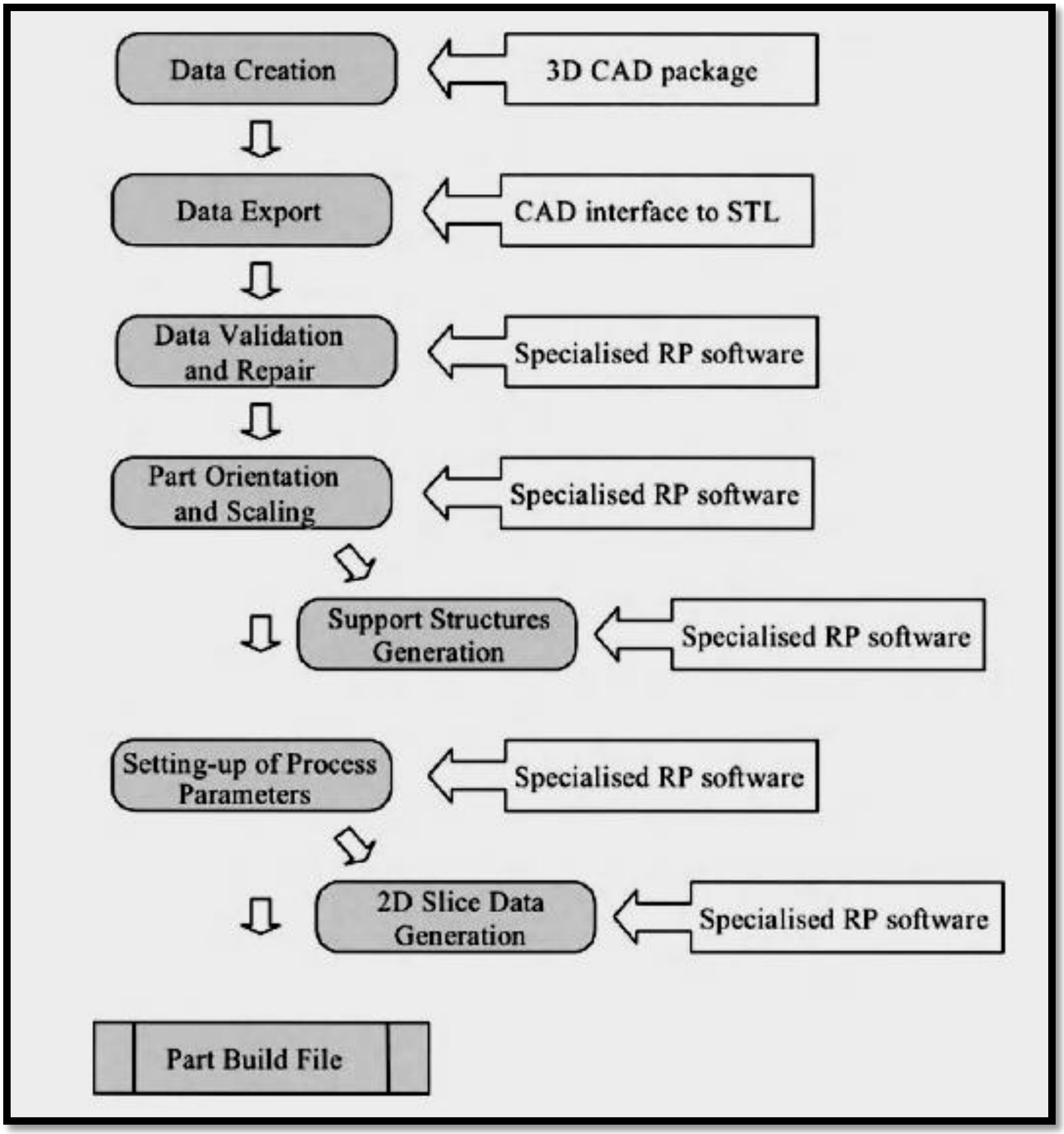
2. Classification of RP systems



Advantages of RP use:

1. Realization of design concepts
2. Saving time and money
3. Customized designs
4. Design flexibility

3. Different steps involved in rapid prototyping

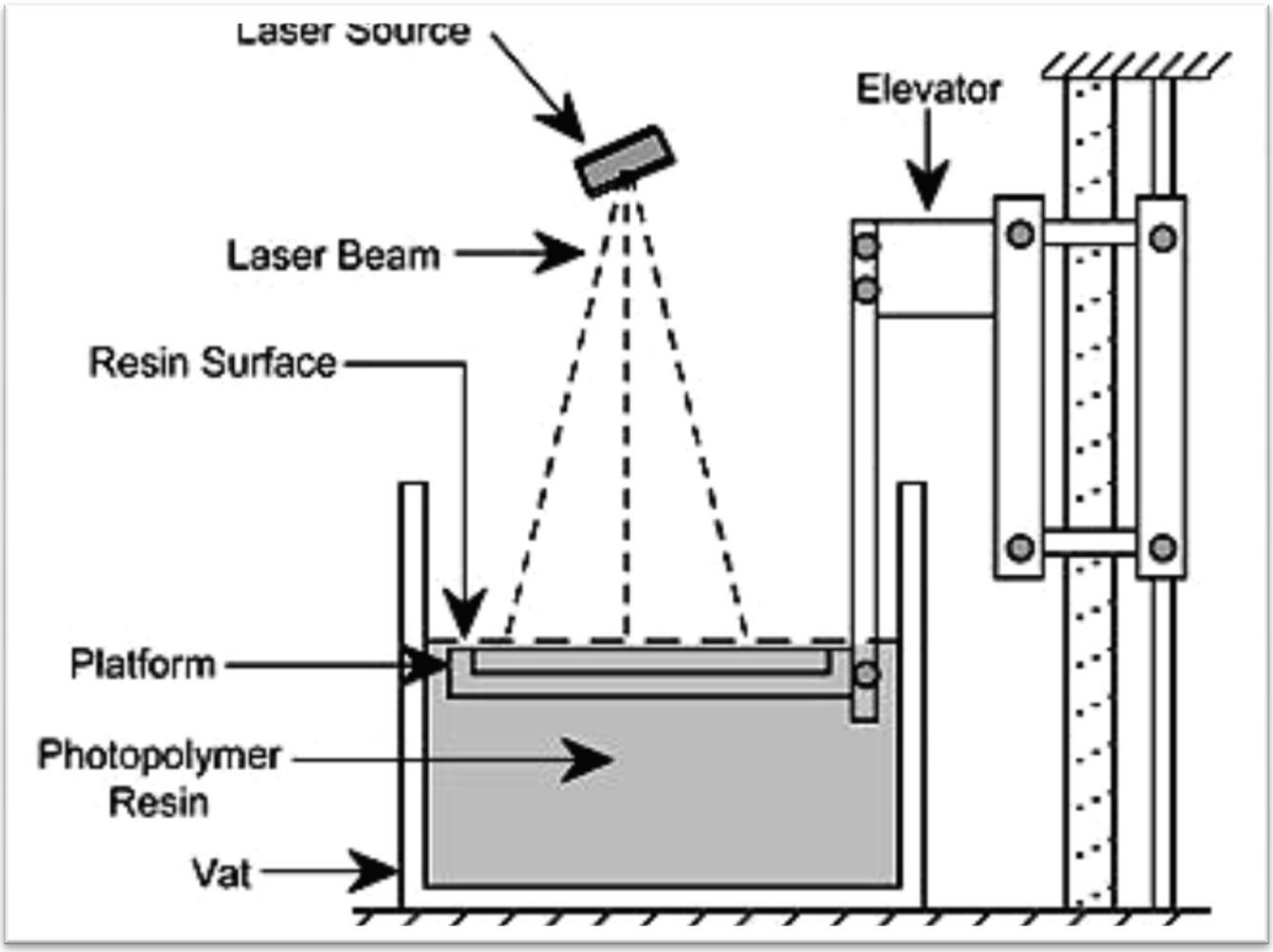


(1) A model or component is modeled on a Computer-Aided Design/ Computer-Aided Manufacturing (CAD/CAM) system. The model which represents the physical part to be built must be represented

as closed surfaces which unambiguously define an enclosed volume. This means that the data must specify the inside, outside and boundary of the model. This requirement will become redundant if the modeling technique used is solid modeling. This is by virtue of the technique used, as a valid solid model will automatically be an enclosed volume. This requirement ensures that all horizontal cross sections that are essential to RP are closed curves to create the solid object.

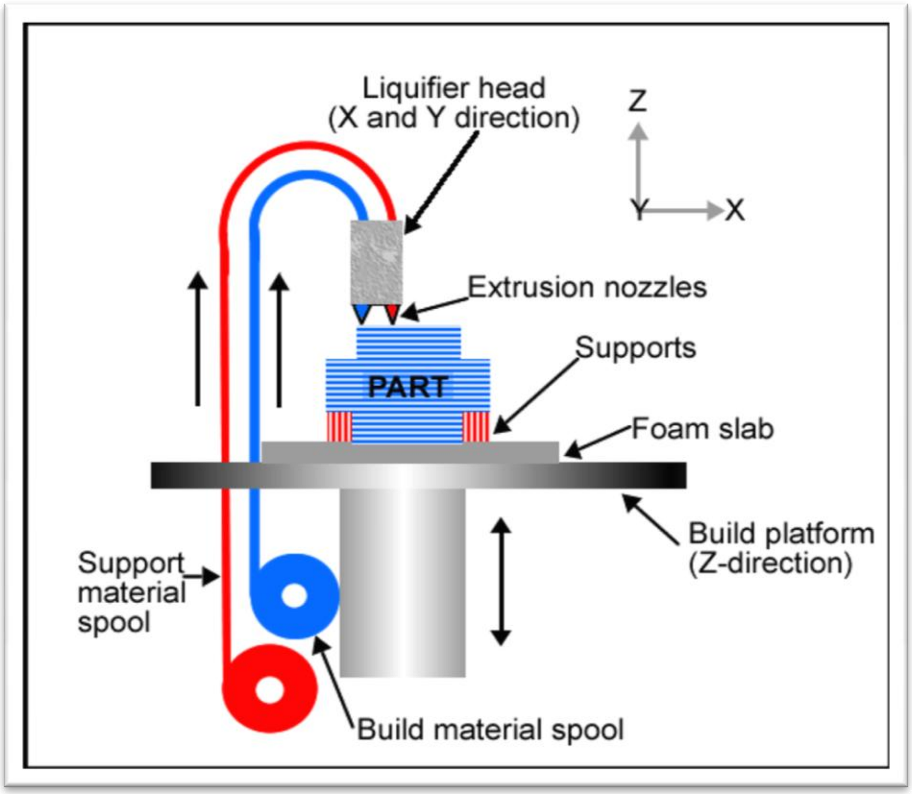
(2) The solid or surface model to be built is next converted into a format dubbed the "STL" (STereoLithography) file format which originates from 3D Systems. The STL file format approximates the surfaces of the model by polygons. Highly curved surfaces must employ many polygons, which means that STL files for curved parts can be very large. However, there are some rapid prototyping systems which also accept IGES (Initial Graphics Exchange Specifications) data, provided it is of the correct "flavor".

4. SLA process



- Parts are built from a photo-curable liquid resin that cures when exposed to a laser beam (basically, undergoing the photo-polymerization process) which scans across the surface of the resin.
- The building is done layer by layer, each layer being scanned by the optical scanning system and controlled by an elevation mechanism which lowers at the completion of each layer.

5. Fused Deposition Modelling



In this patented process [12], a geometric model of a conceptual design is created on a CAD software which uses IGES or STL formatted files. It can then imported into the workstation where it is processed through the QuickSlice® and SupportWorkTM propriety software before loading to FDM.

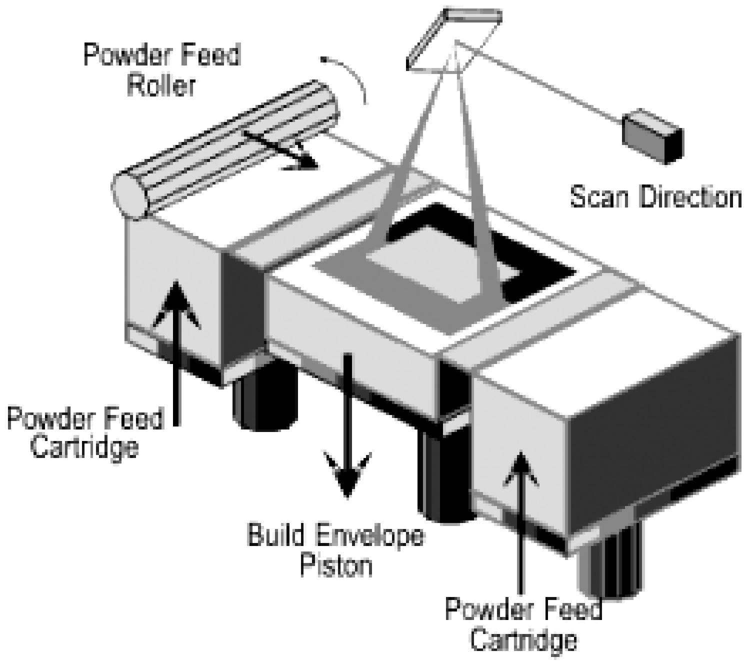
Within this software, the CAD file is sliced into horizontal layers after the part is oriented for the optimum build position, and any necessary support structures are automatically detected and generated. The slice thickness can be set manually to anywhere between 0.172 to 0.356 mm (0.005 to 0.014 in) depending on the needs of the models. Tool paths of the build process are then generated which are downloaded to the FDM machine.

The modeling material is in spools — very much like a fishing line. The filament on the spools is fed into an extrusion head and heated to a semi-liquid state. The semi-liquid material is extruded through the head and then deposited in ultra thin layers from the FDM head, one layer at a time. Since the air surrounding the head is maintained at a temperature below the materials' melting point, the exiting material quickly solidifies.

Moving on the *X*–*Y* plane, the head follows the tool path generated by QuickSlice® or Insight generating the desired layer. When the layer is completed, the head moves on to create the next layer. The horizontal width of the extruded material can vary between 0.250 to 0.965 mm depending on model.

Two modeler materials are dispensed through a dual tip mechanism in the FDM machine. A primary modeler material is used to produce the model geometry and a secondary material, or release material, is used to produce the support structures. The release material forms a bond with the primary modeler material and can be washed away upon completion of the 3D models.

6. SLS process



The SLS process is based on the following two principles:

(1) Parts are built by sintering when a CO_2 laser beam hits a thin layer of powdered material. The interaction of the laser beam with the powder raises the temperature to the point of melting, resulting in particle bonding, fusing the particles to themselves and the previous layer to form a solid.

(2) The building of the part is done layer by layer. Each layer of the building process contains the cross-sections of one or many parts. The next layer is then built directly on top of the sintered layer after an additional layer of powder is deposited via a roller mechanism on top of the previously formed layer.

7.a) Materials used in FDM

ABS (White),
ABSi, Investment
Casting Wax,
Elastomer
ABS, Polycarbonate,
Polyphenyl-sulfone

7.b) Applications of FDM

1. Models for conceptualization and presentation.
2. Prototypes for design, analysis and functional testing
3. Patterns and masters for tooling