International Journal of Computational Intelligence Research
ISSN 0973-1873 Volume 12, Number 1 (2016), pp. 55-61

http://www.ripublication.com

Rapid Prototyping: Process advantage, comparison and application

Vishal Sharma and Sharanjit Singh*

Department of Mechanical Engineering,
DAV University Jalandhar, Punjab INDIA-144012
E-Mail: malhi.sharanjit@gmail.com

Introduction

Since 1980 Rapid prototyping (RP) plays an important role for the development of a various product, having wide applications. In RP process fully functional parts can be easily produced. This RP process can be divided into a two phase's- virtual phase and physical phase. First comes to the virtual phase in which CAD software is used to build a 3D CAD model. Various CAD software's like pro-e, catia and idea etc are used for the creation of various models. After virtual phase the next phase is physical phase, in which an object is build according to a 3D CAD model data [1]. In RP system a CAD model is further changed into a thin slices/layered model and according to these slicing data, the material is deposited in a form of layers. In a RP system a solid model is developed from bottom to top. RP is also known as additive manufacturing, additive fabrication, additive process, solid freedom fabrication and layer based fabrication. In RP system three types of materials i.e. solid form, liquid form or powder form are used for fabrication of different parts.CAD software play a virtual role in RP system. With CAD software we can design a complex shape part easily. In these software objects may be represented as wire frame, surface models or solid models. After these the geometry of model is clearly defined. RP technologies have capability to significantly improve the speed, accuracy and properties of RP parts [2]. Fig (1) shows that the manufacturing of parts by building thin slices and layering the slice on top of each other's.

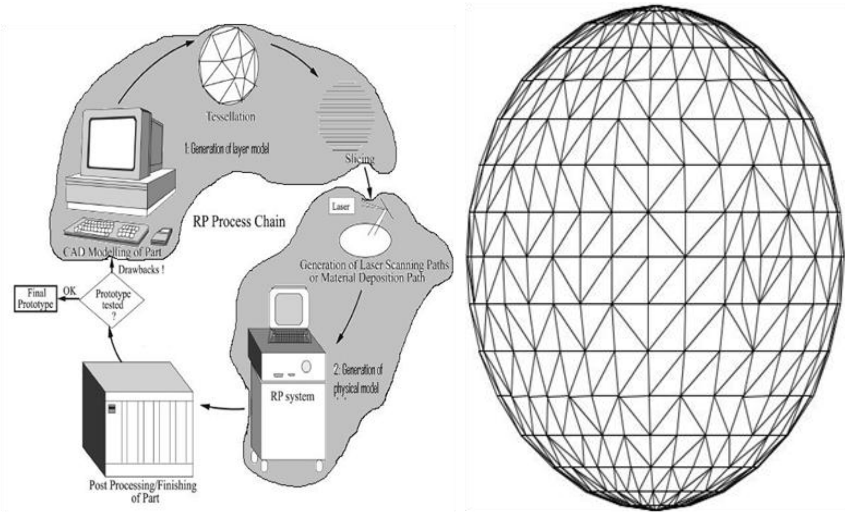


Figure 1: RP process chain and tessellation of a sphere [3]

Basic steps of RP

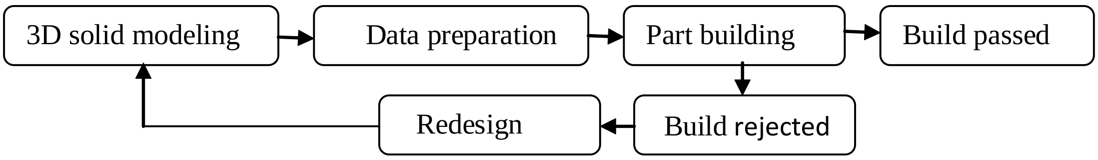


Figure 2: Process cycle

- In the RP process the 3D CAD is sliced into the thin cross sectional.
- The cross sectional is sent to the machine computer which builds part layer by layer.
- The first layer geometry is defined by the shape of the first cross sectional plane generated by computer.
- It is bonded to a starting base and additional layers are boned on the top of the first shaped according to their respective cross sectional planes.
- This process is repeated until final shape is not completed.

Design process of RP

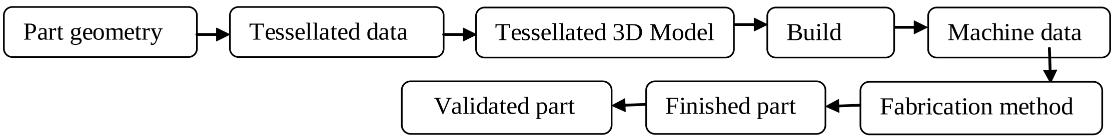


Figure 3: Design process of RP

- **Phase A**-Part geometry: - This phase addresses the information created during early design from conceptual to detailed design. In this phase geometry may exist as a CAD file.
- **Phase B** - Raw data: - This phase is the result of the creation of formatted information from which a 3D part may be created. Currently the transition from phase 1 to phase2 usually done in two ways exporting a CAD geometry file as an STL file or using a 3D scanner to collect raw image data.
- **Phase C**- Tessellated 3D model: - In this phase removing duplicate nodes, inserting missing nodes and creating what can be interpreted as a watertight solid from surface nodes.
- **Phase D** - Build file:- This phase consist of two parts the geometry information and the process in information. The geometry portion of the built file considers specifics such as support structures while the process specific information takes into consideration specifics such as build orientation and process parameters.
- **Phase E** - Machine data: - In this phase production information is introduced into the digital thread. This phase may include information such as machine code or other direct machine specific process plans.
- **Phase F**- Fabricated part: **-** This phase occurs when a part is fully realized. In phase an assimilation of all data and information used in the developed of a specific part including geometry processes and materials.
- **Phase G** - Finished part: **-** The transition from phase 6 to phase7 may be dependent on part performance requirements and on whether secondary processing such as heat treatment is needed.
- **Phase F**- Validated data: - This phase addresses the final product. The information added in this phase may include any mechanical testing or non-destructive evaluation on the manufactured part and the results of this test.

CLASSIFICATION OF RP PROCESSES:

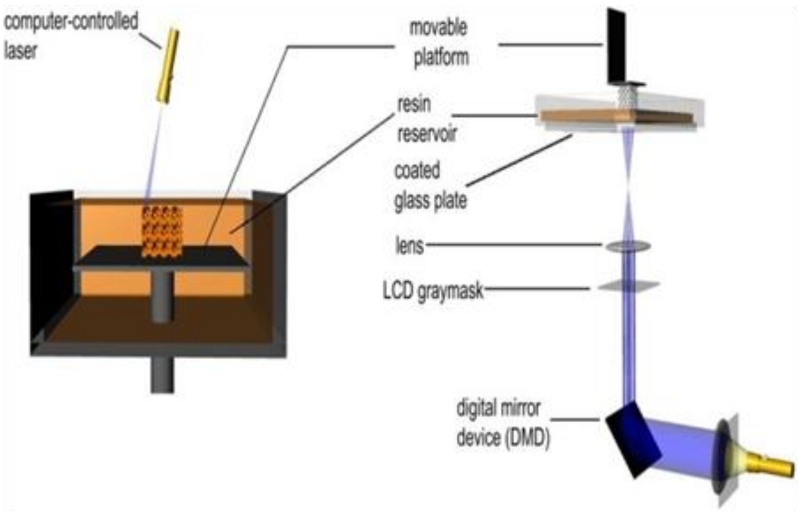
There are several different categories and processes of RP available, each appropriate for different materials and requirements.

- Sterolithography (SLA)
- Fused deposition modeling (FDM)
- Selective laser sintering (SLS)
- 3D printing
- Laminated object manufacturing (LOM)

Sterolithography (SLA):

Sterolithography-Sterolithography as discovered by Charles hull in 1980. Sterolithography machine consists of build platform, which is mounted on a container of resin, blade and ultraviolet head and argon ion laser are used. Fig (4) shows schematic diagrams of sterolithography setups. SLA machine is a low power based process. Its highly focused UV laser to produce a three dimensional objects in a vat of liquid photosensitive polymer.

Fused deposition modeling:
The technology was developed by S. Scott Crump in the late 1980s and was commercialized in 1990.Fig (5) shows that a fused deposition modeling machine are consist of nozzle, platform etc. In this process a plastic or wax material is extruded material a nozzle that traces the part cross sectional geometry layer by layer.



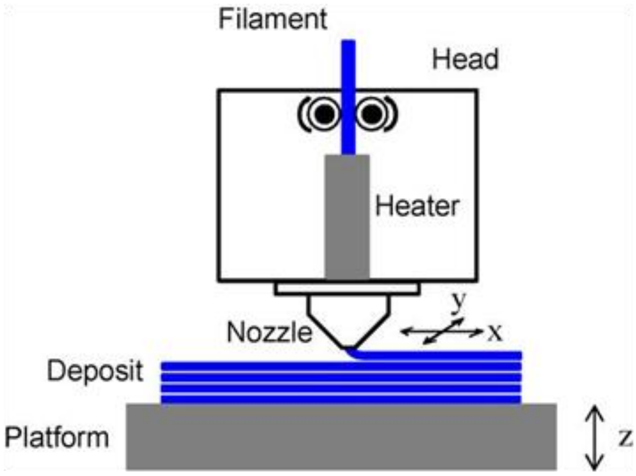


Figure 4: Block diagram ofSterolithography [4]Fig.5Block diagram of fused deposition modeling [5]

Selective laser sintering (SLS):-
Selective laser sintering (SLS) was developed and patented by Dr. Carl Deckard and academic adviser, Dr. Joe Beaman at the University of Texas at Austin in the mid-1980. The selective laser sintering machine consists of carbondioxde laser, powder chamber and nitrogen gas chamber.Fig (6) shows a systematic diagram of selective laser sintering. The fine powder is spread on the build platform by using roller. Before

laser scanning start, the entire bed temperature is raised just below melting point by infrared heater to minimize the thermal distortion. When laser scanning starts laser cures a slice by layer by layer, powder feed chamber raised and the powder speared on the build chamber by using counter rotating roller.

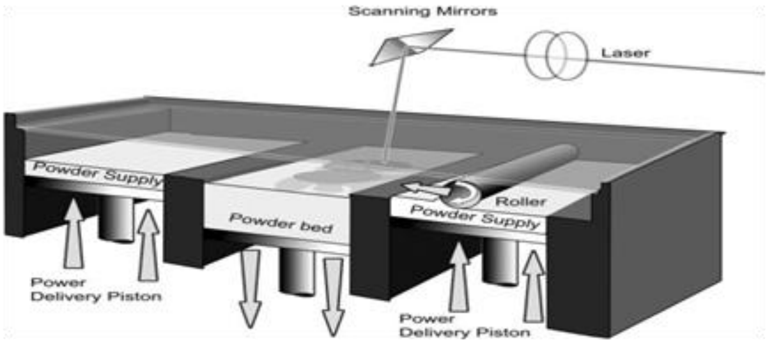


Figure 6: working of selective laser sintering [6]

3D printing:

Three dimensional printing (3DP) was developed at MIT and licensed to serval corporations. Three dimensional printing is similar to selective laser sintering. In fig (7) shows a working of three dimensional printing, In which powder is layered but a liquid binder is eject on a curing area. The powder particles lie in a powder bed and they are glued together when the binder is jetted. This process is similar also ink jet printer. The loose powder acts as support structures for the part.

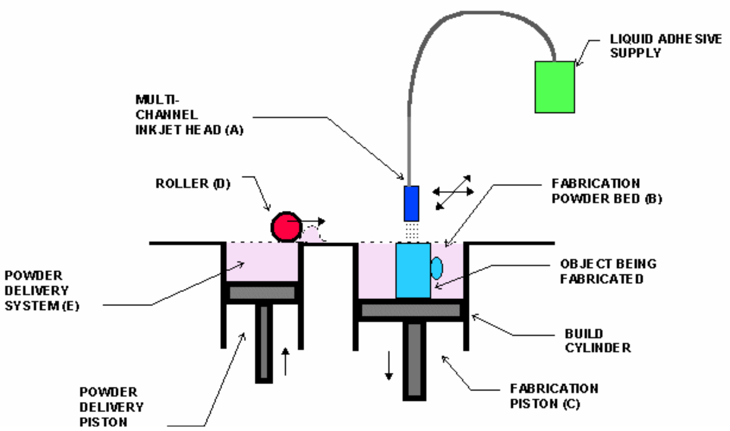


Figure 7: working of three dimensional printing [7]

Laminated object manufacturing (LOM):

Laminated Object Manufacturing is a RP system developed by Helisys Inc. Fig (8) shows a systematically diagram of laminated object manufacturing. Laminated object manufacturing consists of material supply roll, laser, and laminating roller and takes up roll etc. In this process raw material in a form of sheet. They layer are bonded together by pressure sheet and thermal adhesive coating. In which slices are cut in required counter from roll of material are using by carbondioxde laser beam.

COMPARISON OF RP WITH Non-conventional machining:-

Rapid Prototyping	**Non-Conventional machining processes**
• Produce a model by adding material layer by layer. • Addition process. • Unlimited complexity. • No tooling is required. • Parts assembled in a one stage. • Error or flaws can be detected at an early stage.	• Produce a model by removing material bit by bit. • Subtraction process • Limited complexity. • Tooling is necessary. • Parts assembled different stages • Error cannot check earlier stage

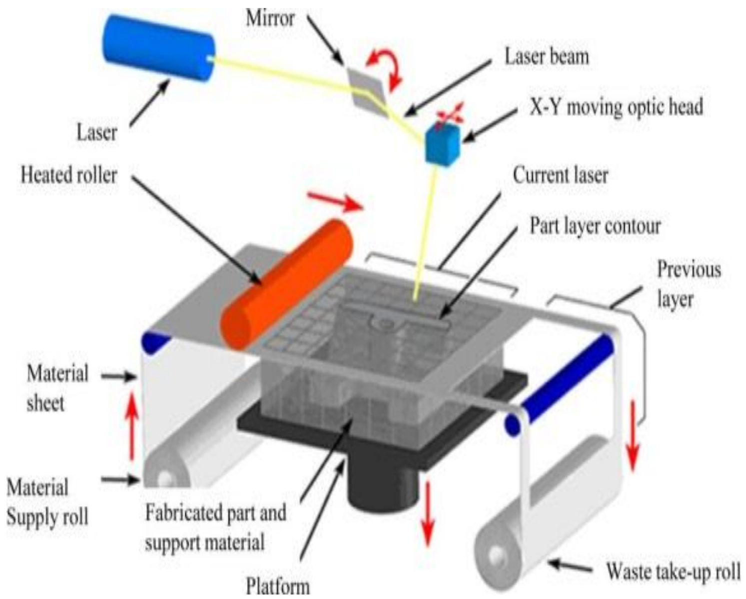


Figure 8: working of laminated object manufacturing [8]

Application of RP:-

➢ Rapid tooling:- A much anticipated application of RP is rapid tooling ,the automatic fabrication of Production quality machine tools.

➢ Medical applications: - Applying RP process in the medicine is a new and exciting field. Medical imaging, computer assisted tomography and magnetic resonance imaging provides high reevaluation images of Internal structures of the human body.

- Rapid manufacturing:- A natural extension of RP is rapid manufacturing, the automated production of Saleable products directly from CAD model.

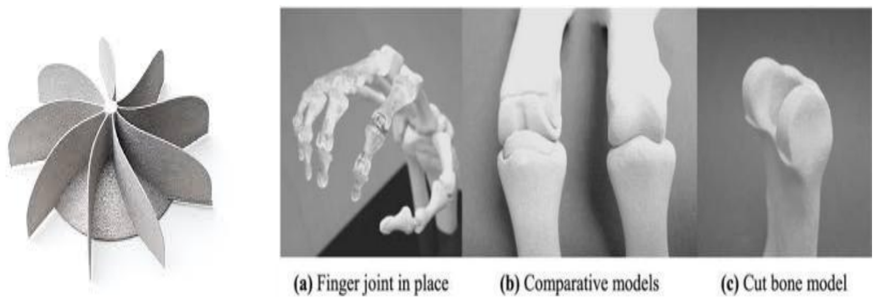


Figure 9: design of fan [9]and design of bio medical parts [10]

Reference:-

1. S. Singh, K. Singh,Review of Computer Aided Design (CAD) DataTransformation in Rapid Prototyping Technology,International Journal of Information & Computation Technology.1(2) (2011), 11-16.
2. S. Singh, V. S. Sharma, A. Sachdeva, Progress in selective lasersintering using metallic powders: a review, Materials Science and Technology, (2016):. http://dx.doi.org/10.1179/1743284715Y.0000000136
3. PM Pandey: Rapid prototyping technologies, applications and part deposition planning. http://web.iitd.ac.in/~pmpandey/MEL120_html/RP_document.pdf
4. Ferrg P.W Melchels, Jan feijen, D. W. Grijpme: A review on sterolithography and its applications in biomedical enginerring; Doi: 1016/J. Biomaterials.2010.04.050
5. D. K. Ahn, J. Hwekween, S. Kwon, S. lee: Representation of surface roughness in fused deposition modeling; Jouranal of material processing technology 209 (2009):5593-5600.
6. R.D Goodridgre, C.J Tuck, R.J.M Houge: Laser sintering of polyamide and other polymers; Progress in material science 57 (2012) 229-267.
7. D.Chandramohan, K. Marimuthu: Rapid prototyping: Aoverview and its applications in orthopedics; International journal of advanced enginerring technology. Vol.111,(2011)435-448.
8. DaekenAhn, Jin hwe KWEAN, Jinhochoi, Seokheelee : Quantification of surface roughness of parts processes by laminatedobject manufacturing; Journal of material processing technology 212 (2012) 339-346.
9. I.gibson L.K Cheung S.P Chow, W.l Cheng, S.L Beh , S.H Lee: The useof rapid prototyping to assist medical applications ; Rapid prototyping journal (ISSN 1355-2546)