IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X
PP. 26-32
www.iosrjournals.org

A Review on 3d Printing

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Abstract: *3D printing, also called additive manufacturing (AM), is gaining huge attention from leading manufacturers of the world due its high potential to revolutionize the world. In this report firstly, the term AM is defined and its significance is discussed. Some historical background of the technology is also highlighted here. Then the process of 3D printing and the materials used in the manufacture of 3D printed objects are stated. Given the attention around additive manufacturing (AM), organizations want to know if their products should be fabricated using AM. To facilitate product development decisions, a reference system is shown describing the key attributes of a product from a manufacturability stand-point: complexity, customization, and production volume. Implications for product development and manufacturing business approaches are discussed. Finally, a conclusion is made based on the references studied and future scope of this technology has been highlighted. Last but not the least, the various fields in which 3D printing is significantly used such as Medical fields, Food items, Automobile sector*

Keywords: *Layer, Rapid prototyping, SDL, SLS, STL*

I. Introduction

3D printing is the "process of joining the materials to make object from 3D model data, layer by layer". Technology has affected recent human history probably more than any other field. Various technologies and creative inventions have made our lives better in many ways, opened up new avenues and possibilities. It is widely believed that 3D printing or additive manufacturing (AM) has the vast potential to become one of these technologies. Experts in the field have that claimed 3D printing would replace many of the existing traditional manufacturing methods and revolutionize design and impose economic, social, environmental and security implications to our day to day lives.

II. Litrature Review

In their work titled "3D printing of polymer matrix composites: A review and prospective" have discussed about'additive manufacturing (AM)' [1] which is very trending topic in today's manufacturing world. They have provided insight into history of 3D printing and then discussed about importance of the technology. Further they have discussed about the number of ways in which 3D printing is done and materials used for the process chosen. Also advantages of 3D printing as compared to conventional methods of manufacturing are stated. Then numerous applications and future scope of the technology is outlined.

In their work titled "Economic Implications of 3D printing: Market structure Models in light of additive manufacturing Revisited", [2] have made detailed analysis about the parameters of additive manufacturing technology. From the study of previously established economic models, they have given technological and economic characteristics of AM. Also, four key principles that critically assess the effects of AM to the manufacturers at industry level are given. By their remarkable work they have provided a great support to a firm to evaluate their current manufacturing process against the potential of 3D printing technique to maximize their profit margin.

In this paper [3] 3D printers allow researchers to produce parts and concept models rapidly at low-cost and allow rapid prototyping of many designsfromthecomfortoftheirdesk.3Dprintingtechnologieshave been explored for a wide range of applications including robotics, automobile components, firearms, medicine, space, etc. Owing to lower costs and increased capabilities of 3D printing technologies, unprecedented opportunities in the world of oceanography research are being created. Some examples include 3D printed components being employed in autonomous underwater (or surface) vehicles 3D printed replicas of marine organisms being used to study biomechanics, hydrodynamics, and locomotion; and 3D printed coral reef replicas being used to restore damaged coral reefs.

The paper provides the review of literature concerning the application of 3D printing in education system. In The review [7] are identifies that 3D printing is being applied across K-12 spectrum and in universities, as well as libraries and in some educational systems. The review is also finds that 3D printing is being used to teach both students educators about 3D printing is being used to teach both students and educators about 3DP and 3DP skills. University libraries in particular are rich source of insight into their adoption. 3D

printing is also is used to develop 3D skills 3DP methodologies for creativity and to create artefect that can be used as a learning aids or as assistive technologies in the special learning setting.

In their Work [8] they have discussed about the beneficial ability to build parts with geometric and material complexities that could not be produced by subtractive manufacturing processes. Through intensive research over the past two decades, significant progress has been made in the development and commercialization of new and innovative AM processes, as well as numerous practical applications in aerospace, automotive, biomedical, energy and other fields. This paper reviews the main processes, materials and applications of the current AM technology and presents future research needs for this technology. with desired material properties for evaluation and testing, as well as to manufacture small or medium quantities of end-use products. Currently, the direct fabrication of functional end-use products has become the main trend of AMtechnology.

III. Advanced Manufacturing 3d Printing

Different methods adopted for 3d printing: [1]

- Stereo lithography (STL)
- Selective laser sintering (SLS)
- Fused deposition modeling (FDM)
- Selective Deposition Lamination (SDL)

Stereo lithography

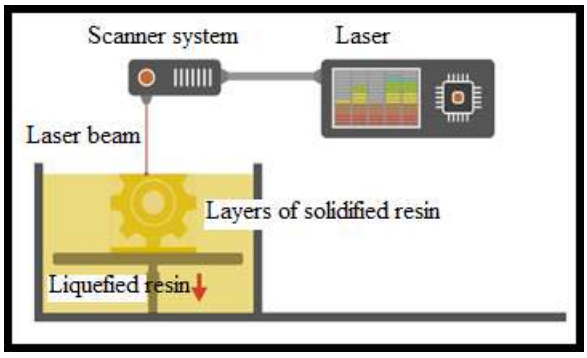

Fig 1 – Stereo lithography (STL)

Ultraviolet light is used to form the object in Stereo Lithography .The laser from the scanner system is come in contact of the liquified resin the it will solidify into the layers. The layers will combine to form a 3D model object which we want. The formed layer goes down in the liquid and hence by the phenomenon of the liquid it will come back to the surface. And the process continuous till the object form.

Selective laser sintering (SLS)

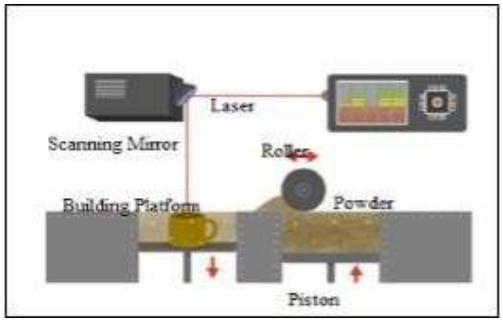

Fig 2 – Selective laser sintering (SLS)

There is the two-powder blow for the Selective Leaser Sintering and Elevator is attached to it for lifting purpose. Roller is doing the work of leveler, and also has some temperature to heat the powder. which is to level the powder layer. CO_2 laser is used in SLS technique. The piston from the right side goes upward to push the powder to the left. After the contact of laser and the powder Object will form on the building platform.

3.3 Fused Deposition Modeling

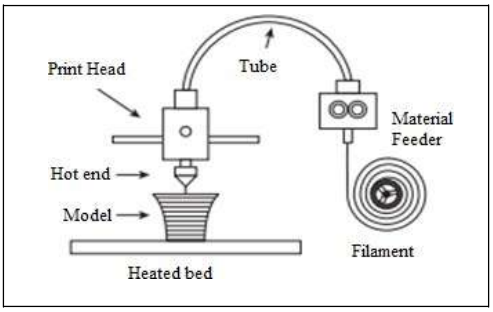

Fig 3 – Fused deposition modeling (FDM)

There is the Filament which goes in the tube with the help of material feeder. After the extrusion process this wire goes to the print head which have the hot end at the bottom. Wire gets melted there to form the object. Formation of the object is occurred layer by layer. The heated bed goes down after the formation of a layer. And the process continues till the object form.

3.4. Selective Deposition Lamination (SDL)

Selective Deposition Lamination (SDL) is a proprietary 3D printing process developed and manufactured by Mcor Technologies. The SDL 3D printing process builds parts layer by layer using standard copier paper. Each new layer is fixed to the previous layer using an adhesive, which is applied selectively according to the 3D data supplied to the

. When this cutting sequence is complete, the 3D printer deposits the next layer of adhesive and so on until the part is complete. SDL is one of the very few 3D printing processes that can produce full colour 3D printed parts, using a colour palette.

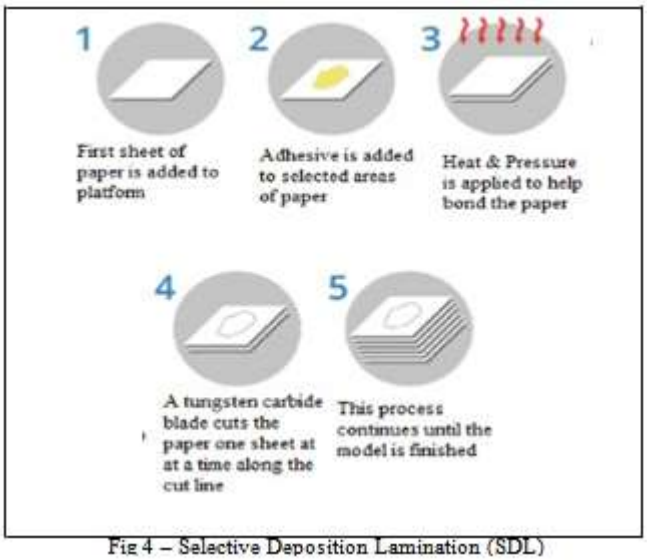

Fig 4 – Selective Deposition Lamination (SDL)

Fig 4 – Selective Deposition Lamination (SDL)

IV. 3d Printable Materials

Gypsum

Gypsum also called sandstone is a rigid and delicate material which is made from powder. It is naturally white, but it now comes in many different colors. Layers of 100 mm are possible with a 2-mm minimum wall thickness, They are constructed from a white, very fine, granular powder. This material in not the watertight.

Stainless steel

Stainless steel is a very durable alloy material made directly from stainless steel powder. Coloring options

include gold and bronze plating. Layers of 200 mm are possible with a 3-mm minimum wall thickness. Stainless Steel is made with multiple steps or from powder directly, they have colouring option like gold and bronze plating. Stainless steel can not be recycled and not food safe.

Titanium

Titanium is the strongest material which can be directly laser sintered. Layers of 30 mm are possible with 0.2-mm minimum wall thickness. Use for the direct metal laser sintering. Shape of titanium powder use in 3DP is generally spherical and the melting point is 2477 °C.

Ceramics

Ceramics are rigid and delicate. First the ceramic is printed and then the surface is glazed. Typically, the material is white with 200 mm layers with 3-mm minimum wall thickness capable of being produced. 3D printing material that has a shiny appearance, is heat resistant, recyclable and food safe. Models made out of ceramics are constructed from alumina silica ceramic powder, then sealed with porcelain and silica and glazed. A perfect material for home decor items and tableware.

Lay Wood

Lay Wood is a specially developed 3D printing material for entry level extrusion 3D printers. It comes in filament form and is a wood/polymer composite (also referred to as WPC).

Paper

Standard A4 copier paper is a 3D printing material employed by the proprietary SDL process supplied by Mcor Technologies. The company operates a notably different business model to other 3D printing vendors, whereby the capital outlay for the machine is in the mid-range. The glued paper use in the 3DP is completely reusable.

IV. 3d Printing Technique

First of all it is necessary to create a computer model for printing the object. For doing this computer aided software like AutoCAD, 3DS Max, 3D Scanner can be used. CAD output is in form of electronic files. After the object file is created, the file needs to be modified. The object file contains numerous curves which cannot be printed directly by the printer. The curve has to be converted to STL (Stereo lithography) file format. The STL file format removes all the curves and it is replaced with linear shapes. Then the file needs to be sliced into layer by layer. The layer thickness is so processed and generates the special coordinates. These coordinates can be processed by a controller to generate required signal to the motor for driving extruder. This layer by layer generates a complete object.

Fig. 5- 3D Printing Techniques

V. Current Applications Of 3d Printing

Aerospace Sector

Aerospace sector was an early adopter of 3D printing technologies in their earliest forms for product development and prototyping. Because of the critical nature of aircraft development, the R&D is demanding and strenuous, standards are critical and industrial grade 3D critical and industrial grade 3D printing systems are put through their paces.

Medical Field

Due to the customization and personalization capabilities of the technologies and the ability to improve people's lives as the processes improve and materials are developed that meet medical grade standards. The technology used to manufacture both stock items, such as hip and knee implants, and patient-specific products, such as hearing aids, personalized prosthetics and one-off implants for patients suffering from diseases such as

osteoarthritis, osteoporosis and cancer, along with accident and trauma victims.

Fig.6 – Printing of human ear by 3D printing technique

Jewellery

Traditionally, the design and manufacturing process for jewellery has always required high levels of expertise and knowledge involving specific disciplines that include fabrication, mould-making, casting, electroplating, forging, silver/gold smithing, stonecutting, engraving and polishing.

Fig.7- 3D printed Jewellary

Architecture

Architectural models from long span have been a staple application of 3D printing processes, for producing accurate demonstration models of an architect's vision. 3D printing offers a relatively fast, easy and economically viable method of producing detailed models directly from 3D CAD, BIM. other digital data that architects use.

Fig. 8- 3D printed Architecture Model

Fashion industry

3D printed accessories including shoes, head-pieces, hats and bags have all made their way on to global catwalks. Even some more visionary fashion designers have demonstrated the capabilities of the tech for haute couture - dresses, capes, full-length gowns and even some under wear have debuted at different fashion venues around the world.

Fig. 9- 3D printing is Fashion Industry.

VI. Advantages And Challenges To 3d Printing

Advantages	Challenges
• Small batches of customized products are economically attractive relative to traditional mass production methods • Direct production of 3D CAD Model mean that no tool and molds are required, so there are no switch off cost. • Design in the form of digital files can be easily shared, facilitating the modification of customization of components and the products. • The additive nature of process gives material savings, as does the ability to use waste material. (i.e. Powder, Resin) • Novel, Complex Structure, such as free form enclosed structure, and channels lattices are achievable. • Final parts have very low porosity. • Making to order reduces inventory risk, with the no unsold finishing goods, while also improving revenue flow as good are paid for prior to being manufactured. • Distribution allows direct interaction between local consumer/ Client and producer.	• Cost and speed of production • Support structure material cannot be recycled so need to be minimized through a good build up operation. • Validation of Mechanical and thermal properties of existing material and AM technology. • Support structure material cannot be recycled so need to be minimized through a good build up operation. • Defects in the designer and engineer skilled in the additive manufacturing.

VII. Conclusion

If AM technology unleashes its potential along all parameters in a manufacturing firm's payoff function, a monopolist can increase profits by offering customized products with a price premium at no cost penalties in manufacturing as long as marginal costs of production, processing time, and the probability of a defective batch are not excessively high.

Entry of manufacturers using AM technologies will lead to lower market prices as the entrant lowers the upper price barrier.

In a market where many firms have adopted AM, the competitive position is determined by other costs than manufacturing costs; in particular, procurement and delivery costs. If delivery costs for finished goods exceed procurement costs for raw materials, local production close to the customer becomes beneficial.

Acknowledgement

It is my great pleasure to acknowledge sense of gratitude to all, who have made it possible for us to complete this seminar with success. It gives me great pleasure to express my deep gratitude to my seminar guide Prof. P. Z. LOKHANDE for his support and help from time to time during seminar work. It is my pleasure to acknowledge sense of gratitude to Dr. P.S. Purandare our Head of Department, and Principal Dr. S. M. Deshpande for their great support and encouragement in work.Finally, yet importantly I would like to thank all Staff Members and all our colleagues for their valuable suggestions and support.

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