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ROLE OF 3D PRINTING TECHNOLOGY

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Abstract— The research paper is on “3D Printing” which has become a remarkable topic in today’s technological discussion. The paper emphasizes more on the applications of the 3D Printing technology. 3D printing is an excellent approach which will help in the overall development of the country. In this paper, we will learn about the history and principles of 3D Printing technology. We shall also see the advantages of 3d Printing and how it is better approach than conventional methods of manufacturing. There are many different technologies of 3D Printing technology that has been highlighted in this paper. The paper has also outlined the impact of 3D printing technology over the mass and the society and how it has contributed towards the “smart cities Mission”.

Keywords—3D Printing; 3D Printers; Stereolithography; Additive Manufacturing.

I. INTRODUCTION

3D printing also known as additive manufacturing is a fascinating and attractive technology used for constructing a three dimensional solid object from a digital model. It consist of three phases – Modelling, printing & finishing the product. 3D printing uses a layering technique where an object is created by successive layers of materials. The main material utilized in the development of 3D objects is plastic, though alternative materials like metals of various sorts and additionally organic matter like carbon are used now days.

In the approach of smart cities mission, the main incentive is to promote cities that provide core infrastructure & give decent quality of life to its citizen, a clean & sustainable environment & application of “smart solution”. You can consider an example, how a city will be affected if the majority of people engage themselves in 3D-printing world. Is 3d printing possibly the new industrial revolution? I think it is. It is well said, “3d printing, a kidney today is something like trying to build an iPhone with Lego Blocks”.

The world of 3D printing is growing exponentially & it impacts not only how buildings are built but their looks & better surrounding. It has been applied in the various sectors like research, education, construction, fashion & many others. Interestingly, the cost of acquiring 3D printers has been decreasing with the advancement of technology. 3D printing has also a tremendous usage in the field of medicine, from the field to bionics to digital dentistry.

II. PRINCIPLE OF 3D PRINTING

A. Working Process of 3D Printing

The main principle of 3D printing is stereo-lithography, which was outlined by Charles Hull in 1984 as a system for generation of 3 dimensional objects by making cross sectional pattern of the object to be formed. 3D Drawing software is used to generate 3D objects which are first split into layers and then these layers are successfully printed by the machine.

The very first step followed in 3D printing is the generation of 3D printable model. The models are produced by using computer aided design software. Then the CAD drawing is converted to STL format. STL is a file format developed for 3D Systems in 1987 for use by its stereo lithography apparatus (SLA) machines. Here we can customize various aspects of design such as layer thickness, outer finish, temperature, etc. So once the STL file is generated, the object is ready to be printed.

The second important step is printing. The STL file is fetched into the printer and according to the layers, the machine starts out laying the plastic out layer by layer. The layers are automatically mold to get the final shape. The final phase consist of finishing the product.

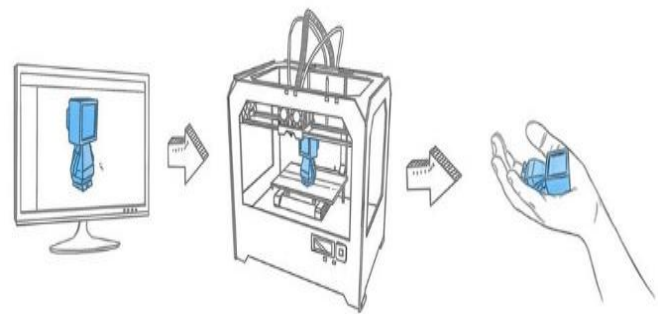


Figure 1: Working process of 3D printer

B. 3D Printers

3D printer is a tool or a device which is used in 3d printing process. In the rapidly evolving business world, you need a 3d printer that puts you ahead of the competition.

A very important question that arises is which 3D printer is right for use? A printer that provides high accuracy and better quality with excellent printing capacity should be preferred for 3d printing.

There are many 3d printing technologies or some may call them different types of 3d printer.

- Stereo lithography
- Digital light processing(DLP)
- Electronic beam melting(EBM)
- Laminated object manufacturing(LOM)
- Fused deposition modeling(FDM)

Now here arise a question what materials do 3D printers use? 3D printers can use a wide range of materials like plastic, resins, ceramics, titanium, bronze, stainless steel, gold, etc. The most popular material used is plastic.



Figure 2: Different types of 3D Printers

1) Stereo lithography:

Stereo lithography is an oldest 3D printing method in history of 3D Printing. The process of printing involves a uniquely designed 3D Printing machine called stereo lithography apparatus that converts liquid plastic into solid objects.

Stereo lithography can help you to turn your models into real 3D printed objects. It doesn't require too much of time to produce an object and its cost is relatively cheap as compared to other methods.

2) Digital light processing(DLP):

This technology was created by Larry Hornbeck in 1987 and is very popular nowadays. It uses digital micro mirrors laid out on a semiconductor chip. This technology is very fascinating for movie projectors, cell phones & 3D printing. The material used for printing is liquid plastic & the printing speed is impressive as well. The results are robust and have excellent resolution.

Examples of DLP are Mycroft high resolution 3D Printers, Luna vast XG2, etc.

3) Fused Deposition Modeling(FDM):

Fused Deposition Modeling technology was developed & implemented by Scott Crump in 1980. FDM can be used not only to print functional prototypes, but also concept models.

3D printing machine that uses FDM technology build objects layer by layer from the very bottom up by heating & extruding thermoplastic filament. FDM technology is widely spread nowadays in variety of industries such as automobile companies, food companies, etc. this technology is said to be simple to use and environment friendly.

III. APPLICATIONS OF 3D PRINTING

1. Medical

In the past time, prototypes were used in medical design work, but 3d printing provides a faster system that allows manufacturing medical models.

Medical devices are very difficult to produce, due to small size and intricacy of the parts. But 3d printing allows manufacturing difficult parts from 3D CAD models. There are many things in medical which can be manufactured like low cost Prosthetic parts, tissues with blood vessels, drugs, bone, ear cartilage, medical equipment's, synthetic skin, etc.

2. Construction

With the help 3D printer, we can significantly reduce the time & expenses in producing building models which requires highly delicate details. 3D Printers is a better approach than traditional methods.

By Printing more detailed models, this will help the clients to visualize the final project in a better manner, ultimately helping the organizations to win more business. 3D Printing promotes innovative model making.

3. Aerospace Design

The 3D Printing technology can be widely used in aerospace design. We can replace the expensive CNC milled parts with plastic parts, which dramatically will reduce the production cost. The printed plastic parts also perform better, weigh less & provide better electrical insulation.

4. Education

Nothing conveys an idea better than holding it in your hand. 3D printing is an effective way to enrich learning virtually. 3D printing allows students to create prototypes of items without the use of expensive tooling required in subtractive methods. Students design and produce actual models they can hold. The classroom environment allows students to learn and employ new applications for 3D printing. Students can boost their career opportunities by showing potential interest in 3D Printing technology. This will enable them to grow and thus will increase the employability rate.

5. Automotive design

Additive manufacturing enables a continuous factory production for individual parts and prevents losses which might take place during a normal production process. Speed is another factor, because a faster process means more continuity to the design and thus to the overall development process. 3D printing enables more flexibility in the design and thus will revolutionize the auto industry.

6. 3D Animations

3d printing has equally contributed in the 3d animation. The requirement of the animation industries is for highly detailed models with good surface finish so that models can be used for mock ups, film shoots, etc. This is made possible with the 3D Printing technology. Now it is easy to make 3d animations in very less period of time.

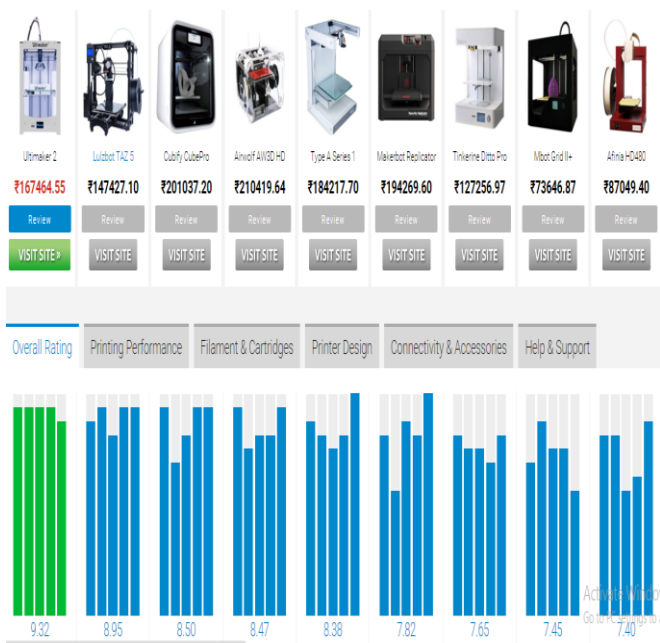


Figure 3: Rating of 3D Printers

IV. ADVANTAGES OF 3D PRINTING

1. Complex manufacturing:

Complete 3d models can be manufactured including the hollow parts that could not be made by hand in one piece, even by skilled engineers or craftsman. Complex working models can be manufactured using 3d printing technique.

2. Saves money:

The 3d printing process allows the creation of tools and models at very low cost then traditional manufacturing which ultimately saves expenditures.

3. Mitigate risk:

Being able to verify a design before investing expensive tools is worth. Printing a production-ready prototype builds confidence before making large investments.

4. Build your imagination:

In the modern boom of digital art & design, the possibilities are not only accelerating but limitless. One can now 3d print almost anything they imagine after drawing it up virtually. The 3d printing process allows the creation of tools and models at very low cost then traditional manufacturing.

V. COMPARISON BETWEEN 3D PRINTING & TRADITIONAL METHODS OF MANUFACTURING

There are different 3D manufacturing methods like selective laser Sintering (SLS), Binder Jetting, Fused Deposition modeling, etc. The traditional methods of manufacturing are injection molding, CNC Machining, plastic forming and plastic joining. Below is the comparison between 3D methods and traditional methods of manufacturing.

Process	Description	Details	Advantages	Disadvantages	Applications
Selective Laser Sintering	Laser fusion in a powder bed	Layers : 0.06-0.15 mm Features : 0.3mm Surface : rough Print speed : fast	Strong Complex parts Large build volume Parts can be stacked in build volume Living hinges and snap features possible	Grainy surface finish	Electronics housing Mounts Custom consumer products Aerospace hardware
Stereo lithography	UV laser scanning vat polymerization	Layers : 0.06-0.15 mm Features : 0.1mm Surface : smooth Print speed : average	Fine detail Smooth surface finish	Weak parts Susceptible to sunlight and heat	Medical/dental products Electronics casings Investment casting patterns Art
Binder Jetting	Particle binding in a powder bed	Layers : 0.089-0.12 mm Features : 0.4mm Surface : rough Print speed : very fast	Multicolor prints Fast print speed	Very weak parts Rough surface finish	Full color prototypes and objects Figurines
Fused Deposition Modeling	Extruded layers of thermoplastic	0.1-0.3 mm layers Surface : very rough finish Print speed : slow	High part strength Low cost	Poor surface finish Slow printing	Electronics housing Mounts Custom consumer products
Injection Molding	Material mixed and forced into a mold	Surface : excellent finish Tolerance : 50 um	Broad material selection High volume High tolerance Great surface finish	High start-up cost Long lead time Thin walled parts only	Automotive Aerospace Electronics Packaging Containers
CNC Machining	Material removal	Surface : smooth Tolerance : 25 um	All materials compatible Very high tolerances Reasonable turnaround	Difficulty with complexity High equipment cost Lot of scrap	Jigs and fixtures Automotive Aerospace
Plastic Forming	Stretched and formed plastic sheets	Surface : smooth Tolerance : typical 1mm	Very large parts Affordable price	Thermoplastics only Limited shape complexity Thin walled parts only One sided control	Packaging Containers Panels
Plastic Joining	Welded or adhered plastic parts	Dependent on semi-finished products	All materials	Time consuming High labor cost	Automotive Electronics Medical



VI. CONCLUSION

In this paper, we have analyzed the impact of 3D Printing technology on the society & economy. In the first section, we have highlighted the introduction of 3D printing & need of 3D printing. In the second section, we have depicted the principle & working of 3D printers along with various technologies of 3D printing. We have also highlighted all the applications of 3D Printing. Hence we can conclude that 3D Printing is an important technology which has significantly influenced the human life, economy & modern society. It gives everyday consumers the power of manufacturing.

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