A Review on 3D Printer- A New Technology

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***Abstract*: 3d Printing is also called additive manufacturing is simply a process of adding layers upon one another, in a desired manner to print three dimensional solid figures from CAD designs. 3d printing would be manufacturing without any boundaries. Prototyping which would take up to weeks in the old days can be done in a matter of hours using 3d printing. The innovators today are only limited by their imagination. anything they can think of can be printed irrespective of the complexity of the shape.3d printing offers freedom to create. Keywords: 3d Printer, types, Applications**

1. INTRODUCTION

3d Printing is also called additive manufacturing is simply a process of adding layers upon one another, in a desired manner to print three dimensional solid figures from CAD designs.3d printing would be manufacturing without any boundaries. Prototyping which would take up to weeks in the old days can be done in a matter of hours using 3d printing. The innovators today are only limited by their imagination. anything they can think of can be printed irrespective of the complexity of the shape.3d printing offers freedom to create. From kids in school rooms to researchers in their high tech labouratories, all find it to be beyond compare [1-4].

2. HISTORY:

Charles hull first invented stereolithography apparatus back in 1983 and attained a patent for it in 1986.he later went onto become the CEO of 3DSYSTEMS,which is still a giant in the 3d printing field. In 1987,Carl Deckard of the University of Texas filed for a patent in selective laser sintering(SLS).in 1992 Scott Crump received the patent for FDM printing. up to the year 2007,the 3d printer were really expensive and many quite frankly had no idea what it was. It was much similar to what a computer was 20 year back[2-4].

2.1 The RepRap project:

Figure 1. Professor bowyer and vik oliver of the RepRap community model

The Replication Rapid-Prototyper Project also called the RepRap project was initiated by Professor Bowyer of the University of Bath, London with the goal of making 3d printers at low costs so that it will be available to everyone on the planet as in figure 1.. RepRap concept was to print another 3d printer using a 3d printer, like in the picture above were the printer on the left printed out the parts for the printer on the right. RepRap project is an open source, online community that actively shared designs, fixed bugs and shared new ideas. They were able to bring down the prices rapidly, making efficient FDM 3d printers affordable by all. In 2004, they released their first affordable 3d printer based on the RepRap concept, called the BfB RapMan 3D printer. It was soon followed by companies such as Makerbot, Ultimaker etc. Many companies now offer the facility and end user are growing .designs, print speed, print quality ,printable material are all variables being competed among companies. Though the professional grade printers are a bit pricy, RepRap printer are available now for less than the price of a smart phone [2-5].

3. HOW IT WORKS:

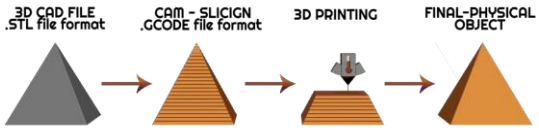

Figure 2. Work process

a. A 3d model of the design is made using modeling software such as fusion 360, blender soli works etc. its also possible to download it or even scan an object using a 3d scanner which would be an expensive option. The file is then saved in STL format (Stereo Lithography). The 3d model is converted into x, y and z coordinates using slicing software's such as cura, slicer etc. the file containing the x, y and z coordinates is called a Gcode file, saved in the system with a Gcode extension.
b. The gcodes are then fed to the printer using either a USB cable or a SD card. the printer lays the resin at the described XYZ coordinates.
c. The solid object is then removed and finishing processes such as removal of supports, dipping the print in solvent solution are performed if necessary[2-6].

4. TYPES OF 3D PRINTERS:

a. FDM

FDM (fused deposition modeling) is the popularly used technique for 3d printing as shown in figure 3. It works by passing a plastic tube through a heated nozzle at around 200 degree Celsius, the heated nozzle which then places the melted filament at pre-programmed locations. the filament

leaving the nozzle is cooled using a fan. a new layer is then added on top of this cooled layer. Layer upon layer is placed until the desired shape is reached [2-8].

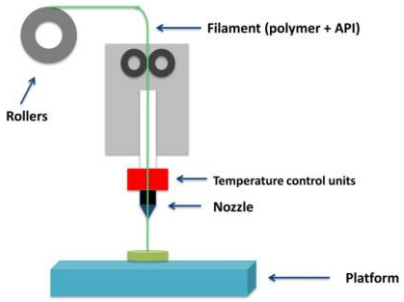

Figure 3. FDM printing

b. SLA

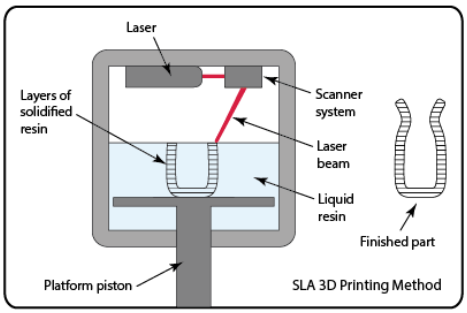

Figure 4: SLA

It's similar in working to a FDM printer except for the fact that instead of a nozzle we have a laser and instead of a plastic filament roll we have a liquid resin as shown in figure 4. The laser shines ultraviolent light in the desired shape to light-sensitive resin that solidifies in the presence of UV light. Where ever the liquid hits, it turns from a liquid to a solid. after the bottom layer is solidified on to the platform, the piston moves allowing for a new layer to be formed on top of the old one. This continues till the desired solid shape is attained [2-8].

c. Selective Laser Sintering(SLS):

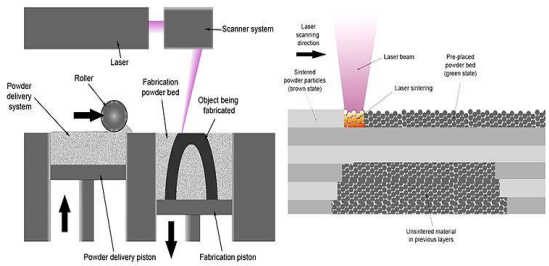

Figure 5. Selective Laser Sintering (SLS)

SLS is a popular technique used in metal printing as shown in figure 5. It is used to bind plastic, ceramic, metal or even glass powder using a high power laser. Fine metal powder is spread evenly on the platform. the high power laser moves along the programmed coordinates specified in the Gcode file, fusing the metal particles .the powder is usually preheated to temperature lower than the melting temperature of the metal powder to make it easier to raise the temperature of the heated area. After the specified area has been melted, a roller adds another layer on top of the old one. This goes on till the specified shape is reached. SLS does not require support material as it is always covered in powder. one key advantage of SLS is that it supports nesting, that is parts to be built within other parts, which were not possible with other techniques. Materials used: nylon, polystyrene, steel, titanium, alloy mixtures etc. [2-8]

5. SCOPE

5.1. Micro batteries:

In 2013, researchers at the University of Illinois and Harvard were able to 3d print a lithium-ion battery the size of a grain of sand. The team created a special ink with lithium ion nano particles in it. Using a custom made 3d printer they were able to print stacks of electrode each thinner than a human hair. they then put the stack in an electrolyte solution to provide a medium for the current to pass. These micro batteries were found to just as efficient as a regular lithium-ion battery. These can have application in medical implants, miniature cameras and so on to all the projects that had to be put on hold due to lack of availability of a power source small enough [2-9].

5.2. Efficient water filters:

Water filters filter water by passing it through a membrane .most filters get clogged up easily bringing down its ability to pass water through. In 2014, a Singapore based company was able to print out a membrane made out of titanium dioxide with has the ability to kill microbes when exposed to UV light. it also has the ability to break down organics particles to prevent clogging of the filter. it has better efficiency and lifespan compared to conventional filters

5.3.3d Printing in Space:

In 2014, astronauts carried out 3d printing aboard the international space station, making 3d printing a suitable solution to a variety of problems in space. spare parts, damaged equipment parts etc. can now be printed in space, which otherwise would have been a costly affair. The European space agency is planning on using 3d printing technology to build a colony on the moon in the near future. They plan on first collecting lunar legorith (moon rock) as the raw material and later using it to print colonies.

6. APPLICATION

6.1. Prosthetics:

e-NABLE is an online 3d printing community which provide free 3d printed prosthetics to children and adults who are missing fingers, hands or limbs. Volunteers from all over the globe participate, sharing designs, printing parts and lending a hand to the less fortunate. With over 5400 contributors, the community is on track to provide prosthetics to over 2000 people over the next two years.

6.2. Rapid Prototyping:

This has always been the popular use for 3d printing .this ability of a 3d printer to print out a model moments after

finishing a CAD design helps designers get a feel of the what they want and the flaws they want to fix before they sent it to mass production.

6.3. Medicals:
Bio texture modeling is a technique of 3d printing to simulate the texture and wetness of human organs allowing the doctor even dissect the organs before an actual operation.

6.4. Cars:
Strati by Local Motors, US is the worlds first electric car where 3d printing was heavily utilized. unlike in conventional cars where the cost of replacement of a car part would eventually be about the same of the car, the solution offered by 3d printed cars is fascinating. if you get in an accident and damage any part, simply 3d print that particular part.

6.5. Military:
R.A.M.B.O (Rapid Additively Manufactured Ballistics Ordnance) is a 3d printed grenade launcher created by the US Army. It consists of about 50 individual 3d printed parts except for the spring and the fasteners. it was made using metal sintering process.

6.6. Architects:
Architects can print out miniaturized versions of their building . he can get a much more understanding of the design when he can actually touch and see it in real life, something an artist would greatly appreciate.

6.7. Metal parts:
Any metal component such as ball bearing or even an engine block can now be printed, depending on the size constraint on the printer of course. It provides the perfect solution to meet today's demand for replacement and spare parts which are very hard to come by.

6.8. Jigs and fixtures:
Over 2016, Volkswagen Autoeuro has saved around 150,000 Euros by using 3d printer to print their jigs and fixtures. The company earlier relied on third party companies to get their jig and fixtures which often took weeks to complete. This held up production and this eventually cost the company money. Volkswagen now has 7 Ultimaker printer which produces 93% of all externally manufactured tools in-house. The transition to 3D printing saved Volkswagen Autoeuropa 91% in tool development costs and reduced development time by 95%.

Is 3d printing suitable for mass production?
Voodoo manufacturing company in Brookline, mass produces 3d designs based on customer demands. They currently own a fleet of 160 printers, all connected to a central server. They can print from 1 to 10,000 parts in less than 24 hours. high volume in small batches is possible through voodoo manufacturing. The future holds so many possibilities for 3d printing that we are yet to see.

CONCLUSIONS

3D-Printing is seeing significant growth. At present the majority of this is based on product prototyping, but truly digital additive manufacturing is now taking place. A brief history of 3D printing, in the second section we have depicted the additive technology and the materials used in rapid prototyping. One can conclude that the 3-D printing technology's importance and social impact increase gradually day after day and significantly influence the human's life, the economy and modern society.

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