Study of 3D Printing and its Application

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ABSTRACT

This is a research paper on 3D printing which has become a notable topic in today's technological discussion. In this paper, we will look at additive manufacturing or 3D printing. In this paper, we will look at additive manufacturing or 3D printing. We will firstly define what we mean by this term and what is so significant about it. We will delve a bit into the history. Then we shall see about the process of 3D printing and the materials used in the manufacture of 3D printed objects. We shall also see the advantages of 3D printing as compared to conventional methods of manufacturing. We shall observe the numerous applications it is being out to use today We will firstly define what we mean by this term and what is so significant about it. We will delve a bit into the history. Then we shall see about the process of 3D printing and the materials used in the manufacture of 3D printed objects. We shall also see the advantages of 3D printing as compared to conventional methods of manufacturing. We shall observe the numerous applications it is being out to use today. Finally the future potential of this technology is outline Introduction - 3D printing is a form of additive manufacturing technology where a three dimensional object is created by laying down successive layers of material. It is also known as rapid prototyping, is a mechanized method whereby 3D objects are quickly made on a reasonably sized machine connected to a computer containing blueprints for the object. The 3D printing concept of custom manufacturing is exciting to nearly everyone. This revolutionary method for creating 3D models with the use of inkjet technology saves time and cost by eliminating the need to design; print and glue together separate model parts. Now, you can create a complete model in a single process using 3D printing.

Keywords:- 3D Printing, Printers, Dentistry
is stereo lithography.

II. INTRODUCTION

3D printing, additionally referred to as additive manufacturing, may be a method of basically making a three-dimensional object from a package model. The thing may be of just about any form. The method of making these objects in largely additive. Within the additive method, an object to be written is built from the base-up by in turn adding it to layers of the development material. The additive method may be contrasted with the subtractive process, where material is removed from a block by methods such as sculpting or drilling. The main material utilized in the development of 3D objects is plastic, though recently, there has additionally been a slew of innovation toward using alternative materials like metals of various sorts and additionally organic matter like carbon and its varied derivatives. Hideo Kodama of Nagoya Municipal Industrial Research Institute is generally regarded to have printed the first solid object from a digital design. However, the credit for the first 3D printer generally goes to Charles Hull, who in 1984 designed it while working for the company he founded, 3D Systems Corp. Charles a Hull was a pioneer of the solid imaging process known as stereo lithography and the STL (stereo lithographic) file format which is still the most widely used format used today in 3D printing. He is also regarded to have started commercial rapid prototyping that was concurrent with his development of 3D printing. He initially used photopolymers heated by ultraviolet light to achieve the melting and solidification effect.

II. PRINCIPLES OF 3D PRINTING

The main principle of 3D printing is *stereo lithography*, outlined by Charles Hull in a 1984 patent as "a system for generating three-dimensional objects by making a cross-sectional pattern of the object to be formed". This means that any 3D object generated using a 3D drawing software is first split into layers and these layers are then successively printed by the machine on top if one another.

Step one of 3D printing is the generation of a 3D printable model. This model is generated using a computer aided design software or via a 3D scanner. A real life object can

be set to be 3D printed by scanning it to get a 3D model that is realistically within the bounds of the 3D printer's capability. Then the STL file is generated by running the design through converting software. You can customize various aspects of the design such as the layer thickness, temperature, and outer finish, etc. Once the STL file is generated, then the object is ready to be printed. After the designing step comes the printing part. The converted STL file is fed into the printer and according to the layers we have obtained, the machine starts out laying the plastic out layer by layer. The material need not be plastic but it can be anything ranging from liquid, powder, paper or sheet material. The layers are automatically fused to get the final shape. Its advantage over conventional machining techniques is that it can be used to create almost any geometric shape. The object may take anywhere from several minutes to several hours to complete depending on the size and complexity of the model and also on the type of machine used. Some additive manufacturing techniques are capable of using multiple materials to construct parts. They can also use multiple color combinations simultaneously. In case there are projecting parts in the model, supports are used like scaffolding until the overhanging part sufficiently hardens. These supports can be dissolved in water when the model is printed.

III. 3D PRINTERS

Although most 3D printers are expensive, recently there has been a steep decline in the prices of 3D printers. This has led to it going from being a niche industry novelty to a hobbyist's item. There are many affordable 3D printers that are available for much less than they are worth, if we take all its production capabilities into account. Companies have also realized the potential of a consumer market for 3D printers and as such have been aggressively courting enthusiasts with cheaper and better models. There are many communities formed around these enthusiast groups which are active on the internet set up to share projects and ideas and new possibilities. One of the most popular is known as Riprap. Its goal is to produce a free and open-source hardware (FOSH) 3D printer licensed under GNU Public License. These printers are also intended to be capable of replicating itself printing many of its own plastic parts to create more machines.

Fig 1: Typical 3D Printer

3D Printers are machines that produce physical 3D models from digital data by printing layer by layer. It can make physical models of objects either designed with a CAD program or scanned with a 3D Scanner. It is used in a variety of industries including jewelry, footwear, industrial design, architecture, engineering and construction, automotive, aerospace, dental and medical industries, education and consumer products

History of 3d Printing

The technology for printing physical 3D objects from digital data was first developed by Charles Hull in 1984. He named the technique as Stereo lithography and obtained a patent for the technique in 1986. While Stereo lithography systems had become popular by the end of 1980s, other similar technologies such as Fused Deposition Modeling (FDM) and Selective Laser Sintering (SLS) were introduced.
In 1993, Massachusetts Institute of Technology (MIT) patented another technology, named "3 Dimensional Printing techniques", which is similar to the inkjet technology used in 2D Printers. In 1996, three major products, "Genisys" from Stratasys, "Actua 2100" from 3D Systems and "Z402" from Z Corporation were introduced. In 2005, Z Corp. launched a breakthrough product, named Spectrum Z510, which was the first high definition color 3D Printer in the market. Another breakthrough in 3D Printing occurred in 2006 with the initiation of an open source project, named Reprap, which was aimed at developing a self-replicating 3D printer.

3D Printing Capabilities:

As anticipated, this modern technology has smoothed the path for numerous new possibilities in various fields. The list below details the advantages of 3D printing in certain fields.

1. Product formation is currently the main use of 3D printing technology. These
Machines allow designers and engineers to test out ideas for dimensional products cheaply before committing to expensive tooling and manufacturing processes.

2. In Medical Field, Surgeons are using 3d printing machines to print body parts
For reference before complex surgeries. Other machines are used to construct bone grafts for patients who have suffered traumatic injuries. Looking further in the future, research is underway as scientists are working on creating replacement organs.

3. Architects need to create mockups of their designs. 3D printing allows them to Come up with these mockups in a short period of time and with a higher degree of accuracy.

4. 3D printing allows artists to create objects that would be incredibly difficult, costly, or time intensive using traditional processes.

3D Saves Time and Cost:-

Creating complete models in a single process using 3D printing has great benefits. This innovative technology has been proven to save companies time, manpower and money.

Companies providing 3D printing solutions have brought to life an efficient and competent technological product.

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UNCONVENTIONAL APPLICATIONS OF 3D PRINTING

3D printing has a wide variety of uses and it can also be put to some unconventional uses. People have tried to make stuff that not only eschews the usual plastic used to make the objects but also makes use of non-traditional and commonly unavailable material to print objects. Scientists have successfully been able to print ears, skin, kidney, blood vessels and bones using 3D printers. Instead on typical plastic, a gel like substance made of cells is used. For bones, a ceramic powder is used instead. In the future, every patient will have their own matching set of skin for a graft, a bone fragment or an organ. Already, 3D printers are capable of printing prosthetic limbs for people with disabilities. The biggest challenge is the challenge of printing a fully beating human heart that works just as well as a natural one. Bio-engineers at the Cardiovascular Innovation Institute at the University of Louisville have printed a coronary artery some small blood vessels of the heart muscle and are hoping to soon print a functioning heart. Of course, to keep them alive must prove daunting. In the future, we may live in houses that have been 3D printed. A researcher at University of Southern California claims to have designed an enormous 3D printer that is capable of printing a whole house in just a day. This conceptual model uses concrete as its base element in order to replicate computer programs of houses. In order to ensure that the house is compatible with plumbing and electrical apparatuses, it uses a layered fabrication tech called "Contour Craft". A printed house could have far reaching implications for low income housing, disaster- recovery applications such as creating models of plastic that can serve as a sample or a prototype of a larger-scale version of itself. NASA has been developing technologies to print wood from the printers using 3D bio printing technology. The basic theory is that the printer will lay out living cells in a specific manner upon a gel. This gel stimulates the cells to start excreting wood. One application could be that astronauts could bring wood to space without actually having to carry any of it. NASA will have the technology ready by the year-end.

Hearing aids 3D printing technology for manufacturing hearing aids was introduced more than 10 years ago. Using 3D printers for manufacturing hearing aids is common in this sector. "3D printing has shortened the hearing aid manufacturing process to three steps: scanning, modeling, and printing. …printers can print 65 hearing aid shells or 47 hearing aid molds within 60 to 90 minutes. The printing speed helps manufacturers scale and adjust demand to supply. In addition, the digital file helps modelers adjust and reuse ear impressions to correct for errors. In other words, 3D printers enable rapid prototyping and manufacturing." [Forbes 2013]

Dentistry:-

3D printing is widely used in dental labs. With the help of oral scanning, CAD software and AM crowns, bridges, stone models and a range of orthodontic appliances can be produced [stratus's 2013]. An automobile component BMW produces prototypes of metallic parts by using AM. Engine parts for motor sports racing cars also have been fabricated using direct metal laser sintering. Furthermore some luxury car manufacturers as Bentley and Rolls-Royce can produce some parts more economically by using AM instead of conventional manufacturing. Tesla, the producer of electric cars, also produces automobile components by using 3D printers. [Süddeutsche Zeitung 2013]

Aircraft components:-

"EADS has developed the technology to the extent that it can manipulate metals, nylon, and Carbon-reinforced plastics at a molecular level, which allows it to be applied to high-stress, safety Critical aviation uses. Compared to a traditional, machined part, those produced by AM are up to 65% lighter, but still as strong as those would be. The development of AM is an activity that spans the entire EADS group, with early applications in the production of fixtures and tooling for Airbus, and flying applications being implemented by Eurocopter and Astrium. EADS' UK research facilities have the lead in the group's AM activities." [Techno polis Group 2013]Airbus produced a door bracket for the A350-1000 in 2011 by using AM. For such components it takes the 200-Watt laser two hours to complete the print job. [Airbus 2011] Boeing and other companies in the aerospace sector have also developed large internal AM research groups [Technology Strategy Board 2012]. The Boeing company has been utilizing SLS (Selective Laser Sintering) for flight hardware in regular production since 2002, for both military and commercial programs [Boeing 2011].

IV. CONCLUSION:

In conclusion, this research would suggest that it is unlikely that AM will present significant challenges to the UK's existing intellectual property framework over the next ten years. The limitations of the technology are substantial especially with regard to consumer level technology and this will hinder widespread adoption within this time frame. It is anticipated that there will inevitably be instances of infringement that is enabled by AM technology, such as in the manufacture and distribution of unlicensed spare parts, however this infringement is covered by the UK's intellectual property framework and there are well-established mechanisms in place for rights-holders to address these incidents. The Replacement Parts case studies showed that there will be very little commercial impact on either the automotive or domestic appliance aftermarket within the next decade as a function of either consumer 3D printing or industrial additive manufacturing. Current technologies do not produce parts that are of a suitable quality to replicate traditionally manufactured automotive or domestic appliance components. Where the technology is technically acceptable, the economics of AM production are greater than the accepted price point of current spare parts.

REFERENCES

1]. http://www.theengineer.co.uk/in-depth/the-big-story/the-rise-of-additive-manufacturing/1002560.article

[2]. http://www.redorbit.com/education/reference_library/general-2/history-of/1112953506/the-history-of-3D-printing

[3]. http://readwrite.com/2014/02/17/future of 3D printing what can we 3D print#awesm=~ozykT14wlGsiL5

[4]. http://whatsnext.blogs.cnn.com/2013/07/31/study at home-3-d-printing-could-save-consumers-thousands/

[5]. http://abcnews.go.com/Technology/story?id=1603783&page=1

[6]. http://reprap.org

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