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3D PRINTING TECHNOLOGY OR ADDITIVE MANUFACTURING

(An Advance in Manufacturing Engineering)

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***Abstract*—3D printing technology is a boon for humans. It is the process by which you can form any solid shape from a digital model. It is based on additive manufacturing technology where a three dimensional object is created by adding layers. It is also known as rapid prototyping. Doesn't it sound interesting? In this technique you can remove the unwanted material by cutting or drilling. There are many printers which use digital technology to do 3D printing processes. The sales of these machines have grown with the time. Chuck Hull of the 3D system Corp, Inc made the first 3D printer. What are the applications of 3D printing technology? Initially, manufacturing companies used this technology. With the introduction of 3D printing technology, you can go for mass production.**

IndexTerms-**3Dprinting, additivemanufacturing, rapidprototyping, Chuck Hull**.

I. 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. The basic principles include materials cartridges, flexibility of output, and translation of code into a visible pattern.

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 jewellery, footwear, industrial design, architecture, engineering and construction, automotive, aerospace, dental and medical industries, education and consumer products.

II. HISTORY

The first published account of a printed solid model was made by Hideo Kodama of Nagoya Municipal Industrial Research Institute in 1982. The first working 3D printer was created in 1986 by Charles W. Hull of 3D Systems Corp. Hull published a number of patents on the concept of 3D printing, many of which are used in today's additive manufacturing processes. Of course, 3D printing in the early days was very expensive and not feasible for the general market. As we moved into the 21st century, however, costs drastically dropped, allowing 3D printers to find their way to a more affordable market. The cost of 3D printers has even decreased in the years from 2010 to 2014, with machines generally ranging in price from $20,000 just three years ago, to less than $1,000 in the current market. Some printers are even being developed for under $500, making the technology increasingly available to the average consumer.

III. LATEST TRENDS IN 3D PRINTING

Stereo lithographic 3D printers (known as SLAs or stereo lithography apparatus) position a perforated platform just below the surface of a vat of liquid photo curable polymer. A UV laser beam then traces the first slice of an object on the surface of this liquid, causing a very thin layer of photopolymer to harden. The perforated platform is then lowered very slightly and another slice is traced out and hardened by the laser. Another slice is then created, and then another, until a complete object has been printed and can be removed from the vat of photopolymer, drained of excess liquid, and cured. Selective laser sintering builds objects by using a laser to selectively fuse together successive layers of a cocktail of powdered wax, ceramic, metal, nylon or one of a range of other materials. The Nano factory 3D printing technologies are introduced that are related to the nanotechnologies. The VFlash printer, manufactured by Canon, is low-cost 3D printer. It's known to build layers with a light-curable film. Unlike other printers, the VFlash builds its parts from the top down. CLIP i.e. Continuous Liquid Interface Production is also one of the recent innovations in Additive Manufacturing which is explained in brief under the category Processes and technologies.

IV. Processes and technologies

Not all 3D printers use the same technology to realize their objects. There are several ways to do it and all those available as of 2012 were additive, differing mainly in the way layers are build to create the final object. Some methods use melting or softening material to produce the layers. Selective laser sintering (SLS) and fused deposition modeling (FDM) are the most common technologies using this way of printing. Another method of printing is to lay liquid materials that are cured with different technologies. The most common technology using this method is called stereolithography (SLA).

A. Selective laser sintering (SLS)

This technology uses a high power laser to fuse small particles of plastic, metal, ceramic or glass powders into a mass that has the desired three dimensional shape. The laser selectively fuses the powdered material by scanning the cross-sections (or layers) generated by the 3D modeling program on the surface of a powder bed. After each cross-section is scanned, the powder bed is lowered by one layer thickness. Then a new layer of material is applied on top and the process is repeated until the object is completed.

All untouched powder remains as it is and becomes a support structure for the object. Therefore there is no need for any support structure which is an advantage over SLS and SLA. All unused powder can be used for the next printing. SLS was developed and patented by Dr. Carl Deckard at the University of Texas in the mid- 1980s, under sponsorship of DARPA.

B. Fused deposition modeling (FDM*)*

The FDM technology works using a plastic filament or metal wire which is unwound from a coil and supplies material to an extrusion nozzle which can turn the flow on and off. The nozzle is heated to melt the material and can be moved in both horizontal and vertical directions by a numerically controlled mechanism, directly controlled by a computer-aided manufacturing (CAM) software package. The object is produced by extruding melted material to form layers as the material hardens immediately after extrusion from the nozzle.

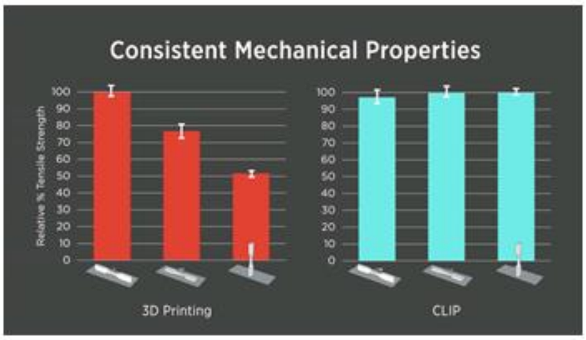
FDM was invented by Scott Crump in the late 80's. After patenting this technology he started the company Stratasys in 1988. The software that comes with this technology automatically generates support structures if required. The machine dispenses two materials, one for the model and one form a disposable support structure. The term fused deposition modeling and its abbreviation to FDM are trademarked by Stratasys Inc. The exactly equivalent term, fused filament fabrication (FFF), was coined by the members of the RepRap project to give a phrase that would be legally unconstrained in its use.

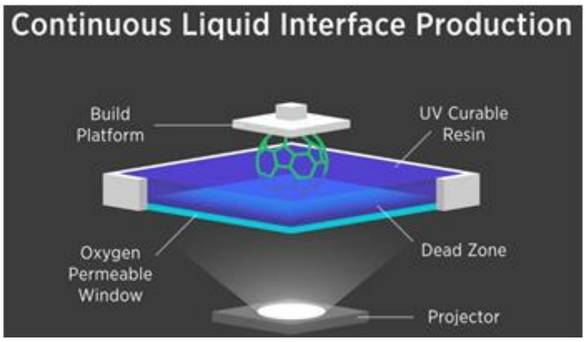
C. Stereolithography (SLA)

The main technology in which photopolymerization is used to produce a solid part from a liquid is SLA. This technology employs a vat of liquid ultraviolet curable photopolymer resin and an ultraviolet laser to build the object's layers one at a time. For each layer, the laser beam traces a cross-section of the part pattern on the surface of the liquid resin. Exposure to the ultraviolet laser light cures and solidifies the pattern traced on the resin and joins it to the layer below. After the pattern has been traced, the SLA's elevator platform descends by a distance equal to the thickness of a single layer, typically 0.05 mm to 0.15 mm .Then, a resin-filled blade sweeps across the cross section of the part, re-coating it with fresh material. On this new liquid surface, the subsequent layer pattern is traced, joining the previous layer. The complete three dimensional object is formed by this project. Stereolithography requires the use of supporting structures which serve to attach the part to the elevator platform.

D. Continuous Liquid Interface Production (CLIP)

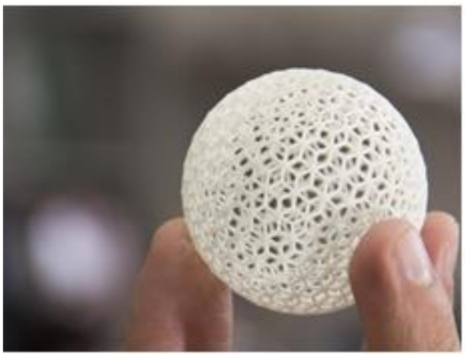
The continuous process begins with a pool of liquid photopolymer resin. Part of the pool bottom is transparent to ultraviolet light (the "window"). An ultraviolet light beam shines through the window, illuminating the precise cross-section of the object. The light causes the resin to solidify. The object rises slowly enough to allow resin to flow under and maintain contact with the bottom of the object. An oxygen-permeable membrane lies below the resin, which creates a "dead zone" (persistent liquid interface) preventing the resin from attaching to the window (photopolymerization is inhibited between the window and the polymerizer). Unlike stereolithography, the printing process is continuous. The inventors claim that it can create objects up to 100 times faster than commercial three dimensional (3D) printing methods. CLIP objects have smooth sides, unlike 2015 commercial 3D printers, whose sides are typically rough to the touch. Some resins produce objects that are rubbery and flexible, that could not be produced with earlier methods.





V. APPLICATIONS

Additive manufacturing's earliest applications have been onthe toolroom end of the manufacturing spectrum. For example, rapid prototyping was one of the earliest additive variants, and its mission was to reduce the lead time and cost of developing prototypes of new parts and devices, which was earlier only done with subtractive toolroom methods (typically slowly and expensively). With technological advances in additive manufacturing, however, and the dissemination of those advances into the business world, additive methods are moving ever further into the production end of manufacturing in creative and sometimes unexpected ways. Parts that were formerly the sole province of subtractive methods can now in some cases be made more profitably via additive ones. Standard applications include design visualisation, prototyping/CAD, metal casting, architecture, education, geospatial, healthcare, and entertainment/retail.



1) *Rapid prototyping*

Industrial 3D printers have existed since the early 1980s and have been used extensively for rapid prototyping and research purposes. These are generally larger machines that use proprietary powdered metals, casting media (e.g. sand), plastics, paper or cartridges, and are used for rapid prototyping by universities and commercial companies.

2) Automobiles

In early 2014,the Swedish supercar manufacturer, Koenigsegg, announced the One:1, a supercar that utilises many components that were 3D printed. In the limited run of vehicles Koenigsegg produces, the One:1 has side-mirror internals, air ducts, titanium exhaust components, and even complete turbocharger assembles that have been 3D printed as part of the manufacturing process. An American company, Local Motors is working with Oak Ridge National Laboratory and Cincinnati Incorporated to develop large scale additive manufacturing processes suitable for printing an entire car body. The company plans to print the vehicle live in front of an audience in September 2014 at the International Manufacturing Technology Show. "Produced from a new fiber-reinforced thermoplastic strong enough for use in an automotive application, the chassis and body without drivetrain, wheels and brakes weighs a scant 450 pounds and the completed car is comprised of just 40 components, a number that gets smaller with every revision."

3) Aerospace

In December 2013, BAE Systems fitted and successfully test flew a Panavia Tornado with parts made by 3D Printing.recently a metal Airbus wing bracket was mase of titanium.

4) Domestic use

As of 2012, domestic 3D printing had mainly captivated hobbyists and enthusiasts and had not quite gained recognition for practical household applications. A working clock was made andgears were printed for home woodworking machines among other purposes. 3D printing was also used for ornamental objects. Web sites associated with home 3D printing tended to include backscratchers, coathooks, doorknobs etc. The open source Fab@Home project has developed printers for general use. They have been used in research environments to produce chemical compounds with 3D printing technology, including new ones, initially without immediate application as proof of principle. The printer can print with anything that can be dispensed from a syringe as liquid or paste. The developers of the chemical application envisage that this technology could be used for both industrial and domestic use.

5) Construction

An additional use being developed is building printing, or using 3D printing to build buildings. This could allow faster construction for lower costs, and has been investigated for construction of off-Earth habitats. For example, the Sinterhab project is researching a lunar base constructed by 3D printing using lunar regolith as a base material. Instead of adding a binding agent to the regolith, researchers are experimenting with microwave sintering to create solid blocks from the raw materials.

VI. . EFFICIENCY

The current slow print speed of 3D printers limits their use for mass production. To reduce this overhead, several fused filament machines now offer multiple extruder heads. These can be used to print in multiple colors, with different polymers, or to make multiple prints simultaneously. This increases their overall print speed during multiple instance production, while requiring less capital cost than duplicate machines since they can share a single controller. Distinct from the use of multiple machines, multi-material machines are restricted to making identical copies of the same part, but can offer multi-color and multi-material features when needed. The print speed increases proportionately to the number of heads. Furthermore, the energy cost is reduced due to the fact that they share the same heated print volume. Together, these two features reduce overhead costs. Many printers now offer twin print heads. However, these are used to manufacture single (sets of) parts in multiple colors/materials. Few studies have yet been done in this field to see if conventional subtractive methods are comparable to additive methods.

VII. ADVANTAGES OF 3D PRINTING

Manufacturing Options: 3D printing provides a wide variety of manufactured products, including customizable products and even an individual's personal designs.
Rapid Prototyping: Products can more quickly go from just a design to an actual prototype.
Manufacturing Speed: Just like the previous advantage, the manufacturing speed for a large number of final products is equally fast.
Reduced Costs: Even though the initial setup costs are higher, 3D printing has become cheaper than cheap labor in third world countries. Additionally, the costs of 3D printing are still decreasing, with the potential of 3D printers in homes in the near future. Furthermore, the costs of customized products are the same for mass production products.
Medical: One of the innovative products that 3D printing may provide is the manufacturing of customizable human body parts or organs. While these usages are still experimental, the potential advantages are huge. Imagine doctors quickly building and replacing critical organs, such as the heart, lungs, or liver that will have almost no chance of donor rejection, since the organs will be built using the patients' unique characters and DNA.

VIII. DISADVANTAGES OF 3D PRINTING

1. Fewer Manufacturing Jobs: As with all new technologies, manufacturing jobs will decrease. This disadvantage can and will have a large impact to the economies of third world countries, especially China, that depend on a large number of low skill jobs.
2. Limited Materials: Currently, 3D printers only manufacture products out of plastic, resin, certain metals, and ceramics. 3D printing of products in mixed materials and technology, such as circuit boards, are still under development.
3. Copyright: With 3D printing becoming more common, the printing of copyrighted products to create counterfeit items

will become more common and nearly impossible to determine.

4. Dangerous Items: 3D printers can create dangerous items, such as guns and knives, with very little or no oversight.

CONCLUSION

With the advantages of 3D printing, mankind may be entering a new post-industrial manufacturing age where products are significantly cheaper and built quicker than ever before, however the disadvantages of 3D printing needs to be known to be better understood and mitigated against3D Printing Technology have reduced the complex process of printing into a single & simple way. Nothing communicates ideas faster than a 3-Dimensional part or model. With a 3D Printer we can bring CAD files & design/ideas to life right from the desktop. In an age in which the news, books, music , videos &even our communities are all the subjects of digital dematerialization, the development & application of 3D Printing reminds us that human beings have both a physical & psychological need to keep at least one foot in the real world. 3D Printing has a bright future, not least in rapid prototyping where it is the impact is already highly significant but also in medical arts & outer space.

However 3D Printing has struggled to deliver its promise to transform manufacturing. Prints take forever, parts ae mechanically weak and material choices are far too limited, that’s because the conventional or current 3D printing Technology is just 2D printing over and over

CLIP-Continuous Liquis Interface Production- is a breakthrough technology that grows parts instead of printing them layer by layer. CLIP allows businesses to produce commercial quality parts at game changing speeds, creating a clear path to 3D Manufacturing.

REFERENCES

[1] FDM is a proprietary term owned by Stratasys. All 3-D printers that are not Stratasys machines and use a fused filament process are referred to as or fused filament fabrication (FFF).

[2] Deckard, C., "Method and apparatus for producing parts by selective sintering", U.S. Patent 4,863,538, filed ctober17, 1986, published September 5, 1989.Greenberg, Andy (2012-08-23). "'Wiki Weapon Project' Aims To Create A Gun Anyone Can 3D-Print At Home". Forbes. Retrieved 2012-08-27.

[3] "3D-printed sugar network to help grow artificial liver", BBC, 2 July 2012

[4] Dan Thomas, Engineering Ourselves – The Future Potential Power of 3D-Bioprinting?, engineering.com, March 25, 2014

[5] The Diplomat (2013-08-15). "Chinese Scientists Are 3D Printing Ears and Livers – With Living Tissue". Tech Biz. The Diplomat. Retrieved 2013-10-30.

[6] "How do they 3D print kidney in China". Retrieved 2013-10-30.

[7] "Transplant jaw made by 3D printer claimed as first". BBC. 2012-02-06.

[8] "Confronting a New 'Era of Duplication'? 3D Printing, Replicating Technology and the Search for Authenticity in George O. Smith's Venus Equilateral Series". Durham University. Retrieved July 21, 2013.

[9] "Joseph DeSimone: What if 3D printing was 100x faster?". TED. Retrieved 20 March2015.

[10] "Continuous liquid interphase printing". Retrieved March 20, 2015.

[11] Making guns at home: Ready, print, fire". The Economist. 2013-02-16. Retrieved2013-10-30.

[12] IIT Bombay Techfest 2015.