



3D Printer

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Abstract: 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes. In an additive process an object is created by laying down successive layers of material until the entire object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object.

Keywords: 3D Printer, Fused Deposition Moulding, Selective Laser Sintering.

I. INTRODUCTION

3D printing is also known as desktop fabrication or additive manufacturing; it is a prototyping process whereby a real object is created from a 3D design. The digital 3D-model is saved in STL format and then sent to a 3D printer. The 3D printer then prints the design layer by layer and forms a real object [4]. 3D printing is a fast developing and cost-effective form of rapid prototyping. 3D Printing technology based upon common inkjet desktop printers where multiple jets deposit the print material layer after layer based on the 3D CAD data. The process of "printing" a three-dimensional object layer-by-layer with equipment. 3D printing makes it possible to make a part from scratch in just hours. It allows designers and developers to go from flat screen to exact part. 3D printing can provide great savings on assembly costs because it can print already assembled products.

With 3D printing, companies can now experiment with new ideas and numerous design iterations with no extensive time or tooling expense. They can decide if product concepts are worth to allocate additional resources. 3D printing could even challenge mass production method in the future. 3D printing is going to impact so many industries, such as automotive, medical, business & industrial equipment, education, architecture, and consumer-product industries.

II. PROCESS OF 3D PRINTING

The basic process of 3D printing are defined and simplified in the following 5 steps: **CAD Model Creation:** First, the object to be built is modeled using a Computer-Aided Design (CAD) software package. Solid modelers, such as Pro/ENGINEER, tend to represent 3-D objects more accurately than wire-frame modelers such as AutoCAD, and will therefore yield better results. The designer can use a pre-existing CAD file or may wish to create one expressly for prototyping purposes. This process is identical for all of the RP build techniques.

Conversion to STL Format: The various CAD packages use a number of different algorithms to represent solid objects. To establish consistency, the STL (stereo lithography, the first RP technique) format has been adopted as the standard of the rapid prototyping industry. The second step, therefore, is to convert the CAD file into STL format.

Slice the STL File: In the third step, a pre-processing program prepares the STL file to be built. Several programs are available, and most allow the user to adjust the size, location and orientation of the model. The preprocessing software slices the STL model into a number of layers from 0.01 mm to 0.7 mm thick, depending on the build technique. The program may also generate an auxiliary structure to support the model during the build. Supports are useful for delicate features such as overhangs, internal cavities, and thin walled sections. Each RP machine manufacturer supplies their own proprietary pre-processing software.

Layer by Layer Construction: The fourth step is the actual construction of the part. Using one of several techniques (described in the next section) RP machines build one layer at a time from polymers, paper, or powdered metal. Most machines are fairly autonomous, needing little human intervention.

Clean and Finish: The final step is post-processing. This involves removing the prototype from the machine and detaching any supports. Some photosensitive materials need to be fully cured before use. Prototypes may also require minor cleaning and surface treatment. Sanding, sealing, and/or painting the model will improve its appearance and durability.

III. PROCESS

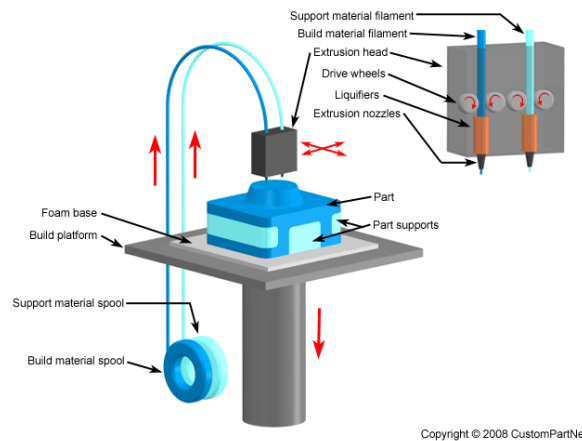
The different technologies are being used in this technology, some of them are mentioned below:



A. FUSED DEPOSITION MODELING (FDM):

Fused deposition modeling (FDM) was developed by Mr. Scott Scott Crump in the late 1980s and was commercialized in 1990 by Stratasys. Fused Deposition Modeling (FDM) creates 3D prototypes by heating and extruding a filament of plastic material. In a typical FDM system, the extrusion nozzle moves over the build platform in X and Y directions. This “draws” a cross section of an object onto the platform. When this thin layer of plastic cools and hardens, it immediately binds to the layer beneath it. Once a layer is completed, the base is lowered slightly, making way to add the next layer of plastic.

This is most widely used and affordable technology in 3D Printing. As it uses real engineering grade thermoplastics, parts built are more stronger, durable and widely used for functional testing applications. You can build parts directly into ABS, polycarbonate, nylon and various other materials. Due to its simplicity and ease of use; these machines are office friendly machines and can be installed in Design office.



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Fig. 1

B. SELECTIVE LAYER SINTERING (SLS)

Powder Based 3D Printing Selective Laser Sintering (SLS) was developed and patented by Dr. Carl Deckard and academic adviser, Dr. Joe Beaman at the University of Texas at Austin in the mid-1980s, under sponsorship of DARPA. In Selective Layer Sintering, a computer controlled laser pulses down on the platform, tracing a cross-section of the object onto tiny particles of plastic, ceramic or glass. The laser heats the powder either to just below its boiling point (sintering) or above its boiling point (melting), which fuses the particles in the powder together into a solid form. This process continues until the entire object has been printed. SLS parts are widely used for snap-fit applications. As powder is used for printing the parts; special care needs to be taken while handling these machines. These machines cannot be used in office environment and needs a special environment.

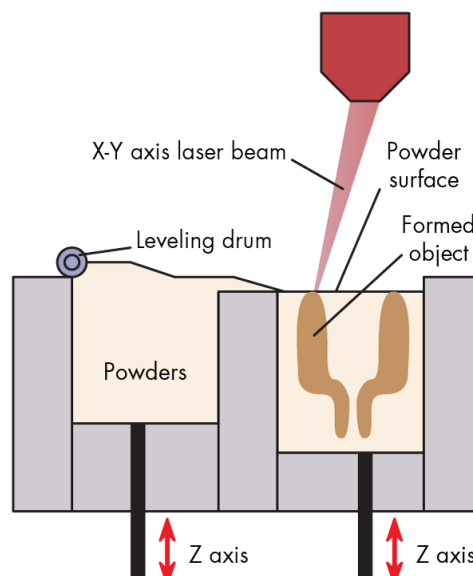


Fig. 2



C. STEREOGRAPHY (SLA)

Liquid Based 3D Printing the first commercial 3D printer was based on a technique called Stereolithography, invented by Charles Hull in 1986. It is also called as SLA (StereoLithographyApparatus)In Stereolithographic 3D printers, successive layers of fluid resin are hardened using UV rays or lasers. After each layer is fused, the perforated platform is lowered very slightly and another slice is traced out and hardened by the UV / laser. This process is repeated until a complete object has been printed.

This technology is widely used in jewellery industry due to its fine surface finish and accuracy. It is one of the most expensive technologies to use. Objects printed cannot be used directly as it needs post-curing operation to strengthen the parts.

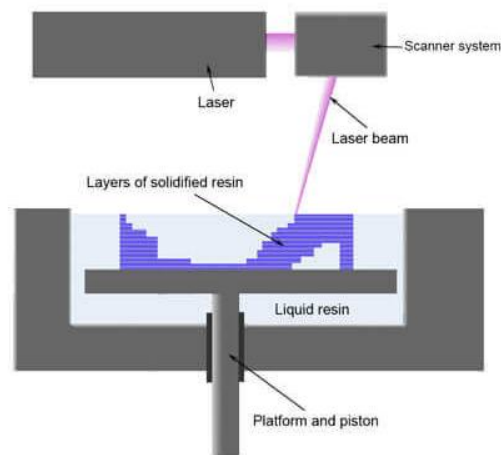


Fig. 4

D. POLYJET / INKJET 3D PRINTING

PolyJet inkjet technology works by jetting state of the art photopolymer materials in ultra-thin layers (16μ) onto a build tray layer by layer until the part is completed. Each photopolymer layer is cured by UV light immediately after it is jetted, producing fully cured models that can be handled and used immediately, without post-curing. The gel-like support material, which is specially designed to support complicated geometries, is easily removed by hand and water jetting. This technology helps us in printing rigid parts, Transparent Parts, Rubber like / Flexible parts required for prototyping applications. This is the only technology which can print multi-materials and multi-colors in a single build. Again, Stratasys is a major player in this field. The company has a significant market share for Polyjet printers in India.

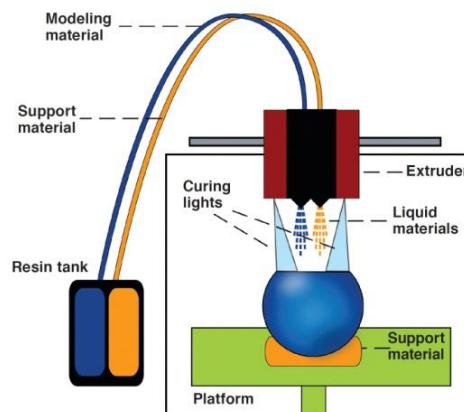


Fig. 5

IV. APPLICATION

The worldwide 3D printing industry is expected to grow from \$3.07B in revenue in 2013 to \$12.8B by 2018, and exceed \$21B in worldwide revenue by 2020. As it evolves, 3D printing technology is destined to transform almost every major industry and change the way we live, work, and play in the future.



A. MEDICAL INDUSTRY

The outlook for medical use of 3D printing is evolving at an extremely rapid pace as specialists are beginning to utilize 3D printing in more advanced ways. Patients around the world are experiencing improved quality of care through 3D printed implants and prosthetics never before seen.

B. BIO-PRINTING

As of the early two-thousands 3D printing technology has been studied by biotech firms and academia for possible use in tissue engineering applications where organs and body parts are built using inkjet techniques. Layers of living cells are deposited onto a gel medium and slowly built up to form three dimensional structures. We refer to this field of research with the term: bio-printing.

C. AEROSPACE & AVIATION INDUSTRIES

The growth in utilization of 3D printing in the aerospace and aviation industries can, for a large part, be derived from the developments in the metal additive manufacturing sector. NASA for instance prints combustion chamber liners using selective laser melting and as of March 2015 the FAA cleared GE Aviation's first 3D printed jet engine part to fly: a laser sintered housing for a compressor inlet temperature sensor.

D. AUTOMOTIVE INDUSTRY

Although the automotive industry was among the earliest adopters of 3D printing it has for decades relegated 3D printing technology to low volume prototyping applications. Nowadays the use of 3D printing in automotive is evolving from relatively simple concept models for fit and finish checks and design verification, to functional parts that are used in test vehicles, engines, and platforms. The expectations are that 3D printing in the automotive industry will generate a combined \$1.1 billion dollars by 2019. CTIS is provided to control the air pressure in each tyre as a way to improve performance on different surfaces. For example, lowering the air pressure in a tyre creates a larger area of contact between the tyre and the ground and makes driving on softer ground much easier. It also does less damage to the surface. This is important on work sites and in agricultural fields. By giving the driver direct control over the air pressure in each tyre, manoeuvrability is greatly improved. Another function of the CTIS is to maintain pressure in the tyres if there is a slow leak or puncture. In this case, the system controls inflation automatically based on the selected pressure the driver has set. The CTIS includes a speed sensor that sends vehicle speed information to the electronic control unit. If the vehicle continues moving at a higher speed for a set period of time, the system automatically inflates the tyres to an appropriate pressure for that speed. Tire Maintenance System (TMS) Tire Maintenance System is a "smart" system for tractor trailers that monitors tire pressure and inflates tires as necessary to keep pressure at the right level. It uses air from the trailer's brake supply tank to inflate the tires.

V. FUTURE

It is predicted by some additive manufacturing advocates that this technological development will change the nature of commerce, because end users will be able to do much of their own manufacturing rather than engaging in trade to buy products from other people and corporations. 3D printers capable of outputting in color and multiple materials already exist and will continue to improve to a point where functional products will be able to be output. With effects on energy use, waste reduction, customization, product availability, medicine, art, construction and sciences, 3D printing will change the manufacturing world as we know it.

VI. CONCLUSION

3D printing technology has reduced the complex process of printing into a single and simple way. Nothing communicates ideas faster than a three-dimensional part or model. With a 3D printer you can bring CAD files and design ideas to life – right from your desktop. Test form, fit and function – and as many design variations as you like – with functional parts. In an age in which the news, books, music, video and even our communities are all the subjects of digital dematerialization, the development and application of 3D printing reminds us that human beings have both a physical and a psychological need to keep at least one foot in the real world. 3D printing has a bright future, not least in rapid prototyping (where its impact is already highly significant), but also in medicine, the arts, and outer space. Desktop 3D printers for the home are already a reality if you are prepared to pay for one and/or build one yourself. 3D printers capable of outputting in color and multiple materials also exist and will continue to improve to a point where functional products will be able to be output. As devices that will provide a solid bridge between cyberspace and the physical world, and as an important manifestation of the Second Digital Revolution, 3D printing is therefore likely to play some part in all of our futures.



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