A

Seminar report

On

3D Printing

Submitted in partial fulfillment of the requirement for the award of degree of Bachelor of Technology in Computer Science

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Preface

I have made this report file on the topic **3D Printing**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Content

What 3D Printing is

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.

History

In the history of manufacturing, subtractive methods have often come first. The province of machining (generating exact shapes with high precision) was generally a subtractive affair, from filing and turning through milling and grinding.

Additive manufacturing's earliest applications have been on the 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). However, as the years go by and technology continually advances, additive methods are moving ever further into the production end of manufacturing. Parts that formerly were the sole province of subtractive methods can now in some cases be made more profitably via additive ones.

However, the real integration of the newer additive technologies into commercial production is essentially a matter of complementing subtractive methods rather than displacing them entirely. Predictions for the future of commercial manufacturing, starting from today's already- begun infancy period, are that manufacturing firms will need to be flexible, ever-improving users of all available technologies in order to remain competitive.

General Principles

Modeling

3D printable models may be created with a computer aided design (CAD) package or via a 3D scanner or via a plain digital camera and photogrammetry software.

The manual modeling process of preparing geometric data for 3D computer graphics is similar to plastic arts such as sculpting. 3D scanning is a process of analysing and collecting digital data on the shape and appearance of a real object. Based on this data, three-dimensional models of the scanned object can then be produced.

Regardless of the 3D modelling software used, the 3D model (often in .skp, .dae, .3ds or some other format) then needs to be converted to either a.STL or a .OBJ format, to allow the printing (a.k.a. "CAM") software to be able to read it.

Printing

Before printing a 3D model from an STL file, it must first be examined for "manifold errors", this step being called the "fixup". Especially STL's that have been produced from a model obtained through 3D scanning often have many manifold errors in them that need to be fixed. Examples of manifold errors are surfaces that do not connect, gaps in the models, ... Examples of software that can be used to fix these errors are netfabb and Meshmixer, or even Cura, or Slic3r.

Once that's done, the .STL file needs to be processed by a piece of software called a "slicer" which converts the model into a series of thin layers and produces a G-code file containing instructions tailored to a specific type of 3D printer (FDM printers). This G-code file can then be printed with 3D printing client software (which loads the G-code, and uses it to instruct the 3D printer during the 3D printing process). It should be noted here that often, the client software and the slicer are combined into one software program in practice. Several open source slicer programs exist, including Skeinforge, Slic3r, and Cura as well as closed source programs including Simplify3D and KISSlicer. Examples of 3D printing clients include Repetier-Host, ReplicatorG, Printrun/Pronterface, ...

Note that there is one other piece of software that is often used by people using 3D printing, namely a GCode viewer. This software lets one examine the route of travel of the printer nozzle. By examining this, the user can decide to modify the GCode to print the model a different way (for example in a different position, e.g. standing versus lying down) so as to save plastic (depending on the position and nozzle travel, more or less support material may be needed). Examples of GCode viewers are Gcode Viewer for Blender and Pleasant3D.

The 3D printer follows the G-code instructions to lay down successive layers of liquid, powder, paper or sheet material to build the model from a series of cross sections. Materials such as plastic, sand, metal, or even chocolate can be used through a print nozzle. These layers, which correspond to the virtual cross sections from the CAD model, are joined or automatically fused to create the final shape. Depending on what the printer is making, the process could take up to minutes or days. The primary advantage of this technique is its ability to create almost any shape or geometric feature.

Printer resolution describes layer thickness and X-Y resolution in dots per inch (dpi) or micrometres (µm). Typical layer thickness is around 100 µm (250 DPI), although some machines such as the *Objet Connex* series and 3D Systems' *ProJet* series can print layers as thin as 16 µm (1,600 DPI). X-Y resolution is comparable to that of laser printers. The particles (3D dots) are around 50 to 100 µm (510 to 250 DPI) in diameter.

Construction of a model with contemporary methods can take anywhere from several hours to several days, depending on the method used and the size and complexity of the model. Additive systems can typically reduce this time to a few hours, although it varies widely depending on the type of machine used and the size and number of models being produced simultaneously.

Traditional techniques like injection moulding can be less expensive for manufacturing polymer products in high quantities, but additive manufacturing can be faster, more flexible and less expensive when producing relatively small quantities of parts. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer.

Finishing

Though the printer-produced resolution is sufficient for many applications, printing a slightly oversized version of the desired object in standard resolution and then removing materialwith a higher-resolution subtractive process can achieve greater precision.

Some printable polymers allow the surface finish to be smoothed and improved using chemical vapour processes.

Some additive manufacturing techniques are capable of using multiple materials in the course of constructing parts. These techniques are able to print in multiple colors and color combinations simultaneously, and would not necessarily require painting.

Some printing techniques require internal supports to be built for overhanging features during construction. These supports must be mechanically removed or dissolved upon completion of the print.

All of the commercialized metal 3-D printers involve cutting the metal component off of the metal substrate after deposition. A new process for the GMAW 3-D printing allows for substrate surface modifications to remove aluminum components manually with a hammer.

Methods of 3d Printing

There are a few different methods of 3d printing, of which I will explain the pro's and con's for instrument making.

Selective laser sintering (SLS)

- Description

This method uses a high powered laser to melt powder together. When set up carefully, this can create an almost perfectly uniform material of nearly injection mold quality. This make for very durable products. This is very interesting for musical instruments, as this allows us to create objects with the same materials as conventional instruments, but with the ease of printing instead of manual labor. The method is relatively simple, due to inherent supports it avoids additional step in between the 3d model and printing. The surface quality is fair, but not as detailed as other techniques.

- Materials

Plastics, Elastomers, Metal, Ceramics, Glass

- Product example

- Machines which use this technique[1]

Stereolithography (SLA)

- Description

A layer of fluid resin is hardened by UV or laser. It makes for great surface quality and build accuracy. Useful, as this removes the need for post-finishing. But the products remain brittle, which disqualifies this method for musical instruments, because an instrument which could break during performance, is no use at all.

- Materials

Epoxy polymers, both rigid or flexible

- Product example

- Machines which use this technique

Polyjet or Jetted Photopolymer (J-P)

- Description

Extrudes a photo polymer which hardens with UV light. Can create rubber-like objects. This could be interesting for creating one-piece string instruments (is 1 - 20 MPa Tensile strength enough??

- Materials

Photopolymers, both solid as rubber-like.

- Product example

- Machines which use this technique

Fused deposition modeling/fused filament fabrication (FDM/FFF)

- Description

The most seen 3d printing method, as most inexpensive machines use this method. (Usually) A plastic wire is molten and laid down in layers. Inherently unsolid material, always has air-spaces and fuse lines. In default setting this provides a material which is not interesting for musical instruments, but with a careful setup, the air spaces could be tuned, so it could resonate in a controlled fashion.
A big advantage is that is method is used in the cheapest and most common 3d printers. This is also the method that seems to make most promise for cheap home printers.

- Materials

ABS, PC, concrete, chocolate, icing and other food

- Product example

- Machines which use this technique

RepRap

Cladding or Laser Powder Forming or Laser Fusing

- Description

Instead of feeding the printing head a solid core of material, a powder is fed. This provides a more accurate method. It creates a full density product without porosity or weld-lines. A method for making very detailed and small parts. This method seem perfect for 3d printing replica's of mouthpieces. The biggest disadvantage is that this is one of the most expensive 3d printing methods.

- Materials

Metal, Ceramic, Polymer

- Product example

- Machines which use this technique

Laminated object manufacturing or LOM

- Description

Sheets of raw material are laid on each other, after which it will be cut out by laser or knife. Objects can get wood-like properties, by simulating year ring.

- Materials

Paper, Plastic or Metals.

- Product example

- Machines which use this technique

Printers

Industry use

As of October 2012, Stratasys now sells additive manufacturing systems that range from $2,000 to $500,000 in price and are employed in several industries: aerospace, architecture, automotive, defense, and dental, among many others. For example, General Electric uses the high-end model to build parts for turbines.

Consumer use

Printing in progress in a Ultimaker 3D printer during Mozilla Maker party, Bangalore

Several projects and companies are making efforts to develop affordable 3D printers for home desktop use. Much of this work has been driven by and targeted at DIY/enthusiast/early adopter communities, with additional ties to the academic and hacker communities.

RepRap is one of the longest running projects in the desktop category. The RepRap project aims to produce a free and open source hardware (FOSH) 3D printer, whose full specifications are released under the GNU General Public License, and which is capable of replicating itself by printing many of its own (plastic) parts to create more machines. RepRaps have already been shown to be able to print circuit boardsand metal parts.

Because of the FOSH aims of RepRap, many related projects have used their design for inspiration, creating an ecosystem of related or derivative 3D printers, most of which are also open source designs. The availability of these open source designs means that variants of 3D printers are easy to invent. The quality and complexity of printer designs, however, as well as the quality of kit or finished products, varies greatly from project to project. This rapid development of open source 3D printers is gaining interest in many spheres as it enables hyper-customization and the use of public domain designs to fabricate open source appropriate technology. This technology can also assist initiatives in sustainable development since technologies are easily and economically made from resources available to local communities.

The cost of 3D printers has decreased dramatically since about 2010, with machines that used to cost $20,000 now costing less than $1,000 For instance, as of 2013, several companies and individuals are selling parts to build various RepRap designs, with prices starting at about €400 / US$500. The open source Fab@Home project has developed printers for general use with anything that can be squirted through a nozzle, from chocolate to silicone sealant and chemical reactants. Printers following the project's designs have been available from suppliers in kits or in pre-assembled form since 2012 at prices in the US$2000 range.The Kickstarter funded Peachy Printer is designed to cost $100 and several other new 3D printers are aimed at the small, inexpensive market including the mUVe3D and Lumifold. Rapide 3D has designed a professional grade crowdsourced 3D-printer costing $1499 which has no fumes nor constant rattle during use. The 3Doodler, "3D printing pen", raised $2.3 million on Kickstarter with the pens selling at $99, though the 3D Doodler has been criticised for being more of a crafting pen than a 3D printer.

As the costs of 3D printers have come down they are becoming more appealing financially to use for self-manufacturing of personal products. In addition, 3D printing products at home may reduce the environmental impacts of manufacturing by reducing material use and distribution impacts.

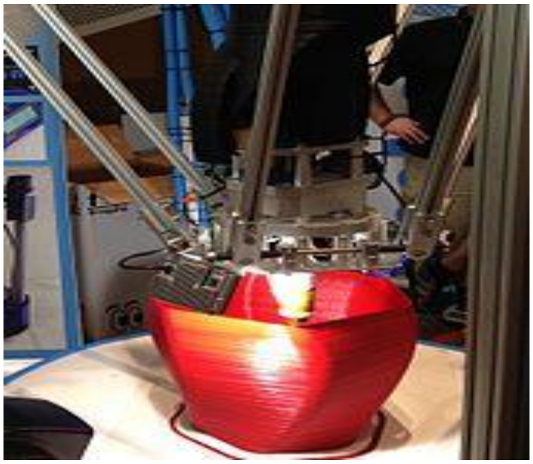
In addition, several RecycleBots such as the commercialised Filastruder have been designed and fabricated to convert waste plastic, such as shampoo containers and milk jugs, into inexpensive RepRap filament. There is some evidence that using this approach of distributed recycling is better for the environment.

The development and hyper-customization of the RepRap-based 3D printers has produced a new category of printers suitable for small business and consumer use. Manufacturers such as Solidoodle, RoBo, RepRapPro and Pirx 3D have introduced models and kits priced at less than $1,000, thousands less than they were in September 2012. Depending on the application, the print resolution and speed of manufacturing lies somewhere between a personal printer and an industrial printer. A list of printers with pricing and other information is maintained. Most recently delta robots, like the TripodMaker, have been utilised for 3D printing to increase fabrication speed further. For delta 3D printers, due to its geometry and differentiation movements, the accuracy of the print depends on the position of the printer head.

Some companies are also offering software for 3D printing, as a support for hardware manufactured by other companies.

Large 3D printers

Large scale industrial 3D printing



Large delta-style 3D printer

Large 3D printers have been developed for industrial, education, and demonstrative uses. A large delta-style 3D printer was built in 2014 by SeeMeCNC. The printer is capable of making an object with diameter of up to 4 feet (1.2 m) and up to 10 feet (3.0 m) in height. It also uses plastic pellets as the raw material instead of the typical plastic filaments used in other 3D printers.

Another type of large printer is Big Area Additive Manufacturing (BAAM). The goal is to develop printers that can produce a large object in high speed. A BAAM machine of Cincinnati Incorporated can produce an object at the speeds 200-500 times faster than typical 3D printers available in 2014. Another BAAM machine is being developed by Lockheed Martin with an aim to print long objects of up to 100 feet (30 m) to be used in aerospace industries

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 colour 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.

Conclusion

3D Printing technology could revolutionize and re-shape the world. Advances in 3D printing technology can significantly change and improve the way we manufacture products and produce goods worldwide. An object is scanned or designed with Computer Aided Design software, then sliced up into thin layers, which can then be printed out to form a solid three-dimensional product. As previously described, the importance of an invention can be appraised by determining which of the human needs it fulfills.

As shown, 3D printing can have an application in almost all of the categories of human needs as described by Maslow. While it may not fill an empty unloved heart, it will provide companies and individuals fast and easy manufacturing in any size or scale limited only by their imagination. One of the main advantages of the industrialization revolution was that parts could be made nearly identically which meant they could be easily replaced without individual tailoring.

3D printing, on the other hand, can enable fast, reliable, and repeatable means of producing tailor-made products which can still be made inexpensively due to automation of processes and distribution of manufacturing needs. If the last industrial revolution brought us mass production and the advent of economies of scale - the digital 3D printing revolution could bring mass manufacturing back a full circle - to an era of mass personalization, and a return to individual craftsmanship.

Reference

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