Team code: 16 - 0379

# *3D Printing*

## *Advancing Industry One Layer at a Time*

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### I. Introduction

3D printing takes construction to a whole new level. It is the process in which an object is made with a 3D printer by layering on thin material to create the shape of the object. 3D printing was invented by a man called Charles "Chuck" Hull in 1983.

### II. Types of 3D Creation

#### *A. Stereolithography*

In 3D printing, an object is created by layering many thin layers of material over each other to create the form of the object. First, the object needs to be modeled using a 3D design software that can also connect to a 3D printer, or it can be scanned in a 3D scanner. Different 3D printers use different technology to produce an object. Some printers use Selective Laser Sintering (SLS), and others use Fused Deposition Modeling (FDM) to melt or make materials softer to print an object. The most common way of 3D printing is by using a laser to layer material. This is called Stereolithography (SLA).

The American Society for Testing and Materials split up the processes of 3D printing into 7 different categories (2010):

- Vat Photopolymerisation
- Material Jetting
- Binder Jetting
- Material Extrusion
- Powder Bed Fusion
- Sheet Lamination
- Directed Energy Deposition

#### *B. Vat Photopolymerisation*

Vat Photopolymerisation is when a light-sensitive material is in a container and is them molded or hardened by a light source or a laser. This technique is the oldest technique, and was invented by Charles "Chuck" Hull at the same time that he invented the first 3D printer. The most common type of Vat Photopolymerisation is Stereolithography, which we discussed earlier. Vat Photopolymerisation builds the object one layer at a time by hardening each individual layer and then joining it to the layer below with the laser or light source. Then, the now hardened layer is coated with a fresh, soft layer, which is hardened by the laser. This process repeats itself until the object is built. Other types of 3D printing techniques that fall under the Vat Photopolymerisation category are Continuous Liquid Interface Production (CLIP), Film Transfer Imaging and Solid Ground Curing.

#### *C. Material Jetting*

Material Jetting involves the soft material being piped into where it's supposed to be and then hardened by a UV laser. The material is in a separate container and is then piped into the printing area and applied as a layer. The layer is then hardened by a UV laser.

#### *D. Binder Jetting*

Binder Jetting uses the material in powder form, and connects it with a glue called a liquid binder. In the building place the powder is spread into separate layers and is then glued together in the form of the object by the liquid binder.

#### *E. Material Extrusion*

Fused Deposition Modeling, which we mentioned earlier, falls under the category of Material Extrusion. First, material is heated up and can be directed horizontally and vertically across the building area in layers. Once the material is in place, it hardens by itself.

#### *F. Powder Bed Fusion*

Selective Laser Sintering, which we mentioned earlier, is part of the category of Powder Bed Fusion. The process used here is that many small particles (powder) of material are placed in the form of the 3D object that is desired, and then a laser passed over and through it to melt the particles together and fuse them. The laser fuses them together layer by layer. After each layer is fused, the whole structure is made smaller in height by one layer thickness. Then, once the whole structure is made smaller in height by that layer thickness, a new layer is applied on the top and the process is repeated until the structure is completed.

#### *G. Sheet Lamination*

Sheet lamination takes already-stuck-together layers of material and then connects them. The layers can be made of anything: metal, wood, paper etc. The metal sheets are welded together and the paper ones are stuck together with adhesive

glue. The metal sheets are cut by a cylindrical cutting tool in a process called CNC Milling.

### *H. Direct Energy Deposition*

Directed Energy Deposition consists of a robotic arm putting material in powder form on the building area, and then a laser melting and hardening that material to create the form of the 3D object.

## III. Commercial Usage

Naturally, 3D printing is also revolutionary to the engineering industry, as it becomes extremely easy and also a lot cheaper to 3D print complicated parts quickly. Designing a complicated object on a computer, for someone who is experienced with modeling software, is not a difficult task and of course the object can be modified, tweaked and changed as much as you want before you 3D print it. Then, once you have designed one of these objects, you can copy them and print them again, so printing in bulk is also feasible and cheap.

3D printers are already available commercially, and you can buy one easily. Many schools, offices and companies have 3D printers. There are also shops that are making money off of 3D printing. At a certain business, called 3dee, based in Antwerp, Belgium, you can get things 3D printed for you, you can get help with creating models to 3D print, you can 3D scan objects, you can be trained in how to model and how to use a 3D printer, and more. You can even get yourself scanned and then 3D printed into a model.

### *A. The use of a 3D Printer in Ford Motor Company*

Ford use 3D printing to make parts for cars, and, in fact, Ford have used 3D printing since the 1980's: when it was made. According to the Ford website, using 3D printing has proved to be much faster and cheaper, costing $3000 and taking four days, whereas if they hadn't used a 3D printer the same process would have costed $500,000 and taken four months.

### *B. The use of 3D Printing in The Boeing Company*

Boeing use 3D printing to make parts for their planes. They have already printed more than 20,000 parts and implemented those into 10 different military planes, and, like ford, were one of the first major companies to use 3D printing.

### *C. The use of 3D Printing in Nike*

Nike use 3D printing to make cleats for shoes. The CEO has stated that using 3D printing has been a big boost for their company, lowering costs for making shoes and raising the production rate. Materials are lighter and more flexible. The company has implied that they will be using 3D printing a lot more in the future, but no more details were given.

### *D. The use of a 3D Printer in a multinational toy and board game company Hasbro*

Hasbro uses 3D printing to print parts for toys and board games. They 3D print toys from brands such as My Little Pony, Playskool and Sesame Street. They have a partnership with 3D systems, one of the leading companies in 3D printing technology.

### *E. The use of a 3D Printer in a American Pearl a Jewellery Company*

A jewellery company called American Pearl is using 3D printing to custom design and then print different kinds of jewellery, including wedding rings. Clients at American Pearl can choose all the materials, gems and diamonds to fully customise their wedding ring. The unique service does come at a cost, though - hundreds of thousands of dollars worth of jewellery.

### *F. The use of a 3D Printer in a Hershey Chocolate Company*

Even Hershey's is using 3D printing to make 3D printed chocolate. They are doing this to show the public that even they can stay mainstream in technology, and now, with the ease of 3D printing, they can customise and 3D print edible shapes and confectionaries.

### *G. The use of 3D Printing in The National Aeronautics and Space Administration*

NASA have plans to put 3D printers in space, to print things such as supplies and even food. NASA will begin by putting 3D printers on the International Space Station, so that people there have easy access to critical maintenance supplies.

## IV. Medcal Usage

3D printing is very useful in the medical industry. Right now, we can already print tissue with working blood vessels. It is also possible to make custom-designed prosthetic parts at a low cost. 3D printing is developing rapidly. Companies are becoming familiar with this technique of printing and in the future, it might even help prolong lives by fixing disabilities and disorders temporarily, if not permanently.

### *A. Experimentations with 3D Printing in the Medical Field*

At the University of Glasgow, they have discovered a way to make medicine with a 3D printer that can function at a molecular level. To use this, patients would go online with a digital prescription, buy the material and download the design of the medicine they need, and then they can print the medicine themselves.

### *B. Different Parts of the Human Anatomy that have been printed and some that have been tested*

Bones can be 3D printed, as well as heart valves, working liver cells, medical equipment and cranial replacement. One of the most interesting innovations in 3D printing is a 3D printed ear that has superhuman hearing. Even people who have lost their

sense of sight have a chance in getting it back with the 3D printed bionic eye from the researchers at Bionic Institute. This 3D printed eye has been tested and so far, is shown to work.

## V. Getting Involved

Inside 3D Printing is the host of numerous 3D printing events around the world. On April 4th-5th they will be hosting a convention in Sao Paulo. On April 10th-12th there'll be an event in New York and from May 11th-13th there will be an event in Sydney. On May 24th-26th there will be an event in Paris, and lastly on 22nd-24th there will be an event in Seoul. These are the next five events that will be hosted by Inside 3D Printing.

## References


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