

## Terms

**Stereolithography:** a technique or process for creating three-dimensional objects, in which a computer-controlled moving laser or light beam is used to build up the required structure, layer by layer, from a photo-sensitive liquid polymer resin.

**Additive Manufacturing** refers to a process by which digital 3D design data is used to build up a component in layers by depositing material. The term "3D printing" is increasingly used as a synonym for Additive Manufacturing.

**Rapid prototyping** is a group of techniques used to quickly fabricate a scale model of a physical part or assembly using three-dimensional computer aided design (CAD) data. Construction of the part or assembly is usually done using 3D printing or "additive layer manufacturing" technology.

## **CNC - Computer Numerical Control**

**CAD** Computer-Aided Design

**CAM** Computer-Aided Manufacturing

## **File Formats**

**OBJ:** OBJ is an open file format that represents 3D geometry. It is a common file used in 3D printing because many design software exports to OBJ and most printers accept OBJ as a printable file.

**STL:** STL files are a standard file type that interfaces between Computer Aided Design (CAD) software and 3D printers. Most CAD software exports to an STL file and most 3D printers accept STL files.

**VRML:** VRML (or WRL) files are commonly used when a 3D model has color and you want to transfer that color to the print.

**X3G :** X3G is the file type that interfaces with the MakerBot 3D printer. MakerWare and ReplicatorG will output an X3G file.

**PLY:** PLY files are normally scanner-generated models and will have to be imported into some type of design software before sending to a 3D printer to print.

**FBX:** FBX is a file format owned by Autodesk. It is used to efficiently exchange data between Autodesk programs including 3ds Max, Autodesk and Maya.

**Additive Manufacturing File Format (.AMF)** is a new XML-based open standard for 3D printing. Unlike STL, it contains support for color. They can also be compressed to about half the size of a compressed STL file. AMF is not widely used at present, but in future we would like to add this an option for uploading and downloading files to and from the NIH 3D Print Exchange.

**GCode** - G-code is a language in which people tell computerized machine tools how to make something. The "how" is defined by instructions on where to move, how fast to move, and what path to move. The most common situation is that, within a machine tool, a cutting tool is moved according to these instructions through a toolpath and cuts away material to leave only the finished workpiece. The

same concept also extends to non-cutting tools such as forming or burnishing tools, photoplotting, additive methods such as 3D printing, and measuring instruments.

**NURBS**, Non-Uniform Rational B-Splines, are mathematical representations of 3D geometry that can accurately describe any shape from a simple 2-D line, circle, arc, or curve to the most complex 3-D organic free-form surface or solid. Because of their flexibility and accuracy, NURBS models can be used in any process from illustration and animation to manufacturing.

## **Types of Filament (These are the most popular - there are many more)**

### **ABS (Acrylonitrile Butadiene Styrene)**

ABS is generally very durable and strong, slightly flexible and quite resistant to heat. Printers able to process ABS plastics normally operate with a hot end (the heated part melting the plastic, before it's forced through the print nozzle) at a temperature around 210-250°C. Therefore, a 3D printer able to process ABS is necessarily equipped with a heated printbed (the surface that the 3D prints are built on), in order to prevent warping or cracking of the printed materials.

### **PLA (Polylactic Acid)**

PLA is a biodegradable thermoplastic which is derived from renewable resources, such as cornstarch, sugar cane, tapioca roots or even potato starch. This makes of PLA the most environmentally friendly solution in the domain of 3D printing, compared to all the other petrochemical-based plastics like ABS or PVA.

### **PVA (Polyvinyl Alcohol)**

PVA is a special plastic that is water-soluble. It is most commonly used as paper adhesive, as thickener, as packaging film, in feminine hygiene and adult incontinence products, as mold release agent or in children's play putty or slime. Another wide use is in freshwater sport fishing, where PVA bags filled with bait are thrown into the water. The bag rapidly dissolves, releasing the bait, in order to attract the fish.

## **3D Design/Render Programs**

Cura - (Free) provided by Ultimaker, compatible with a wide range of file formats.

Autodesk

- Fusion360 (free for hobbyists)

- Inventor

- 123D Design

- 123D Make - assembly instructions & slice options

- 123D Catch - make 3D models from photos

- 123D Circuits

- AutoCAD - \$1200+ per year

Rhino - (\$1000+) Uses NURBS in its file formatting to render geometry

Grasshopper - add-on for Rhino that can use algorithms to generate structures

Blender - Free (also used for animation, realistic rendering, and much more)

Sketchup - Free

## **Where to get things printed**

<http://www.shapeways.com/>

<https://www.ponoko.com/>

<https://www.you3dit.com/>

<https://www.makexyz.com/> - listing of local 3D printers

<https://www.3dhubs.com/> - listing of local 3D printers

## **Learn More**

3D Printing for Beginners - <http://3dprintingforbeginners.com/>

3D Printing Industry - <http://3dprintingindustry.com/>