3D Printing

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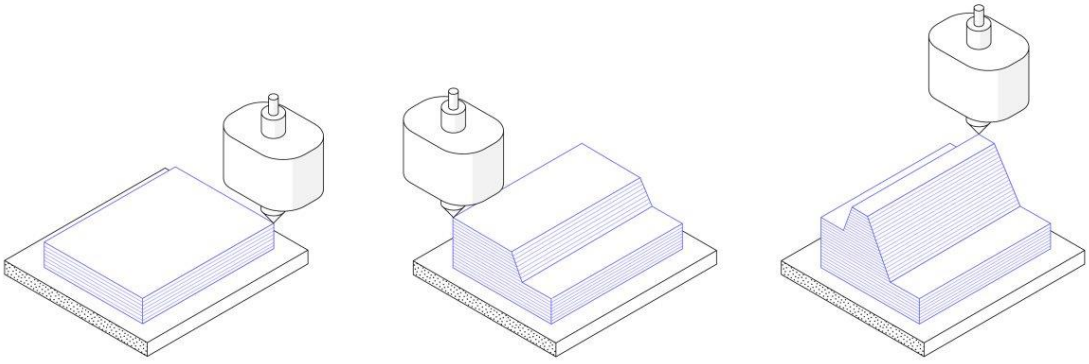
Course Objective: To gain a basic understanding of what 3D printing is, what the Benefits and Limitations of 3D Printing are, what applications could use 3D printed parts, and how to model an object to be printed.

What is 3D Printing?

All 3D Printers work along the same basic concept: a digital model is turned into a physical three-dimensional object by adding layer upon layer of material. This is where the original name for 3D printing, Additive Manufacturing, came from.

3D Printing is a radical new way to create something, totally different from traditional methods such as, CNC Machining or Injection Molding.



The process will always begin with a digital 3D model, this will be the blueprint for the physical object that we create. Next the printer's software will slice that 3D object into 2D layers, these layers are what will make up our 3D object.

The next step varies depending on the type of material you are using. Most of you will probably run into FDM (Fused Deposition Modelling) type printers, which use a filament that is made out of plastic, which is then heated up and run through a computer controlled nozzle, similar to a fancy glue gun. If you ever find yourself in an industrial manufacturing setting you might be using a SLS (Selective Laser Sintering) machine, which will use a laser to superheat and melt (or sinter) metals to be laid down.

Here at the Library we use a **Dremel Idea Builder 3D40** and **Lulzbot Taz 6**, both of these printers are FDM type.

Most prints will take between 4-16 hours depending on the size of the object you are printing (**many downloaded prints will tell you how long the print will take on average**). Parts often require finishing touches out of the printer such as sanding or assembly if multiple parts were printed for one object.

Benefits and Limitations of 3D Printing

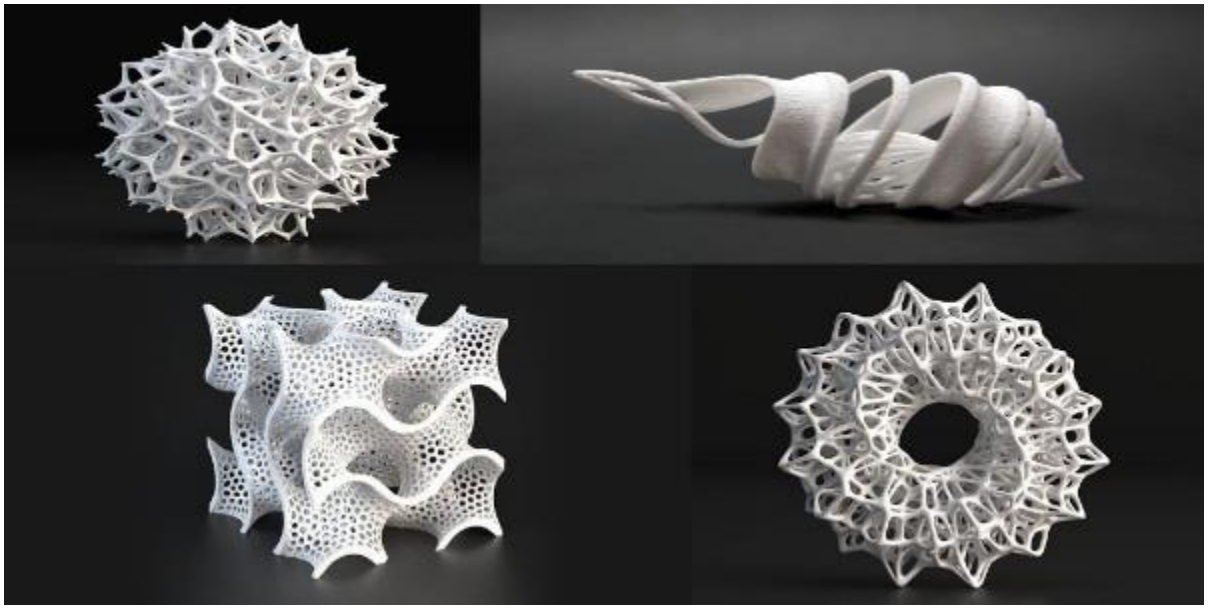
Benefits

There are many benefits to using a 3D printer for developing parts, but there are also some limitations. First we will cover what benefits you might find over more traditional types of manufacturing.

One of the main benefits is the low startup cost. Once you buy the printer, usually around $1000-$2000, you are only paying for raw materials. Compare this to injection molding, where you have to pay for a custom mold of each part, and those custom molds can be a pretty penny.

Another benefit is the ability to customize parts on the fly, this makes prototyping easy and is one of the main things that 3D printing is used for. Think if you needed to tweak on little part of your prototype, would you want to wait for a new mold to be made and shipped to you, or would you rather tweak your design and then start printing? Your product could take 5-10 days to ship, instead of 5-10 months.

One of the coolest things that 3D printing allows us to do, is to make complex shapes. Many of these shapes cannot be created by any other manufacturing technique. These complex shapes can be attained due to the additive nature of 3D printing, meaning it possible to create these structures for a significantly cheaper price compared to traditional manufacturing methods.



Limitations

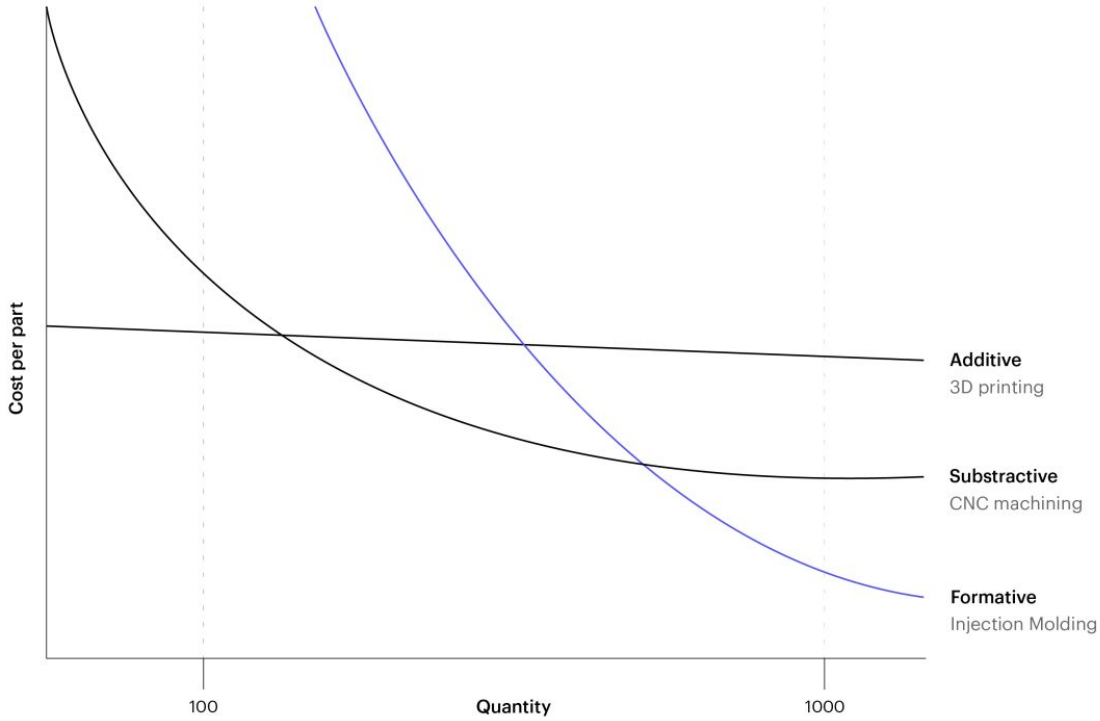
One of the main limitation to 3D printing is the strength of the parts created, particularly with FDM type machines. Most (plastic) parts that are created with 3D printers are more brittle and weaker in one direction by 10-50% compared to their more traditionally manufactured counterparts. Plastic 3D printed parts are most often used for non-critical functional applications.

SLS and other metal type printers do not run into this problem.

Limitations Continued

Another drawback is the lack of scaling when facing large production runs. Since there is a lack of custom tooling used in 3D printing, the startup costs are low and small production runs (think 1-10) are economical, but unit prices only decrease a small amount at higher quantities. This prevents economies of scale from kicking in.

This graph from 3dhubs.com shows this lack of scaling with 3D printing.



The final limitation is the fault tolerance for accuracy. What this means is that when you create something, you have to calibrate your machine down to the millimeter, something that is almost impossible to do.

"Typically, parts printed on a desktop FDM 3D printer have the lowest accuracy and will print with tolerances of ± 0.5 mm. This means that if you design a hole with diameter of 10 mm, its true diameter after printing will something between 9.5 mm to 10.5 mm."

-3dhub.com

Again, this is typically why [plastic] parts are used in non-crucial areas of the product.

Applications of 3D Printing

In this modern day, 3D printing has found itself in many different applications. Some of the biggest sectors that use 3D Printing are: Aerospace, Automotive, Robotics and Tooling. We will see how much of an effect 3D printing in more detail in this following section.

Application: Aerospace

One of the biggest advantages 3D printing has is its ability to create custom parts on the fly. The ability to create topology optimized structures with a high strength-to-weight ratio, as well as the capability to consolidate multiple components into a single part can be astronomical.

Take into consideration the International Space Station. Astronauts are trained to deal with any situation that may arise, be it mechanical or personal. If a single part fails, it could be catastrophic and until recently an entire mission would have to be planned to just get that single part to the station. Now, though, we have sent the first 3D Printer (Made in Space) to the ISS and they know have the ability to not only 3D print, but do it in a Zero-Gravity Environment. Funnily enough, the first thing to print on the ISS was a spare part for the printer itself, a faceplate for the print head.

Another project using more than 100 custom 3D printed parts, is the Orion Spacecraft, which will hopefully launch on NASA next generation heavy-lift rocket, the Space Launch System (SLS).

Application: Automotive

One of the main things that the automotive industry has benefited from 3D printing, is the fast turnaround on prototyping parts, as well as the ease of customization for those part.

“Volkswagen traditionally used CNC machining to create custom jigs and fixtures. CNC has typically longer production times and higher cost. The same jigs and fixtures could be 3D printed overnight and tested on the assembly line the next day. Feedback from the operators was incorporated almost immediately and a new jig was ready to test the next day until the perfect tool was created.”

-3dhubs.com

Application: Robotics

Most everyone wants to have that robot butler that will take care of your every whim and need, and with 3D printing we are coming closer and closer to that fantasy. Almost every robotics project is going to need to use custom parts, because of this 3D printing has become the main production method that these people use. Design freedom and the speed of parts allows these people to create things we would have called science fiction fantasy 20 years ago.

Application: Tooling

The development of new types of material that are highly resistant to heat as well as tensile strength, while combining this with the ability to create these parts quickly and at low cost has allowed 3D printing to become almost standard in many applications in industrial tooling.

"For example, 3D printing is used today to manufacture low-run injection molds. These molds are used to produce a few hundred parts (compared to the 10.000+ of metal molds), but come at a fraction of the cost of a "traditional" mold and can be manufactured overnight. This makes them ideal for low-volume, low-cost production or small tests runs before full scale manufacturing."

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3D Printing Hobbyist

As a hobbyist, you most likely won't be creating the next big thing for the International Space Station, but rather creating small things that you could use on a day-to-day basis. Creating things from game controller stands to vases, the limit is your own creativity and your ability to create objects. Here is a list of things that you could potentially create as a 3D Printing Hobbyist.

- Board Game Models
- Dice
- Halloween Costumes
- Six Pack Carrier (if you are of age!)
- Pen and Pencil Holders
- Coasters
- Bottle Openers
- Keychains

IF you can think of it, you can print it! Check out Thingiverse.com for pre-modeled objects!

Modeling Objects for 3D Printing

Compatible files for 3D printing: .stl | .obj

While there are many different software used to create 3D models, here at the library we use a program called **Tinkercad**. This is a free resource that will allow you to create or import 3D designs and from there you can download the file to put through your printer. You can find it at **tinkercad.com**, and the program is hosted on the web!

To use Tinkercad all you need to do is create an account, and from there you can design and watch tutorials on how to create on object. Tonight we will have some time for all of us to tinker with and create an object, if you like it we can put it in the queue to print.

If you are feeling lazy, or just want to look at designs other people have created, check out **Thingiverse.com.**

This website [thingiverse] allows people to upload their own designs for others to use. If you find something you like, you can either import it back into Tinkercad to modify it further, or you can take the file and put it straight through the printer.

3D Printing at Bloomingdale Public Library

If you would like to print something here at the library, we ask that you submit a request. This can be found on our website under the “Services >> 3D Printing” tab. Here you can also see our rules and regulations for printing here at the library.

Below are the important snippets from the page.

Using Our 3D Printers

The 3D printers are open to all library users and are not limited to Bloomingdale patrons. Submit your 3D print request (Link on Webpage), and a librarian will contact you within one week to confirm your file submission, your estimated print cost, and estimated print time. 3D Print Club for Teens is a monthly club for 7th-12th graders to learn how to use our 3D printers.

Ready to print? Submit your 3D print request (Link on Webpage). Please check the 3D print specs below before submitting.

3D Print Specs

- Printers available: Dremel Idea Builder 3D40 and Lulzbot Taz 6
- Maximum print size: 280mm x 280mm x 250mm (11 in x 11 in x 9.8in)
- **Maximum print time: 8 hours (for all files submitted). If your project/files are over 8 hours total, you must break you project into smaller time increments. We only accept one 8 hour project per patron per two week period.**
- File types accepted: .stl or .obj
- Print colors: Filament color choices are available on the 3D print request form
- Filament type: PLA only
- File names: Before uploading, name your print file as your full name and the color of filament. (Example: John Thompson True Black.stl) If you're submitting multiple files, please number your files. (Example: 01 John Thompson Cool Grey, 02 John Thompson Cool Grey, etc.)
- Cost: 50 cents per half hour of printing
- Payment: Cash only
- Pick up and pay for your item at the Adult Reference Desk
- You will not be charged for failed prints
- Prints will be processed in the order that they're received
- Staff will contact you within one week to confirm your file submission, your estimated print cost, and estimated print time.
- **Please allow up to 2-3 weeks for prints to be completed**