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**TANDON SCHOOL
OF ENGINEERING**



Promoting robotic design and entrepreneurship
experiences among students and teachers

Lesson 10: Technology Subsystem — 3D Printing for STEM and Robotics Applications

CONTENTS



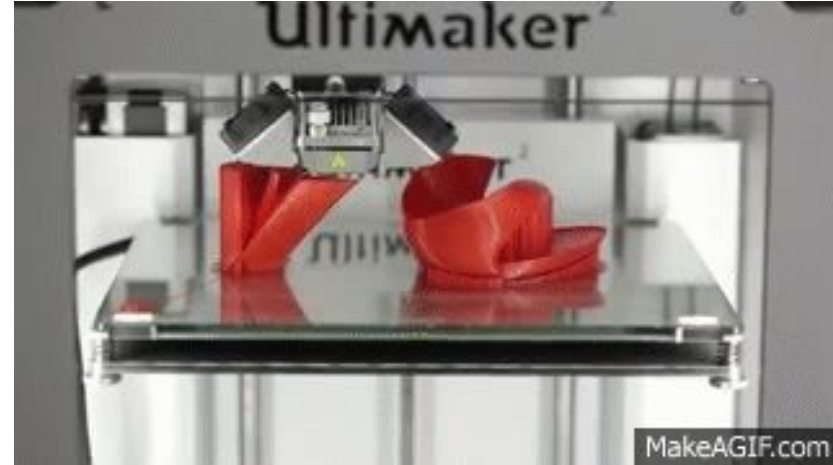
- Introduction to 3D printing
- History and modern era of 3D printing
- Process of 3D printing
- Types of 3D printing
- **TASK/ACTIVITY:** Touring the makerspace

- **3D printing** is an **additive manufacturing process** that creates 3-dimensional objects from 3-dimensional design model
- 3 dimensional digital models are “**sliced**” into many **2-dimensional** cross-sections that are then “**printed**”, **one on top of the other**
- There are other digitized processes that are a **subtractive manufacturing process** (ex. CNC, milling) often referred to as “**machining**”



[Source](#)

- 3D printing is an **additive method** i.e. material is added rather than taking it away (subtractive)
- The material is **layered** using an **extruder**, onto a bed with each layer bonding to the previous
- The process follows the structure of a **CAD** file in computer using data from an **STL** file

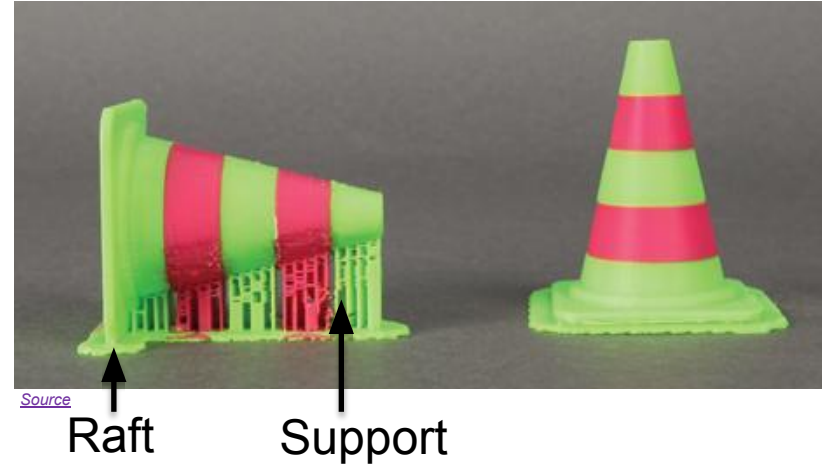


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MakeAGIF.com

When the design is complete, the part is removed from the bed, and is either:

1. Finished and ready to be used
2. Cleaned up to **remove support material** – when support material is used to build the design
3. Cleaned up by **removing raft material**
4. Heat treated prior to use



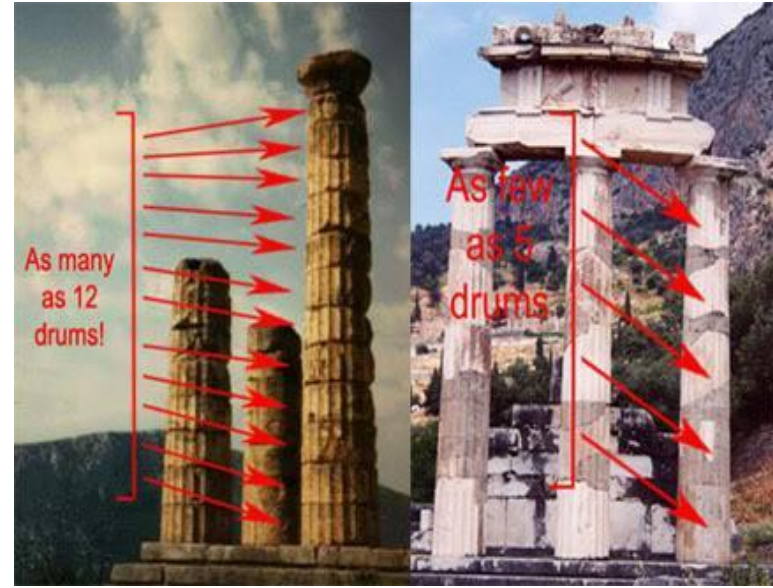
NOTE: For common school printers that use **plastic** as the **3D printing material**, options 1-3 apply. For **metals** or other composites, option 4 also applies.

HISTORY OF 3D PRINTING

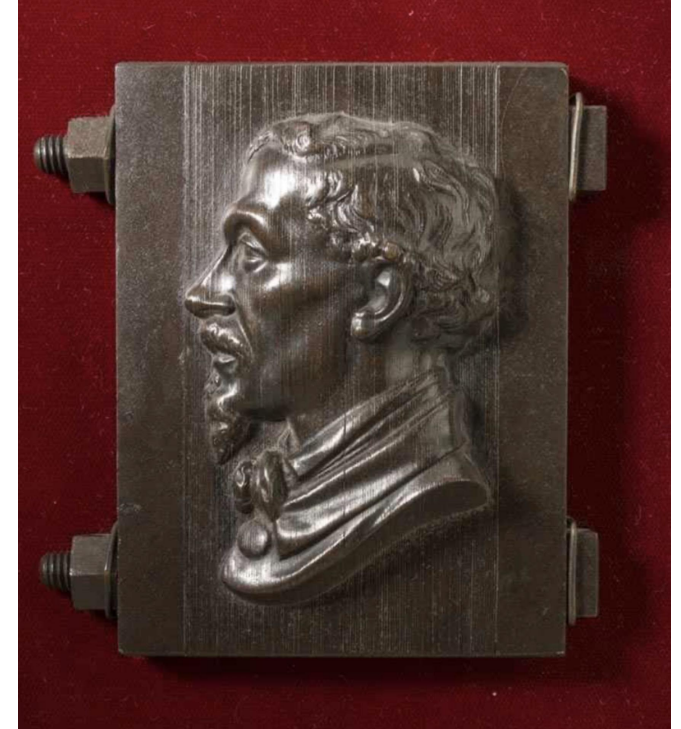
- The “idea” of 3D printing has existed for centuries, millennia possibly
- Looking at columns built by ancient Greeks we may be seeing the beginning



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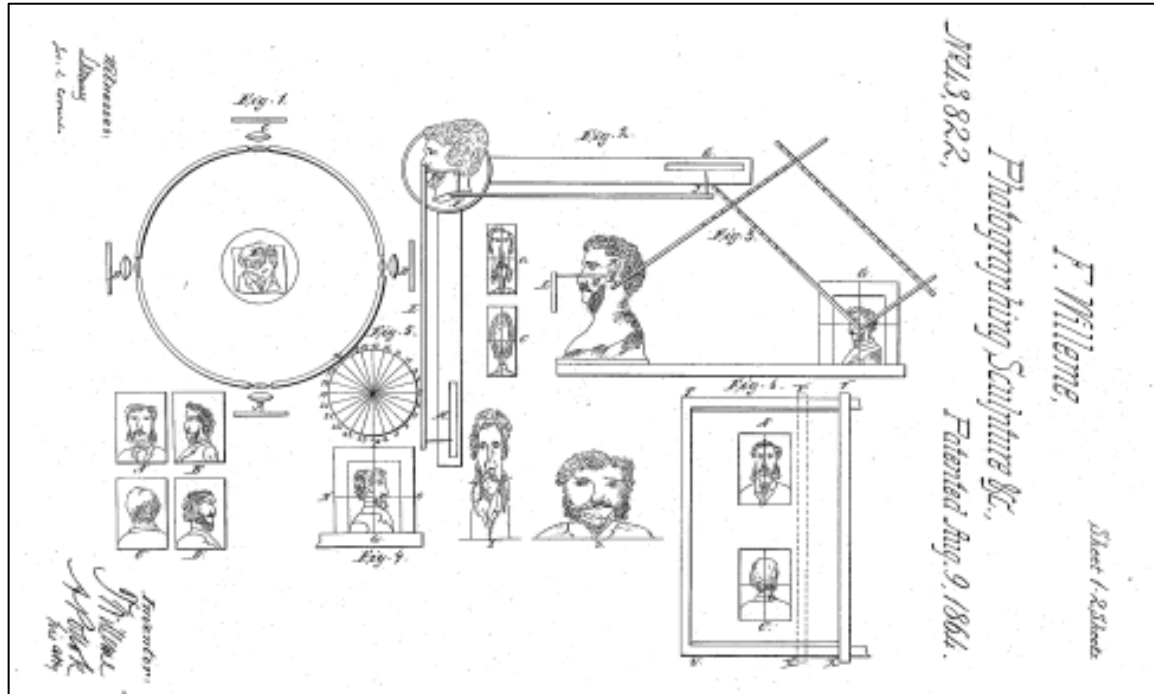
- François Willème 1806's work on "**Photosculpture**" was his patented technique of combining photography with the pointing machine, used by sculptors to reproduce 3D art



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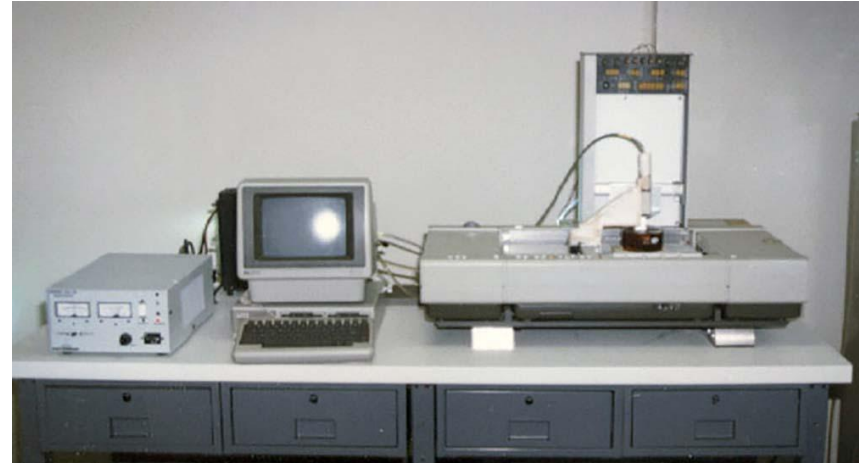
HISTORY OF 3D PRINTING

- The original patent by François Willème on “**Photosculpture**”



Photosculpture patent

- **1980:** The early roots of 3D printing lie in photo-sculpture and topography
- **1981:** Hideo Kodama of Nagoya Municipal Industrial Research Institute in **Japan** was first to publish paper outlining a working 3D printer
- **1984:** Charles “Chuck” Hull of 3D Systems develops first prototype 3D printer
- He called it stereolithography and developed the STL file format widely used today



[The first 3D printer - by Charles Hull](#)

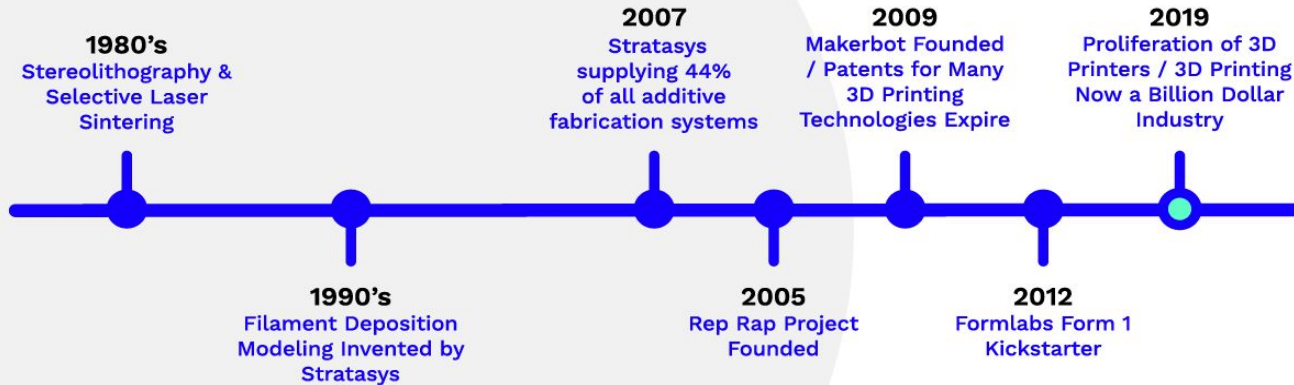
AS A SUMMARY

- Developed in the **1980s**
- A **fast** and cost effective process for industry to make parts
- It was never patented by the person who **invented** the process in **1980**, **Dr. Kodama** from **Japan**
- Later patented by **Charles Hull** in **1986** who set up the company 3D Systems Corporation
- In **2012**, the first crowd funded printers became **available to market** using the platform **Kickstarter**



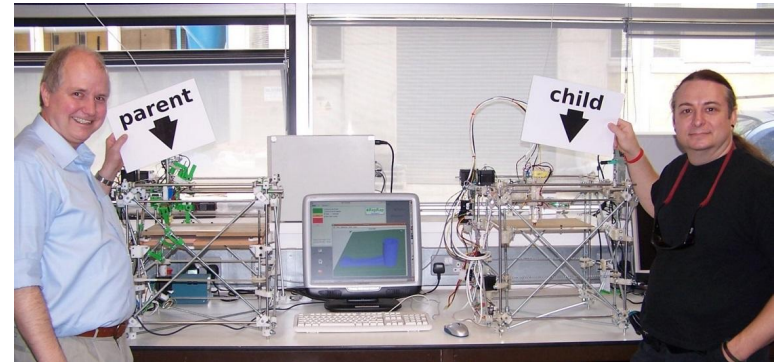
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Timeline of 3D Printing Technologies



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- **RepRap Project (2005):** A collaborative challenge to create a self-replicating machine!
- Up until this point 3D printing was very expensive and, almost available only to the manufacturing industry
- Beside the RepRap what else made 3D printing more available?
 - Cheaper technology
 - Patent expiration
 - Open source



[Source](#)

2009: The **MakerBot** - 3D Printers for Everyone!

- After the success of RepRap, **MakerBot** made open-source DIY kits to build their own 3D printers or 3D printed products
- Thingiverse was created, for users to post or download printable files for 3D designs



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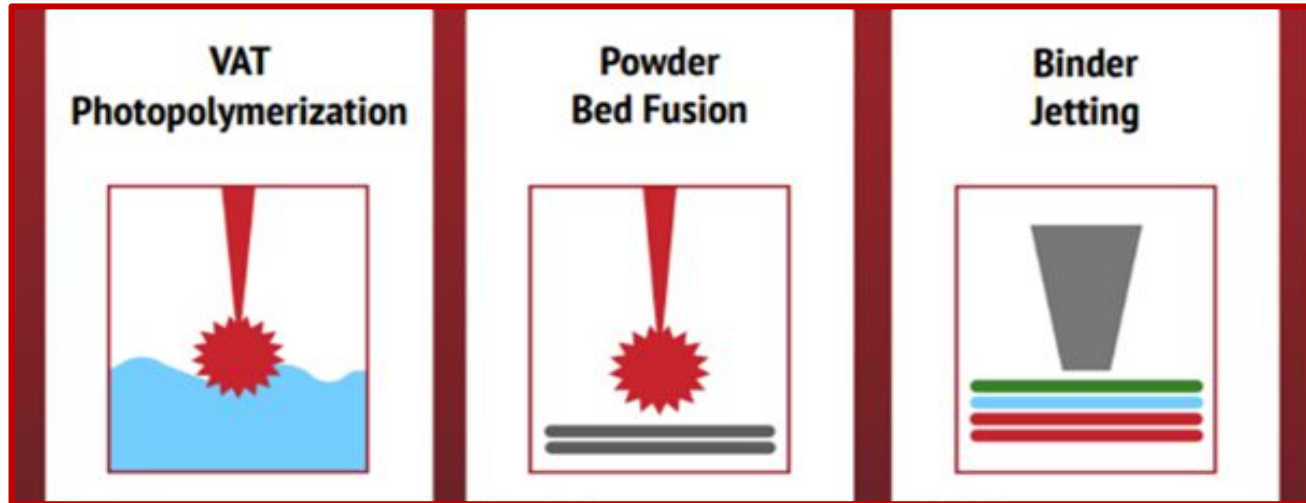
- From the first **3D printed kidney** in **2000**, to the first **3D printed house** in **2018**, to today, 3D printing is revolutionizing big sectors such as automotive, architecture, medical and more



[Europe's first fully 3D printed house](#)

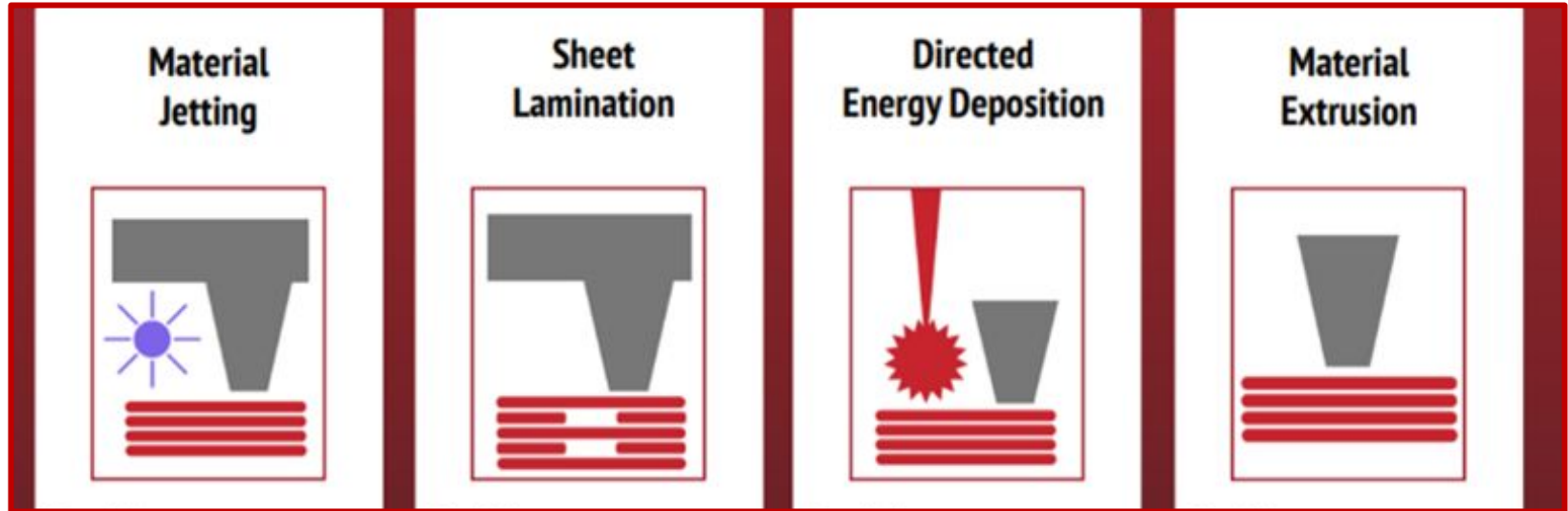
TYPES OF 3D PRINTING

- **Different types of 3D Printing Mechanisms:** 3D Printing comes in 7 different forms based on its application, material, type of manufacturing as follows



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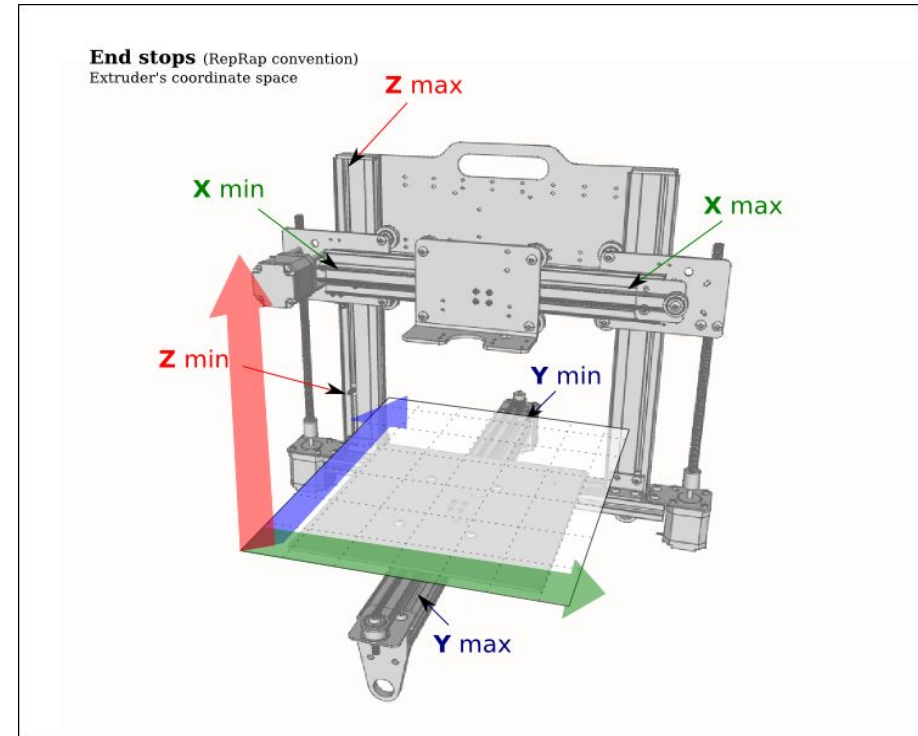
TYPES OF 3D PRINTING



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PROCESS OF 3D PRINTING

- A 3D printer's extruder moves along 3 axes:
 - X: left to right
 - Y: back and forth
 - Z: up and down



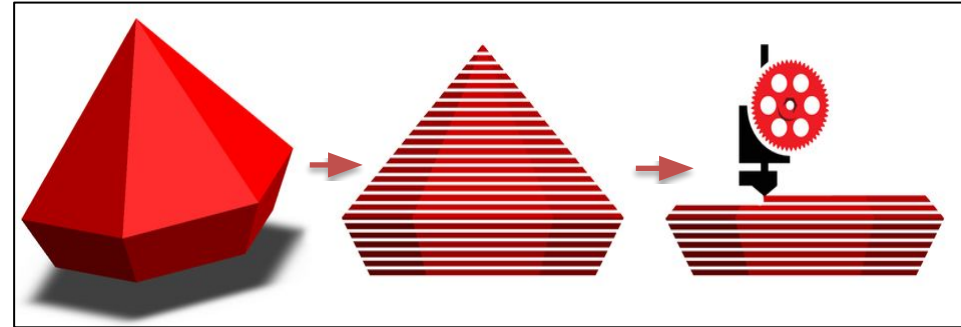
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The process:

- **3D modelling:** We can model an object in **3D design software**, **scan** an object with a 3D scanner, or **download** an already made **CAD file**
- **Upload into Ultimaker Cura:** The design file is uploaded into the **Cura** software in **STL** or **OBJ** format
- **Format:** Choose the parameters such as size, placement, print speed, etc. and material of the print
- **Slice and Print:** 3D model is sliced (converted to **Gcode**), and the data is sent to a 3D printer which recreates the object one layer at a time, stacking consecutive layers atop one another

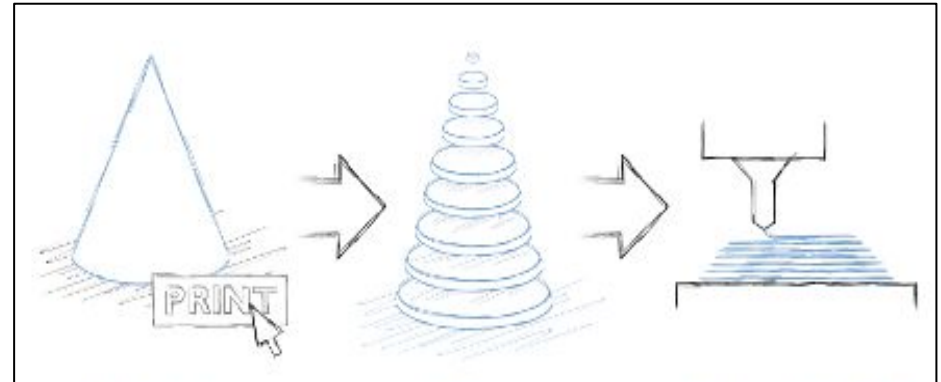
PROCESS OF 3D PRINTING

- **Gcode:** It is a specific code containing exact instructions for the printer
- **Printing:** The 3D printing software (Ultimaker Cura) “slices” the model into many **3D cross-sections**



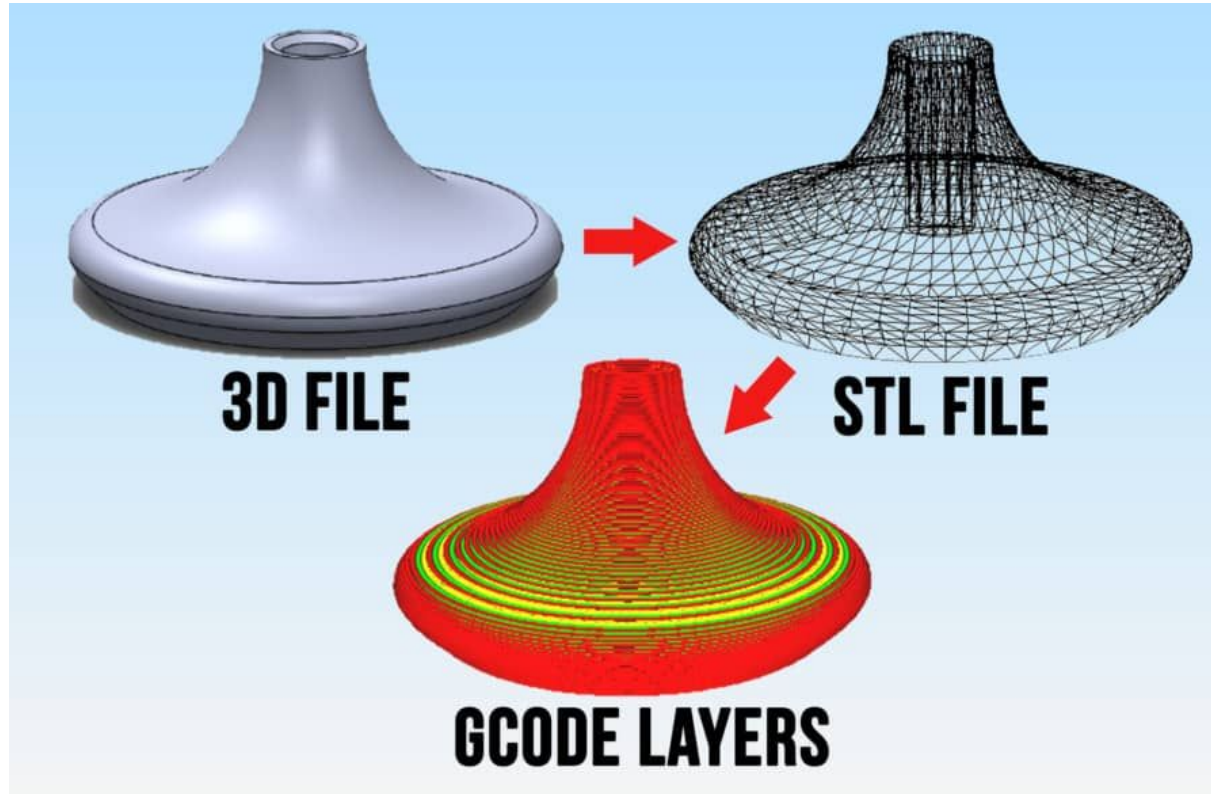
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Model → Slice → Print



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PROCESS OF 3D PRINTING



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Task / Activity: Touring the makerspace

Innovative Technology Experiences for Students and Teachers (ITEST), Professional Development Program, July 2017
Mechatronics and Robotics Laboratory, Department of Mechanical and Aerospace Engineering, NYU Tandon School of Engineering



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Thank You!

Questions and Feedback?

Innovative Technology Experiences for Students and Teachers (ITEST), Professional Development Program, July 2017 - 19

Mechatronics, Controls, and Robotics Laboratory, Department of Mechanical and Aerospace Engineering, NYU Tandon School of Engineering