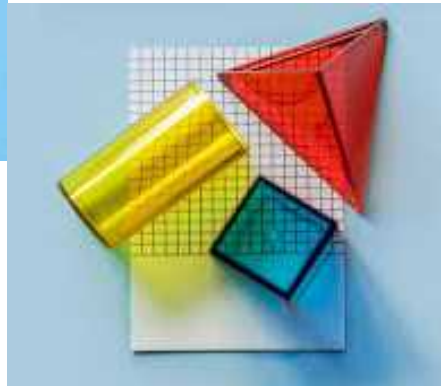




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3D printing technology aims students understanding maths and recycling procedure

*Part A - 3D Printing Technology and Application
"3D Printing Techniques"*

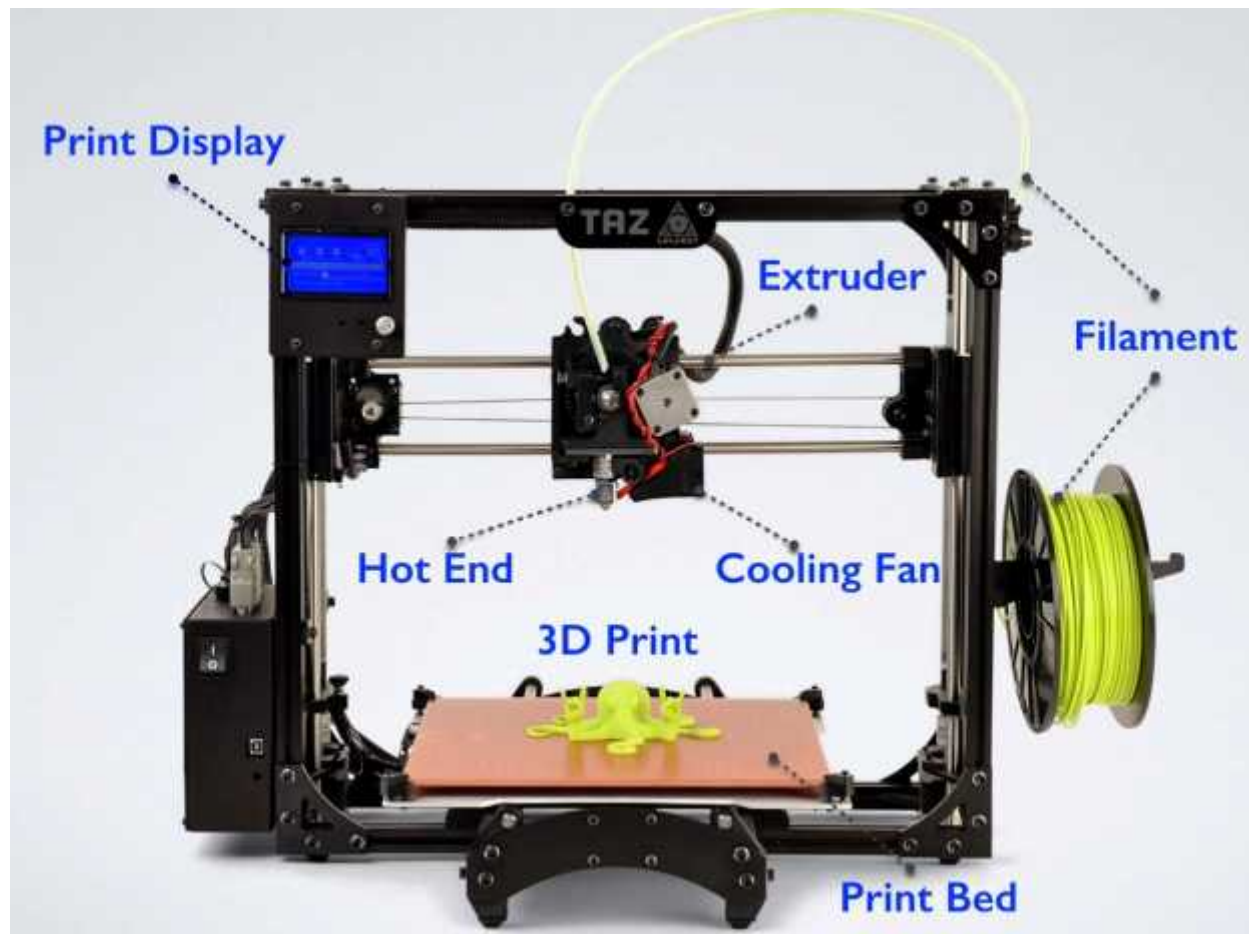
Output 3 (O3) - 3D Printing and Maths

Description



The goal of this session is to specify the basic features of a 3D printer as well as the processes that a user needs to get acquainted with, in order to accomplish succeeded 3D printing. There is a particularly wide range of 3D printers, which vary in features, capabilities and price range. It is critical that the preparatory procedures of the 3D printer, the settings of the slicer along with the design of the 3D model in first place, to be the required according to the type of printer.

Components of 3D Printer



Limitations of 3D Printer

- Lower strength & anisotropic material properties
- Less cost-competitive at higher volumes
- Limited accuracy & tolerances
- Post-processing & support removal



Types of 3D printers



- Fused deposition modeling (FDM)
- Stereolithography (SLA)
- Digital Light Processing (DLP)
- Selective Laser Sintering (SLS)
- Selective laser melting (SLM)
- Laminated object manufacturing (LOM)
- Electronic Beam Melting (EBM)
- Binder Jetting (BJ)

Materials of the most common used printers



- Fused deposition modeling (FDM)

PLA , ABS, PET, PVA, Nylon, Composites, Metal , Wood

- Stereolithography (SLA)

Resin

- Binder Jetting (BJ)

Ceramic, Metal

3D printer – Fused deposition modeling (FDM) (1/2)



- Fused deposition modeling (FDM) technology was developed and implemented at first time by Scott Crump, Stratasys Ltd. founder, in 1980s. Other 3D printing companies have adopted similar technologies but under different names. A well-known nowadays company MakerBot coined a nearly identical technology known as Fused Filament Fabrication (FFF).
- With help of FDM you can print not only functional prototypes, but also concept models and final end-use products. What is good about this technology that all parts printed with FDM can go in high-performance and engineering-grade thermoplastic, which is very beneficial for mechanic engineers and manufactures.
- FDM is the only 3D printing technology that builds parts with production-grade thermoplastics, so things printed are of excellent mechanical, thermal and chemical qualities.

3D printer – Fused deposition modeling (FDM) (2/2)



Youtube. Solid Concepts. “Fused Deposition Modeling (FDM) Technology”. 2013



3D printer – Stereolithography (SLA) (1/2)



- Stereolithography is a 3d printing method. Although this method is the oldest one in history of 3D printing it's still being used nowadays. This method was patented by Charles Hull, co-founder of 3D Systems, Inc in 1986. The process of printing involves a uniquely designed 3D printing machine called a stereolithograph apparatus (SLA), which converts liquid plastic into solid 3D objects.
- SLA resin printing works with a photopolymer resin tank and a UV laser beam that traverses the layer shape and forms the part, which grows on the printer platform. SLA printers get high quality parts from without the need for post-processing. It is a technology that allows us to obtain great finishes and details for pieces such as prototypes, figures, complex or small parts.
- They have the disadvantage that it is necessary to wash and cure the pieces so that they harden after printing.

3D printer – Stereolithography (SLA) (2/2)



Youtube. Formlabs. “Introduction to Stereolithography”. 2015



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This project is funded by the European Union.

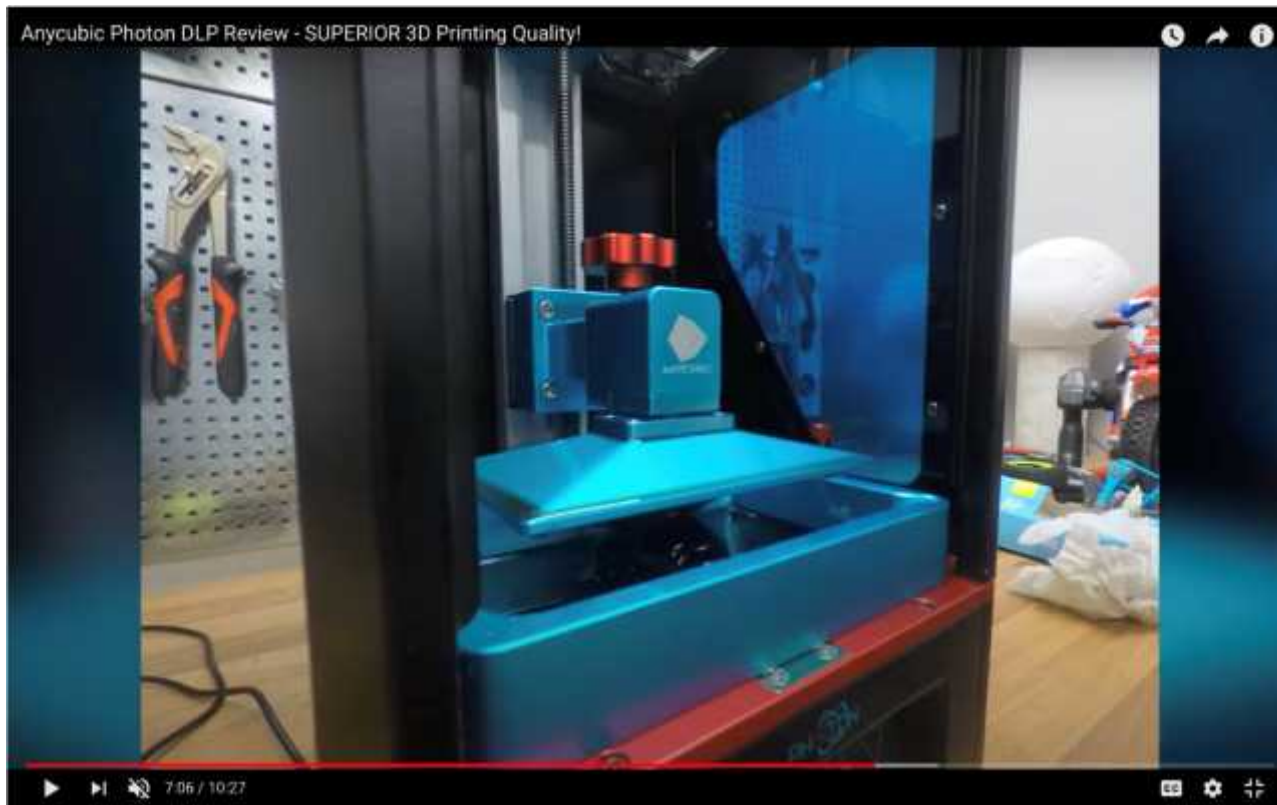


3D printer – Digital Light Processing (DLP) (1/2)



- Digital Light Processing is another 3D Printing process very similar to stereolithography. The DLP technology was created in 1987 by Larry Hornbeck of Texas Instruments and became very popular in Projectors production. It uses digital micro mirrors laid out on a semiconductor chip. The technology is applicable for movie projectors, cell phones and 3D printing.
- For 3D printing DLP as well as SLA works with photopolymers. But what makes SLA and DLP processes unlike is a different source of light. For DLP 3D amateurs generally use more conventional sources of lights such as arc lamps. The other important piece of process is a liquid crystal display panel, that is being applied to the whole surface of building material during single run of DLP process. The material to be used for printing is liquid plastic resin that is placed in the transparent resin container. The resin hardens quickly when affected by large amount of light. The printing speed is pretty impressive. The layer of hardened material can be created with such printer in few seconds. When the layer is finished, it's moved up and the next layer is started to be worked on.

3D printer – Digital Light Processing (DLP) (2/2)



Youtube. RCLifeOn. “Anycubic Photon DLP Review - SUPERIOR 3D Printing Quality!”. 2018

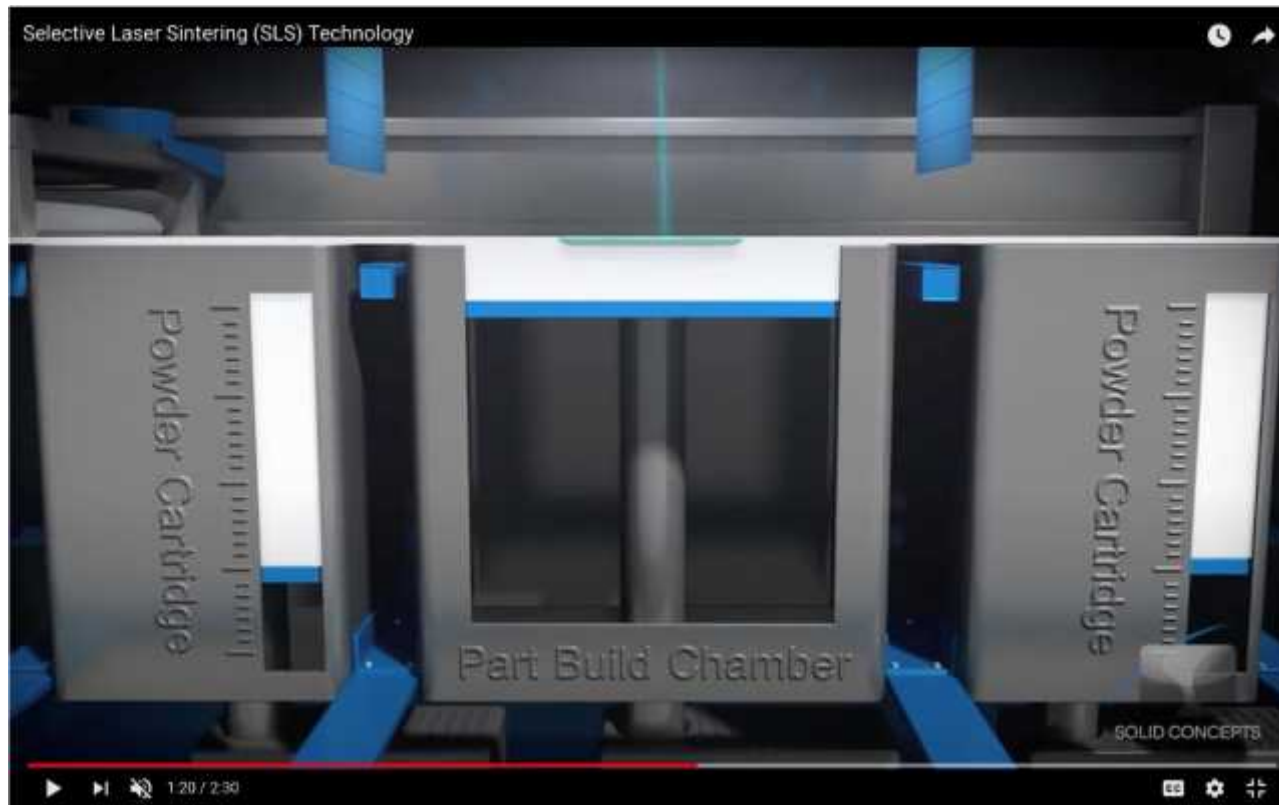


3D printer – Selective Laser Sintering (SLS) (1/2)



- Selective Laser Sintering (SLS) is a technique that uses laser as power source to form solid 3D objects. This technique was developed by Carl Deckard, a student of Texas University, and his professor Joe Beaman in 1980s. Later on they took part in foundation of Desk Top Manufacturing (DTM) Corp., that was sold to its big competitor 3D Systems in 2001.
- As was stated previously, 3D systems Inc. developed stereolithography, which in some way is very similar to Selective Laser Sintering. The main difference between SLS and SLA is that it uses powdered material in the vat instead of liquid resin as stereolithography does.

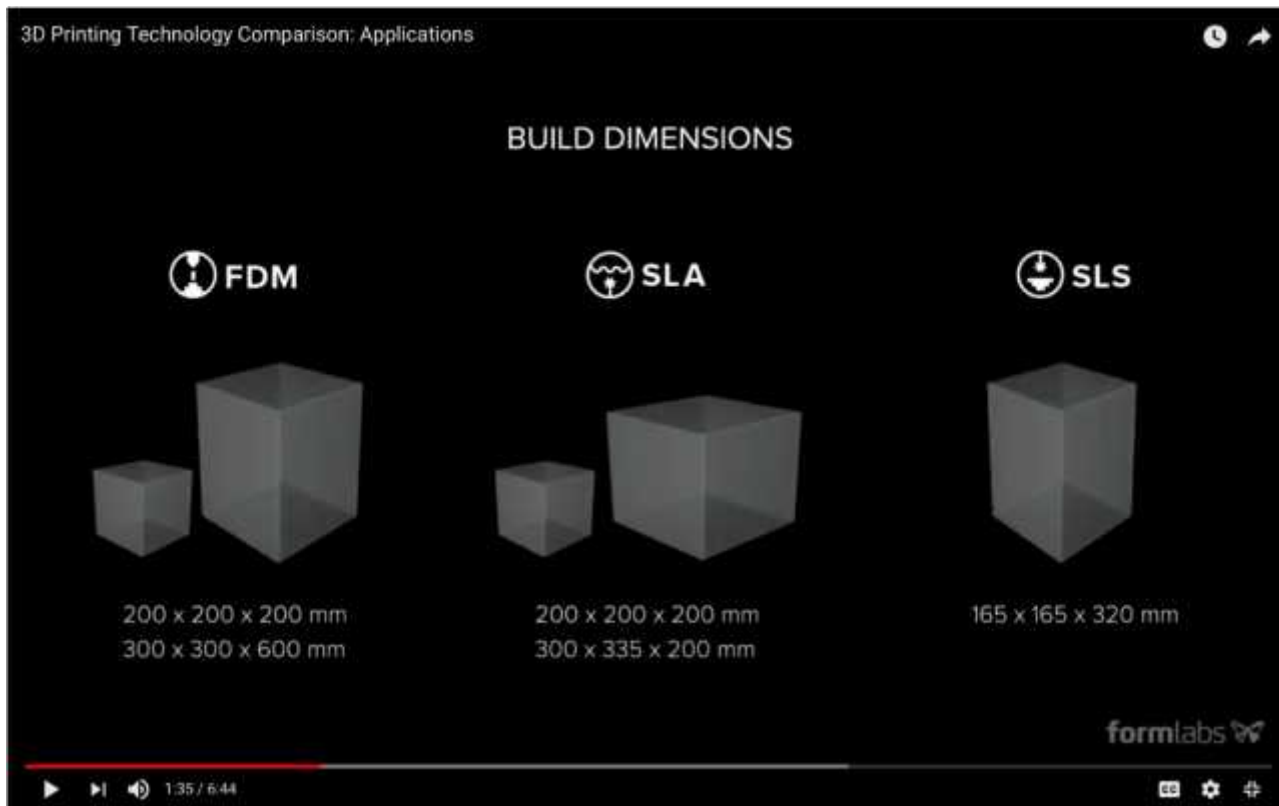
3D printer – Selective Laser Sintering (SLS) (2/2)



Youtube. Solid Concepts. “Selective Laser Sintering (SLS) Technology”. 2013.



3D printers – FDM/SLA/SLS



Youtube. Formlabs. “3D Printing Technology Comparison: Applications”. 2020.



3D printer – Selective laser melting (SLM) (1/2)



- Selective laser melting (SLM) is a technique that also uses 3D CAD data as a source and forms 3D object by means of a high-power laser beam that fuses and melts metallic powders together. In many sources SLM is considered to be a subcategory of selective laser sintering (SLS). But this is not so true as SLM process fully melts the metal material into solid 3D-dimensional part unlike selective laser sintering. The history of SLM started with German research project held by group of Fraunhofer Institute ILT in 1995.
- This method of printing is widely applied to parts with complex geometries and structures with thin walls and hidden voids or channels. Lots of pioneering SLM projects were dedicated to aerospace application for different lightweight parts. SLM is great for project that experience such kind of problems like tooling and physical access difficulties to surfaces for machining, as well as restrict the design of components.
- The technology is not widely spread among at-home users but mostly among manufactures of aerospace and medical orthopedics. But the whole process of acceptance, certification and final approval takes some time which results in long time for development and qualification for this technology.

3D printer – Selective laser melting (SLM) (2/2)



Youtube. DMG MORI. “New method of manufacturing using powder bed: Additive Manufacturing with Selective Laser Melting”. 2017



3D printer – Laminated object manufacturing (LOM) (1/2)



- Laminated object manufacturing (LOM) is one more rapid prototyping system that was developed by the California-based company Helisys Inc.
- During the LOM process, layers of adhesive-coated paper, plastic or metal laminates are fused together using heat and pressure and then cut to shape with a computer controlled laser or knife. Post-processing of 3D printed parts includes such steps as machining and drilling.
- Probably LOM is not the most popular 3D printing method but one of the most affordable and fastest. The cost of printing is low due to not expensive raw materials. Objects printed with LOM can be relatively big, that means that no chemical reaction needed to print large parts.

3D printer – Laminated object manufacturing (LOM) (2/2)



Youtube. Sergey E. "LOM - Laminated Object Manufacturing". 2016



3D printer – Electronic Beam Melting (EBM) (1/2)



- EBM is another type of additive manufacturing for metal parts. It was originally coined by Arcam AB Inc. in the beginning of this century. The same as SLM, this 3d printing method is a powder bed fusion technique. While SLM uses high-power laser beam as its power source, EBM uses an electron beam instead, which is the main difference between these two methods. The rest of the processes is pretty similar.
- The material used in EBM is metal powder that melts and forms a 3D part layer by layer by means of a computer, that controls electron beam in high vacuum. Contrary to SLS, EBM goes for full melting of the metal powder. The process is usually conducted under high temperature up to 1000 °C.
- Comparing to SLM the process of EBM is rather slow and expensive, also the availability of materials is limited. So the method is not so popular though still used in some of manufacturing processes. Currently the most well spread materials that are used for EBM are commercially pure Titanium, Inconel 718 and Inconel 625. The application of EBM is mainly focused on medical implants and aerospace area.

3D printer – Electronic Beam Melting (EBM) (2/2)



Youtube. GE Additive. “Transformative technology—Electron Beam Melting (EBM)”. 2019

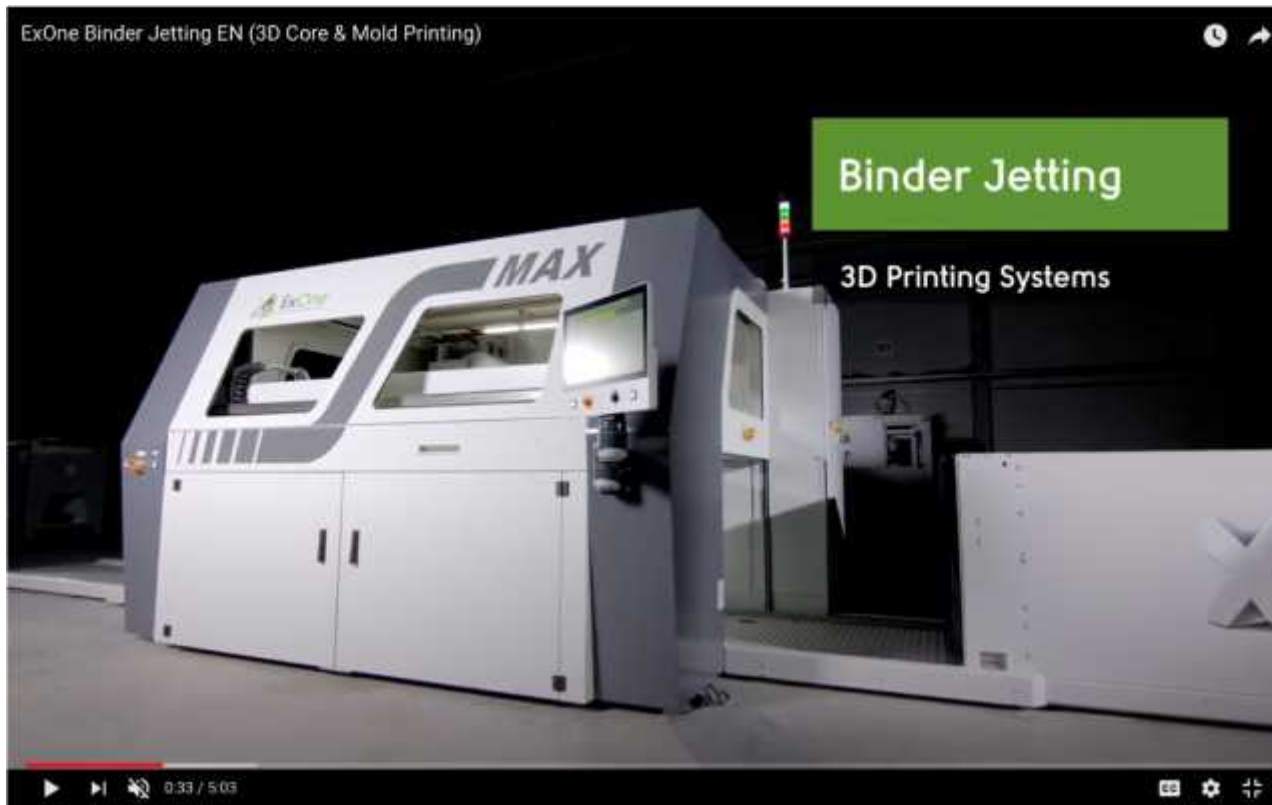


3D printer – Binder Jetting (BJ) (1/2)



- Binder Jetting (BJ) printers are some of the most interesting because of the large amount of materials (and even color!) they offer. Unfortunately for home users these are usually industrial machines.
- They are the printers that most resemble the 2D paper printer you have at home or in your office: these machines also use cartridges that instead of ink project a binder on a bed of dust of the material we want to use to make our parts.
- This technology can be used to make plastic or metal parts (which are then sintered –“fused”– in an oven). You can also make colored pieces if you add a coloring ink to the powder while binding it.

3D printer – Binder Jetting (BJ) (2/2)



Youtube. Moving People Marketing. “ExOne Binder Jetting EN (3D Core & Mold Printing)”. 2018



3D Printing Preparation



Youtube. Prusa 3D by Josef Prusa. “Easy printbed preparation – Tips and Tricks #3 [3D Print]”. 2016





3D Printer Settings and Preparation

- Having a good first layer is crucial
- Z offset is a value that essentially tells your printer how far to move the Z axis from the Z endstops, i.e. the bed
- Set the nozzle gap
- Calibrate your 3D printer axes
- Tuning Filament Settings
- Clean the nozzle
- Clean the build surface
- Hot or cold?

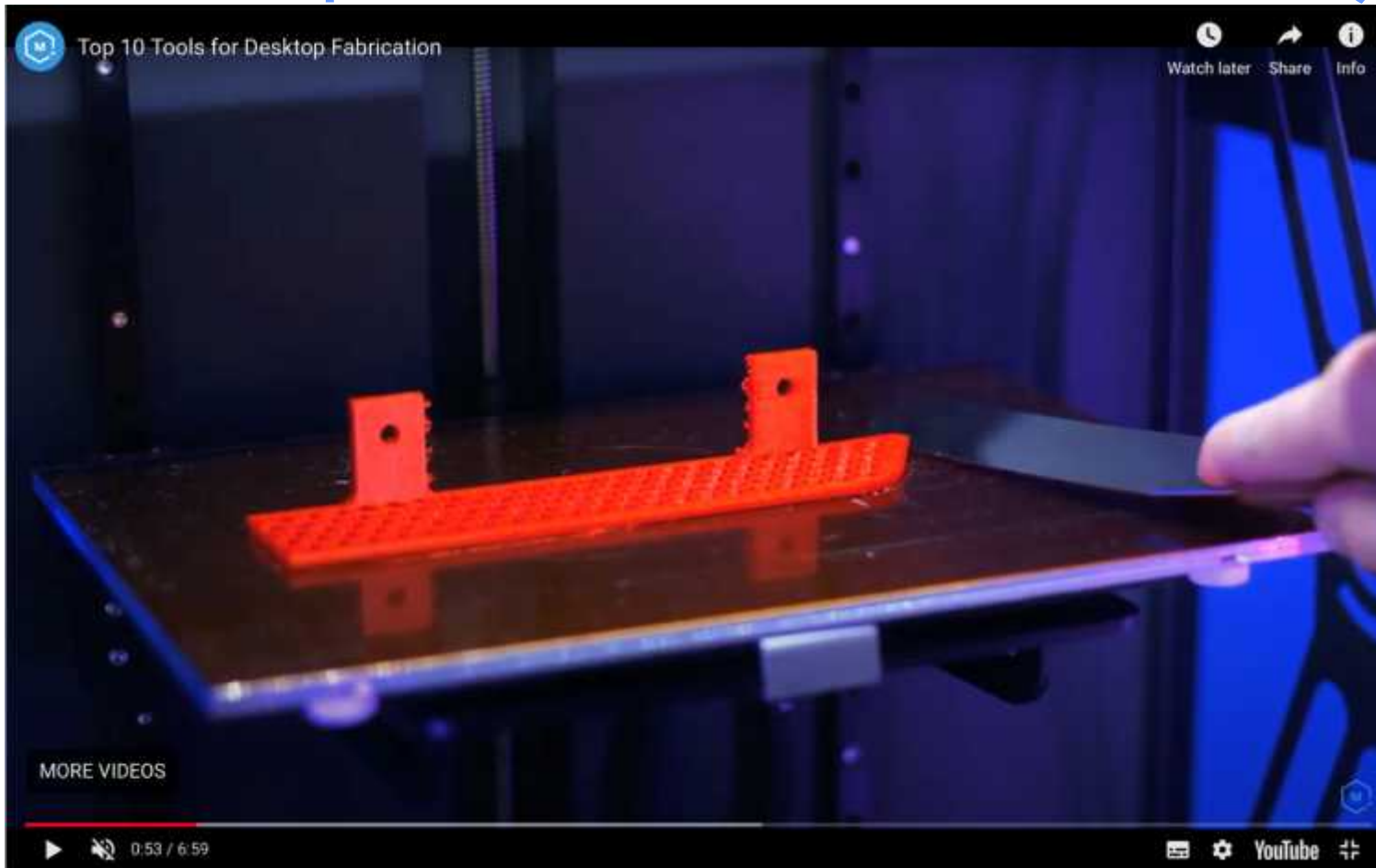


10 Required Tools (1/2)

- Bed removal tools
- Flush Cutters
- Brass Wire Brush
- Needle Files
- Deburring Tool
- Nozzle Needle cleaner
- Digital Calipers
- Adhesives
- Hex Wrench Set
- Hobby Knife



10 Required Tools and their use (2/2)



Youtube.MatterHackers. "Top 10 Tools for Desktop Fabrication". 2019



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Thank you!!

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