



Trainers for Visually Impaired Students Introduce 3D Printing

Glossary

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Glossary

3D pen (3Doodler)

A 3D pen is a pen that extrudes liquid plastic from an extruder that is integrated into the pen tip. The speed and quantity of the extruded plastic can be controlled by the user in most cases. Once the liquid plastic has been extruded, it begins to dry quickly in the air. In this way, 3-dimensional objects can be drawn from plastic. If the filament-shaped plastic (filament) is changed to a different colour during use, multi-coloured objects can also be created with a 3D pen. A 3D pen with a dual extruder is not known at this time.

3D pens first gained worldwide attention when the first prototype of the 3Doodler was presented by Maxwell Bogue and Peter Dilworth in early 2012. The idea for the 3D pen was born from a faulty 3D print. Both inventors started a crowd-funding campaign on Kickstarter under the company "WobbleWorks" with the goal of reaching \$30,000. The funding goal was reached after just a few hours. On 25.03.2013, the end of the funding round, "WobbleWorks" collected more than \$2 million for its 3Doodler. In January 2015, the successor 3Doodler 2.0 was released. Since then, numerous new models from a wide range of manufacturers have appeared on the market. ¹

3D selfie

A 3D selfie is a self-portrait taken with a 3D printer. The result is a printed figure of one or more persons, which is printed on the basis of a previously created photo. An important intermediate step is to convert the photo into a CAD file before 3D printing. This requires 3D software that constructs a 3D model from the 2D image. The data is then sent to a 3D printer that builds the selfie layer by layer. ²

ABS

ABS filament for 3D printers (acrylonitrile butadiene styrene) is a synthetic terpolymer and belongs to the amorphous thermoplastics. In the FDM process of 3D printing, ABS filament is equally important as PLA filament, but differs in certain points. ABS filament offers high heat resistance and a hard, scratch-resistant surface. Due to its many positive properties, ABS plastic is used in many household and consumer products beyond the 3D printer.

ABS filament is slightly more difficult to process than PLA filament. The biggest difficulty is the strong tendency to warp – here a heated printing plate and/or a closed installation space of the printer helps.

¹ <https://www.3d-grenzenlos.de/glossar/3d-stift/> (07.05.19)

² <https://www.3d-grenzenlos.de/glossar/3d-selfie/> (07.05.19)



In order to prevent premature detachment of the print from the printing plate, the right printing base is crucial. In this case, additional aids such as permanent printing plates or adhesive spray are available.³

Autodesk Fusion 360

CAD Software

- Cloudbased
- For Mac and PC

Buildplate, print bed, heating bed

The print bed is one of the most important components of a 3D printer. This refers to the area on which the objects are built up layer by layer. Depending on the type of printer, the print bed is stationary or moves horizontally or vertically. The print bed extremely important for the print result. The first layer of the object to be printed must adhere well to the print bed. On the other hand, the object must be easy to remove from the print bed after 3D printing. These requirements were often not met by simple 3D printers in the early years of low-budget 3D printers.

With the further development and optimisation of the devices in recent years, significantly better print beds are now being built into the devices or can be retrofitted. Heatable print beds, i.e. heatbeds, have also played a significant role in this. Well-known brands for pressure beds include BuildTak, Aptotec and SainSmart.⁴

Cura

Slicing Software

Digital Light Processing (DLP)

Digital Light Processing is another resin-based 3D printing technology. It is used by DLP 3D printers. Here, the object is created by a digital light processor that serves as a UV light source and solidifies photoreactive resin. The projector built into the 3D printer can be a video projector, for example, whose resolution also determines the 3D printing resolution. Due to the light projector, the printing speed of DLP 3D printers is usually higher than with other 3D printing processes. The light projector hardens the resin layer by layer.⁵

The DLP process is very similar to the SLA process and is based on light-induced curing of photoreactive resins. With SLA printers, however, a laser is usually used. In this tutorial, both processes are simply referred to as the SLA process.

³ <https://www.filamentworld.de/produkt-kategorie/abs-filament-3d-drucker/> (07.05.19)

⁴ <https://www.3d-grenzenlos.de/glossar/druckbett/> (07.05.19)

⁵ <https://www.3d-grenzenlos.de/3d-druckverfahren/photopolymerisation/digital-light-processing-dlp/>



Direct Manufacturing

Components with characteristics of an end product

Direct/RapidTooling

Additive manufacturing of tool inserts, tools, gauges and moulds

Extruder, Dual Extruder,

The extruder is the component on a 3D printer that forces the melted filament out of the nozzle of the machine. A coil rotates in a tube and transports the plastic filament – or any other print material – onto the print bed. The extruder is attached to the motion rails (or arms, in the case of a delta 3D printer) of the 3D printer and rotates on the x, y and z axes. In the process, the printing material is evenly pressed out of the extruder and the object to be printed is thus built up layer by layer.

The extruder is an essential component of extrusion, the process in which malleable materials such as plastics, ceramics, biomass, foodstuffs and also metals are continuously pressed out of a shaping opening under pressure.⁶

Filament

In 3D printing, filament is understood to be thread-like plastic strands that build up the object to be printed layer by layer with the help of extrusion. Filaments are used as printing material in Fused Deposition Modelling (FDM)/ Fused Filament Fabrication (FFF). The dominant filaments on the market are ABS and PLA. PLA is more suitable for beginners because it is easier to print. With ABS print objects, the surface can be smoothed with acetone, for example, which leads to very attractive results. Problems such as the "warp effect" do not occur with PLA.

For some years now, more and more flexible filaments have been available on the market. These are thermoplastic elastomer (TPE), i.e. plastic that can withstand loads such as tension or pressure, deform and return to their original shape when the load is released. As an example, consider a rubber ball.⁷

Fused Deposition Modelling (FDM), Fused Filament Fabrication (FFF)

FDM and FFF processes belong to the extrusion processes, i.e. processes during which a thermoplastic material heated to a doughy state, is pressed – preferably continuously – through one or more nozzles and the resulting strand is deposited in a defined manner on a substrate. The energy in the material is sufficient to melt the substrate in such a way that a permanent bond is created after cooling.⁸

G-Code

In the context of 3D printing, G-code refers to print commands that are generated by software to communicate commands in the form of instructions to a 3D printer. The

⁶ <https://www.3d-grenzenlos.de/glossar/extruder/> (07.05.19)

⁷ <https://www.3d-grenzenlos.de/glossar/filament/> (07.05.19)

⁸ Gebhardt, Andreas: Additive Fertigungsverfahren, Carl Hanser Verlag, München, 2016, S.259

G-code can therefore be understood as a language between the computer/CAD software and the 3D printer.

There are different ways to prepare G-codes for use in 3D printing. In slicing, for example, there is a code for each layer. Or one works with a library that makes the printing of complicated models more controllable. The G-codes can also be written by the maker and can even be changed during the printing process. Resourceful makers also use G-codes to repair their 3D printers. This is always the case when commands are needed that the control software does not contain. .⁹

IDEX

IDEX refers to dual extruders that can print independently of each other. With IDEX it is possible to print one part with two filaments or to print two smaller parts at the same time with one of the extruders.

Layer

In 3D printing, a layer is each individual layer with which a 3D printer builds up the object layer by layer. A large number of layers results in a fully layered 3D object. The terms layer size, layer height and layer height are often used in connection with layers. This refers to the height of a single layer with which the 3D printer builds up the object. The layer height depends on the 3D printer used and is one of the elementary product properties for 3D printers.

Levelling

- Aligning the print bed/building platform
- Removing differences between different levels

MeshMixer

Free software for 3D modelling and simple mesh optimisation from Autodesk.

Nozzle

In 3D printing, nozzle refers to the nozzle that is part of the extruder, i.e. the print head. The consumable material, which is also referred to as filament in technical jargon, is pressed through the nozzle and applied layer by layer to the build plate or printing plate. With most 3D printers, the nozzle can be replaced. During the printing process, the nozzle is usually very hot. Depending on the material used, but also depending on the size of the opening, blockages can occur from time to time, which must be removed. At the same time, it will suffer from signs of wear over time and must then be replaced. The opening of the nozzle should be selected according to the material used and the object to be produced.

As a standard, most makers usually resort to nozzles whose opening is 0.4 mm in diameter. The choice of nozzle size can affect both print time and print quality.¹⁰

⁹ <https://www.3d-grenzenlos.de/glossar/g-code/> (07.05.19)

¹⁰ <https://www.3d-grenzenlos.de/glossar/nozzle/> (07.05.19)

PETG

Filament

PETG is the abbreviation for polyethylene terephthalate, modified with glycol.

PETG filament is superior to other filaments in many properties. It combines the positive properties of PLA and ABS.

Hence, PETG is very durable, has strong mechanical properties, is flame retardant, resistant to many chemicals and easy to print.

The printing speed for PETG filament varies depending on the printing temperature, the hotter the print head, the faster the 3D printer can print the PETG.¹¹

PLA

Filament

Poly lactides (PLA) are synthetic polymers that belong to the polyesters. They are used to make plastic that is obtained from regenerative sources (such as corn starch). This makes PLA a biocompatible raw material. 3D printing filament is often not pure PLA, but a so-called PLA blend, whose basic structure is enriched with additives to obtain certain desired properties.¹²

¹¹ <https://www.filamentworld.de/produkt-kategorie/special-filament/petg-filament> (07.05.2019)

¹² <https://www.filamentworld.de/3d-druck-wissen/was-ist-pla/> (07.05.2019)

PVA

Filament

Polyvinyl alcohol (PVA or PVOH) is a thermoplastic plastic that is produced as a white to yellowish powder mostly by saponification (hydrolysis) of polyvinyl acetate (PVAC). PVA is water-soluble and therefore well suited as a support material for 3D printing.

Selective Laser Melting (SLM)

Selective laser melting (SLM) is a generative manufacturing process that belongs to the group of beam melting and powder-bed based processes. Selective laser melting is often also referred to as 3D printing and is therefore an additive manufacturing process.

In the SLM process, the material is applied as powder to the base plate and melted with the laser beam. The material solidifies and the base plate is lowered by the layer thickness so that new powder can be applied. 3D software (see also CAD) is used to create the data for the laser beam guidance. The object is then built up by the SLM 3D printer from many individual layers. This layer-by-layer construction is repeated until all layers of powder have been remelted. The shape of the object results from the areas where powder was deposited by the machine and melted by the laser. At the end of production, the manufactured product is freed from powder residues and is ready for use. In most cases, series materials without binders are used, as these can be pulverised.

With selective laser melting, no (casting) moulds are required, thus creating geometric freedom. The production time is reduced, which leads to lower storage and production costs.

Selective Laser Sintering (SLS)

Selective Laser Sintering is an additive manufacturing (AM) technique that uses a laser as the power source to sinter powdered material. It is similar to selective laser melting and belongs to the powder-bed based processes. SLS and SLM are instantiations of the same concept but differ in technical details. In the SLM process, the aggregate state of the powder is changed by melting, the powder is liquefied and when it cools it becomes solid. In the SLS process, the laser only bonds the powder.

Slicing

To prepare for printing, the object must be optimally aligned on the building platform and divided into height layers. This is called slicing.

Stereolithography (SLA or STL)

In stereolithography, a light-curing liquid plastic (photopolymer), for example synthetic or epoxy resin, is cured in thin layers by a laser. This is done in a bath filled with the basic monomers of the light-sensitive plastic. After each step, the workpiece is lowered a few millimetres into the liquid and returned to a position that is the amount of a layer below the previous one. The liquid plastic is evenly distributed over the



previous layer by a wiper. Then a laser, controlled by moving mirrors, moves over the hardening surface on the new layer.¹³

STL file format

STL files describe mesh surfaces as lists of geometric features. A body is composed of three triangular surfaces consisting of a normal and 3 axes, which are described by their coordinates. The STL file format provides geometric information for the CAD programmes so that 3D printing can be used to produce three-dimensional objects.¹⁴

Support

Additionally generated structures to support model parts with overhangs. Without this structure, such parts would collapse.

Tank/VAT

A component of SLA printer. The resin tank is a transparent container located in the middle of the Formlabs 2 3D printer. It is made of a UV-blocking acrylic. The tanks containing the liquid resin can be removed and reinserted very quickly and easily. In addition, the reusable lid makes it possible to stack several tanks that have already been filled with resin. This means that the resin left over after a 3D print can be stored safely and easily outside the Formlabs 2 3D printer. It makes sense to have a resin tank for each type of resin. This way you can decide spontaneously at any time which material you want to work with. The iGo3D recommends that you change the resin tanks after 2-3 litres of resin consumption.

VAT is the term used for the tanks of Digital Light Processing (DLP) printers. Here, the bottom consists of a replaceable transparent film.

Thingiverse

Thingiverse is an online platform for exchanging digital design data (CAD) that can be used for 3D printers, laser cutters, CNC mills and other machines. Thingiverse is one of the world's most popular platforms of the DIY movement. The files uploaded to Thingiverse.com are open source and mainly subject to CC and GPL licences. Most of the files uploaded on Thingiverse are used for repair purposes. Nevertheless, jewellery, decorative items and creative ideas can also be found in countless variations on Thingiverse, and can be printed by anyone at home using a 3D printer, for example.

The owner of Thingiverse is MakerBot. The creators of Thingiverse are MakerBot founders Zach Smith and Bre Pettis. The platform has been online since November 2008 and is available in English. Thingiverse was founded by Zach Smith.¹⁵

¹³ Fastermann, Petra: 3D-Druck/Rapid Prototyping, Springer Verlag, Berlin Heidelberg, 2012, S. 121

¹⁴ <https://www.sculpteo.com/de/glossar/stl-definition-de/> (29.04.2019)

¹⁵ <https://www.3d-grenzenlos.de/glossar/thingiverse/> (25.04.2019)



Z-Wobble / Z-Wobble

A Z-Wobble (alternatively spelled Z-Wobble) occurs when lateral forces act on the nut on the threaded rod. This can lead to a rotation of the Z-axis in some 3D printers. As a result, the extruder shifts in both the Y and Z directions.