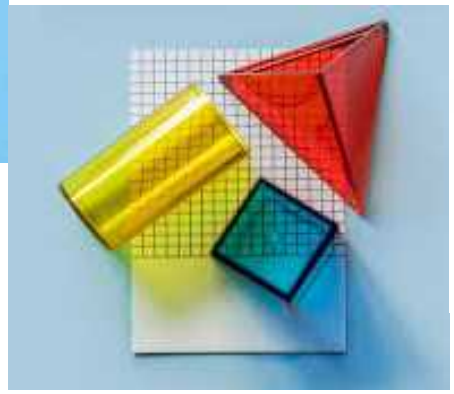
Project code:
2019-1-EL01-KA201-062914

Erasmus+ Call: 2019 - KA2 -



Erasmus+
This project is funded by the European Union.
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

3D printing technology aims students understanding maths and recycling procedure

Curricula 1: 3D Printing Technology and Application "3D Printing Principles"

Output 3 (O3) – 3D Printing and Maths

Description

In order to have the best 3D printed objects, some rules are recommended and should be followed. These are analysed in this session, aiming to be absorbed by the audience and used during the preparation of 3D printing.

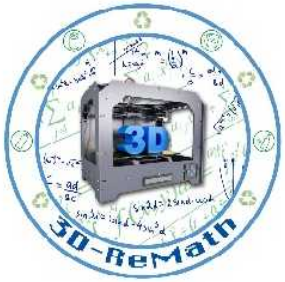
Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

Introduction

- Anything can be designed in the digital space, but not everything can be 3D printed. Different 3D printing processes have different capabilities and different design restrictions.
- When you design a part for 3D printing - whether it's for prototyping or for manufacturing end-use products - certain limitations apply. These limitations have to do with the basic mechanics of each additive manufacturing process (and the laws of physics).
- A successful print always begins with a correctly designed 3D model. Other important factors for designers to consider include the material and type of 3D printing technology that will be used, basic design rules are in many ways determined by these key factors. Ultimately, exploring design considerations and requirements will be the first step in ensuring a successful printing process.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

Digital vs. Physical

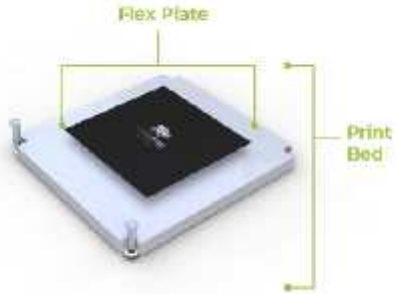


- The most important thing to remember while designing for 3D printing is the fact that your digital design will become a physical object. In the digital design environment, there are no laws of physics to adhere to, such as gravity.
- Anything can be "drawn" in 3D on a digital canvas, but not everything can be 3D printed.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

Print Bed

- The print bed is the area that holds the 3D printed object. It operates along the Z axis and descends to allow for the layering process. Different 3D printers use a number of materials as print beds. The most common are acrylic, glass or aluminium.
- Print beds can also feature a heated surface which is designed to reduce warping of the object which is caused by different cooling rates at the base.
- Heated beds are heavily advised to use when you need to reduce printing issues especially when working with engineering filaments.



Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

Extruders (1/2)

- Extruders are the main components in a 3D printer. They are parts that allow for heat transfer to melt the thermoplastics and move around the printing space to create the 3D printed part via extrusion.
- They operate along the X and Y axis in the print chamber and create the layers on the print bed. Many printers come either with a single extruder configuration or dual.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

Extruders (2/2)

- Single extruder printer models have limitations that need to be considered before the printing process, while dual extruders have the advantage of being able to print with two materials.
- This feature gives users the option to use support material to help hold the thermoplastic object in place allowing for more complex objects which are a major consideration for single extruder setups.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

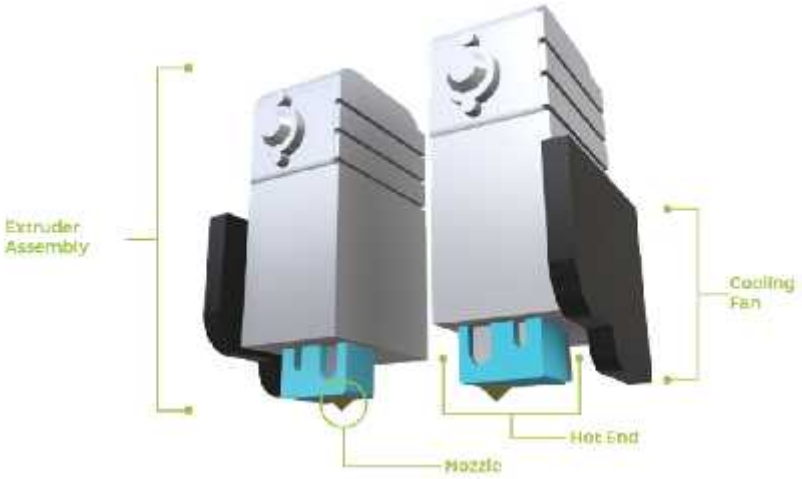
Hot-Ends (1/2)

- A hot end is the bottom part of an extruder and it is the location where the filament is melted and then extruded through a nozzle onto the print bed.
- There are a variety of hot end types. Some are designed for high temperature extrusion and reduce heat creep. Others are required for certain materials due to the materials' properties during the extrusion process.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

Hot-Ends (2/2)

- Most hot-ends feature a heat break, a feed tube and heatsink. The top half of a hot end, has a heat break that stops heat creep from melting the filament at the top of the extruder where it is inserted. A heat sink is added to reduce heat creep.
- As the the filament is pushed through by a stepper motor, it melts slowly and then as the extruder moves, each layer is added.



Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

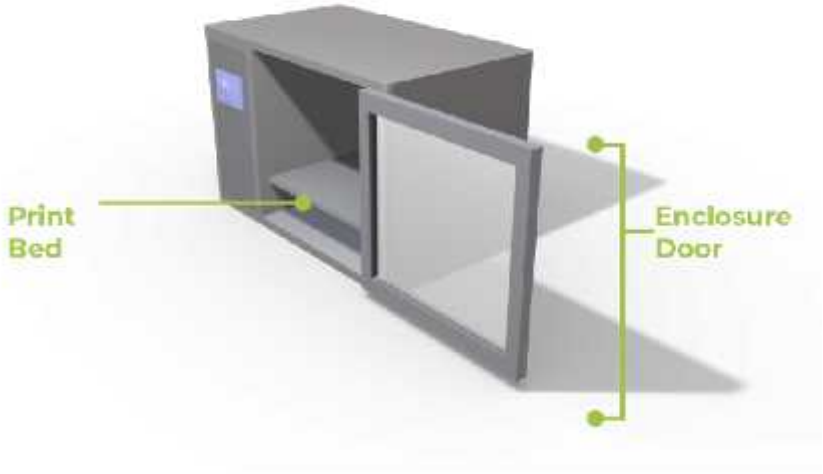
Enclosures (1/2)

- FFF printers can have either an open setup or an enclosure system. Printers that have an enclosure allow for a number of advantages over printers that do not.
- Firstly, enclosures provide better ambient temperature distribution which reduces fluctuations. This reduces cases of 3d printed objects deforming similar to the warping issue caused by different cooling rates.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

Enclosures (2/2)

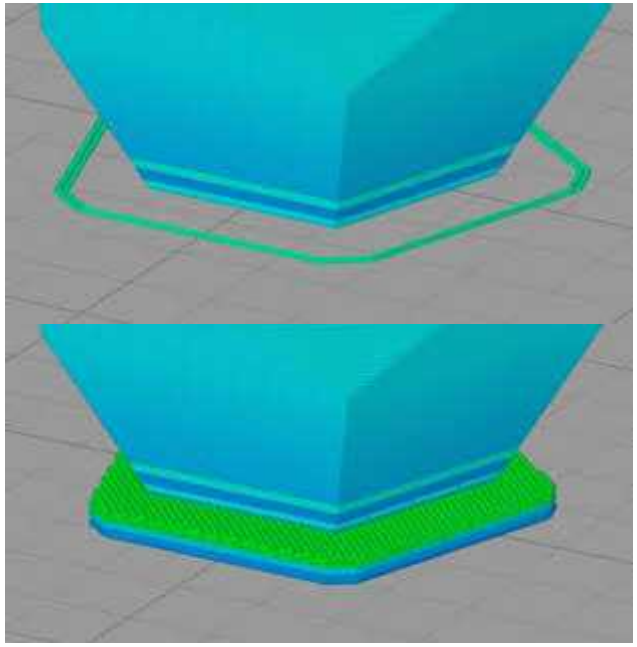
- Secondly, an enclosure limits 3D printing fumes that can occur with certain 3D printing materials. Some printers come with a HEPA filter that will eliminate this issue.



Erasmus+
This project is funded by the European Union
ΙΚΥ

Bed Adhesion

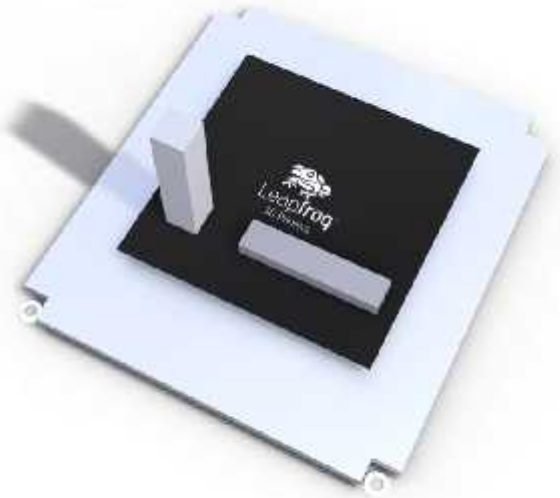
- The biggest issues that can occur during the printing process can be reduced if the first layer process is calibrated correctly. This is mainly a temperature setting issue and having a heated bed can help reduce issues such as warping.
- Additionally you need to ensure that the layer sticks correctly to the bed to reduce issues that can occur with the layering process. This can be done using special or standard glues that are purchasable online.
- Another solution is to apply skirts or brims to allow for better printing results.



Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

Model Orientation (1/2)

- The print orientation is the direction that the object will be constructed through the layering process.
- There are two possible directions, either vertically or along the X/Y axis (Horizontally).
- The orientation that you print an object can affect its strength and overall structure. This is especially important for functional prototypes.



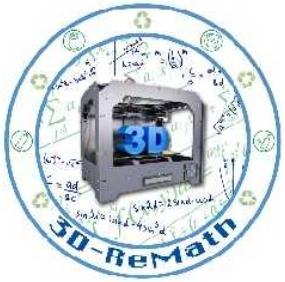
Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

Model Orientation (2/2)

- The orientation that you print an object can affect its strength and overall structure. This is especially important for functional prototypes.
- As you can surmise if stress is applied the same direction as the layering process, the weakest areas come about between the layers.
- An example would be to use the standard tensile strength test on the vertical bar in the image, which will have a lower yield and failure point.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

General Design Consideration for 3D Printing



- Overhangs
- Wall thickness
- Warping
- Level of detail

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

General Design Consideration for 3D Printing - Overhangs

- All 3D printing processes build parts layer-by-layer. Material cannot be deposited onto thin air, so every layer must be printed over some underline material
- Overhangs are areas of a model that are either partially supported by the layer below or not supported at all. There is a limit on the angle every printer can produce without the need of support material. For example, for FDM and SLA this angle is approximately 45o degrees.
- It is a good practice to limit the overhangs of a model, as layers printed over support usually have a rougher surface finish.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

General Design Consideration for 3D Printing - Wall thickness

- The second thing to keep in mind when designing a part to be 3D printed is wall thickness. Every 3D printing process can produce accurately features that are thin up to a certain point.
- For example, imagine you are an engineer who designs hang gliders for a living. You have come up with a great, new design that you have decided to 3D print scaled down for testing. 3D modeling programs allow you to model the sailcloth of the wing, but you would encounter problems when you would try to 3D print it, as its thickness would be extremely small.
- As a good practice, always add thickness to your models. Walls with thickness greater than 0.8 mm can be printed successfully with all processes.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

General Design Consideration for 3D Printing - Warping

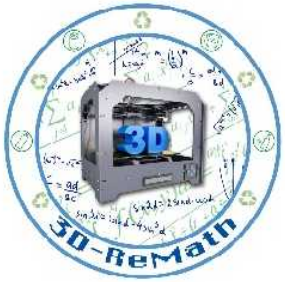
- Something that is often easily overlooked while designing a 3D model is the fact that the materials used for 3D printing undertake physical change: they are melted, sintered or scanned with a laser and solidified. The heating and cooling of material can cause the parts to warp while printing.

- Large, flat surfaces can be especially prone to warping. Warping can typically be avoided by using correct machine calibration and having adequate surface adhesion between your part and the print bed. Your Hub will be able to offer more advice on design techniques that can be used to minimize the likelihood of warping.

- A good practice is to avoid large flat surfaces and add rounded corners to your 3D models.

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

General Design Consideration for 3D Printing - Level of detail



- When you are creating a 3D model with intricate details, it is important to keep in mind what is the minimum feature size each 3D printing process can produce. The minimum level of detail is connected to the capabilities and mechanics of each 3D printing process and to the selected layer height.

- The process and materials used will have an impact on the speed and cost of your print, so determining whether smaller details are critical to your model is an important design decision.

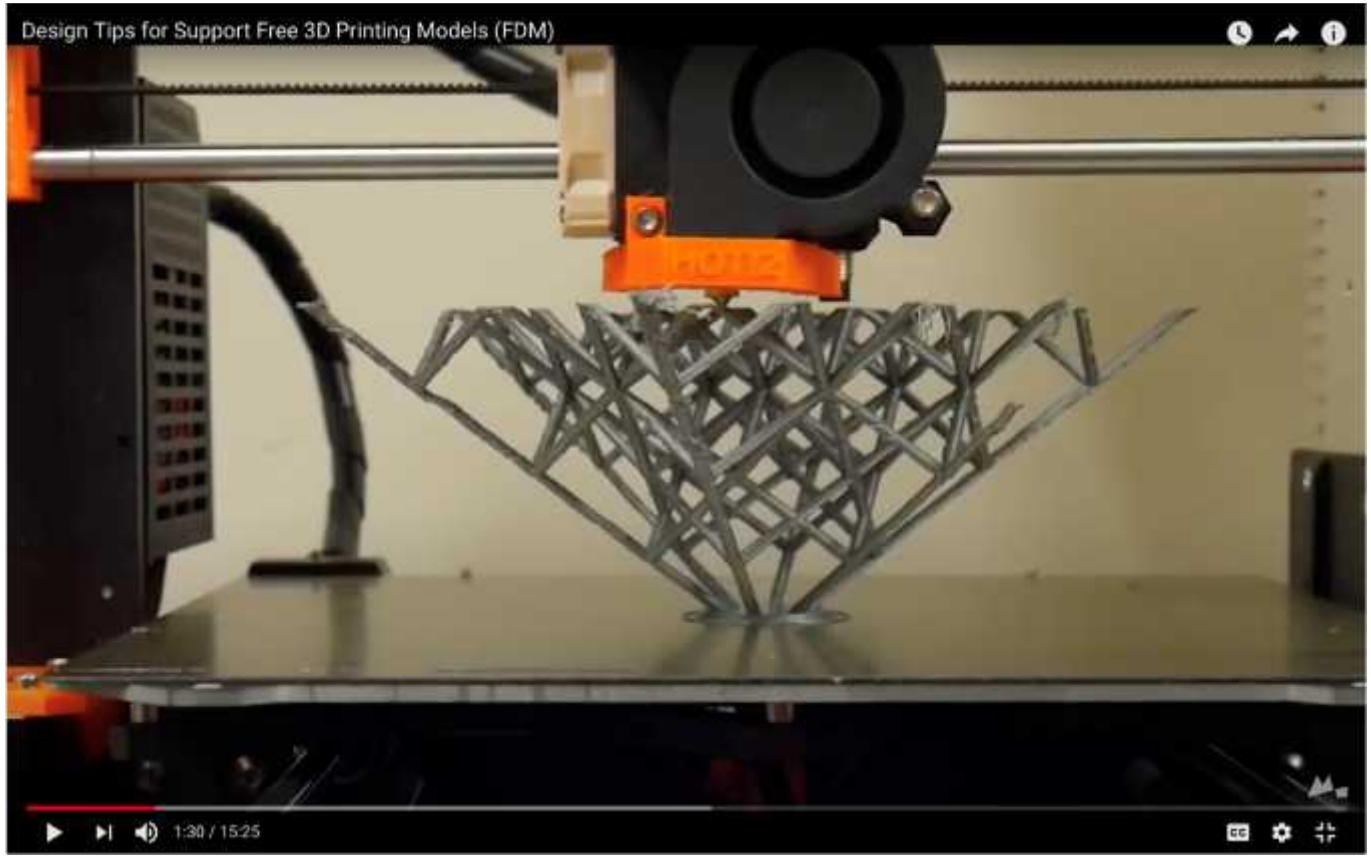
Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ

Rules of Thumb

- Avoid overhangs in your design when possible, by using angles smaller than 45^{o}.
- Add at least 0.8 mm wall thickness to your models.
- Avoid large flat surfaces and use rounded corners to avoid warping.
- Decide what is the minimum level of detail your models require and choose a 3D printing process accordingly.

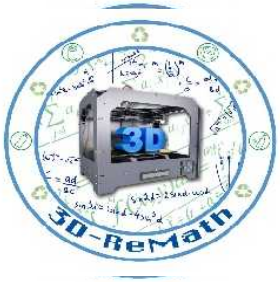
Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

Design tips for Support



Youtube. Maker's Muse. “Design Tips for Support Free 3D Printing Models (FDM)”. 2018

Erasmus+
This project is funded by the European Union
ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY



Thank you!!

privasi.aegean.gr

Erasmus+

This project is funded by the European Union

ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ
ΙΚΥ