

Title: 3D printing of a BIM model

This Erasmus+ Project ID: BIMVET3 2020-1-ES01-KA203-083262 has been funded with support from the European Commission. This publication reflects the views only of the authors, and the European Commission and Erasmus+ National Agencies cannot be held responsible for any use which may be made of the information contained therein.

1 – Aims.

The objectives of this 3D printing tutorial are as follows:

- Learning about the technology and technique of 3D printing.
- Knowing about several uses of this technology.
- Creating a model in standard format of 3D printing (STL) from a BIM model.
- Using Cura software to configure printing parameters.
- Printing a 3D object

2 - Learning methodology.

The teacher will give an explanation about 3D printing of 10 minutes.

Students will read this tutorial and will watch the video.

Students will follow the steps shown in the video:

- Construction of the 3D geometric model (in STL format) from a BIM model.
- Configuration of the printing and 3D printing of the part.

To assess the achievement of the practice, each student will write a report.

3 - Tutorial duration.

The practice described in this tutorial will be carried out in a computer classroom.

It will last 3 teaching hours.

4 – Necessary teaching recourses

Computer room with PCs with internet access.

Required software: Revit, Cura



Hardware required: Pcs and 3D printer model *Creality CR-10S Pro* (Type: layer overlay) or others.

Ink for 3D printing: Filament coil.

5 – Contents & tutorial

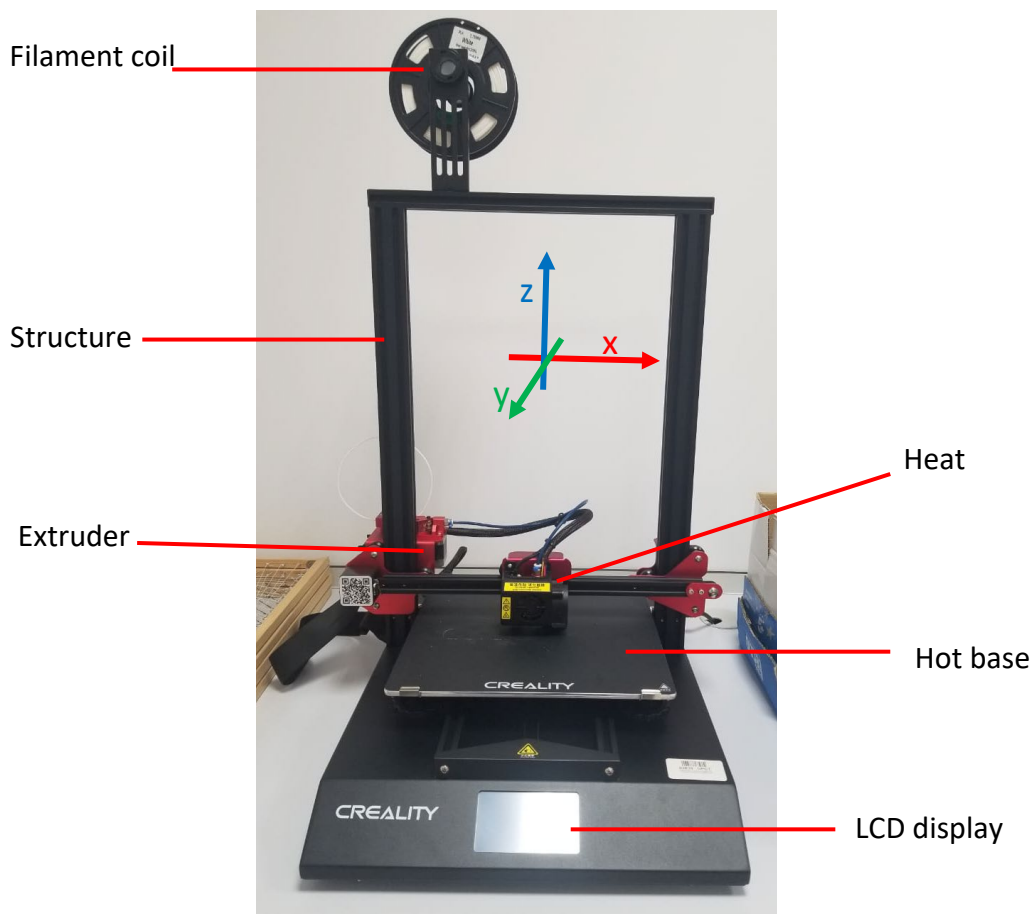
5.1 – Introduction

3D printing has become a viable alternative because parts of complex geometry can be generated within everyone's reach.

This technology makes it possible to reproduce objects in three dimensions from a prototype designed by computer. The two most common types of printing are:

- Layer overlay: Objects are created by superimposing successive layers of a certain material (plastics or resins).
- By injection: a thin layer of powder is placed and then the printer adds a glue in the part that is to be solidified. This step is repeated until the model is finished, and then the remaining material (dust) that has not been set by blowing is removed

Parts of a 3D printer:



Parts of a 3D printer. Model: Creality CR-10S Pro (Type: layer overlay)

5.2 - Printing process

The printing process can be summarized in three steps:

1. **3D design.** Either start from an existing design in 3 dimensions or software is used to create a model and then saved in STL format.
2. **Parameters.** A transition software is used between the design/model and the printer. The software to be used is called Cura and with it you can set the printing parameters (thickness, filling, speed, among others).
3. **Print.** The printer executes the code from Cura to generate the 3D model.

5.3 – Application Scope

The scope of 3D printing is enormous and has had a great impact in several fields, among which we can mention:

- **Medicine:** the most recent example occurred during the COVID pandemic in 2020. In Europe and other parts of the world the number of ventilator valves in hospitals was insufficient. Many collaborated in taking the design of the valves



to print them in 3D, one of them was the British manufacturer Photocentric. Another example in this field is the printing of prostheses in 3D.



3D printed valves. Source: 3DNatives.

(<https://www.3dnatives.com/es/italia-impresion-3d-salvo-vida-pacientes-covid-19-170320202/>)

- **Architecture and engineering:** support in the fast production of conceptual models. In addition, for the reproduction of non-existent parts of equipment or machinery. Or for the creation of molds to be able to use a different material than the one supported by the printer.

There are even houses that were fully 3D printed. For example, in Eindhoven, Netherlands, there is the first house made with a 3D printer using specially formulated concrete. Another example is in Germany, where a two-level house of 160 m² was built (printed).

5.4 - Tips before 3D printing

1. Check the STL file and make sure that it is a closed model. That is, it does not have open areas anywhere on its surface.
2. Fine tune the printing parameters. Depending on its configuration, it can cause delay in printing, lack of detail, poorly scaled drawing, among others.
3. Avoid parts in flat cantilevers or horizontal distances between two supports. It is recommended not to exceed 45° of inclination. If the model requires these parts, it will be necessary to use temporary supports during the printing of the model.
4. Check the amount of material in the filament coil before printing.

5.5 - What is the STL format?

It is the most used format (not the only one) for 3D printing. Its acronym comes from the English *Stereo Lithography* and its structure is composed only of triangles. This

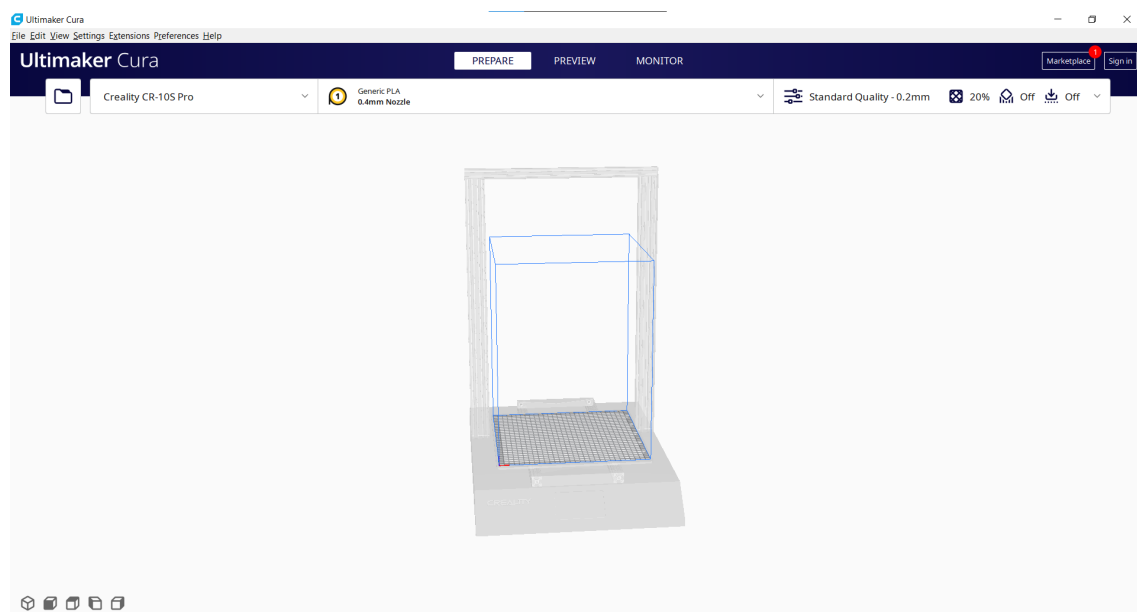
format is lighter than a conventional CAD file because it excludes information such as texture, color, physical properties, among others.

5.6 - What is Cura?

Ultimaker Cura is the most popular 3D printing software among users and is responsible for giving the instructions to the printer. It is open source and you can add plugins to it.

It can be downloaded for free through its website:

<https://ultimaker.com/software/ultimaker-cura>

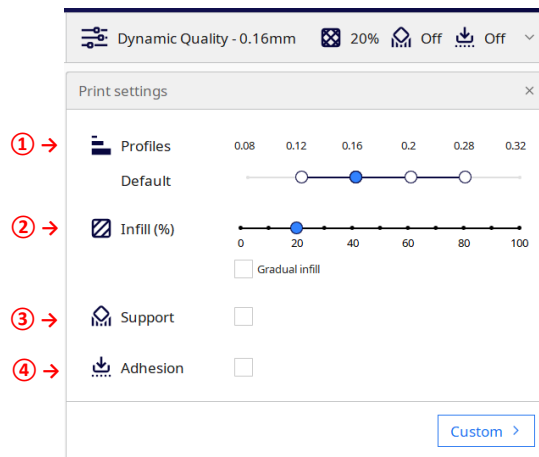


Ultimaker Cura Interface

Its simple and intuitive interface allows new users to quickly adapt to its ecosystem. In addition, it works with STL, OBJ, 3XD, JPG, PNG files, among others.

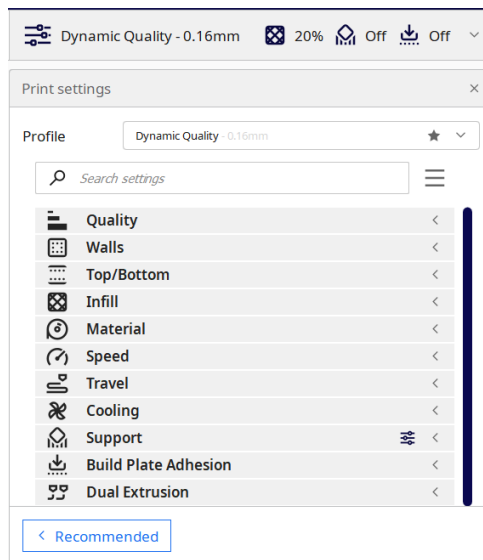
It has a standard print setting in which you can configure:

- ① → quality,
- ② → percentage of fill,
- ③ → option to generate structures to support parts of the cantilevered model,
- ④ → option to add a small wing at the base of the model

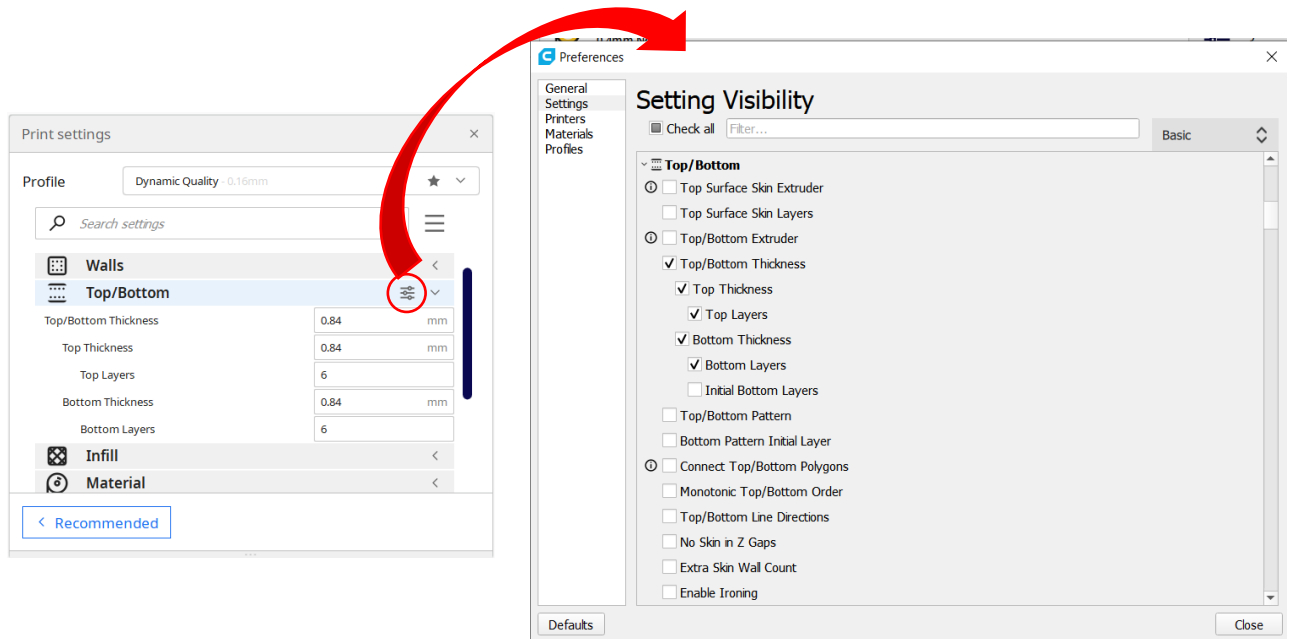


Recommended configuration parameters

It also has custom settings that are more advanced. Here, each parameter is set at will.



Advanced configuration parameters



Visibility settings preferences

5.7 - Video

In this tutorial, a video will be shown with a step-by-step example of how to print a model on a 3D printer.

- We will start from the fact that we have previously designed a model in Revit and we will export it to the STL format.

Quick tip: On the Internet there are many free 3D models in STL format for download.

- In Ultimaker Cura the printing parameters will be configured.
- A USB stick will be used to transfer the model to the printer.
- The model uploaded to the platform will have an X-length of 150 mm instead of 125 mm.

**Video**

<https://www.youtube.com/watch?v=AzYZWlu57Ak>

**6 - Deliverables**

To assess the achievement of the practice, students will write a report of 3 pages maximum.

In this report, the student will explain the steps taken in practice, the difficulties encountered and the decisions taken. The report will be illustrated with photographs of the printing process and the printed part.

7- What we have learned

Various uses of 3D printing in different fields

To save 3D object models in STL format in Revit.

To configure the printing with the Cura software.

To 3D print a part.

8 – Files to use in this tutorial

Model in IFC format

Model in STL format