Digital Twin for VET schools

Additive Manufacturing Technician Module

3D Printer Digital Twin Guide

December 2024

Content

This document is a step-by-step guide for the proper use of the digital twin of the Bambu Lab X1E 3D printer, as part of the "Additive Manufacturing Technician" module. It provides detailed instructions on downloading and installing the necessary software, preparing and slicing 3D models for printing, and connecting to the digital twin to send the model to the printer. Additionally, it covers monitoring and controlling the printing process remotely using the printer's control interface.

With this guide, users will gain a comprehensive understanding of how to effectively operate the digital twin and prepare models for 3D printing, optimizing both accuracy and efficiency in the additive manufacturing process.

1. BAMBU STUDIO INSTALLATION AND CONFIGURATION

Bambu Studio is an open-source, cutting-edge slicing software for preparing 3D models for printing. It is specifically designed to work with Bambu Lab 3D printers like the X1, P1, and A1 Series. The software offers an intuitive interface for beginners while also providing advanced customization options for experienced users.

Slicing is the process of converting a 3D model into layers that a 3D printer can understand and print. The slicing software takes the 3D model file (e.g., STL, OBJ) and generates a G-code file that contains detailed instructions for the printer.

The process for installing the software is as follows:

- Access the official **BambuLab** website through the following link: https://bambulab.com/en/download/studio
- Select the download for your operating system (Windows, Mac, or Linux).
- Run the downloaded file, and the installer will start the installation process.

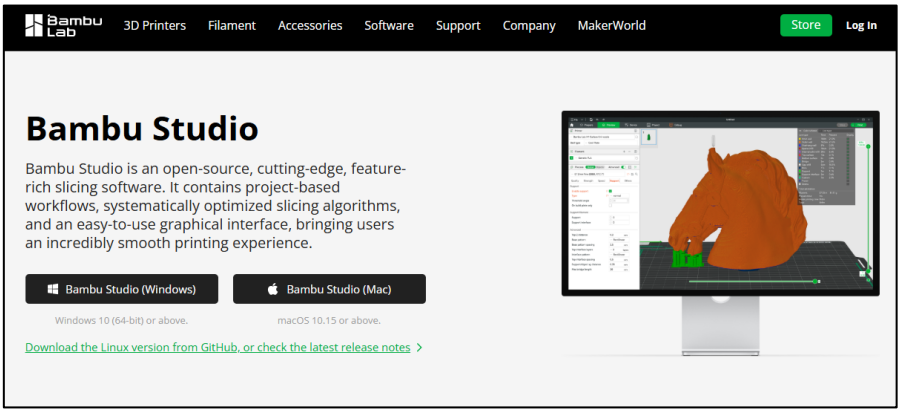

Figure 1: Download BambuStudio software

Once the Bambu Studio software is installed, an initial configuration is carried out following the steps shown in the following figures. This involves selecting the region (in this case, Europe), the nozzles for the printer according to the model (marking all those corresponding to the "Bambu Lab X1E"), and finally selecting the filaments to be used (in this case, the default options are kept).

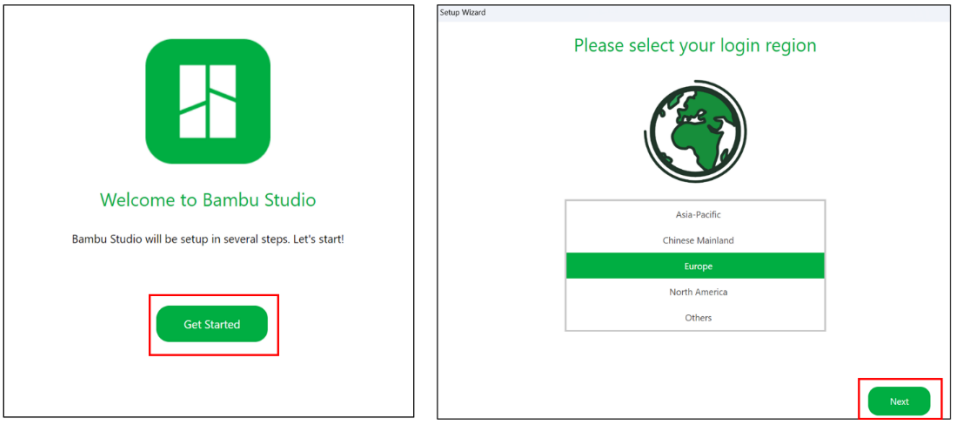

Figure 2: Select region configuration

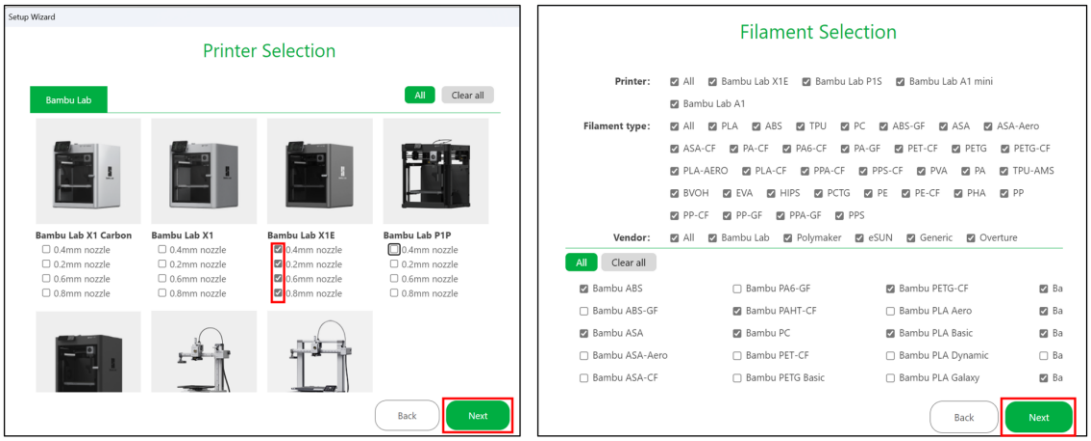

Figure 3: Printer's nozzles and filament configuration

All the configurations established in these steps, such as the selection of the printer or the types of filaments to be preloaded into the program, can be reconfigured at any time by clicking the settings button in the **Prepare panel**, as shown in Figure 4:

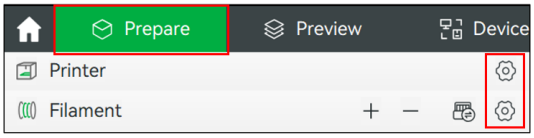

Figure 4: Printer and filament configuration

The final step of the initial configuration is selecting the installation of the **Bambu Network plug-in**, which allows connecting to the printer via a wireless connection to access its remote control, send designs to print online, or access its webcam to observe the printing process in real-time.

In this case, it is not necessary to check this box because, to connect to the actual printer, users will not establish a direct connection from their device. Instead, as indicated in section 3 of this document, they will access a laboratory computer remotely from their device, which is already connected to the printer via a wireless connection.

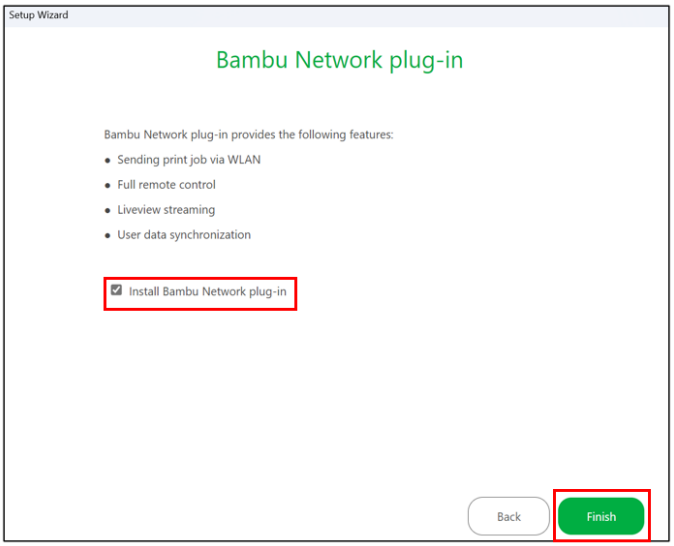

Figure 5: Instalation Bambu Network plug-in

2. SLICING A MODEL IN BAMBU STUDIO

This section explains the process of preparing and slicing of a 3D model using **Bambu Studio** to make it ready for printing. Slicing is an essential step in 3D printing, as it converts the 3D design into a set of instructions (G-code) that the printer can understand and execute. These instructions detail how the model will be printed layer by layer, including settings like filament type, layer height, and support structures.

The section is divided into subsections covering everything from loading the model into the software, configuring the basic and advanced printing parameters, adding support structures, modifying the design if necessary, and finally simulating the print to ensure the model is prepared correctly. Each step is explained with practical examples and visuals for better understanding, ensuring a seamless workflow for users at any experience level.

2.1 Model Preparation

This section explains the steps required to configure a 3D model in **Bambu Studio** before printing. It covers essential settings such as adding the model to the workspace, adjusting general and advanced printing parameters, enabling supports for complex geometries, and modifying the design's scale, rotation, and measurements.

Proper configuration ensures that the 3D model is accurately interpreted by the slicing software, optimizing the final print quality. Each subsection provides a detailed explanation of the available features, including how to adjust filament types, layer height, and support structures. This allows for customization based on the specific requirements of the model and printing process.

2.2.1 Add model

The first step in preparing a part for printing is to load the design into the software. To do this, click on the first **Add** icon located on the top toolbar of the **Prepare** panel, as shown in Figure 6. Supported file formats include 3mf, stl, stp, step, amf, and obj.

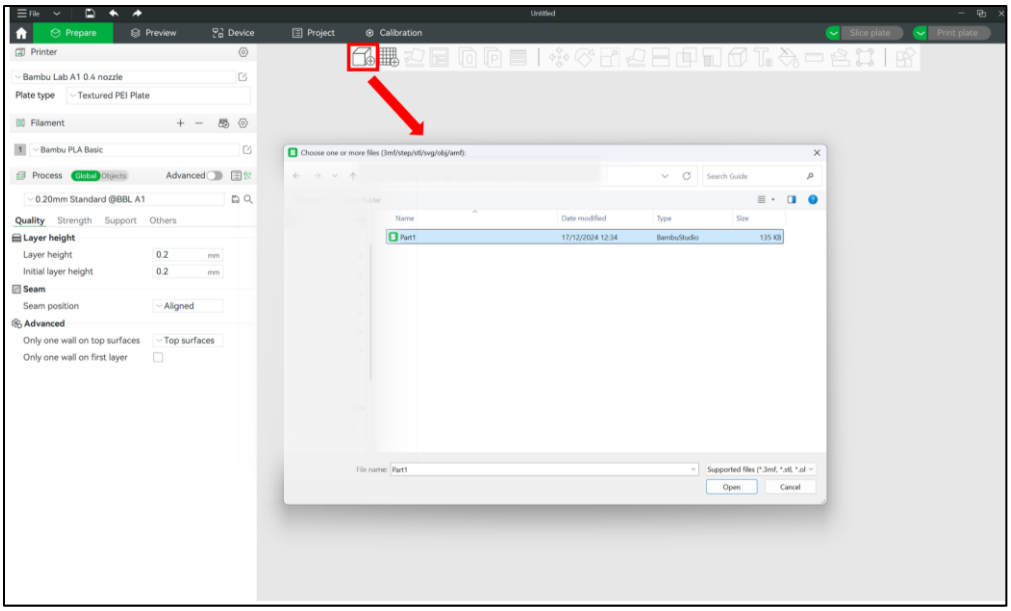

Figure 6: Add a model into BambuStudio

2.2.2 General configuration of printing parameters

To configure the general printing parameters for the model, follow the steps shown in Figure 7:

- Select the printer: Choose the printer from the drop-down list under the Printer option. In this case, the printer model is Bambu Lab X1 Carbon with a 0.4 mm nozzle.
- Filament option: Different types of filaments can be added by selecting both the material and color. When selecting a different filament color, the color of the model will change accordingly. In this case, Generic PLA filaments will be created.
- Process drop-down menu: Choose the layer height for printing the model. The lower the layer height, the longer the print will take, but the model will have more detail with fewer visible layer lines. A 0.20 mm layer height is the standard for most prints.

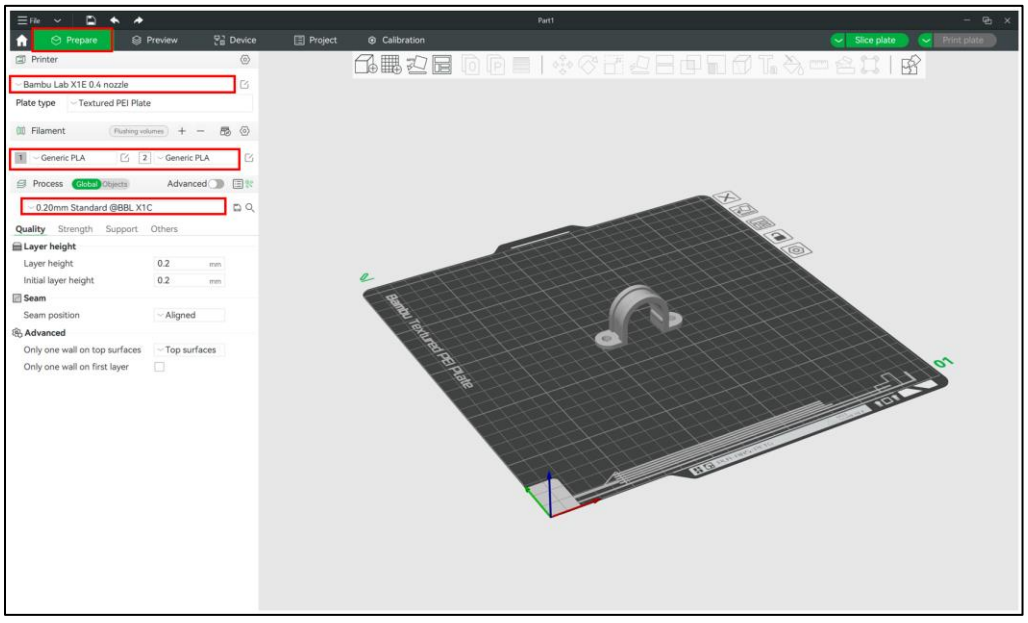

Figure 7: Configure general printing parameters

If the file contains multiple objects, the parameters for each of them, such as the type of filament used or the layer height, can be configured individually. To do this, as shown in Figure 8, click on the **Objects** option and select the object whose printing parameters you want to adjust.

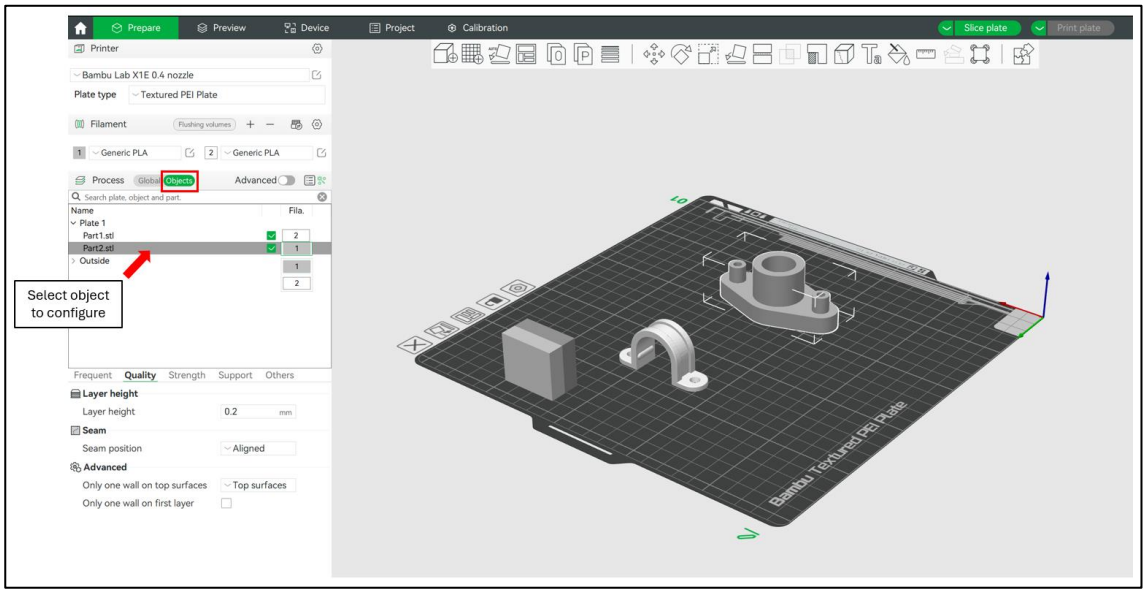

Figure 8: Configure parameters with a design with more than 1 object

2.2.3 Advanced configuration of printing parameters

The **Advanced** option, shown in Figure 9, gives users more detailed and specific control over printing parameters. Enabling this option allows users to optimize and customize their 3D prints.

New parameters such as line width and print speed become available, allowing adjustments to the thickness and printing speed of specific layers, such as the initial layer or the inner and outer walls.

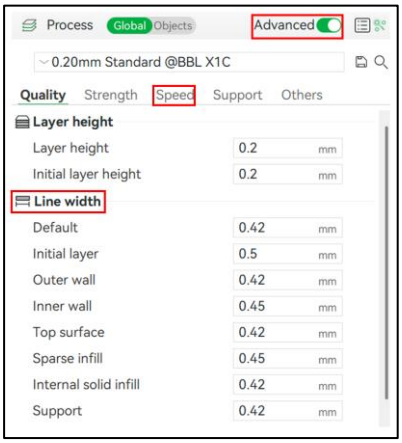

Figure 9: Configure advanced printing parameters

2.2.4 Adding print supports

Enabling print supports is essential when a model has parts that are not well supported or do not have direct contact with the heated bed, such as overhangs or arches. These temporary structures are added to prevent floating parts from deforming or collapsing during the printing process.

There are two types of supports available:

- Normal support: This is the standard support generated by creating vertical lines under the areas that require support.
- Tree support: This type of support is branched, simulating the shape of a tree. It consumes less material than the normal support type while still providing stability.

It is important to note that generating supports increases both filament consumption and printing time.

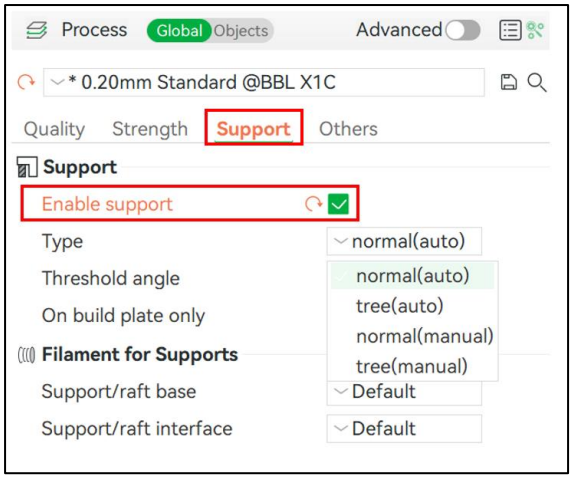

Figure 10: Enable print support

2.2.5 3D Model Modification

The available options for modifying the 3D model to be printed are described below. To access these options, click on the object, and the features shown in **Figure 11** will be enabled.

Figure 11: Model modification options

- Model rotation

  The “rotate” icon allows rotating the model around each of its axes X, Y, Z, which will be displayed when this option is activated as shown in Figure 12. The rotation angle for each axis is entered in degrees (º).

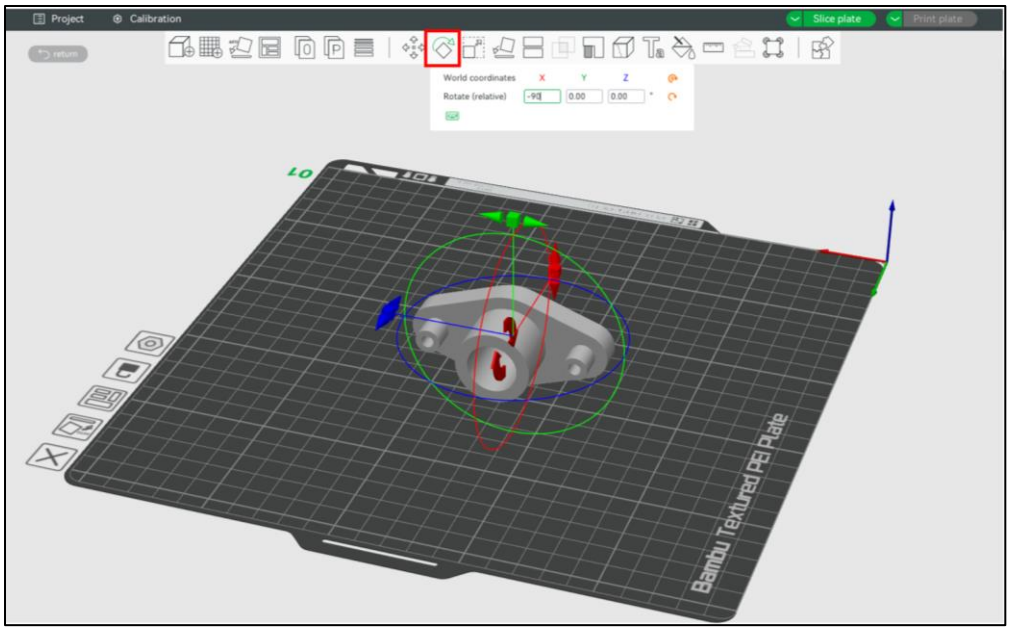

Figure 12: Rotate model

- Measurement between model planes

The "measure" option allows measuring the distance in millimeters (mm) or the angle in degrees (º) between two planes as shown in Figure 13. The measurement provides the magnitude and the components along each axis X, Y, Z.

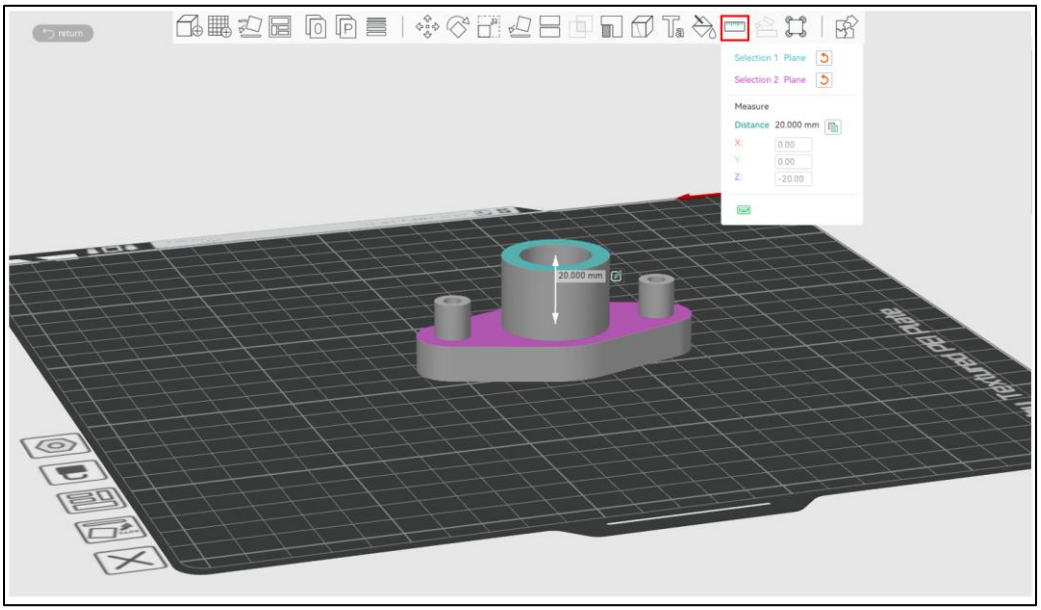

Figure 13: Measurement between two planes

- Model scale modification

The "scale" option allows entering a scale factor to adjust the size of the model. When the "uniform scale" option is enabled, the entered factor will be applied to all axes as shown in Figure 14. If this option is disabled, the scale factor will only be applied to the selected axis.

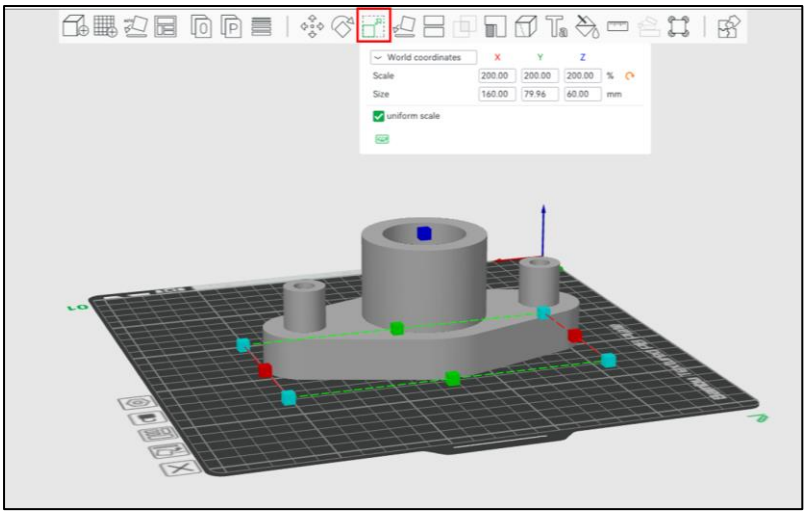

Figure 14: Factor scale to adjust the model

2.2 Model simulation and processing

This section describes the process of slicing a part, meaning simulating the model's printing by generating a visualization of how the layers and supports will be printed. It also creates a G-code file containing all the necessary instructions for the Bambu Lab X1E to print the model if desired.

To run the simulation, select the **Slice plate** option in the **Prepare** panel.

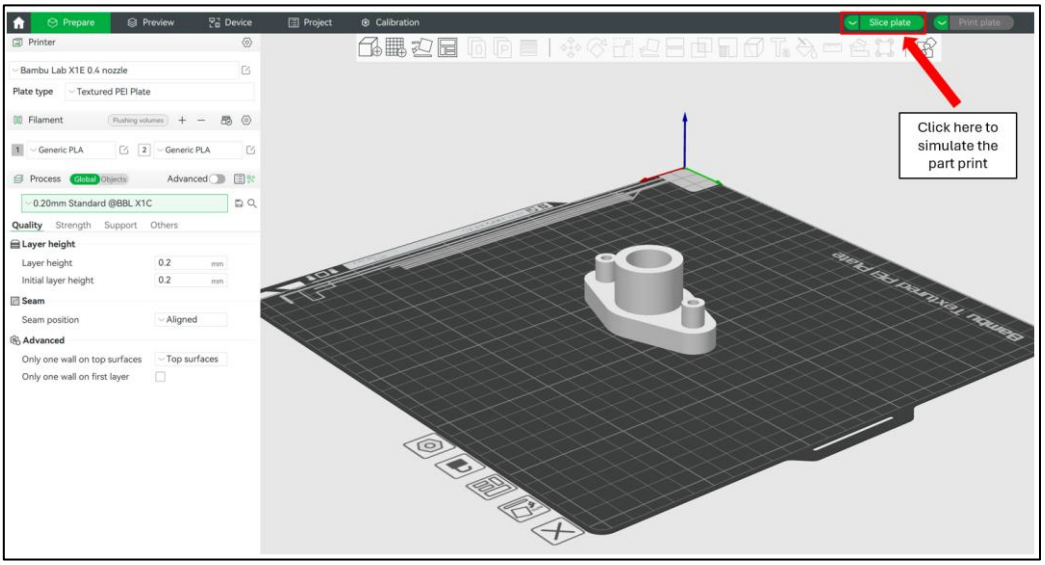

Figure 15: Slicing a model

In the **Preview** panel, the following information will appear as shown in the Figure 16:

- **Information of the printing process:** This section provides details such as total filament used, estimated weight, total cost, preparation tiem, model printing time, and the overall estimated time required for the print. It helps the user evaluate the material or printing parameters chosen before starting the real print.
- **Progress of the simulation across the different layers:** The green bar on the right allows the user to navigate throught the layers of the sliced model. By moving the slider, you can

visualize how and in wich time each layer will be printed, including internal structures, walls and supports. It helps to detect an issue before initiating the print process.

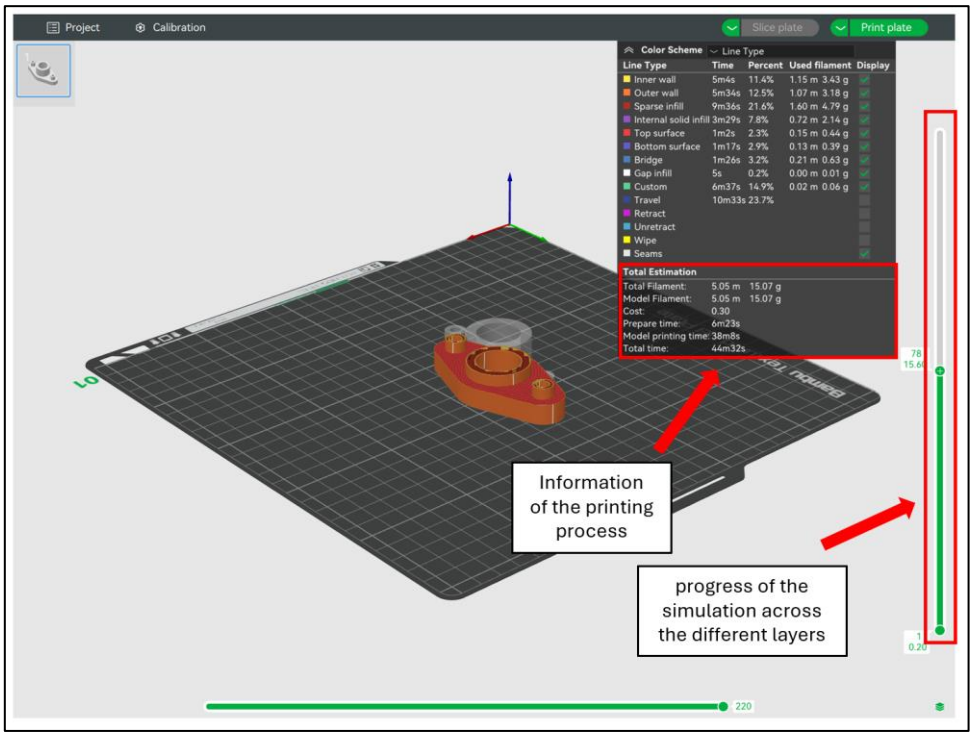

Figure 16: Model simulation

3. CONNECT WITH THE DIGITAL TWIN

Once the model has been designed and simulated, connecting to the digital twin to send the model to the 3D printer requires downloading the AnyDesk program from the following link: https://anydesk.com/es. After installing it, follow these steps:

1. To access the digital twin, enter the remote address (ID number) provided by the lab team in the upper text box of AnyDesk (highlighted in blue in the Figure 17).
2. Wait for the lab team to grant you access to the digital twin.
3. Once access is granted, open BambuStudio and import your designed model. This device is already connected to the 3D printer via a wireless connection.

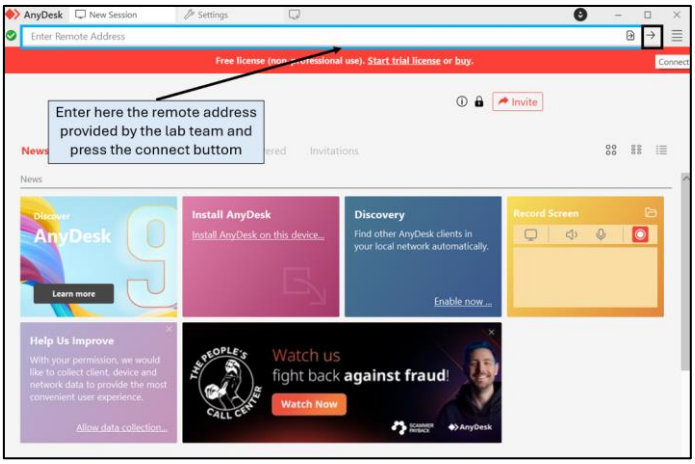

Figure 17: Access to the digital twin of the 3D printer

4. REAL PART'S MODEL PRINTING

This section presents the final steps to print the prepared and sliced model using the 3D printer. After connecting the model to the digital twin, the process of sending it to the printer for real-time printing is shown. Additionally, the printer's control interface is described, highlighting its key features and functionalities to monitor and manage the printing process.

4.1 Send part's model to 3D printer

To send the designed model to the 3D printer after slicing, follow the steps shown in Figure 18. It is important to note that the model must be sliced as described in Section 2 of this document before sending it to the printer.

1. First, in the Preview panel, click Print plate in the top right corner. A window will appear showing a preview of the model, along with the estimated print time and material weight.
2. Select the printer model 3DP-03W-925 and leave all options checked by default, as shown in Figure 18.
3. Click the send button, and the printing process will begin.

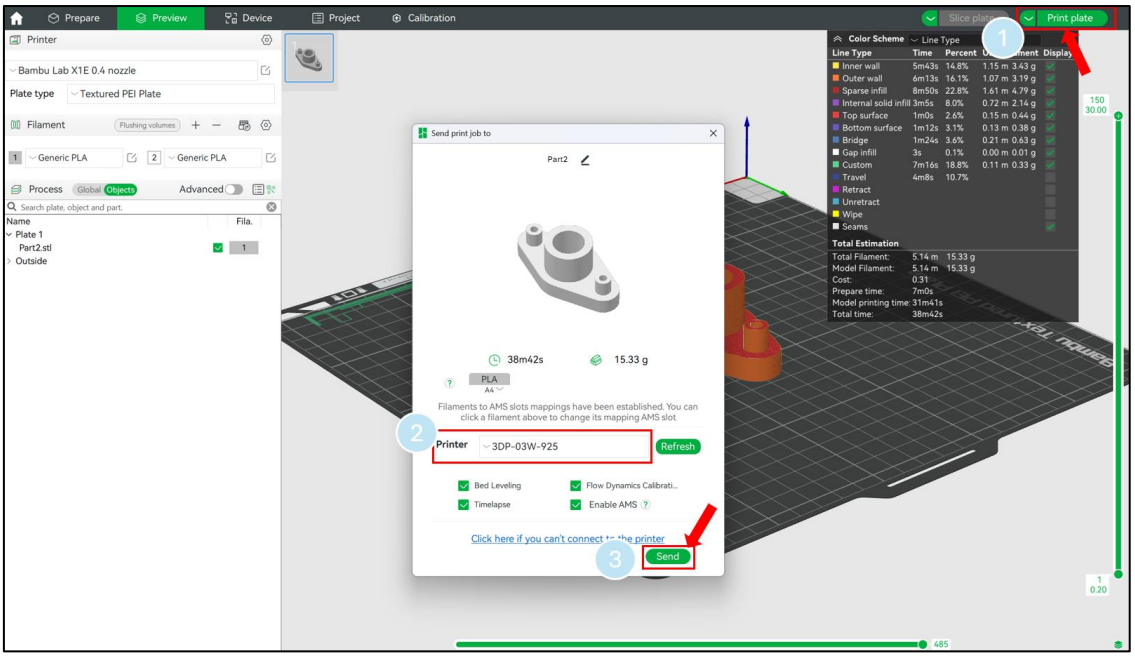

Figure 18: Send part's model to the 3D printer

4.2 3D Printer remote control interface

The **Device** panel on Bambu Studio will allow you to control and monitor the print remotely in real time. You can find the “Printing progress” as shown in Figure TAL of the current print job and stop or pause/resume it. Wether printing or not you can monitor the printer from the “Camera” tab.

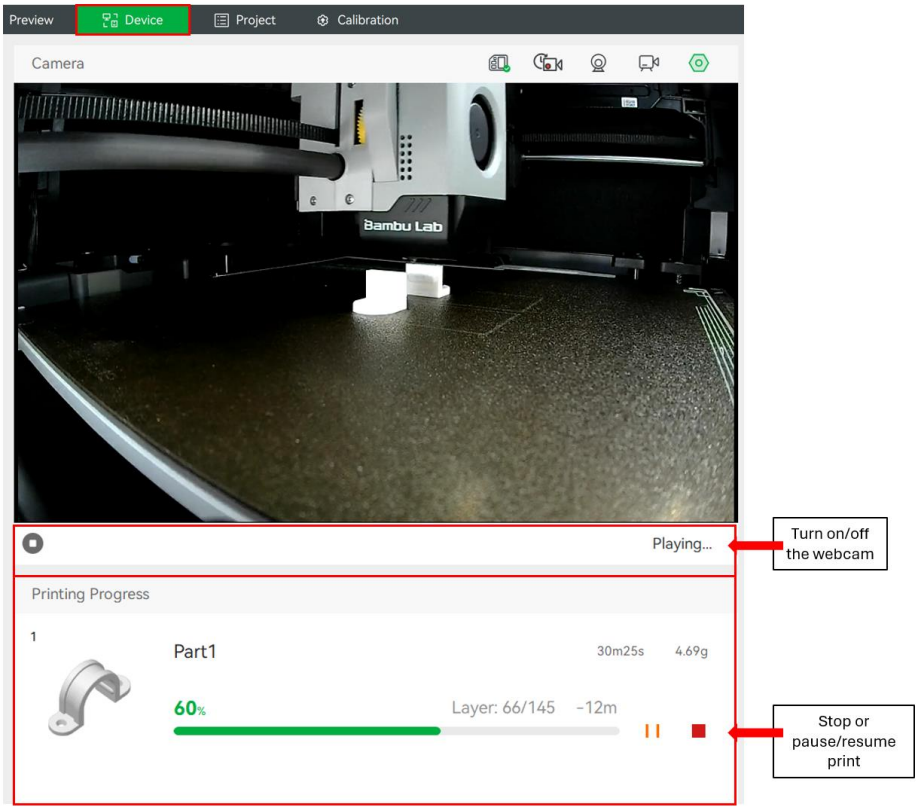

Figure 19: Printing progress

The **Device panel** also provides “Control widgets” in the right panel for the following controls as shown in Figure 20:

- X/Y/Z/E movement: Allows precise manual movement of the printer's axes and the extruder.
- Bed temperature: Displays and adjusts the temperature of the heated bed.
- Nozzle temperature: Controls the temperature of the extruder nozzle.
- Lamp: Toggles the printer's internal lighting for better visibility.
- Aux Cooling Fan: Adjusts the auxiliary cooling fan speed for additional cooling needs.
- Part Cooling Fan: Manages the cooling fan that directly affects the printed part.
- Speed Level: Modifies the speed of the print process dynamically.

It is recommended not to adjust these controls and to leave them at their default settings.

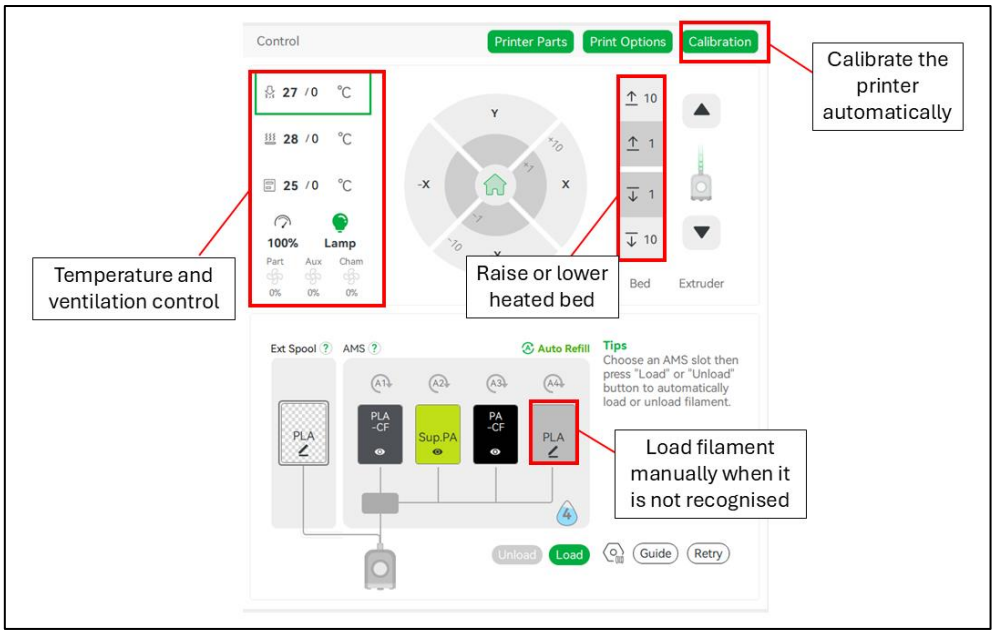

Figure 20: Remote control interface