

Getting Started with Filament-Based Printing in the Library Collaboratory

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Supplemental Information

Autodesk Educational Licenses	https://www.autodesk.com/education/edu-software/overview
3D Design for Prototyping with Autodesk Fusion workshop	https://calendar.library.torontomu.ca/calendar/events?cid=8236&t=g&d=0000-00-00&cal=8236&inc=0
Bambu Studio Software	https://bambulab.com/en/download/studio
Library Collaboratory LibCal for Printer Logging	https://calendar.library.torontomu.ca/equipment?lid=3026
Bambu Lab® X1Carbon Operational Manual	https://wiki.bambulab.com/en/x1/manual

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If you have questions about anything in this document, please contact the Library Collaboratory Research Technology Officer Jimmy Tran (q2tran@torontomu.ca)

Introduction

Hello and welcome to the TMU Library Collaboratory! This training document will guide you through the basics of filament-based 3D printing at the Library Collaboratory.

What is filament-based 3D printing? Filament-based 3D printing is a form of additive manufacturing (AM) which means that it creates objects by adding material layer by layer. Filament-based 3D printing is also known as:

- Fused Deposition Modeling (FDM)
- Fused Filament Fabrication (FFF)
- Material Extrusion (MEX)

It involves heating a polymer filament by passing it through a hot extruder nozzle to soften the material; afterwards, it is deposited onto a heated print bed. 3D printers use a gantry system to control the nozzle's position relative to the print bed. Rollers control the rate at which the filament is passed through the nozzle.

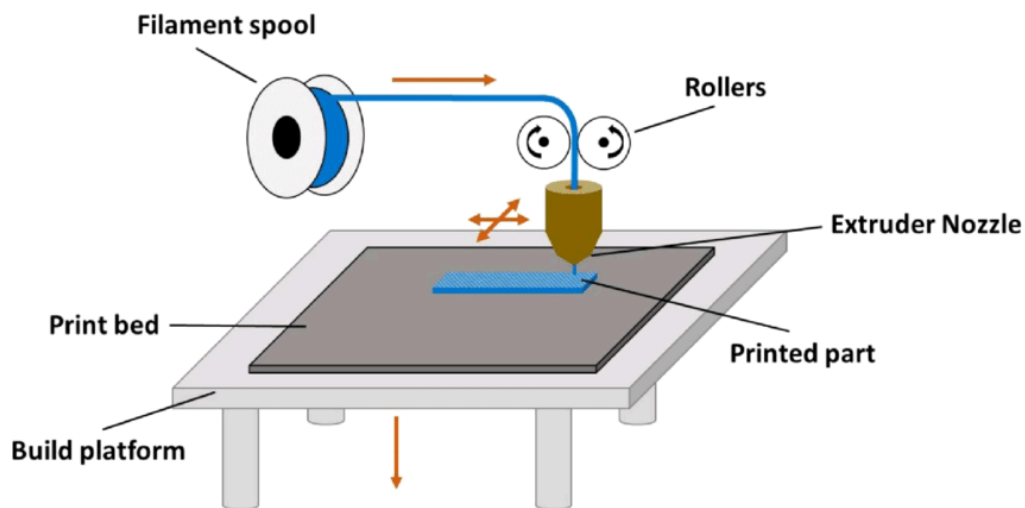


Figure 1: Schematic of the 3D printing process [1].

3D printers work by reading a set of instructions through G-Code. G-code is generated by an intermediate software program known as a 3D Slicer which is responsible for converting various types of computer-aided design (CAD) file types into G-code. There is a wide selection of CAD software that you can use to generate your models; for example:

- Autodesk Fusion
- Tinkercad
- AutoCAD

Autodesk offers educational licenses for these products and more which can be found at this link: <https://www.autodesk.com/education/edu-software/overview>. The Library Collaboratory offers a great introductory workshop for working with Autodesk Fusion called “3D Design for Prototyping with Autodesk Fusion” if you are interested. This workshop plus more can be found here:

<https://calendar.library.torontomu.ca/calendar/events?cid=8236&t=g&d=0000-00-00&cal=8236&inc=0>.

Three Bambu Lab® X1 Carbon FDM printers are operational at the Library Collaboratory. Each has a unique identification code:



HAL9000

T1000

ED209

Figure 2: Location of 3D printers at the Library Collaboratory.

Bambu Lab® 3D printers use their own 3D slicing software known as Bambu Studio. You can download this software via this link: <https://bambulab.com/en/download/studio>. Here is some basic printer terminology:

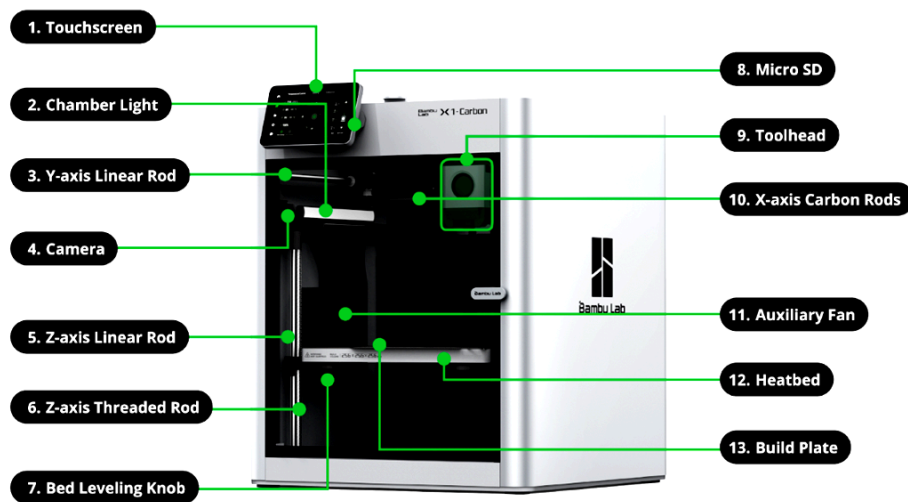


Figure 3: Bambu Lab® X1 series schematic [2].

House Rules and Printing Etiquette

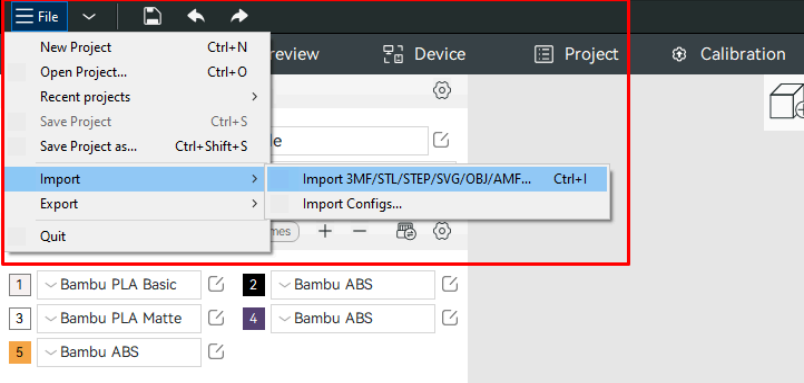
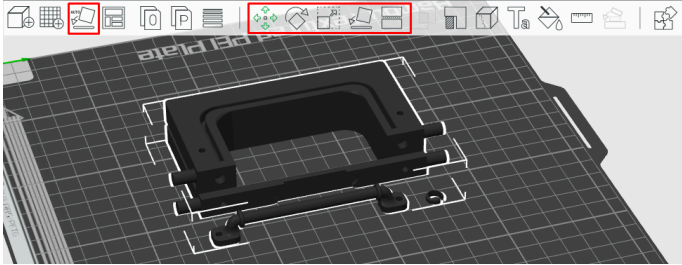
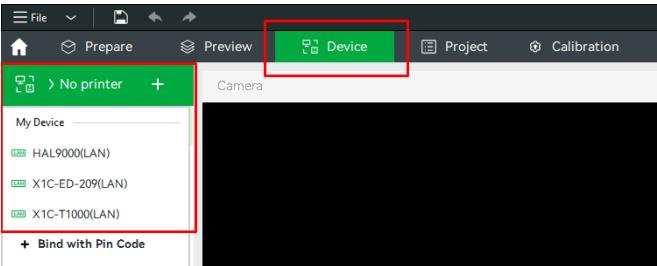
Before starting your first print, please review the following house rules at the Library Collaboratory. These rules ensure that the Library Collaboratory remains a fair, safe, and respectful space for all members.

- When starting a print, log your information and print time on the Library Collaboratory's LibCal website: <https://calendar.library.torontomu.ca/equipment?lid=3026>. If a Library Collaboratory staff sees a print that is not logged, it could be mistaken for an unauthorized user and the print might be cancelled. For ease of logging and your convenience, there is a QR code next to the printer.
- While in use and after use, ensure your workspace including the printer area is kept clear of spills, unattended sharp/hot objects, and clutter.
- Do not drink or eat near the apparatuses.
- Recycle support material from your finished part by throwing it into the designated plastics bin.
- Unless granted by the Research Technology Officer, you may only use one printer at a time to ensure all members have equal access to the printers.
- You may not use the printers for commercial purposes.
- Bambu Lab® rated filaments are preferred. The Library Collaboratory has third-party filaments and those are permitted as well.
 - If you would like to print with your own filaments, please consult the Research Technology Officer first.
- Consult the Research Technology Officer before beginning large-scale projects requiring large amounts of plastic.
- Design models according to the capabilities of 3D printing; be mindful of their printability. Unless necessary, orient the model to minimize the amount of support material.
- If you would like to start a print on a printer that has someone else's finished part, gently remove the part (if possible) from the plate and place it in the "finished prints" basket.
 - If you find it difficult to detach the part from the plate, remove the part along with the plate and place it in the basket (cool it down first). You may use another available plate.
- Ensure you set the proper nozzle diameter on Bambu Studio to match the nozzle diameter.

- The indicator on the bottom right side of the printer door specifies the nozzle diameter. Normally, the attached nozzle diameter is 0.4mm.
- If you are unsure about the nozzle diameter or would like to print with a different nozzle diameter, contact the Research Technology Officer.

How to Print

Before beginning these steps, install the Bambu Studio software onto your computer. In addition, connect to the Library Collaboratory equipment LAN by going to wifi settings and selecting “Collab_Equipment”. Ask the Research Technology Officer for the password.

Step	Description
1	<p><u>Importing files</u></p> <p>First, export your part from the CAD software as a readable file type in Bambu Studio. These include:</p> <ul style="list-style-type: none">• .3mf• .stl• .stp• .step• .amf• .obj <p>To import, select: File → Import → Import 3MF/STL...and select your desired file. You should now see your part on the plate.</p> <p>Note: you can also drag and drop files into the Bambu Studio user interface</p> 
2	<p><u>Moving and Orienting your Model</u></p> <p>From the “Prepare” tab, there are different tools that you can use to move and orient your model. Some commonly used tools are the Auto Orient, Move, Rotate, Scale, Lay on Face, and Cut tools.</p> 
3	<p><u>Selecting and Connecting to Printer</u></p> <p>Click on the “Device” tab, press the + sign next to “No printer,” and select a printer under the drop-down menu to connect to it.</p> 

Note: sometimes, a lock will appear next to the device. After selecting the locked printer, a pop-up will appear asking you to input the printer access code. On the corresponding printer's touchscreen, select settings, take note of the access code, and input it into Bambu Studio. The printer should then connect.

4 **Setting the Nozzle Size and Plate Type**

Select the “Prepare” tab. Define which nozzle size and print bed you will use for your print by selecting the appropriate nozzle and plate types from the drop-down menus under “Printer”.

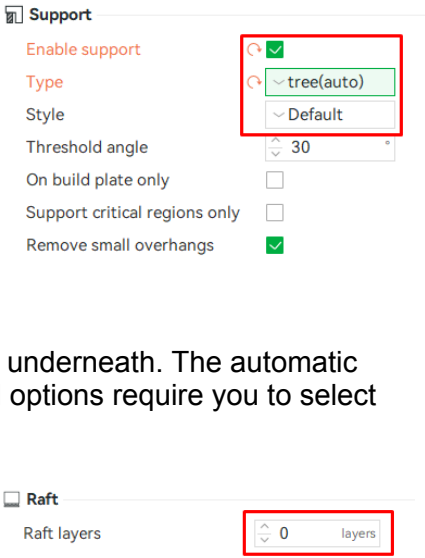
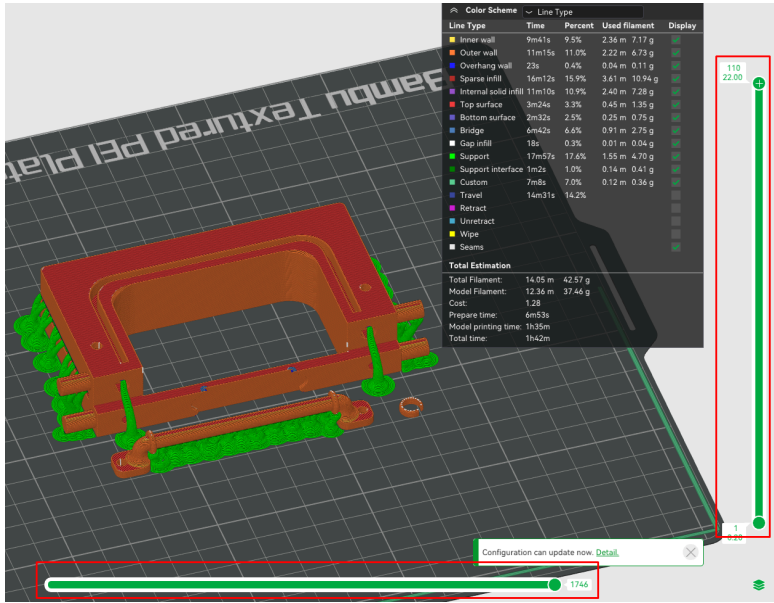
Typically, the nozzle that is installed on the printer is 0.4mm in diameter. If you are uncertain or would like to change the nozzle, consult the Research Technology Officer.

5 **Setting the Nozzle Size and Plate Type**

Sync the materials by pressing the icon shown in the red box. A window asking you to sync or resync will appear. Click “Resync”. If the materials were not previously synced, the materials shown will change to match those in the printer’s AMS (Automatic Material System).

6 **Selecting Material for Print**

Select the desired material per body of your model by right-clicking on your model, selecting “Change Filament”, and then your desired material. If your part has multiple bodies and you would like to print with different materials, simply repeat this step per body.

<p>7</p>	<p><u>Adding Support Structures and Rafts</u></p> <p>Support structures should be enabled for prints including overhangs. Check the “Enable support” box to turn on support structures.</p> <p>There are different types of support structures:</p> <ol style="list-style-type: none"> 1. normal(auto) 2. tree(auto) 3. normal(manual) 4. tree(manual) <p>Further styles are available in the drop-down menu underneath. The automatic options will generate support automatically. Manual options require you to select points for support.</p> <p>You may also want to add a raft to promote bed adhesion. To do so, select the desired number of raft layers.</p> 
<p>8</p>	<p><u>Slicing the Model</u></p> <p>When all appropriate settings are complete, slice the model (convert into G-code) by selecting “Slice Plate” located on the top right. You may observe the printing process by dragging the vertical and horizontal bars.</p> 
<p>9</p>	<p><u>Starting a Print</u></p> <p>If you are satisfied with the sliced model, select “Print Plate” on the top right. A window displaying information about your print including print time and material usage will appear. It is generally recommended to enable “Bed Leveling” and “Flow Dynamics Calibration”. If using the AMS, check the “Enable AMS” box.</p>

Congrats! Your print should now be running.
Do not forget to log your print by inputting your information to the following website:
<https://calendar.library.torontomu.ca/equipment?lid=3026&gid=6686>

Citations

[1] A. D. Banjo, V. Agrawal, M. L. Auad, and A.-D. N. Celestine, "Moisture-induced changes in the mechanical behavior of 3D printed polymers," *Composites Part C: Open Access*, vol. 7, p. 100243, Mar. 2022. doi:10.1016/j.jcomc.2022.100243

[2] "X1 series," Bambu Lab Wiki, <https://wiki.bambulab.com/en/x1> (accessed Oct. 17, 2024).