INSTRUCTIONS:
ONE-HANDED GAME CONTROLLER

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TOOLS AND MATERIALS

- 3D Printer
- Memory Card
    - Not needed if your printer can upload files over the cloud
- PLA Filament
- Soldering Iron
- Solder
- Heat Shrinks or Electrical Tape
- (ONLY IF using Heat Shrinks) Heat Gun
- Threaded Wire
    - Solid Wire works too, but it will be more difficult when assembling as it is easier to break.
- Arduino Micro (x1)
- Analog Joysticks (x2)
- Two-Prong Buttons (x16)
- Dr.Scholl's Thickest Padded Moleskin
- Front and Back PCBs
    - Refer to page 9 for instructions on how to order these.
- 2-56 ½" Screws (x8)
- 2-56 1 ½" Screws (x3)
- 2-56 1" Screws (x2)
- 2-56 Nuts (x8)
- Micro USB to USB-A Cable (x1)
- Phillips Screwdriver
- (Optional for faster assembly) Drill with Phillips Bit

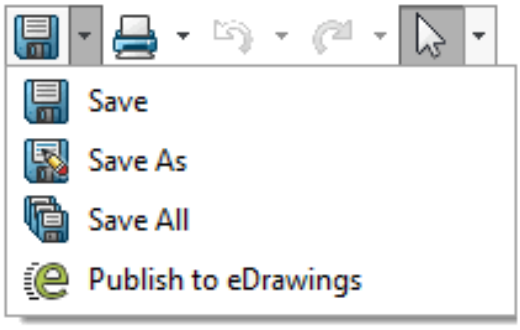
SOFTWARE

- 3D Printer Slicer

- (Optional for editing STL files) *SolidWorks*
- (Optional for editing PCB files) *KiCad*

SETTING UP YOUR FILES FOR 3D PRINTING

1. If you are making changes, download the necessary SLDPRT files from our *GitHub* and do the following after you are done making changes on *SolidWorks*:
    a. Navigate to the save icon and press the drop-down arrow.
    b. Click “Save As” and rename the file if you desire.
        i. **Note: Be sure to change the file extension type to “.STL” and save it to a location on your computer that is easily findable.



2. If you are not making changes with the files, download the STL files from our GitHub. Be sure you have all of the following files:
    a. Front Face
    b. Back Face
    c. Front Side
    d. Back Side
    e. Top-Front Mount
    f. Top-Back Mount
    g. Bottom-Front Mount
    h. Bottom-Back Mount
    i. Handle
    j. Front Buttons
    k. Back Buttons

3. Start by opening up file '**a**', Front Face, on your 3D Printer's slicer.
    a. A slicer is a software used to prepare files for printing. For most 3D Printers, the software *Cura* will work, but it is best to use their designated slicer.
    b. Launch the software and create a new project.
    c. Import the STL file from the location you saved it by dragging and dropping the STL file into the slicing software or using an import button.
    d. Example: For *Bambu* printers, open up *Bambu Studio* and navigate to "File" at the top left corner and then "Open" to browse for the STL file.
4. Prepare your file by doing the following:
    a. Turn on supports and adhesion as necessary.
        i. For parts with overhangs like the 'Back Side' and 'Front Side', it is highly recommended for you to turn on supports to avoid print failure. It is also okay to turn on supports for printing all the files to ensure no mishaps.
        ii. Depending on your printer's history, you may have higher print success with adhesion on to make sure your print sticks onto the print bed.
    b. Adjust print infill between 15% to 40% depending on your printer.
        i. For higher-end printers like the *Bambu Carbon*, around 15% to 20% is good enough.
        ii. For lower-end printers like the *Ender v3*, around 40% or higher will be necessary.
    c. Optimize the orientation of the part on the print bed.
        i. Please refer to each file's page for more information on how to best print them. You can quickly find the pages in the Table of Contents on Page 2
    d. Be aware of what units you are in (inches or millimeters)
5. Slice the file.

    a. Usually, you will be moved to another section with detailed information including a breakdown of how the part will be printed with supports and the time it will take to finish printing.
6. Save the sliced file to your printer's memory card unless you are printing over the cloud.
    a. The file extension is usually ".g3code" or ".gcode" but this can vary on the printer.
7. Repeat this procedure for parts '**b**' through '**k**'
    a. You can print more than one part at a time, but keep in mind that a longer print time poses a higher risk of print failure.
8. Eject the memory card from the computer and insert it into the printer unless you are printing over the cloud.

PREPARING YOUR 3D PRINTER AND PRINTING

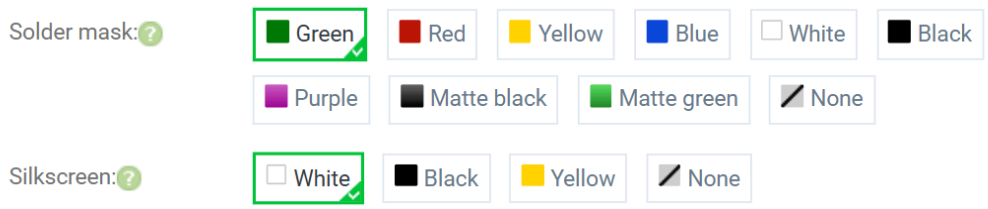
1. Turn on your 3D printer.
2. Calibrate the 3D printer's levels as necessary.
    a. Some printers will auto calibrate before every print. This step is only necessary if you need to manually level your printer. Refer to your printer's manual for further assistance as this varies from printer to printer.
3. Change filament to the correct color as necessary.
    a. Most printers have an option that reads "Unload" for removing, or unloading, the current filament and an option that reads "Load" for putting in, or loading, the new filament. Follow the steps on the printer for these procedures; otherwise, refer to your printer's manual for further assistance.
4. Clean your print bed.
    a. This can be done by spraying Isopropyl Alcohol directly on the print bed and wiping it off with a clean towel .
        i. If Isopropyl Alcohol is not available, you can also use soap and water.
    b. Be mindful to not touch the print bed directly with your fingers.
5. Print your file.
    a. If you are not printing over the cloud, search for the files from the memory card and press print.
    b. If you are printing over the cloud, the 3D printer's slicer usually has a print button that will automatically start your printing process.
6. Make sure to watch the first few layers of the print to ensure that it will not fail.
    a. If it does fail, remove the failed parts from the print bed and clean the print bed again (refer to step 4).
    b. Before attempting to print again, check the slicer's settings to make sure everything is correct.

    c. Print the part again. If it continues to fail, consider using a different 3D printer or consulting someone for help with troubleshooting.
7. If all is well, you have successfully 3D printed a part! Repeat this process for all files that are ready to be printed.

ORDERING PCBS

This controller requires two PCBs. One for the front buttons and one for the back buttons. For the instructions below, we will be using PCBway.com to order the PCBs. There are several other websites that you can order from and the procedure should be similar.

1. Download back_order.zip and front_order.zip from Github inside the PCBs folder.
2. Choose a website to order from (PCBway, JLCPCB, ...)
    a. We will be using PCBway.com
        i. Navigate to the PCB Instant Quote tab and click on Quick-Order PCB (or click on the link above).
3. Upload one of the zip files by clicking + Add Gerber File
4. Keep the default settings.
    a. Make sure that “2 Layers” is selected.
5. Choose the color you want your PCB to be and the color you want the text to be.



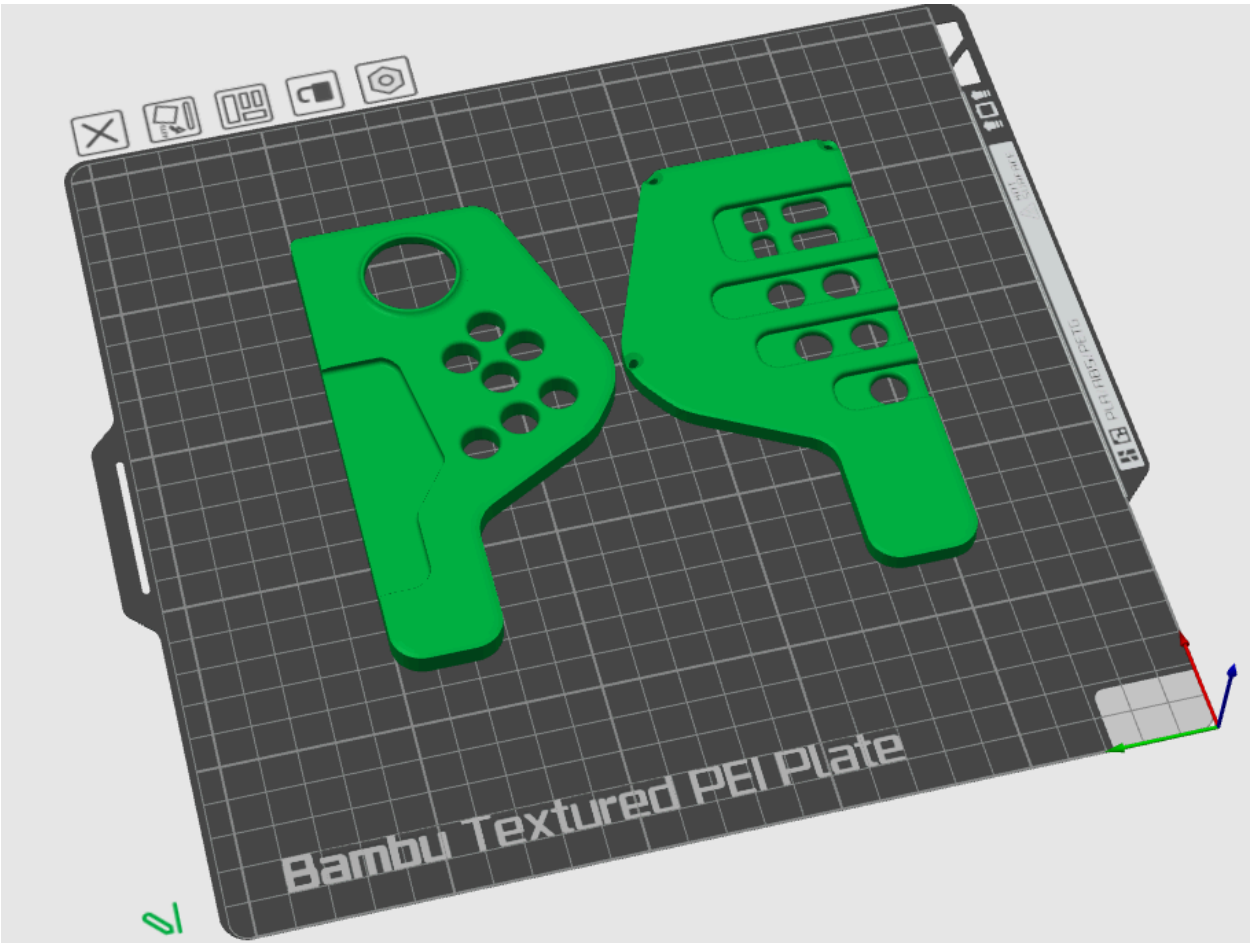
    a. Solder mask is the color of the PCB and Silkscreen is the color of the text.
6. Purchase the PCB
7. Follow the same instructions to order the other PCB.

FRONT AND BACK FACE

Print Orientation

- Flat on the side that will be facing the inside of the controller. Please refer to the images for reference.
- In this case, be sure that the front face has the thumb rest (indent) on top and the back face has the finger indents on top.

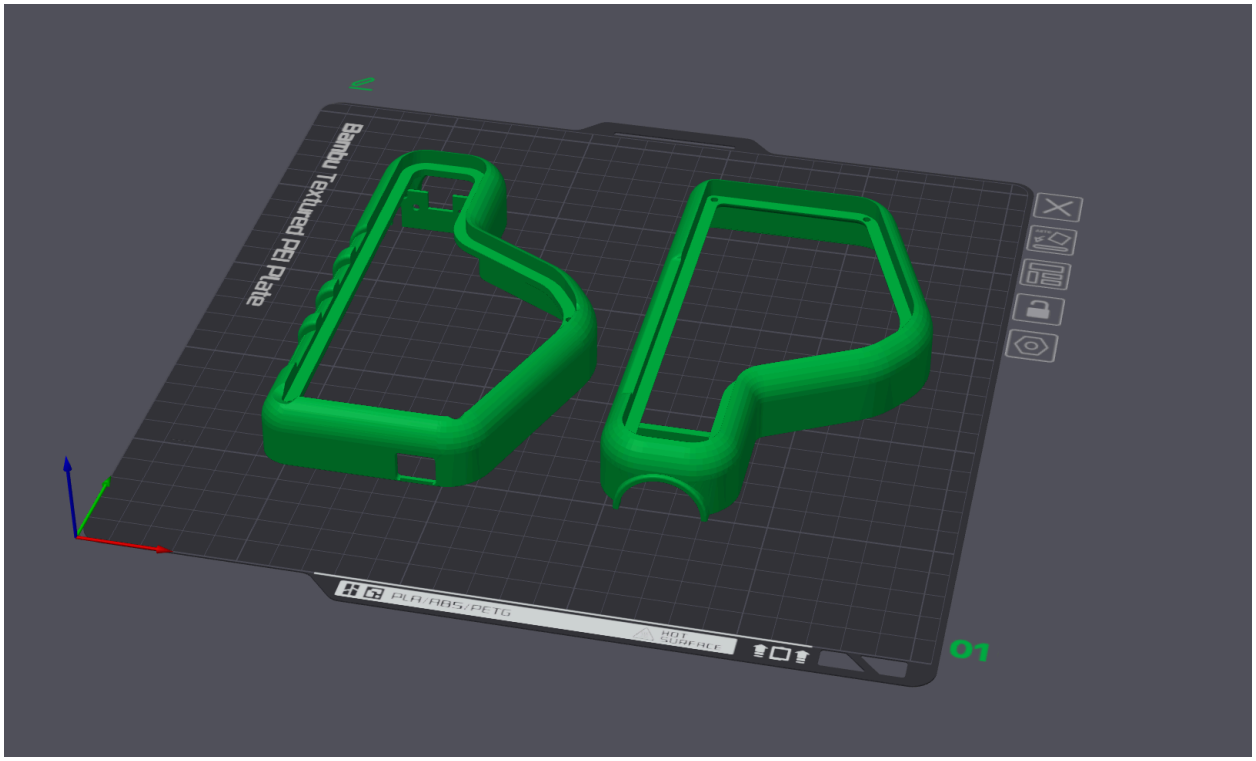
Image of what part looks like in *Bambu* Studio:



FRONT AND BACK SIDES

Print Orientation

- For the back side, it's best to print it on the face that connects with the front side. This is because the back of the back side contains ridges that will not print correctly if placed on that face
- For the front side, print orientation does not matter, but for consistency, place it on the face that connects with the back side so that the 2 faces connect easily

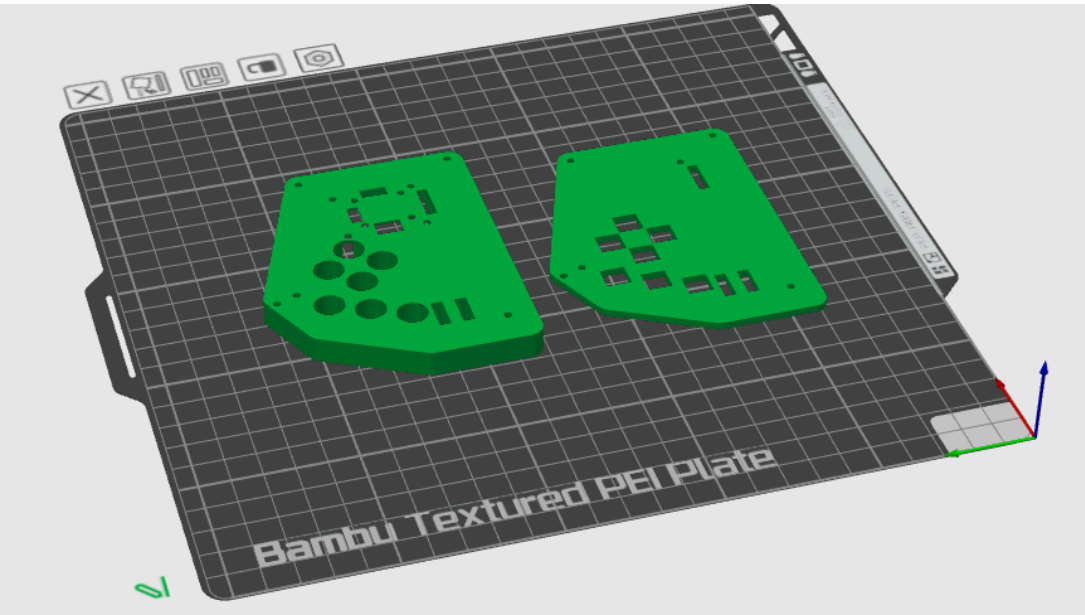


FRONT TOP AND BOTTOM MOUNTS

Print Orientation

- It is best to print the Front Mounts on their flat side. Please refer to the images for how it should look in a slicer and when the parts are done printing.

Image of what part looks like in *Bambu Studio*:

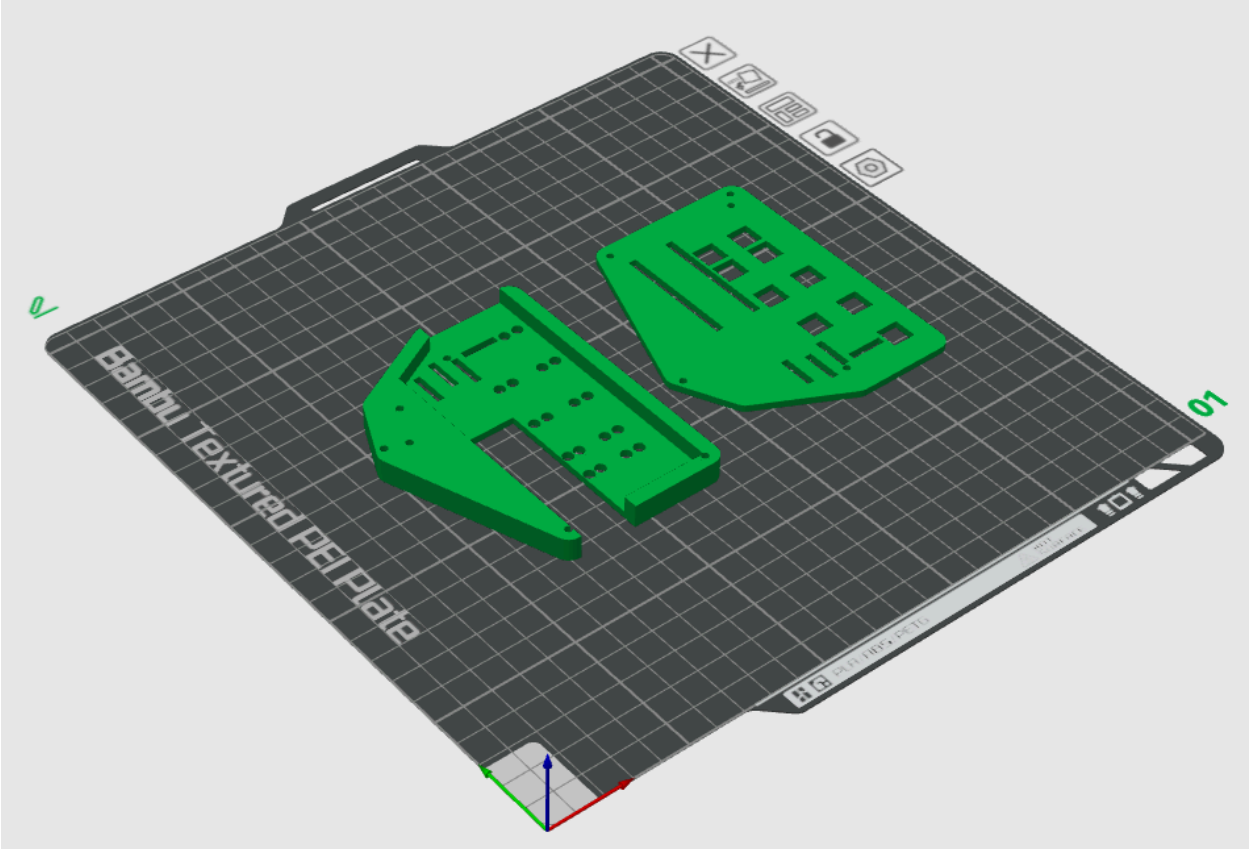


BACK TOP AND BOTTOM MOUNTS

Print Orientation

- Place the mount flat side down on the build plate to ensure a **stable base** for printing. No support should be necessary for printing for the B_Back_Mount.
- As for the B_Front_Mount, please reference the image below for the correct orientation. The side that is sort of 'valleyed' should be facing up.

Image of what part looks like in *Bambu Studio*:

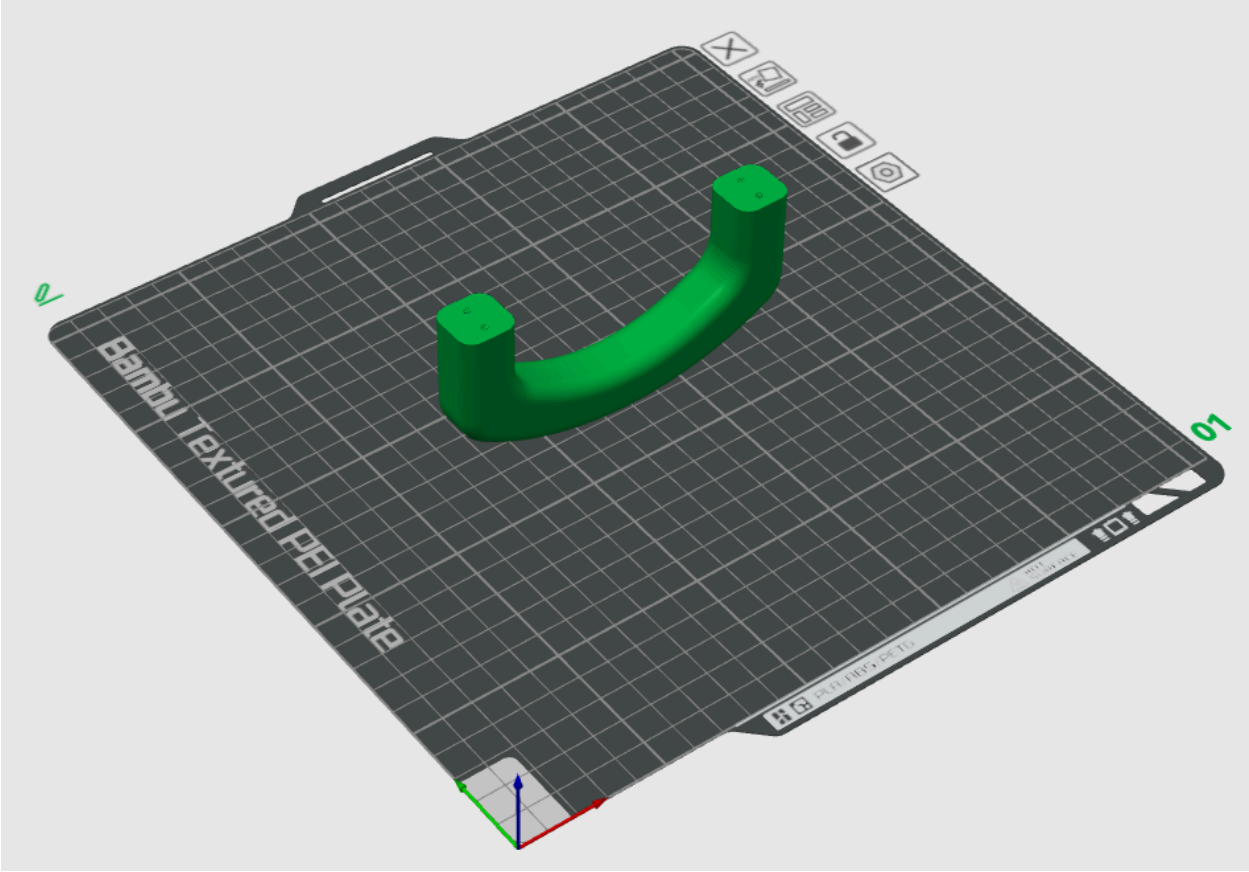


HANDLE

Print Orientation

- Print with the screw holes facing up to make sure the thread quality is good.

Image of what part looks like in *Bambu Studio*:

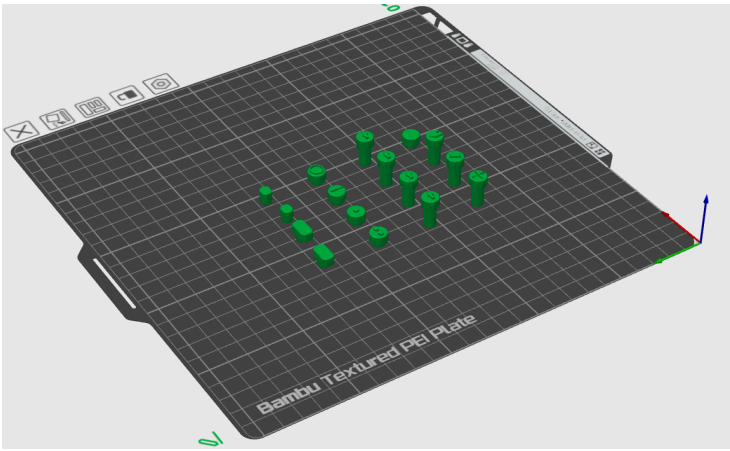


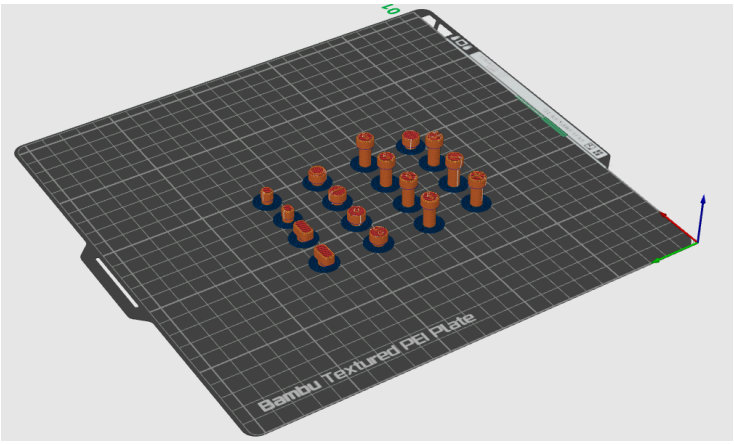
BUTTONS

Print Orientation

- Place the buttons upright, with the bottom of the button on the build plate. This orientation mimics how the button would stand when assembled and ensures a smooth top surface for interaction.
    - All buttons can be printed simultaneously on one build plate.
- Since the **stem** (the narrow part of the button that fits into the controller housing) **is thinner** than the top, **enable "outer brim" supports** in your slicer software to prevent wobbling or deformation.
    - On *Bambu Studio*, select Others > Brim type: Outer brim only

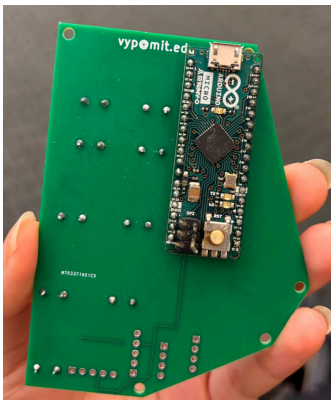
Image of what part looks like in *Bambu Studio*:



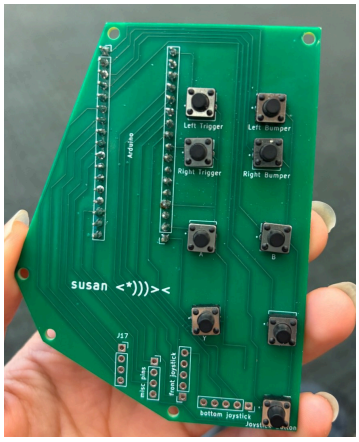


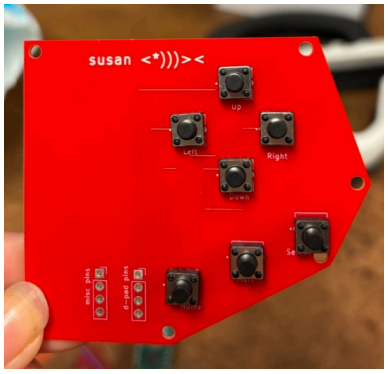
SOLDERING

1. Solder the Arduino Micro onto the back PCB, ensuring that the Arduino is placed like the image below.

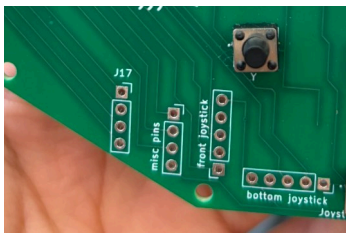


2. Solder 16 buttons on the back and front PCBs.





3. Now we will connect the front PCB to the back PCB. Cut several pieces (at least 8) of threaded wire around 3".
    a. Strip the ends of the wires with a wire stripper and twist the threads so that it is easier to solder.
4. Solder 8 of the wires on the holes labeled d-pad pins (J17 in the image below) and misc pins.



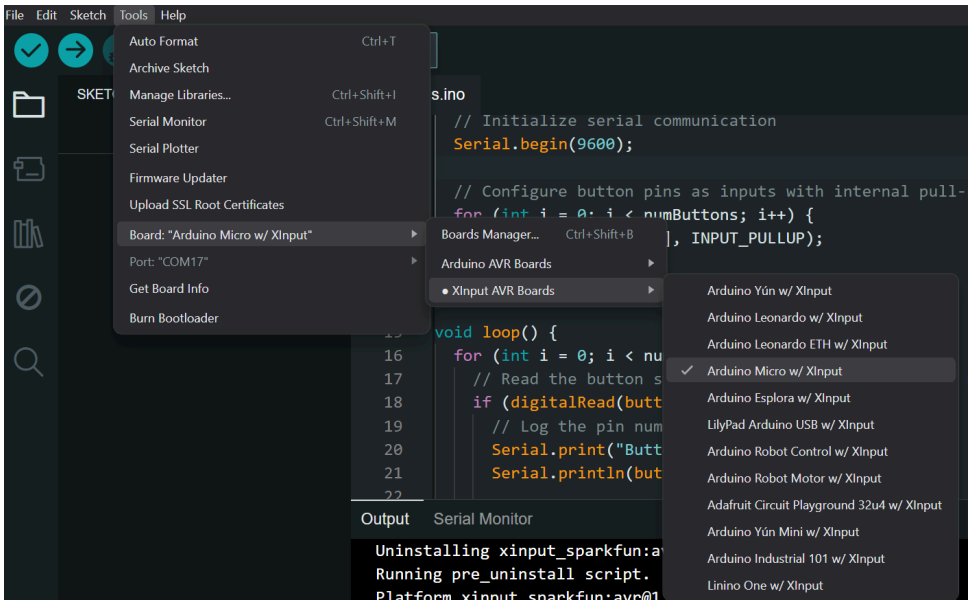
5. Cut and place 1 heat shrink of ~½" on each of the wires and use a heat gun to secure it near the soldered end of the wire.

6. Place the back bottom mount on the back PCB and pull the wires through the designated holes on the mount.
7. Cut and place 1 heat shrink of ~½” on each of the wires. Do not use a heat gun yet.
8. Place the front bottom mount on the front PCB and pull the other end of the wires through this mount and the front PCB.
    a. The wires connected to misc pins on the back PCB should correspond to the misc pins on the front PCB. Similarly, the d-pad pin wires should correspond to the d-pad pin holes on the front PCB. The order of the wire should stay consistent on both PCBs (eg. the top hole should connect to the top hole on both PCBs).
9. Solder these ends of the wire to the corresponding front PCB holes.
10. Use a heat gun to secure each of the heat shrinks on the front PCB end of the wires.
11. Cut 5 4” stranded wires and solder them to a joystick breakout board.
12. Solder the other end of the wires to the holes on the back PCB labeled front joystick. The holes from top to bottom correspond to: GND, VCC, HORIZ, VERT, SW.
    a. Make sure each wire is connected to the proper hole.
13. Cut 5 4” stranded wires and solder them to a joystick breakout board.
14. Solder the other end of the wires to the holes on the back PCB labeled bottom joystick. The holes from left to right correspond to GND, VCC, HORIZ, VERT, SW.

UPLOADING XINPUT

1. Download the latest Arduino IDE. We will be using Arduino IDE 2.3.3 for the instructions below.
2. Navigate to the Library Manager and install XInput. Navigate to the Boards Manager and install XInput AVR Boards.

3. Go to tools -> Board -> XInput AVR Boards and change the board to Arduino Micro w/ XInput



4. Download the [Arduino Code] from Github inside the Code folder and upload to the Arduino Micro.
    a. You may have to hold the reset button on the Arduino Micro to upload successfully.
    b. It should say Done Uploading if successful.

TESTING

1. Once the code is uploaded to the Arduino, we can test whether it works by using an online controller tester.
2. Try pressing a few buttons to see if the controller is detected.
    a. If it is not detected, try to press every button, refresh the page, or reupload the code to the Arduino.
3. Once the controller is detected, press each button to make sure it works.
    a. If there is a button that isn't detected, check if the button is soldered properly.

ASSEMBLY

1. Put together the Bottom PCB and Back Mounts
2. Put together the Top PCB and Front Mounts
3. Screw the Handle onto the Back Side
4. Snap together the Back and Front Side. Then, screw the Bottom Joystick onto the now together sides.
5. Snap the Back Face onto the now combined Back and Front Side
6. Begin screwing in the long screws through the Back Face and Back SIde on the controller. Once you see about a centimeter of the screws through, you can now put the Bottom PCB and Back Mounts on top. Continue screwing.
7. Once the screws have gone through the Bottom PCB and Back Mounts about a centimeter, now put the Top PCB and Front Mounts on top. Continue screwing until the screw is completely through.
8. Snap the Top Face on and screw the long screws a bit more.
9. Starting with the back buttons, put super glue in each button cap and place it on top of the buttons on the PCB through the button holes.
    a. **NOTE: DO NOT PRESS THE BUTTON AS THE GLUE IS DRYING. THIS WILL RUIN THE BUTTON AND YOU WILL HAVE TO DISASSEMBLE TO REPLACE THE BUTTON ON THE PCB AND REASSEMBLE THE CONTROLLER.
10. Once the glue is dried, flip to the front side and glue on the button caps for this side.
11. Plug in the USB cable through the hole and into the Arduino. Assembly is now done and you are ready to plug it in your computer!

PLAYING GAMES

This controller only works on Windows computers. Since it is emulating an XBox controller, it can be directly plugged into a Windows computer, and the computer should immediately recognize the controller as an Arduino. This means you are able to play any games downloaded directly from the Microsoft Store such as Minecraft and Roblox. You are also able to play any games on Steam. As for games on different services like Epic Games, as long as you are able to add it to the Steam library, you should still be able to use the controller.

This means the controller will not work for website games and on any computers running macOS.

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We would like to thank the following organizations and people.

Susan for presenting us with this project and giving us wonderful feedback throughout the whole design process.

Assistive Technology Club for connecting us with our codesigner Susan and providing resources and funding for us to work on our project.

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XInput by David Madison for allowing this to be possible on an Arduino.

Aimee Liu for leading the team during the Fall 2023 and Spring 2024 terms and designing the first iteration of the product.