NWA3D A31 User Manual

Version 2.1

1. 3D Printer Parts Diagram

FRONT

BACK

2. Assembly

1. Remove the parts from the box and remove any tape and padding from the parts. Inspect the parts to make sure they were not damaged in shipment.

   Packing list:
   - Base frame
   - Gantry frame
   - Power & control box
   - Power cord
   - M5x20 machine screw (4)
   - Washer (4)
   - Frame reinforcement plates (2)
   - Spool holder bracket
   - Spool holder tube
   - Spool holder thumb screws (2)
   - Sample spool of filament
   - USB–miniUSB cable
   - Maintenance tool kit
   - Scraper
   - Nozzle cleaner
   - microSD card with USB adapter
   - Spare parts bag with extra fasteners, nozzle, and Bowden tube coupler

2. Install the gantry frame (A) to the base frame (B).
   a. On the gantry frame, make sure the nozzle assembly is on the front, and the long vertical lead screw is on the back. On the base frame, make sure the black belt cover is on the front, and the motor is on the back.

   b. Use the M5x20 screws (4) and lock washers (4). Raise the base frame above the table with two blocks (boxes, books, etc.) Install the screws through the base frame into the threaded holes in the gantry frame. Tighten with the M5 hex key (Allen) wrench.
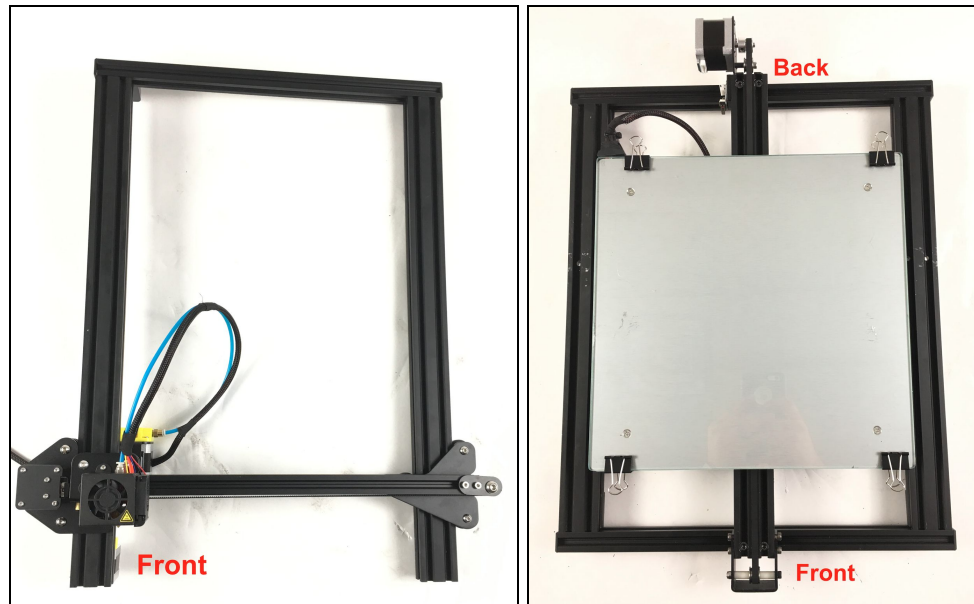
A   B

3. Install the two T-shaped frame reinforcement plates. The plate with a limit switch goes on the left (the side with the leadscrew). The plate with no limit switch goes on the right.
   a. Loosen the t-nuts by hand so that they will fit into the grooves on the frames. You want the nuts to be loose so that when you tighten the bolts, the nuts will rotate 90°C and grab onto the inside of the groove.
   b. Align the nuts to the grooves and insert the T-shaped plates into the frames.
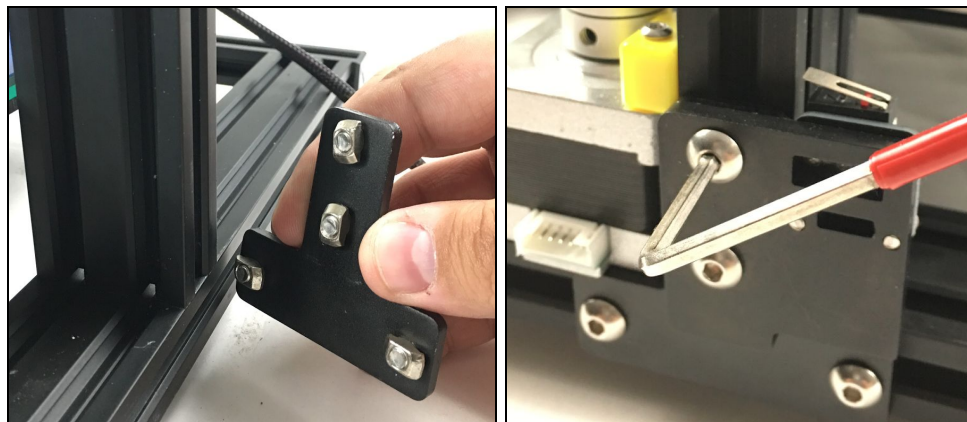
   c. Tighten all eight bolts using the M4 hex key (Allen) wrench.

4. Attach the Bowden tube coming out of the hot end to the brass tube coupler on the extruder. Firmly push the tube into the connector on the extruder. You should feel it slide in and lock into place.
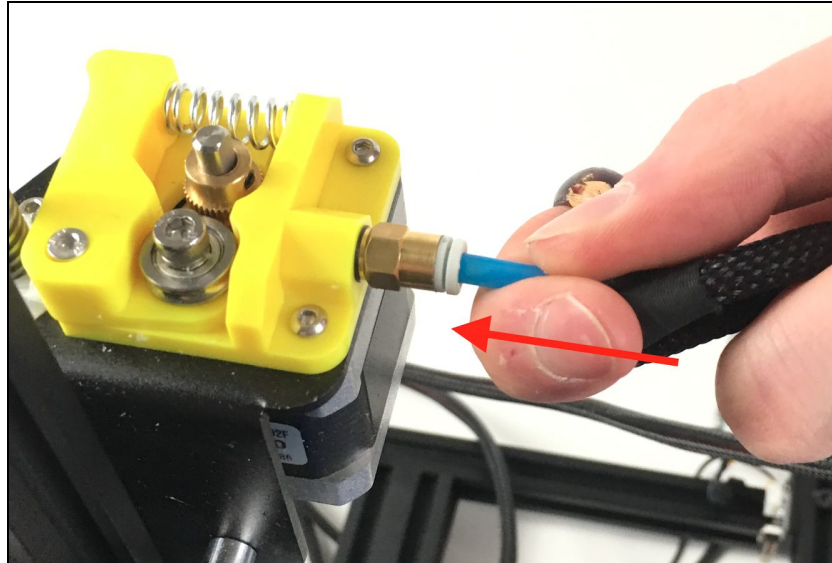

5. Install the filament spool holder.
   a. Attach the bracket to the top of the power & control box using two thumbscrews. Tighten the screws by hand. Do not overtighten.
   b. Remove the nut from one side of the filament holder tube. Install the tube into the bracket and re-install the nut to hold it in place. Tighten the nut by hand so that the tube is snugly attached to the bracket. Do not overtighten.
   c. Tighten the nut on the other end of the tube by hand. Do not overtighten.

6. Place the power & control box on the left side of the base plate, as shown in the image on Page 1 of this manual.
7. Connect all electrical cables.
   a. On the right side of the power & control box, make sure the voltage select

switch reads "110V." If it doesn't, select "110V" by gently sliding the switch with a screwdriver or other tool.
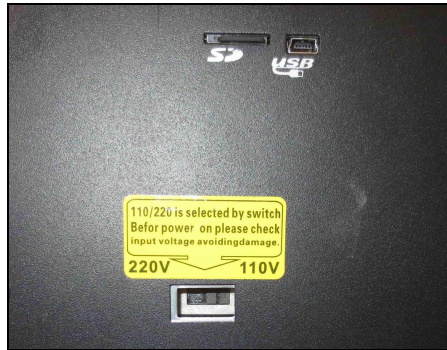
b. Connect the heater cables to the power & control box.
The cable for the build plate heater has four pins. The cable for the nozzle heater has eight pins. Rotate the connector until the pins slide easily into the socket. Do not force them. After the pins are fully inserted, hand-tighten the knurled nuts so they won't become unplugged.

c. Connect the motor and limit switch cables.
The Y cables go to the motor and switch at the back of the base frame that move the build plate. The Z cables go to the motor and switch on the left side of the base frame that move the nozzle gantry. The X and E (extruder) cables go onto the gantry frame. The X cables go to the motor and switch that runs the belt and the E cable goes to the motor that feeds the filament. Hint: Install the smaller limit switch connectors first. Small hands are an advantage. Don't bend the connectors as you push them in.

Y limit switch cable

Y motor cable

Z motor cable

Z limit switch cable

X limit switch cable

X motor cable
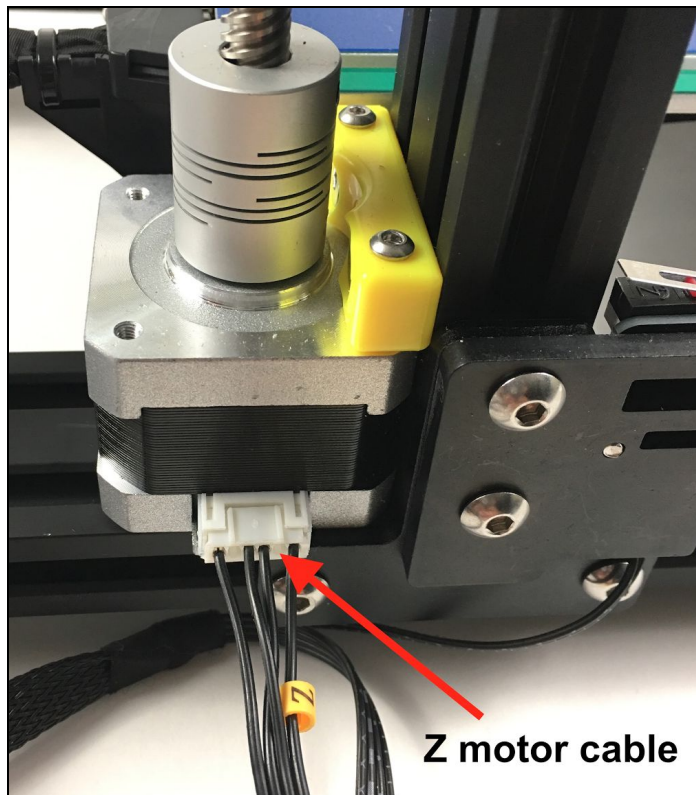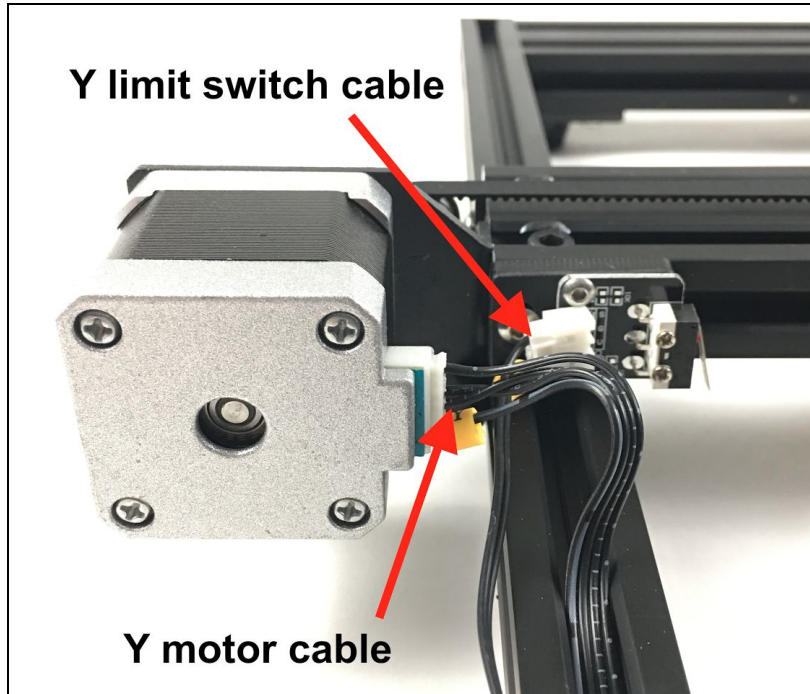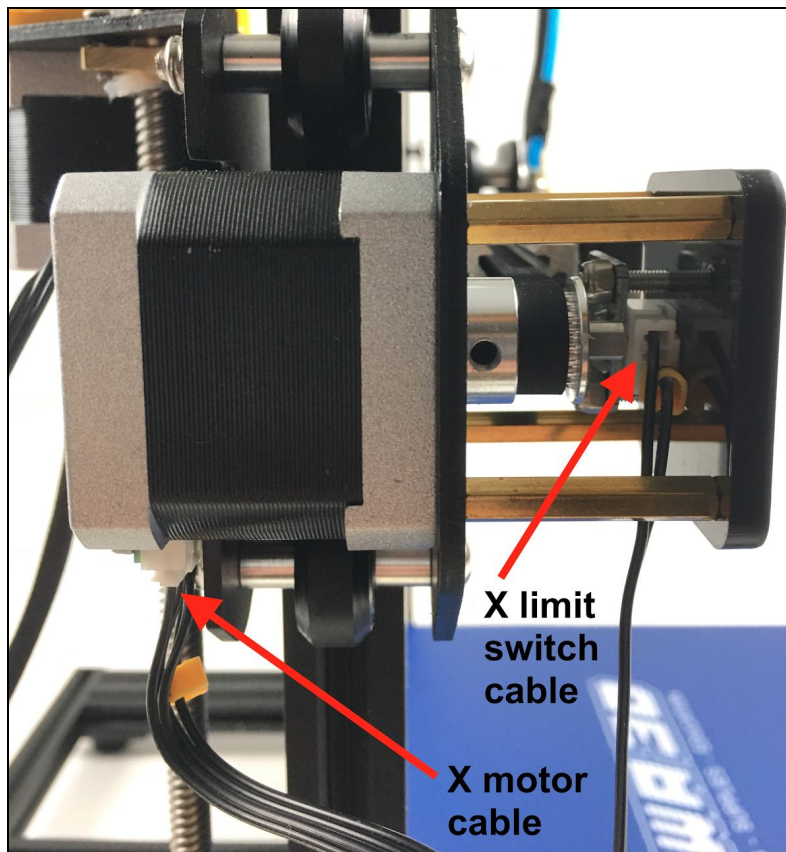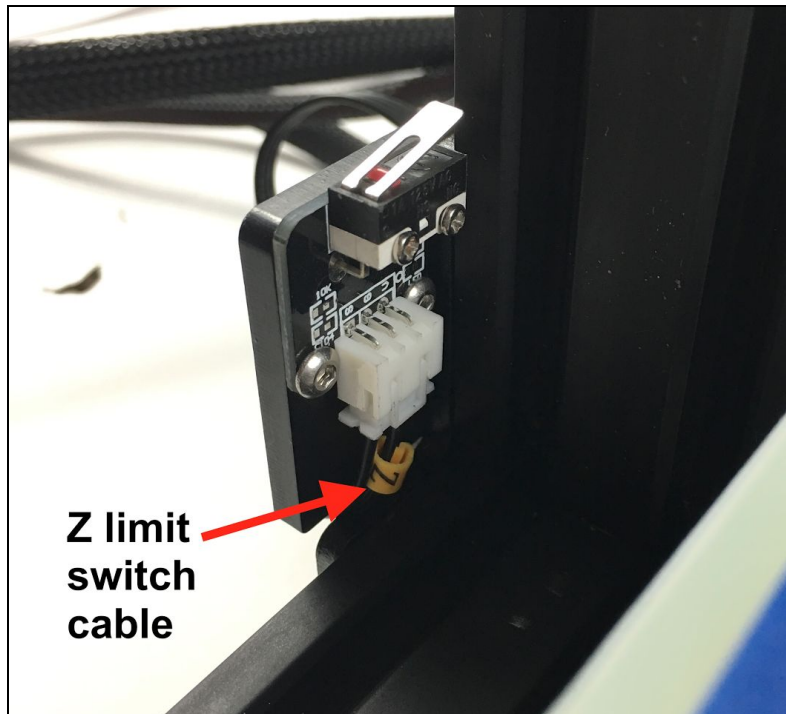
d. Connect the power cord to the back of the power & control box and to a standard 110-volt electrical outlet.
e. Turn the power on using the switch is on the back of the power & control box.
f. To operate the controls, rotate the button to scroll and push the button to select.

3. Fine Tuning

1. Adjust the tension of the build plate assembly on the Y-axis on the base frame.
   a. Check the tension of the build plate assembly. Hold the build plate carriage under the build plate and try to wiggle it left and right. If the build plate assembly wiggles back and forth on the Y-axis frame, it is too loose.
   b. To tighten the build plate assembly, rotate the three eccentric nuts that connect the three wheels to the right side of the build plate assembly. Use the open-end wrench to rotate the nuts slightly—a quarter turn is usually enough—until each of the three wheels is tight against the Y-axis frame and the carriage no longer rotates.

   c. Re-check the tension of the build plate assembly. The assembly and the belt should move forward and backward without much effort, but there should have no side-to-side wiggle or play.
2. Adjust the tension of the gantry on the right pillar of the gantry frame.
   a. Check the tension of the gantry assembly at the right pillar of the frame. Hold the gantry and try to wiggle it up and down. If the gantry wobbles on the right pillar frame, it is too loose.
   b. To tighten the gantry, rotate the one eccentric nut that connects the wheel to the inside of the gantry. Use the open-end wrench to rotate the nut slightly—a quarter turn is usually enough—until the wheel is snug against the frame pillar and the gantry no longer wobbles.
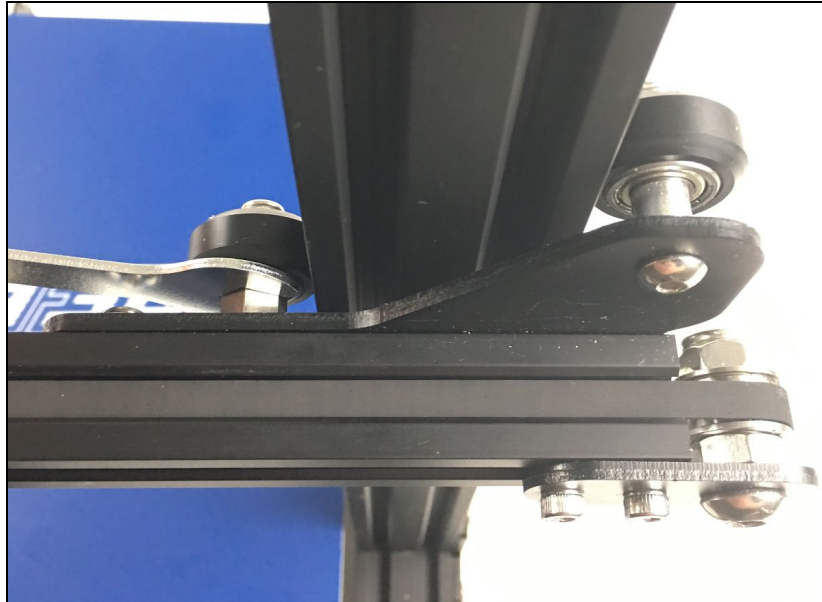
    c. Re-check the tension of the gantry by rotating the leadscrew. The gantry should move up and down smoothly, and there should be no wobble, play, or "chatter" on the right side of the gantry.

3. Adjust the tension of the nozzle assembly on the X-axis on the gantry frame.

    a. Check the tension of the nozzle assembly. Hold the mounting bracket behind the nozzle and try to wiggle it back and forth. If the nozzle assembly wobbles on the X-axis frame, it is too loose.

    b. To tighten the nozzle assembly, rotate the one eccentric nut that connects the wheel to the bottom of the nozzle assembly. Use the open-end wrench to rotate the nut slightly—a quarter turn is usually enough—until the wheel is tight against the X-axis frame and the assembly no longer wobbles.
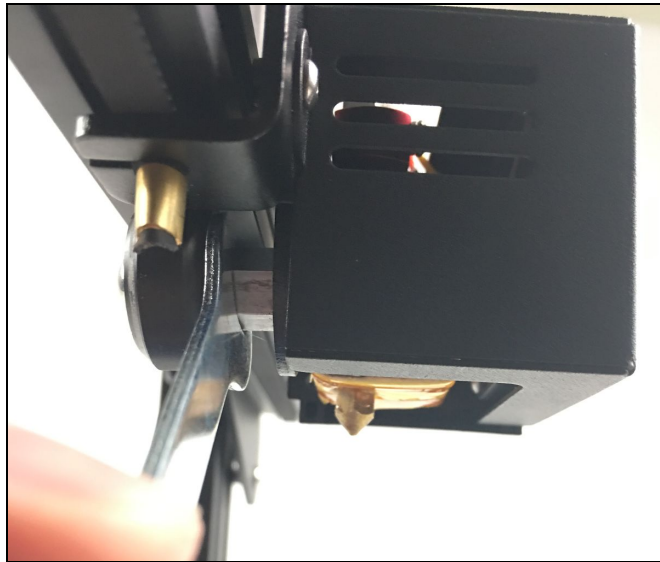
    c. Re-check the tension of the nozzle assembly. The assembly and the belt should move left and right without much effort, but there should have no side-to-side wiggle or play.

4. Check the tension of the belt driving the Y-axis (under the build plate). The belt should be taut, with no slack or slop. If the belt is loose:

    a. Loosen the four bolts at the front of the base frame holding the belt follower pulley to the base frame.

    b. Using an Allen wrench as a lever, push the follower pulley away from the frame to tighten the belt.

    c. Holding the belt taut, tighten the four bolts.
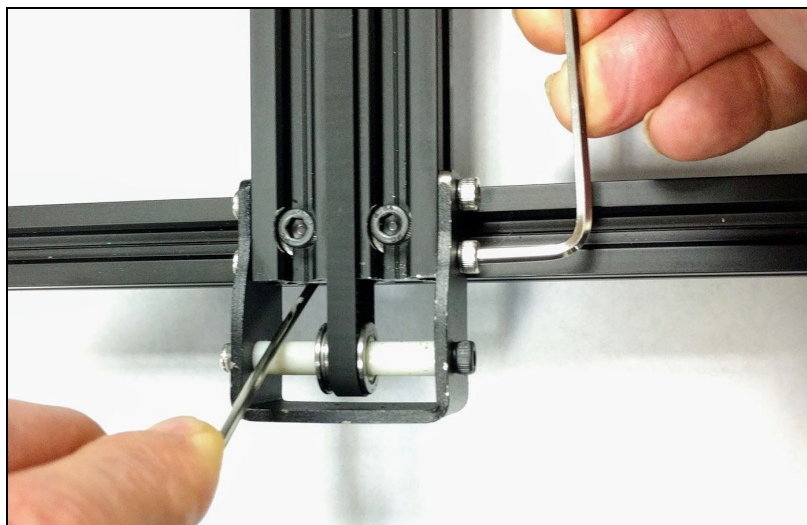
5. Check the tension of the belt driving the X-axis (on the gantry). The belt should be taut, with no slack or slop. If the belt is loose:

   a. Loosen the two bolts at the right side of the gantry holding the belt follower pulley to the gantry.

   b. Using an Allen wrench as a lever, push the follower pulley to tighten the belt.

   c. Holding the belt taut, tighten the two bolts.
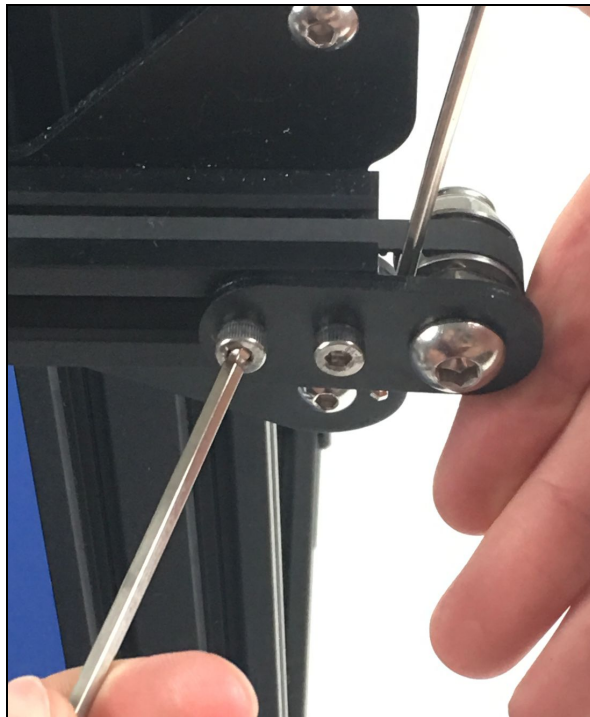
4. Leveling the Build Plate

Video Tutorial: <u>How to level the build plate</u>

To 3D print good parts, the build plate needs to be level and at the correct distance from the nozzle. If it's too close to the nozzle, the nozzle will dig into the build surface, or the melted plastic will not be able to come out of the nozzle. If it's too far from the nozzle, the part will not stick to the build surface or will warp.
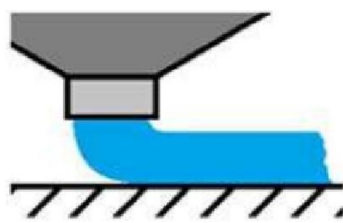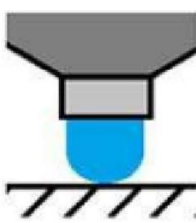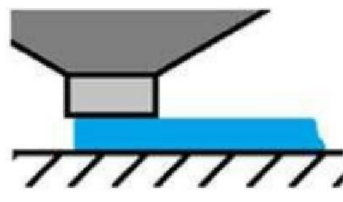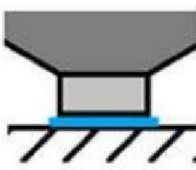
If you use blue painter's tape as your print surface, the nozzle needs to be about 0.10mm from the build plate in all locations. This is about the thickness of a single sheet of copier paper. If you use a LokBuild print surface, the nozzle needs to be about 0.20–0.25mm from the build plate in all locations. This is about the thickness of two sheets of copier paper (or one sheet folded in half to double its thickness).

You want to adjust the height of the build plate so that you can slide the paper between the nozzle and the build plate with some resistance. You should feel the paper vibrating and dragging when you move it between the nozzle, but not so close that the copier paper buckles.

1. Select Setup > Auto home. This will move the nozzle to the home position at the front left corner of the build plate, where the X, Y, and Z axis are set to 0,0,0.
2. When the motors stop, select Setup > Disable motors. This will allow you to move the hot end of the extruder assembly (X axis) and build plate (Y axis) by hand.
   > **Pro Tip:** The Z axis motor is also disabled, and you don't want it to move at all. So you should handle the printer gently during the leveling process. Keep it on a flat surface and move the nozzle assembly carefully.
3. For painter's tape print surfaces, slide a piece of copier paper between the nozzle and the build plate. For LokBuild print surfaces, first fold the paper in half to double its thickness, then slide it between the nozzle and build plate.
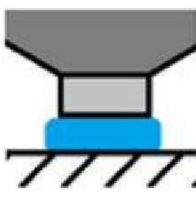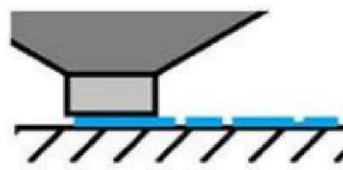4. Move the hot end (X axis) and build plate (Y axis) so that the nozzle is directly above one of the four adjustment nuts under the bed. Adjust the nut until the paper slides with just a tiny bit of drag, then move the nozzle and repeat the process at the other three nut locations.
5. Repeat Steps 1–4 until the amount of tension on the paper is consistent at all locations, including the center of the build plate.
6. The first layer of the print will show whether the distance between the nozzle and build plate is correct. Refer to the following graphic for clarity.

a. If the bed is too high, the extruded plastic will squeeze out the sides of the nozzle. The nozzle will plow the plastic and leave a first layer that is too thin. Or it may be so close that no plastic is extruded at all.

b. If the bed is too low, the extruded plastic may not stick to the build plate. Even if it does stick to the build plate, parallel lines of filament on the first layer will look mounded, with gaps in between them.

Pro Tip: You can "Hot Level" your printer by carefully adjusting the nuts during the first layer of the build while the plate is moving until the distance between the build plate and the nozzle is producing smooth extruded lines. Be careful of the moving parts to not get pinched. After you have fine-tuned the bed level during the first layer, you may want to stop the build, clear the build plate, and restart the build so it will look better on the bottom.

5. **Loading and Removing Filament**

Video Tutorial: <u>How to remove clogs, load, and change filament</u>

1. Loading filament
   a. Load a spool of filament into the spool holder.
   b. Cut the end of the filament at an angle so the irregular melted plastic at the end doesn't cause a clog. It will also be easier to feed into the extruder and Bowden tube.
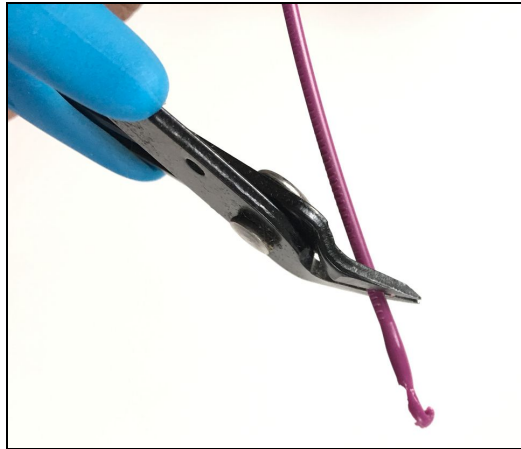
   c. Feed the end of the filament into the extruder by hand as you squeeze the extruder release lever.
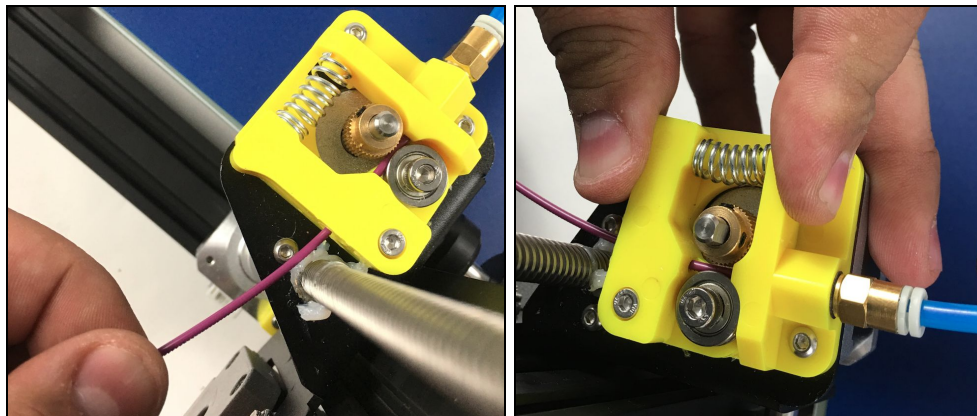
   d. Push the filament all the way through the Bowden tube until it stops when it hits the back of the nozzle.
   e. Select Setup > Preheat PLA.
   f. When the printer is fully heated, you may want to remove all of the

filament color left in the printer from previous prints before you start a new print. To do this, manually push filament through the extruder as you squeeze the extruder release lever until the new color starts coming out of the nozzle.

> **Pro Tip:** Never leave the printer preheated with material inside of it when it is not printing. The filament will bake inside of the nozzle assembly and create a clog.

2. Removing filament
   To remove the filament cleanly, you should do a "soft pull." This involves heating the nozzle to 100°C, and then pulling the filament out of the printer.
   a. Select Setup > Preheat soft pull and wait until the nozzle to reach the set temperature.
   b. Wait a minute for the temperature to become stable.
   c. When the nozzle temperature is a stable 100°C, squeeze the extruder release lever and pull the filament out of the extruder with a steady, firm motion.
   d. Cut the end of the filament to remove irregular melted plastic at the end.

   > **Pro Tip:** Feed the end of the filament roll into the hole on the side of the spool. This will insure it doesn't get tangled and cause a build to fail the next time you use it.

   e. Remove the filament from the filament spool holder.

6. Operation: The Four Steps of 3D Printing

3D printing involves these four steps:
1. Create a 3D file (Make)
2. Slice the file for 3D printing (Slice)
3. Send the file to the printer (Transfer)
4. Select the file on the printer (Print)

1. Create or find a 3D file

   a. You can create a 3D model—a digital geometry—using any CAD (computer-aided design) software program. We recommend free programs, such as TinkerCAD and OnShape. Autodesk's Fusion360 is free to students. Another is SketchUp, which has free licenses available for schools. These programs take some time to learn, and can be challenging. But they are also rewarding, especially when you see your own creation being printed on your 3D printer!

      Every CAD program allows users to save or export digital files for 3D printing. You want to save your file as an STL file ("filename.stl"). The STL file is the standard file format for 3D printing. In some programs, it's as easy as the Save command. In others, you need to select the File > Export option, and choose the STL format. OBJ files can also be sliced and 3D printed.

   b. You can find 3D models in many online libraries of digital content. Thingiverse, GrabCAD, and Instructables are examples, and many other sites exist.

2. Slice the file for 3D printing

   Video Tutorial: How to set up Cura 3.1

   Slicing is the process of converting your 3D model into the layered print language your printer can understand, called G-Code. We recommend using free, open-source slicer programs. Our favorite slicers are Ultimaker Cura and Repetier Host. Both are free and easy to use. We've included Cura and its setup profile on your printer's SD card because it's easier for beginners. For beginning users, we recommend that you install Cura on a PC or Mac and use it to do your slicing.

   There are a lot of slicers that will create G-Code automatically for your printer. All you have to do is input the correct settings for your printer (using

the files we included), import your 3D model, and save the G-Code. It's that easy!

a. Install Ultimaker Cura on a PC or Mac (both the .exe and .dmg versions are included on your microSD card).
b. Open the Cura application. When it's opened for the first time, you'll see the "Add Printer" window. Select "Custom > Custom FDM machine." In the lower left, type "NWA3D A31" for the printer name, and then click the "Add Printer" button on the lower right.
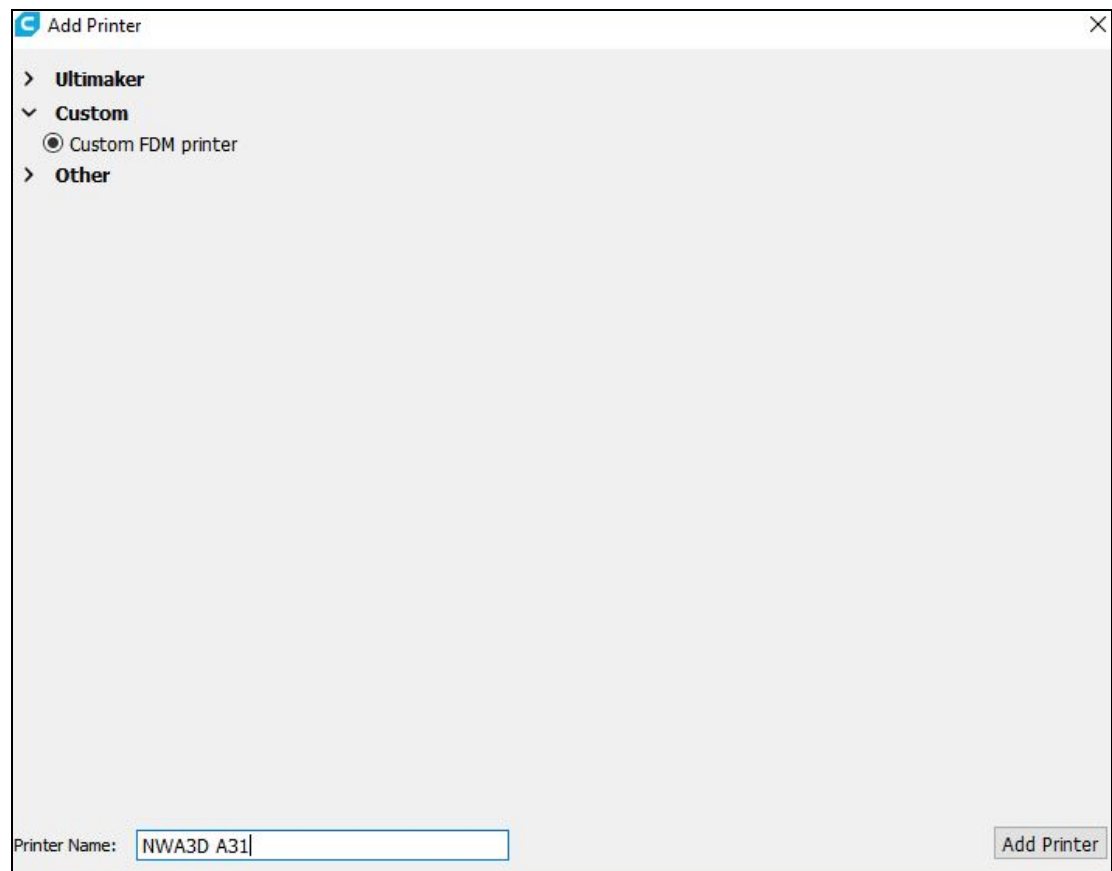
c. In the Machine Settings window, enter the following settings:
X (Width): 300 mm
Y (Depth): 300 mm
Z (Height): 400 mm
Build plate shape: Rectangular
Origin at center: unchecked
Heated bed: checked
GCode flavor: RepRap
Number of Extruders: 1
Material Diameter: 1.75 mm
Nozzle Diameter: 0.4 mm
Don't change any other settings. Click the "Finish" button at the bottom right of the window.
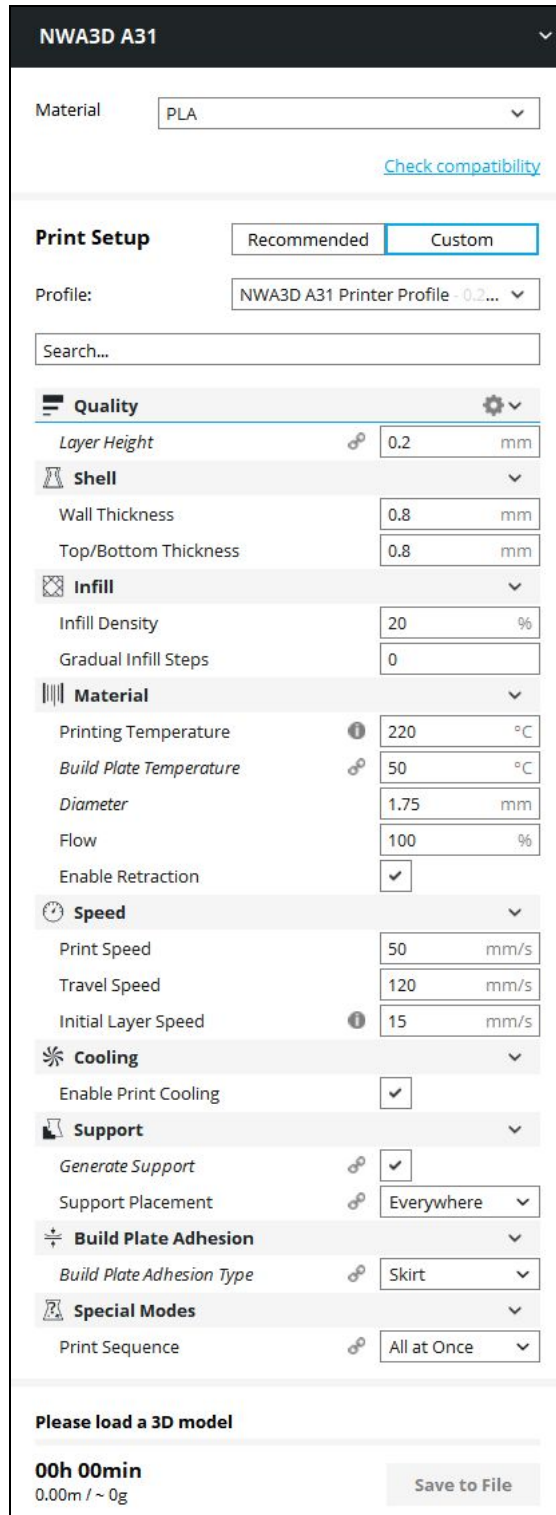
d. Select Settings > Profile > Manage Profiles. Then click on the Import button. Select "NWA3D A31 Printer Profile.curaprofile" from the microSD card. This is the medium-quality settings for the NWA3D A31. We recommend that you use this profile as your default. If you modify your Cura settings, you can always reload this profile from the microSD card to reset your profile to this default.
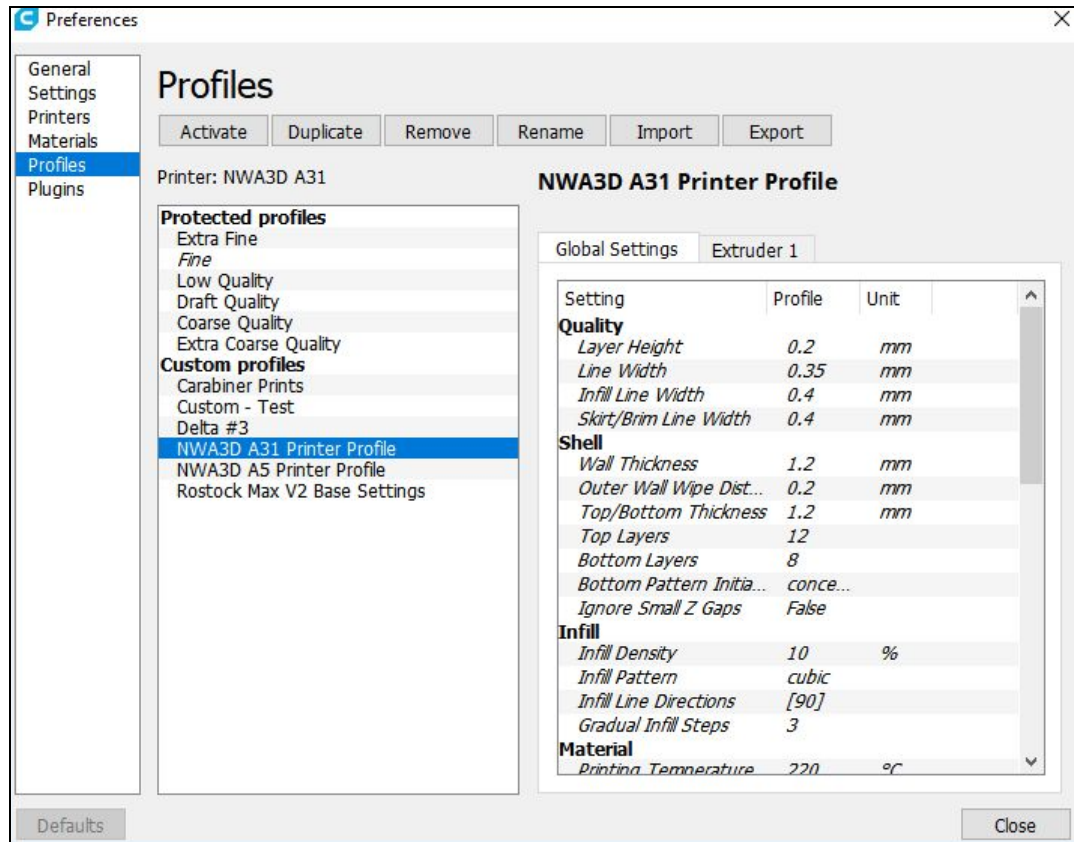
e. Here are the key Cura parameters for the NWA3D A31:

Layer Height	0.2mm	Wall Thickness	0.8mm
Top/Bottom Thickness	0.8mm	Infill Density	20%
Gradual Infill Steps	0	Printing Temp	220°C
Build Plate Temp	50°C	Diameter	1.75mm
Flow	100%	Enable Retraction	On
Print Speed	50mm/s	Travel Speed	120mm/s
Initial Layer Speed	15.0mm/s	Print Cooling	On
Generate Support	On	Support	Everywhere
Build Plate Adhesion	Skirt	Print Sequence	All at Once

f. The following images show these settings, visible with the default visibility settings in Cura. Initial Layer Speed is an advanced slice setting, activated by clicking the gear icon next to each input box.

g. The document "Complete Cura Settings for NWA3D A31.pdf" is included on the microSD card. Refer to it if you want to compare your settings. The images in that document show <u>all</u> the settings for the NWA3D A31 Cura profile. You can always reset your settings to the original default NWA3D A31 settings by importing the "NWA3D A31 Printer Profile" from the microSD card.

h. You may need to check "Generate Support" and select the "Everywhere" support placement, depending on the shape of the part you are printing. Also, you can change the layer height from 0.2mm to 0.1mm for a smoother, higher quality part, although the print will take longer.

i. As you become more advanced with 3D printing, you may want to experiment with many settings. Remember that you can always revert to these default settings at any time by reloading the "NWA3D A31 Printer Profile.curaprofile" on your microSD card, or ask us for help by filling out a <u>Troubleshooting Request</u>.

j. Load a model file in Cura. Rotate and move the file to the best orientation for printing. You may want to scale the file at this point as well.

Scale Tool:
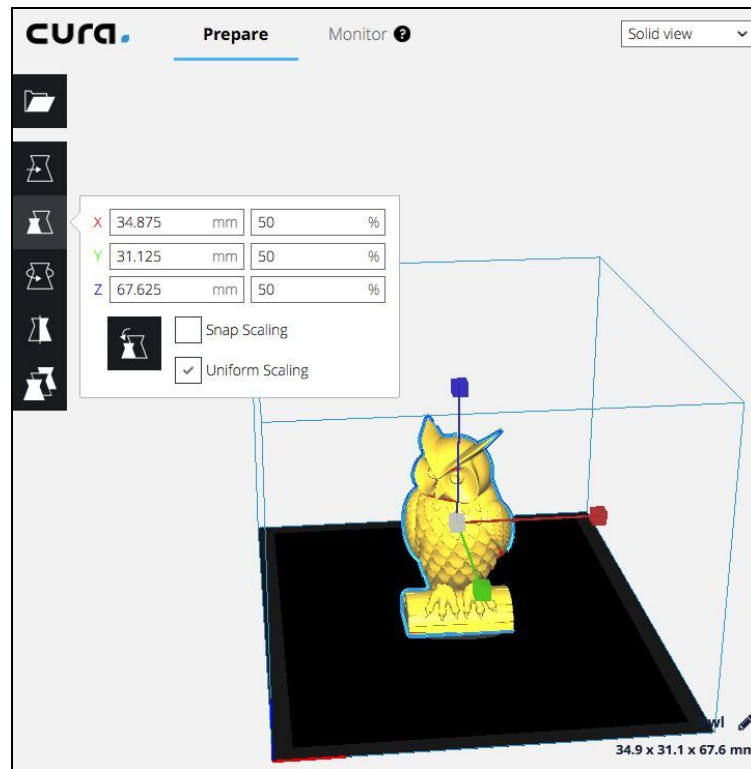
Rotate Tool:
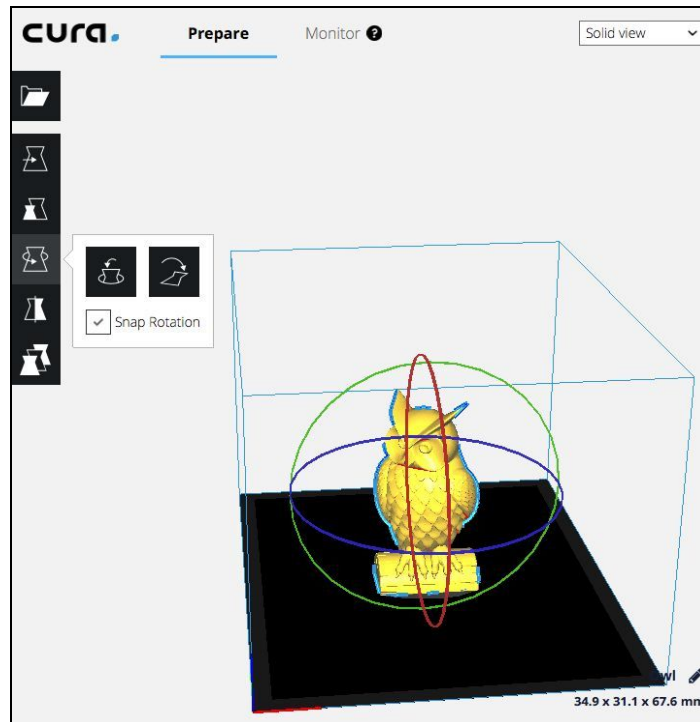
k. When you are satisfied with the Cura settings and the position, orientation, and scale of the model, you are ready to print! Insert your microSD card that came with your printer into your computer and select "Save to Removable Drive" to save the file to the microSD card.

Pro Tip: You can also save the file to the computer by selecting "Save to File" or connect your printer to your computer and print over USB using the "Monitor" feature.

3. Send the file to the printer
    a. Remove the microSD card from the computer.
    b. Insert the microSD card, upside down, into the slot on the side of the A31 control box. The contacts on the card should be facing up.
    c. By using this method, no computer needs to be plugged into your printer and it will run autonomously until the print is finished.

4. Print!
    a. On the NWA3D A31 control screen, select Refresh SD card (the last selection on the bottom of the main screen). and select "Print from SD."
    b. Select your print (.Gcode) file.
    c. Watch the 3D printer create your model!

6. Troubleshooting

This section covers the most common printing problems and how to fix them. Because 3D printing is still an emerging technology, a small level of tinkering and troubleshooting is needed. But if this section doesn't solve your printing problems, then contact us by filling out the Troubleshooting Request on our website. We're here to help you every step of the way to get you 3D printing!

1. Step-by-Step Troubleshooting
   a. Step 1: Diagnose the problem.
      This may seem obvious, but many problems can be solved if you take a step back and see exactly what the printer is doing incorrectly.
   b. Step 2: Determine if the problem is mechanical or digital.
      - Mechanical problems are in the actual operation of the printer, such as the motors that drive the X, Y, and Z axes, the motor that pushes the filament, the nozzle heater, and the level of the build plate. The most common mechanical problems are caused by a build plate that is not adjusted correctly, a clogged nozzle, or an unplugged connector on a motor or limit switch.
      - Digital problems are in the slice file that you prepare in Cura or other slicing program. Important slice file settings include layer height, print (nozzle) temperature, and print speed.
   c. Step 3: Fix the problem.
      Once you've discovered what the actual problem is, you can fix it with the following procedures. (If none of these fix the problem, contact us!)

2. Mechanical problem #1: Leveling the build plate

   Video Tutorial: How to level the build plate

   a. If the nozzle is digging into the build plate or is so close that no filament can extrude, you'll know the build plate is too close.
   b. If your print looks like spaghetti or the nozzle knocked the model off of the build plate, then you'll know the build plate is too far away.
   c. Many of the failures in 3D printing are caused by a build plate that is not level or is not the correct distance from the nozzle. See the section "Leveling the Build Plate" in this manual.

3. Mechanical problem #2: Filament is not coming out of the nozzle

Video Tutorial: How to remove clogs, load, and change filament

When filament is not coming out of the nozzle, the nozzle may be clogged. You have three good options for clearing a clogged nozzle:
1. You can pull the clog out of the nozzle using the "soft pull" method.
2. You can "floss" the clog out of the nozzle using a nozzle cleaner.
3. You can heat the nozzle and push the clog through the nozzle.

Pro Tip: Do NOT remove the nozzle or disassemble the hot end of the printer when you have a clog. Instead, try these three options. If they don't fix the problem, complete a troubleshooting request and our Service Team will help you.

Pro Tip #2: Never leave your printer nozzle at build temperature (220°C) while the printer is idle. The melted plastic remaining in the nozzle will "bake" onto the nozzle and become a hard carbon blockage.

a. Try to pull the clog out of the nozzle using the "soft pull" method:
1. Turn the machine on, select Setup > Preheat soft pull, and wait until the temperature reaches 100°C.
2. When the nozzle temperature stabilizes at 100°C, squeeze the extruder release lever with one hand and pull the filament out of the extruder with your other hand with a steady, even force.
3. Inspect the end of the filament. If the end of the filament has the shape of interior of the nozzle—a thicker cone-shaped plug—you have successfully pulled all of the filament out of the nozzle, including the clog.
4. If the clog did not clear using the "soft pull" method, clip the melted end of the filament off, reload it, and select Setup > Cooldown and wait five minutes for the hot end to cool down. Then repeat the soft pull process.

Pro Tip: Every time you change filament on your 3D printer, remove the filament with the nozzle at around 100°C. This "soft pull" method usually removes all the old color of filament from the hot end, so when you begin printing again, the new color will begin printing immediately.

b. Use a nozzle cleaner to clear the nozzle:
   1. Remove the filament using the "soft pull" method.
   2. Select Setup > Preheat PLA. Wait for the nozzle to reach the set temperature of 220°C for PLA.
   3. Raise the Z axis carriage by selecting Controls > Move axis > Move 1mm > Move Z and spinning the knob. (You can also manually rotate the leadscrew to move the gantry up.)
   4. When the nozzle has reached 220°C, use pliers to carefully insert the nozzle cleaner up into the tip of the nozzle. IT IS VERY HOT, SO BE CAREFUL NOT TO BURN YOURSELF!
   5. Squeeze the extruder release lever with one hand and push the filament into the extruder manually.
   6. Alternate "flossing" with the nozzle cleaner and pushing the filament through the extruder until a consistent bead of filament is extruded through the nozzle.

c. Try to push the clog through the nozzle:
   1. Select Setup > Preheat PLA. Wait for the nozzle to reach the set temperature of 220°C for PLA.
   2. When the nozzle has reached 220°C, squeeze the extruder release lever and load the filament. When the filament would normally stop, keep pushing to manually push the filament out of the hot end nozzle of the extruder assembly.
   3. Watch the filament to ensure it is not curling as it comes out of the nozzle. After pushing several inches of filament through, it should be going relatively straight. If it isn't, turn off the printer and do another soft pull (step a).

4. Digital problems: Slicer settings

Video Tutorial : [How to set up Cura 3.1](#)

Sometimes, models don't print correctly because the settings in the G-Code are wrong. Here are some steps to make sure your Cura settings are correct.

a. Check your slice file in Cura. Make sure the print is centered in the build area, is making good contact with the build surface, and isn't too big for the build envelope.
b. Check the slice settings.
   ● Make sure that the layer height is between 0.1mm (high-quality prints) and 0.3mm (low-quality prints).
   ● Check the speed and temperature. For PLA, they should be set to 30–50mm/s and 220°C.
   ● Make sure the filament diameter is 1.75mm and the flow rate is 100%.
   ● Check the Fill Density (infill) and make sure it is at least 5%. You may need to adjust this value to your liking for your model.
   ● Refer back to the "Operation" section of this manual for other slicer settings and to better understand Cura.
c. Your part may need supports. If it's rounded you may need to select "Everywhere" for the support type. If it's intricate, it may need to select "Raft" for the Build Plate Adhesion Type. (A raft is a hatch pattern on the build plate that the model will print on.) If the part warps when you begin to build it, you may need to select the "Brim" adhesion type and reslice the file. (A brim will help the part stick so it doesn't curl up at the edges.)
d. If you think your slice settings are really messed up, try re-loading the file "NWA3D A31 Printer Profile.curaprofile" from the microSD card. The profile will restore the slicer settings to a medium-quality profile that will work well. Click Settings > Profile > Manage profiles. In the Profiles Preferences window, click on the Import button, navigate to the printer profile "NWA3D A31 Printer Profile.curaprofile" that came on the microSD card in the Cura folder, and open it. Your slice and build parameters are now reset to our default settings for the NWA3D A31.

8. Glossary of 3D Printing Terms

3D
Three-dimensional

3D Printing
The process of creating a three-dimensional object from a digital file. Usually, it is achieved by stacking two-dimensional layers of material to form a physical 3D object. There are many different 3D printing processes that use many different materials, but the most common process is material extrusion—also known as Fused Deposition Modeling and Fused Filament Fabrication—which uses thermoplastic filament. Also known as additive manufacturing.

3D Printer
It's basically a crazy robotic hot glue gun! A type of industrial robot that prints three-dimensional objects from a digital source. This machine usually reads g-code files that give it specific instructions on how to print an object. Examples include the A5, A31, and all the other awesome printers we carry.

3D Design Program
A type of software used to visualize, design, and manipulate 3D products while providing a test environment for strength and dynamic analysis. Also known as a Computer Aided Design (CAD) program or 3D Modeling Software. Free examples for educators include Autodesk Inventor, Fusion360, SketchUp, Onshape, and Tinkercad.

3D Modeler
A type of multimedia artist or animator who creates three-dimensional models or visuals of items using a variety of different computer software programs and tools. Also, a program used to manipulate 3D shapes to create objects for animation or production.

A5
The A5 is an open source material extrusion 3D printer design that prints 125 x 150 x 100mm. NWA3D heavily modifies this original design to meet the rigorous classroom environment and calls the version an NWA3D A5. We build, modify, and test every printer. We are the sole-source provider of the NWA3D A5.

Changes include hardware upgrades, custom operating system, and our unmatched warranty, lifetime training, and support for educators.

A31
The A31 is an open source material extrusion 3D printer design that prints 300 x 300 x 400mm. NWA3D modifies the original design to meet the rigorous classroom environment and calls the version an NWA3D A31. We build, modify, and test every printer. We are the sole-source provider of the NWA3D A31. Changes include hardware upgrades, custom operating system, and our unmatched warranty, lifetime training, and support for educators.

ABS
Stands for Acrylonitrile Butadiene Styrene, which is a thermoplastic used for 3D printing. ABS is a common form of plastic found in most household items that were injection molded.

Additive Manufacturing
The process of creating an object from a digital file by stacking 2D layers to form a 3D object. Also called 3D printing. *see also* 3D Printing

Axis Binding
A problem associated with the X-, Y-, or Z-axis on a printer, in which the axis is unable to move freely or perform a given movement.

Belt
Toothed gear belt that is used to transfer movement.

Bridging
Bridging occurs in a 3D print when filament is extended across an open area without supports. The distance a print can bridge is determined by the hardware capabilities of the printer and the slicer settings.

Brim
A platform adhesion option whose function is to reduce shrinkage of bottom print layers or better adhere a low surface area object by providing a larger base platform.

Build Plate
The surface where the printer deposits the materials used for printing. Also known as the Print Bed. *see also* Print Bed

Bowden Extruder
An extruder assembly used pushing filament that uses a tube to feed the filament from the motor to heated areas. This type of extruder assembly reduces heat transfer to filament pressure point, thereby reducing plastic buildup and clogs.

CAD
Computer Aided Design or CAD is the process of digitally designing 3D models. *see also* CAM

Calibration
The act or process of adjusting a device or instrument to perform correctly or more efficiently.

CAM
Computer Aided Manufacturing or CAM is the process using digital programs and/or CAD to physically manufacture objects through additive or subtractive manufacturing.

Carriage
The moving assembly that holds the nozzle and hot end of the of the extruder.

CNC
A Computer Numerical Control machine, or CNC, a a machine that uses subtractive manufacturing to create 3D objects. *see also* Subtractive Manufacturing

Control Screen
LCD screen that displays information and provides an interface to select settings and manipulate the printer.

Cooldown
The process of cooling down the hot end. Cooldown occurs automatically after a print is finished, or can be done manually after changing filament to to prevent

filament baking and clogs. Can be controlled using the Control Screen or turning off the 3D printer.

Cura
A 3D printer slicing software. Utilized to transform 3D models into a X, Y, and Z coordinate language called g-code in ".gcode" format.

Endstop
Mechanical switches that indicate where the "home" or "zero" position is on each print axis. *see also* Limit Switch

Extrude
The act of dispensing build material onto the build platform through a small nozzle commonly referred to as a "hot end."

Extruder
The assembly that handles feeding and extruding filament during a print. The extruder has two parts: the stepper motor and feeding system that pushes the material into the printer, and a hot end that heats and extrudes the material through a nozzle onto the build surface.

Extruder Fan
Fan that cools the heat sink of the extruder.

Extruder Motor
Stepper motor of the extruder assembly.

Extruder Nozzle
A brass or steel funnel-shaped die through which melted plastic is extruded.

Extruder Release Lever
The trigger lever that applies pressure to the extruder gear, which forces filament to flow into the Bowden tube of the extruder to the hot end.

Extrusion Multiplier
A percentage value associated with the flow rate of plastic extrusion. The flow rate can be manipulated by adjusting this multiplier.

Filament

Typically a thermoplastic formed into a continuous wire and wound onto a spool so it is compatible with a 3D printer's extrusion system. *see also* ABS, PLA, TPU

Filament Diameter

The size designation of a roll of filament. Usually 1.75mm or 3mm/2.85mm (3mm and 2.85mm are in the same size filament category are used interchangeably in 3mm and 2.85mm material extrusion 3D printers).

Fill

The area within a 3D-printed object that connects the top, bottom, and side layers. *See also* Infill

Fill Density

A percentage value that determines how much of the interior volume of a 3D-printed object is filled with material. This value can range from 0–100%, recommended is 5–25%.

Flow

The action of filament moving in a steady continuous stream. *see also* Extrusion Multiplier

Fused Deposition Modeling (FDM)

FDM is another name for material extrusion and FFF. It is a trade name created by Stratasys, the company that invented and first commercialized the material extrusion process. *see also* FFF, Material Extrusion

Fused Filament Fabrication (FFF)

FFF is another name for material extrusion and FDM. *see also* FDM, Material Extrusion

Gantry

The part of the extruder assembly and X-axis motor that moves up and down on the Z-axis of a 3D printer. *see also* Z-Axis Carriage

G-code
Coding language that the 3D printer understands. It is used to transmit instructions to a 3D printer's control system to tell the printer how to print the 3D model. *see also* Cura, Slicer

Heated Build Plate / Heated Print Bed
The heated surface where the printer deposits the material used for printing. A heated bed can help reduce warping on large prints and help adhere parts better.

HIPS
High Impact Polystyrene (HIPS) is a thermoplastic used as a 3D printing material that can be dissolved using limonene and therefore used for dissolvable supports on delicate prints.

Hot End
The heated portion of the extruder assembly that includes the nozzle and heating block.

Infill
The area within a 3D-printed object that connects top, bottom, and side layers. This creates a rigid structure and determines print durability.

Kapton Tape
Heat-resistant polyimide adhesive tape typically used to secure wiring and insulate the hot end of the extruder.

Layer
Extruded plastic of a closed loop, represented as a two-dimensional drawing on the X-Y plane. When replicated over again in the Z direction, it produces a 3D object or multi-layered X-Y drawing. *see also* Layer Height

Layer Height
Utmost determinant of quality for 3D printing, it defines the distance between lines of extruded plastic in the Z-direction. Material extrusion 3D printers typically print layers between 0.1mm and 0.3mm high. A lower layer height

translates to a smoother, higher quality print. A higher layer height translates into a faster, low quality print.

Limit Switch

Mechanical switch that indicates where the "home" or "zero" position is on each print axis. *see also* Endstop

Material Extrusion

A 3D printing process that dispenses material through a nozzle or orifice. Also known as FFF or FDM. *see also* FDM, FFF

Minimal Layer Time

The least amount of time required of the printer to maintain action on any layer of a printed object for the filament to sufficiently cool before fusing a layer on top if it.

Mesh

A collection of polygons attached by edges and vertices that makes up a net-like surface area in CAD.

Motor

In 3D printing, the stepper motor that produces precise movement of the extruder, X-, Y-, or Z-axis. *see also* Stepper

Nozzle

A brass or steel funnel-shaped die through which melted plastic is extruded. *see also* Extruder Nozzle, Hot End

OBJ

OBJ stands for Object File, an alternative to the STL file format. OBJ (.obj) files store object exterior pattern and color.

PLA

Polylactic Acid (PLA) is a biodegradable thermoplastic polymer derived from the starch in plants (normally corn) that is used for 3D printing.

Perimeter

A continuous line forming the boundary of a closed geometric figure. In 3D printing, the perimeter is created by the edges of every layer. *see also* Shell

Preheat
Heating prior to using the device or tool. In 3D printing, the nozzle needs to be preheated before printing or for loading and unloading filament.

Print Bed
The surface where the printer deposits the materials used for printing. Also known as the build plate. *see also* Build Plate

Print Speed
The rate at which a 3D printer is capable of moving while extruding plastic. A print speed of 50mm/s will be successful on most FDM printers. A print speed of 20–30mm/s will produce higher quality prints.

Print Quality
Refers to the quality of the print and is determined by many factors including mechanical capabilities of the printer, slicer used, layer height, print speed, support, and print orientation.

Printing Temperature
The temperature of the hot end at which the filament is melted and extruded.

PVA
Polyvinyl Alcohol (PVA) is a water soluble plastic that is a common ingredient in standard wood glue. It can be used in 3D printing to print dissolvable supports.

Raft
A platform adhesion option in which several layers of printed material are deposited on the build surface to smooth out any irregularities in the build surface and help prevent warping in the model being printed on top of the raft. A raft also helps with bed adhesion of delicate models.

RepRap
An open source 3D printing project, started in 2005, to create the best desktop printers and to make them capable of duplicating themselves.

Repetier Host
An open source slicer program, used for the preparation of STL files prior to 3D printing. Allows manipulation of files prior to printing; rotating, scaling, and duplication.

Resolution
The smallest movement a printer's extruder can make within a single X-Y layer. Often indicates the produced quality of a printed model.

Retraction
Backwards movement of an extruder motor to reduce the amount of material stringing or oozing.

SD Card
A non-volatile memory card for use in portable devices to transfer information, such as .gcode to 3D printers.

Seam
The point at which two layers of 3D-printed material connect.

Shell
The sidewalls of a 3D printed model, created by the exterior edges of every layer. *see also* Perimeter

Shell Thickness
The total width of an outside wall of a 3D-printed part. Shell thickness should be a multiple of nozzle size. Two shells is typically best. An increased number of shells will lead to a stronger model. *see also* Shell

Skirt
A platform adhesion option that extrudes an offset outline of the model on the first layer of the print. The skirt helps to remove unwanted colors and build pressure for material extrusion. It also checks the accuracy of bed leveling.

Slice
The action of changing a model file (STL, OBJ, etc.) into a a G-code file. The coordinate type can vary depending upon setting selection. The most common type uses cartesian coordinates on an XYZ plane. *see also* Slicer

Slicer
A type of program, such as Cura or Repetier Host, that allows manipulation of a 3D model and converts the file type into a coordinate system (usually .gcode) the printer follows to create a model. *see also* Cura, Repetier Host

Soft Pull/Soft Removal
The process of heating filament to the phase transition temperature (solid to liquid) and removing it from the extruder assembly. The process helps to remove unwanted material and can assist in the removal of nozzle blockage. NWA3D recommends to always remove filament using the soft pull method as preventive maintenance for your 3D printer.

Stepper/Stepper Motor
An electric motor that moves in discrete movements, or steps, to allow more precise regulation of its movement. *see also* Motor

STL
The STL file format (STL stands for stereolithography) is the recommended file format for 3D models for 3D printing. The filetype contains the best mesh for solid 3D-printed objects. *see also* Mesh

Support
Additional removable structures that are printed to support overhangs or other parts of a model that do not make contact with the build plate during printing.

Subtractive Manufacturing
Manufacturing techniques that remove material to create an object. Common types are CNC routing and laser cutting.

Tension Arm
Arm that presses the filament into the gear of the extruder motor. *see also* Extruder Lever

TPU
Thermoplastic urethane (TPU) is a semi-flexible plastic that is used in 3D printing.

Travel Speed
The rate at which the nozzle assembly will move to a new position when not extruding.

USB Connection
USB, short for Universal Serial Bus, is a connection type to send files from a slicer on a computer to a 3D printer via a USB cable.

Viscosity
A measure of a fluid's resistance to flow. The higher the viscosity, the more resistant the fluid is to flowing.

Vitamin
A part for a 3D printer or 3D printing project that isn't 3D printable.

X-Axis
The principal or horizontal axis of a system of coordinates.

Y-Axis
The secondary or vertical axis of a system of coordinates.

Z-Axis
The axis in three-dimensional Cartesian coordinates which is usually oriented vertically.

Z-Lift
The process that a printer uses to lift the hot end upward prior to retraction and moving.

Z-Axis Carriage

The part of the extruder assembly and X-Axis motor that moves up and down on the Z-Axis of a 3D printer. *see also* Gantry

9. Additional Resources

nwa3d.com

NWA3D Troubleshooting Request

Video Tutorial: How to remove clogs, load, and change filament

Video Tutorial: How to level the build plate

Video Tutorial: How to set up Cura 3.1

The Simplify3D Troubleshooting page provides good explanations and photographs of common problems in 3D printing:
https://www.simplify3d.com/support/print-quality-troubleshooting/