TAKE HOME LABS
OKLAHOMA STATE UNIVERSITY

Introduction to 3D Printing

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1 OBJECTIVE

The objective of this experiment is to introduce you to 3D printing, by having you print some simple parts that will be used in later experiments. This introductory experiment should help you build your confidence for printing more complex parts. This experiment is described for a specific printer, but could be used with other printers with a few modifications.

2 SETUP

2.1 REQUIRED

2.1.1 HARDWARE

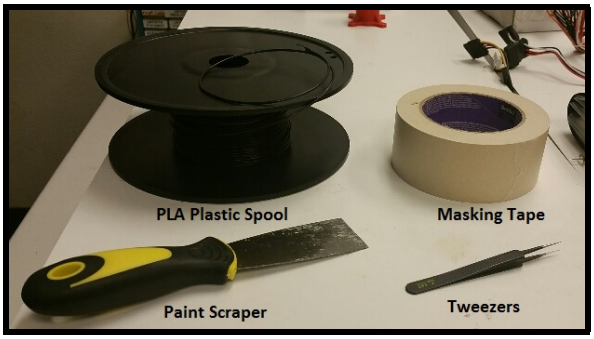


Figure 2.1: Hardware Required for *Introduction to 3D Printing* Experiment

Figure 2.2: Solidoodle SD4 3D Printer Required for *Introduction to 3D Printing* Experiment

- Solidoodle SD4 3D Printer
- PLA Plastic Spool
- Masking Tape (or painters tape)
- Paint Scraper
- Tweezers

2.1.2 Software

- Repetier Host V0.85b
- Windows 7

2.1.3 Previous Experiments

- This is an introductory experiment and does not require that any other experiments be performed first

2.2 Software Setup

2.2.1 Downloading Repetier Host

You can skip this section if the printer software is already available on your print server.

1. Download the file **setupRepetierHostSolidoodle_0_85_1.exe** from the take home labs*** website.

2. Double-click on the file and follow the setup instructions.

   NOTE: Follow the standard installation procedures. This would require clicking next for each prompt in the setup window until it says to click “Finish".

3. Double-click on the Repetier Host desktop icon  . If the Repetier Host page appears with no error, then the setup is complete. If you have errors, refer to the **http://www.repetier.com/tecl** page for Repetier Host support.

2.3 Hardware Setup

2.3.1 Power and USB for Solidoodle Printer

4. Obtain a power supply and USB B-to-A Convertor for the Solidoodle SD4 3D Printer.

   NOTE: If the power supply and USB cable is already plugged into your printer, you may skip this section.

5. Plug the power supply (barrel jack) into the Solidoodle 3D printer. Connect the plug side of the power connector into a wall outlet. If the light inside the Solidoodle printer does not come on, check to see that the power cable is connected correctly to the power socket.

6. Plug the USB-B connector into the back of the 3D printer (see Figure 2.3), and the USB-A connector into your computer’s serial port.

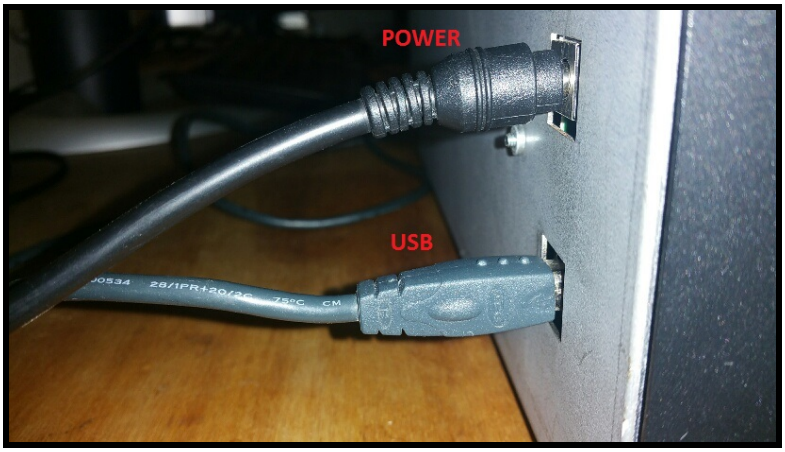


Figure 2.3: Tape Placed Length-Wise On Printer Surface

7. You have completed the power and USB connections for the Solidoodle 3D printer.

2.3.2 Placing Masking Tape On Printing Surface

8. Obtain masking tape or painters tape.
9. Take a piece (slightly longer than the length of the bed, in the direction coming from you, and going to the back of the printer) and rip it from the roll.
10. Place the piece of tape on the bed in the length-wise direction (see Figure 2.4).

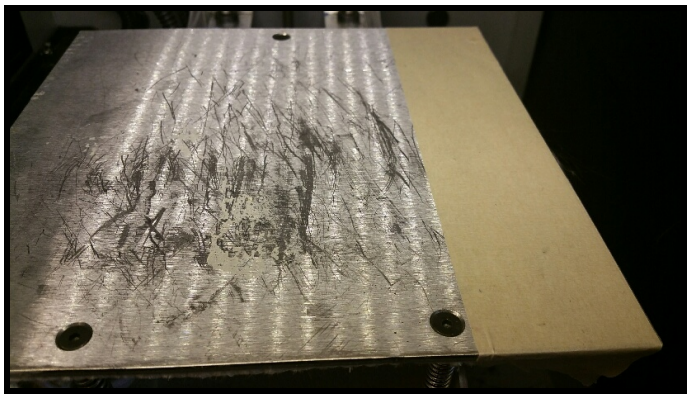
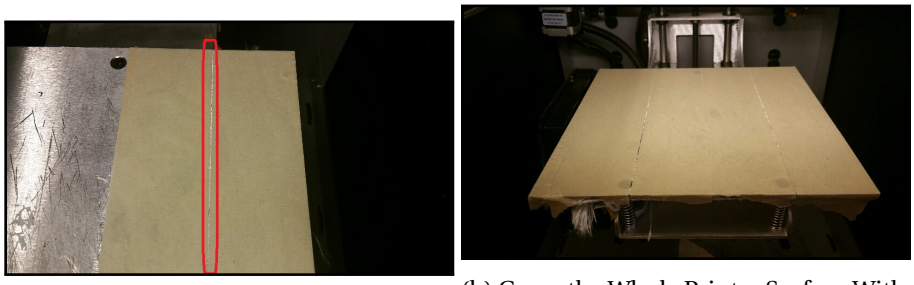


Figure 2.4: Tape Placed Length-Wise On Printer Surface

11. Cover the entirety of the printer surface with tape, leaving a gap between each strand, as shown in Figure 2.5.

12. The masking tape setup for the 3D printer is now complete.



(a) Leave Gap Between Tape Strands

(b) Cover the Whole Printer Surface With Tape

Figure 2.5: Cover Printer Surface With Tape

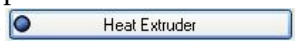
2.3.3 Placing Plastic Into Extruder (with no existing plastic in the nozzle)

13. Retrieve the PLA plastic spool.

14. Open **Repetier-HostV0.85b** by double-clicking on the icon  .

15. Once the Repetier Host program appears, click on 

in the upper left-hand corner of the screen. This will connect the Repetier Host program with the Solidoodle 3D printer.

16. Click on the tab labeled **Manual Control**. Once the GUI has appeared, scroll down until a bar labeled **Extruder 1** appears. Type “200" in the box to the right of the bar and press “Enter". Click on the **Heat Extruder** 

icon above.

17. Allow the Extruder to heat to 200 degrees Celsius. Once the text to the right of the **Extruder 1** button shows 200 degrees Celsius, proceed to the next step.

18. Feed the PLA plastic spool through the back opening of the Solidoodle printer.

(a) Feed PLA Plastic Into Printer (Close-up View)

(b) Feed PLA Plastic Into Printer (Side View)

Figure 2.6: Feed PLA Plastic Into Printer

19. Inside the 3D printer, pull the plastic through the hole further until it reaches the nozzle. Push the plastic through the top of the nozzle assembly until it touches the two disks. Make sure the plastic is on top of the grove between the two disks. Do not push it any further.

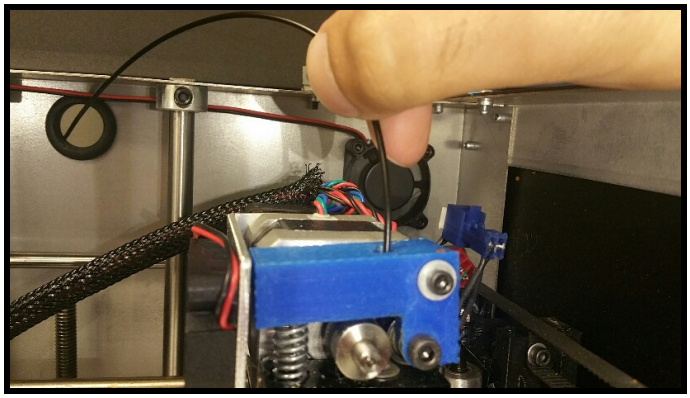


Figure 2.7: Put Plastic In Nozzle Assembly

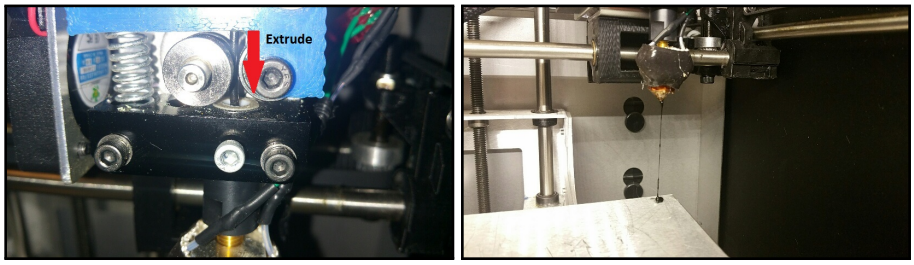
20. In the Repetier Host program, set the Speed [mm/min] as 100, the **Extrude [mm]** as 10, and the **Rertract [mm]** as 10. Click on the extrude icon (while pressing the plastic slightly into the nozzle), which is the down-arrow farthest to the right, shown in Figure 2.8.

Figure 2.8: Click Extrude

21. Continue clicking on the extrude button, waiting between each extrusion, until you begin to see the color of your plastic appear from the nozzle.

    NOTE: Click the extrude button a couple of more times after you begin to see plastic to ensure you have a clear stream of plastic coming through. Make sure that the plastic is between the two disks of the nozzle assembly the whole time you are extruding.

22. Remove the excess plastic from the nozzle and the printer area using tweezers.



(a) Extrude Direction (b) Plastic Appearing From Nozzle

Figure 2.9: Extruding Plastic Through the Nozzle

Figure 2.10: Remove Excess Plastic From Nozzle

23. You have completed the extruder setup for the Solidoodle 3D Printer. Skip to the **Experimental Procedures** section if you are satisfied with the plastic material currently in the nozzle. If you wish to retract out the material in the nozzle (especially old plastic,) continue to the next section.

2.3.4 Placing Plastic Into Extruder (with unwanted plastic in the nozzle)

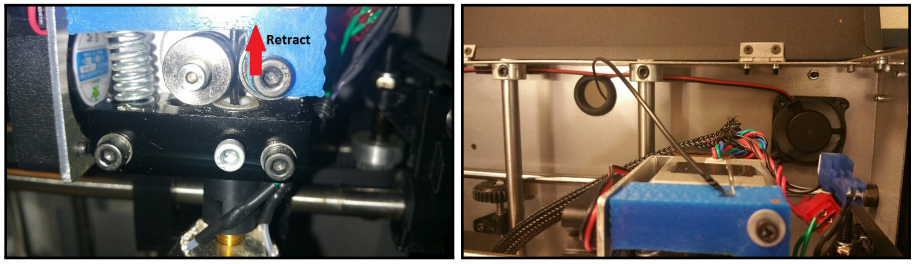
24. Repeat Steps 14-17.

    NOTE: If you are already connected to Repetier Host, start from the next step.

25. Hold on to the plastic coming out of the nozzle. While gently pulling on the plastic in the nozzle, click on the **Retract** button shown in Figure 2.11.

Figure 2.11: Click Extrude

26. Continue pulling and clicking retract until the plastic comes out of the nozzle.



(a) Retract Direction (b) Plastic Pulled From Nozzle

Figure 2.12: Retracting Plastic From the Nozzle

27. Once you have pulled the plastic from the nozzle, repeat steps 18 - 23.

    NOTE: With old plastic in the nozzle (especially when the color that you just retracted is different from what you wish to extrude into the nozzle) it will take a while to extrude all of the old plastic out. Repeat step 21 until the color of the plastic is the color of the plastic you are extruding through the nozzle.

28. You have completed the hardware setup for this experiment.

3 Experimental Procedures

3.1 Exercise 1: Adjusting Print Surface

3.1.1 Printing Bed Level Part

29. Download the **BedLevel.stl** file from the website.

30. Open Repetier Host and click **Load** 

in the upper left hand corner.

31. Navigate to the folder where **BedLevel.stl** is saved, click on it, and then click “Open" at the bottom right-hand corner of the window. The part should now be in the 3D Viewer (see Figure 3.1).

NOTE: The extruder should already be heated up to 200 degrees Celsius. If this is not the case, repeat step 16.

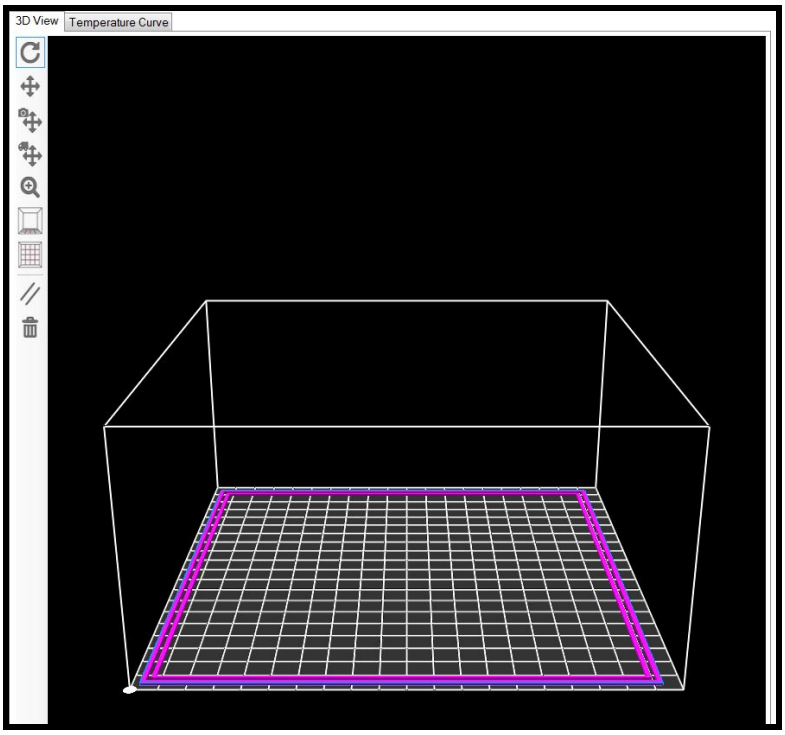


Figure 3.1: 3D View of BedLevel.stl Part

32. In the Repetier Host program, click on the tab labeled “Slicer" on the right hand side of the screen. Click on the **Configure** button on the top right hand corner of the Slicer tab window (see Figure 3.2).

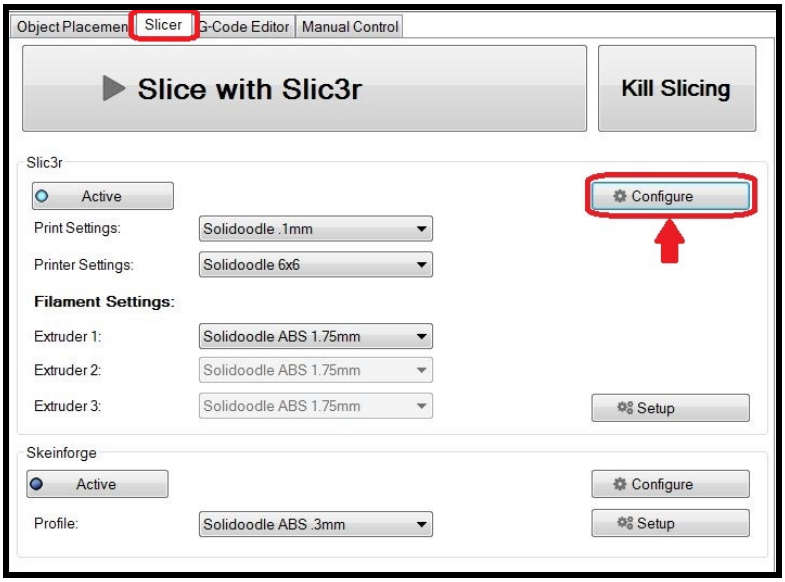


Figure 3.2: Click Configure

33. Once the Slicer Configure page appears, click on the drop-down menu under the **Print Settings** tab and select **Solidoodle .3mm**. This will configure the extruder to create strands of plastic that are .3mm thick.

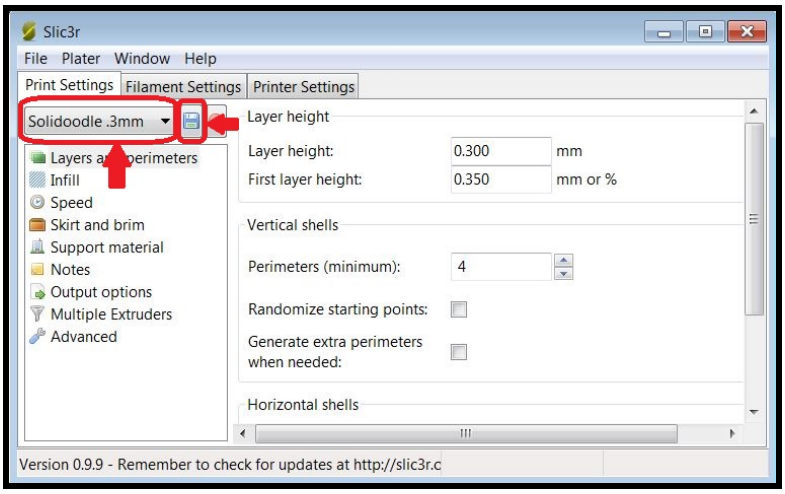


Figure 3.3: Print Settings With .3mm Resolution

34. Click on the **Printer Settings** tab. In the column on the left side of the Printer Settings tab window, click **Custom G-code**. Add the following code to the box under the “Start G-code" heading:

    G28 ;home allaxes

G1 z5 F5000 ;liftnozzle

This code will run once you begin printing your 3D part. The code's function is to first calibrate the location of the nozzle (this will cause the extruder to move around, finding it's home position). Next, the code will wait for the extruder nozzle to heat up to the specified G-code settings, which are automatically generated for you later on.

35. Click the **Save Current Printer Settings** button  next to the "Solidoodle 8x8" drop-down menu then click on the **Filament Settings** tab.

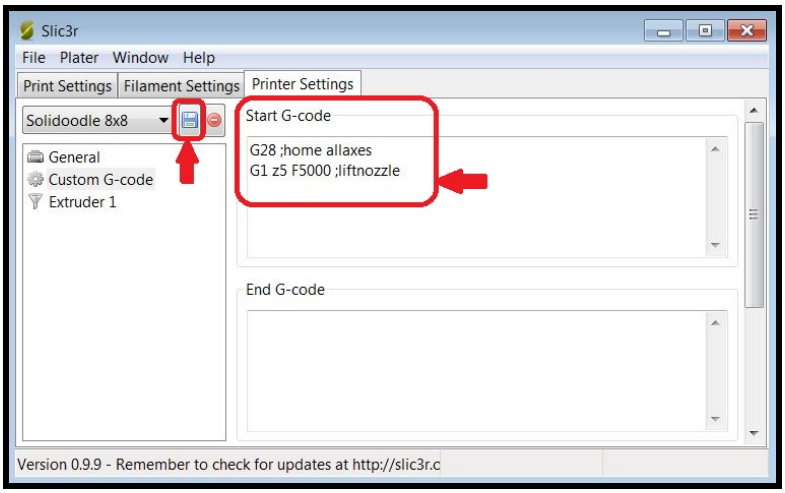


Figure 3.4: Printer Settings

36. Click on the drop-down menu under the Filament Settings tab and click **Solidoodle PLA 1.75mm**. Click the **Save Current Filament Settings** button  to the right of the drop-down menu.

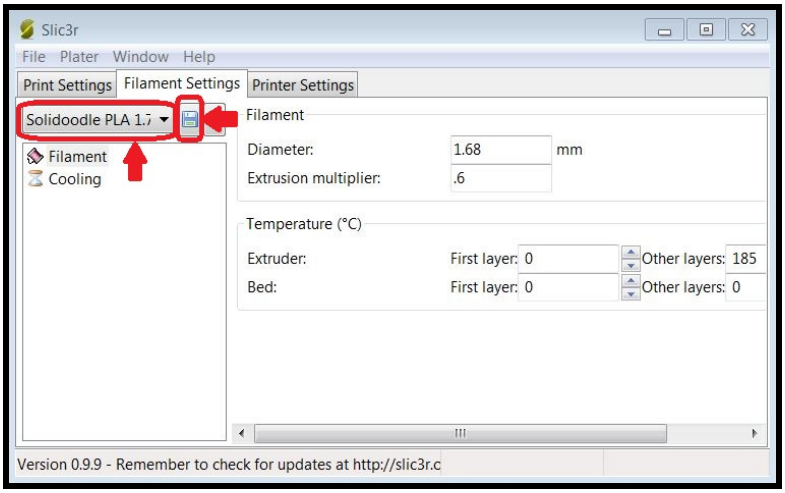


Figure 3.5: Filament Settings

37. Click **Close** at the top of right-hand corner of the Slicer window.

38. In the main Repetier Host program window, click on **Printer Settings** 

at the top right-hand corner of the window (You can also use the keyboard combination **Ctrl-P**).

39. Click the drop-down menu **Baud Rate** and choose 57600.

40. Next to “Port:" click on the drop-down menu and choose the COM port that corresponds to the 3D printer. If you only have one option to choose for the COM port (while the printer is connected) then choose that option and skip the next step. Otherwise, continue to the next step.

41. If multiple COM ports are listed, unplug the USB-B cable from the Solidoodle printer and click 

. Check the ports listed in the drop-down menu. Take note of the ports currently listed in the drop-down menu. Plug the USB-B cable back into the Solidoodle printer and click 

once more. Check the ports. The port that was not listed before is your printer’s COM port number. Choose your printer’s COM port number by clicking on it in the drop-down menu.

42. Click **OK** at the bottom of the Printer Settings window. On the right-hand side of the main Repetier Host program window, choose the **Slicer** tab. Click on the big button that says **Slice with Slic3r**. A small window that says “Slicing info" will appear temporarily.

43. Once the G-Code tab comes into view, click on the “Run Job" button 

.

44. The printer should now begin heating up the extruder (if the extruder is not already hot).

3.1.2 LEVELING THE BED

45. Open the Solidoodle printer door once the extruder begins moving.

    CAUTION: Do not put any body parts near the extruder head. It will be extremely hot and can result in burns when touched.

46. Find the three wing nuts beneath the print bed.

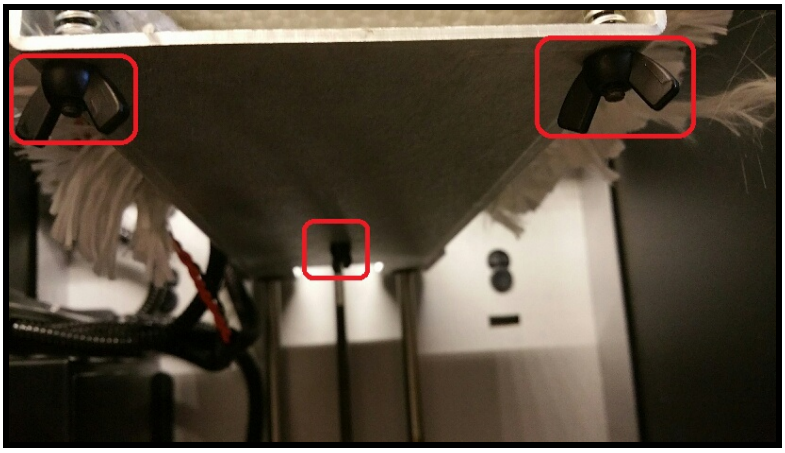


Figure 3.6: Wingnuts Under Printing Surface

47. After the extruder has made two or three loops around the plate, observe the plastic coming out of the extruder nozzle. Follow the guidelines below for correcting the level of the plate:
    - If the plastic appears to be thin and drooping (extruder is too far away from print surface) on one side of the plate, twist the wingnut corresponding to that side to the left. This will raise the plate.
    - If the plastic appears to be thick and flat (extruder is too close to print surface) on one side of the plate, twist the wingnut corresponding to that side to the right. This will lower the plate.
    - If the plastic is desirable on one side, do not change the level of that side.

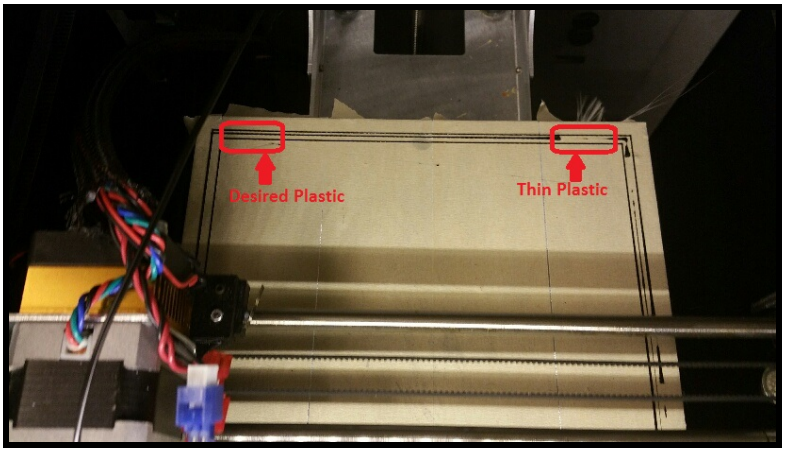


Figure 3.7: Desired vs. Thin Plastic On Plate

48. Continue adjusting the plate levels until all of the plastic on the plate is extruded as desired. After this, you may click **Kill Job**  on the main Repetier Host window.

49. This completes the bed leveling exercise. Close Repetier Host.

3.2 Exercise 2: Printing Motor Load

50. Open Repetier Host. Load the **Motor Load.stl** file from the website into the Repetier Host program. Figure 3.8 shows the part as it should appear in the 3D viewer.

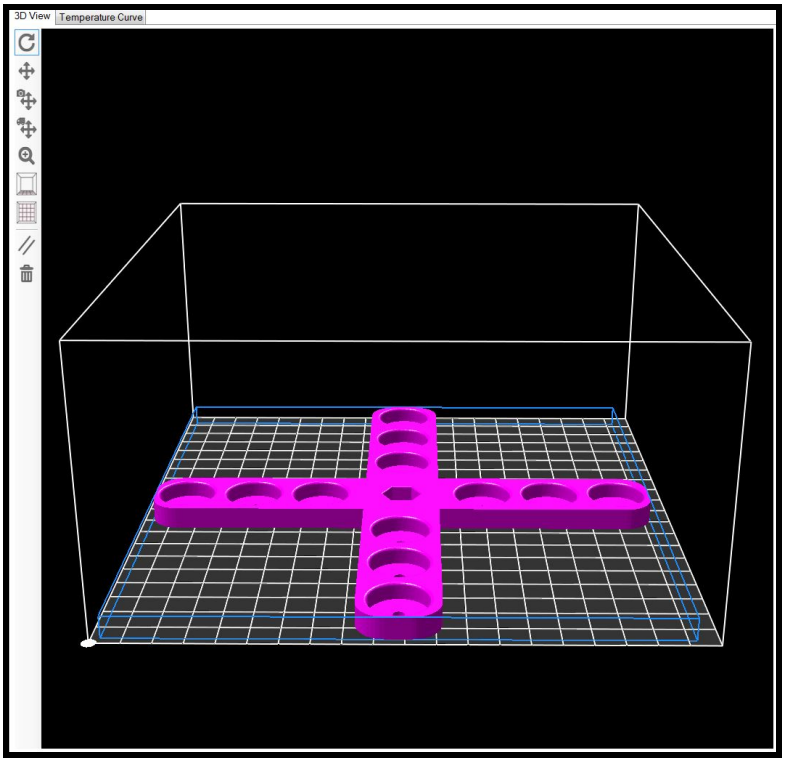


Figure 3.8: Motor Load in 3D Viewer

51. Repeat steps 32-43 with the following exceptions.
    - If the filament settings are already setup as they were in steps 32-36*** then you may skip those steps.
    - Skip steps 38-42.
    - After the first layer of the part has been laid on the plate (you will notice the bed level lower) click on the **Manual Control** tab on the main Repetier Host program window. You should notice that the **Heat Printbed** button 

is illuminated. This means the print bed is now heating. In the box next to “Temp" type **50** and press **Enter** on the keyboard. The print bed should now heat up to 50 degrees Celsius.

52. Observe the 3D printed part as it is layered by the extruder. Click the **Kill Job** button if any of the following things occur:
    - The part begins to warp. This indicates that the print bed is too hot, or the tape was not pressed to the plate enough.
    - The extruder position becomes offset from where the part was originally being laid to the plate. This can occur if the spool gets wound up on the back, restricting the movement of the extruder. It is important to pay attention to the printer, if just

by sound, during runtime. This will eliminate many issues you might run into later on.

- Anything catches on fire or becomes too hot.
- The printer begins to make loud, peculiar noises. The only noises you should hear during runtime are the fans and the extruder moving along (producing a light, whirring noise).

53. Once the part has fully printed, this exercise is complete. Once the extruder and tray bed stop moving, you may close out of Repetier Host.

3.3 Exercise 3: Printing Insert

54. Open Repetier Host. Load the **Load Insert.stl** file from the website into the Repetier Host program. Figure 3.9 shows the part as it should appear in the 3D viewer.

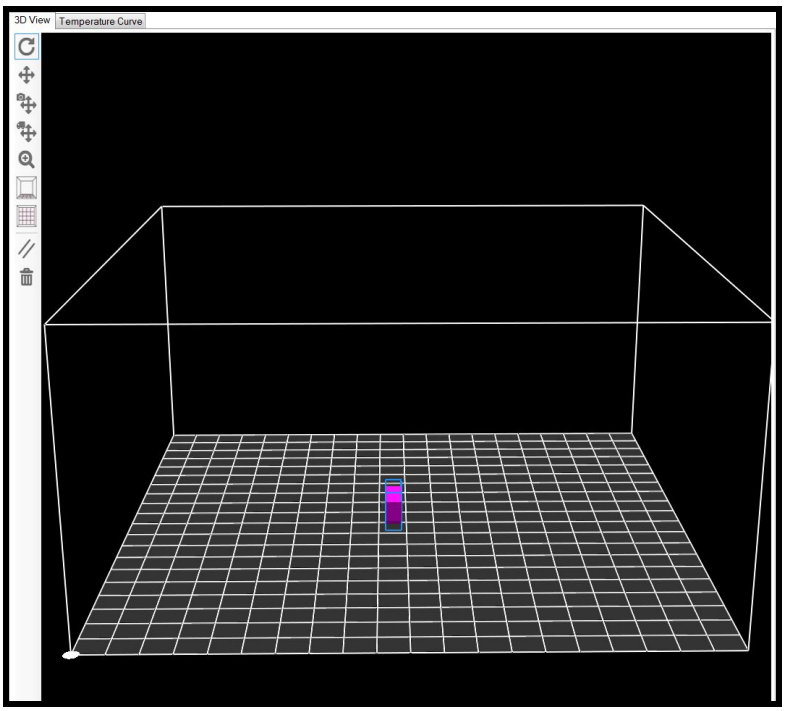


Figure 3.9: Gear Insert in 3D Viewer

55. Notice that the part is standing on one side. Under the **Object Placement** tab on the right-hand side of the screen, change the values for Translation, Scale, and Rotation to have the values for their respective X, Y, and Z values as shown in Figure 3.10.

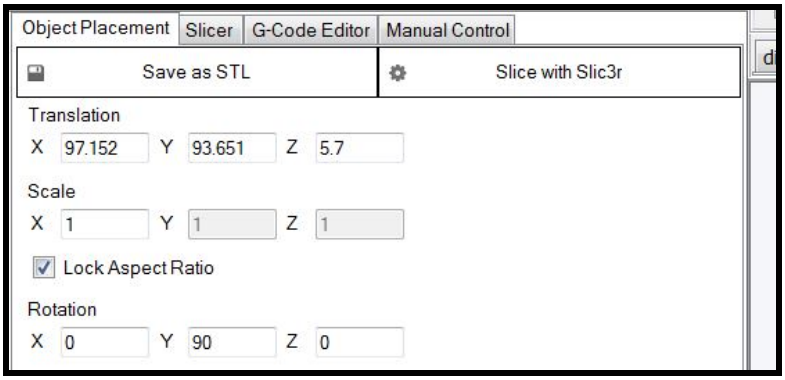


Figure 3.10: Correct Object Placement Values

56. After making the changes to the Object Placement values, the 3D viewer should look like Figure 3.11.

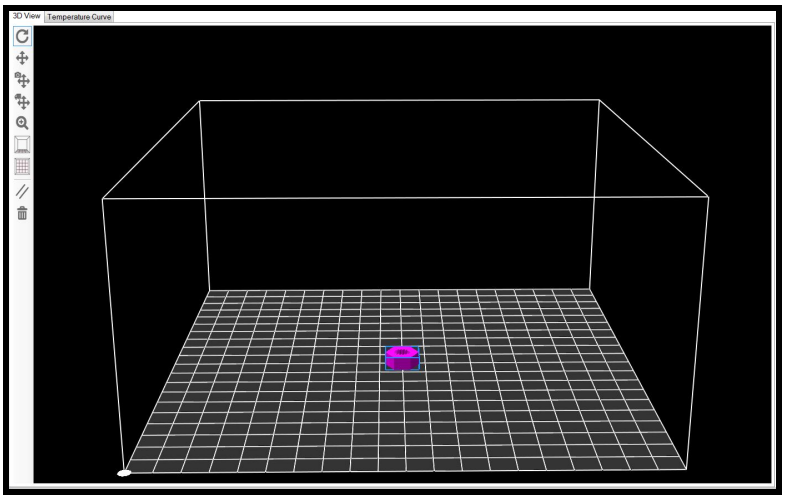


Figure 3.11: Gear Insert in 3D Viewer (Corrected)

57. Repeat steps 32-43 with the following exceptions.
    - In step 33 select **Solidoodle .1mm** in the drop down menu instead of **Solidoodle .3mm**.
    - Skip steps 38-42.
    - After the first layer of the part has been laid on the plate (you will notice the bed level lower) click on the **Manual Control** tab on the main Repetier Host program window. You should notice that the **Heat Printbed** button 

is illuminated. This means the print bed is now heating. In the box next to “Temp" type **50** and press **Enter** on the keyboard. The print bed should now heat up to 50 degrees Celsius.

58. Repeat also steps 52 and 53.

59. You have now completed this experiment.

4 Conclusion/Student Feedback

This experiment provided a basic introduction to 3D printing. All of the parts created in this experiment will be used in later experiments. This experiment is by no means an “end all" to 3D printing. As you gain exposure to using the 3D printers, you will begin to incorporate more complex methods.