



SPRING 2011

BUILDING 3D FABRICATORS

T.H 0330-0615PM CRN 35208 ROOM 192

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FIRE THE MAKERBOT!!

BE CAREFUL

1. Never leave the Makerbot unattended. It gets lonely and needs attention when it's not hibernating in its dark cabinet.
2. Remember to feed the Makerbot plastic. Like all of us it needs food or it gets cranky.
3. Do not move the cabinet very far as it might damage our unofficial network wiring.
4. **Be careful—it's hot!**

SETUP

1. Log in to the iMac using your academic login that you use in the computer labs.
2. Go to the  Apple Menu > System Preferences... > Desktop & Screen Saver > Set "Start screen saver:" to "Never". This may not be an end-of-world scenario but wakeful computers make happy prints.
3. Open ReplicatorG v0024 in Applications > replicatorg-0024-mac
4. With the Makerbot plugged into the iMac, select Machine > Driver > Cupcake with heated build platform
5. Then select the serial port in Machine > Serial Port > /dev/tty.usbserial
6. You will also need to setup Skeinforge by opening an .stl file (see below), click the Generate GCode button in the sidebar, choose the profile named "cupcake-mk5-heated-platform-abs", click the Duplicate button, name the new profile "pistachio-mk5-heated-platform-abs", click OK, then click Edit.
7. In Skeinforge you need to setup the profile according to the information below.

BUILDING

1. Open ReplicatorG v0024
2. If not already so, click on the Connect button in the toolbar.
3. Start the warm up process by selecting Machine > Control Panel ^J, set Target Temperature (C) to 200, set Platform Target Temperature (C) to 100, and leave the control panel open.
4. Open an .stl file through File > Open... ⌘O, and find your file.
5. In the sidebar, click Move, then click **both** Center and Put on platform.
6. Double check that the object sits on the platform and is within the boundary box before continuing.
7. Click the Generate GCode button in the sidebar (if you haven't it will ask you to save the file), choose the profile named "pistachio-mk5-heated-platform-abs", and then click the Generate... button.
NOTE: If the object you are building is particularly tricky, i.e. it has a small base, is narrow and tall, or otherwise does not make a good contact with the build platform, you should select "Use raft" before generating the tool path.
8. While the toolpath is being worked out, lower the Z platform by (gently) sliding the top belt to the left until the tip of the nozzle is within a piece of paper's thickness of the build platform. **Be careful—it's hot!**
9. Looking from above, verify that the nozzle is in the approximate center of the build platform.
10. Once the toolpath (gcode) has been generated, double check the control panel to see if Current Temperature (C) and Platform Current Temp (C) has reached the desired temps.
11. When you are all ready, proclaim, "Firing the Makerbot!!" and press the Build button in the tool bar (⌘B). At this point the Makerbot will raise the Z platform and then heat up to build temperatures.

12. Wait until both LED's for the heater core and build platform (located on the top left corner of the extruder controller on the side of the machine) have turned off at least once, then click Yes on the dialog box (or hit Enter on the keyboard).
13. Grab the metal tweezers and wait for the Makerbot to spit out a test extrusion and begin lowering the Z platform then pinch off the plastic with the tweezers. You might need to clean off any stranded lumps of plastic on the build platform at this point. **Be careful—it's hot!**
14. Now sit back while the Makerbot does what it does. Remember to feed it plastic by making sure that there is plenty of slack on the plastic as it feeds into the extruder and occasionally watch the build for any assorted weirdness. If something happens either press the Pause or Stop buttons on the tool bar.

POST-BUILD

1. When the build is complete, the Makerbot will raise the Z platform and then turn off the motors, the heater core, and build platform. Resist the temptation to pull the object out immediately when its completed—it is still hot and can deform in the process.
2. Once allowed to cool for a few minutes, use a putty knife to gently pry the object off the build platform—try not to tear up the tape or you get to replace it.
3. If you can get in there to remove the object, you may need to raise the Z platform manually to get enough room to remove it without damaging the extruder.
4. You may also want to remove the platform that is only held in place with magnets—be careful if you do this because the platform will be stupid hot and is still connected with wires.
5. Once finished return the X and Y stages back to center and if there is another print to do once you are done, it would be a good idea to open up the control panel and start the warm up process again.

OTHER STUFF

1. If you try to move any of the axes and they won't budge **don't** force it. Instead, open up the control panel, and click Disable under Stepper Motor Controls to turn off the motors.
2. If you forgot to click on Center and Put on platform before building the gcode, you could end up driving the nozzle into the build platform. Immediately hit the stop button and lift up the z platform so that the plastic is not driven into the extruder. You will need to re-level the z platform by positioning the nuts on the z rods so that they are all at the same height and rotated so that the z platform will firmly sit on top of them. Be careful not to damage the wires and avoid all those hot bits. Now try again.
3. If someone is using the iMac or there is a particularly tricky build you can opt to print from the SD card on the Makerbot. Instructions can be found here (<http://wiki.makerbot.com/building-from-an-sd-card>) essentially, with the gcode generated select Upload to SD Card from the tool bar—this can take quite a long time to do so it is better if you have access to an SD card reader on your computer. Once uploaded you can click Build from SD Card, select the file you want to build, then click OK. You can now disconnect the Makerbot from your computer while it builds. **Note:** if something happens during the build, the stop button on the toolbar will only work if the computer is still attached, otherwise hit the reset button on the motherboard to cancel a build.
4. Feel free to replace the blue tape build surface every few prints. Best when cool!

CHANGING FILAMENT

1. To change the filament, first open the control panel and bring the extruder up to the temperature of 215 C.
2. When the extruder reaches temperature, release the tension on the pinch wheel using the thumbscrew on the side of the extruder.
3. Quickly, pull the filament straight up and out of the extruder. If the thumbscrew has been backed off enough this should be a quick and fluid motion.
4. Feed the new filament into the hole on the top of the extruder, through the pinch wheel assembly, and into the heater core as far as you can.
5. Tighten the thumbscrew to apply pressure on the pinch wheel. This pressure should be just right—not too tight and not too loose.
6. In the control panel, set Motor Speed (PWM) to 255 and click on Forward under Motor Control to turn the motor on.
7. If the pressure on the pinch wheel is correct, the motor should feed the filament into the heater core and plastic should begin to extrude from the nozzle. If not, adjust the thumbscrew.
8. Allow the extruder to run until the new filament comes out of the nozzle (especially evident with a different color) and then click Stop under Motor Control.
9. **Note:** Never reverse the direction of the extruder under Motor Control, as this will likely clog up the pinch wheel mechanism and cause the extruder to need to be rebuilt.

SKEINFORGE PROFILE

Skeinforge can be overwhelming at times but there are only a handful of settings that we really need to worry about: how fast the plastic comes out, the layer thickness, how fast the XY axes move, the extrusion width, and the temperature of the heater. While I wish we would never have to adjust these settings that won't happen so you should familiarize yourself with the settings as best as you can. If the top and bottom layers look too stringy then either the temperature is too low or the width over thickness settings (there are 3) are too high. If the finished build is bubbly or drooping then the temperature is too high or the width over thickness too low. Simple right?

Here are some base settings to start with. These settings can be adjusted depending on the type of object being printed. Only time and experience will show us how this works out.

FILL

Infill solidity > .5

RAFT

Base layer thickness over layer thickness > 2.04

Temperature of raft > 200

Temperature of shape first layer outline > 212

Temperature of shape first layer within > 212

Temperature of shape next layers > 212

Temperature of support layers > 212

Temperature of supported layers > 212

SPEED

Extrusion diameter over thickness > 2.04

Feedrate > 24

Flowrate PWM setting > 245

Travel feedrate > 32

CARVE

Extrusion width over thickness > 2.04

Layer thickness > .37

INSET

Extrusion perimeter width over thickness > 2.04

PID SETTINGS

The Makerbot motherboard's PID setting controls the temperature swings of the heater core and heated platform. This can be set under Machine > Toolhead preferences. For the moment we will use the following settings though this could change at any time. After changing these settings, you will need to disconnect the motherboard from the USB cable and reset the motherboard.

P 7.0

I 0.34765625

D 36

SOME ALTERNATE SETTINGS:

P 5.143

I 0.0612

D 108

P 5.1367

I 0.055

D 108

P 5.0

I 0.0078125

D 35