LASER CUTTER WORKSHOP

No. 1

Cut and Fold Polyhedra

- Materiality
- Project creation
- Preparing to cut
- Laser cutter operation

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OVERVIEW

In this workshop you'll use the laser to cut shapes from card, raster engrave text and engrave score lines and at the perfect depth for controlled folding.

This document has two parts. The first guides you through the design and file prep process, the second shows you the basic operations of the machine.

MATERIALITY

PROJECT CREATION
I. vector cuts
II. vector engraving
III. raster engraving
IV. glue tabs

PREPARING FILE
I. formatting the artboard
II. colour, line and type

It will then show you how to use the Laser system to execute your design, in twelve steps:

EXECUTION
I. book a time
II. preparing material
III. turning on the system
IV. check the lens
V. focus the laser
VI. open an AI file
VII. create a test object
VIII. explore possible settings
IX. test and refine settings
X. cut your project
XI. put things away

DO NOT CUT

PVC (vinyl, fake leather)

emits chlorine gas which corrodes optics, metal, motor belts, lungs, etc.

ABS (legos)

emits cyanide gas, catches fire

Polycarbonate (Lexan)

HDPE (milk bottles)

Polystyrene foam (rigid insulation, foamcore)

Polypropylene foam

all of these plastics melt and catch fire

Fibreglass

Coated carbon fibre

the epoxy resin in these compound materials emits noxious fumes

ENGRAVE

Glass

Brick

Stone

Anodized aluminum

Other metals, with Cermark

attempting to cut these materials produces undue stress on the laser cutter - it is simply not powerful enough. Reflections off these materials may further damage the machine

Paper on foamcore board

observe the entirety of the engraving process on foamcore to ensure heat does not build up in the plastic and ignite it

CUT & ENGRAVE

Paper

Cardboard

Other paper products

Acrylic

Wood

Plywood

Hardboard

Cork

Delrin

fair game! too much power will still set these on fire though

MATERIALITY

When choosing materials, keep in mind that the laser cutter will apply heat to the site of the cut and burn the edge of your material to some degree. The burn marks are difficult to remove from thick plywood, but you can almost entirely wipe them off of some card stock. If you use acrylic, the heat will actually polish the cut. These qualities are similar for engraving pieces as well.

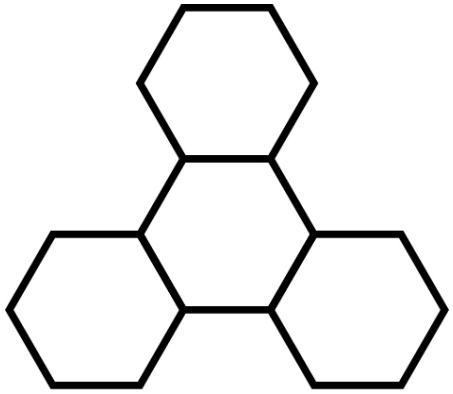
Spend some time to find the power settings that get the look you desire - this will take some time, but can make or break your project.

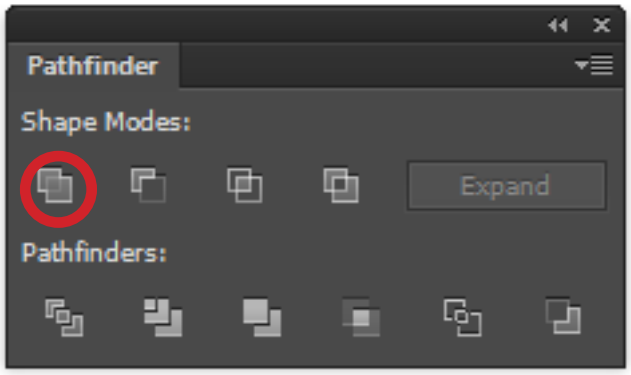
Thick materials may need multiple passes, rather than one super heavy cut.

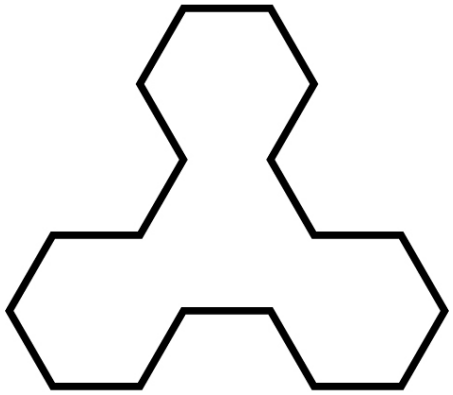
Stay in the laser cutter room to make sure nothing is burning or excessively smoking. Even if your test patch did not catch fire, lines close to each other will heat up more and pose a risk for fire. Something could also go wrong in the machine, and cause a fire that way.

This laser cutter can cut or engrave most things, but please be super cautious when using plastics and research what you are cutting. The list on the left details which plastics are not allowed, as they will destroy the machine/the room through poisonous gasses or fire. **You must know what plastic you are putting into the laser cutter before you start cutting it.**

Most materials can be cut or engraved, but a few materials can only be engraved, such as stone, brick, glass, etc.







This first project will acquaint you with creating vector cuts, vector engraving and raster engraving on the laser cutter. We are making a truncated tetrahedron, to show that the laser cutter can produce 3-dimensional objects, not just flat cards.

I. VECTOR CUT LINES

When set to vector mode, the laser cutter will follow a path set out in Illustrator. A vector cut line has enough power to cut entirely through the material being used. We will use boolean operations to construct the basic net.

1. Snap together four hexagons

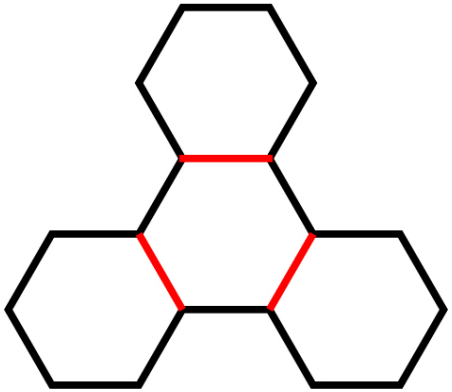
   Where the hexagons are snapped together, you see one line but the machine sees (and cuts) the lines from both hexagons. Let's merge the shapes together to fix this.

2. Open the pathfinder window

   Window > Pathfinder

3. Select the hexagons, click the unite icon

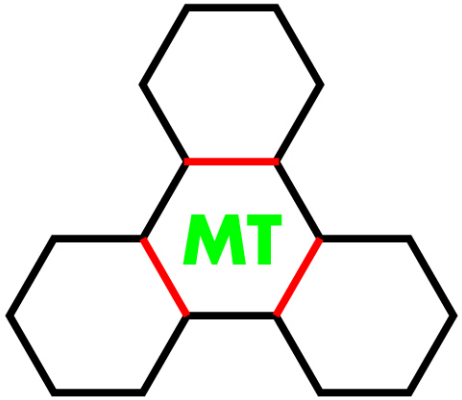
   This will make a truncated tetrahedron, but the folds will be ugly. Let's score the fold lines to keep it crisp.



II. VECTOR ENGRAVED LINES

The laser cutter still follows a path set out in Illustrator, but the power is set so the laser does not cut all the way through the material. This allows for score lines, or designs to be engraved.

1. Add the fold lines using the line tool, making sure to go from anchor to anchor
2. Change the color of the fold lines to red, in order to differentiate them from the vector cut lines.

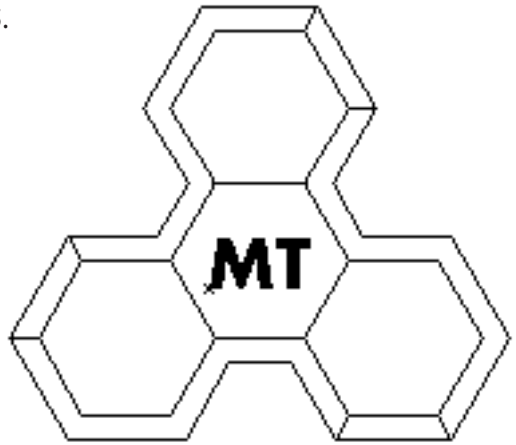


III. RASTER ENGRAVING

Raster engraving is much slower than vector work, as the laser cutter acts much more like an inkjet printer. The laser cutter head moves back and forth, engraving one horizontal line at a time. This allows you to engrave photos and other complex graphics.

1. Type out your initials
2. Change the text color to green, to differentiate from the other types of cuts

5.



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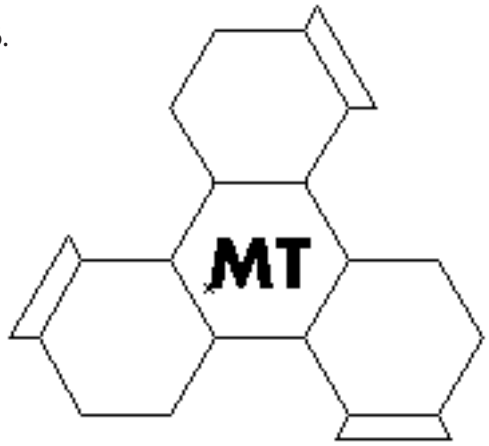
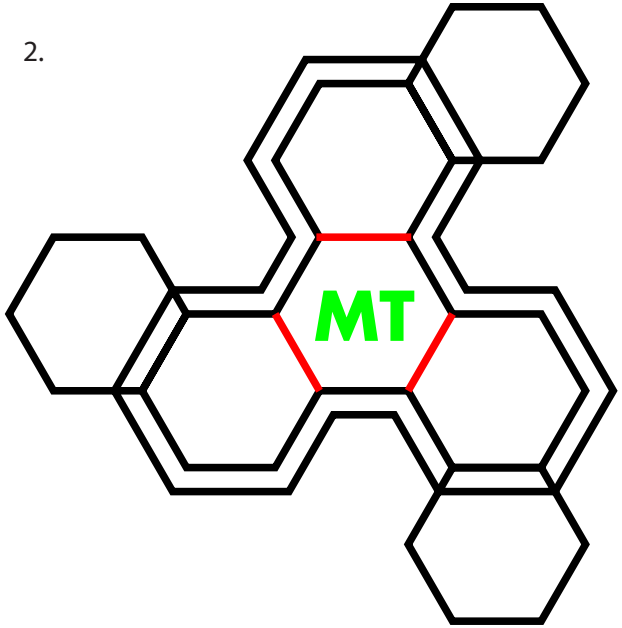


The difference between steps 5 and 6 is more visible in outline view (**ctrl + y**). This view shows all paths, in uniform stoke and no fill. It is very useful for carefully lining up elements, as well as finding hidden lines that will wreck havoc with your cut.

2.



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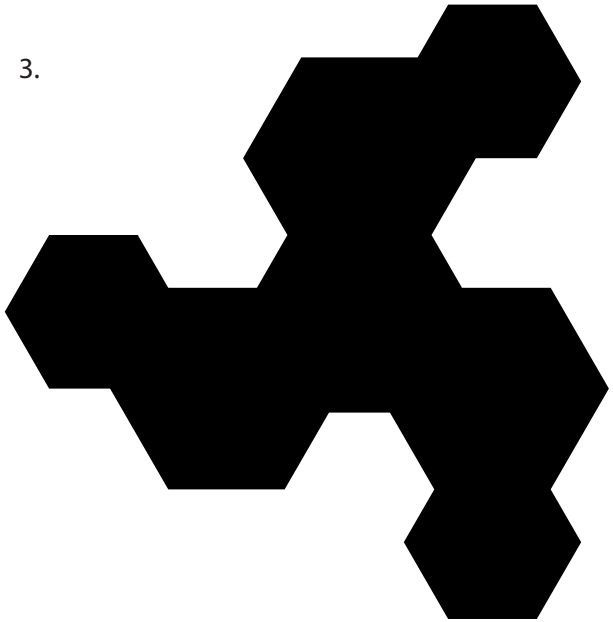

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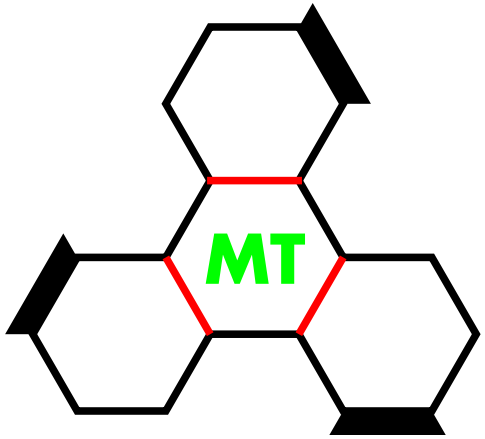

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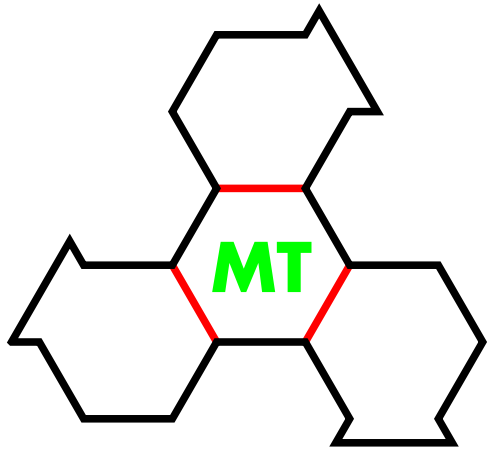

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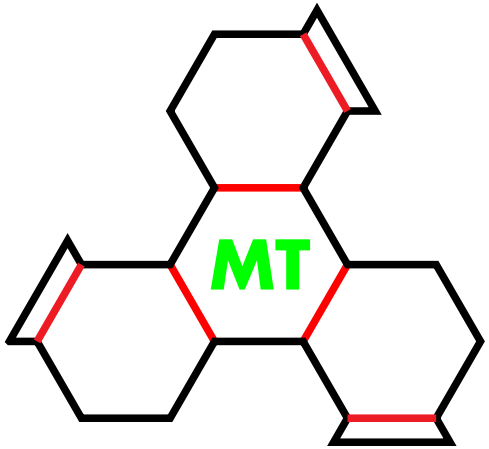


IV. GLUE TABS

1. Snap three hexagons onto the net

   These will become the tabs.

Offset the net - this will be the depth of your glue tabs

Cutting the tabs to a reasonable size.
Object > Path > Offset

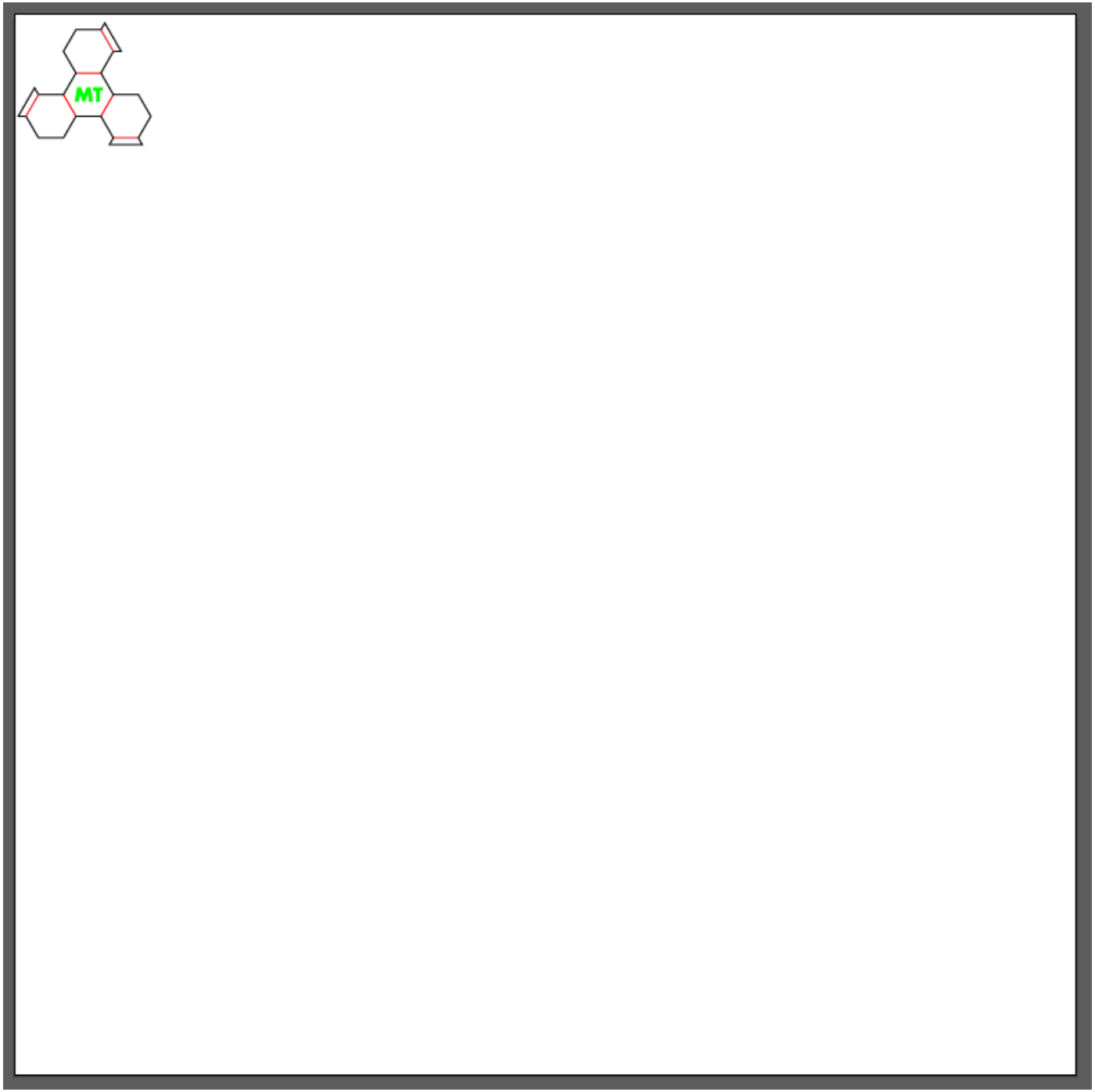
2. Change the fill of the hexagons and offset path to black, and the stroke to none
3. Bring the offset path to the front

   Right Click > Arrange > Bring to Front

4. Crop these elements in the pathfinder window
5. Ungroup the result and delete the leftover offset

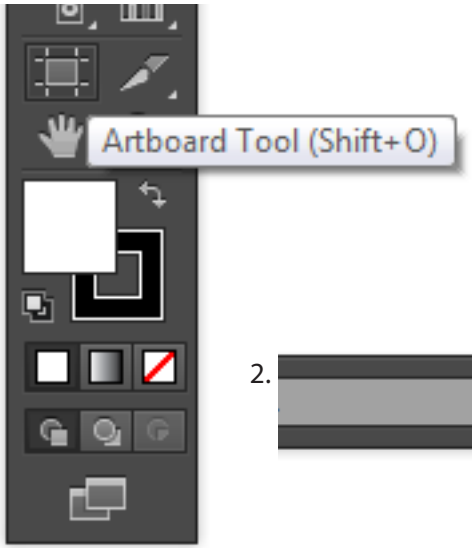
   The crop function creates the tabs, but also keeps the excess - we don't need to cut this, so we will get rid of it

6. Unite the tabs with the net
7. Add in red fold lines



The artboard properly set up

1.



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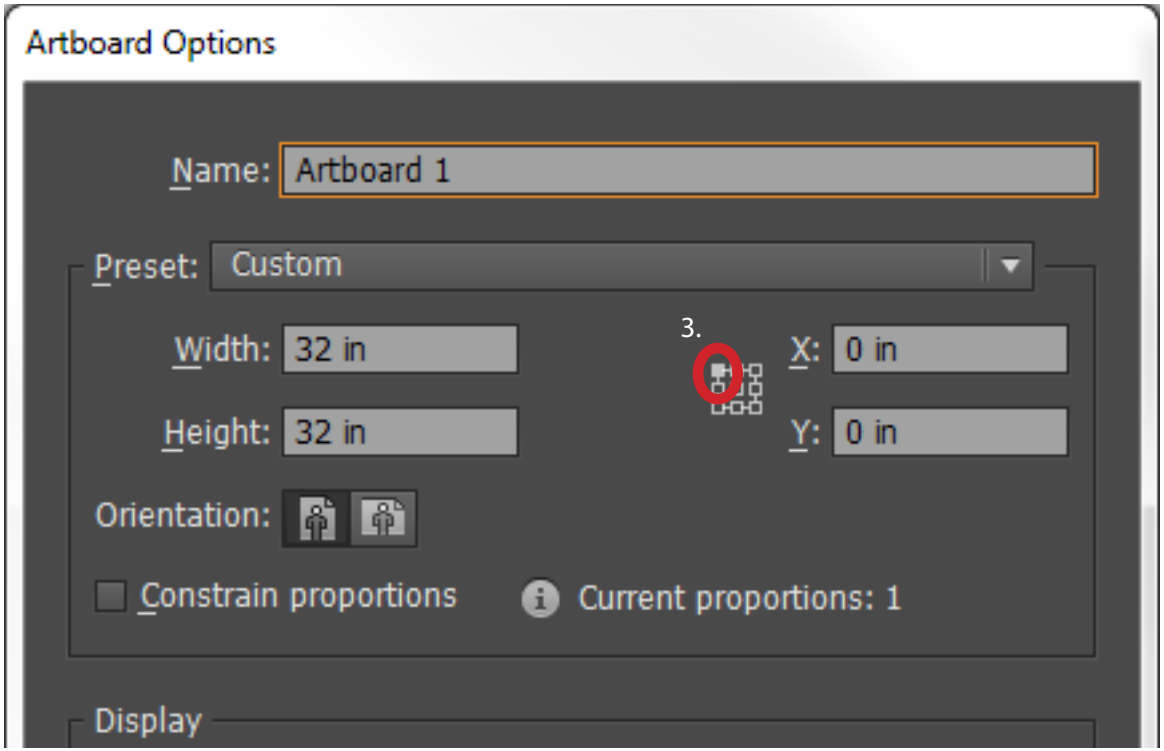


3.

I. FORMATTING THE ARTBOARD

Now that you have a project you want to cut, we must make sure that the laser cutter can correctly read the file. Follow these steps with any file you created or imported into Illustrator.

1. Select the Artboard Tool
2. Enter into artboard settings
3. Set the reference point to the top left corner by clicking on it
4. Set the position of the top left corner to X: 0 and Y: 0

   This step aligns the rulers in Illustrator with the rulers on the bed of the laser cutter.

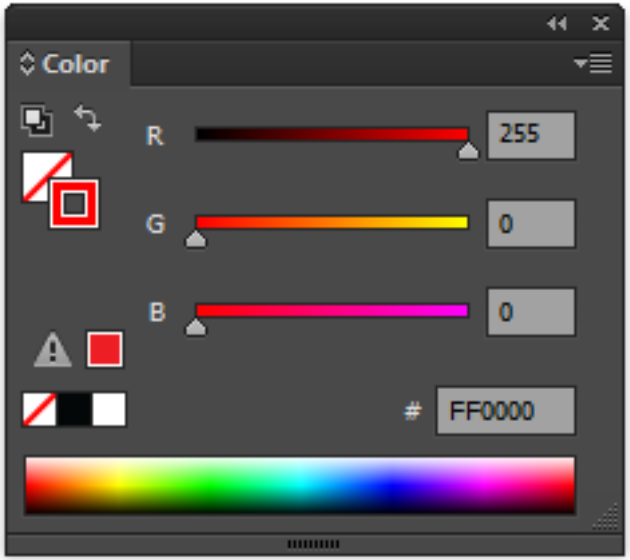
5. Set artboard size to 32" x 32", either by entering it into the control bar or creating a rectangle and dragging the artboard to fit

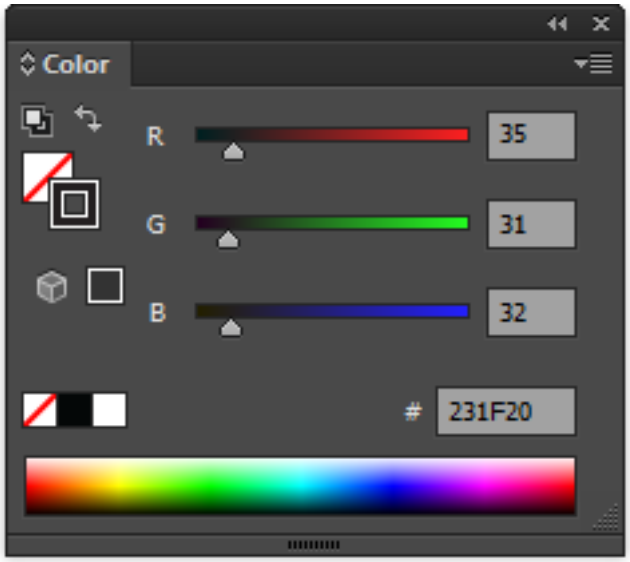
   While the cutting area is 32"x18", this artboard size keeps the software happy.

6. Set the artboard to portrait orientation
7. Set document colour mode to RGB
   File > Document Color Mode > RGB Color
8. If using an Illustrator file, make sure it is saved as a CS5 file. There will be issues cutting if it is saved for a newer version

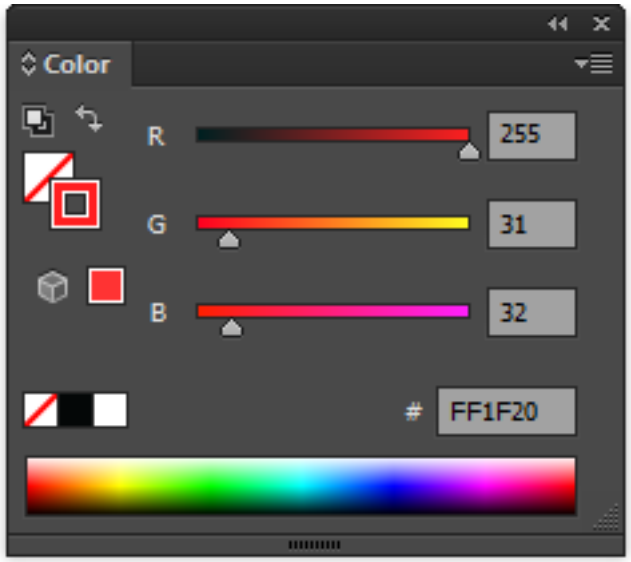
Black R G B
Red R G B
Green R G B
Yellow R G B
Blue R G B
Magenta R G B
Cyan R G B

Colors the laser cutter will recognize
(also R:255, G:102, B:0 if needed)

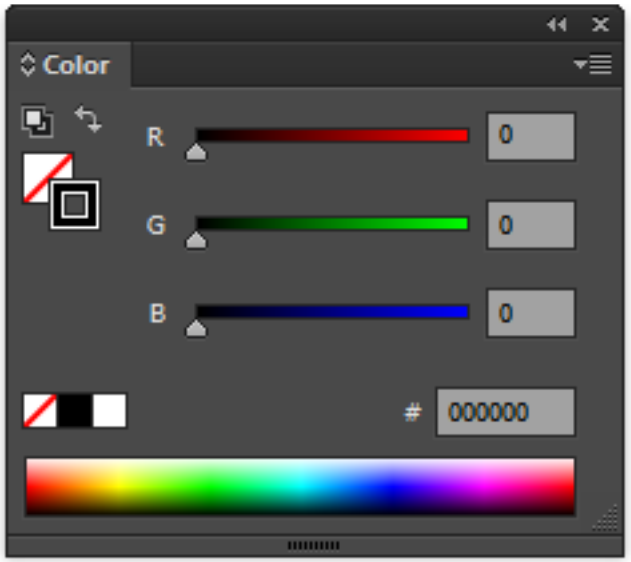




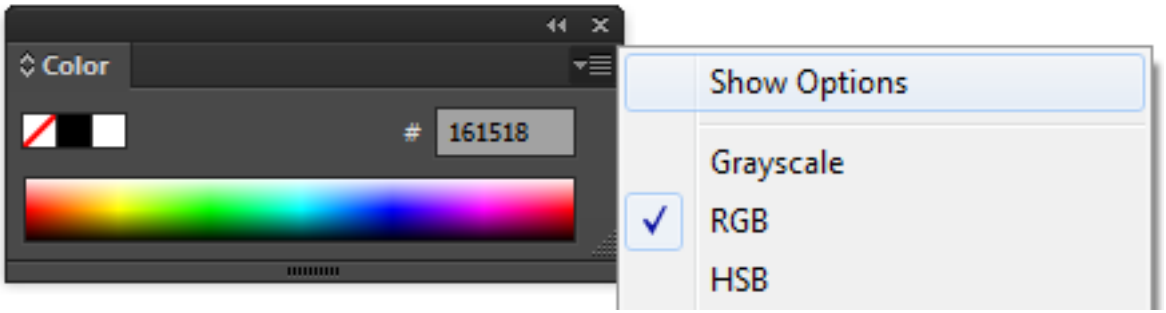
A bad black; this may not print

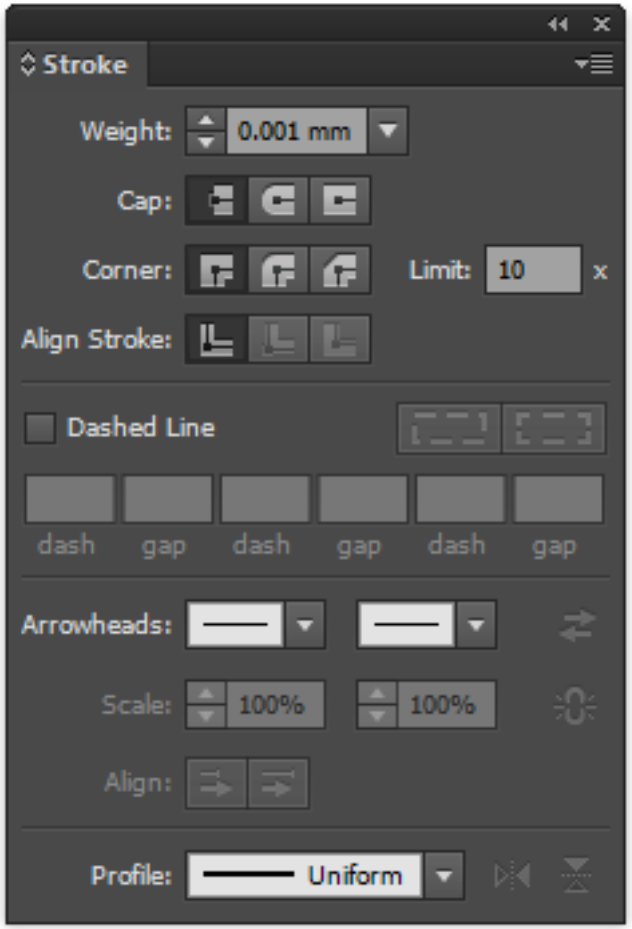


A bad red; this will default to black, or not print



Good! This is the red and the black the laser cutter will recognize





Properly set up lines

II. COLOR, LINE & TYPE

A uniform, thin and pure colored path must be utilized for vector work. The laser cutter prints one color at a time, and allows your to have distinct power settings for each color.

1. Set the colours of the cutting job. The RBG sliders must all be at 0 (hard left) or 255 (hard right)

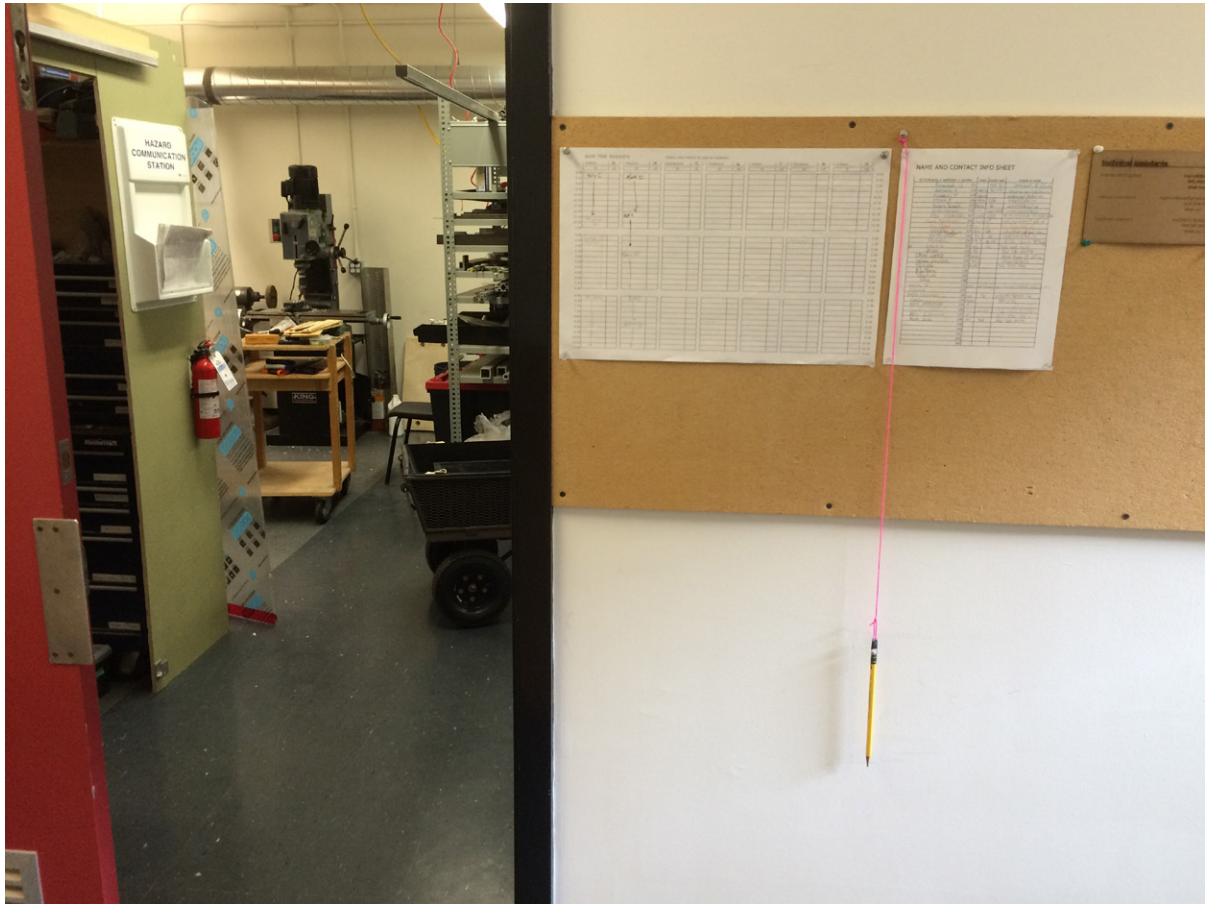
   You may need to show options in the color window to see the sliders. Make sure its set to RGB color.

2. Set the stroke to some value beneath 0.1 pt or .001" or 0.025mm

   Otherwise, the lasercutter will think you mean to raster the line.

3. Set line type as solid, single, with no ends. Ensure the opacity is 100%. No other funny business to confuse the laser cutter
4. Set the fill to none
5. If you would rather vector the outline of text instead of rastering the whole thing, outline those text elements
   Type > Create Outlines

OPERATING THE MACHINE



I. BOOK A TIME

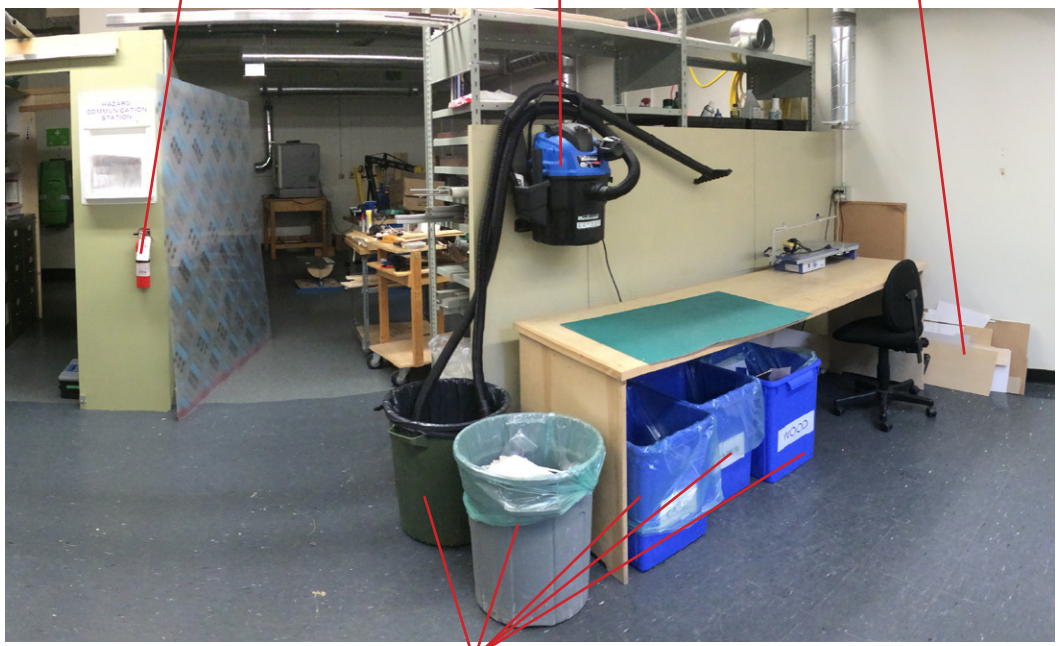
1. On the bulletin board in the hallway outside of the laser cutter room is a signup sheet. Sign up for a free spot, and put your name in the contact list- this allows people to inform each other if the lasercutter is free in times of high use.

II. PREPARING MATERIAL

1. Cut material to size, leaving a margin as perfect registration is likely a waste of time. Save scrap for test pieces

   There are xacto knifes, rulers and squares provided in the laser cutter room. Please deposit used blades into the big, yellow, prominently placed sharps container!

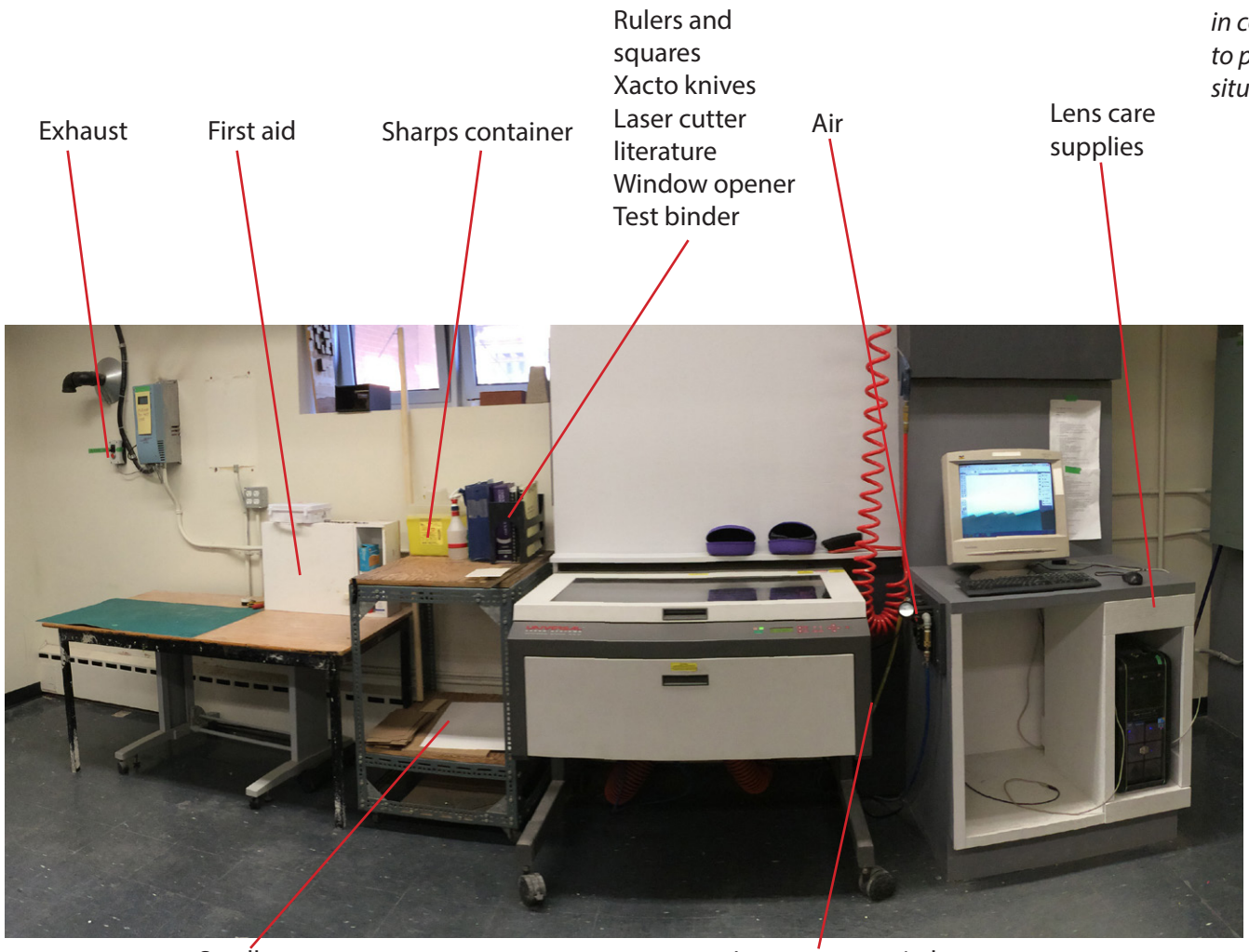
Air turned on; valve handle in line with pipe, gauge showing pressure.

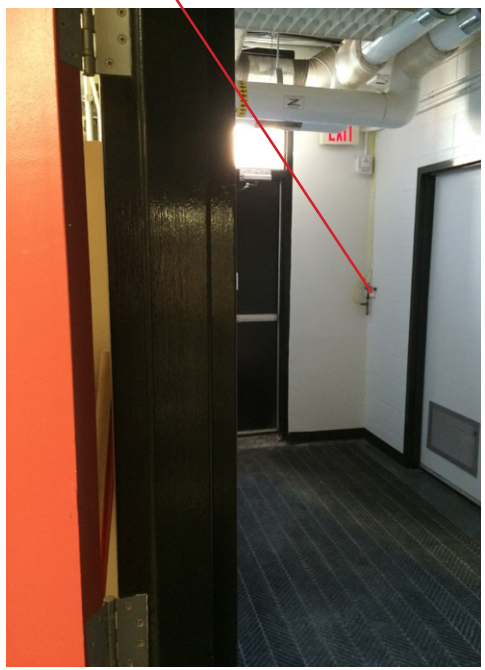


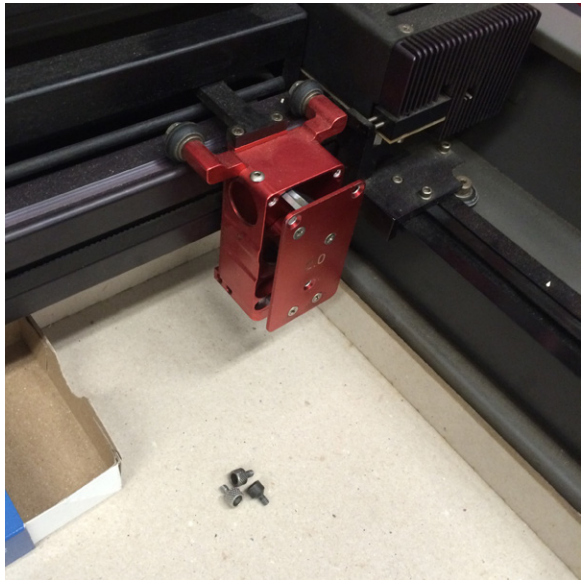
III. TURNING ON THE SYSTEM

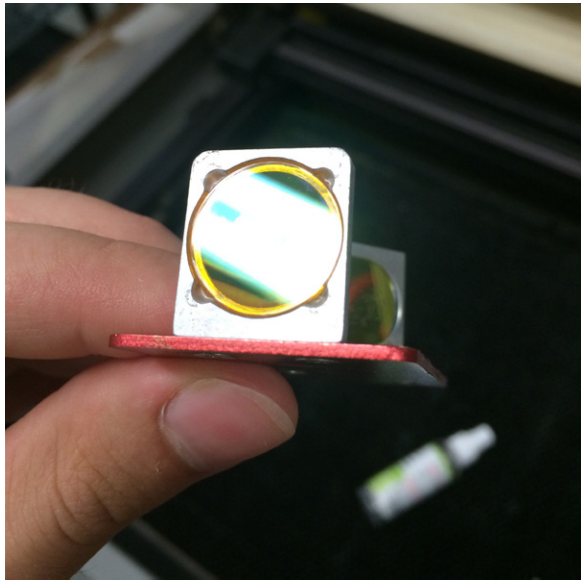
1. Turn on the laser cutter
2. Turn on the compressed air by turning the handle in line with the pipe.
3. Check the hallway valve (turn left out the laser room, in the corner by the exit door) if the gauge shows no pressure
4. Ensure the exhaust fan is on

Usually, you do not have to turn the computer off and on, but sometimes there is an error in communication and you will not be able to print. Turning it off and on again resets the situation.









IV. CHECK THE LENS

1. Place cleaning tray under laser cutter head

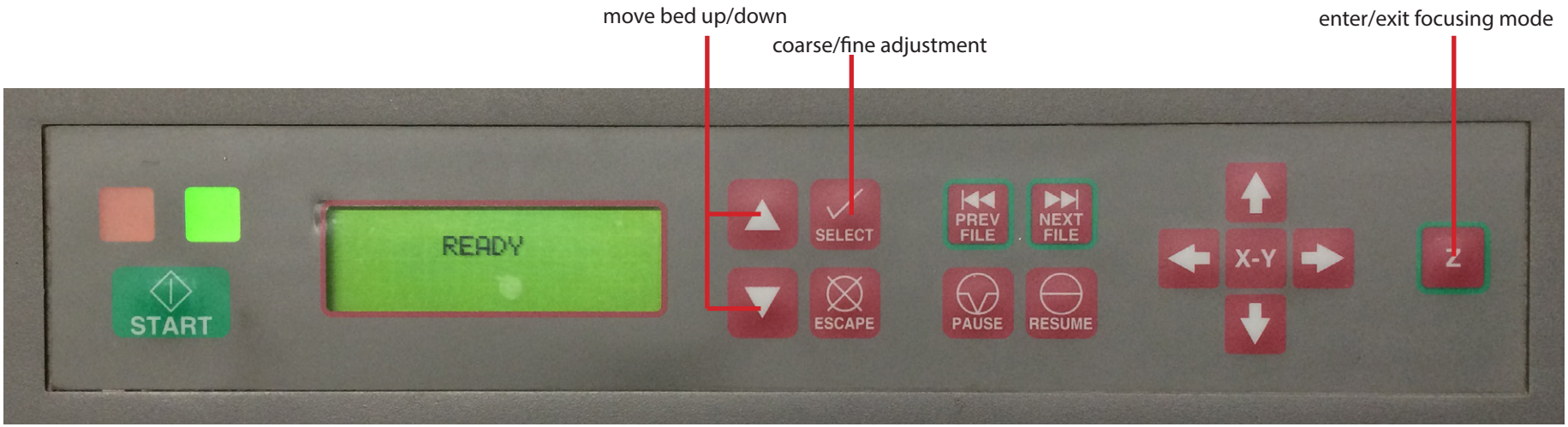
   This prevents the screws from dropping into the depths of the machine.
2. Unscrew three thumbscrews, withdraw focusing assembly
3. Hold the lens in such a way that the over-head light creates glare; this will make it easier to spot contaminants
4. If you spot any contaminants, spray a swab with lens cleaner and daub them off, being careful to not drag the contaminant and hence scratch the lens. Rotate the swab each time, to avoid redepositing the gunk you just cleaned off
5. Spray a fresh swab and clean the whole lens in a zig-zag motion, applying as little force as needed; scrubbing the lens will end up scratching it or rubbing off the optical coatings
6. Check to make sure no cotton fibres from the swab were left behind

   If contaminants build up on the lens, they will accumulate heat until the lens cracks and become useless.

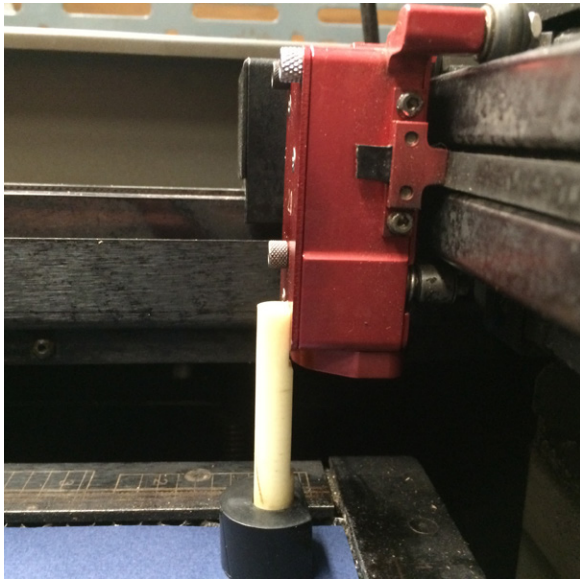
   Lenses are ~$400, and come from DASA funding. If properly cleaned, each lens should last 800 hours of 100% laser power.

   BE GENTLE when cleaning the lens - scratches are just as bad as accumulated gunk. Don't overclean - this will wear away coatings.

7. Replace assembly


move bed up/down
coarse/fine adjustment
enter/exit focusing mode
START
READY
SELECT
ESCAPE
PREV FILE
NEXT FILE
PAUSE
RESUME
X-Y
Z

Location of focusing stick



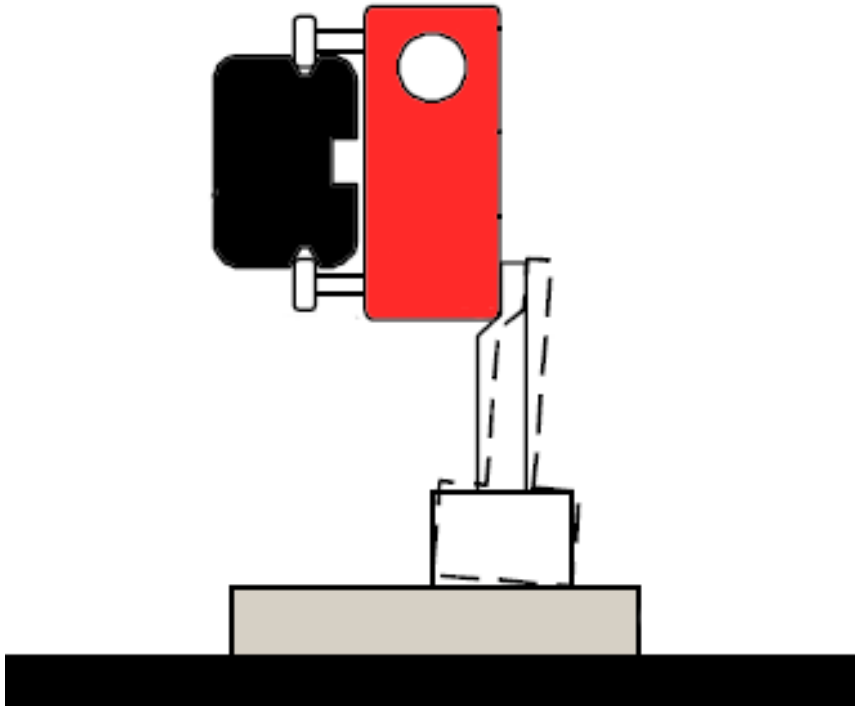
Placement of focusing stick

V. FOCUS THE LENS

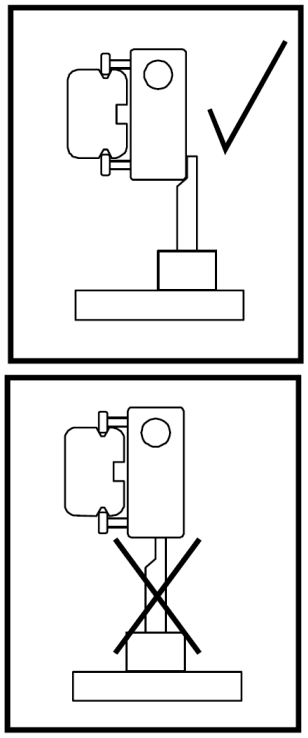
1. Press the "Z" button on the laser cutter
2. Place focusing stick on top of material to be cut

   The laser is focused when the laser head rests in the notch in the stick .

3. Press the up and down arrows to approximate the focus
4. Press the select button to enter fine movements
5. Press up and down arrows to precise focus
6. Press "Z" to exit the focusing mode.



When focusing begins to tip, the lens is focused



Power Rules of Thumb

Power is the power of the laser beam.

Speed is how fast the printer moves

Double power >> Double depth of cut

Double speed >> Half depth of cut

The ratio between speed and power determines the depth of the cut

You want to apply the least amount of power to your piece, as this reduces discoloration through smoke and heat buildup. It also places the least strain on the laser cutter.

You want the laser cutter to work as fast as possible. However if you push it too fast though the accuracy will go down, as it will not be able to change directions fast enough.

PPI is the laser cutter's resolution, "pulses per inch"

Sample test object

VI. OPEN AN AI FILE

1. Put your thumbdrive with your CS5 Illustrator file into the computer.
2. Open the file to be cut in Illustrator

VII. CREATE A TEST OBJECT

This test object will be used to experiment with power settings to ensure you achieve the desired results on your final cut.

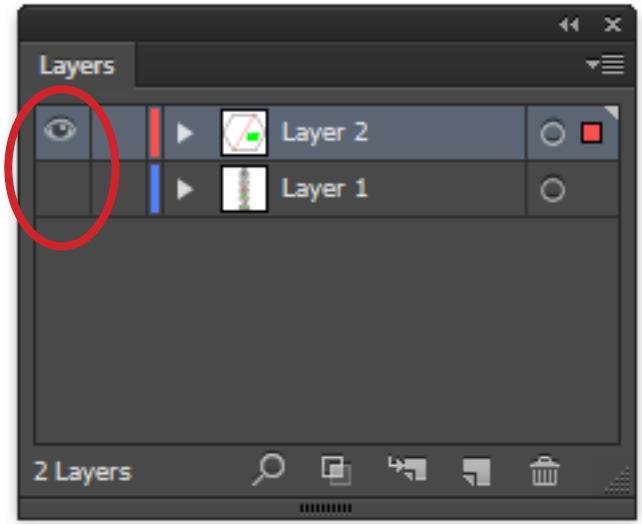
1. Create a new layer
2. On this layer, either copy a small part of your design or create a test object.

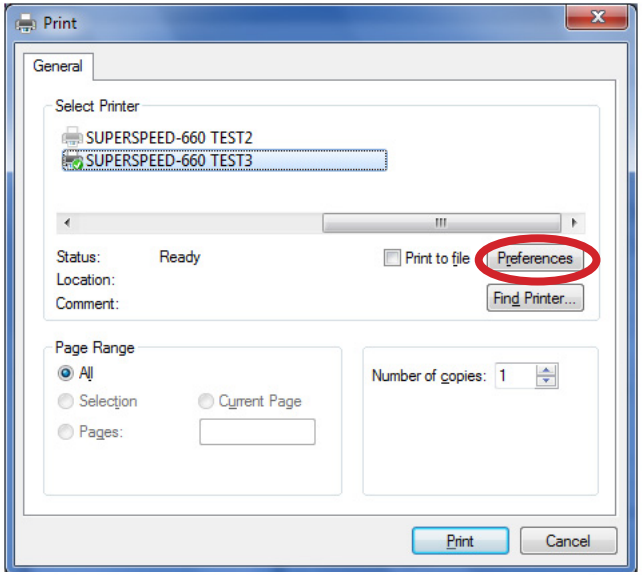
   Make sure all the different power settings you need are represented in the test piece.

VIII. EXPLORE POSSIBLE SETTINGS

Find a ballpark range of power settings, within which you can experiment and fine tune.

1. Read the laser cutter literature on general power advice
2. Read the laser cutter literature on your specific material
3. Read the rules of thumb on the left
4. Look at the sample binder


Layers
Layer 2
Layer 1
2 Layers


Print
General
Select Printer
SUPERSPEED-660 TEST2
SUPERSPEED-660 TEST3
Status: Ready
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Print to file
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Find Printer...
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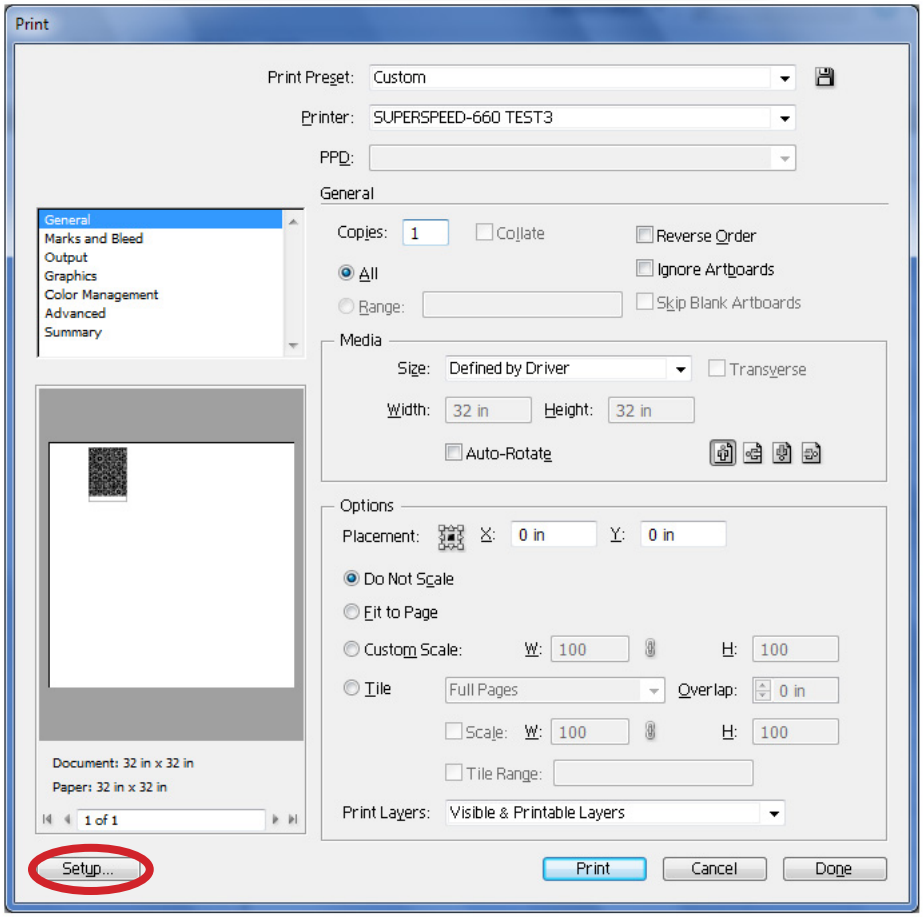
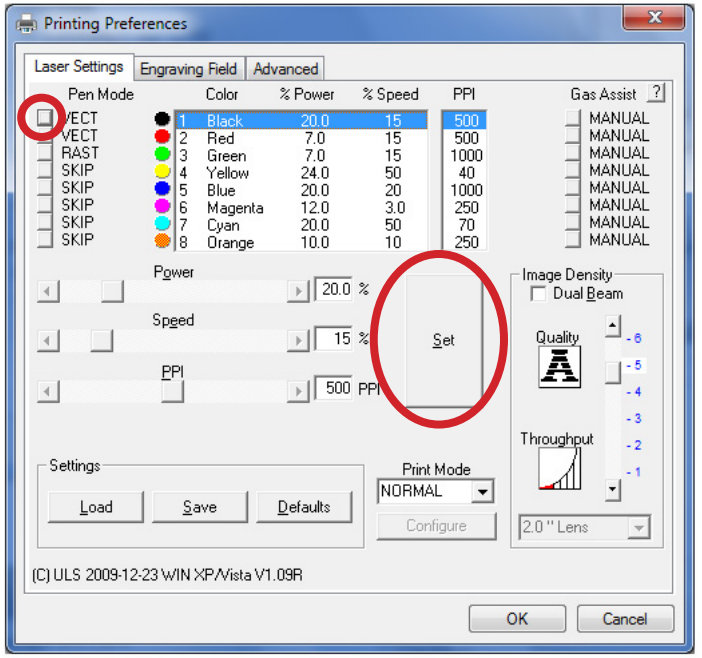
Print
Cancel


Print
Print Preset: Custom
Printer: SUPERSPEED-660 TEST3
PPD:
General
Marks and Bleed
Output
Graphics
Color Management
Advanced
Summary
Copies: 1
Collate
Reverse Order
All
Ignore Artboards
Range:
Skip Blank Artboards
Media
Size: Defined by Driver
Transverse
Width: 32 in
Height: 32 in
Auto-Rotate
Options
Placement:
X: 0 in
Y: 0 in
Do Not Scale
Fit to Page
Custom Scale: W: 100 H: 100
Tile
Full Pages
Overlap: 0 in
Scale: W: 100 H: 100
Tile Range:
Print Layers: Visible & Printable Layers
Document: 32 in x 32 in
Paper: 32 in x 32 in
1 of 1
Setup...
Print
Cancel
Done


Printing Preferences
Laser Settings
Engraving Field
Advanced
Pen Mode
Color
% Power
% Speed
PPI
Gas Assist
VECT 1 Black 20.0 15 500 MANUAL
VECT 2 Red 7.0 15 500 MANUAL
RAST 3 Green 7.0 15 1000 MANUAL
SKIP 4 Yellow 24.0 50 40 MANUAL
SKIP 5 Blue 20.0 20 1000 MANUAL
SKIP 6 Magenta 12.0 3.0 250 MANUAL
SKIP 7 Cyan 20.0 50 70 MANUAL
SKIP 8 Orange 10.0 10 250 MANUAL
Power 20.0 %
Speed 15 %
PPI 500 PPI
Set
Image Density
Dual Beam
Quality
Throughput
Settings
Load
Save
Defaults
Print Mode
NORMAL
Configure
2.0 " Lens
(C) ULS 2009-12-23 WIN XP/Vista V1.09R
OK
Cancel

START
READY
SELECT
ESCAPE
PREV FILE
NEXT FILE
PAUSE
RESUME
X-Y
Z

Troubleshooting

Go back through “Preparing a File”

Release clipping masks

Release compound paths

Create a new CS5 Illustrator file, copy/paste the job into it. *Tip - Illustrator can remember layers when copy/pasting, if you set it in the layers window options.*

Turn the laser off, restart the computer, open the job in Illustrator, turn on the laser cutter

IX. TEST AND REFINE SETTINGS

1. Turn off everything but the test layer
2. Enter print dialogues
   File > Print

3. Click Setup
4. Click Preferences

   For each color you are using;

   5. Press the button to select from SKIP/ RASTER/VECTOR according to your cut.
   6. Enter the power settings for each color to be utilized.

      Hit “set” for each colour. Hitting enter will not work, and instead change the SKIP/ RAST/VECT you just set.

7. Send the job to the cutter
8. Press start on the laser cutter

   If the cutter angrily beeps instead of cutting, see troubleshooting on the left.

9. Write the settings on the material next to the test cut
10. Examine results; could the cut be less smoky? Faster? Do score lines fold cleanly?
11. Set new power settings
12. Print
13. Repeat until settings perfected

While you run the job

This job wont take much time but others will get quite boring...

- cleanup (there is a vacuum!)
- tidy tools, materials, etc. (prep for leaving)
- tidy scrap areas
- read the main manual, especially the materials section. there are many helpful tips
- review this handbook

X. CUT YOUR PROJECT

1. Load your final piece of material
2. Using the provided brass weights, try to make the material lie as flat as possible

   The laser beam is focused, so variations in height will result in sub-optimal cuts. Ensure that the weights are not on top of a cutline, and that the laser cutter head can clear the weights.
3. Turn off the test layer
4. Turn on the main layer
5. Send the job to the cutter

XI. PUT THINGS AWAY

1. If the cut was smoky, check the lens
2. If you finish before the end of the time you signed up for and it is busy, contact the next person in line with the contact information next to the sign up sheet.
3. Dispose of scrap. Trim usable pieces out of waste sheets and deposit in the scrap areas
4. Vacuum the laser cutter bed, other places that you have made messy
5. Return everything to where you found it

If nobody is coming immediately after you, also

1. Turn the machine off
2. Turn the air off
3. Turn the exhaust off

If you are the last for the day, also

1. Turn the hall air off
2. Turn the computer off

LOOKING AHEAD

Further workshops are being developed. A draft list is shown here.

1. BASIC OPERATIONS
1.1 Polyhedra
1.2. Graphics
1.3 Sophistication of Line
1.4 Richness and speed of Fill

2. TECTONICS
2.1 Design for connections
2.2 Laser Joinery
2.3 Development of Curved Surfaces

2. SOME ADDITIONAL FUNCTIONS
2.1 Lens Options
2.2 Dual Laser Functions
2.3 Writing and Drawing on Metal

3. 3D FUNCTIONS
3.1 3D Interpretations of 2D Graphics
2.2 Printing Images
2.3 Rubber Stamp Mode