

BLOOMINGLABS LASER WORKSHOP

PART 1: LASER OPERATION AND SAFETY

IN CASE OF EMERGENCY

- ❖ Emergency stop (smash that button)
 - ❖ Power strip off
 - ❖ Fire Extinguisher on the wall
 - ❖ 911
 - ❖ Get out (you are more important than the laser)
-

NEVER BURN

PVC

Vinyl sheet

Foam

Styrofoam

Small-cell sheet foam

Unknown materials of any sort!

THE TUBE AND OPTICS

- Never touch any glass (tube, mirrors, lens) in the laser with bare hands!
 - Check the tube to make sure it isn't cracked or completely dirty
 - Check the mirrors and lens to make sure they're clean
-

OPERATIONAL CHECKS

- Is there water in the bucket?
 - Is the gate open?
-

TURNING IT ON

- Is the water flowing?
 - No, but really, is the water flowing and free of bubbles?
 - How about airflow? Do you feel a slight suction from the front, and is air being pushed out from the lens?
 - Turn the Big Red Button!
-

HOMING

Button on the laser with the house symbol

"H" in RetinaEngrave

CONNECTING

Use the machine next to the laser

Start RetinaEngrave

If it's just *not* seeing the laser:

Use the circular arrow in the lower left of RetinaEngrave to reconnect

If nothing else works, restart the laser and RetinaEngrave (close RetinaEngrave, power down the laser, wait a few seconds, power back up, wait until it finishes booting, then start RetinaEngrave)

PRINTING

- Send your files to: **laserbox@bloominglabs.org**
 - This sends your attachments to a Box account synched on the laser computer
 - From there, you can open them in Inkscape
- Placing your material
 - The laser will start from the top left of your material and picture
 - Place material to align with the top of the honeycomb
 - Move the laser head right and left to make sure it stays aligned with the top of the material
 - Shift the honeycomb as necessary to align your material with the alignment dot
- Focusing (basic version)
 - Use the aluminum billet (~1" cylinder on the left side of the laser)
 - Move the lens head to a point inside your cut
 - Loosen the thumb screw on the lens head and raise it slightly
 - Set the billet on the surface of your material under the lens head
 - Let the lens head drop gently onto the billet
 - Tighten thumb screw
 - Remove billet
- Sending your job to RetinaEngrave
 - Make sure RetinaEngrave is running
 - Print in Inkscape
 - Choose "FullSpectrum Laser" print driver
 - Switch over to RetinaEngrave
- Choosing print settings
 - There is a degree of subjectivity to choosing the "right" settings, since these will vary based on your intended use and desired outcome
 - The best way to find what works for you and your project is, as usual, to play around with the settings

My defaults (for 1/8" Baltic birch plywood):

Color	Purpose	Order	Speed	Power	Passes
Red	external cut lines	10	27	100	1
Green	internal cut lines	8	27	100	1
Blue	deep marked lines	5	100	20	1
Black	"default" marked lines	4	100	12	1
Magenta	light marked lines	3	100	6	1
Yellow	very light marked lines	2	100	2	1
Cyan/aqua	visual guides-not cut	1	100	0	0

○ BURNING!

- Make sure:
 - The laser is homed
 - Your material is aligned as desired
 - The lens is in focus
 - The lid is down
 - Your cut settings (including order and what lines NOT to cut) are correct
- Choose whether to cut as a raster or vector
- Check the outline using "J" or "P" to trace or go corner-by-corner
- Press the play icon or "G" to make it go

CLEANING UP

- Pick up the big pieces
- Vacuum the rest
- Wipe down the optics (gently)
- Clean out the honeycomb (gently)

SHUTTING DOWN

- Big Red Button
- Power strip
- The Gate! (Remember the Winter of 2014!)

PART 2: VECTORS!

VECTOR TOOLS:

- Illustration/Design
 - Inkscape
 - Adobe Illustrator
 - Corel Draw
- CAD
 - FreeCad
 - LibreCAD
 - Blender (+LaserSlicer: <http://blendscript.blogspot.co.uk/p/scripts.html>)
- Unlikely candidates
 - Office software (LibreOffice, MS Office: PowerPoint, Write, Excel, etc.)
 - PDF tools
 - Web browsers...sometimes

WHY INKSCAPE IS MY DEFAULT:

- User-friendly
 - Free (beer & speech)
 - Cross-platform
 - Easy (enough) to use
 - Uses open standards (SVG)
 - Tools are mostly easily discoverable
- Laser-friendly
 - 2D layers work the way the laser does
 - Precise enough
 - Easy to color lines/fills to work well with RetinaEngrave

THINGS TO SET

- Auto-save
- Default template
- Rulers (sometimes--Intel driver weirdness)

EXTENSIONS TO ADD

- Eggbot tools (hash fills)
- Laser tools (tabbed box maker)

TOOLS IN INKSCAPE:

MAKING SHAPES

- Freehand drawing
 - Smoothing can be your friend
- Bezier curves
 - For when you want more control

- Circles, ellipses, arcs, and spirals
 - You can change the arc length to create Pac-men
 - Ellipses are fun, but can get boring quickly
- Rectangles, polygons, and stars
 - Stars/polys are fun--just play with them

MANIPULATING SHAPES

- Select
 - This grabs objects, and can be used for basic shape scaling, rotation, and transformation
- Point select
 - This grabs points on lines or shapes, and lets you do point-specific operations (set Bezier points, change arc length, join points)
- Erase
 - It probably doesn't do what you want it to
 - Use point/segment deletion or CFG Difference operations (below) to cut open your shapes
- Object to Path
 - To do path joins and CFG operations, you'll have to convert circles, rectangles, etc. to paths
- Stroke to Path
 - For ellipses or freehand lines where you want to cut around the shape, thicken the stroke, then convert the stroke to a path
- Constructive flat geometry: Union, Difference, etc.
 - Boolean math for shapes
 - Some operations are tricky
- Inset/outset
 - Shift the outline to be just a tiny bit bigger/smaller
 - Not much control here
- Transform and align
 - Easiest way to center things on each other
- Fill and Stroke
 - Set the colors for your cuts
 - Set width and end curvature for stroke to path ops
 - Set fills for raster engraves

GROUPING

- Combine/break-apart
 - Path-oriented version
- Group/ungroup
 - Object-oriented version (you'll usually want this one)

LAYERS

- Layers are a good way to control complex cuts and allow the same lines to be used for multiple cut layers (same outline for multiple versions of an object)

KERF!

IT'S A FUNNY WORD WITH SERIOUS REPERCUSSIONS

- Kerf == cut width
 - Affects actual size
 - Affects fit
- Affected by material and settings
 - For 1/8" Birch and acrylic: ~0.233mm / ~0.009"
- Setting stroke width to the kerf value for what you want to cut can help estimate more accurately, but it's not a complete solution for getting parts to fit together

DESIGNING FOR THE LASER

- Cut order matters
 - Mark lines first
 - Burn inner cutouts next
 - Burn outer cuts last
- Make sure you're not cutting things off by overlapping your cut lines (unless you mean to)
- Test on wood
- If you're having trouble thinking of a thing, it's OK to look online
 - Look for open-license SVGs (you can import other formats, SVG just makes it easier)
 - Check out Thingiverse--it's great for inspiration
 - Even if you download something basic, customize it!
- If things aren't fitting right, it's probably a kerf issue
 - When working with perpendicular friction-fit joints, measure your material thickness, then bring your lines in by ~1/2 your kerf on either side
- Play around to see what you can do

ACRYLIC

- Things often look best when burned from the back side of acrylic, especially fluorescent stock
- Use RetinaEngrave to mirror **both** vector and raster components

PHOTO ENGRAVING

PICKING A PIC

- Good lighting
- High contrast, especially between subjects and background
- Large, distinct areas of flat/gradient color
- Reasonably high resolution
- Reasonably high clarity
- Not too many small highlight/dark spots

TOUCHING UP

- Given the right image, you probably don't need to do much
- Inkscape is not a photo editor--use something else for touching up your images (almost any image editing tool will work for this)
- Look for bright highlight spots on dark backgrounds--these will show up as unburned peaks in your final work, and should be darkened or blended to match the surrounding area
- White won't get burned, so if you want to mask your image so that only a portion (heads within a portrait) gets lasered,
- RetinaEngrave will take care of most of the dithering, but if you want to manage things with a little more control, you can convert your image to greyscale and manage brightness and contrast
- Make sure your DPI (dots per inch) and resolution match your desired physical engraving size
 - DPI doesn't have to match the intended engraving DPI (below)

COMBINING WITH VECTORS

- Import your image into Inkscape
- Frame around it
- Feel free to cover it with vector shapes
- Create a frame with a red (or cut color of your preference) outline
- Consider black an unmarked (0 passes) line color--RetinaEngrave will pick up a black outline on raster images by default

BURNING

- 500dpi ought to be enough for anybody!
 - 250 isn't great for detail
 - 1000 will be considerably slower and will carve deeper, but it can give you a smoother image--only move up to 1000 if you really need to
- Use the RetinaEngrave dither methods, rather than editor-based filters

- - If you move up to 1000dpi, re-run any dither operations for best results
- 40-60% is a good raster speed
 - Going slower won't increase quality or depth
 - Going faster...might not actually be faster (or at least not by much)
- Try starting at 50% power, then increase or decrease as needed for contrast/desired depth

ACRYLIC

JUST LIKE BIRCH!

- The cut and etch settings for most acrylic are the same as they are for Baltic birch (non-composite core) plywood
- Test using wood--it's cheaper and you can keep settings the same from test to final burn

...ALMOST

- Acrylic can melt slightly on slower cuts or as the beam gets reflected by the support honeycomb
- It can frost inconsistently from gasses settling and bonding with its surface
- Leave protective backing on when possible to alleviate both of these
 - If etching or doing extensive vector marking, remove the top, but leave the bottom on
 - If only cutting and/or doing minor vector marking, leave both sheets on, but increase vector power for marking by a few percent/lower cut speed by 1-2%
- Kerf is slightly tighter and acrylic has less flex/is more brittle than wood--be careful not to break things

PLAN FOR LIGHTING

- Etched or marked acrylic catches light better if burned from behind--use RetinaEngrave's flip tools to quickly reverse BOTH raster and vector images, and make sure things still line up correctly after doing so
- Light from the edge, not the front (back is...OK, but usually not as good as an edge)
- Fluorescent acrylic is UV-reactive and blacklight LEDs are cheap (though it looks good without blacklight, too)

GREAT FOR BOXES

- Acrylic doesn't soften or warp over time like wood
- It's easily held together by either friction fit or machine screws and nuts

GREAT FOR LINE DRAWINGS/PICS WITH LARGE COLOR BLOCKS

INCONSISTENT FOR PHOTOS

PART 4: ADVANCED MATERIALS AND TECHNIQUES

MATERIALS

NEVER BURN

- PVC
- Vinyl sheet
- Foam
 - Styrofoam
 - Small-cell sheet foam
- Unknown materials of any sort!

HELPER MATERIALS

- Aluminum foil
 - Can be used between folds/plies of paper or cloth to prevent cut-through
- Metal hold-down objects

FAST CUT (100% SPEED) MATERIALS

- Paper (incl. origami)
- Cardstock
- Felt
- Cloth

STINKY THINGS

- Leather
- Wool
- Rubber (even "low odor" stamp material)
- Some acrylics, other plastics

BURNING THROUGH

PAINT & FINISHES

- Watercolor
 - Usually safe, lowest risk (but potentially on high-risk materials)
- Polyurethane
 - Usually safe
- Acrylic
 - Usually safe--if in doubt, do a flame test
- Latex
 - Usually safe--do a flame test
- Tempera
 - Brittle--not great candidate
- Oil
 - Not recommended--do a flame test

ANODIZED COATINGS

One of the best ways to mark on metal: the laser will remove dyes from an anodized coating, revealing clean metal to shine through

MULTI-LAYER ACRYLIC

- Often used as sign material
- Kind of expensive
- Can warp easily—do tests on small samples

CREATING A KERF GUIDE

In Inkscape:

Create a 2"x3" rectangle, transparent fill, red outline

Inside the rectangle, create two yellow lines, 1/2" in from each corner, running the length of the rectangle (2")

Between the lines, create 5 green lines, 1/2" from each other

Cut on the laser, using standard/desired power settings for material

Cut order: green: 1, yellow: 2, red: 3

Remove from laser, place on flat surface

Put all internal pieces inside outer rectangle, and slide them to one end

Measure remaining gap between last piece and internal cut of rectangle

Divide this by the number of green lines (5), and you'll have your kerf!