Laser Cutting Laboratory Manual

GNG1103 – Engineering Design

Objectives

The objectives of this laboratory is to learn the basics of 2D modelling and the use of a laser cutter. The laboratory will go through the functions of a 2D modelling software that are the most useful for laser cutting. Also, you will learn how to convert a 2D modelling file to a file that can be cut in a laser cutter. Finally, you will learn how to operate a laser cutter.

Background

Laser cutting uses a high-powered beam to cut material based on computer-controlled parameters. As the laser guides its beam along the material, everything in its direct path is vaporized, burned or melted. One of the benefits of laser cutting technology is the cut product rarely needs any finishing work as this process ensures a high-quality surface finish. A graphics software is used to import or create designs that are meant to be cut.

Inkscape

Inkscape is primarily a vector drawing software. It allows you to create graphics very accurately and contains many effects.

It allows you to create shapes, clones, markers, paths, 3D shapes or text. All parameters can be adjusted very precisely and a large choice of predefined shapes is available, which makes it customizable. It is also possible to draw freehand with, for example, a calligraphy writing tool. These tools are present in various menus and accessible by buttons on the side in the manner of the Paint accessory present with Windows.

Besides drawing, Inkscape also allows some editing with the ability to incorporate images. This allows you to adjust certain visual parameters, such as brightness, color saturation, or noise. The software also contains a developed layer system.

Regarding operation, Inkscape uses the Scalable Vector Graphic (SVG) file format for patterns, paths or created texts. It also conforms to XML and CSS standards. Images created in Inkscape can be converted into many formats such as JPEG, EPS, and TIF. However, its export format is in PNG by default. To laser cut a file draw in Inkscape, the ideal export format is PDF.

To download Inkscape go to https://inkscape.org/release/inkscape-0.92.4/, choose the appropriate operating system and follow the instructions.

Useful tools in Inkscape

- **Panning the canvas**

There are many ways to pan (scroll) the document canvas. Try `Ctrl+arrow` keys to scroll by keyboard. (Try this now to scroll this document down.) You can also drag the canvas by the middle mouse button.

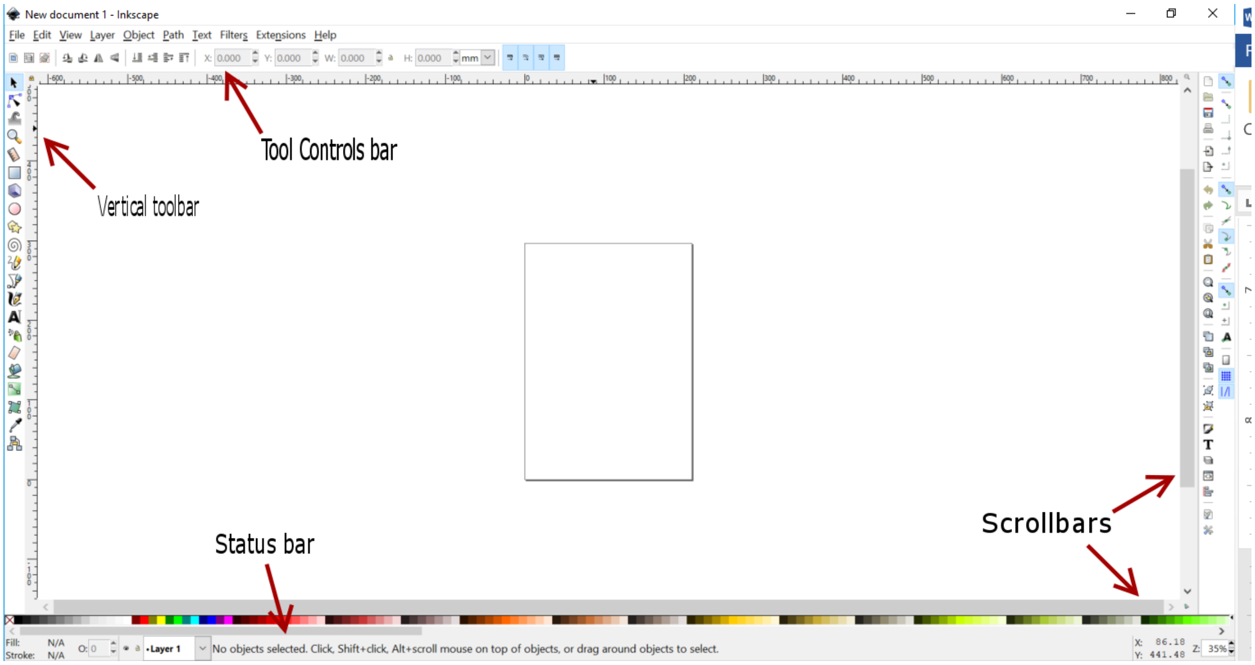
Or, you can use the scrollbars (press `Ctrl+B` to show or hide them). The `wheel` on your mouse also works for scrolling vertically; press `Shift` with the wheel to scroll horizontally.

- **Zooming in or out**

The easiest way to zoom is by pressing `-` and `+` (or `=`) keys. You can also use `Ctrl+middle click` or `Ctrl+right click` to zoom in, `Shift+middle click` or `Shift+right click` to zoom out, or rotate the mouse wheel with `Ctrl`. You can also click in the zoom entry field (in the bottom right corner of the document window), type a precise zoom value in %, and press Enter. We also have the Zoom tool (in the toolbar on left) which lets you to zoom into an area by dragging around it. Inkscape also keeps a history of the zoom levels you've used in this work session. Press the `` ` `` key to go back to the previous zoom, or `` Shift+` `` to go forward.

- **Inkscape tools**

The vertical toolbar on the left shows Inkscape's drawing and editing tools. In the top part of the window, below the menu, there's the *Commands bar* with general command buttons and the *Tool Controls bar* with controls that are specific to each tool. The *status bar* at the bottom of the window will display useful hints and messages as you work. Many operations are available through keyboard shortcuts. Open Help > Keys and Mouse to see the complete reference.


New document 1 - Inkscape
File Edit View Layer Object Path Text Filters Extensions Help
X: 0.000 Y: 0.000 W: 0.000 H: 0.000 mm
Tool Controls bar
Vertical toolbar
Scrollbars
Status bar
Fill: N/A
Stroke: N/A
O: 0
Layer 1
X: 86.18 Y: 441.48 Z: 35%

No objects selected. Click, Shift+click, Alt+scroll mouse on top of objects, or drag around objects to select.

Figure 1.Workplace of Inkscape

Laser cutter

The laser is not directly cutting material, we use optic bending to remove material. The focal length is very important and dependent on the thickness of your piece. If the focal length is too far away it won’t allow a clean vectoring. The laser cut works by cutting along the X-Y plane.

Laser cutter safety

- In operation there is a laser diode pointer (red dot pointer), this is similar to a laser pen but it should never be directed into anyone's eyes. The actual laser beam that will be cutting is invisible so never modify the enclosure.
- The filter should always be attached while performing a cut, the laser cutter is not to be used without the filter, this ensures that the air in the room is safe for users and limits potentially hazardous debris (see Materials below for more).
- The laser can cut many materials but some materials that can be hazardous or dangerous to cut (ex. the small dust particles of MDF are cancer causing).
- Never let the laser system operate unattended.
- When vector cutting, use the air assist (located below the table or on the wall) to provide sufficient airflow for the cut.
- A vector cut moves much slower than a raster engrave therefore a lot of heat is being applied to the material for longer time, which may cause it to combust.
- Make sure you know where the fire extinguisher is and the closest emergency exit.
- Remove debris from crumb tray after machine use to prevent fires.
- Never disassemble the machine or remove protective covers. Never open the machines access panels while unit is plugged in. The AC input to the Epilog Laser is potentially lethal and fully contained in the cabinet.

Example of Laser cutter (Epilog Laser Mini)

The laser cutter that is going to be used for this laboratory is the Epilog Laser mini.

Figure 2. Epilog Laser Mini

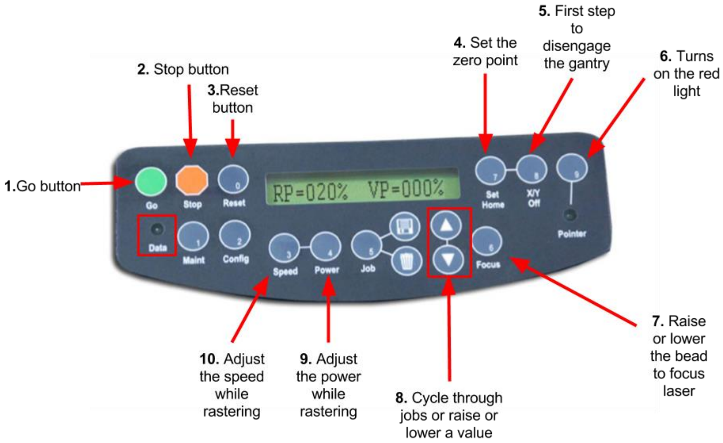
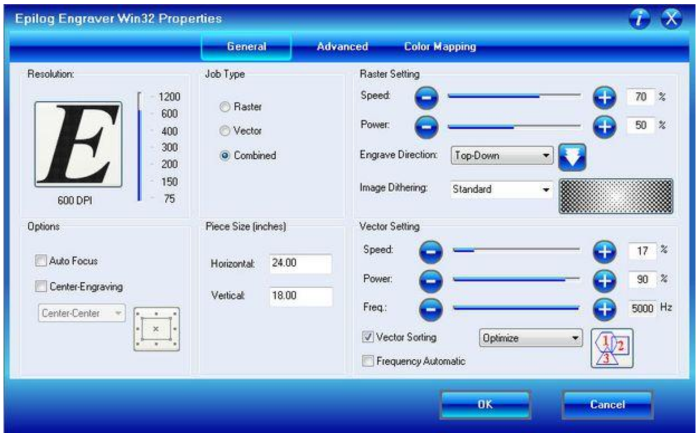

1.Go button
2. Stop button
3.Reset button
4. Set the zero point
5. First step to disengage the gantry
6. Turns on the red light
7. Raise or lower the bead to focus laser
8. Cycle through jobs or raise or lower a value
9. Adjust the power while rastering
10. Adjust the speed while rastering
RP=020% VP=000%
Go
Stop
Reset
Data
Maint
Config
Speed
Power
Job
Focus
Set Home
X/Y Off
Pointer

Figure 3. Command of the Epilog Laser Mini

Steps to start a laser cut

- First open your PDF files that is going to be used and click on `print`.
- Select Epilog Engraver Win32 as your printer. The Epilog software should appear.



Resolution: 600 DPI

Job Type:
○ Raster
○ Vector
● Combined

Options:
☐ Auto Focus
☐ Center-Engraving
Center-Center

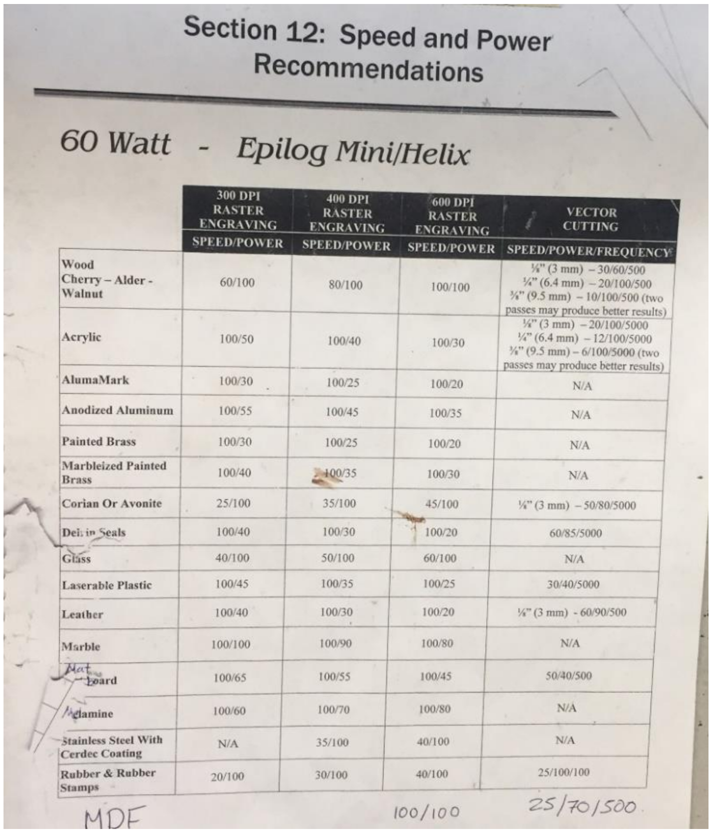
Piece Size (inches):
Horizontal: 24.00
Vertical: 18.00

Raster Setting:
Speed: 70 %
Power: 50 %
Engrave Direction: Top-Down
Image Dithering: Standard

Vector Setting:
Speed: 17 %
Power: 90 %
Freq.: 5000 Hz
☑ Vector Sorting: Optimize
☐ Frequency Automatic

Figure 4. Epilog Laser software

- Under the general tab, set all the parameters that need to be fill in. The **Job type** allows you to decide if the laser need to raster (engrave), vector (cut) or do both. Then change the **Raster** and/or **Vector setting**, these values must be specific to the actual material being used. See the list below.



Section 12: Speed and Power Recommendations

60 Watt - *Epilog Mini/Helix*

	300 DPI RASTER ENGRAVING	400 DPI RASTER ENGRAVING	600 DPI RASTER ENGRAVING	VECTOR CUTTING
	SPEED/POWER	SPEED/POWER	SPEED/POWER	SPEED/POWER/FREQUENCY
Wood Cherry – Alder - Walnut	60/100	80/100	100/100	⅛" (3 mm) – 30/60/500 ¼" (6.4 mm) – 20/100/500 ⅜" (9.5 mm) – 10/100/500 (two passes may produce better results)
Acrylic	100/50	100/40	100/30	⅛" (3 mm) – 20/100/5000 ¼" (6.4 mm) – 12/100/5000 ⅜" (9.5 mm) – 6/100/5000 (two passes may produce better results)
AlumaMark	100/30	100/25	100/20	N/A
Anodized Aluminum	100/55	100/45	100/35	N/A
Painted Brass	100/30	100/25	100/20	N/A
Marbleized Painted Brass	100/40	100/35	100/30	N/A
Corian Or Avonite	25/100	35/100	45/100	⅛" (3 mm) – 50/80/5000
Delrin Seals	100/40	100/30	100/20	60/85/5000
Glass	40/100	50/100	60/100	N/A
Laserable Plastic	100/45	100/35	100/25	30/40/5000
Leather	100/40	100/30	100/20	⅛" (3 mm) - 60/90/500
Marble	100/100	100/90	100/80	N/A
Mat Board	100/65	100/55	100/45	50/40/500
Melamine	100/60	100/70	100/80	N/A
Stainless Steel With Cerdec Coating	N/A	35/100	40/100	N/A
Rubber & Rubber Stamps	20/100	30/100	40/100	25/100/100
MDF			100/100	25/70/500

Figure 5. Speed and power recommendations of the Epilog Laser Mini

- Set the dimensions of your piece size.
- Click OK. You should be able to visualize your print on the right bottom corner of the screen.
- Send the print to the laser by clicking on `print.`
- Place your material inside the laser cutter.
- To focus the laser, press `Focus`. You will be able to move the bed up and down by pressing the up/down arrow. Put the focusing tool in the laser, move the bed down to make sure that your material is not touching the focusing tool and move the bed up until it touches the focusing tool. Once it touches the focusing tool, move the bed down one (1) time.
- Set your home by pressing `X/Y off? > Go`. You should be able to freely move the X and Y axis of the laser cutter. Once you moved it at the desired position, press `Set home`.
- On the laser cutter Press `Job`, select your jab name and press `Go`.

Pre-Lab

1. How does laser cutting work?

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2. Why is it important to have the filter always ON when using the laser cutter?

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3. What type of file does Inkscape uses?

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4. If I only want to cut my materials, what type of job do I need to choose in the Epilog software?

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5. What are the vector settings for glass?

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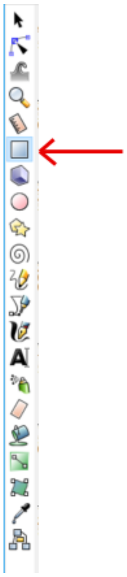
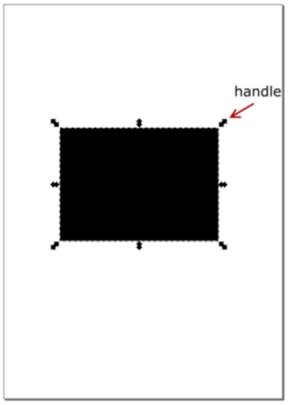
Part 1. Getting used to Inkscape

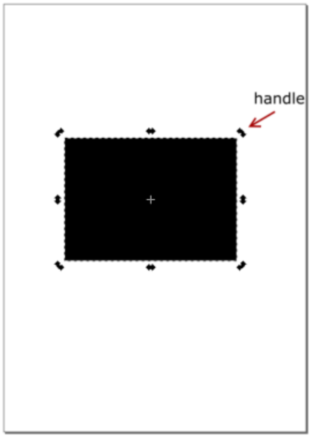
1. To create a new empty document, use File > New (or press `Ctrl+N`).
2. Click on the Rectangle tool in the vertical toolbar (or press `F4`) and click-and-drag, in the empty document and press `F1` or space.



3. Select the rectangle and move it by dragging it. Roughly place it at the center of your workspace. Press `F1.`
4. Click the rectangle and scale the object by dragging any handle.

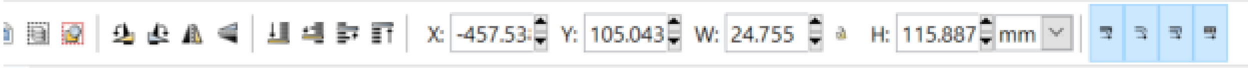


5. Now click the rectangle again. The handles change.



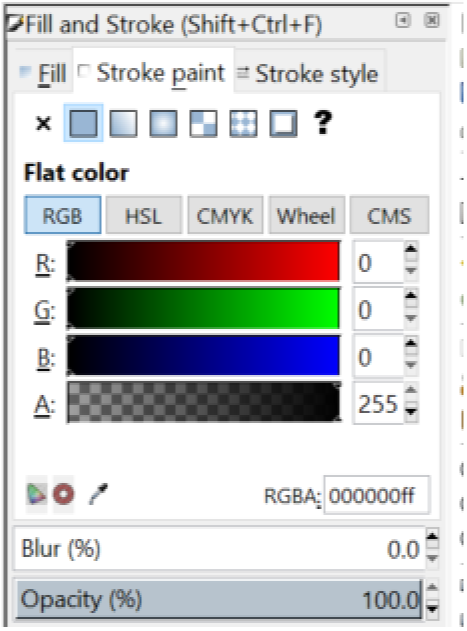
6. Rotate the object by dragging corner handles. (Press `Ctrl` to restrict rotation to 15 degree steps). Do a 90 degree rotation to the left.

7. Skew (shear) the object by dragging the top non-corner handle. (Press Ctrl to restrict skewing to 15 degree steps.) Do a 30 degree skewing to the left.
8. While in Selector, you can also use the numeric entry fields in the Controls bar (above the canvas) to set exact values for coordinates (X and Y) and size (W and H) of the selection.
9. Set X to 2.5mm, Y to 60mm, W to 205mm and H to 170mm.



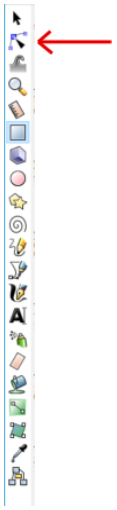
X: -457.53
Y: 105.043
W: 24.755
H: 115.887 mm

10. Select the rectangle and open the Fill and Stroke dialog from the Object menu (or press Shift+Ctrl+F). You will see that the dialog has three tabs: Fill, Stroke paint, and Stroke style. The Fill tab lets you edit the fill (interior) of the selected object(s). Using the buttons just below the tab, you can select types of fill, including no fill (the button with the X), flat color fill, as well as linear or radial gradients.

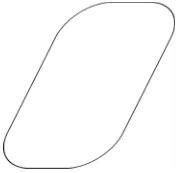


R: 0
G: 0
B: 0
A: 255
RGBA: 000000ff
Blur (%) 0.0
Opacity (%) 100.0

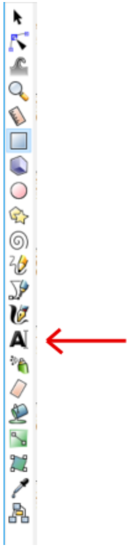
11. Select the Fill tab and click on the no fill button (the button with the X).
12. Now select the Stroke paint tab, select Flat color and if it is not already set, set the R, G and B to 0 and the A to 255.
13. Now select the Stroke style and change the width parameter to 1mm.
14. Select your object (press F1 to get back to the selector) and click on nodes tool in the toolbar (or press F2).



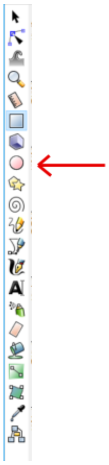
15. Move the circle corner (should be the right bottom corner of your object) to round up the corners of your rectangle. Your part should approximatively look like this:



16. Rotate your object by 90 degree to the left. If the dimensions of your object changes, set them back to X: 2.5mm, Y: 60mm, W: 205mm and H: 170mm.
17. Click on the text tool in the toolbar (or press F8) and write your name inside your object. Scale your name so that it fit in your object.



18. Click on the circle tool in the toolbar (or press F5) and click-and-drag in your document.



19. Set the coordinates and size of your circle to X: 150mm, Y: 65mm, W: 50mm and H: 50mm.
20. Select your circle, open the Fill and Stroke dialog from the Object menu (or press `Shift+Ctrl+F`), select the Fill tab and click on the no fill button (the button with the X).
21. By holding shift, select your circle and your rectangle, select the Stroke style and change the width parameter to 0.001 **in** (Careful, it's now in inches not in millimeters). Your lines are now really thin, you may want to zoom in to be able to see them.
22. Finally, by holding shift, select your circle, rectangle and you text, and group them by pressing `Ctrl+G`. Note: to undo, press `Ctrl+U`.
23. Save your file under the name Tutor1 first as a .SVG and then as a PDF. While saving as a PDF a box will appear. Make sure that the Resolution for rasterization (dpi) is 600 and click OK.
24. Your file is ready to get laser cut.

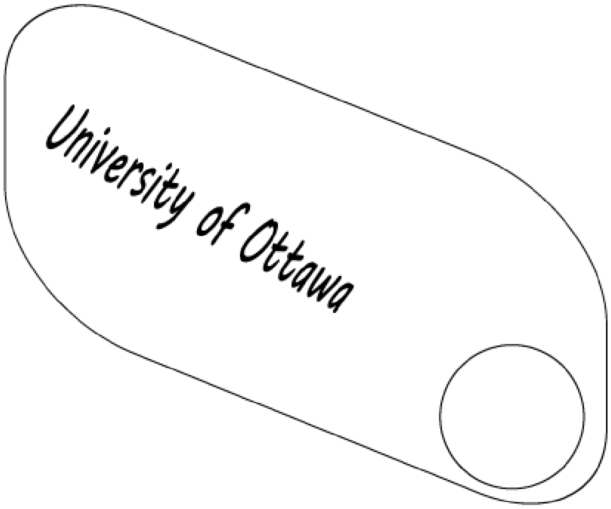


Figure 6. Finished PDF part of the laboratory

Part 2. Create a box

Creating a box may seem complicated (it is), but there are some online tools that can be used to make it really easy.

1. Go to http://www.makercase.com/

2. Fill out the dimensions that you want.
3. Select your material thickness.
4. Select your type of edge joint.
5. Click on generate laser cutter plans.
6. You can also go to another website that has more options: https://www.festi.info/boxes.py/ and select the type of box that you would like.

Part 3. Playground

In Inkscape, create a personalize part and show it to the TA/PM.