Intro to Laser Cutting and Engraving

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This Clinic

- Introduction to Inkscape (2D CAD) software
- Introduction to XTool S1 Low-cost laser cutter/engraver
- Questions? Please ask!

I don’t intend to teach you how to use either the software or the hardware in any detail - that would require multiple clinics - but instead to show you what the potential might be and what the learning curve looks like.

What is Laser Cutting/Engraving?

- 2D fabrication tool
- Think pen plotter, but with a laser! <pew> <pew>
- Way cooler than an X-Acto knife!
- Allows for both cuts and surface texturing.

Why Use Laser Cutting/Engraving?

- Allows for rapid prototyping - test designs in cheap materials and troubleshoot before final design
- Allows for production of ANY prototype. You are no longer dependent on manufacturers
- Greater use of sustainable materials (wood, paper, etc, rather than plastic
- Especially good for scales other than HO, where commercial kits are more limited.
- Prototype modeling - build things you can’t buy.

Getting Started

You need two things:

1. A laser cutter/engraver

    Traditionally $10K and up

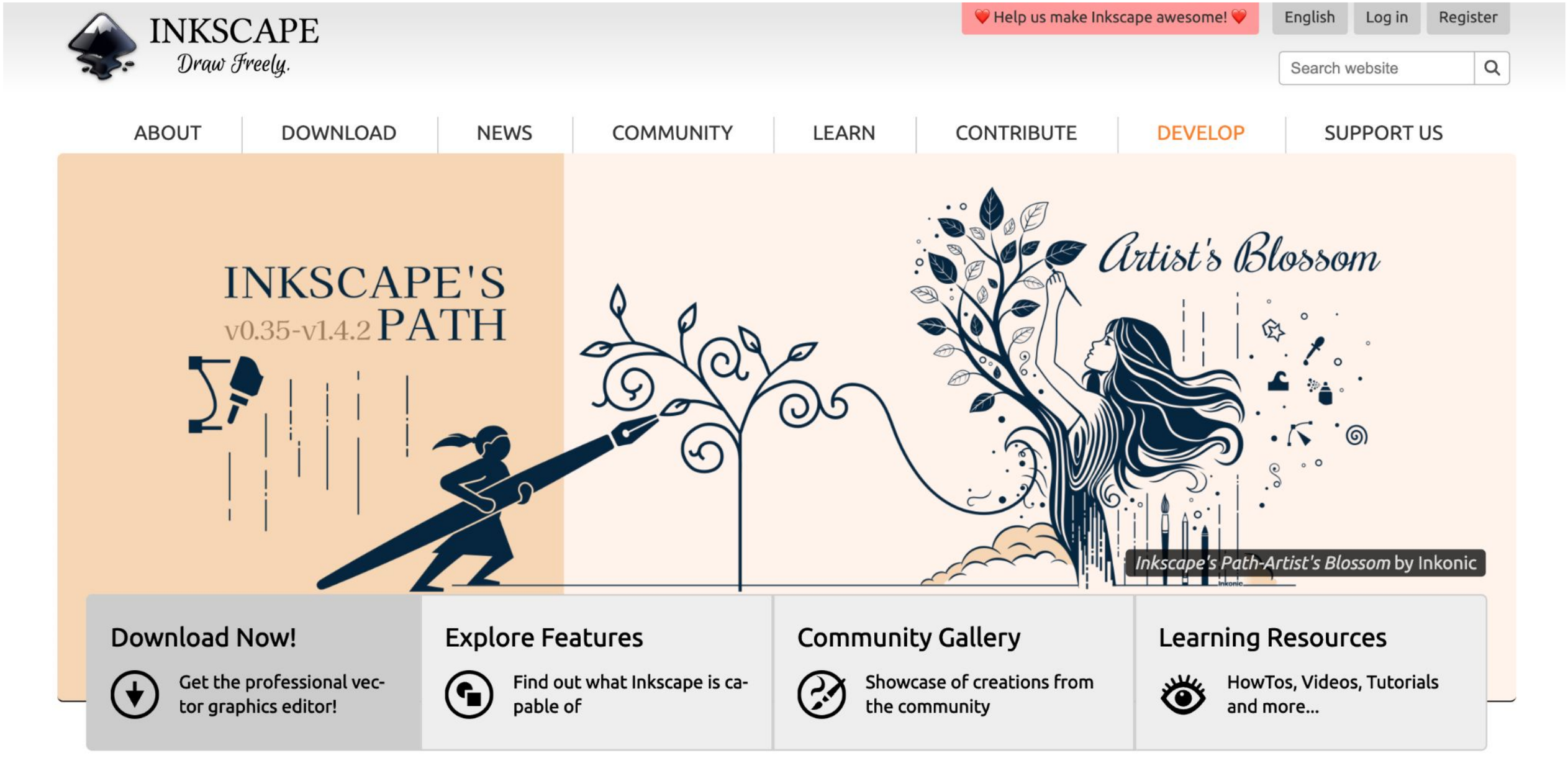
    New machines $1K and up

2. Drawing Software (2D CAD)

    Anything that can generate vector and raster graphics

    I use Inkscape, because it’s free and open source

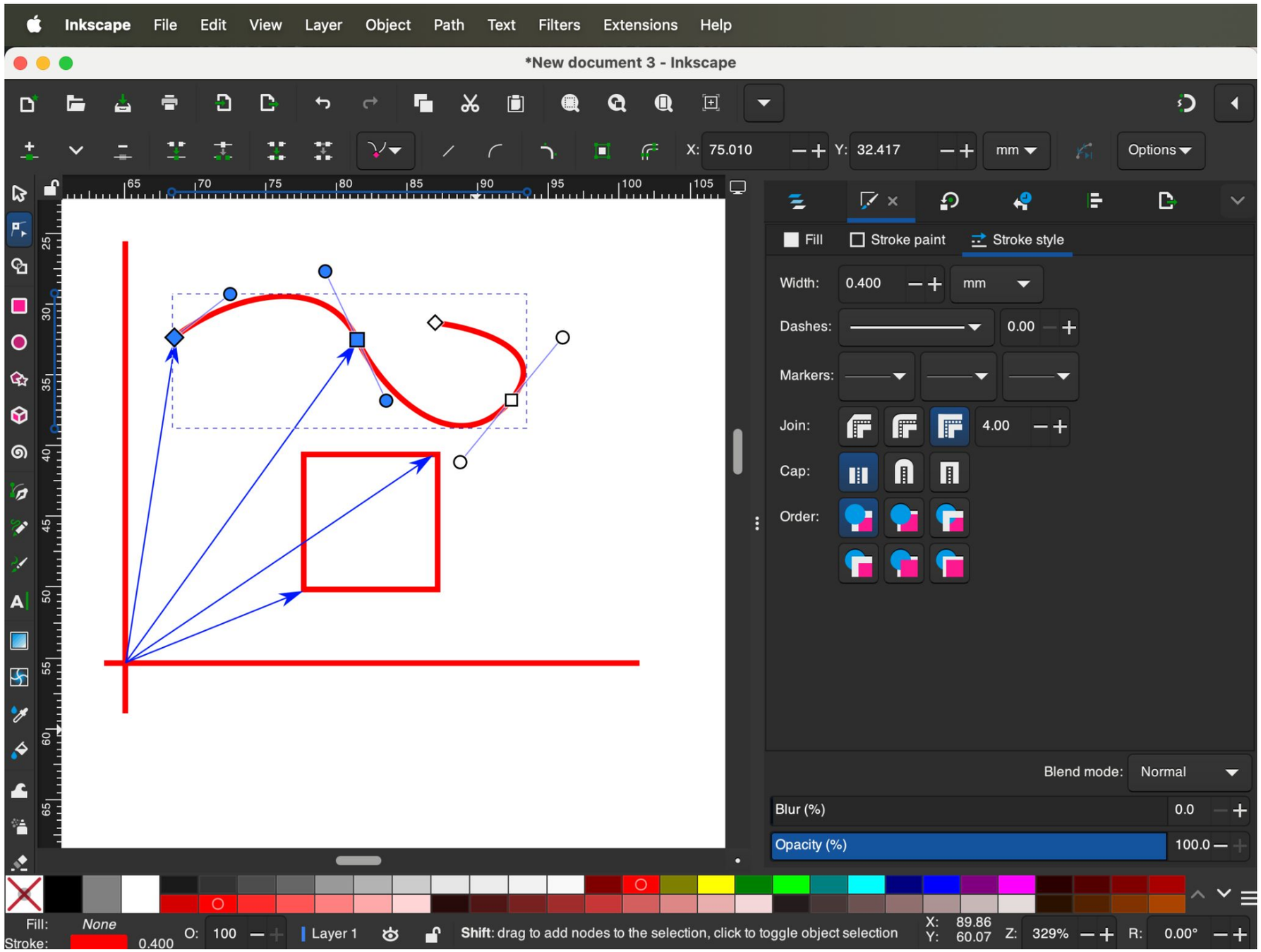
Inkscape



https://inkscape.org

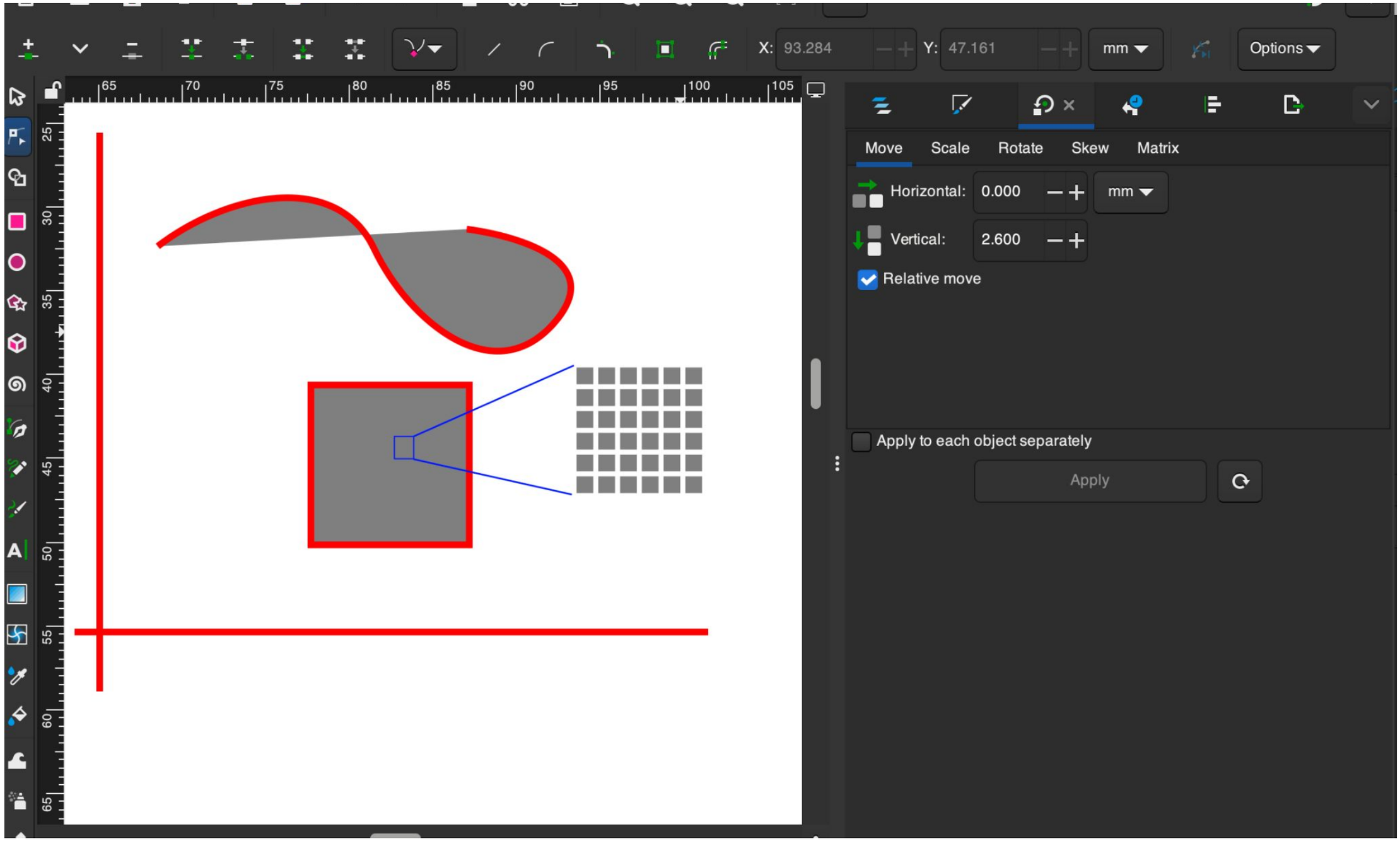
Vector Graphics

Bezier curves: lines and shapes defined by anchor points and tangent lines -”Path” in Inkscape
Polygons: closed forms defined by corner points - “Object” in Inkscape



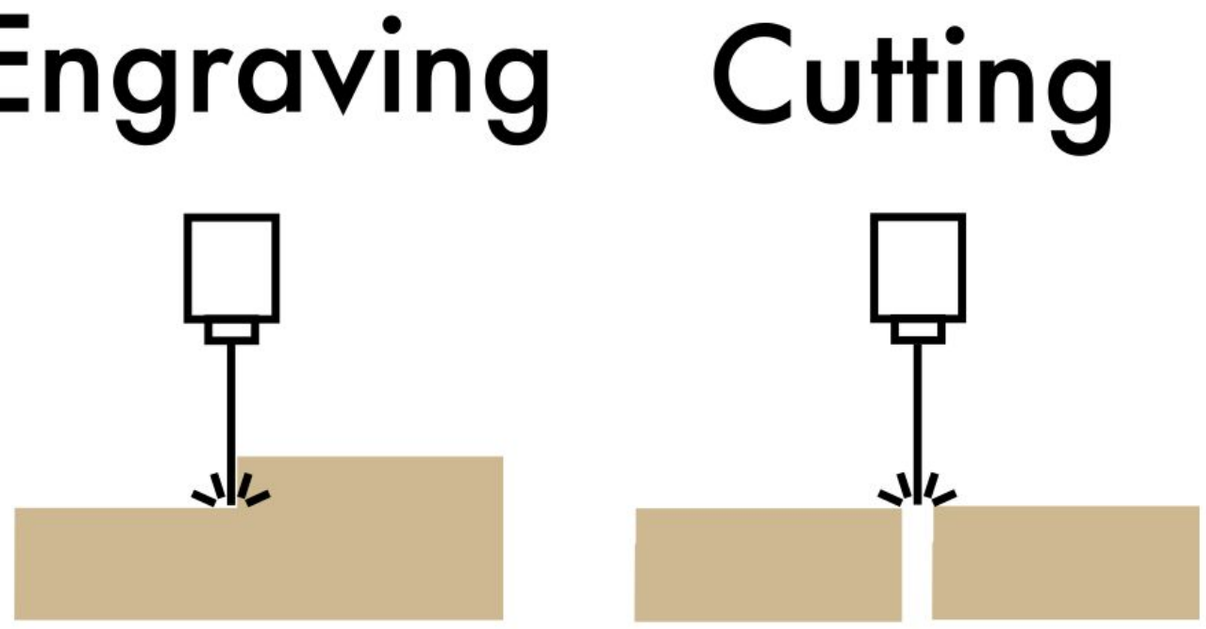
Raster Graphics

Anything composed of pixels - “Fill” in Inkscape, also imported “bitmap” files (JPEG, TIFF, PNG, etc.)



Engraving vs. Cutting

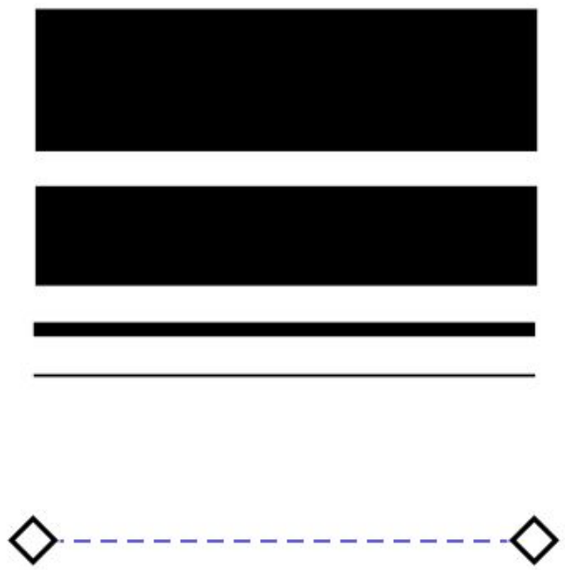
Engraving: Milling away material across an area with one or more passes of the laser
Cutting: carving through the material with one or more passes along a single line



Raster Graphics

Vector Graphics

Vector Graphics and Engraving



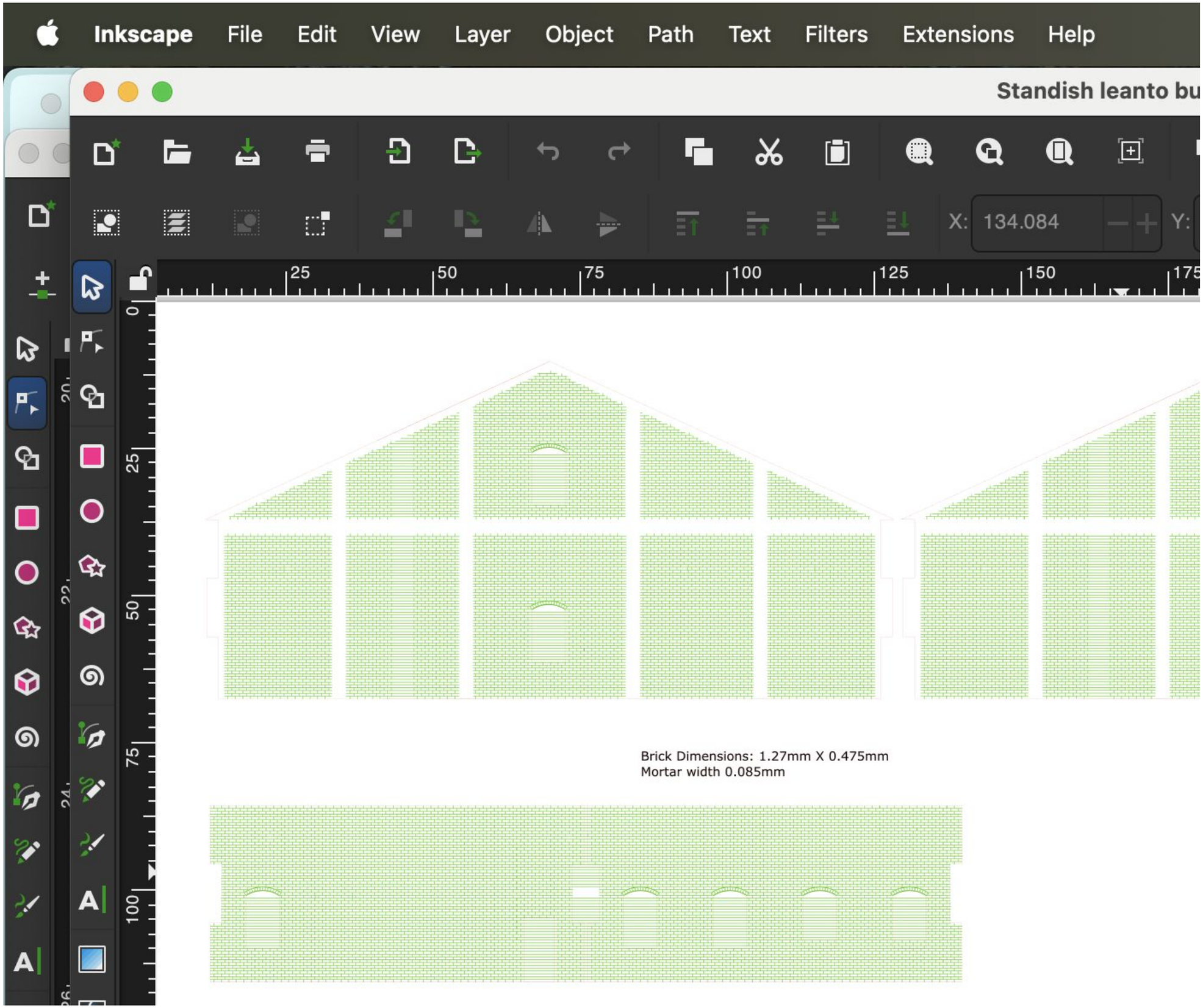
No matter what
the line weight is,

the software sees this
infinitesimally thin line

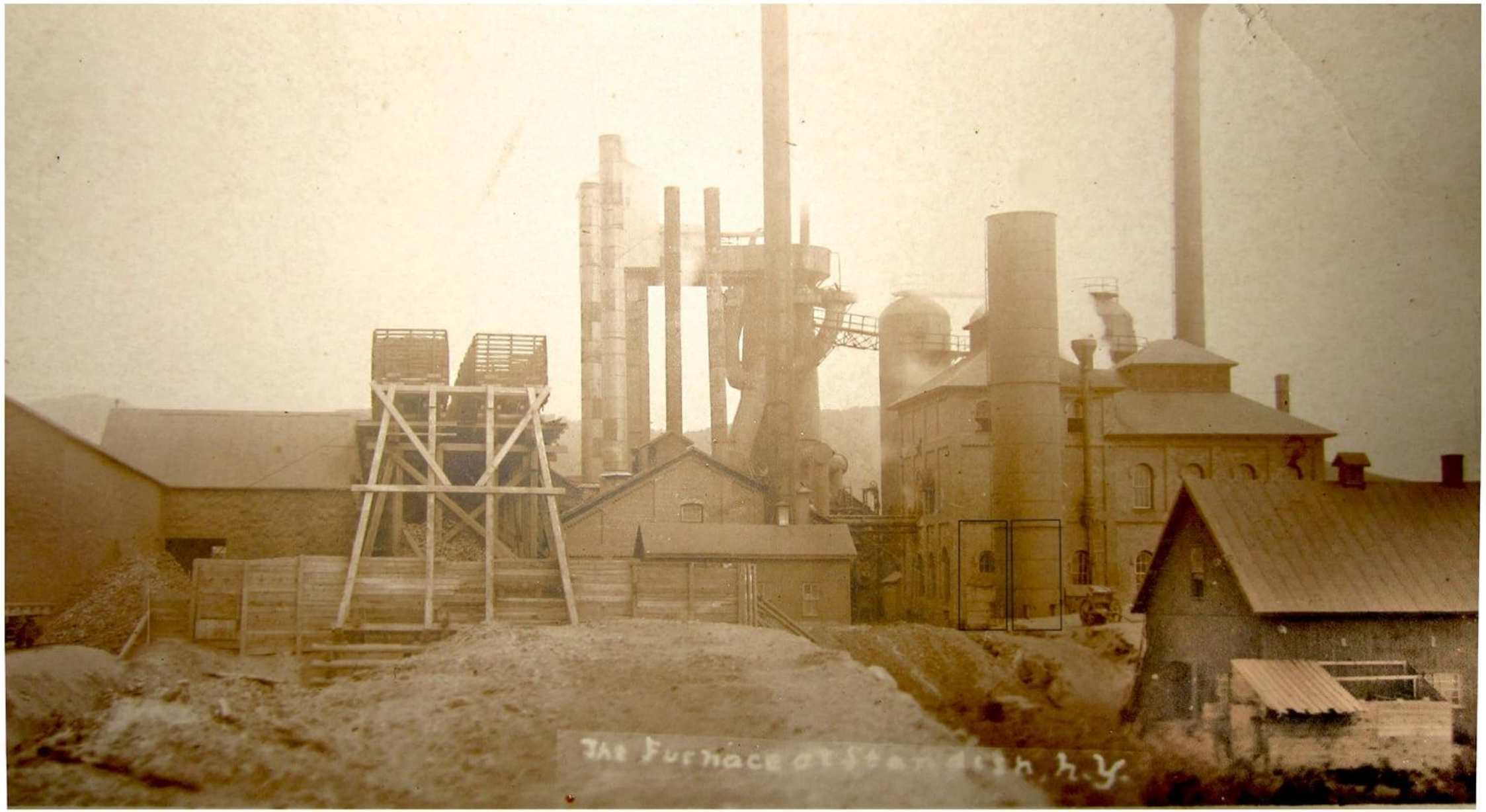
If you are trying to engrave a wide line, and you use a vector line, you will only get a single narrow line, no matter what the line width.

To engrave a wide line, you must use a raster fill or object in your design.

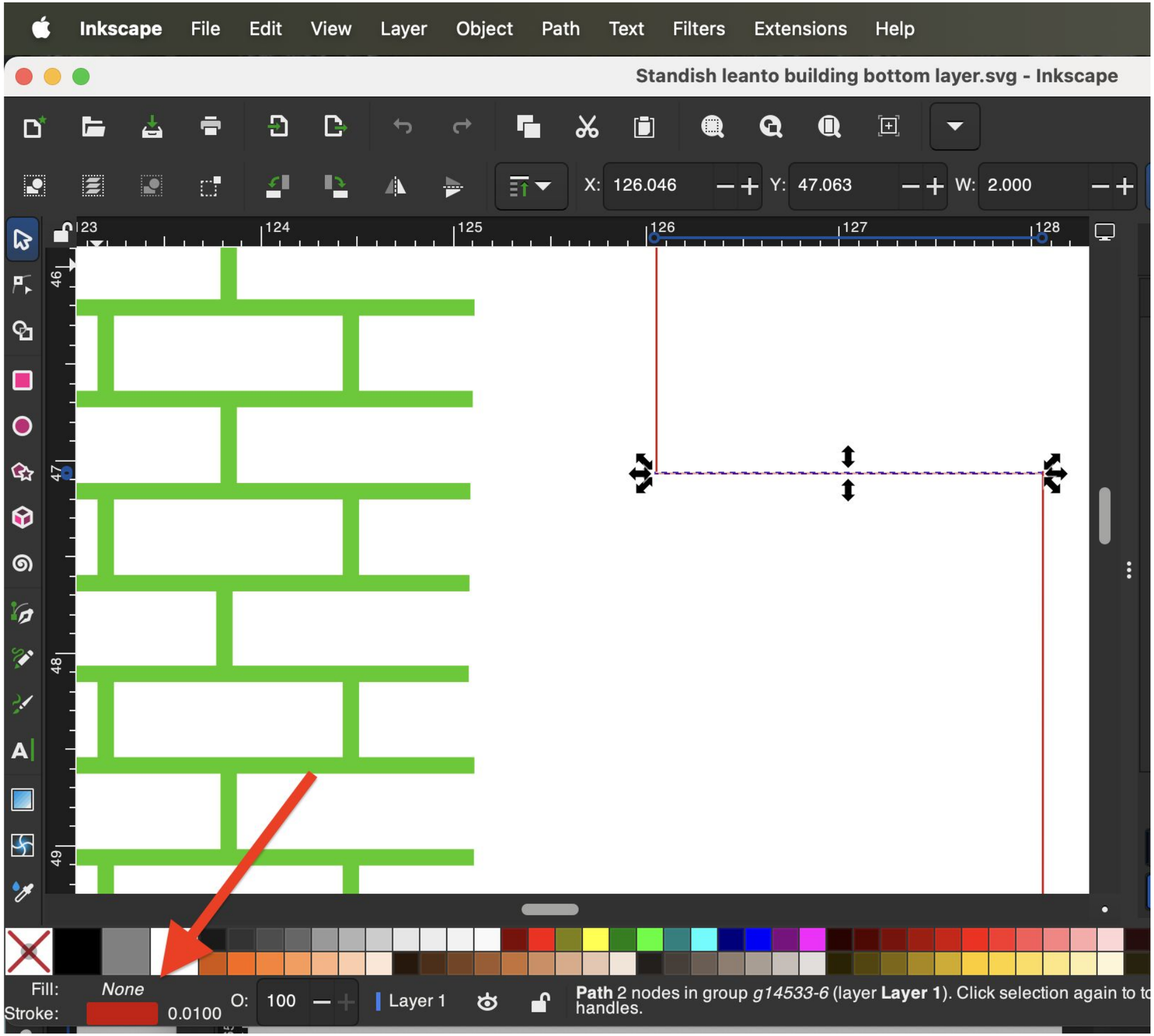
Example: Building for the Standish Blast Furnace



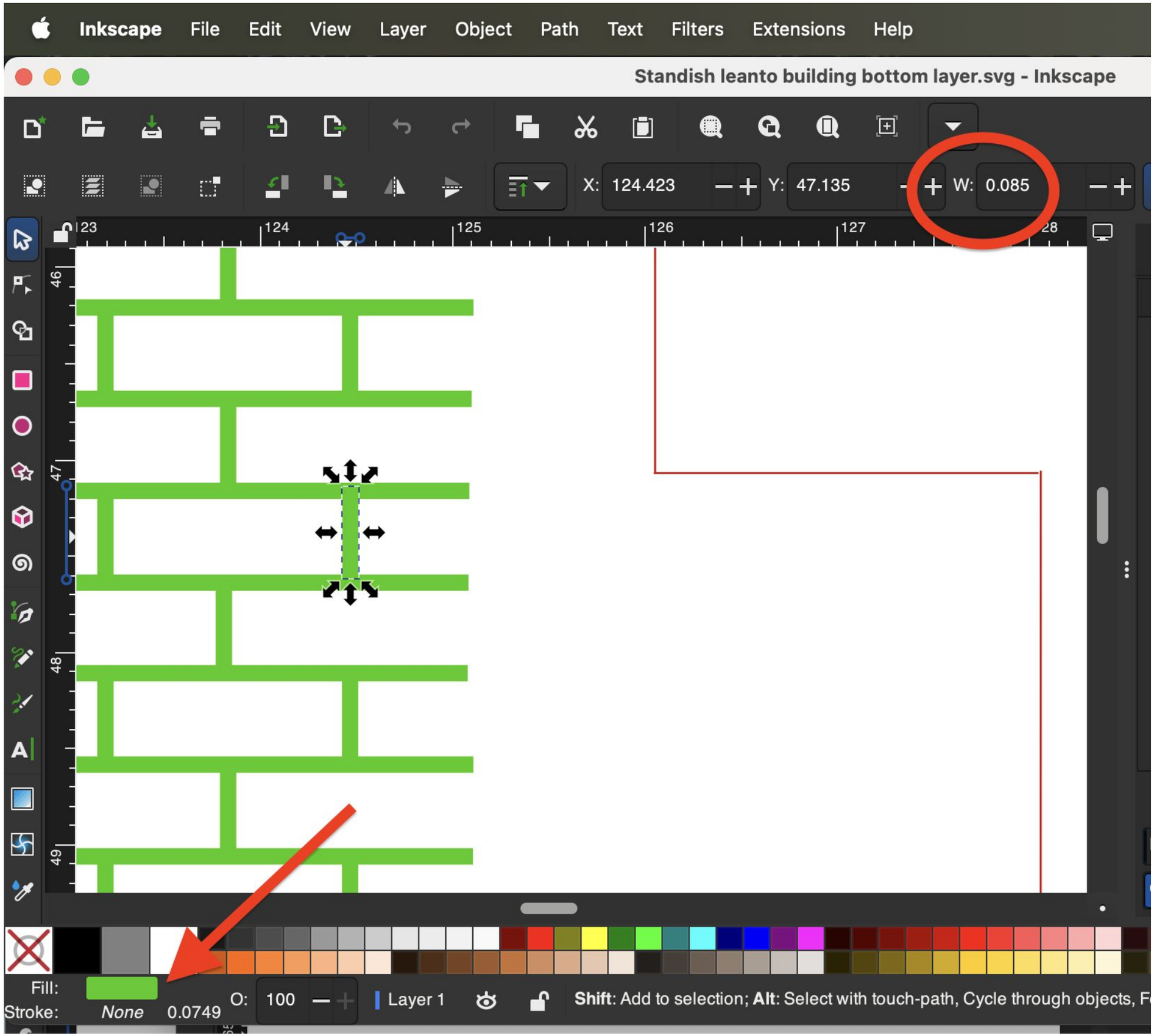
Reference Image



Vector element - cut line on edge of wall



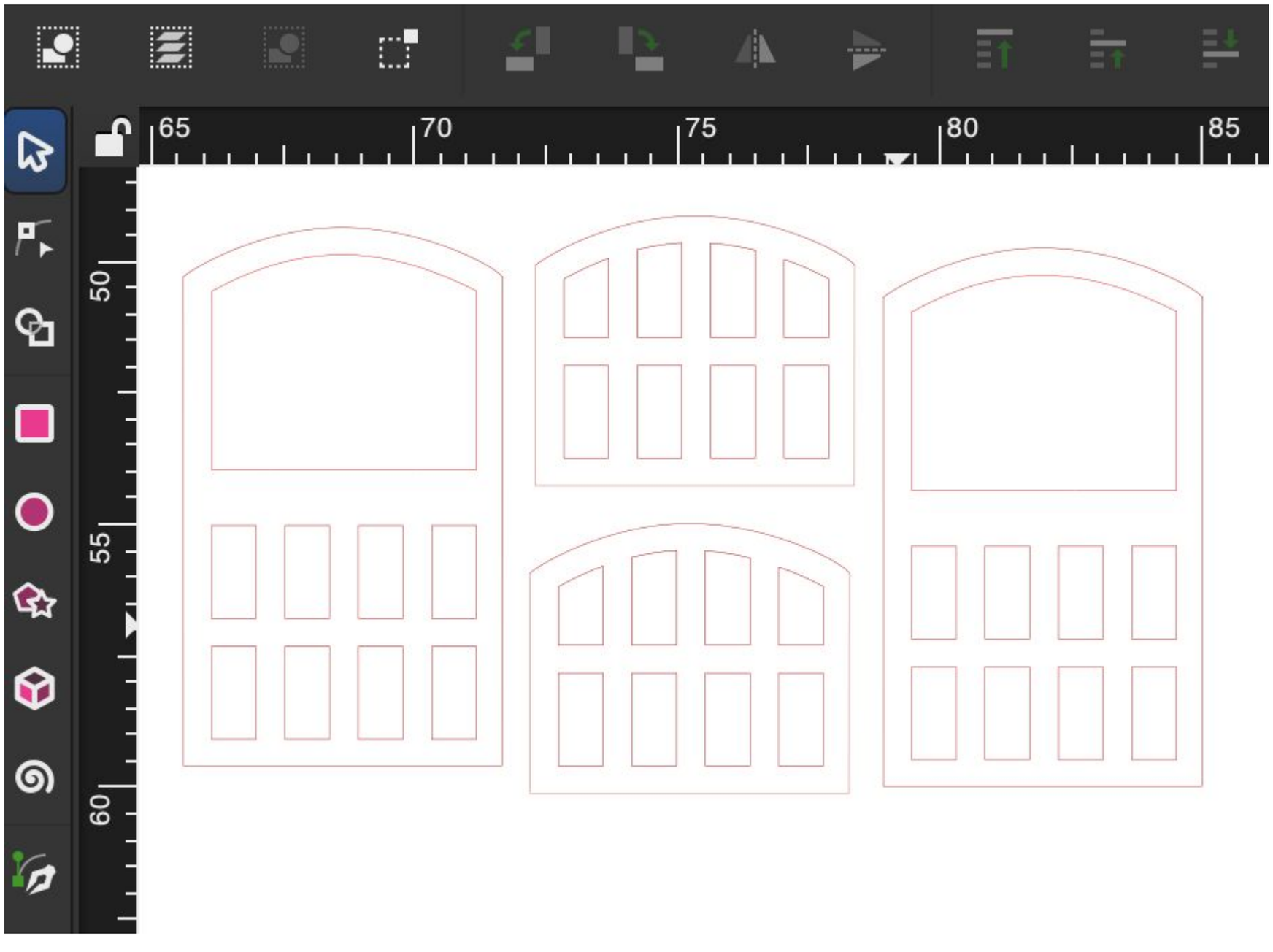
Raster element - mortar lines in brick wall*



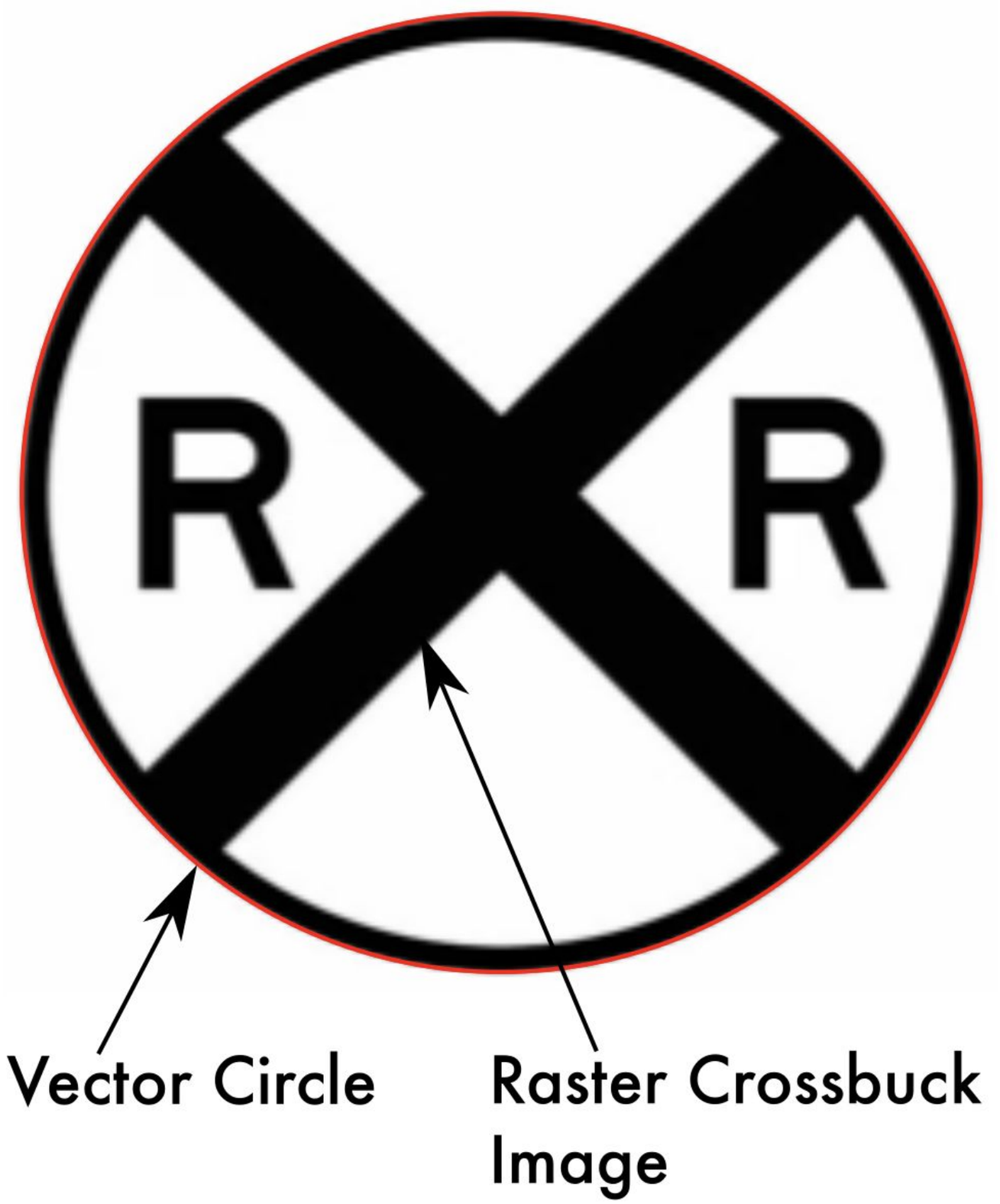
* Note that different colors are assigned here, and will denote different laser operations in the laser cutter software.

Can cut very thin details from the right material

Minimum line separation for my laser is 0.5 mm (experimentally determined).
Laser cutting kerf is about 0.2-0.3 mm (depends on power, material)
Resulting detail is 0.2-0.3 mm wide (~1 ½” in N, ~¾” in HO)



Simpler example



Coaster for the train room

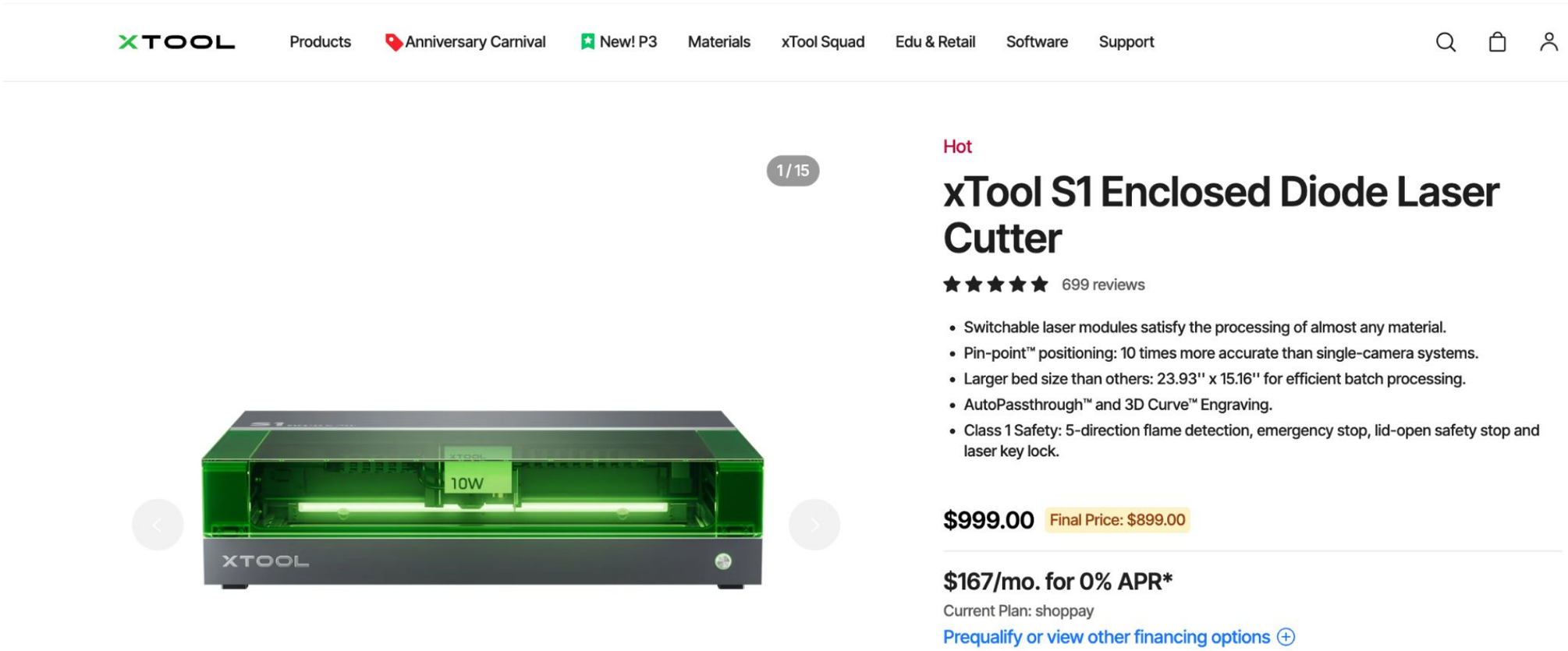
Find a crossbuck raster graphic online

Import to Inkscape

Draw a 3” circle

Scale crossbuck to fit circle

Laser Cutter



This is the system I purchased: low cost, but high quality.

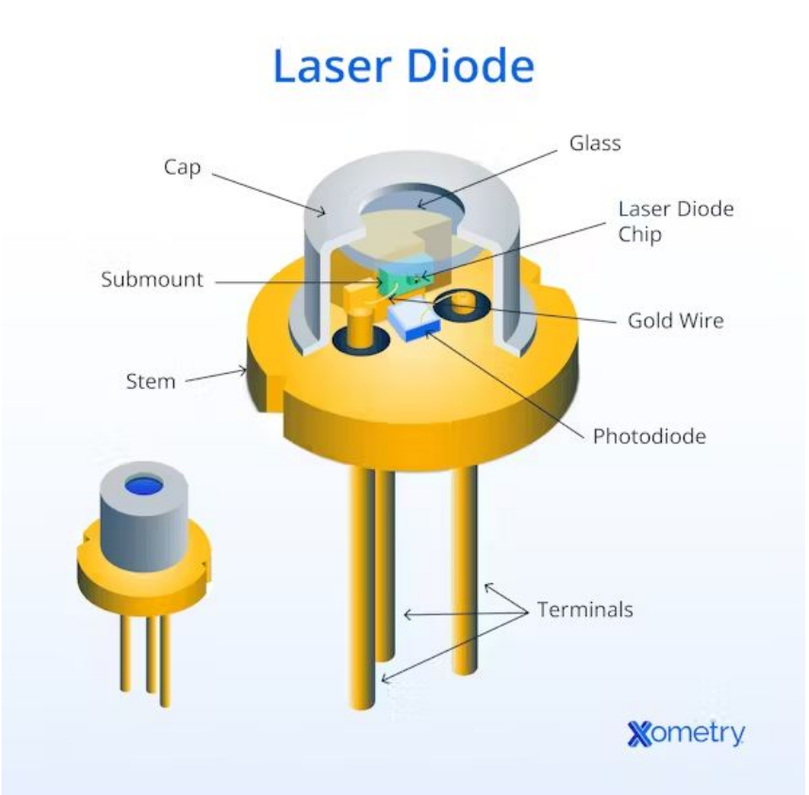
Interchangeable laser modules make more powerful upgrades easy

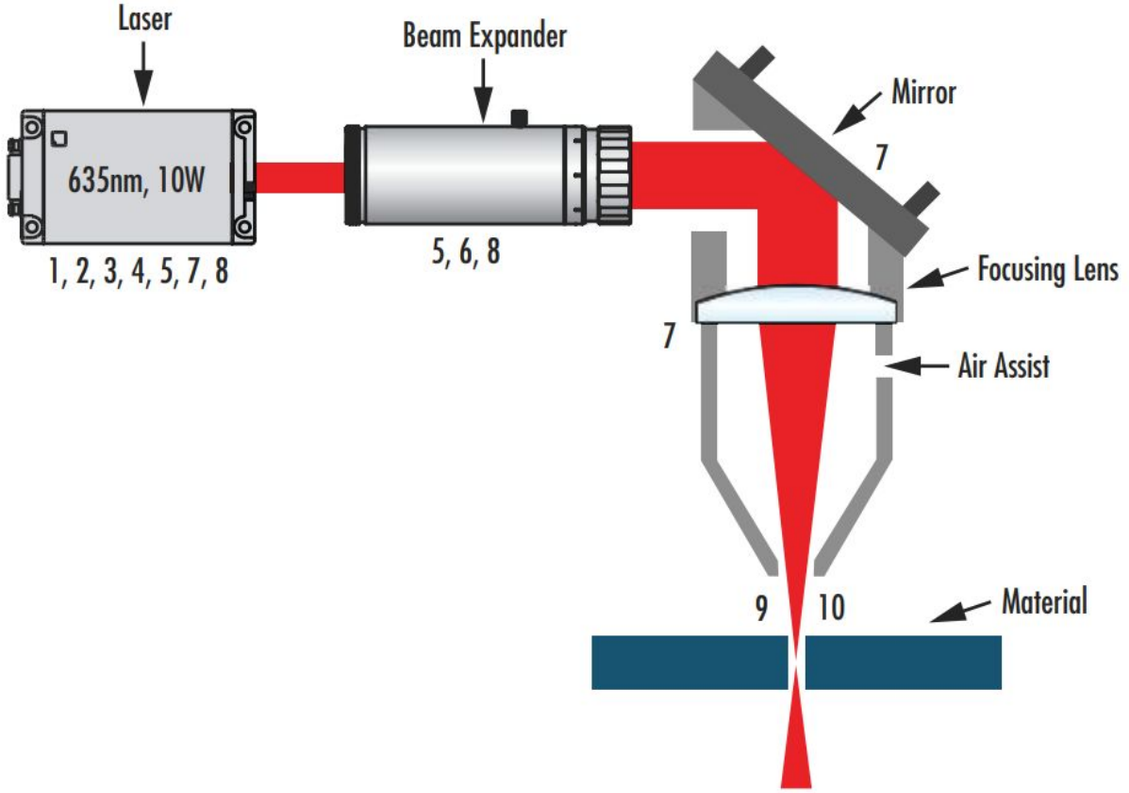
Diode vs CO2

Two different kinds of lasers

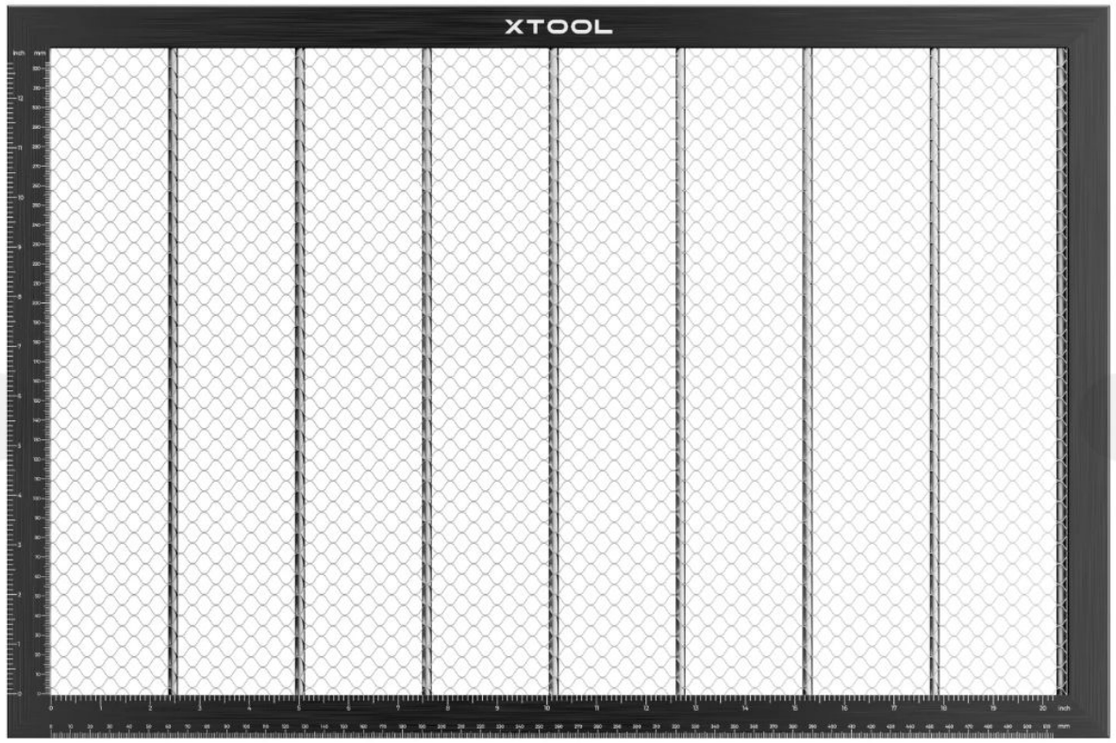
CO2 lasers are capable of cutting thicker materials and are more expensive. Overkill for model railroad applications.

Diode lasers are lower power and good for hobby applications





Helpful Accessories



Air Assist - blows smoke away from lens (but can also blow tiny parts around)

Honeycomb panel - allows the use of magnets to secure your material

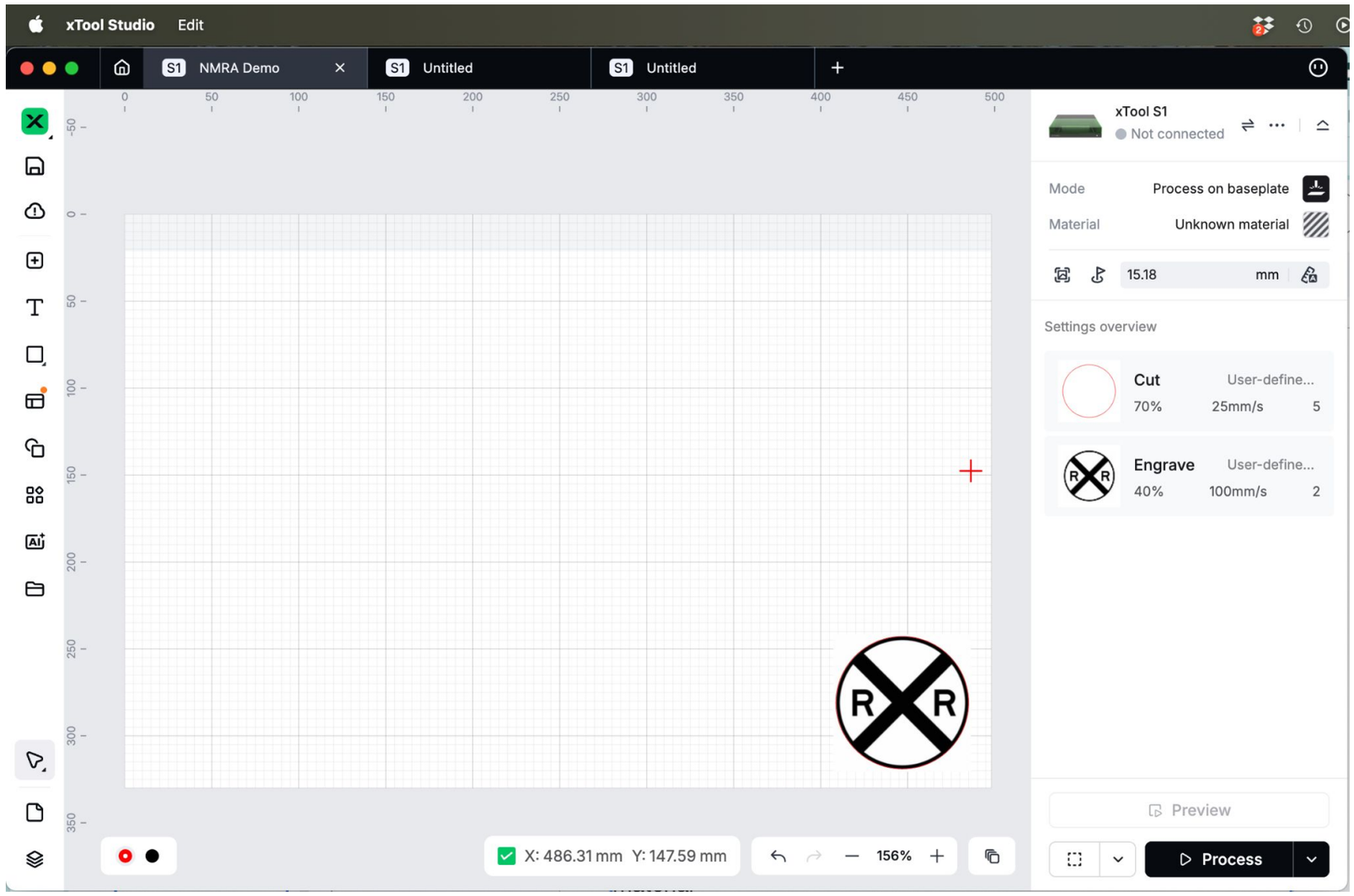
Safety First!

Class 3 laser - it can hurt you!

There are safety interlocks for a reason - USE THEM!

Very real **FIRE** danger - do not leave unattended!

XTool Studio

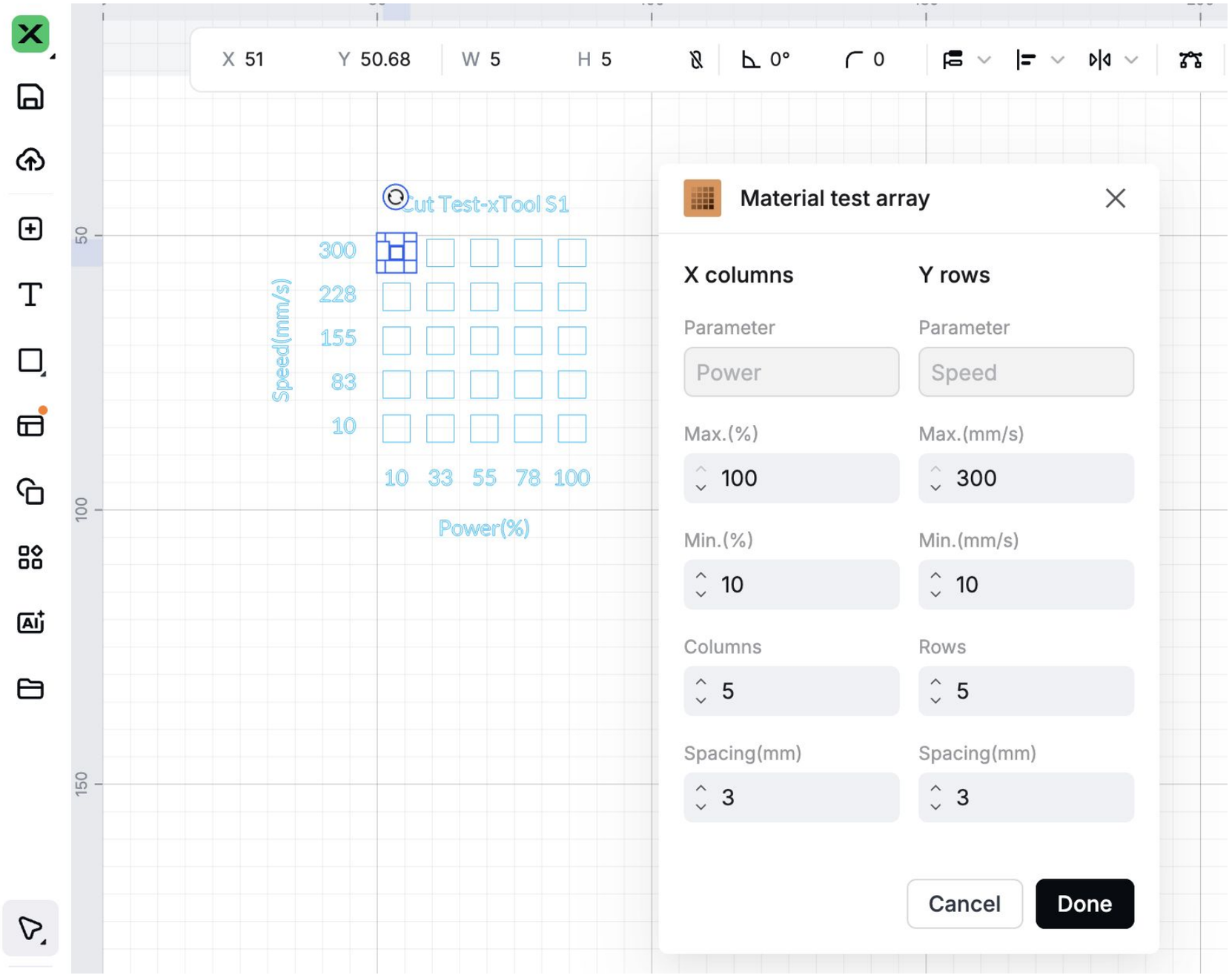


Software driver for the laser

Has basic graphic tools and the ability to manipulate (rotate, duplicate, move, etc) imported graphics

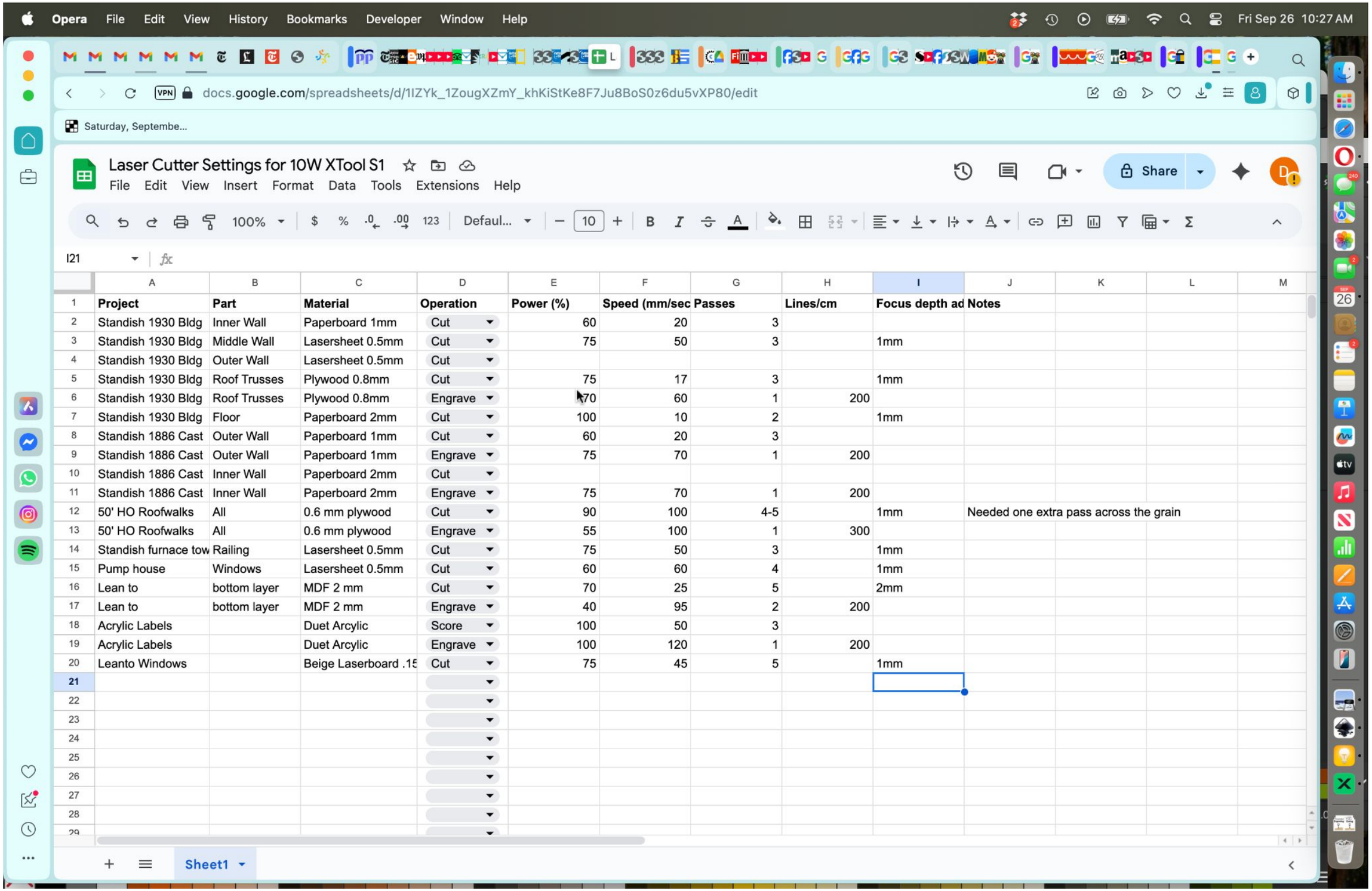
Takes .svg files for vector art, .jpg etc. for raster art

Calibrating Materials



For every material, I do a material test array for cutting and another one for engraving. Then I save those “swatches”.

Record Keeping



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Project	Part	Material	Operation	Power (%)	Speed (mm/sec	Passes	Lines/cm	Focus depth ad	Notes			
2	Standish 1930 Bldg	Inner Wall	Paperboard 1mm	Cut	60	20	3						
3	Standish 1930 Bldg	Middle Wall	Lasersheet 0.5mm	Cut	75	50	3		1mm				
4	Standish 1930 Bldg	Outer Wall	Lasersheet 0.5mm	Cut									
5	Standish 1930 Bldg	Roof Trusses	Plywood 0.8mm	Cut	75	17	3		1mm				
6	Standish 1930 Bldg	Roof Trusses	Plywood 0.8mm	Engrave	70	60	1	200					
7	Standish 1930 Bldg	Floor	Paperboard 2mm	Cut	100	10	2		1mm				
8	Standish 1886 Cast	Outer Wall	Paperboard 1mm	Cut	60	20	3						
9	Standish 1886 Cast	Outer Wall	Paperboard 1mm	Engrave	75	70	1	200					
10	Standish 1886 Cast	Inner Wall	Paperboard 2mm	Cut									
11	Standish 1886 Cast	Inner Wall	Paperboard 2mm	Engrave	75	70	1	200					
12	50' HO Roofwalks	All	0.6 mm plywood	Cut	90	100	4-5		1mm	Needed one extra pass across the grain			
13	50' HO Roofwalks	All	0.6 mm plywood	Engrave	55	100	1	300					
14	Standish furnace tow	Railing	Lasersheet 0.5mm	Cut	75	50	3		1mm				
15	Pump house	Windows	Lasersheet 0.5mm	Cut	60	60	4		1mm				
16	Lean to	bottom layer	MDF 2 mm	Cut	70	25	5		2mm				
17	Lean to	bottom layer	MDF 2 mm	Engrave	40	95	2	200					
18	Acrylic Labels		Duet Arcylic	Score	100	50	3						
19	Acrylic Labels		Duet Arcylic	Engrave	100	120	1	200					
20	Leanto Windows		Beige Laserboard .15	Cut	75	45	5		1mm				
21													
22													
23													
24													
25													
26													
27													
28													

Sheet1

For every project, I track the material and settings I use.

Materials

Laser Board - thin (0.5-0.6 mm/.02-.026”) stiff material - essentially resin-impregnated cardboard. Really excellent for fine details.

Paper and Cardstock - very thin, less stiff than laser board

QuickBoard - 1 mm or 2 mm thick recycled paperboard product, inexpensive and excellent for mocking up structures and for testing your graphics

MDF - same stuff as in the hardware store, but as thin as 1.5 mm, stiff, very good for structure walls,

Plywood - as thin as .6 mm, stiff, shows wood grain, may require more power or more passes to cut across the grain of the face sheets.

Basswood or other wood - wood grain

Acrylic - opaque color cuts best, engraveable 2-color sheets for panels and signs

NO STYRENE! It creates toxic smoke and can damage the laser

Sources

MakerStock: https://makerstock.com

Laser One: https://encompass-media.salesvu.com

LaserSheets: https://lasersheets.eu (EU only - I had a friend in Germany reship for me before I found Laser One)

XTool: https://www.xtool.com/pages/xtool-selected-materials

Woodworking stores, hobby shops, etc.