Preparing Files for the Laser Cutter

The UD/Art Laser Cutter (see a brief description here) is a tool that can be used to cut, mark and/or engrave into various materials. The laser cutter can accept vector (line art) and/or bitmap (1-bit raster images), but knowing which to use is a combination of artistic vision and technical knowledge. Knowing how to prepare your files for feeding into the laser cutter software will streamline your work, and this article will provide details for doing so.

Terminology

In this section we will define some terms so that the following discussions are more clear.

Bitmap

A **bitmap** is an image made up of a rectangular grid monochrome dots (or pixels). Usually the dots are thought of as being black and the lack of a dot as white. As far as the laser cutter is concerned, a dot is a spot where the laser will hit. The laser will not hit a place without a dot. The **bitmap** file format also contains resolution information which indicates how many dots fit within a given linear distance. For example, a 200 dpi (dots per inch) bitmap is meant to be represented by dots packed close enough together to fit 200 of them in a linear inch (both horizontally and vertically).

Cut

Cutting is when the laser is used to follow a path, penetrating completely through the material. Usually the path followed is closed so the material within the path falls out.

Engrave

Engraving is when the laser is used to mark material, column by column, with a bitmap – a grid of dots (or *pixels*). The laser cutter uses the resolution information in the bitmap to know how far apart mark the dots, both within the columns and distance between the columns. Sometimes engraving is referred to as "rastering" (even though that's not really a word). This word comes from computer terminology where vector artwork (see definition below) needs to be converted to dots to be represented on a screen or printer (or laser cutter).

Mark

This is similar to cutting (see above), but the laser is set to not completely penetrate through the material. The laser makes a visible mark along the path.

Vector

Vector artwork is made up of straight or curved paths. These types of drawings are created in software like Adobe Illustrator. Even though most software for drawing vector artwork can produce paths with a thickness (or *stroke*), the laser cutter software ignores this because the laser beam has a thin, fixed width.

What you can/cannot do with the laser cutter

The laser cutter can only burn into or through material. Also, the beam can only be made to follow straight or curved paths or to burn a grid of dots (a bitmap image). There is no way for the laser to represent color. The laser can only cut through certain materials (e.g. wood, cardboard, paper and plastic). Otherwise, it can only etch the surface of the material.

For the materials that the laser can cut, the laser can be adjusted for power and speed to determine how far into the material the engraving or marking will go. Engraving deeply into the material can be done for a certain effect if desired. There's no point to engraving all the way through the material because it's slower than cutting through using paths. For example, say you wanted a 5″ square hole cut into a piece of 1/4″ plywood. It makes more sense to define a 5″ square path to cut around versus a 5″ filled square bitmap. Both will produce a 5″ square hole in the plywood, but engraving the hole row by row with a laser beam that's only about .01″ thick will take much longer and will waste the wood inside the square. That being said engraving through some materials is possible and can be done if a shape cannot be easily define by paths.

What do you want to do?

One of the first things to think about when preparing artwork files for the laser cutter is what you want to do to the material. In general, cutting through material requires the artwork to be in a vector format, like Adobe Illustrator or AutoCAD DXF, because paths in the artwork are used in the laser cutter software to define laser cut paths. Paths may also be marked, if desired.

Engraving requires a bitmap image. The grid of pixels of a bitmap will be burnt into the material column by column, and the dots will be spaced horizontally and vertically according to the resolution information in the bitmap format.

Some guidelines

- **Cutting Paths** – If you want to cut shapes out of the material (vector shapes/paths examples below), the shapes must be defined in a vector format, like Adobe Illustrator or AutoCAD DXF. When the laser cutter operator imports the file, the paths that make up your shapes will be converted to laser cut paths in the laser cutter software.

Vector Graphics Examples
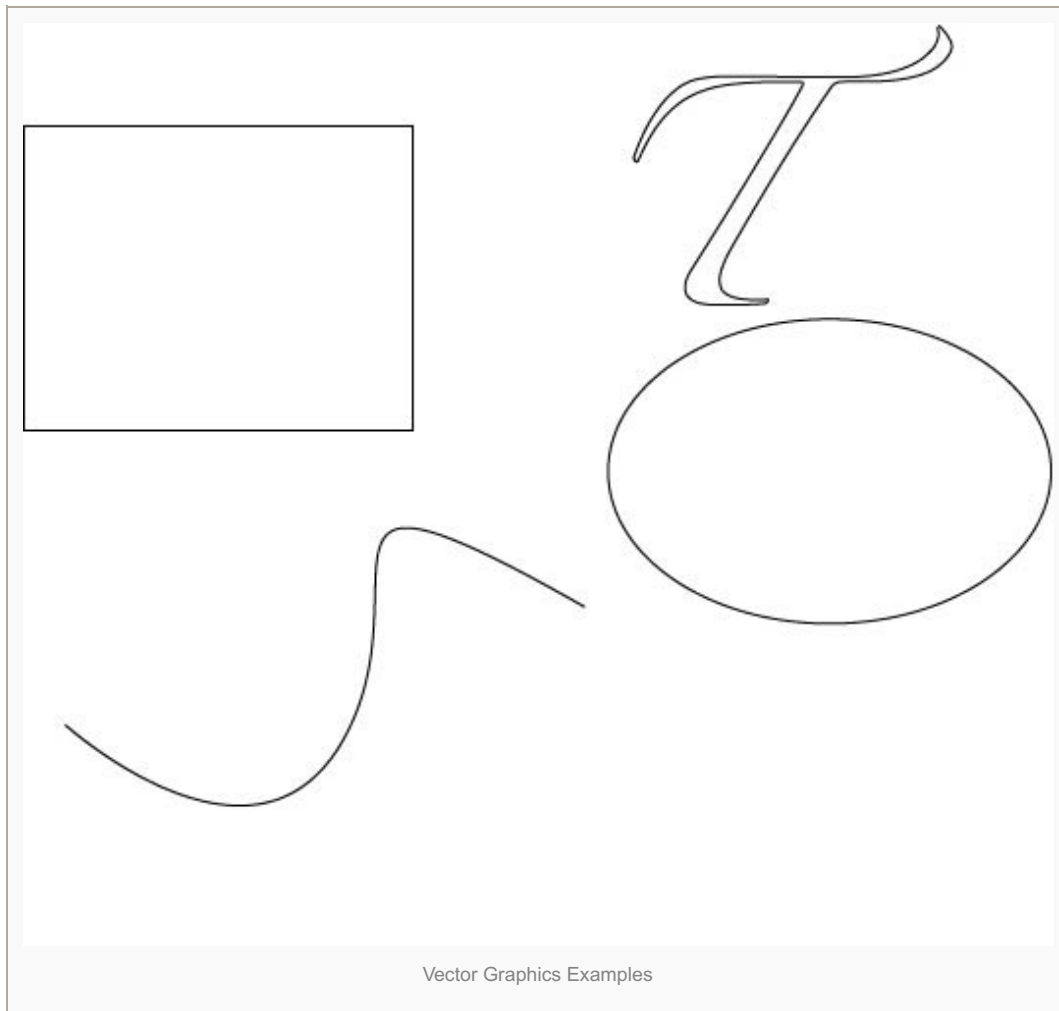
- **Marking Paths** – If you want to mark the material with the thinnest lines possible, the width of the laser beam (approx. .012″), then designing your work in a vector format will work the best. This can even include outlining text.

- **Paths with a stroke (thickness)**- If you want the artwork to be filled in or for line/text to have thickness, then for the most part the artwork should be in the form of a bitmap so that it can be "rastered" into the material by the laser. Less commonly used is the ability to define a "fill path" which is a pattern (e.g. cross hatch, spiral, etc.) that gives a bit of the illusion of filling in but it doesn't completely cover the inside of the surrounding path.

Circle filled as a bitmap (grid of laser spots)

- **Raster Images**- If you scanned an image, it should be black and white or close to it because the image file needs to be converted to a 1-bit Windows bitmap (BMP) file where you will only have black and white pixels available to you. If the image is the entirety of what you want to apply to the material, then the BMP file can be fed directly to the laser cutter. The resolution of the BMP file is important because of the laser beam spot size. A good resolution to shoot for is either 100 to 200 pixels per inch. Any lower, and you may not get a good fill. Think of the examples below as being magnified because the laser spot size is really small (about .01″).
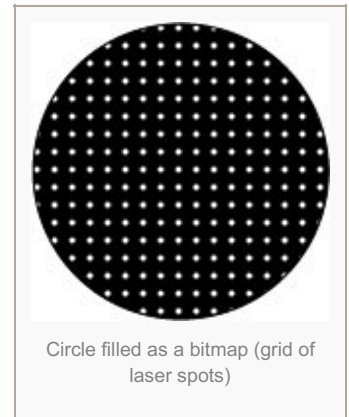
Any higher, and the laser beam spots will overlap and not really increase the quality of the image and take much longer to run on the machine.

A word about text

Text can be handled a few ways with the laser cutter, but in practically every scenario, it is best to convert the text (fonts) to vector paths. This is so font availability issues and licensing are avoided. Some fonts are not allowed to be embedded in the artwork file.   One may have special fonts that are not universally available, so it is best to **convert text to vector paths** which skips the need for the laser cutter computer to have the fonts used in the original artwork.

Outlining text is handled simply by laser engraving the outline, but filling in text can be handled a couple ways. To fill in text, it can either be converted to a bitmap (a grid of black and white pixels) or be "filled" with a laser cut path of various patterns (e.g. cross hatch, grid, etc.). This fill pattern is very evident in the final result, but that may be desired. Both of these operations (converting to bitmap and/or defining a fill patter) may be handled in the laser cutter software, so it is not necessary to do so in the original artwork.

Circle filled with a pattern of paths
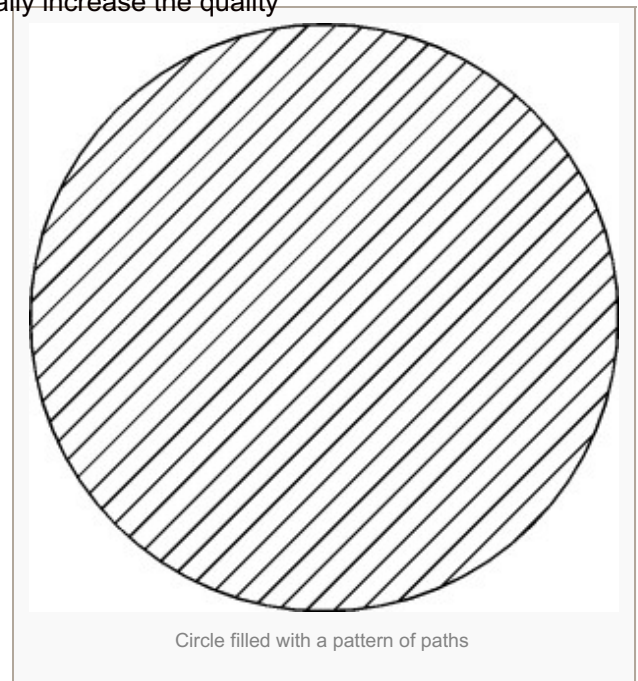
Preparing an Illustrator file for the laser cutter software

This section will provide some guidelines for how you should prepare your Adobe Illustrator vector artwork for use in the laser cutter software. Keep in mind that importing the file into the software is just the first step in the process of generating a file with which the laser cutter can work. Once imported, the laser cutter operator will


Too much space between laser spots
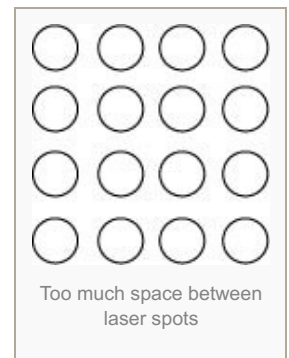
- Shapes that are to be filled will be **converted to bitmaps** or will be assigned **machine fill paths** depending on the desired result

- Assign what are called **machine paths** to the paths from the imported Illustrator file. You will need to know which paths you want to cut through versus mark the surface. The paths that are intended to be cut through will happen last. This is so that engraving and marking can happen without fear of the material shifting.

- The operator will produce an output file that will be fed into the laser cutter and run.

What the laser cutter operator will need to know about your Illustrator file

In general, the laser cutter operator will need to know the following about your Illustrator file.

- What shapes do you intend to fill in? How do you want them to be filled in – with a solid (bitmap) fill or do you want a pattern fill? There are only several patterns from which to choose and they will be quite visible in the result.

- What paths do you intend to only mark into (not cut through) the material?

- What paths do you intend to cut through the material?
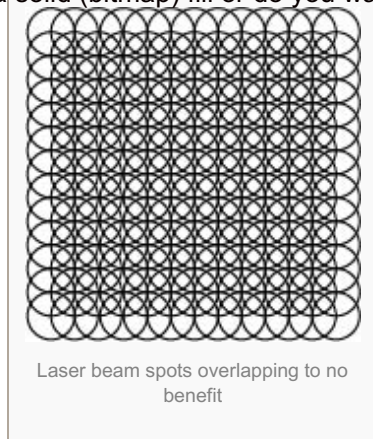
## Illustrator file design guidelines

When creating a design that you intend to use in the laser cutter, there are some guidelines that you should follow to reduce problems and make the file easy to import into the laser cutter software.

Laser beam spots overlapping to no benefit

Beware of overlapping shapes/paths

In Illustrator, it's common to use overlapping shapes to give the illusion of one complex shape because shapes underneath can be hidden. This strategy will not work with the laser cutter because the hidden parts are seen by the laser cutter software. The following images of ice cream cones will illustrate the problem with using overlapping shapes. The intent is to get a shape like figure (1). It is constructed with a triangle overlapping a circle, but since the laser cutter software ignores the fill, it doesn't matter that one shape is overlapping another and the laser cutter will produce what is found in figure (2). While it is possible to fix this in the laser cutter software, it is a lot more work than getting it right in Illustrator in the first place.

Stroke thickness is ignored

In Illustrator, it is common to draw paths with a thickness. The laser cutter cannot represent thickness in vector artwork without some additional work. In any event, you will need to outline your strokes in Illustrator. This will produce a shape that can later be converted to a bitmap or assigned a "fill" machine path in the laser cutter software. You will need to decide which is appropriate for your work, but most of the time a bitmap is chosen because it produces the most complete fill if a high enough resolution is chosen (usually 100 dpi). In the following figure, you will see an example of a path in Illustrator with a thick stroke. This stroke cannot be directly represented in the laser cutter software so the stroke would need to be outlined.

(1)   (2)

Overlapping shapes example

Path with thick stroke
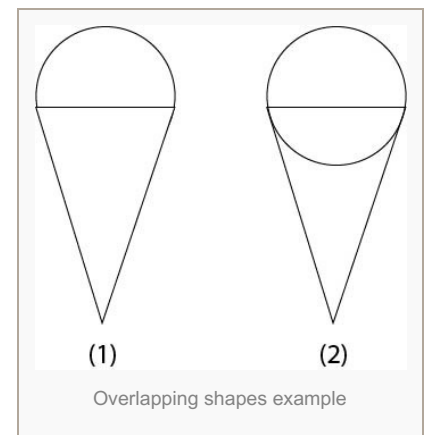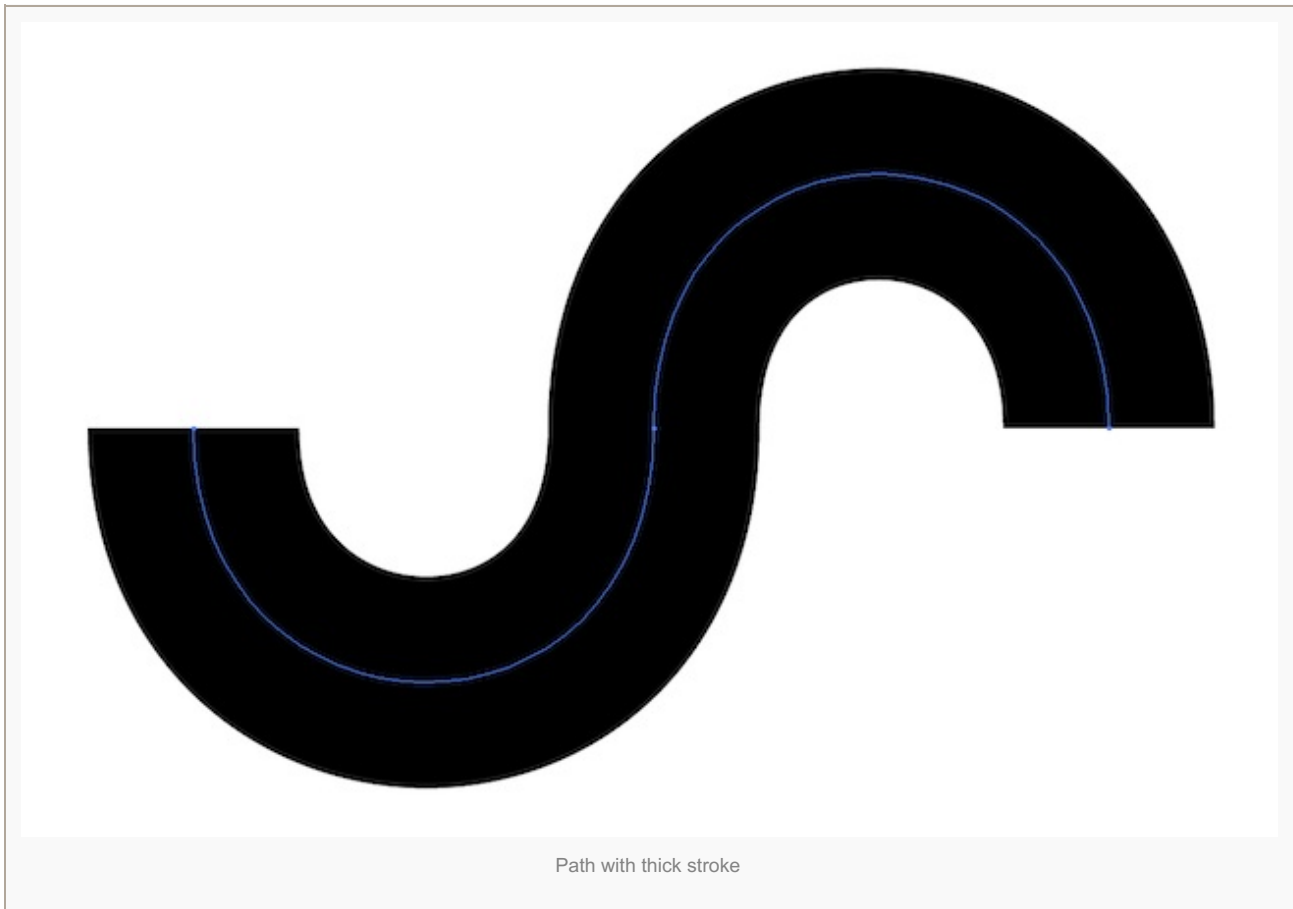
In the following figure, the path with thick stroke has been outlined with a new path (in Illustrator: Object (menu) -> Path -> Outline Stroke). NOTE: The original path remains. Either remove it or let the laser cutter operator know to ignore it when assigning laser paths.

Path with thick stroke that has been outlined
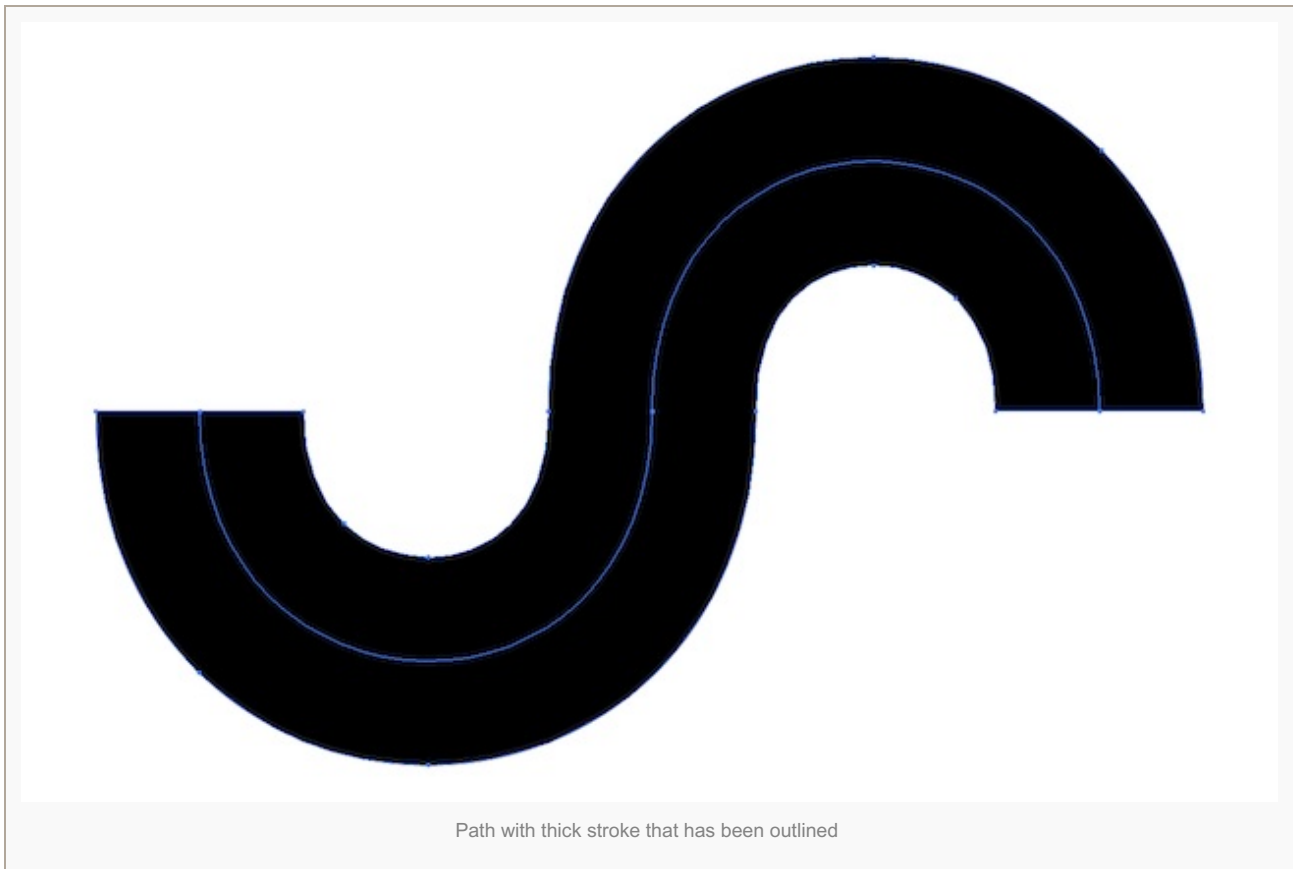
Save the Illustrator file in the CS2 format

The manual for the laser cutter specifies that any Illustrator file that one intends to import into the laser cutter software should use the CS2 format.

In Illustrator, save a copy of the file you are going to submit for laser cutting by following these instructions.

1. Go to the **File** menu and select **Save As…**

2. Navigate to the location where you would like to save the file and type a name in for it.

3. Click the **Save** button.

4. In the **Options**box that appears, make sure the following options are as specified.

   1. The **Version** of the saved file should be **Illustrator CS2**.

   2. The **Create PDF Compatible File** option should be **checked**.

   3. The **Embed ICC Profiles** option should **NOT** be checked.

   4. The **Use Compression** option should **NOT** be checked.

   5. Click the **OK** button.

Preparing an image file for the laser cutter

This section provides some guidelines for preparing image file for the laser cutter.

Bitmaps ONLY

The only image format that the laser cutter accepts is the Windows Bitmap (BMP) format. The bitmap must be monochrome (1-bit). The laser beam burns the pixels row by row in the bitmap – the laser is on for black pixels and off for the white (background) pixels.

Images that are in other formats MUST be converted to a 1-bit Windows Bitmap.

## Converting color images to 1-bit Windows Bitmaps

It is possible to convert a color image to a 1-bit Windows Bitmap. Most image editing software can handle the job. The examples in this article will use Photoshop CS6. In general, the steps are from color image to grayscale to monochrome. There is a large potential for quality degradation with this process, so the closer to monochrome the image is to start out with (e.g. scanned/drawn monochrome line art) the better.

## Example 1: Scanned black and white line art

In this example, we will show one way to convert a color image of black and white line artwork to a 1-bit Windows Bitmap using Photoshop CS6.

The following picture is a full-color JPEG even though it's essentially just a black and white drawing.

First, open the image in Photoshop. With a full color (RGB in this case) image, you cannot jump directly to a bitmap format, but you can convert it to grayscale mode as an intermediate step. To do this, in the **Image** menu, choose **Mode**, then **Grayscale**.
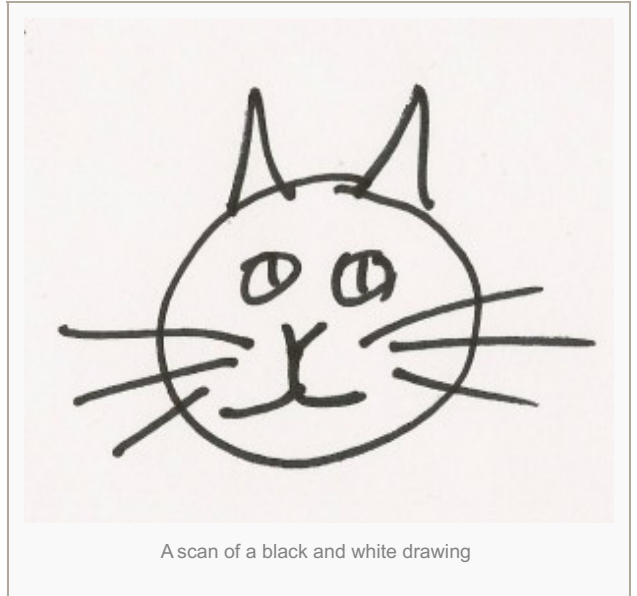
A scan of a black and white drawing
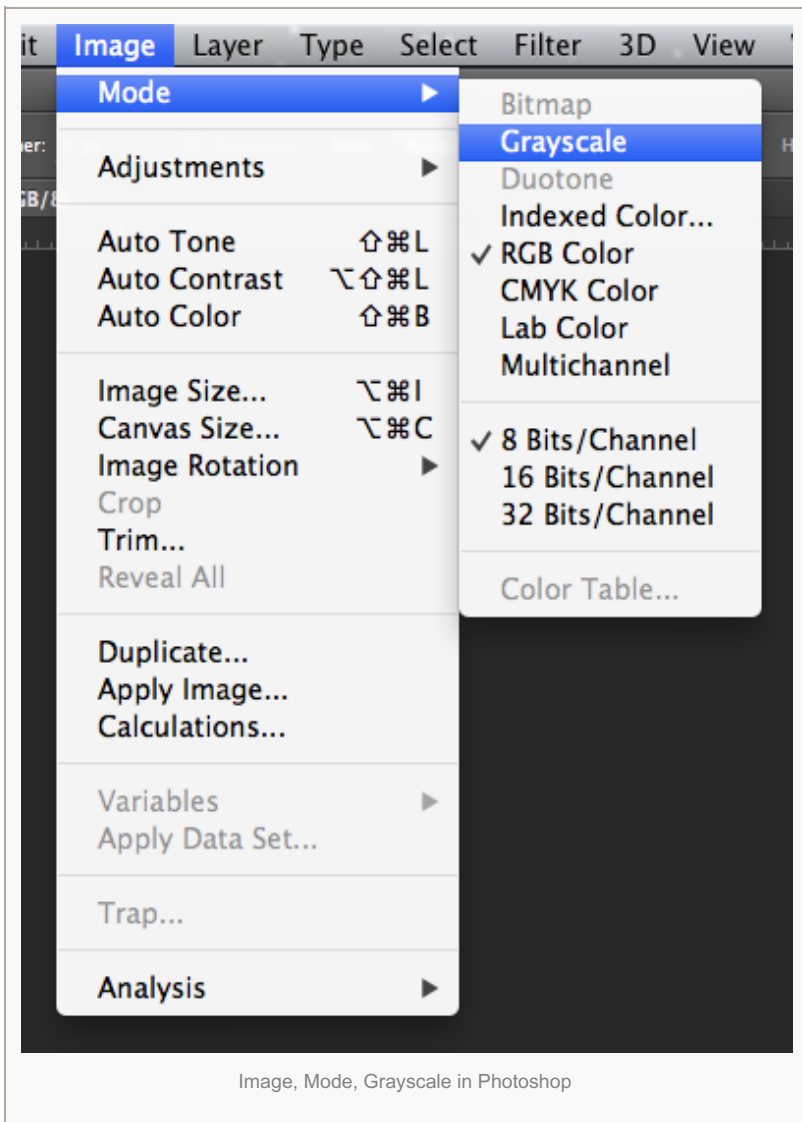
Image, Mode, Grayscale in Photoshop

This will remove color information from the image, but that's ok in this case because the desired result is a black and white bitmap, and the image was originally black lines drawn on white paper. If you are warned about this in Photoshop (see figure below), then click the **Discard** button.

Next, we can change the image mode to bitmap by clicking **Image** in the menu, then the **Mode** option, then **Bitmap…**.

Photoshop's discard color information warning

Image, Mode, Bitmap in Photoshop
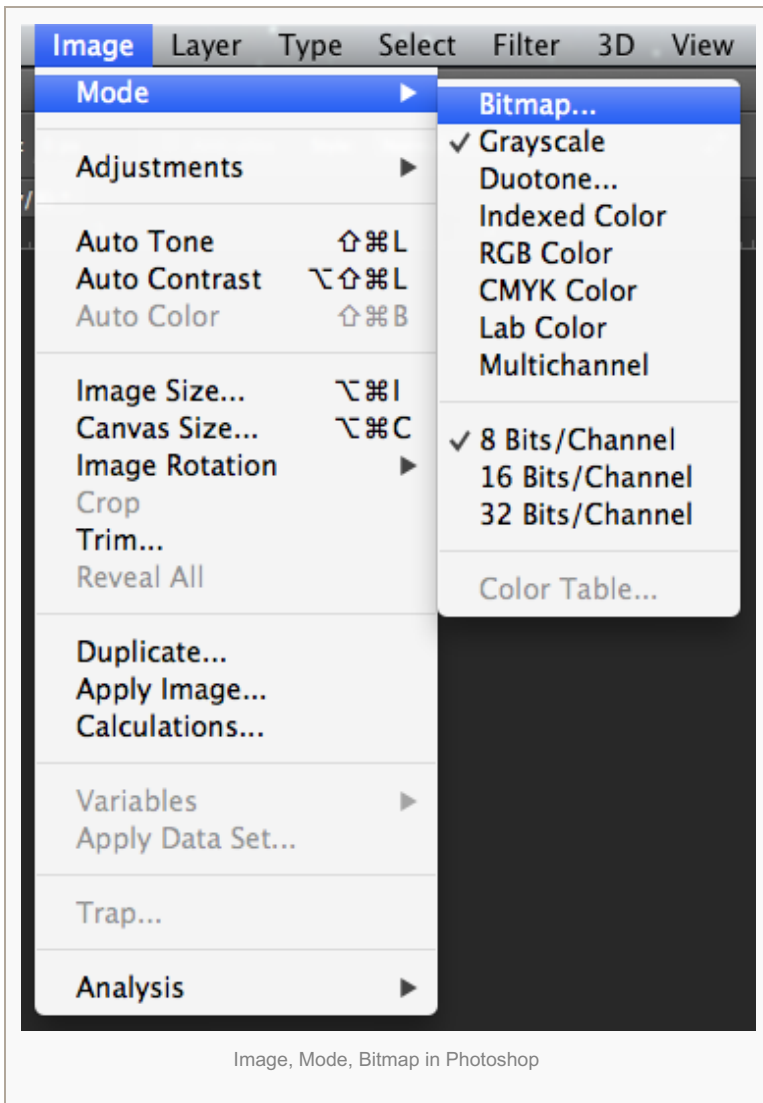
There are ways that Photoshop can give the illusion of gray shading when going from grayscale to monochrome, but for this line art that illusion is not necessary because we want crisp black lines. In the dialog box that appears, you are given the option to specify the desired resolution as well as the method for Photoshop to use to fake grays. A resolution of between **100** and **200** should be sufficient. 200 can look better, but takes more time to engrave than 100. Choose the "50% Threshold" method for faking grays.
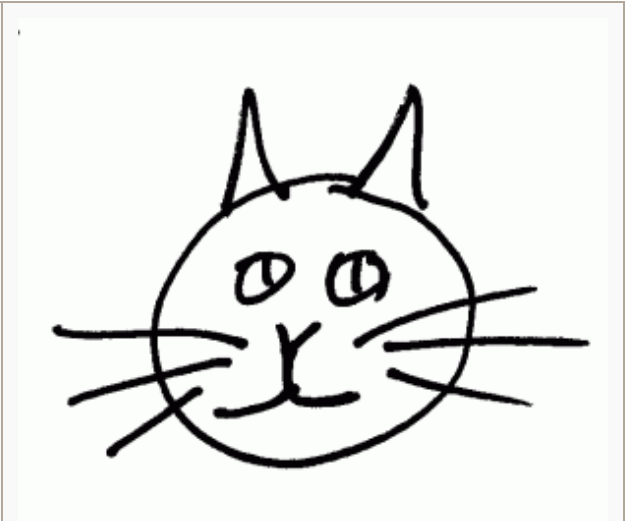
Bitmap conversion options dialog
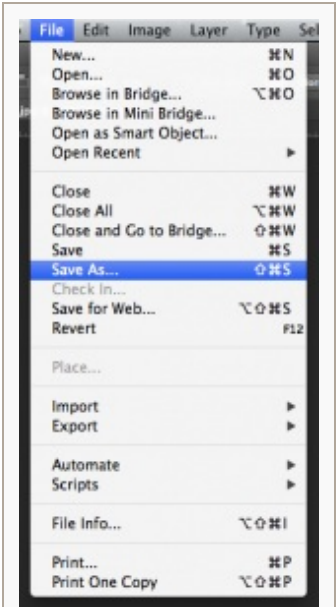
The result is a 1-bit image.

The last step is to save the image in the Windows Bitmap format. To do so, choose **File** then **Save As…** from the menu.

In the **Save As…** dialog box, the **BMP** option should be chosen in the **Format** list. Make sure that it is. Change the name, if desired, but leave the .bmp extension. Click the **Save** button.
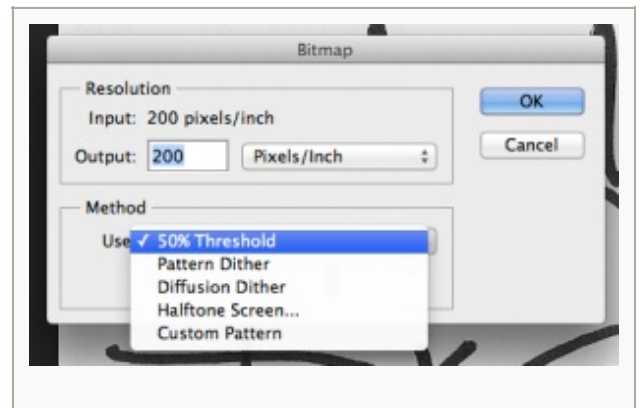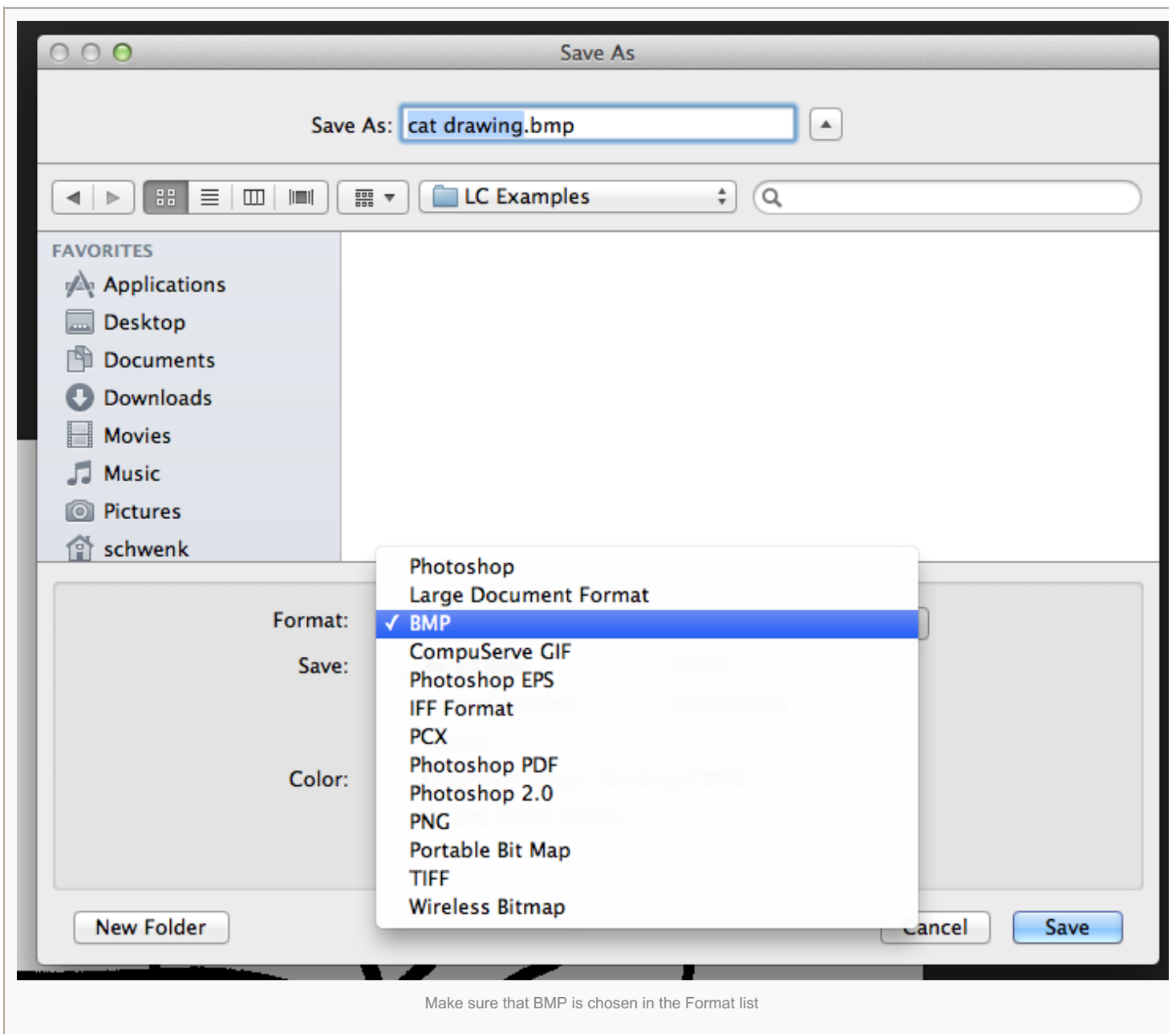
Final product, 1-bit bitmap of original image

Save As… in the Photoshop menu

Make sure that BMP is chosen in the Format list

There are some options available when saving a file in Windows Bitmap format. Make sure that **Windows** is chosen for the **File Format** and **1 Bit** is chosen for the **Depth** as shown in the following figure. Click the **OK** button to complete the save.

The BMP file that you just saved can be fed directly into the laser cutter. Copy it to a memory stick to give to the laser cutter operator.

BMP saving options