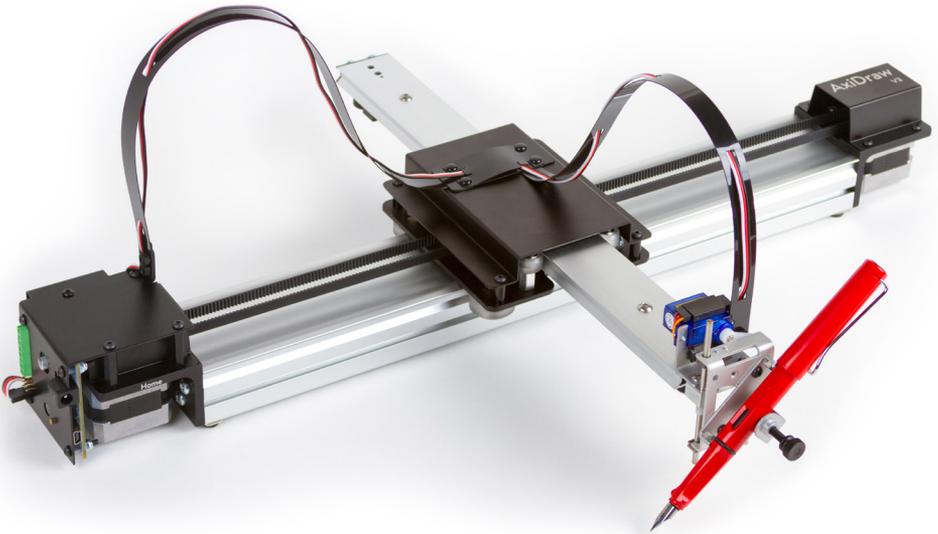


AxiDraw[®] V3

Personal Writing and Drawing Machine



User Guide

0. Preliminaries

0.1 Welcome

Welcome to AxiDraw!

This is the user guide for the AxiDraw V3 family of personal writing and drawing machines. This guide is here to help you get started. There is a lot here—covering how you set up and use the machine, and pointing you towards additional resources for the future.

This guide covers operation of the following AxiDraw models:

- AxiDraw V3
- AxiDraw V3 XLX
- AxiDraw V3/A3
- AxiDraw SE/A3

0.2 This guide is a work in progress!

This guide is a continuing work in progress, and we want to suggest you to check back occasionally for the latest version of this manual, and to check that you have the latest version of the software.

Recent changes to this guide include updates to the current software version, which is v1.7.8, additions to the sections about text, and about vectorizing images.

You can download the latest version of this at <http://axidraw.com/guide>

Look at the front cover of the guide to find the date and version number of the guide that you are looking at.

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1. Introducing the AxiDraw

The AxiDraw is a simple, modern, precise, and versatile pen plotter, capable of writing or drawing on almost any flat surface. It can write with your favorite fountain pens, permanent markers, and other writing implements to handle an endless variety of applications. Its unique design features a writing head that extends beyond the machine, making it possible to draw on objects bigger than the machine itself.

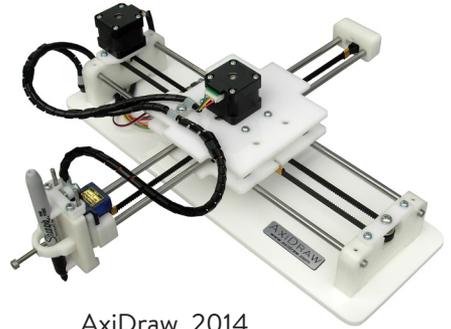
The AxiDraw is an extremely versatile machine, designed to serve a wide variety of everyday and specialized drawing and writing needs. You can use it for almost any task that might normally be carried out with a hand-held pen.

It allows you to use your computer to produce writing that appears to be hand-made, complete with the unmistakable appearance of using a real pen (as opposed to an inkjet or laser printer) to address an envelope or sign one's name. And it does so with precision approaching that of a skilled artist, and — just as importantly — using an arm that never gets tired.

1.1 Credits and History:

The AxiDraw project has been active since 2014, when it was first created by Dr. Lindsay Robert Wilson of IJ Instruments Ltd. in the UK.

Early AxiDraw units had a different design. It had a smaller format with a chassis made from machined Delrin plastic. It had two independent timing belts, one driven by a stepper motor on the base, and the other by a stepper motor on the moving carriage. For software, it used a modified version of the WaterColorBot driver developed at Evil Mad Scientist.



AxiDraw, 2014

AxiDraw V2



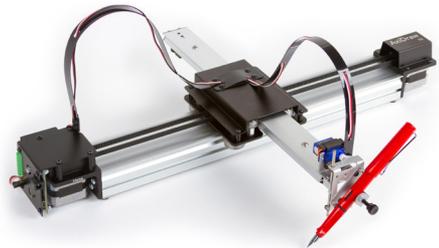
AxiDraw V2, 2016

In 2015, Wilson began collaborating with Windell Oskay and Lenore Edman of Evil Mad Scientist Laboratories towards a new AxiDraw model that would be principally designed and manufactured in the USA.

This second-generation AxiDraw was enlarged to reach twice the travel area, to cover a full page of A4 or US Letter paper. Its geometry was changed to use a single drive belt, with two larger stepper motors stationary on the base. Its major components would now be made of aluminum (machined or stamped and folded), and the new pen holder could be mounted vertically or at 45° to the paper.

AxiDraw V3

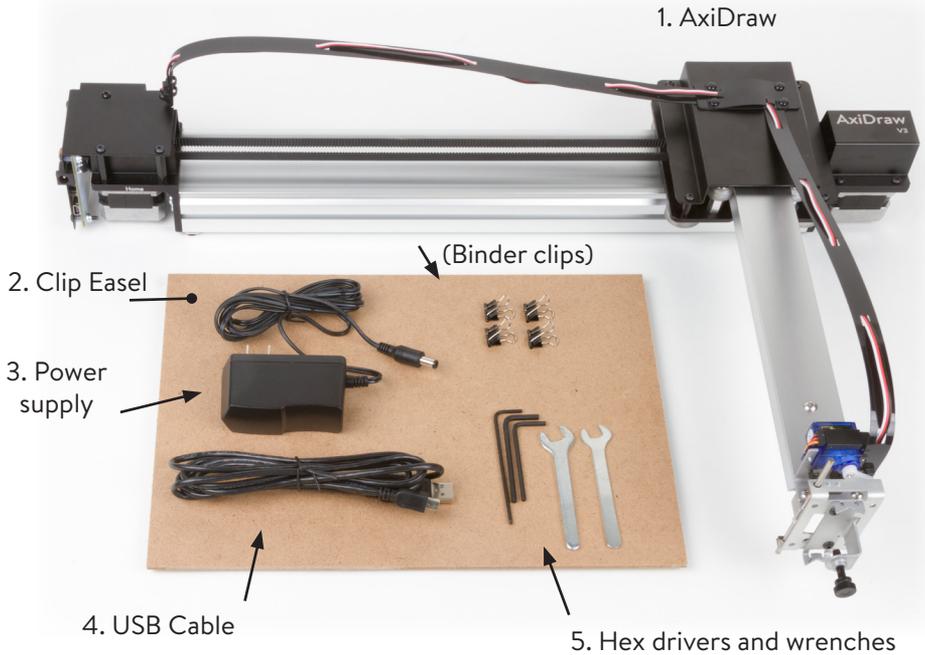
The third generation, AxiDraw V3, is a full redesign of the machine for higher performance. While previous models had steel shafts and linear ball bearing slides, this new version features custom aluminum extrusions with rolling wheels. The vastly increased stiffness of the structures allow the machine to operate at roughly twice the speed of the previous version, without a loss in quality.



AxiDraw V3

The AxiDraw V3 family is currently available in several models that differ principally in available travel area: AxiDraw V3, AxiDraw V3 XLX, and the AxiDraw V3/A3. There is also a Special Edition, AxiDraw SE/A3, which features a base machined from a solid block of aluminum.

2. Checking out your AxiDraw



2.1 Parts and accessories

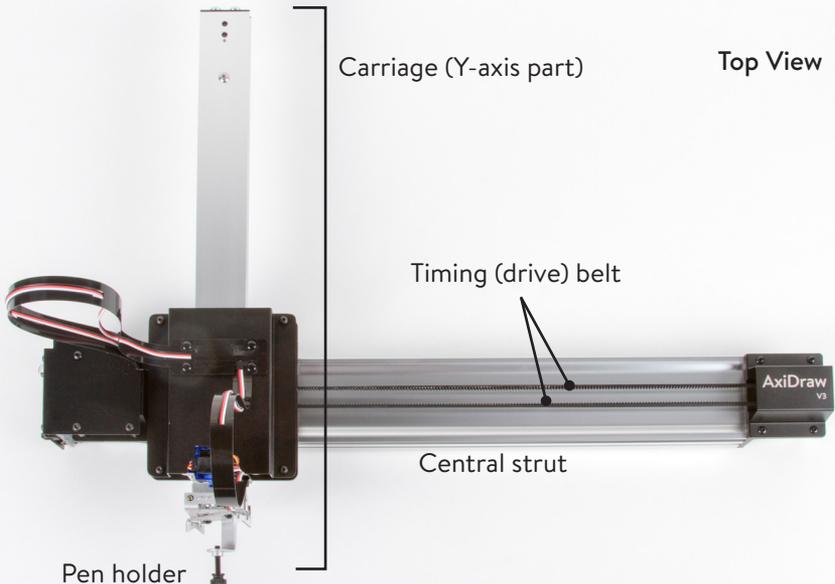
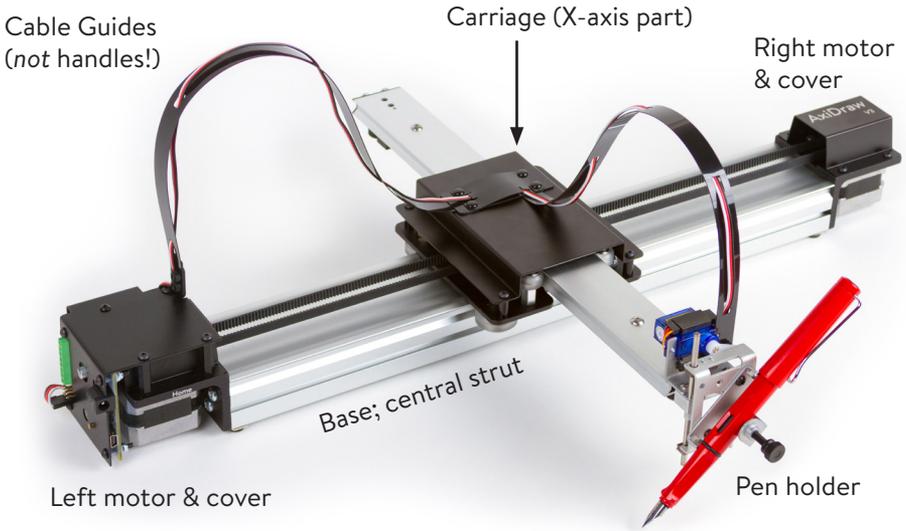
Here are the parts that come with AxiDraw:

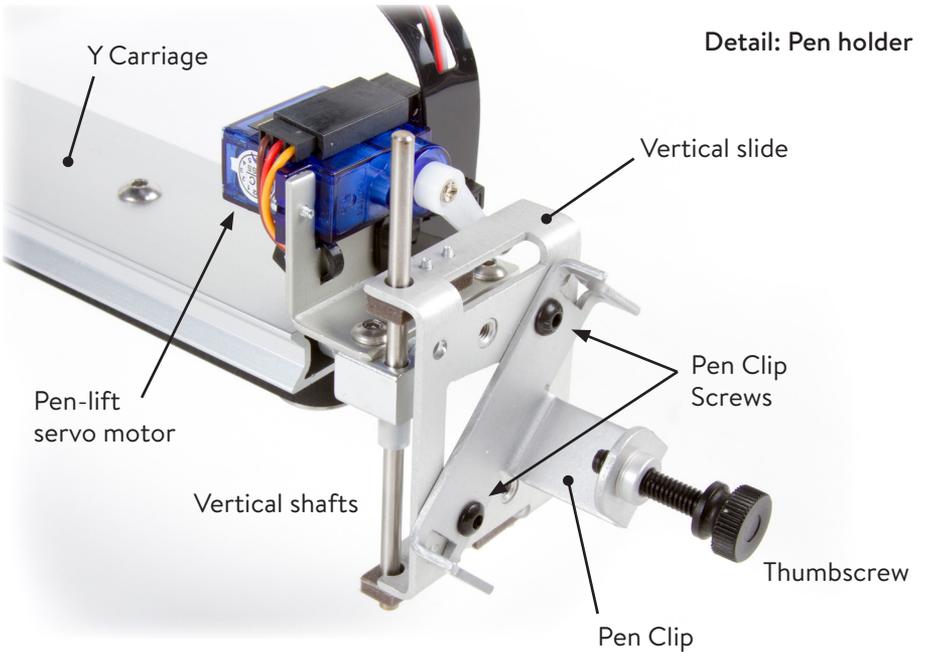
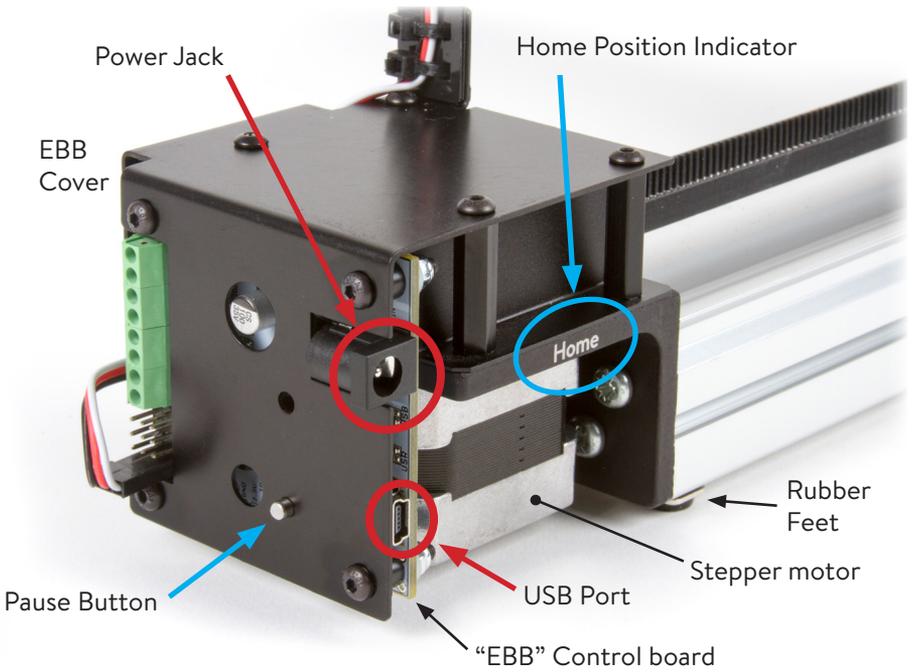
1. The AxiDraw itself
2. Clip Easel and binder clips (4 on AxiDraw V3, 8 on larger models)
3. Plug-in power supply
4. USB cable
5. Hex drivers and wrenches
Sizes include 2 mm, 2.5 mm, and 3 mm hex drivers, and low-profile 8 mm and 10 mm wrenches. Of these, only the smallest (2 mm) hex driver is used in normal operation.
6. Not shown: Extra rubber feet (AxiDraw V3 and V3 XLX only)
Normally not needed. But, just in case a rubber foot gets bumped off of the base during shipping, these are spares.
7. Not shown: Rubber bands
These can be used to add a little extra pen force if needed.
See the last chapter, *AxiDraw Tips and Tricks*.
8. Not shown: Special accessories included only with AxiDraw SE/A3
The SE/A3 also includes an XL pen clip and an italic pen adapter.
These are available separately for use with other AxiDraw models.

To learn more about available AxiDraw accessories, please visit: emsl.us/902

2.2 AxiDraw Anatomy

Let us look at the different parts of the AxiDraw. We will refer to these parts by name throughout this guide. These features are common to each model of AxiDraw, though appearances may vary slightly. For example, the AxiDraw V3/A3 and SE/A3 have extended “outrigger” feet, and the AxiDraw SE/A3 base is colored black and covers the two motors.

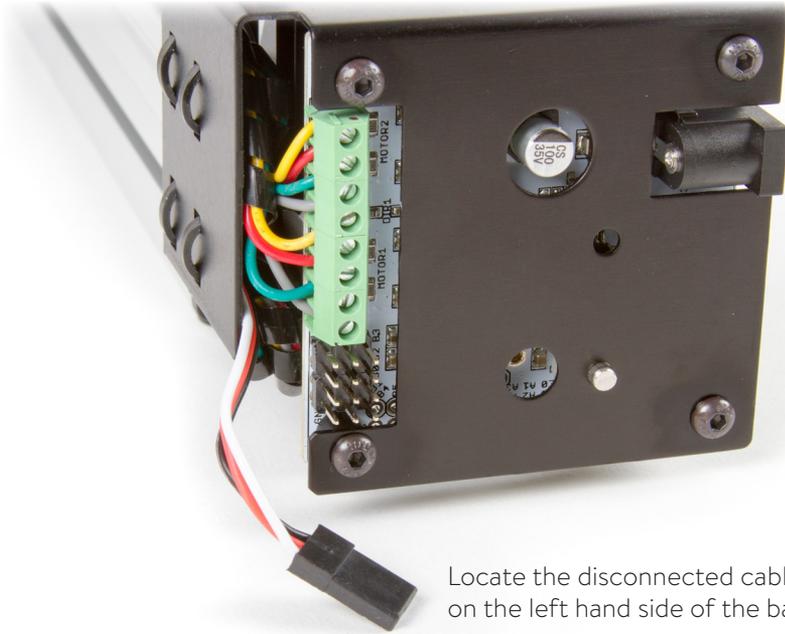




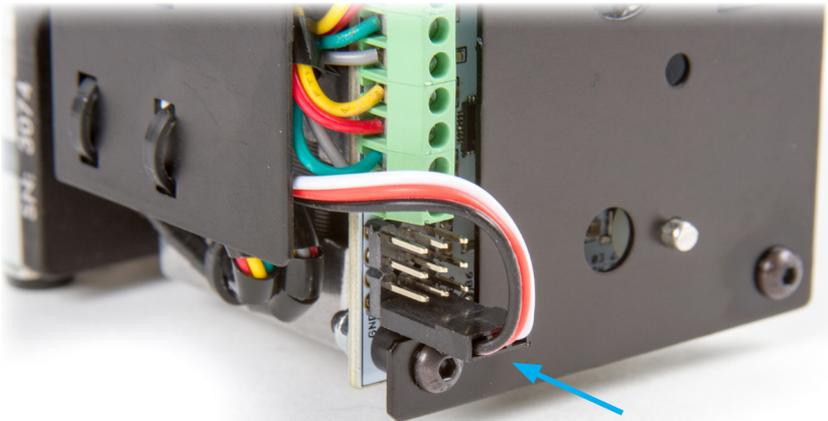
Note: AxiDraw ships with its pen clip disconnected; see the next section.

2.3 Unboxing

The pen-lift motor cable and the pen clip are disconnected for shipping.



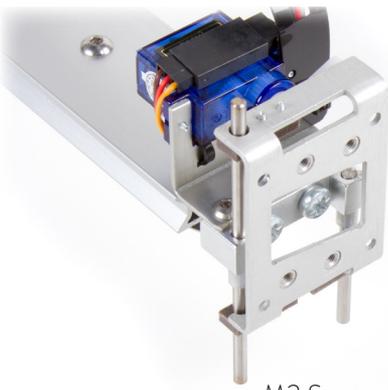
Locate the disconnected cable end on the left hand side of the base.



The cable has three wires: Black, red, and white.

Plug its connector into the bottom three pins on the EBB Control Board as shown. The black wire faces back, towards the edge of the board.

§2.3, Unboxing, continued:



The pen clip is also disconnected for shipping.

Vertical slide
(Appearance may vary; see next page.)

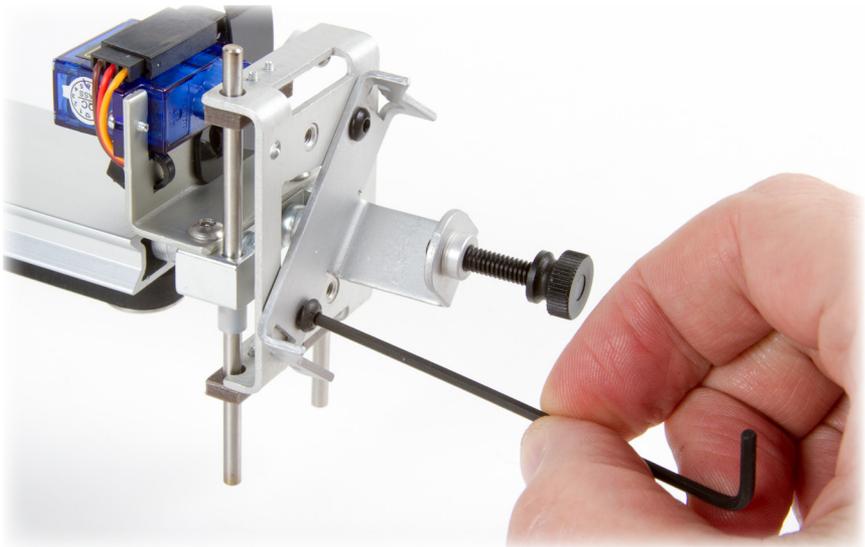
M3 Screws
for pen clip

Thumbscrew



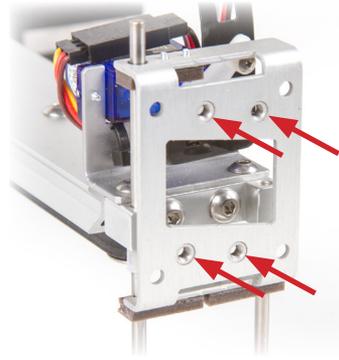
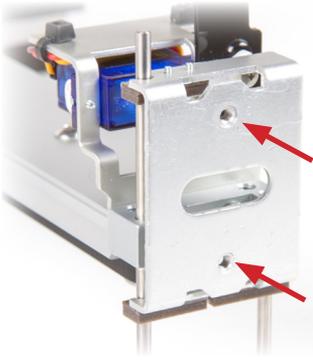
Pen clip

2 mm ball-end
hex wrench

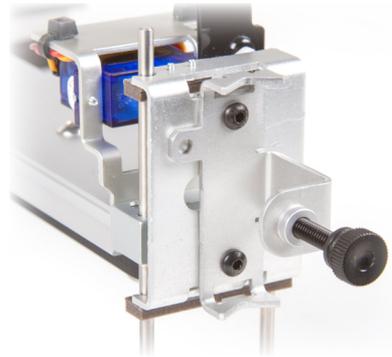
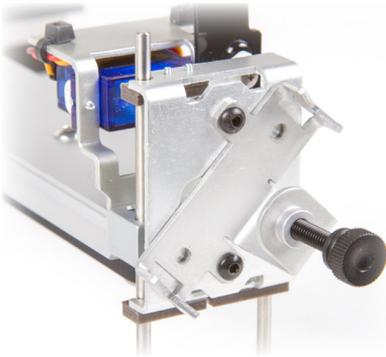


Thread the black plastic thumbscrew into the pen clip.

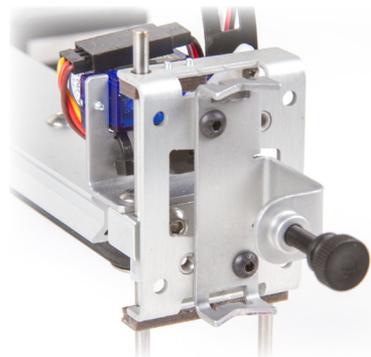
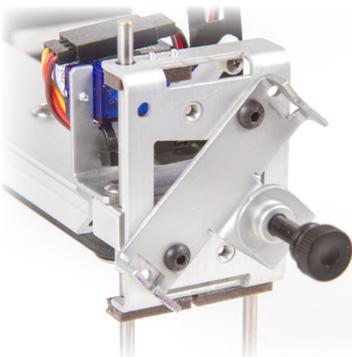
Attach the pen clip to the vertical slide with the two small black M3 screws, using the 2 mm hex wrench, which has a ball end for easier access. The pen clip may be attached either in a vertical or diagonal orientation, depending on what kind of a writing implement you are using. (Continues on next page.)



Your vertical slide may have either two or four threaded holes for the pen clip. Both styles have the same function, but they do look a little bit different. In either case, use exactly two screws to attach the pen clip in place.



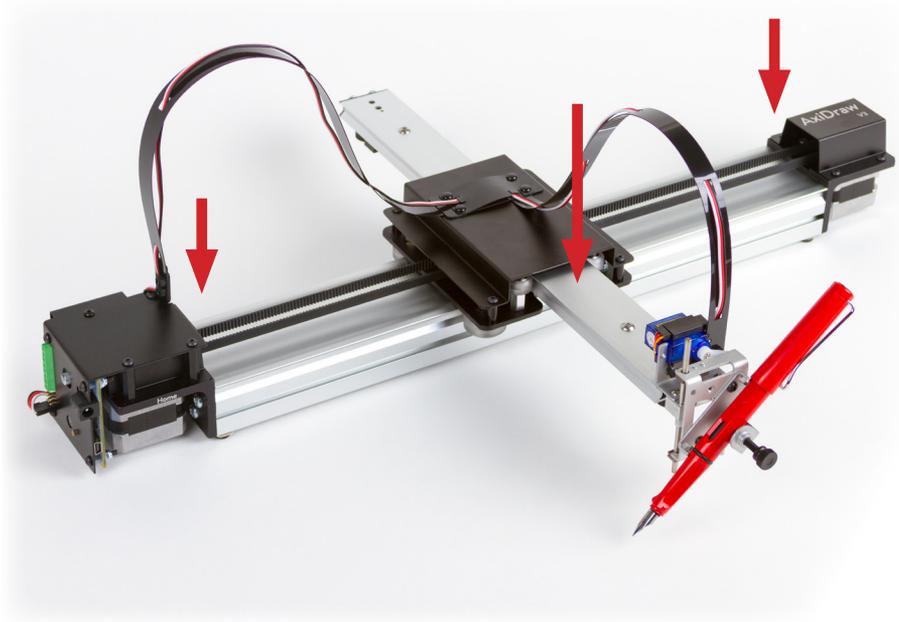
Current production two-hole slide with the pen clip mounted in the diagonal (left) and vertical (right) configurations.



Older AxiDraw units may have a four-hole slide, with only two holes in the pen clip. Here it is shown with the pen clip mounted in the diagonal (left) and vertical (right) configurations.

2.4 Safe handling of the AxiDraw

- 1). **Lifting:** Lift AxiDraw by the central strut of the base, or by the stepper motors if necessary. Do not lift by the cables, cable guides, carriages, or pen holder. The AxiDraw SE/A3 has a handle milled into the back of the central strut, to provide an additional lifting point in the middle of the machine.
- 2). **Heat:** Please note that the two stepper motors may get warm. This is normal, but it is helpful to be aware of it. They should not get too hot to touch.
- 3). **Moving parts:** AxiDraw has exposed moving parts. Keep fingers, hair, and other things that could get caught, crushed, or tangled safely away from the belt and the pinch points between the moving carriage, the pen holder, and the motor covers.



Warning: Keep fingers away from pinch points while AxiDraw is operating.

3: Overview: Getting Started with AxiDraw

In brief, here are the steps to getting started with the AxiDraw:

- 1) Install the software.
- 2) Open or create the artwork that you would like to plot.
- 3) By hand, move the carriage to the upper-left Home Corner.
- 4) Connect power and USB cables.
- 5) Check pen-up and pen-down heights.
- 6) Set up your pen and paper.
- 7) Begin plotting from within the AxiDraw software.

Part 4 of this guide goes through the first item on the list: Installing the software. Parts 5 through 8 go through setting up your AxiDraw for use. Part 9 walks through making your first plot, and various options available while plotting. Part 10 talks about designing for AxiDraw. It is followed by sections on various tips and tricks for using your machine.

4: Software for AxiDraw

4.1 Installing software

You will need to install software on your computer to operate the AxiDraw. Current instructions and download links are available at: <http://axidraw.com/sw>

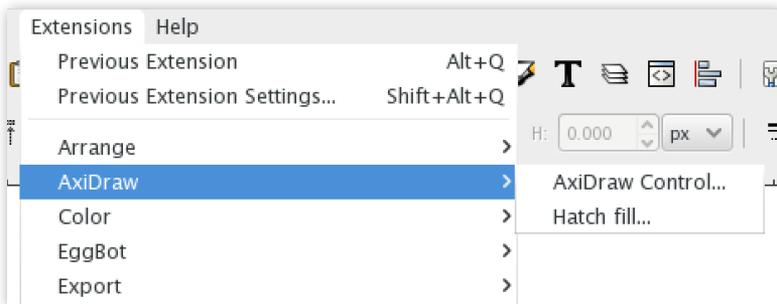
From there, follow the directions specific for your operating system:

- For Mac and Windows, there are easy installers that you can download.
- For Linux, one or more manual steps are required.

The software that you will install includes Inkscape, the superb (and free) drawing program, and a set of extensions that operate the AxiDraw from within Inkscape.

4.2 Inkscape and the extensions

Once you have installed the software, launch Inkscape. The AxiDraw software will appear in the menu at **Extensions > AxiDraw**. All machine control is performed from within the **AxiDraw Control** panel. A second extension, **Hatch Fill**, is provided as well, to help with filling in shapes.



4.3 Aside: Alternative software and APIs

RoboPaint is an alternative driver software available for painting and drawing robots. It requires a separate install process, but does support AxiDraw.

Programming is not required to operate the AxiDraw. In the case that you would like to program it or remotely send data to it, we do have interfaces and documentation available. All of our software is open source.

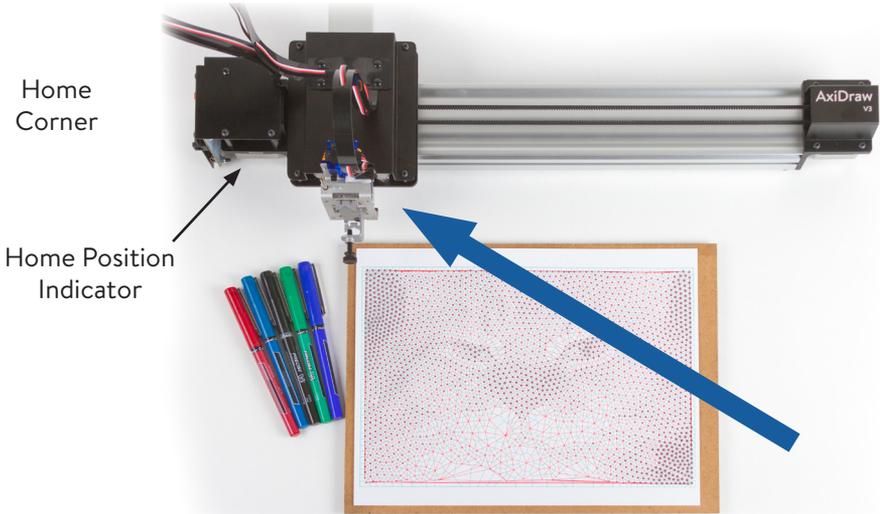
For more information about RoboPaint or our APIs, please see the documentation on our wiki site at <http://axidraw.com/docs>

Beyond these options, a stand-alone command line version of our (otherwise) Inkscape-based software is in development, and available in beta to AxiDraw users. If you would like early access, please contact us directly:

<https://shop.evilmadscientist.com/contact>

5: The Home Corner

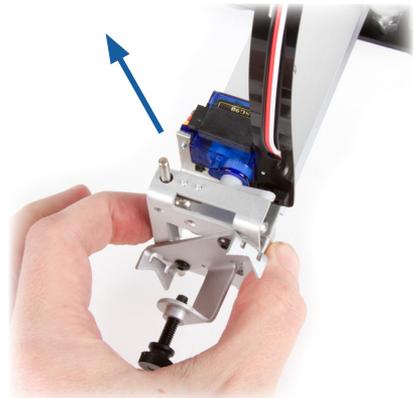
Before you start plotting, the pen holder must be moved to the **Home Corner**. This is as far left and as far back as it will go: where the pen holder is closest to the left side of the base, that is when the pen holder is closest to the engraved label “Home”, and the USB port.



When a plot finishes, the AxiDraw will return to its Home Corner automatically, leaving it ready for the next plot.

Slide the carriage to the Home Corner by hand. You can move it diagonally by holding the solid block of metal behind the vertical side of the pen holder. Do not push the vertical side of the pen holder directly.

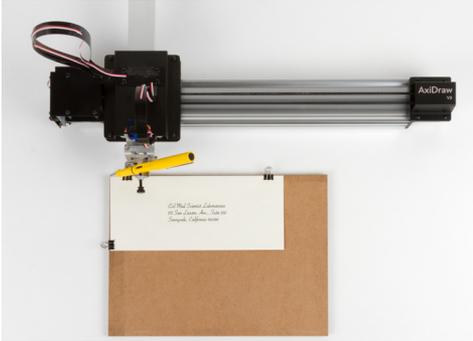
The carriage should only be moved when the power to the motors is off. If it does not move easily, turn off the motors so that you are not trying to force them.



To do so, use the “Raise pen, turn off motors” command in the Setup tab of AxiDraw Control (see page 22). If necessary, you can also physically disconnect the AxiDraw from power.

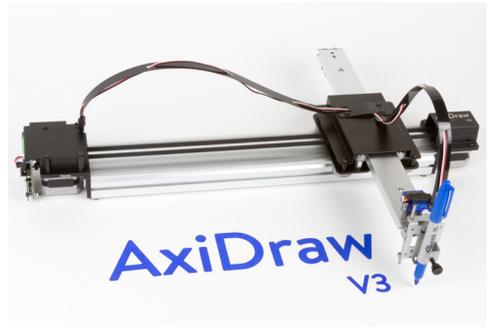
6: Workholding

Whatever workpiece the AxiDraw is to write or draw upon – whether that is paper, wood, or cookies – needs to be reasonably fixed in place so that it does not move while plotting.



6.1 Printing on large workpieces

For large workpieces such as the large poster board shown here, the AxiDraw may be placed directly on top of the workpiece. Other examples of large workpieces that AxiDraw can sit upon might include things like fabric, wooden surfaces, or large whiteboards.



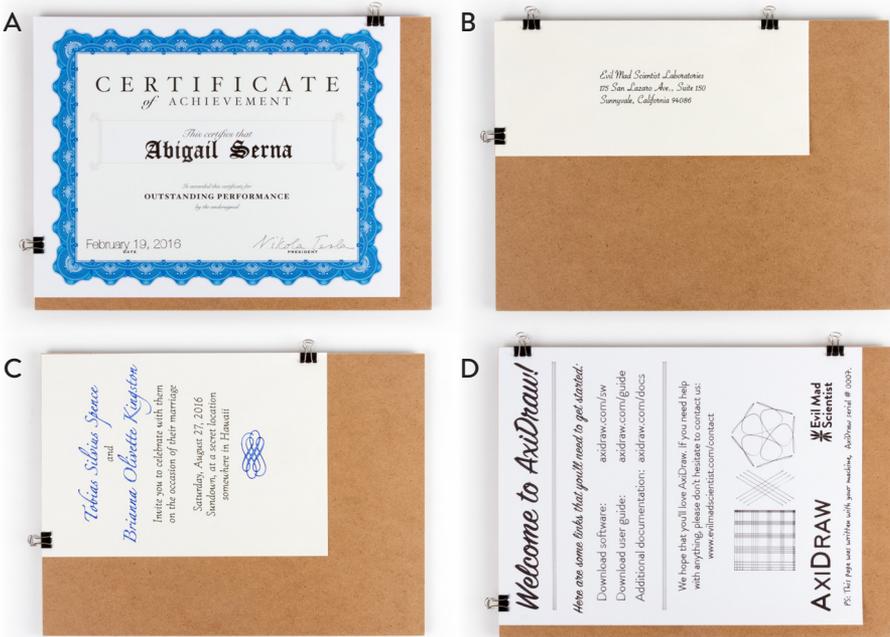
With some awkwardly shaped workpieces (framed art, irregular objects, etc.), you may need to prop up the base of AxiDraw to make it tall enough to reach.

6.2 Workholding with the Clip Easel

A simple board with clips, the **Clip Easel**, is included with the AxiDraw for holding smaller workpieces – principally different shapes and sizes of paper – that are not large enough to be held down by the AxiDraw itself. This is a great way to mount paper when getting started with the AxiDraw.

The AxiDraw V3 Clip Easel is 9 × 12 inches (about 23 × 30 cm) in size, with rubber feet and four small binder clips. (Larger easels are included with the larger-sized AxiDraw models.) You can mount different sizes of to it, including US letter size (or A4) paper, and smaller sizes including envelopes, cards, and invitations. With smaller paper, you can also potentially mount several pieces at the same time. The clips can be positioned as needed to hold the paper flat, and avoid the areas where you will be writing.

§6.2, Workholding with the Clip Easel, continued



The examples shown above are:

- A) A certificate to be filled out (Letter size, landscape orientation)
- B) Mailing address (#10 envelope, landscape orientation)
- C) A formal invitation ($6 \frac{3}{8} \times 8 \frac{7}{8}$ inch, portrait orientation)
- D) A page of mixed text and drawing (Letter size, portrait orientation)

In every case, line up the corner of the paper with the upper left corner of the Clip Easel, such that the corner of the paper is closest to the Home Corner.

If your document is wider than it is tall (or square), it is said to be in *landscape orientation*, and your paper should be oriented as in examples **A** and **B** above. If is taller than it is wide, it has *portrait orientation*; turn your paper “sideways” as in examples C) and D) above. (This default behavior can be overridden. See “9.7 Advanced options” on page 37.)

6.3 Using multiple Clip Easels

A common technique is to use more than one clip easel, such that you can quickly swap out your completed workpiece for the next one. The key advantage is that one page can be plotting while you unclip and clip the next page. You can use tape marks or hard end stops on your table (like a carpenter’s square) to facilitate quick alignment.

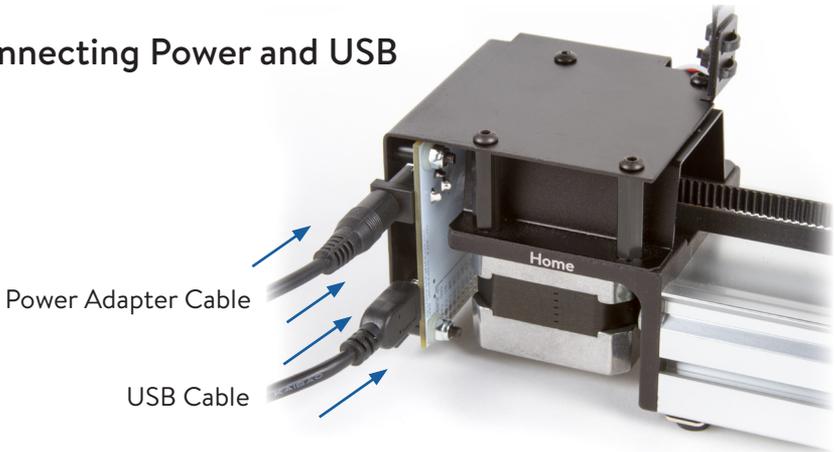
A second method can be used when your workpieces are substantially smaller than the working area of your machine. For example, if you are labeling small note cards with the AxiDraw, or if you are plotting two side-by-side letter (A4) size pages with the AxiDraw V3/A3 or AxiDraw V3 XLX. Using two small easels side by side, you can designate one “A” and one “B”, and alternate plotting on the “A” or “B” side. If you change out each side when it finishes, you can plot continuously without ever pausing to swap out the paper.

6.4 Moving beyond the Clip Easel

While the Clip Easel is versatile, its use is entirely optional. Paper can be also held in place with tape, clamps, tacks, paper clips, magnets, other types of clipboards, the weight of the AxiDraw itself, or by other means that you see fit.

If your AxiDraw is used as a single-purpose machine (that is, if you use the same pen and paper size consistently), you may prefer to make a workholding solution tailored for your specific application. In some cases, making a fixture that is permanently mounted to a tabletop or work surface can save you a great amount of time.

7: Connecting Power and USB



In the next section, when setting the pen heights, it is necessary to plug in the AxiDraw. When it is time to do so, connect the power and USB cables to the AxiDraw as shown above. Connect the USB cable to any available USB port on your computer.

The plug-in power adapter included with the AxiDraw (9 V dc, regulated, center positive) works with worldwide mains power (100-240 V ac). Outside of the US, it may require an inexpensive plug-shape adapter.

Once your cables are connected, make sure that the AxiDraw has room to move. As the carriage moves (left to right, back and forward), it is important that it cannot get caught on stray cables.

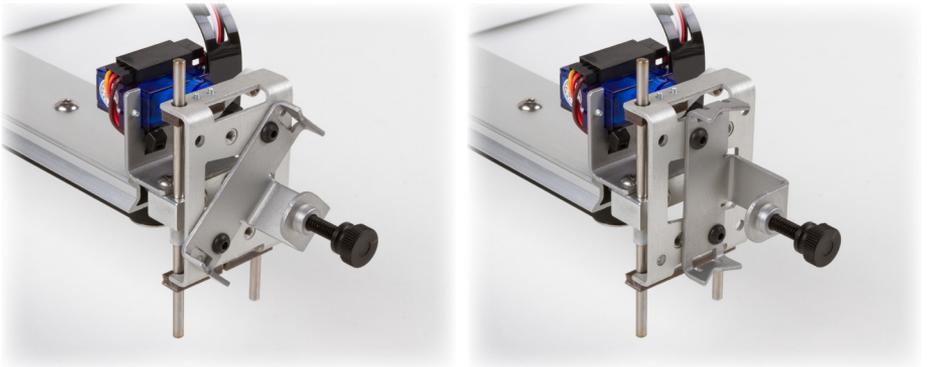
8: Pens and Getting Ready for Printing

In this section we will discuss different types of pens, configuring the pen angle, the pen-up and pen-down positions, setting the pen height, and how to set the paper position relative to the pen.

8.1 Pen choices

The pen holder on the AxiDraw fits pens up to $\frac{5}{8}$ inch (16 mm) in diameter. The maximum recommended pen weight is 1.6 oz (45 g). The design is such that the pen rests on the surface by its own weight. That allows it to ride over surfaces that are textured or otherwise uneven, however it also means that the pen holder does not apply much if any downward pressure.

Good choices for pens include fountain pens, permanent markers, rollerball pens, technical pens, (small-bodied) whiteboard markers, liquid chalk markers, and other writing and drawing instruments that do not require significant pressure. While we refer to writing and drawing instruments as “pens” to be concise, other instruments such as automatic pencils, chalk, charcoal, and brushes can also work well in many cases. Others, like traditional ball point pens, may work poorly because they require a substantial amount of downward pressure to operate.



8.2 Setting the pen angle

The pen may be mounted vertically or diagonally at 45° to the paper by mounting the Pen Clip in either the vertical or angled position.

To detach the pen clip, loosen and remove the two black M3 screws on the front of the pen clip, using the 2 mm hex wrench, which has a ball end for easy access. Use the same two screws to reattach the pen clip, either in the vertical or diagonal orientation. (See pictures starting on page 11.)

The 45° angle position is optimal for use with fountain pens, but will work well with most rollerball and fine point markers. The vertical position is more suited

to markers with fatter tips or writing instruments that require more downward pressure. The vertical orientation is usually the best choice when making plots where you will need to switch between pens (for example with different colors) while maintaining the pen in the same location.

8.3 Inserting a pen

You can insert a pen – or other writing instrument that you are using – into the pen clip and tighten it in place with the thumbscrew.



Take care to only apply *gentle force* with the thumbscrew: You need merely to immobilize the pen, so stop turning once you encounter moderate resistance.

When using any ink-based pen (whether rollerball, fountain pen, or permanent maker), it is helpful to “bleed” out the tip before writing. Try it by hand on a piece of scratch paper, and make sure that ink is actually flowing.

Note on fragile or delicate pens: If you choose to use fragile pens (such as high-end fountain pens with celluloid barrels), exercise great care when inserting the pen. You may wish to wrap the barrel in a thin, soft cloth to avoid scratching, and use little or no pressure from the thumbscrew. Moderately priced fountain pens, like the Lamy Safari shown above, tend to be quite tough, and require little special treatment.

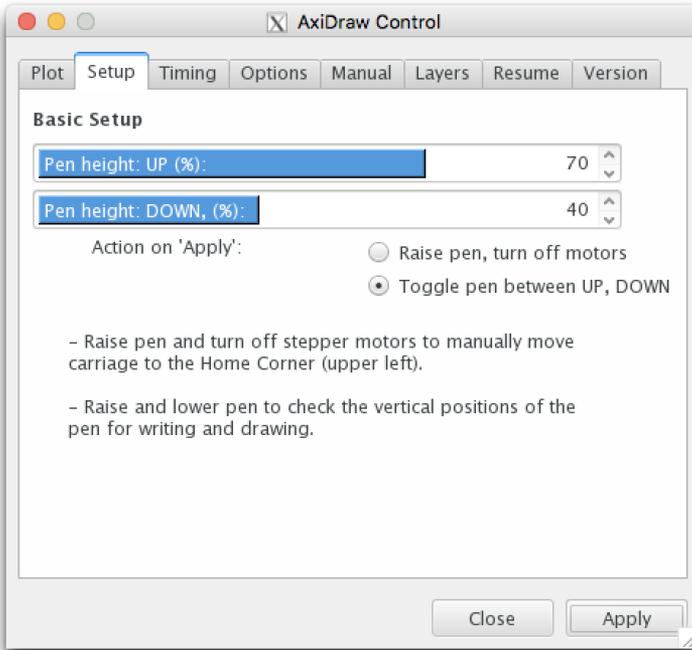
8.4 Pen up and pen down positions

In this step we will check the pen-up and pen-down positions.

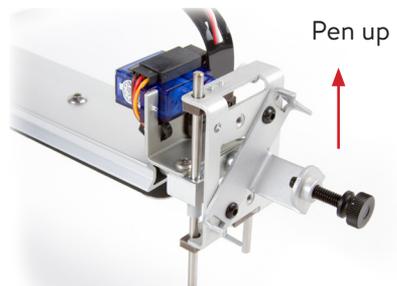
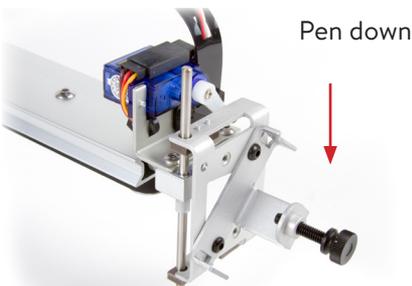
First, connect power and USB to the AxiDraw. (See “7: Connecting Power and USB” on page 19). Then, within Inkscape, open up AxiDraw Control. If the AxiDraw software is installed, you can find it in the menu bar at:

Extensions > AxiDraw > AxiDraw Control

Click on the **Setup** tab:



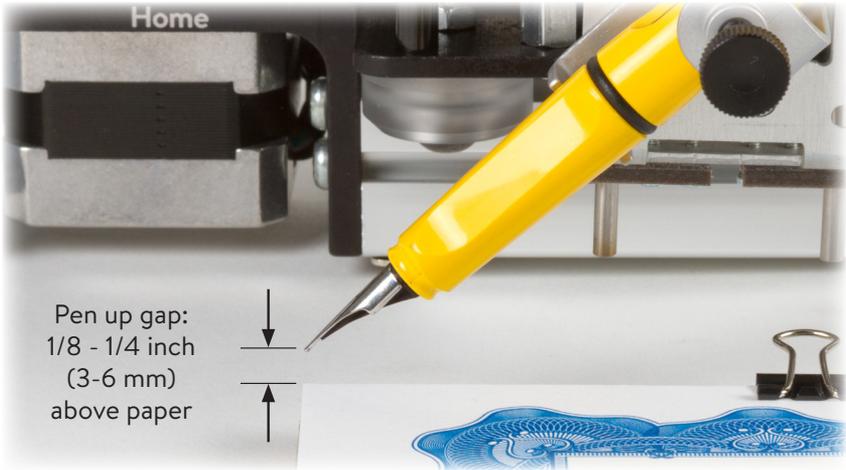
Select the **Toggle pen between UP, DOWN** action, and click the **Apply** button. If your software is all installed correctly and everything is hooked up correctly, the pen lift motor will alternately move to the up or down positions each time that you press Apply. (If it does not move, check that you have correctly hooked up the pen-lift motor cable. See section “2.3 Unboxing” on page 10.)



§8.4, Pen up and pen down positions, continued

The pen-up and pen-down heights may each be adjusted between 0 and 100% to suit your needs. Higher percentage values lift the pen higher.

The factory-default values of 60% (up) and 30% (down) are a good starting point. Try also adjusting them to a different set of values (say, 70% and 30%, respectively) and apply, to see that the positions change when you adjust them. The pen holder should visibly move up and down as you raise and lower the pen holder.



While in the pen-up position, insert your pen and position it above your paper.

The vertical position of your pen should be approximately 1/8 to 1/4 inch (3 - 6 mm) above the surface of the paper. You can physically adjust the position of the pen with the thumbscrew, and/or change the positions from the Setup tab of AxiDraw Control.

Toggle also to the pen-down position. With the pen down, the pen should rest on the paper by its weight. If it does not, you may need to lower the pen-down position. (While testing, you can protect the paper that you will be writing upon with another sheet of paper, to avoid writing on your actual workpiece.)

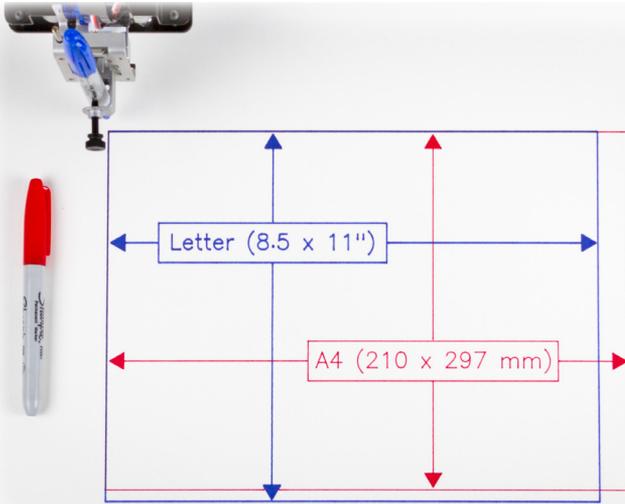
Finally, return the pen holder back up, to position your paper for printing.

Once you are familiar with the process of inserting the pen and setting the height, this process reduces to two steps:

- 1) Raise the pen holder to the pen-up position (if it is not already there).
- 2) Insert your pen into place.

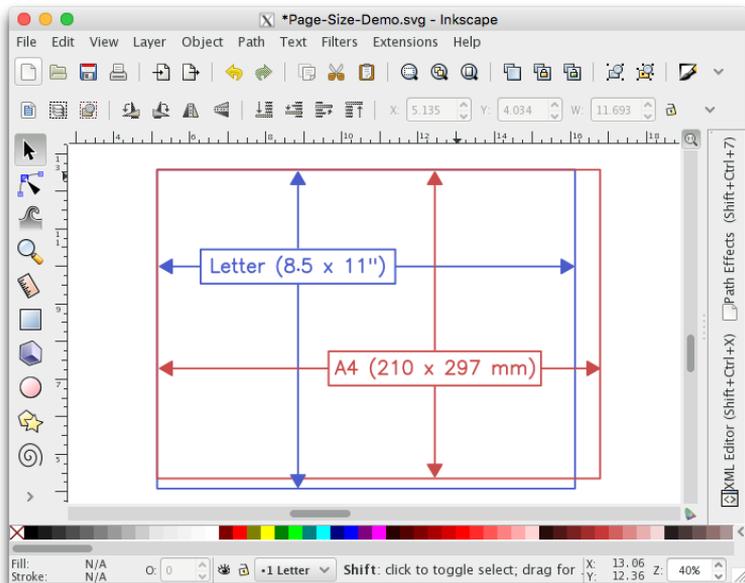
8.5 Positioning your paper

With your pen at the Home Corner, and the pen at an appropriate height, it is time to position the paper with respect to the AxiDraw. The printable area starts at the Home Corner, and extends down and to the right from that point.



Plotting on large surfaces (where the AxiDraw sits directly on the surface): Position the AxiDraw such that the pen tip is at the upper left corner of the area that you intend to plot upon. The software will treat the corner of the page in your Inkscape document as Home Corner for the purpose of plotting.

Here is how the “page” printed above looks from within Inkscape:



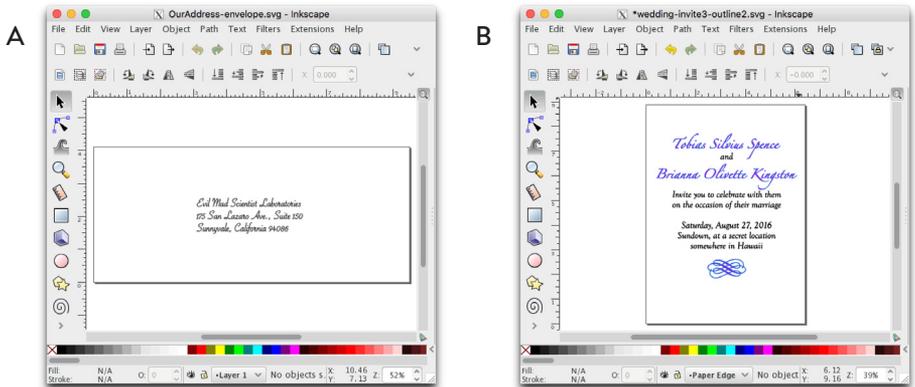
§8.5, Positioning your paper, continued



Plotting on everything else (letters, envelopes, invitations, and smaller items): Position the paper with its upper-left corner directly underneath the tip of the pen. Square the paper up so that its top edge is parallel to the X-Shafts of the AxiDraw.

As we discussed earlier (page 18), documents that are taller than wide are usually turned “sideways”, as in **B** above. Whether vertical or horizontal, it is always the corner of the paper *closest to the Home Corner* that one aligns below the tip of the pen.

For comparison, here are how those two documents look on the computer when setting up to print:



The absolute position of your paper with respect to the AxiDraw will vary, depending on the paper, the pen that you use, as well as the pen length if it is mounted at 45°. For any given pen and paper setup, it is likely to remain relatively consistent. (See “6.4 Moving beyond the Clip Easel” on page 19.)

8.6 Summary

Your AxiDraw is now ready for use. To recap, the steps so far are:

- 1) Move the pen holder to the Home Corner (if it is not already there).
- 2) Connect Power and USB cables.
- 3) Use the setup tab to move the pen holder to the “pen-up” position.
- 4) Insert your pen, just above the paper.
- 5) Position your paper with its corner beneath the tip of the pen.

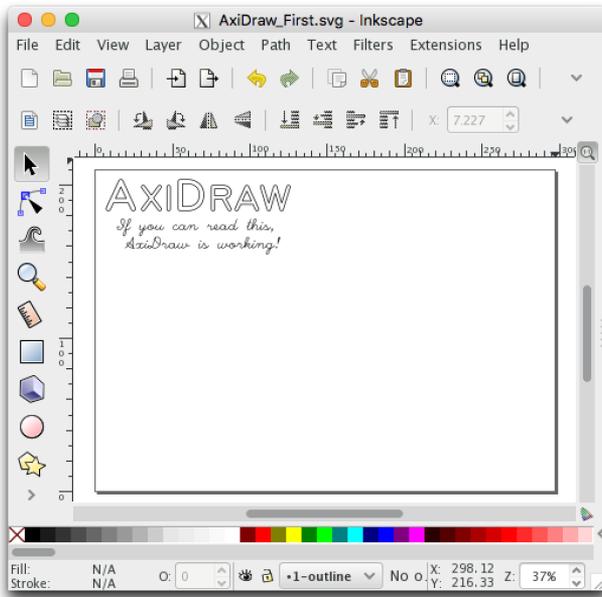
9: Plotting with the AxiDraw

9.1 Making your first plot

In this section we will walk through the steps to make your first plot on the AxiDraw. Finish installing the AxiDraw software (§4) before beginning here. *In addition to what comes with the AxiDraw, you will need pen and paper.*

Download the set of AxiDraw example files from <http://axidraw.com/ex>

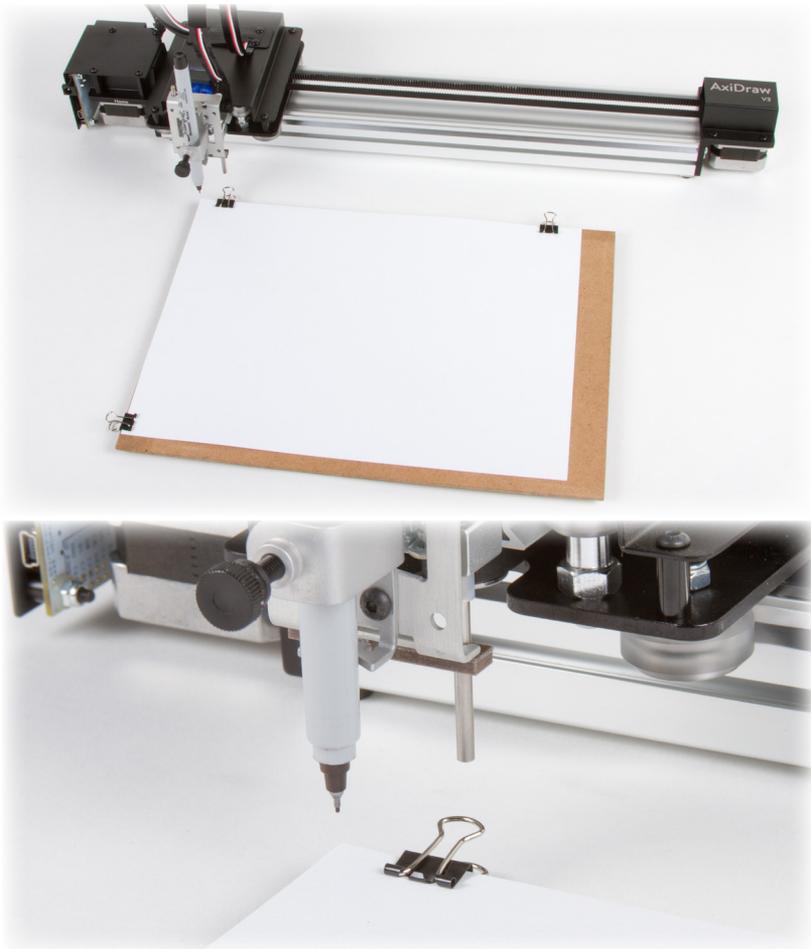
The download is a small zip archive of example files. Open (unzip) the archive, and from within Inkscape open up the file called AxiDraw_First.svg. Once open, the document should look approximately like this:



If you cannot see the full page outline when you first open the file, select from the menu View > Zoom > Page, or type the number ‘5’ on your keyboard.

If you have not done so already, get the AxiDraw set up to print:

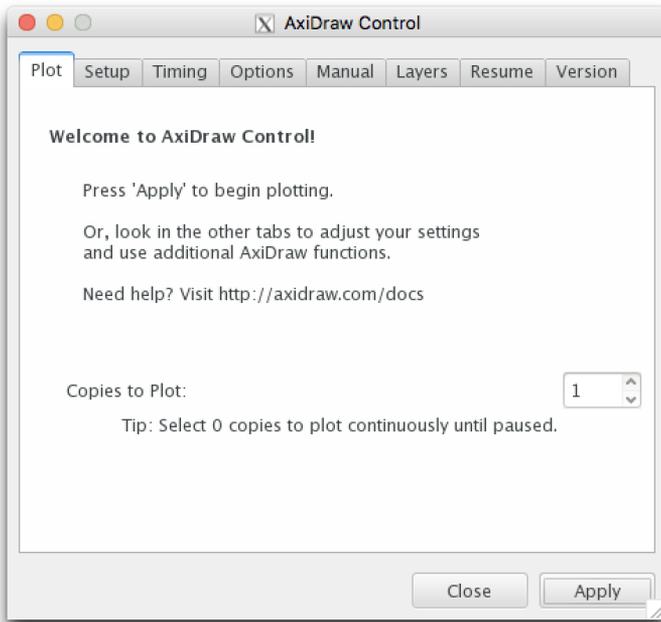
- 1) Slide the pen holder to the Home Corner. (See §5)
- 2) Plug in the power cable and connect the USB. (§7)
- 3) Using the software, toggle the pen down and back up. (§8.4)
 - From the menu, select **Extensions > AxiDraw > AxiDraw Control**
 - In the **Setup** tab, use the **Toggle pen between UP, DOWN** option.
- 4) Clip a piece of paper to the Clip Easel. (§6.2)
 - Align the paper to the upper left of the Clip Easel, closest to Home.
- 5) Clip in your pen, with height just above the paper. (§8.4)
- 6) Position the paper with its upper-left corner beneath the pen tip. (§8.5)



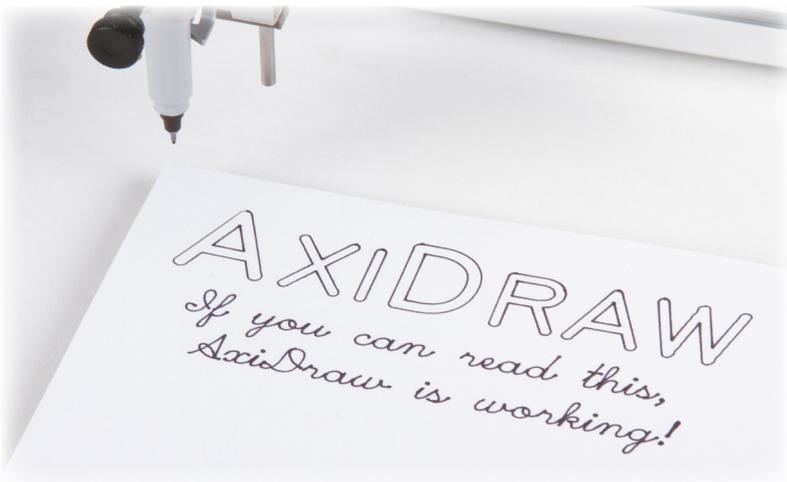
§9.1, Making your first plot, continued

You are now set up to print. Last thing: Check the area around the AxiDraw, and make sure that the carriage has room to move, both in front of and behind the base.

Finally, switch to the **Plot** (first) tab of AxiDraw Control, and click **Apply** to begin.



The AxiDraw should now begin printing your document, and will return back to the Home Corner, with pen up, when it finishes.



9.2 Plotting multiple copies

The **Copies to Plot** option on the Plot tab allows you to plot the same document multiple times, with an optional delay between copies.

Setting the number of copies:

Enter the number of copies that you would like to plot in the **Copies to Plot** box. The default value (1 copy) will only plot the page once.

Setting the delay between pages:

The value of **Seconds of delay between copies** in the **Timing** tab of AxiDraw Control sets how long the AxiDraw will pause between pages when plotting multiple copies. This delay is intended to allow time for you to swap out the paper between copies. The default value is 15 seconds, but it can be set anywhere from 0 (no added delay) to 3600 seconds (1 hour).

Plotting continuously:

If **Copies to Plot** is set to 0 (zero), then the AxiDraw will plot continuously (with the same delay between pages) until you press the physical pause button on the left side of the AxiDraw. (See section “9.3 Pausing, resuming, and canceling plots” on page 30 for more about pausing.)

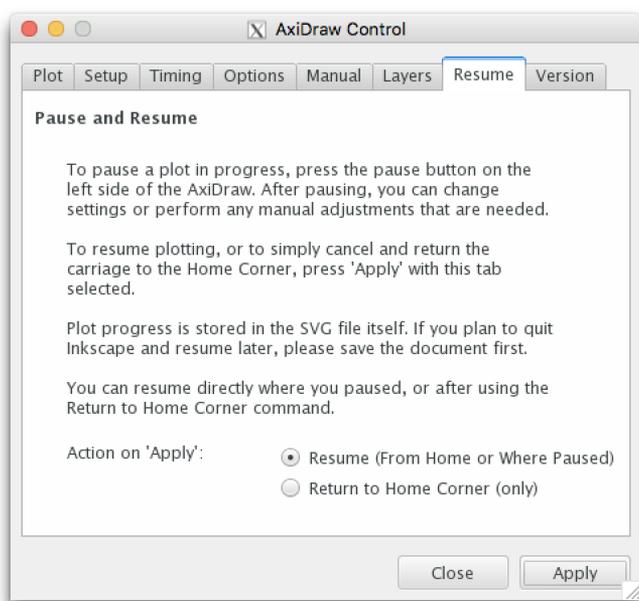
For ease of use, it is recommended to press the button during the delay between plots, while the AxiDraw is resting at the home position.

9.3 Pausing, resuming, and canceling plots

To pause or stop while plotting, press the pause button: the raised silver-colored button located on the left hand side of the AxiDraw. (See “Detail: Left side of base” on page 9.) The AxiDraw will stop plotting and raise the pen after finishing the current line segment.

Note: You must *physically press the pause button* to stop a plot in progress. (Inkscape has a “Cancel” button, but it does not actually stop running extensions.)

Once paused, you can make adjustments in the settings (for example, to the pen height or plotting speed), before resuming, if you choose to do so.



To resume a plot after pausing, open the **Resume** tab of AxiDraw Control, select the **Resume** action and click **Apply**. To instead return the carriage to the Home Corner, select the **Return to Home Corner** option and **Apply**. The plot can still be resumed after moving back to Home (if, and only if, moved by this command).

If you instead want start a new plot (from the Plot or Layers tab), you **must** return the carriage to Home before beginning, just like any other time that you are starting a plot. Failure to do so will cause a loss in position control.

You can also move the carriage Home by hand. To do so, use **Raise pen, turn off motors** in the Setup tab (See “8.4 Pen up and pen down positions” on page 22) to unlock the motors so that the carriage can be moved. You will need to return Home manually in any event where there is a loss of position control.

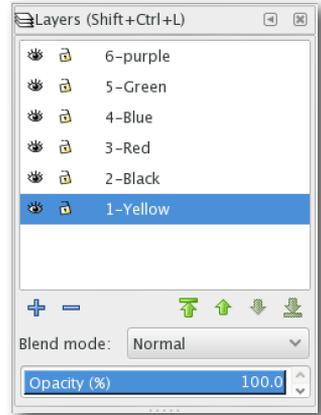
9.4 Plotting with multiple layers and colors

By default, the AxiDraw will plot all visible paths on your drawing. However, if you have a document with multiple *layers*, you can use AxiDraw Control to plot a single layer, or some set of layers.

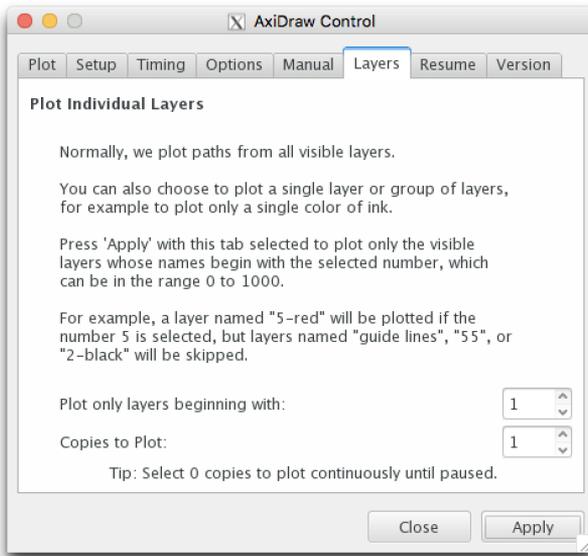
Open the Layers window in Inkscape (shown at right) by selecting from the menu: **Layer > Layers...**

You can add, remove, re-order and rename layers within the Layers window, and the various commands in the Layers menu can also move objects between layers. The little “eye” buttons, to the far left of the layer names, can be used to hide and show individual layers.

Hidden layers are not plotted, and this is one of the simplest ways to plot only certain parts of your document.



A second method of using layers is with the **Layers** tab of AxiDraw Control:



When you click **Apply** with the Layers tab open, the AxiDraw will plot only the layer or layers that have a name beginning with the number entered there (under **Plot only layers beginning with**). The only requirement for using this feature is that you begin each layer name with an integer in the range 0 through 1000.

After plotting from the Layers tab, you can stop to change any settings that you wish to, or switch to a different pen. This makes it possible to plot drawings with portions drawn with different colors and (for example) different speeds.

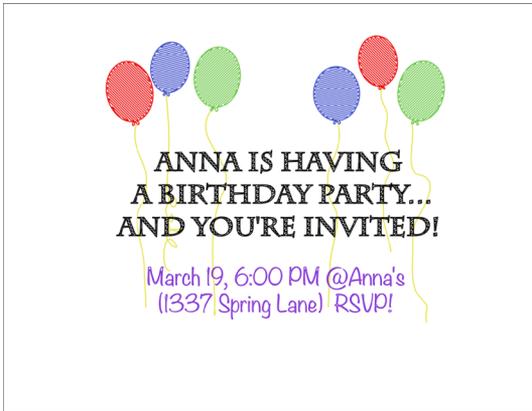
§9.4, Plotting with multiple layers and colors, continued

For example, if you have three layers with the names,

- 1 - Red circles
- 1 - Red squares
- 2 - Blue stars

Then you could plot the two red layers with a red pen by specifying “1” in the **Plot only layers beginning with** field. You can then change the pen to blue and plot the blue layer by specifying “2” in that field. Click the **Apply** button each time to begin plotting of the selected layers.

The set of layers shown in the Layers panel on the previous page corresponds to the example shown below: A birthday party invitation with six colors and six layers. You can see how it appears in Inkscape, as well as printed on the page using six ultra-fine point Sharpie markers.



Plotting multiple copies from the layers tab

The **Copies to Plot** option in the Layers tab allows you to plot the same layer or set of layers multiple times, in the same fashion as plotting multiple copies from the Plot tab. (See “9.2 Plotting multiple copies” on page 29).

The delay time between subsequent pages is set by the **Seconds of delay between copies** parameter in the Timing tab of AxiDraw Control. (This is the same parameter that controls the delay between pages when using the Plot tab.) And, you can plot continuously (until paused) by selecting “0” (zero) for the number of **Copies to Plot**.

Additional Layer Control features

Beyond control with the Layers tab, there are additional commands and parameters that can be specified through the layer name.

You can use properly formatted codes to specify the pen-down height and the speed for printing specific layers. There are also special codes that can introduce a timed delay while plotting or force a programmatic pause (as though you had pressed the pause button to halt a plot). These types of codes are rarely used in everyday plotting, but can be useful in developing specialized applications

One additional, and particularly useful, feature is that any layer with a name starting with a percentage sign “%” is said to be a **documentation layer**, and will not be plotted.

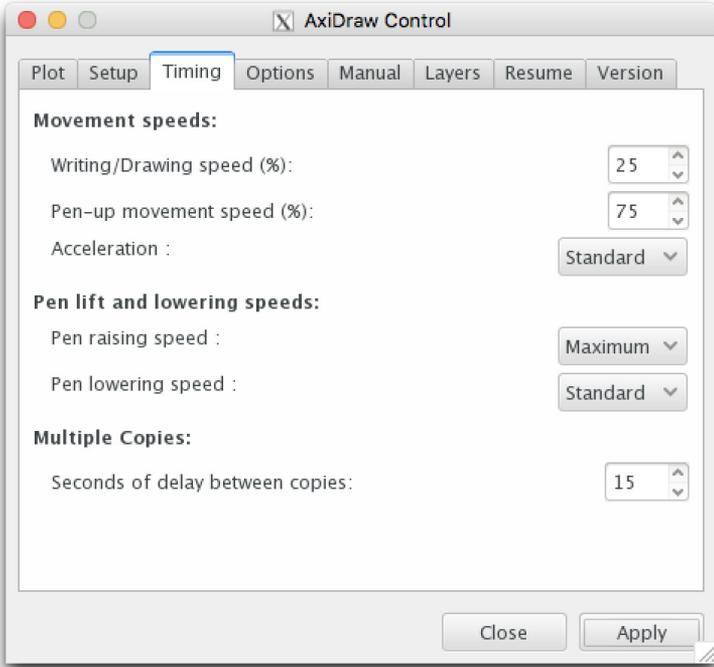
The Layer Control features are always active, and can be used (for example) whether you are plotting from the Plot or Layers tab of AxiDraw Control.

The complete syntax for AxiDraw Layer Control can found at:

<https://wiki.evilmadscientist.com/ALC>

9.5 The Timing tab and basic speed control

The **Timing** tab of AxiDraw control lets you set the basic movement speeds for the AxiDraw. The three parameters at the top under the **Movement speeds** heading set the speeds used for the horizontal (XY) carriage motion.



The first item in the list, **Writing/Drawing speed**, sets the maximum speed that will be used when the pen is down. The second, **Pen-up movement speed**, sets the maximum speed that will be used when the pen is up, traveling between two points.

The default value for these two speeds are 25% and 75%, respectively. You can adjust these speeds. Keep in mind that the quality of printing that you can achieve is always a trade-off between speed and neatness.

The **Acceleration** parameter controls how quickly the pen will approach these maximum speeds, and is typically more important in practice than the speed limits.

Everyday use:

Most of our sample drawings and tests are made with a medium speed that is a compromise between speed and precision. This is a good balance for fine-point permanent markers and wide-nibbed fountain pens:

Writing/Drawing speed: 30%

Pen-up movement speed: 75%

Acceleration: Standard

Working with precision:

When working with fine point pens and tuning for higher precision (with writing or drawing) a good starting point might be:

Writing/Drawing speed: 15%

Pen-up movement speed: 60%

Acceleration: Slow

Working at high speeds:

When using wide-tipped permanent markers or other writing implements that make broad marks, one might go as high as:

Writing/Drawing speed: 90%

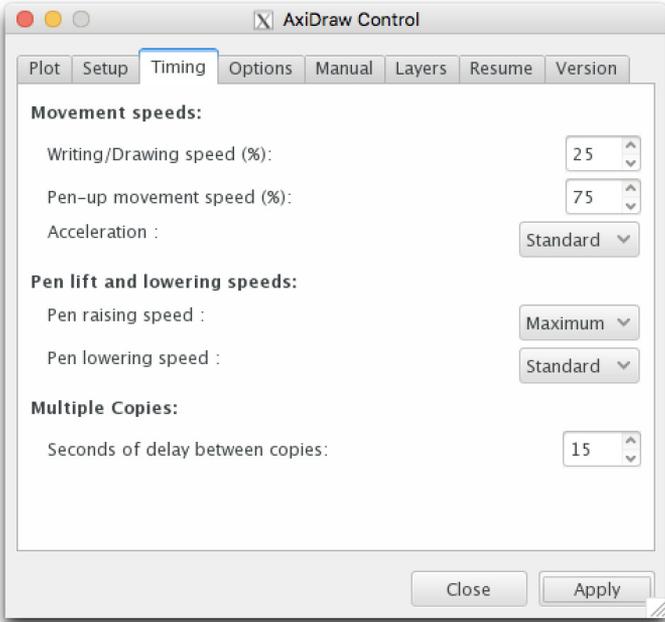
Pen-up movement speed: 100%

Acceleration: Maximum

There are additional factors besides speed that influence precision. These factors include the pen lift and lowering speeds, the weight of your pen, where on the page you are plotting, and so forth. The “right” speed to use for any given application is one that gives you high enough output quality at an acceptable rate.

9.6 Pen lift speeds

The lower half of the **Timing** tab has a heading **Pen lift and lowering speeds**. These control the vertical motion between the heights that are set in the Setup tab (page 22).



The pen raising and lowering speeds can each be selected from a pop-up menu, with options **Maximum**, **Standard**, **Slow**, or **Very slow**.

The AxiDraw will pause its horizontal motion while raising or lowering the pen, until the vertical movement is complete. These pauses are meant to prevent the machine from making pen-up movements until the pen is actually clear of the paper, and to prevent pen-down movements from beginning until the pen is touching the paper.

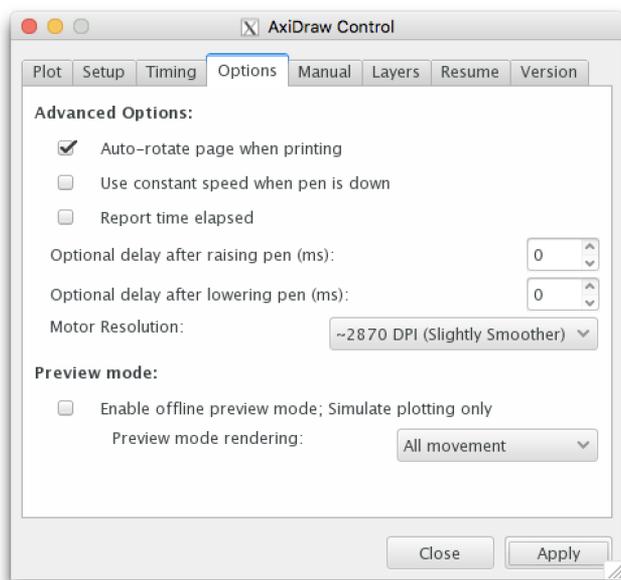
If you are trying to increase the speed of your plots, be aware that the total vertical travel distance is a very important factor in how long pen lifting and lowering takes. Thus, try to decrease the vertical range first, and look at the delays next.

Slower, gentler movements are possible, and will both lead to neater writing and prolong the life of the pen-lift motor as well as your pen tip.

As an advanced option, you can optionally add an additional delay after raising or lowering the pen, to adjust the behavior of one or both of these vertical motions. These additional delays can be set under the **Options** tab of AxiDraw Control.

9.7 Advanced options

The **Options** tab of AxiDraw Control has several advanced settings that do not normally need to be changed, but that you may wish to know about.



Auto-rotate page when printing (Default: on)

Documents taller than wide (those in portrait orientation) will normally be rotated sideways when plotted. (See page 18 for examples.) Uncheck this box to print documents only in the orientation with which they appear on the screen.

Use constant speed when pen is down (Default: off)

When checked, disable acceleration and move the pen only at a constant speed when it is down. This will give neater performance for certain types of paths, but creates more vibration when going around curves. It gives more uniform but less “natural” ink flow.

Report time elapsed (Default: off)

When checked, a dialog box will report the elapsed time and pen-travel distance after each plot finishes. This option is particularly useful in preview mode.

Optional delays (Default: 0):

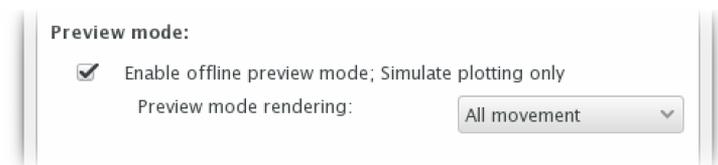
These delays are discussed in the previous section.

Motor resolution (Default: ~2870 DPI)

The two options are for native resolution of about 1435 or 2870 steps per inch (56 or 113 steps per mm). They do not change the effective resolution of your plot; both are finer than what can be resolved with pens. The 1435 DPI option is slightly faster, while the 2870 DPI option is slightly smoother, giving a neater plot.

9.8 Preview Mode

An additional feature located in the **Options** tab is offline **preview mode**. When enabled, preview mode will cause the AxiDraw software to simulate plotting only. That is to say that everything will work normally, with the very large exception that the software not attempt to communicate with the AxiDraw over USB.



Preview mode can be very useful to test workflows or see how the AxiDraw will handle a document, even without the AxiDraw present.

If you simulate plotting a document with preview mode enabled (for example by pressing **Apply** with the **Plot** or **Layers** tab active) the software will parse the document and work through the process of computing how the page will be plotted. Notably, if any errors are encountered, they will be reported in the usual way.

If the **Report time elapsed** option is enabled when you simulate plotting, then the software will provide an estimate of the total plotting time that will be required.

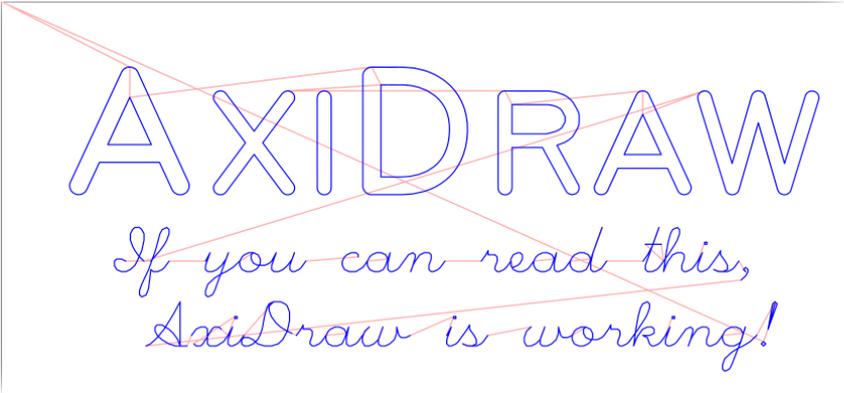
An additional option available within preview mode is **Preview mode rendering**. Preview mode rendering can be enabled from a pop-up menu, with options **None**, **Pen-down movement**, **Pen-up movement**, and **All movement**. If an option other than None is selected, then either the pen-down movement, pen-up movement or both will be simulated and drawn on your page in a documentation layer. (Documentation layers will not be plotted. For more about documentation layers, see “Additional Layer Control features” on page 33.)

If you have chosen to render a preview, then you can use the Layers panel (available in the menu at **Layer > Layers...**) to hide, show, or remove the preview layers. Each time that you render a new preview it will overwrite the old one.

Preview mode rendering is only available when preview mode is enabled.

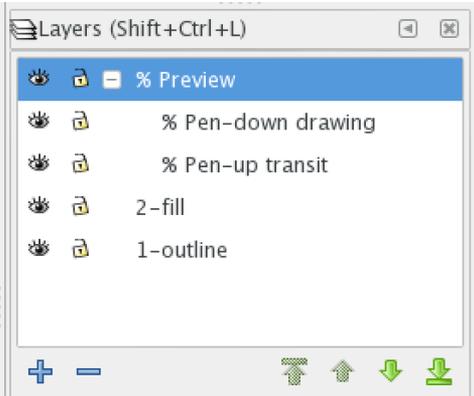
Certain modes and commands (other than plotting) that are primarily designed to communicate with the AxiDraw over USB — including those in the Setup and Manual tabs — are disabled while in preview mode.

Here is how the example file AxiDraw_First.svg renders when you click **Apply** from the **Plot** tab with preview mode enabled and the **All movement** preview mode rendering option selected:



The pen-down movement is shown in blue, and the pen-up movement is shown in light red.

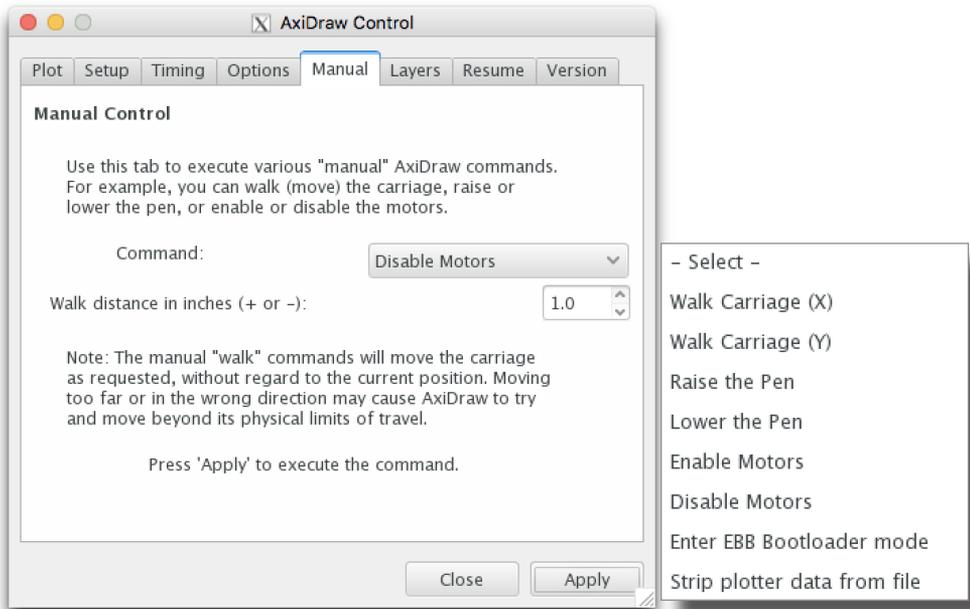
And, here is how those previews appear in the Layers panel:



The pen-down drawing and pen-up drawing are rendered as separate **sublayers** within the Preview layer, so that you can hide one, the other, or both. Since they are documentation layers, these layers will not plot on the AxiDraw, nor will their contents be rendered as part of future preview renders.

9.9 Manual Controls

The **Manual** tab of AxiDraw Control allows you to manually execute select, basic commands and utilities. Select the operation to perform with the Command drop-down list, and then click the **Apply** button. For the two motor walking commands, you can also specify the distance to move the AxiDraw carriage.



The manual commands are as follows:

Walk Carriage (X), or (Y)

Move (“walk”) the carriage in the X or Y direction by the distance specified. The distances are specified in inches (1 inch = 2.54 cm) and may be positive or negative. The Home Corner is the X=0, Y=0 position, and positive moves in both X and Y are *away from the home corner*.

An important note is that no limit checking is performed when manually commanding a move from the Manual tab. Take care not to run the AxiDraw into its physical limits. If you are unsure, you can always disable the motors and move the carriage Home by hand.

Raise the Pen, Lower the Pen

These two commands move the pen to the pen-up or pen-down position.

Enable Motors, Disable Motors

These two commands either energize the two stepper motors or turn power off to them. The carriage can be moved by hand only when the power to these motors is off.

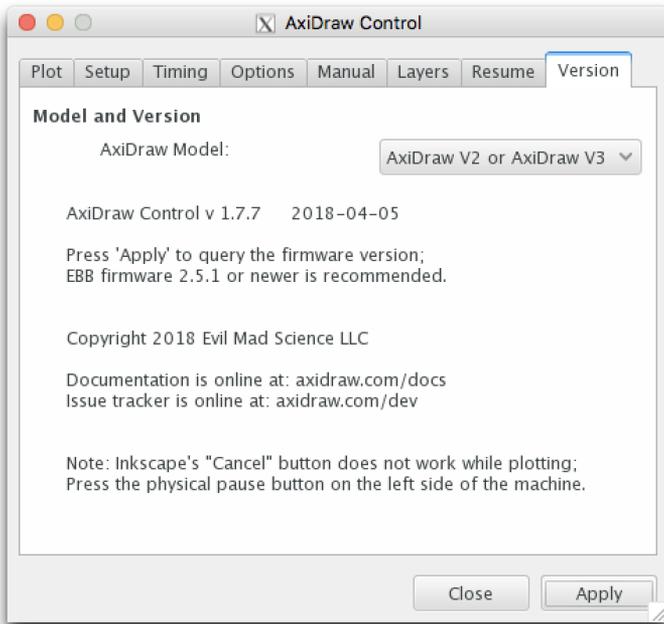
Enter EBB Bootloader Mode

Command the EBB to enter “bootloader” mode. This utility mode is sometimes used in reprogramming the firmware. If you should accidentally enter this mode, disconnect the AxiDraw from both power and USB to reset it.

Strip plotter data from file

The AxiDraw software stores certain configuration data within your document. While having that data there does not cause any known issues, this command can strip that data from the file, should that need arise.

9.9 Model and Version



The **Version** tab of AxiDraw Control lists the current version number of the AxiDraw software on your computer. If your software version is older than the version shown here (1.7.x), we do highly encourage you to update to the current version. (See “4.1 Installing software” on page 15.)

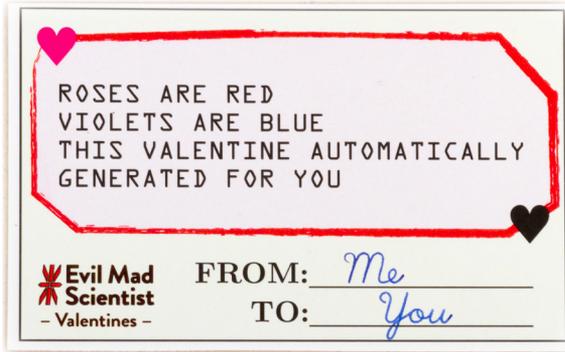
The **AxiDraw Model** pop-up menu allows you to select which AxiDraw model you are using. If you are using one of the larger models, be sure to select that from the pop-up menu in order to access the full plotting area of the machine. For the AxiDraw SE/A3, please select “AxiDraw V3/A3” from the pop-up menu.

If you click **Apply** with this tab selected, it will query the EBB (the AxiDraw control board), and report its firmware version number. AxiDraw is currently shipping with firmware version 2.5.5. In case of USB communication difficulties, this command may be useful to verify that the EBB is talking to your computer.

If your EBB reports a firmware version older than 2.4.6, we do advise that you update to a newer version. Please visit <http://AxiDraw.com/sw> and see the section “Firmware Update”.

9.10 Plotting away from home

Occasionally, it is the case that the subject that one is writing – for example a name, initials, return address, or signature – is both small compared to a page of paper and needs to be positioned precisely.



One approach is to treat this as a normal page, and to position the text on your document carefully. It can help to place a separate “sacrificial” piece of paper over your workpiece to check if you have your artwork lined up in the right places.

A separate approach is to line up your artwork to the Home Corner in your document, and to place the area of the document where you wish to print right underneath the tip of the pen. For signing the valentine card above – where the entire text consists of two words – one could position the position to start writing (the upper-left corner of the word “me”) directly beneath the pen tip.

Extending this idea further, you can even “plot away from home” by starting out not at the Home Corner, but from some midway point (a “virtual” home corner) where the pen can reach to other parts of the document. For example, one could manually walk the carriage to $X=3$ inches, and you could use that as the starting point for your plot. After each plot, the carriage would return home to that position. Use great care when using this method that your drawing does not exceed the now more limited range available from that position.

10: Designing for AxiDraw

10.1 General considerations

The AxiDraw is a *pen potter*, which is fundamentally a single function device. Its sole function is to guide a pen (or other implement mounted in the pen holder) along the set of vector lines, curves, and paths that you ask it to follow. All other things that the machine is ultimately capable of – such as drawing graphics, writing text, or signing documents – are expressions of this basic function. It is capable of drawing essentially anything that can be composed from a set of lines.

Certain object types are automatically treated as paths, for example circles and rectangles. Other types of objects that are made of curves – like text – may need to be converted from (editable) text into simple paths before plotting. You can convert a selected object to a path by using the menu option **Path > Object to Path**.

When designing in Inkscape, it is recommended to create new documents by using an A4 or US Letter sized template. You can create a file from a template by selecting **File > Templates**, and then selecting A4, A4 Landscape, Letter, or Letter Landscape.

Objects that are not paths

The AxiDraw does not directly plot objects that are not made of paths. This includes pictures (raster or bitmap images, such as .jpg, .gif, .png files), and effects such as fills, gradients, and background colors. These kinds of things require conversion to paths before plotting. That is straightforward in some cases, and not in others. One notable example is that you can create solid fills by using the Hatch Fill extension included with the AxiDraw software.

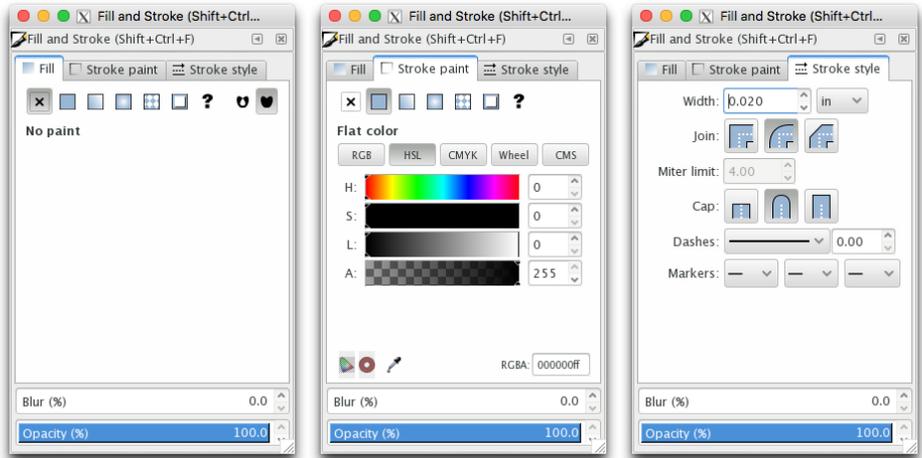
Importing graphics

The native file format of the AxiDraw is SVG (“scalable vector graphics” – a standard interchange format). You can create artwork directly in Inkscape. Many other graphics programs including Adobe Illustrator and CorelDRAW can also export SVG directly. Inkscape can import artwork in formats including .eps, .dxf, .ai, .cdr, .pdf, and others.

It is worth noting that the file type itself is not always a reliable indicator of whether or not the file suitable for use on the AxiDraw. For example, a PDF document with text from Adobe Illustrator will generally work very well, but it is also possible to create a PDF that contains nothing but a picture in JPG format. In the latter case, the image still isn't vector graphics, even though it's tucked into a PDF file.

10.2 Visualizing paths in your document

To see all of the paths in your document, select all in your drawing (From the menu: **Edit > Select all in all layers**). Then, open the Fill and Stroke panel (**Object > Fill and stroke**).



In the **Fill** tab, select “No paint” (the “X”). In the **Stroke paint** tab, select “Flat Color”. And, in the **Stroke style** tab, select a consistent width, say 0.020 inches or 0.5 mm.

This procedure generally provides a good preview of how the AxiDraw will view your page. It is only a preview, not a precise representation of how plotting will work. For example, it shows the outlines around objects even if they are not yet converted to paths.

For a more exact preview of how your document will plot, you may wish to try **preview mode** with rendering enabled, see “9.8 Preview Mode” on page 38.

10.3 Fonts, characters, and languages

To reiterate, the AxiDraw is a single-function device designed to trace the vector paths that you provide to it. The document that you prepare may include any number and variety of different text and graphical elements, so long as they are converted to paths before you plot them.

As its sole function is to follow paths, the AxiDraw itself does not use fonts (built-in or otherwise) nor does it have knowledge about any written languages. Thus, it has no preference for one language over another, and is equally happy to write in English, Japanese, or Arabic, *so long as you can provide suitable input*. Similarly, you can use fonts in any typeface style or character set— including foreign languages and including fonts that resemble handwriting.

Most fonts (e.g., truetype, opentype fonts) that are installed on your computer are accessible directly from within Inkscape. You can create and edit text objects in Inkscape by selecting the text tool, which you can select by clicking the icon shown here, or by using F8 on your keyboard. You can select between available fonts using the Text and Font panel, accessible in the menu at **Text > Text and Font...**



To convert your editable text into paths that can be plotted, select them and choose from the menu **Path > Object to Path**. You may wish to save a separate copy of your document before converting to paths, in case you wish to edit the text again later.



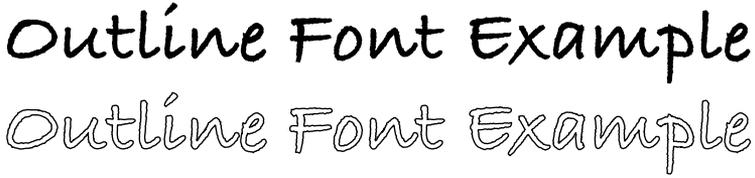
This example was made using the font “Savoye LET” on a Mac.

10.4 About outline fonts

All modern computer fonts — those found in formats including truetype, postscript, and opentype — are **outline fonts**. In outline fonts, each character in the font file describes a vector outline shape, which will be filled in by tiny pixels when displayed on your screen or rendered by an inkjet or laser printer.

Things are different when you wish to use a pen plotter. As described in the previous section, you can easily convert outline font text into a set of paths for plotting, and then plot it with the AxiDraw. When you do so, the machine will follow the actual vector shape contained in that font file, which is that outline.

Below is a sample of text written in a common handwriting-like font:



Outline Font Example
Outline Font Example

The upper part of the sample shows the text filled in, as it will typically appear on your screen, or when printed on a laser printer. The lower part shows the outline: *The actual vector shapes contained within the font file*, and how the output will look when printed with a pen plotter.

Now, if you had picked that handwriting-like font with the intent of creating handwriting-like output on the AxiDraw, this is *probably not what you had intended*.

The cause of this perhaps unexpected behavior is that one could easily (though mistakenly) assume that a handwriting-like font contains handwriting like strokes. The letters “t” and “x” both look like they *could* be made up of two strokes that overlap, and the “O” looks like it could be a single loop. However, in order for outline fonts to render correctly on your screen, the “t” and “x” are instead composed of a single complex shape, while the “O” consists of two concentric loops.

To be quite explicit: there is no absolutely data contained within an outline font that represents or corresponds to the visually apparent centerline of the characters. This fact is consistent for all standard computer fonts, and will present no unexpected behavior, *so long as you are aware of it*.

Suggestions for handwriting-like output:

When trying to achieve output close to that of natural handwriting, an “outlined” effect is generally not desirable. To mitigate it, pick handwriting-like fonts that have a *thin and consistent stroke width*. If a font is available in multiple weights, you’ll want to pick the lightest one available. This, combined with the use of a medium or broad nib pen can often make it so that the two sides of the outline blend together.

Using a broad-point pen, particularly a broad-nibbed fountain pen, is the one of the most effective ways to make a document look closer to hand written. It is also helpful to pick a larger font size, closer to that of natural handwriting (perhaps 18 pt) as a starting point. Humans tend to write much larger than usual typed work when writing by hand.

If you would like to create a custom handwriting font based on your own handwriting, there are free services online (such as <http://calligraphr.com>) that can build fonts based on samples that you provide. Even so, note (1) that these are standard (outline) fonts, and the advice above still applies. In most cases (2), fonts automatically generated from your handwriting tend to be rather crude as compared to high-quality hand-crafted fonts.

Suggestions for block and display output:

The “opposite” case from handwriting occurs when you are working with text that has large block letters, display text, or other instances with characters that have a wide cross section. Text like this will have a very visible outline, which you’ll usually want to fill in with ink.

The best way to do this is to use the Hatch Fill method, as described “10.9 Filling text and shapes” on page 52. When you apply a hatch fill, it will create a back-and-forth pattern for the pen to follow, to fill in the shape. While it may be counterintuitive to fill in text this way, it is much closer to how outline fonts are intended to be used: The outline is filled in with ink.

Block Text
Block Text, Filled

10.5 Stroke fonts

In addition to regular computer fonts (outline fonts), pen plotters like the Axi-Draw can in some cases make use of a second class of specialized fonts, called **stroke fonts**, or **engraving fonts**. In stroke fonts, each visible character is *defined by strokes of non-zero width*, as opposed to the area within an outline.

While they do have some severe disadvantages, stroke fonts are ideal for use with pen plotters, since they plot efficiently (for example, the “o” is one loop, not two). They are particularly suited for handwriting-like applications, because the characteristics of the fonts (having a centerline) more closely mimic how humans write.

The following sample of text is rendered with a stroke font, using a special application called Hershey Text. The second line is identical to the first, except that we have colored the individual paths (strokes) within each character so that you can tell them apart:

Stroke Text Example
Stroke Text Example

As you can see, characters like the “t” and “x” here are composed of two intersecting strokes. Similarly, a letter “o” in this font consists of a single loop. This particular stroke font is a *single-stroke* font, since each visible line is made up of only a single path. Some other stroke fonts instead use multiple strokes to construct wider characters, e.g., bold fonts.

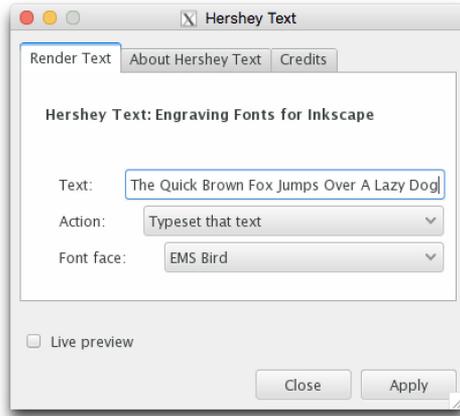
There two severe disadvantages to stroke fonts. First, since they are not regular computer fonts, they generally cannot be used in the same ways as other fonts. You can’t, for example, install them as regular fonts on your computer nor use them in word processors or graphics applications. Second (and mostly because of that first reason) there are at present very few available stroke fonts. Despite these problems, stroke fonts are still worth mentioning, because in the few cases where you can use them, they are worth the effort.

10.6 Hershey Text

Inkscape includes a small application that we developed called **Hershey Text**, which is capable of typesetting short snippets of text in a small number of stroke-based fonts that it includes.

§10.6 Single stroke fonts & Hershey Text, continued

When you use Hershey Text, it takes editable text (that is, text that you type) and **renders** it into a set of vector paths that the pen can follow. Once you have rendered text into paths, it can no longer be edited as though it were text: As rendered, it is a set of paths (lines and curves) that can be edited with Inkscape's path editing tools.



You can find Hershey Text in the menu at **Extensions > Render > Hershey Text**. In addition to rendering short snippets of text, you can use Hershey Text to generate a table of the single-stroke font faces that are available to use.

Besides the fact that Hershey Text renders paths (not editable text) there are two important limitations on the set of included Hershey fonts:

- (I): The set of fonts is limited. It cannot (at present) be expanded.
- (II): The set of characters within each font is limited, essentially to basic ASCII (English) characters. It cannot at present be expanded.

Future versions of Hershey Text will use a new file format that will allow extended character sets and the addition of custom font faces.

Additional single-stroke font resources

Beyond Hershey Text, we are currently developing a new piece of software called **Hershey Advanced**, which can convert a full page of paragraph text into stroke fonts, using the same engine. It is available in beta to AxiDraw users. If you would like early access to this software, please contact us directly:

<https://shop.evilmadscientist.com/contact>

Links to many other sources of single stroke fonts can be found at the IJ instruments Single Line Fonts page (Short URL: <http://bit.ly/1SweD6c>)

10.7 Capturing signatures and handwriting

The best way to transform some handwritten text – whether a signature or a full page of text – into something that the AxiDraw can plot is to use direct handwriting capture, or what you might refer to as “real-time” capture.

In direct capture, you use your computer to record each stroke as it is written, and then save the resulting set of paths as a vector artwork file. This method can also be used when replicating handwriting. For example when replicating historical signatures, it is necessary to trace along the strokes of existing writing and to capture those strokes as you trace them.

For much more about ways to capture and trace handwriting – including a link to jSignature, a program that can easily capture your signature in real time – please see our detailed documentation on the subject:

<http://wiki.evilmadscientist.com/capture>

A link to this page can also be found on our main documentation site,

<http://axidraw.com/docs>

10.8 Aside: Tracing of scanned handwriting

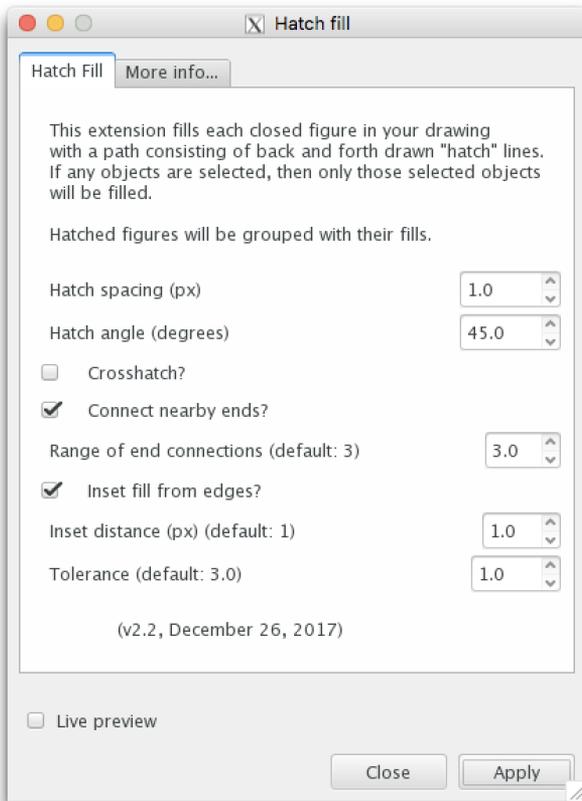
While we are frequently asked about this, it should be noted that there is not any straightforward way of automatically converting scanned handwriting into a set of high-quality vector paths that a plotter such as the AxiDraw can follow. Simple approaches such as centerline tracing rarely approximate the quality and character of real human handwriting.

This is a longstanding problem in artificial intelligence called “handwriting trajectory reconstruction.” Solving it is well outside of what the AxiDraw software aims to support. (Again, the function of the AxiDraw is to plot the vectors that you supply to it.)

When software that performs handwriting trajectory reconstruction comes to exist some day, the AxiDraw will be here, ready to plot its output.

10.9 Filling text and shapes

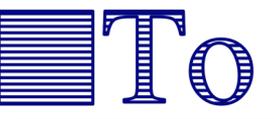
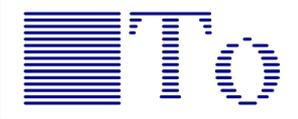
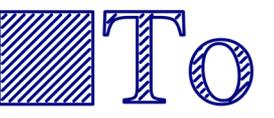
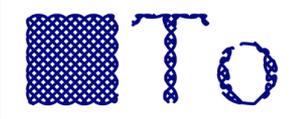
The AxiDraw software includes a second Inkscape extension, which can fill in areas with paths, such that they can be filled in with pen strokes on your page. You can find it in the menu at **Extensions > AxiDraw > Hatch Fill**



Hatch Fill will fill any selected objects with a series of back and forth lines, with adjustable spacing and angle. The hatch spacing is measure in units of screen pixels (px), and the default value of 5.0 is appropriate for wide permanent markers. A lower spacing will produce a more uniform fill, and a higher spacing will produce a more traditional hatch fill for shading. You can use the “Live preview” option to see the effects of different choices without actually applying them to your shapes and text.

The “Connect nearby ends” option (enabled by default) connects the ends of the hatch lines to make long wiggling paths that plot very efficiently. An additional option is provided for insetting the fill from the edges. This helps to avoid “coloring outside the lines” when using the hatch fill.

Here are some examples of how different settings can be used in Hatch Fill. Each of the following are examples are shown actual size, with a 0.016 inch (0.4 mm) stroke width, similar to that of a fine rollerball pen. The Tolerance parameter was set to 1.0.

Objects, including any applied hatches	The hatch fill alone	
		(1) No fill
		(2): Spacing 3 px, Angle 0°. Connect nearby ends: off Inset: off
		(3) Spacing 3 px, Angle 45°. Connect nearby ends: off Inset: on, distance 1.0
		(4) Spacing 3 px, Angle 45°. Connect ends: On, Range 3. Inset: on, distance 1.0
		(5) Same as (4), but with crosshatch: on
		(6) Same as (4) but with Spacing 1.0 px (crosshatch is off)

Examples (4) and (6) above – with a single hatch at 45 degrees, inset from the edges, and with the ends connected – usually give good results for most situations. The key parameter that you’ll need to adjust (based on the pen that you use and so forth) is the Hatch Spacing.

10.10 Vectorizing images

The process of starting turning images (jpg, png, photoshop files, etc) into vector artwork is generally outside the scope of the AxiDraw software. That said, how to do so is a frequently asked question so we are including some notes on the subject.

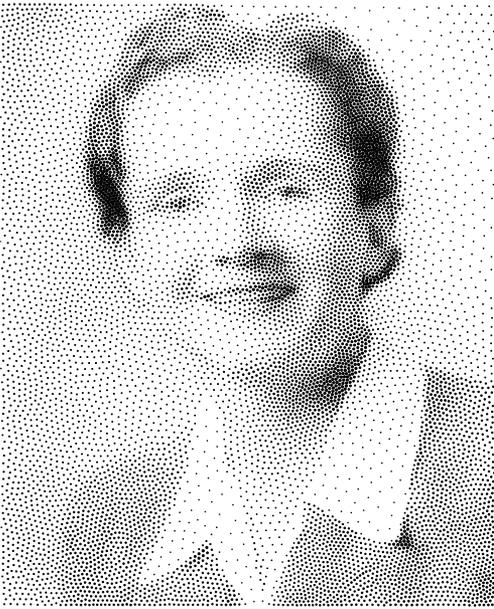
The process of converting a photograph into a piece of pen-ready vector line art can most accurately be described by the word “sketching.” That is to say, it is not really a matter of file conversion, but rather one of artistic interpretation. There are genuinely a limitless number of ways to represent a photo with a set of strokes. Artists that work with plotters often write their own programs to perform this kind of conversion, and we will point out a few of these programs.

Inkscape includes a vectorizing tool, found in the menu at **Path > Trace bitmap**. It works by tracing the outlines of darker regions. It does work, and is sometimes useful for very simple shapes, but it generally *does not* produce high quality output that works well on plotters. You may end up with (for example) ghostly effects, or tens of thousands of tiny little loops that represent stray pixels on the input photo.

While this is nowhere near a comprehensive list, here are three examples of output from different vector “sketching” programs. All three of these are free programs that are written and run in the [Processing](#) development environment.



This portrait was generated from an image with SquiggleDraw, available at: <https://github.com/gwygonik/SquiggleDraw>



The portrait above on the left is a stipple drawing, made with thousands of tiny circles of different sizes, as generated by StippleGen:

<http://wiki.evilmadscientist.com/stipplegen>

The portrait above on the right consists of a single wandering line. Plots like this can potentially print quickly because there is no pen up/pen down movement. This one was generated with an experimental program called ScribbleDraw, available upon request: <https://shop.evilmadscientist.com/contact>

11: Maintenance and troubleshooting

The AxiDraw V3 should not require any regular maintenance under normal conditions.

11.1 No lubrication required

The X carriage contains wheels that allow the X shafts and Y parts to slide. The wheels contain shielded and/or sealed ball bearing mechanisms that are permanently filled with grease. The pen-lift (Z) stage uses grease-free Teflon-filled plain bearings. *Do not apply oil or grease to any of the sliding mechanisms.*

11.2 Cleaning

Clean the AxiDraw only with a soft, clean cloth. The non-electronic metal parts may be cleaned with a cloth moistened with soap and water if needed. Avoid other cleaners and solvents. Do not wet the motors, cables, or controller board.

11.3 Storage

It is recommended to store the AxiDraw with the carriage either in the Home position or (especially if it needs to be put away in a box) in the far opposite corner, fully extended in X and Y, such that the cable guides are fully extended and have the lowest profile. Unplugging the AxiDraw's plug-in power supply when not in use will prolong the life of the machine.

11.4 Belt tension

The AxiDraw uses a single timing belt, looped in an "X" around the two motors and the Y carriage. This belt may gradually stretch a small amount, and can be re-tensioned where it is anchored, if necessary. The necessary hex wrench (2.5 mm) is included with the AxiDraw. Do not retension the belt unless it is actually necessary to do so.

11.5 The wrenches

Several hex wrenches and two thin-profile crescent are included with the AxiDraw. One of these – the ball-end 5/64" (2 mm) wrench – is used for switching the pen between the vertical and angled orientations. The other wrenches are provided "just in case," and are not needed in most circumstances. However, if something should come loose, it is nice to have the right tools on hand. Contact technical support for guidance when needed.

11.6 Wiring

If your motor wires should become disconnected at some point, here is where they go. Left motor: "Motor 2" locations, yellow, red, green, gray (from top to bottom). Right motor: Motor 1 (same order). Servo cable: B1 (lowest three pins on left hand side), with black wire towards the edge of the board. Refer also to the illustrations in section "2.3 Unboxing" on page 10.

11.7 The pen-lift servo motor

The only “expendable” component of the AxiDraw is the small, blue pen-lift servo motor. They do wear out over time but are inexpensive and straightforward to replace. For heavy duty applications, you may wish to keep a spare on hand. Contact customer service if you think that you might need a replacement or a spare.

11.8 Loss of position

The most significant thing that can go wrong under normal operation is a loss of position control while the carriage is moving. This is typically manifested as a loud grinding or screeching noise. It can happen when moving at too high of a speed, or when the carriage hits an unexpected obstacle– for example if it was not moved to the Home Corner before plotting or if it was bumped while moving.

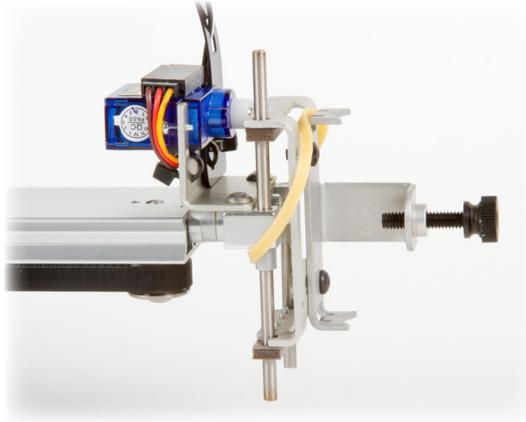
If this should happen, press the pause button as soon as possible to cancel the plot. Remove power to the machine if necessary. Use **Raise pen, turn off motors** in the setup tab to de-energize the motors, and manually return the carriage to the Home Corner before trying to plot again. As a sanity check, the carriage should return exactly to the Home Corner when a plot is finished.

11.8 Service, repair, and parts support

The AxiDraw is designed to be serviceable, and we are here to help. Nothing should require regular replacement. However, most parts of the machine can be unscrewed and replaced if necessary. Please contact technical support directly if you need assistance with troubleshooting or repairing a mechanical issue.

12. AxiDraw Tips and Tricks

1. It is often possible to get better print quality on top of a small stack of paper (say, 5-10 sheets) which gives a little cushion to your writing.
2. High quality paper – especially paper designed for use with pens – tends to give dramatically better results with pens than does cheap copy/laser paper. Bristol paper with a smooth finish is a great example of a paper designed to work well with pens.
3. The flatter that your paper is held, the better your print quality will be. Paper that is warped or “bubbled” will flex as the pen writes, leading to distortion. When the bubbles or warping are tall enough, it can also lead to stray marks on your page during pen-up movements.
4. Reducing the amount of vertical pen travel that is needed will also improve print quality, since the pen-lift servo motor does introduce vibration. It will also make your plots faster.
5. If none of the motors move *but* (1) everything looks correct, and (2) your computer doesn’t report any errors, *triple check* that the 9 V power supply is plugged into a working outlet.
6. When making multiple-color plots, you can get better registration when switching pens by making sure that each pen is set to the same height above the paper. A good way to do this is to rest the tip of the pen on a spacer when tightening the pen in place. Use a small, flat piece of wood, plastic, or metal.
7. It is possible to completely detach the AxiDraw’s pen holder, and affix other types of tools to the front of the Y carriage. Four M4 tapped (or tappable) holes are provided for mounting other types of tool heads there.
8. Certain types of pens can “dry up” if left in the pen-up position for a minute or two. This can lead to an awkward situation where ink does not start flowing until after the machine has already been drawing for a bit. When working with pens like this, it may be helpful to “bleed” out the tip with a bit of scratch paper before printing.
9. Styles applied to paths (width, color, etc) are normally ignored by the AxiDraw software. If you have a dashed line and want it to plot with the dashes visible, you can use **Extensions > Modify Path > Convert to Dashes** to convert the dashes into separate path segments.
10. All else being equal, you will get the best plotting results with lighter weight pens. Leaving the pen cap off is usually a good way to save a little weight.
11. One of the simplest things that you can do to improve the quality of your output is to use a medium or broad-nibbed fountain pen. (Lamy Safari is an excellent starter choice.)



12. A single rubber band can be looped loosely around the pen holder as shown, to add a small amount of additional pressure for use with ball-point pens, or for operating the AxiDraw in other orientations (when gravity is not readily available to pull the pen to the surface). Do not add a rubber band unless it is actually needed; it will reduce the lifespan of the pen-lift servo motor. Example rubber bands are included with the AxiDraw, but will degrade over time.
13. Inkscape has a keyboard shortcut, **Alt-Q** (**Option-Q** on Macs), which will execute the last Inkscape extension once again. This is frequently useful when repeating a command, such as making one additional copy of a plot, without having to open the AxiDraw Control panel again.
14. When saving graphics in SVG format from Adobe Illustrator or CorelDRAW, a helpful tip is to select the “Presentation attributes” option in the SVG export options. This typically helps to make the formatting work better in Inkscape.
15. The order in which objects on your page will plot is generally determined by the order in which they were initially drawn. “Lower” objects on the same layer will print before “higher” objects on the same layer. You can use the **Object > Raise** and **Object > Lower** commands to re-order objects.
16. If you need to drive more than one AxiDraw from a given computer, a special version of AxiDraw Control is available. With that version, you can assign a “nickname” to each AxiDraw, and specify which one to use from within AxiDraw Control. Please contact technical support if this would be helpful to you.

Extended Online documentation
& resources for AxiDraw:

axidraw.com/docs



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