The Pantograph

The invention of this ingenious tool for copying and resizing images dates to at least the 1600's. While seeming primitive it has peculiar advantages over modern digital imaging for resizing, as we will see.

I purchased my vintage K & E Model 1144 21" pantograph for a song at auction, and it has been an essential part of my tool kit ever since. You'll find links for more information about purchasing- and making your own- pantographs at the end of this article.

The basic elements of the pantograph are four scaled bars (or if you like, two pairs of hinged bars) fabricated from hardwood, composite, or even cardboard, with the pairs flipped into opposition and held together by pinned or threaded connectors (screw-eyes on my pantograph) which allow variable enlargements (and reductions) to be transferred from your original image onto a blank sheet.

Properly assembled, the **fulcrum**, **tracer** and **pencil point** will be in a straight line with one another, and the interior of the pantograph will resemble a parallelogram in shape:

![Pantograph Diagram](image)

In this example I want to enlarge the 1/4"-scaled Fred Flounder Project (Plan FF1) to the correct 1/2" scale (or full scale) for tracing the body outline onto my wood stock.

Referring to the above and detailed photos below, the critical mechanical parts of the pantograph are:

the **fulcrum** fastened to your work surface, typically by a clamp or tacks such as push pins. I use a pair of brads inserted through the fulcrum into a pair of pre-drilled holes on my laminate top. Think of the fulcrum as a small vise securing and locating the otherwise moveable parts of the pantograph:
the **pivot** or **sliding support** which balances the pantograph in use:

the **tracer** with the needle tip which follows the original's lines during use:
and the **pencil point** which transfers the image's lines to the blank. Note that this is the only part of the pantograph that you will touch while making your transfer. Your eyes will be on the original, moving the tracer's point along the lines to be copied, while your fingertips will maintain slight pressure onto the pencil point as you make the copy.

![Pantograph Image](image)

**How to use a pantograph**

While the downloaded Fred Flounder plan's background grid measures 1/4" x 1/4" per grid square, the actual size per square is listed as 1/2" x 1/2"- so a 200% enlargement of the original is required. (You can certainly just enlarge it on your copier, but this article is about using the pantograph!).

*Always measure to confirm the grid size* of your original with a rule before adjusting the pantograph.

![Fred Flounder Plan](image)

The heart of the pantograph is a set of adjustable scaled bars which feature those strange-looking number patterns and through-holes for the connectors. Various increments for adjustment are marked on the paired bars depending on the pantograph you're using.

Because of the physical limitations of the typical pantograph, intermediate adjustment options are always more limited as the scaling increases. On my unit, for smaller scaling (x2 or x3 for example),

![Pantograph Scaled Bars](image)
1/8 increments are offered; at the unit's largest scaling limit, you move from x7 to a single x8 adjustment with no intermediaries- take it or leave it! And that's one whopping enlargement, so I hope you have a great big work surface… and a great big piece of paper.

This photo illustrates the pair of "2's" which will be connected by the screw-eye, corresponding to our project's x2 (or 200%) enlargement. Don't over-tighten the connection- it should be just slightly loose so the bars move without friction:

Repeat the same connection on the opposing pair of bars.

With the pantograph adjusted and secured by the fulcrum, place the original image in position on your work surface so that the tracer's tip aligns with the line you wish to copy. Cellophane tape secures the original to your work surface.

Now, using a blank paper at least twice the size of the original, position it parallel to the original and beneath the pencil point- but keep the point raised slightly while you adjust the paper's location until you convince yourself that as you trace the original, the pencil point's tip will be confined to the blank paper! No use enlarging the original if some of it wanders onto your work surface… secure the blank with tape, and you're ready to go.

Keeping your eye on the original's line you wish to copy, follow it with the tracer needle by moving the pencil point maintaining light fingertip pressure. Here is the pencil point:
It takes very little pressure on the point to create your copy. I use my little fingertip to balance it as I carefully follow the line on the original with the tracer, you will experiment and find your own way. Yes it's about precision, but more about keeping a bit of speed up and continuing your movement until you complete each outline you wish to copy. As with everything it requires practice but is very easy to master.

Conclusion

With the mechanism set up, this outline took under two minutes to complete. That's nearly as fast as making a digital enlargement on your copier, and a whole lot less expensive in the long run. Rather than using copy paper I use thick card stock or thin cardboard as blanks for my enlarged patterns so they can be trimmed, saved and used as patterns many times. Both are impossible to run through my own copier.

Again, exactitude as to the line is secondary to getting the enlargement to correct scale. After all, you will be reworking your traced enlargement onto your wood stock when you get to your bench.

Here is "A Description of the Instrument and Directions for its Use" provided by Keuffel and Esser:

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**THE PANTOGRAPH.**

A Description of the Instrument and Directions for its Use.

Applying to Nos. 1144, 1145 and 1146.

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The Pantograph is a simple mechanical apparatus for copying drawings, patterns, photographs and the like, either reducing or enlarging them as may be desired. The instrument serves an almost endless variety of practical purposes which will readily suggest themselves.

The pantograph consists of two pairs of wooden bars arranged as shown in the accompanying illustration. The longer of the two pairs is joined at one end of the bars by a bolt which serves as a sliding support. In an ordinary pantograph the shorter pair is connected by the tracing point when enlarging, while the free ends of the longer bars carry the fulcrum or pivotal point of the instrument, and the pencil point when enlarging, or the tracer when reducing. In No. 1146 the shortest pair is connected by a Tracer or Tracing holder, while the free ends of longer bars carry a similar holder and the fulcrum or pivotal point of the instrument, respectively. The holders of No. 1146 are made to take any pencil or regular size of the wooden pen which serves as a tracer, and can be readily exchanged to enlarge or reduce.

Each bar bears a series of numbered holes, alike on all four bars. There are two sets of numbers for each hole. The numbers 1, 2, 4, 8, etc., serve as guides for setting the pantograph. The numbers 12, 36, 14, etc., indicates the proportion which the copy bears to the original when enlarging. The two pairs of bars are joined by two screw eyes which pass through the holes numbered correspondingly. In pantograph No. 1146 the two pairs are joined by bolts and thumb nuts.
DIRECTIONS.

First set the instrument in the desired proportion. For example—If the original is to be enlarged by one quarter in size, join the two parts of bars by driving the screws or bolts in the holes numbered 1/1", arranging the bars so that one shows the same as shown in the insert. The guide mark should then correspond on the four bars.

Press the follower to the left hand edge of the drawing board.

Place the original under the tracing point, and the paper under the pencil. Take hold of the pencil with the right hand and copy the original, following the lines of the original with the tracer. Care should be taken to lift the pencil from the paper when it is desired to omit any lines of the original.

Whatever pressure is necessary should be applied to the pencil point, and set in the tracer, which should move freely over the original.

The proportions given on the bars relate to enlarging only. Reductions must be figured in the reverse of these proportions. That is, if the pantograph is set at 1/2, the pencil point is set in the center with the tracer point at the center bar, the copy will be reduced by 1/2, that is, to 1/4 the size of the original. If the pantograph is set at 1/2, to enlarge by 1/2. It will reduce (1/2 - 1/2 = 1/2). Proceed as above, when the pantograph is used, and reverse the pencil point to the 1/2 in the center, and the size of the original, the pantograph at 1/2 the scale of proportion, using the pencil point in the center, since the reduction of 2 in 1.

When the pantograph is properly adjusted, i.e., when the screw eyes or bolts are in the correct holes, the follower, tracer and pencil point should be in a straight line.

Care should be taken that the paper is laid enough, and so placed as to take the entire copy. This may be determined by placing the tracing point over the limits of the original, holding the pencil off the paper.

To reduce or enlarge beyond the reach of the instrument, make an intermediate copy and enlarge or reduce that, if necessary, in sections.

See that all joints work freely.

With a little practice, very satisfactory results may be obtained with this instrument, if these directions are carefully followed.

Links:

A simple homemade pantograph, but looks like it would work! This couple's site rocks:
http://users.hubwest.com/hubert/mrscience/pantograph.html

Vintage design notes for pantographs. Also includes a commercial link for Alvin's 18" model currently available online:

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