TreeSoft Skew Calculator
Version 1.0 : 20120409

What is it?

Skew Calculator is designed to make it easy to calculate the skew angle of a gantry relative to the X axis upon which is moves. The math isn't difficult, but this just does it for you.

What is it good for?

It will give you a quantitative guide to know how far off perfect your Y vs X motion is. On my home made machine, I could not get the axes perpendicular, no matter how hard I tried and how many times I tore it apart. I think that my roller bearings may not be perfectly mounted to their carriages, but that is just a guess. As it turns out, I now know (from Skew Calculator) that the two axes are 0.118 degrees off perpendicular. It doesn't sound like much, but over a wide enough cut it becomes enough to mess up a box construction pretty seriously. A nasty discovery in the wee hours leading up to Christmas!

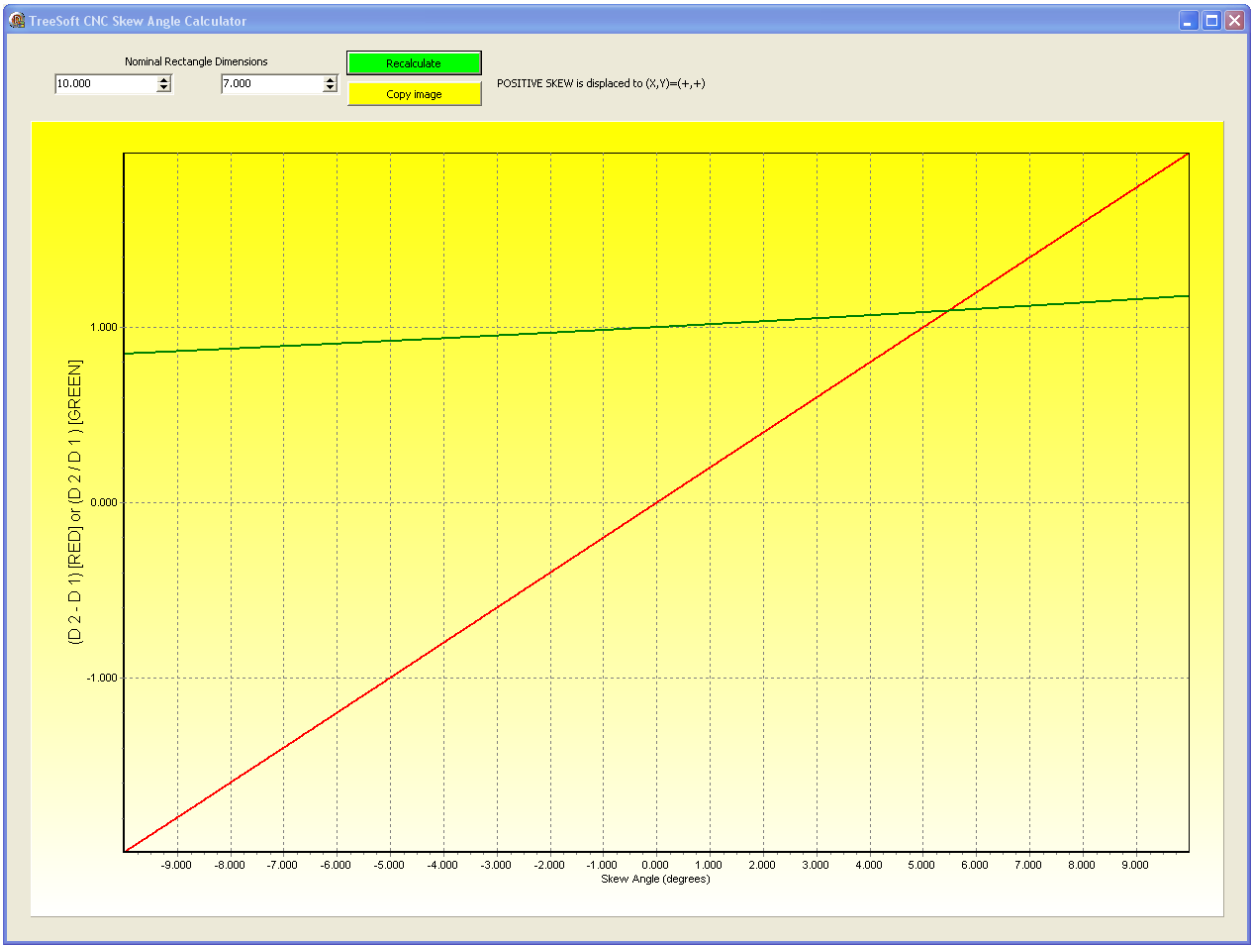
As it turns out, knowing the skew angle allows us to correct the g-code toolpaths too. Ideally, this would be done in the motor controller software (like Mach3), but in the meantime, I have written a companion program, WarpDriver, that can un-skew the g-code produced by CAD/CAM systems and produce code that will result in perfectly square cuts (or round, if that is what you are after). Of course, once warped in this way, the code should not be run on anyone else's machine unless by some amazingly bad luck they have the same skew problem as you do. WarpDriver can be downloaded from **PaulRowntree.weebly.com** at no charge.

One of the problems of doing this to g-code is that the code usually expands in size quite substantially; the worse case scenario is an arc, which is expanded to a large number of very small steps. Still, it seems to work well. I have only tested this on g-code produced by Vectric products, and using Mach3 controller. WarpDriver knows about rapids, standard moves, and CW / CCW arcs. Everything else is untouched. I recommend that you carefully test the output code using air-cuts and perhaps simulation software prior to unleashing it on your machine and that $1,000/foot wood sample you have been hoarding. That being said, it works for me.

How do I use it?

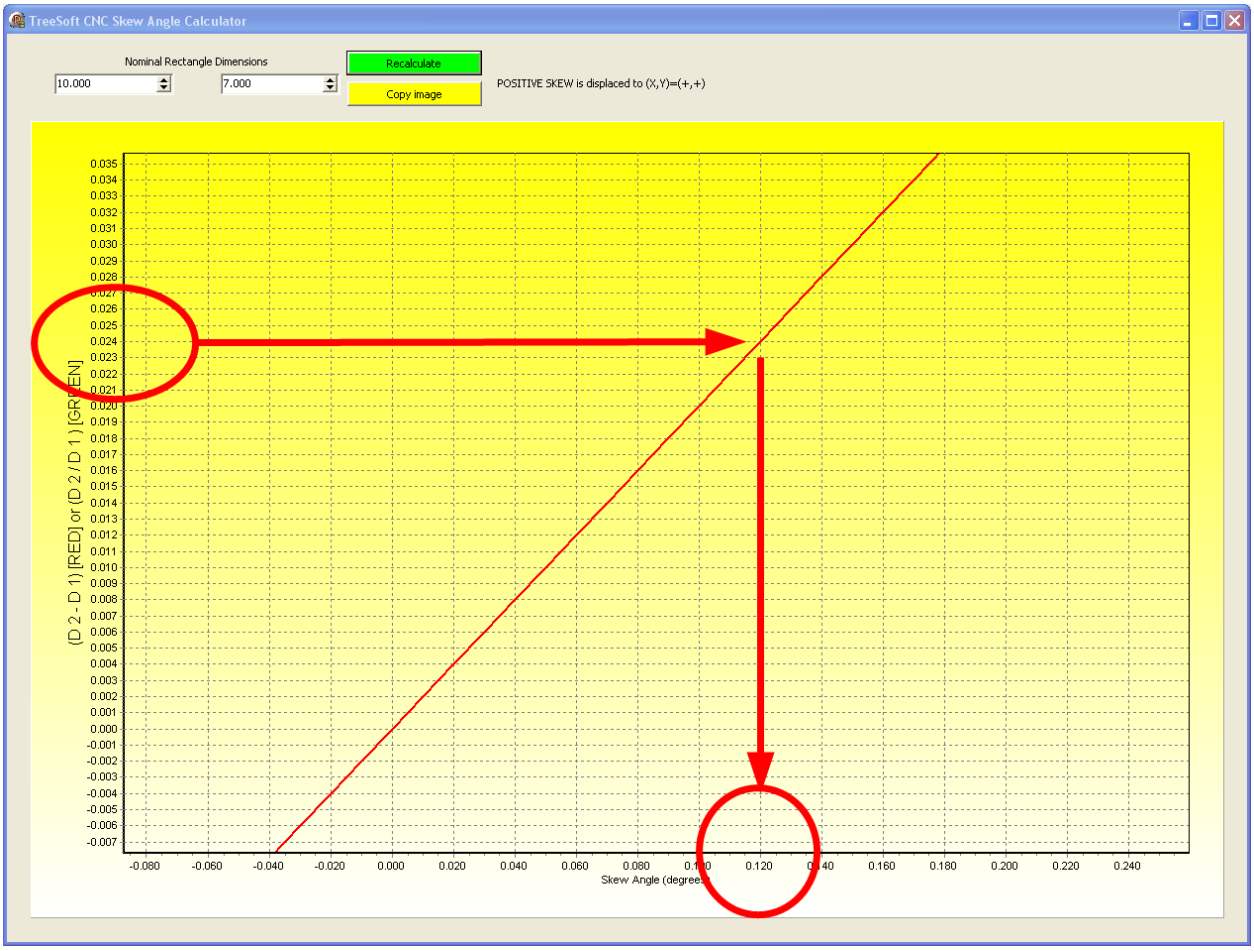
The first step is to create a rectangular patter on your CNC, and measure the two diagonals. You could measure the pattern using marks on the table, but I find it more accurate to actually cutout a shape and measure with verniers. Larger size gives greater accuracy. Do what seems natural and most accurate for you. For the sake of an example, imagine trying to cut a rectangular piece that is 10.000" along X, and 7.000" along Y. Measure the two diagonals, and if you find ***both*** are the expected sqrt(10*10+7*7) = 12.207", then the sides are perpendicular, and the skew is 0.00 degrees. Time to celebrate your construction prowess, and offer praise to Pythagoras! In my case, no such luck. The difference between the two diagonals was ~0.024", with the diagonal leading from (X,Y)=(0,0) off to (+,+) being longer. I call this diagonal 'D2'. Clearly, my gantry is skewed CW, with the positive Y axis being less than 90 degrees from positive X axis.

Run the Skew Calculator, and enter the 10.000 and 7.000 values in the boxes on top, then press 'Recalculate'. The graph should look like this.



The red line shows how the difference between the two diagonals (D2-D1) will vary with the skew angle, and the green line shows how the ratio D2/D1 changes. Use whichever one you prefer. In the range that you will be able to build your machine (skew angles will definitely be less than 1 degree) both the red and green lines are linear in skew.

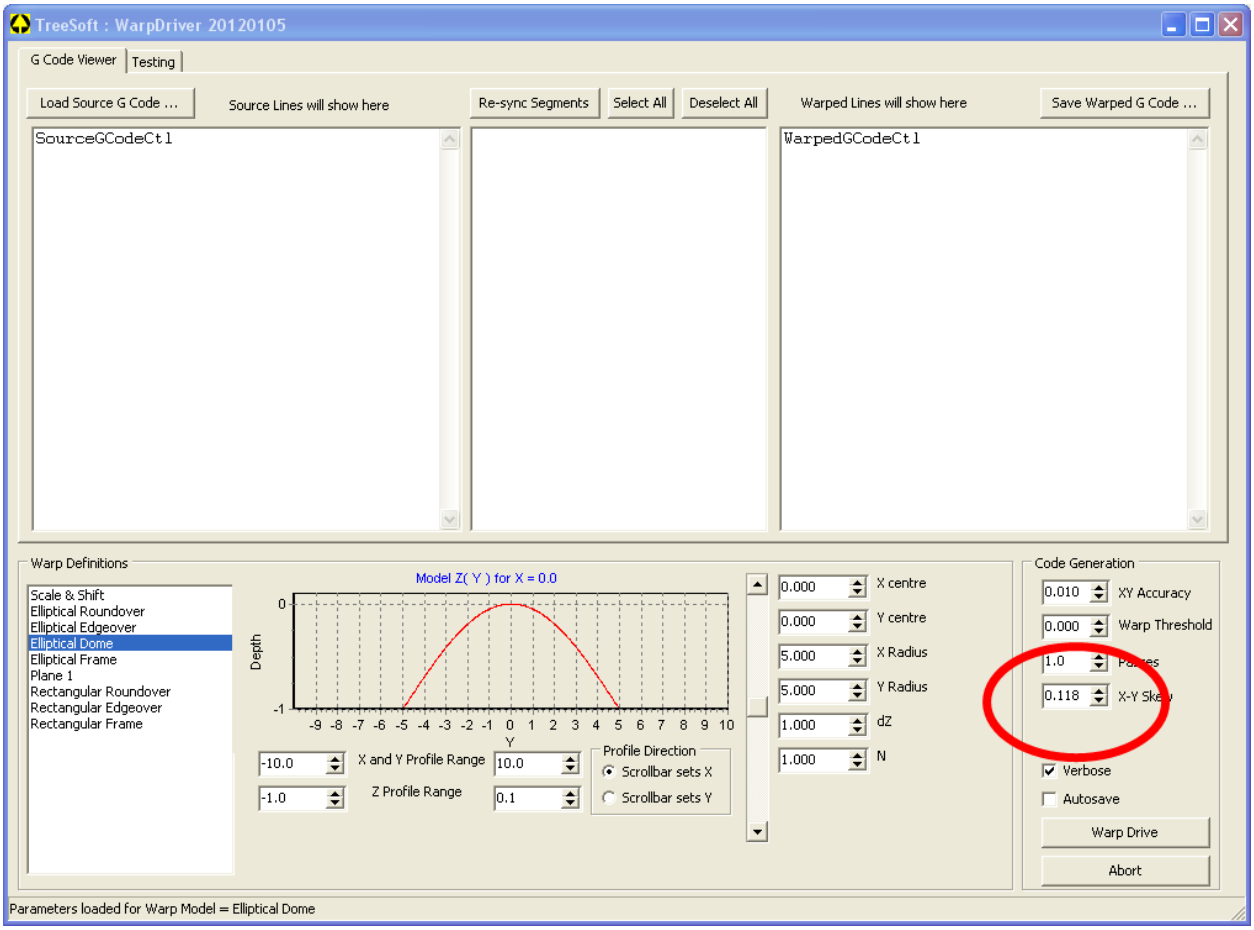
You can zoom in on a region by drawing a box from top-left to bottom-right with the mouse button down; draw a box from bottom-right to top-left expands the view to its original large view. Scroll by moving with the right mouse button down. In the next shot it is zoomed in on the area of interest for my machine.



Reading from the left axis to the line and down to the X axis, you can see that a difference of (D2-D1)=+0.024" corresponds to a skew angle of +0.12 degrees (ie CW).

The best use of this information is to realign the gantry, moving it 0.12 degrees CCW. The distance to move one end would be the length of your gantry multiplied by the sine of the skew angle.

If a true solution is not possible, you can do a software work-around. The skew angle can be entered into WarpDriver's front panel, or on the command line, and will then allow you to de-skew your axes in software. See WarpDriver's manual for more details.



Cheers!

Paul Rowntree