

Precise Puzzlemaking

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Tool Setup

In order to make a precision puzzle you must have your tools precisely aligned and set up. Note that I did not say you have to have precision tools. My friend and fellow puzzlemaker Lee Krasnow did extremely precise work on a very worn out table saw for a long time. However, if your tools are subpar, you must know and work around their limitations. For instance, the angle on Lee's saw would change slightly when he raised and lowered the blade. To compensate, he checked and set the angle every time he changed the blade height. Such attention to detail is a necessity to make quality puzzles.

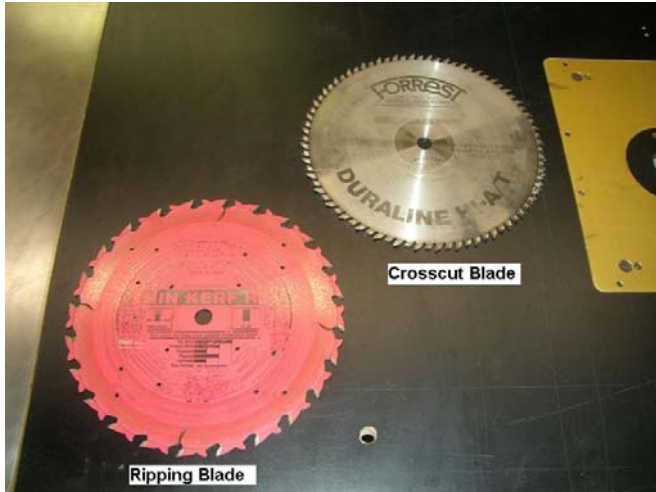
The main tools used in puzzlemaking are the jointer, planer and table saw. Teaching you how to make the specific adjustments for your brand and model of tool is beyond the scope of this document. Check your owner's manual for the specifics.

These setup steps should be repeated at the start of every new project, or once daily in a production environment. Generally if you have quality tools the settings will not change, and you will only have to verify and check. However, it is important to check because if your settings change you will waste time and effort milling stock which is unusable.

Table Saw:

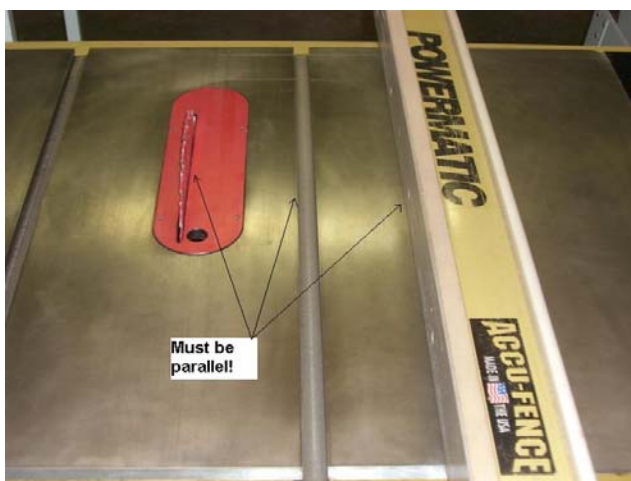
Your table saw must be level and on a flat surface. The table top must be reasonably flat and clean. Saw blades should be sharp and clean.

Using a dedicated blade for ripping and crosscutting is highly recommended. For ripping you want a quality 24 tooth rip blade. For crosscutting, a dedicated 60-80 tooth crosscut blade. I use and recommend Forrest crosscut blades and Freud rip blades.



In order to make square cuts, your saw must be set up properly. The blade must be aligned parallel to the miter slots, and so must the fence. Here is an excellent article about aligning a table saw; your owner's manual should also have the same information:

<http://www.newwoodworker.com/basic/tsalign.html>



The fence should also be square to the tabletop, a measurement that is frequently overlooked. Finally, the blade itself should be set to exactly the angle you are trying to cut. Do not rely on the stops built into the saw – set the blade using a machinist square and make a cut, then measure the result and adjust accordingly.

Blade Squared:



Fence Squared:



Check the RESULT!

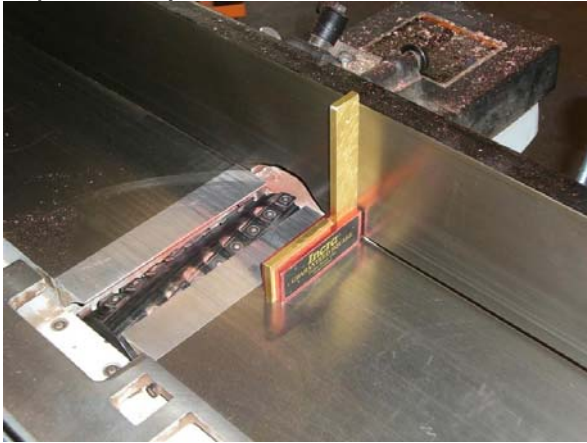


Jointer

The function of a jointer is to square and flatten wood – therefore it must itself be square and flat to do a good job. Check your owner's manual for directions on how to adjust the cutterhead so that it is aligned perfectly parallel to the bed. Also check the manual for instructions on how to align the beds themselves parallel and square.

Once these basics are accomplished, the final and very critical adjustment is setting the fence square to the surface. Square the fence using a quality machinist square on the outfeed side of the machine. Again, do not trust your eyes and the square to make the adjustment perfect...make a test cut and measure the result. If you are off, adjust as necessary until you have an absolutely squared up jointer.

Square the jointer fence:



CHECK the results!



The goal of your jointer setup is to be able to make absolutely flat and square stock on two sides. Once two sides are flat and squared against each other, the planer can be used to enforce these angles on the other two sides.

Planer

Your planer will be used to extrapolate the angles left by the jointer onto the rough sides of your stock. The most essential measurement of the planer is how parallel the blades are to the bed. If your blades are not parallel, you will be making an angled cut against the flat referenced side prepared by the jointer, and you're back to square one.

Consult your equipment user manual for instructions on how to square the blades to the bed. The blades must be kept very sharp since they will give the pieces their final finish. It is not possible to sand puzzle pieces since the practice degrades accuracy.

Stock Selection

Due to the nature of interlocking puzzles, it is essential to use properly seasoned lumber. Using lumber that is wet will result in shrinkage, warping, and unacceptable amounts of wood movement.

The lumber must be kiln dried, or air dried for one year per inch of thickness before it is used. Air dried lumber must then be stored inside the workplace until the moisture content stabilizes at between 8% and 12%.

Stock Preparation

Step 1- Joint one face and one edge of the rough stock flat.

Face Joint:



Edge Joint:



Step 2- Rip the rough edge...this will make both edges square and parallel

Ripping the edge:

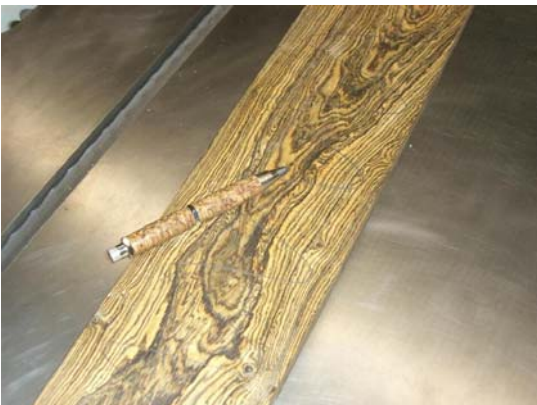


Step 3 – Resaw to .05” over nominal size (i.e. if your final size will be .500” thick, you will resaw to .550” thick). In this example I use a table saw, but band saw is also acceptable.

Resaw:



Mark resawn side so that you know which side is jointed and thus flat.



Step 4 – Plane to rough thickness with jointed side DOWN. If you plane the resawn side first, the wood will not be square any more. If your wood twists or warps excessively during the resaw process, you will need to joint it again before planing to rough thickness. If your wood is consistently warping, you will need to allow more thickness during resawing to joint out the warp caused by the resaw process in order to reach your nominal thickness.



Step 5 – Now your stock should be parallel on the edges and faces. Your next step is to joint the edge one more time to ensure a square angle.



Mark the freshly jointed edge so you have a reference which is perfectly square



Now rip the stick from the plank, and go back and repeat the process until you have ripped the entire plank into sticks.

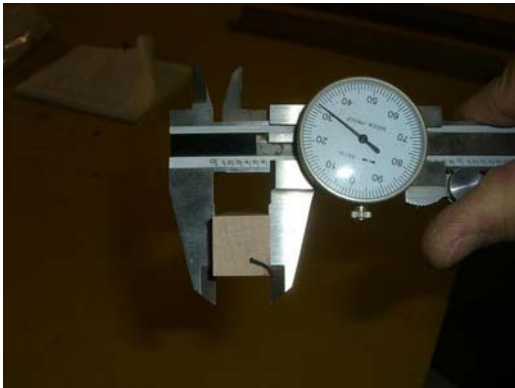


Step 6 – Now we have a pile of sticks, each with a referenced square edge.



Step 7 – Now we will use the planer to enforce the known square corner onto the other two faces, while at the same time bringing the stick down to nominal thickness. You will plane each stick four times, once on each face. Because we are using squares, you will plane two edges, adjust the planer height, and plane the last two for your finished stock. You will turn the stick each time so that the angle is enforced according to the following chart:

You will want to remove 1/2 the difference between the rough size and the final size with each stage. For instance, if I want .500" square pieces, and my rough stick is .550", I will remove .025" the first pass and .025" the second pass;



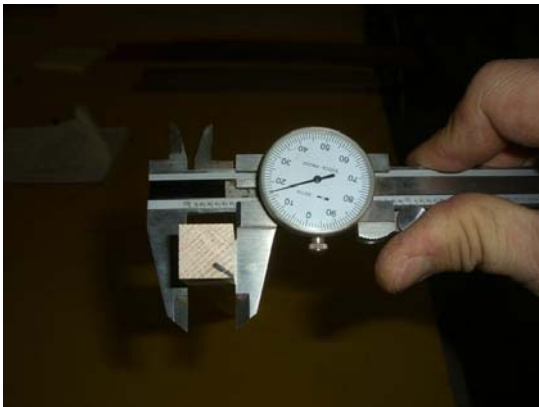
Make the first pass with the reference mark such:



Make the second pass with the reference mark such:



Now your stick is square since the planer has enforced the reference angle on the other two sides. It is also halfway to final thickness:



Now adjust your planer to final thickness, bringing the depth down slowly and measuring each time until you have achieved the desired result. Make two more passes, paying attention to the reference marks so that each face is planed and the final thickness is achieved:



Now your sticks should be perfectly square, parallel and accurate in size.



If you are making rectangular stock, the same process applies. Tape multiple boards squarely together across the ends to plane the edge faces.

Crosscutting

Next you will crosscut the pieces. The best way by far to accomplish this is to use a crosscut sled. Wayne Daniel's crosscut sled design is excellent and simple to build: <http://www.waynedaniel.net/images/crosscut.htm>

The sled can be very simple. The important things to remember are:

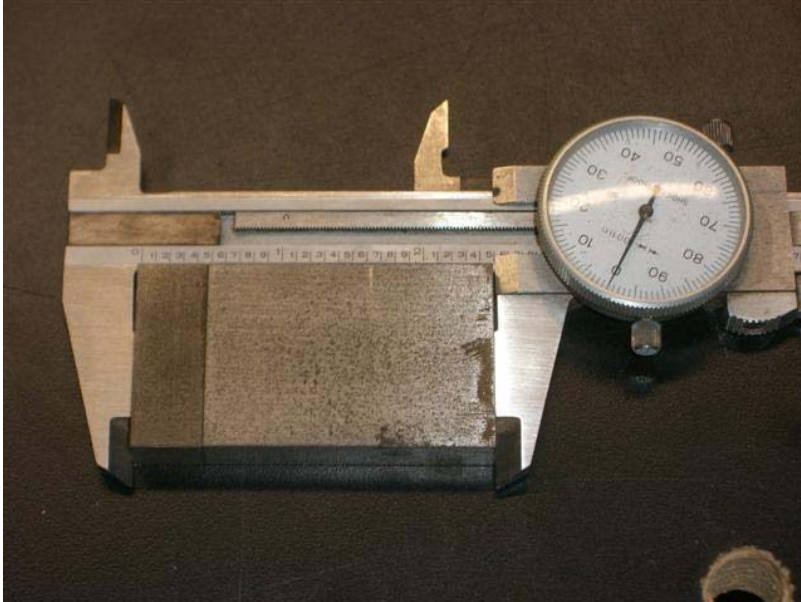
- The sled must fit tightly into the miter slots, and cannot move from side to side at all
- The fence must be *exactly* square relative to the blade

Once your sled is prepared, you will need a set of machinist's gauge blocks. These blocks are ground to precision sizes.



You can transfer the accuracy of the blocks to make a precise cuts using a spacer cut out of accurate rectangular stock. Follow these steps:

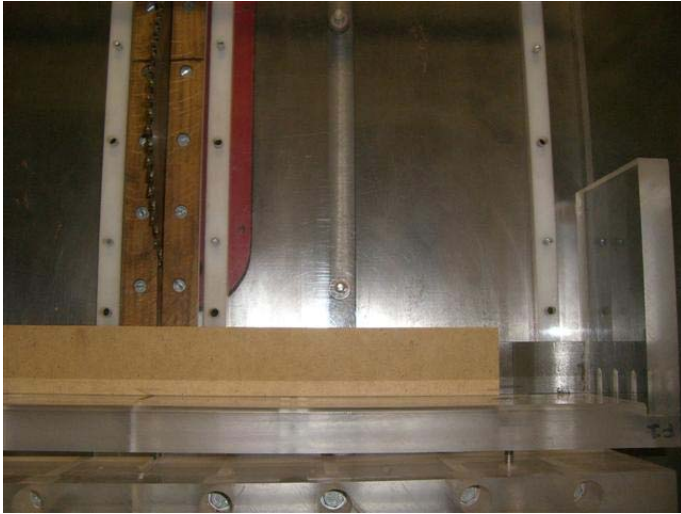
-Select the block or combination of blocks which will add up to your desired stick length. For this example we will make a stick 2.500 inches long. Choose the blocks you need to add up to 2.500 inches.



-Trim the end of the spacer stick so it is square:



-Place the blocks against the sled stop and put the spacer against it as shown:



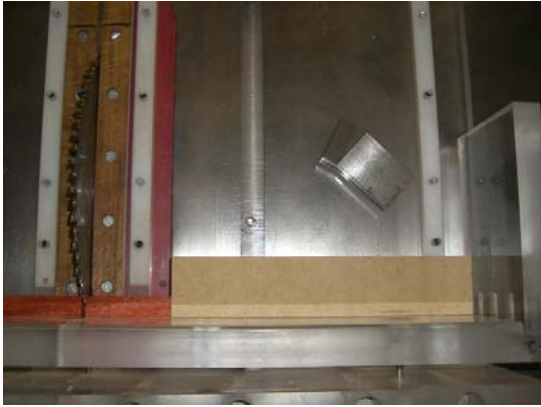
The stick to be cut should be flat with no warping. Now cut the spacer:



Once you remove the gauge blocks and move the stick over, the distance between the blade and the end of the block is exactly the same distance as the gauge blocks were:



Now you can cut a stick to the exact length of the gauge blocks:



The same size as the blocks:



To achieve clean cuts, it is highly recommended to reinforce the back of the material with a disposable piece of wood so that the cut has zero clearance around the rear kerf. Finally, this is the time to double check that the blade is exactly square vertically, and that the fence is exactly square to the blade. As always, do not rely on the setup alone, but rather measure a sample cut to make sure you are achieving the desired results.