Double Error Squaring Method

By Rick Christopherson

When most woodworkers, professional or amateur, need to square up a tool, they grab their trusty steel square, slap it up to the tool, and poof, the tool must be square, Right? Wrong! Not only is that square probably not square itself, but you are relying on your eye to see a minor squaring error over a rather short length.

When I square any machine, whether it is the Jointer's Fence, Table Saw's Sliding Table, the RAS, or an SCMS, I use mathematics to achieve an even greater level of accuracy than what can be achieved from a standard square. This method is what I call the ***Double-Error Method***. The Double-Error Method (DEM for short) doesn't actually square the tool, but it is a check to make sure the setup was done accurately. This method is more accurate than the best steel square because you are not relying on eyeballing several teeth on the blade to a square's steel edge, but are comparing a saw-cut edge with itself. (This method does not work for adjusting blade run-out however.)

If you were building a house, one degree of error wouldn't be noticeable, but if you were building a chess board, then even 1/100 of a degree is going to show. This is why I developed this method. In the project discussion of the large dining room table, I told you that I needed a miter accuracy on the order of 1/1000 of a degree. This method can achieve accuracies on that order.

Basic Concept

Let's start with the idea of placing a construction square across a saw's blade. The total length in which the blade touches the square is less than 3 inches. Furthermore, the camber of the teeth mean that there is very little flat surface to examine. With this method, you would be lucky to distinguish an error as large a one full degree. However, if you had two sharp edges to compare, the human eye could probably distinguish an error on the order of 1/10 of a degree (this also depends on the length of the lines). So if we can't distinguish an error greater than about 1/10 of a degree, then how could I possibly achieve accuracies of 1/100 or 1/1000 of a degree? This is where the mathematics come in.

By multiplying the visible error, it will become more noticeable to the human eye. There are two ways to multiply the error. The first is to increase the length of the lines. That is, if you had a framing square which was 8 feet long, your eye could distinguish an error on the order of 50/1000 of a degree. The second method is to make multiple cuts, where each new cut compounds the error further.

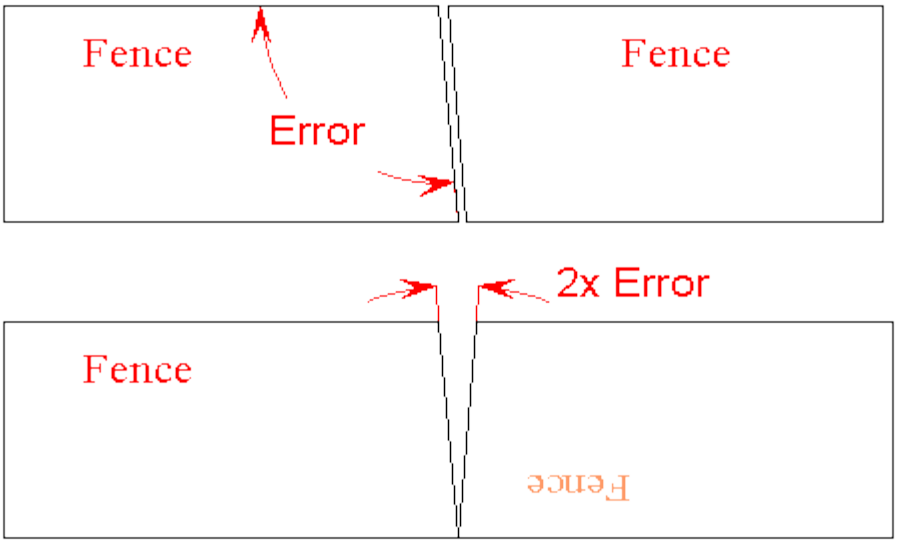
Starting Out (Getting Ballpark Settings)

Because getting extremely accurate settings may take several attempts, I typically use lower quality scrap lumber to start out with, and use the best available scrap for a final check. Any old scrap will work to start with to get ballpark settings. For final checking, I prefer to use white melamine, as the edges are sharp, and any gap becomes quite noticeable. You could also use Formica,

maple, or any other relatively hard, *light colored* wood which will have a sharp edge when cut. A light colored wood accentuates the darker shadow from a small gap. Melamine particle board is OK for a saw, but to square a jointer's fence, it needs to be either MDF or solid lumber. This will be covered below. Also, melamine may not work for you if your blade chips the edges a lot.

Cross-Cut Saws: For the initial ball-park settings, take a piece of scrap wood which is about 3 inches by 10 inches (the poorest of wood is OK for ball-parking).

1. The board must have parallel edges. Make sure both of the long edges are perfectly parallel by either ripping the board on the table saw, or even edge-planing it, but don't run them across the jointer unless you absolutely have to, as there is no guarantee that the edges will remain truly parallel.
2. Cross-cut the board in the middle, and mark which board was to the left/right of the blade, and which edge of each board was against the fence.
3. Take the two boards and set them on edge, with your "fence-side" marks pointing Up (as shown in the upper drawing) on a flat cast iron top like your saw or jointer. Butt the cut edges together. Their orientation should be the same as it was before you cut them in half.



4. Make sure the joint between the two is clean, and hardly visible. This only checks to see if you had a good cut to start with. If the cut is poor, then you will need to reduce your blade run-out first, or this method will not work well.
5. If your cut is good, and the joint is hardly visible, then take ONE of the two boards and flip it over so the opposite edge is on the table ("Fence-side" mark is now Down for right hand board), and the saw-cut edges are still touching.
6. If the gap is tight at the top or bottom, but open at the other side, then the saw is not square. By flipping the board like this, the error in your cut will be doubled. A one degree off-square-cut will show as a two degree gap between the two pieces.
7. Assuming you flipped the right-hand board over, and the left-hand board is fence-side-Up, if there is a gap at the bottom, then move the saw's miter to the right. If there is a gap at the top, move the saw's miter to the left.

8. After readjusting the saw, repeat all of the above steps. When you get to the point where you think the saw is perfect, then do a final check (or maybe several)
9. As a final check, use the best scrap you can find. That is, it should have the sharpest edges when cut. This scrap should also be the widest possible. If it is an RAS or SCMS, use a board about 10 inches wide or more. The wider, the better, as very small error-angles will have bigger gaps.

SCMS, RAS, and Table Saw Bevel Settings:
To check the bevel setting, or pitch, of a saw, the only thing that changes from the above procedure is how you cut the wood. Everything else is the same. When you cross-cut the wood, stand it up against the fence. When you do your checking on the cast iron table, you still stand the board up the same as before. This time instead of marking which side was against the fence, you mark which side was against the table.

Jointer Fence Setting:
To set the fence on a jointer, the principle is the same, but the size of the wood is different.

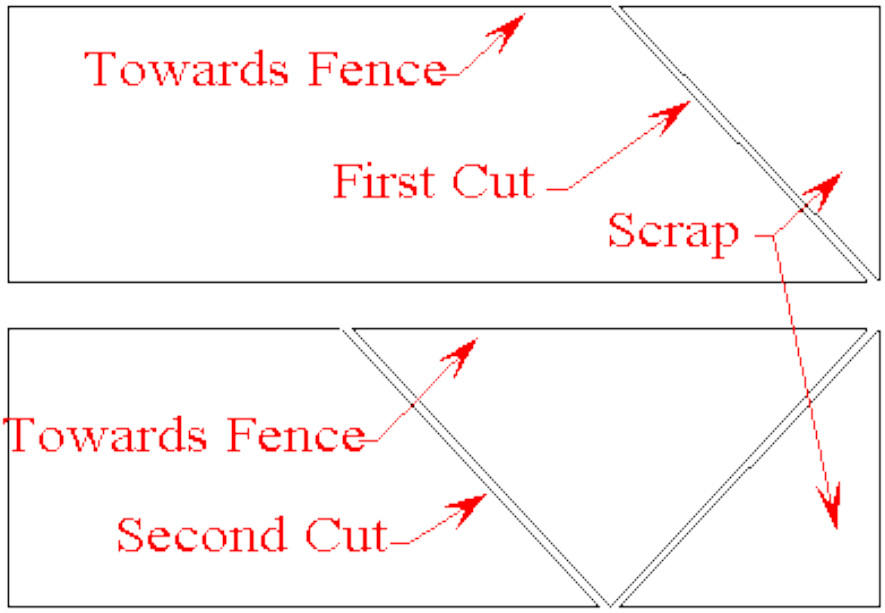
1. For the ball-park setting, use two separate pieces of solid wood which will have sharp edges AND smooth surfaces after jointing. Particle board will not give you the smooth surface after jointing, but MDF will.
2. These two pieces do not need to be the same. They don't need to be square, nor parallel, but they do need to be the same thickness, and at least 3-4 inches wide. (But if they are too wide, you also run the risk of tipping them when they stand up too far above the fence.)
3. Edge-joint each piece with a slow-speed pass.
4. Mark which edge was down, and which was against the fence.
5. Take the two boards and lay them FLAT on a cast iron table with the jointed edges touching, and both boards having Fence-side-Up. (You don't need to flip either of the boards this time, just keep the fence-side-up.)
6. Press the two boards together as tight as you can. If the fence is out-of-square, they will either rise up in the center, or on the outside as the joint becomes tight. (If they rise up in the center, or you aren't sure if they would or not, flip BOTH boards over, as it is easier to see a gap on the outside edge versus the center.)
7. Assuming your boards are fence-side-up, if the outside edges rise, then your fence is greater than 90**°**. If they rise in the center, then it is less than 90**°**.
8. Once you think your settings are good, you can do a final check with better wood if you wish. (I usually don't bother, myself, but it doesn't hurt.)
9. Just like the cross-cut final check above used a Thicker/Wider board. To get thicker boards, you can surface join two or more 3/4 inch thick boards which are at least 3-6 inches wide (3-6 inches tall as they ride along the fence.)
10. Edge joint the two boards just like before, and repeat the above. Just as a double check, if the boards appear to be square, flip ONE of them over, and

check again. This is just in case one of them didn't ride along the fence properly, giving you a false result.

Checking Other Angles Besides 90°

To set up a tool to cut other angles, every thing remains the same, except you will compare more than just two boards. The level of accuracy for this setup increases for smaller angles.

I will use a 45° setting to explain this further. Take a board which has parallel sides, as before. Cut one end of the board with a 45° miter. The end of the board is scrap, so you can through it away so it doesn't get confused with the pieces you want. Now, flip the board over so that the other edge is against the saw's fence. Do not change the miter settings of the saw. It must remain exactly where it is. Make the second cut as shown in the drawing. Even though your saw was set to cut at 45°, the angle between your two cuts is 90°. Continue flipping the board and cutting until you have four triangular pieces.



Once you have four triangles cut, place them together flat on a table with the cut edges touching, and forming a square. If your saw is cutting greater than 45°, you will have a gap in the center of these four pieces. If your saw is cutting less than 45°, you will have a gap at the outside corners. Because it took 2 cuts to make each triangle, and you have 4 triangles, your error will be magnified 8 times. (If you see a 1° error between these boards, this translates to an error at the sawblade of 1/8°.)

To apply this method to other angles, you just need to cut more triangles. For example, to check a 22 1/2° degree miter, you will need to make 8 triangles, and your error will be magnified by 16 times.