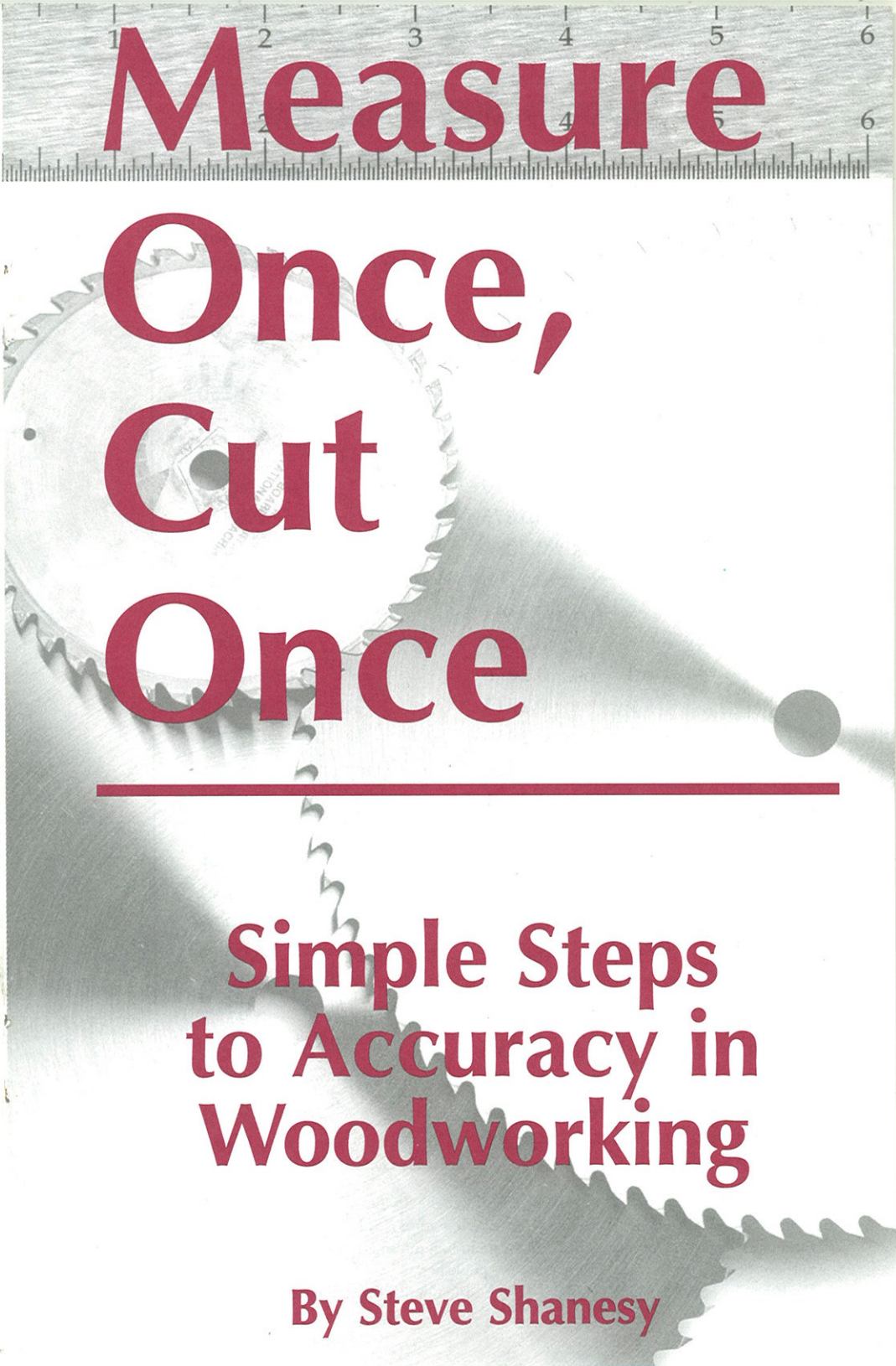


The background of the cover features a circular saw blade, likely a hand saw, with its teeth visible. A ruler is positioned at the top of the image, showing measurements in inches from 1 to 6. The text is overlaid on this background.

Measure

Once,

Cut

Once

**Simple Steps
to Accuracy in
Woodworking**

By Steve Shanesy

FRACTION CONVERSION CHART

$1/64 \cdots 0.0156$	$33/64 \cdots 0.5156$
$1/32 \cdots 0.0313$	$17/32 \cdots 0.5313$
$3/64 \cdots 0.0469$	$35/64 \cdots 0.5469$
$1/16 \cdots 0.0625$	$9/16 \cdots 0.5625$
$5/64 \cdots 0.0781$	$37/64 \cdots 0.5781$
$3/32 \cdots 0.0938$	$19/32 \cdots 0.5938$
$7/64 \cdots 0.1094$	$39/64 \cdots 0.6094$
$1/8 \cdots 0.1250$	$5/8 \cdots 0.6250$
$9/64 \cdots 0.1406$	$41/64 \cdots 0.6406$
$5/32 \cdots 0.1563$	$21/32 \cdots 0.6563$
$11/64 \cdots 0.1719$	$43/64 \cdots 0.6719$
$3/16 \cdots 0.1875$	$11/16 \cdots 0.6875$
$13/64 \cdots 0.2031$	$45/64 \cdots 0.7031$
$7/32 \cdots 0.2188$	$23/32 \cdots 0.7188$
$15/64 \cdots 0.2344$	$47/64 \cdots 0.7344$
$1/4 \cdots 0.2500$	$3/4 \cdots 0.7500$
$17/64 \cdots 0.2656$	$49/64 \cdots 0.7656$
$9/32 \cdots 0.2813$	$25/32 \cdots 0.7813$
$19/64 \cdots 0.2969$	$51/64 \cdots 0.7969$
$5/16 \cdots 0.3125$	$13/16 \cdots 0.8125$
$21/64 \cdots 0.3281$	$53/64 \cdots 0.8281$
$11/32 \cdots 0.3438$	$27/32 \cdots 0.8438$
$23/64 \cdots 0.3594$	$55/64 \cdots 0.8594$
$3/8 \cdots 0.3750$	$7/8 \cdots 0.8750$
$25/64 \cdots 0.3906$	$57/64 \cdots 0.8906$
$13/32 \cdots 0.4063$	$29/32 \cdots 0.9063$
$27/64 \cdots 0.4219$	$59/64 \cdots 0.9219$
$7/16 \cdots 0.4375$	$15/16 \cdots 0.9375$
$29/64 \cdots 0.4531$	$61/64 \cdots 0.9531$
$15/32 \cdots 0.4688$	$31/32 \cdots 0.9688$
$31/64 \cdots 0.4844$	$63/64 \cdots 0.9844$
$1/2 \cdots 0.5000$	$1 \cdots 1.0000$

INTRODUCTION

If you've been around woodworking – or cabinetmaking as I prefer to call it – for more than 15 minutes, you've probably heard this expression:

“The difference between a good cabinetmaker and a bad one is the good one knows how to fix his mistakes.”

The saying is often followed by knowing smiles and nods of approval from all within earshot. Well, I'm not about to disagree with the comment because a good cabinetmaker should know how to fix his mistakes. But I'll bet dollars to donuts that the guys most often quoting this adage make far too many mistakes. In truth, good cabinetmakers make very few

mistakes and great cabinetmakers almost never make them.

I can't promise you that after reading this booklet you'll never make a woodworking mistake, but I can guarantee that if you put most – or even just a few – of these principles, techniques and tips into practice on your next project, several important things will happen. Your project will get done faster, it will turn out exactly as you planned it, the size of your scrap pile may for the first time be smaller than your good lumber pile, and best of all, you'll enjoy your craft more and have greater confidence in your abilities.

Measuring and Marking

To ensure exact measurements, use the same tape measure or folding rule for all of the measuring involved with your project. This ensures that your 6" measurement on one part will equal your 6" measurement on another. You can check the accuracy of your tape measure against a metal rule. Check this accuracy by hooking the tape over the end of the rule and also by putting them side to side with the ends against a surface to check for accuracy making inside measurements.

GET THE ACCURACY ATTITUDE

Before skipping to the next part which, I admit, sounds much sexier, please remain seated in your pew while I turn my woodworking collar around and sermonize a bit from the cabinetmaker's pulpit. I won't dwell here long, but you should know that the sexier tips that follow won't be worth all the maple in Maine if you don't develop a healthy accuracy attitude.

If you just do the following **two things**, you will improve the quality and enjoyment of your craft:

1) GET YOUR IDEA ON PAPER

Always make a drawing of your project before starting, if only a crude hand sketch. The drawing forces you to think in detail about what you're going to build. As you draw, you'll make decisions about

the type of joints you'll use. The process of drawing brings up questions that require answers. The answers at this point are simple and cheap. When you ask yourself questions halfway into a project, the answers are often problems with not-so-simple solutions which can be expensive.

2) CREATE A CUTTING LIST

From the hand sketch, always make a cutting list which includes every part that will go into the finished project. Since you made your drawing, you know what joints you'll be using, so you also know how much extra length or width a part will require. Your list has a little space for notes to remind you to make a notch here or a dado there while you're cutting parts. There are few things worse than discovering during assembly that you should have done something else to a piece first.

MEASURE PRECISELY, MARK PRECISELY

Couple these fundamentals with a shop practice of always cutting to the exact size stated on your cutting list. Also promise yourself that, unless you're cutting a piece to an angle different from 90 degrees, you'll always make square cuts. Assuming your cutting list is correct, you've already won the battle but the war has just begun. Don't think I'm simply stating the obvious. Consider this: if your cutting list says cut to 15/32", it requires you to make that cut. But, you say, it's hard to be that accurate! Think about it. Is it any more difficult to cut a piece exactly 10-1/2" than it is to cut it exactly 10-15/32"? Of course not. Exact is exact no matter what hairline on your tape you're using. The same principle applies to cutting square. It's either square or it isn't. Making exact cuts that are square will save you hours of shop time and put more fun in your woodworking than you thought possible.

The Tape Measure

Many people damage their tape measure by allowing the hook to slam back into the case when it rewinds. Repeated, careless closings like this bend the hook or enlarge the rivet hole in the blade to such an extent that the hook is no longer accurate. And you're wasting your time trying to bend the hook back into position. Do you know why the hook is made to be loose? The answer: for inside and outside measuring. The movement is equal to the thickness of the hook.

When taking an inside measure, you push the hook in, thus measuring from the outside of the hook. When making an outside measure hooking the blade over a board, you pull the hook out, thereby measuring from the inside of the hook.

Conventional Tools

TAPE MEASURE

Although this may be obvious, you should know that all tapes are not created equal, and unless you take care of yours, it may be damaged beyond use. (If it is damaged, save it and use it on a table saw sled, radial arm saw fence, etc.) It may be damaged because the hook is bent out of shape, the tape has been bent backwards and no longer stays stiff when extended, or it's been used so long the numbers and/or lines have worn off. Any of these is reason enough to retire your current tape to less critical use. When buying a tape, I recommend a 12' model with as wide a blade as you can find. Make sure the first 12" are divided by 32nds, and it's best if dimension lines aren't too thick. I've seen some with lines as wide as a sixteenth. Also, a lever to lock the blade in place is helpful.

Keeping Your Rules Readable

After a while, the blade of your combination square will darken, making the fine dimension lines and numbers difficult to read. To make it easy to read again, remove the blade and gently rub it with fine steel wool, 400 grit sandpaper or a fine Scotch Brite® pad until shiny again.

FOLDING RULE

There are tape-measure woodworkers and folding-rule woodworkers. While I use a tape 90 percent of the time, there are some jobs on which a folding rule does much better. Usually, this is when you need an especially rigid extension, or when you want a free hand to mark a line. A folding tape also has the advantage of the sliding tongue on one end that's indispensable for accurately measuring inside dimensions. I've never had complete confidence in adding inches to compensate for the tape measure case after reading the number on the tape where it enters the case. Primarily, I prefer the tape style because I'm too impatient to continually fold and unfold the folding rule. It's also been my experience that the dimension lines are generally fatter on the folding rule than on the steel tape rule.

COMBINATION SQUARE

Get a good combination square, one that's been cast with the 90 and 45 degree angles milled true. I find a 12" blade the right length for cabinet and furniture work. If you're buying a combination square, inspect the blade to see if the dimension lines look fine

(thin and crisp looking) or whether they look like they were stamped in with a worn dye and oversized stamping machine. Spend an extra couple bucks and get a decent one, and then take care of it. A better one will have a small scribe in the end, which can be handy. It will also have a bubble level, which I wouldn't use, unless it were the last level on earth. Its base is simply too short to be of much benefit.

MACHINIST'S DEPTH GAUGE

You've seen this – a thin blade about five inches long with a sliding-T and shirt pocket clip built in. The measuring scale usually goes down to 64ths on one side of the blade and 32nds on the other. I find this little tool very handy for measuring the depth of dados, grooves, rabbets, shoulders on tenons, depths of mortises, etc. It also works well for setting the height of a table saw blade and the distance between a router fence and the cutter. In short, the depth gauge is great for measuring short distances in precise measurements. Best of all, it only costs a few bucks and you can feel like a engineer with one in your shirt or shop apron pocket.

DIAL CALIPERS

I hope I don't lose you here. To some, the notion of using dial calipers, which measure in thousandths of an inch, sounds extreme. I must report, however, that I do find them very helpful in the woodshop. And I'll also tell you that I'm not a neat freak. My bench is usually more cluttered than clear, and I don't sweep up the shop every day or even every week unless it's really a mess. I use the calipers for checking the thickness of boards I'm planing and for measuring the thickness of a tenon. They're also great for measuring the distance between holes and the width of narrow stock, and for setting up machines and checking their accuracy. Have you ever set up a dovetail jig, or made stock for a dovetail jig more or less than asked for, only to find that the dovetails don't fit worth a darn? Dial calipers will solve the problem.

If you say you don't know how to read the measuring device or understand what .25" is (it's a quarter inch), I highly recommend you learn. It's simple and, as you'll read later, calculating in decimals rather than fractions can be an enormous aid in reducing

miscalculations. Personally, I haven't bothered to memorize decimal increments of less than 1/16th inch – that's what reference tables are for, and we've included one on the inside cover of this booklet to get you started.

PLASTIC SQUARES AND ANGLES

Here are low-tech tools you might warm up to more easily. These items are usually found on a drawing board, which is a good place for them. But in the shop you'll want to keep them near the jointer or table saw to check the 90 degree angle of the fence or blade. I drill a hole in them and tie them to the machine with a string so they'll always be where I want them. You can buy them in bright colors, which I suggest, because they are easier to read. I also use them for drawing and layout work. Get one each of an isosceles and equilateral triangle, in a medium size. I've never bought one that wasn't accurate. I wish I could say the same for framing squares and general woodworking squares.

STRAIGHT EDGE

A good straight edge that's about 3' long is quite handy when making full scale layouts which are

required for more complicated cabinet and furniture work. A good one is also indispensable for aligning jointer beds, bottom rollers on planers, table saw alignment, various fences for machinery, etc. If you are a good woodworker, you can make your own straight edge, if you want to take the time and promise to check it regularly. Otherwise, get a straight piece of steel or aluminum.

COMPASS AND BEAM COMPASS

You'll need a decent compass for laying out smaller circles and then dividing them up. You've used them since third grade, so explanation is not required. For larger arcs, however, a beam compass is essential. If you're not familiar with this tool, it works just like trammel points, only you have a pencil in one end instead of another point. Again, you can make your own beams of various lengths in not much time at all. If you don't have trammel points, get a set that doubles as a compass, with a pencil holder already attached to one of the points.

CALCULATOR

Unless you're a savant with math abilities, especially when it comes to adding columns of fractions, a calculator coupled with a fraction to decimal conversion table will help you overcome accuracy problems that result from simple mistakes of addition. Let's face it. When you need to add a group of numbers which include fractions of sixteenths, eighths, quarters, and the like, it's much easier to do if they are simple numbers which happen to have decimal points in them. Over the years, I've developed a certain proficiency at adding fractions with unlike denominators, but I nonetheless find it vastly easier (and more accurate) to use a simple calculator. You don't need an engineering calculator, just a simple one. Of course, when I reach my total, I always convert it back to a fraction, because that's what's on my tape measure.

Making Test Cuts

I like to make my test cuts on scrap material, especially inexpensive $\frac{1}{4}$ " plywood or hardboard left over from cabinet backs or drawer bottoms. When making a test cut, I don't saw through my test piece, just into the leading edge enough to make a measure. And by sawing just $\frac{1}{2}$ " or so in, it's safe to back the material out from the table saw blade. I can usually make a dozen or more test cuts in a 20" long by 8" or 10" wide strip of $\frac{1}{4}$ " scrap.

FORMULAS

Simple mathematic formulas can take both the burden and high potential for error out of calculations which repeat the same process over and over. Some of them you'll use frequently and can just keep in your head for use when making your cutting list.

There are many situations in which a simple formula will come in handy. You should ask yourself as you make up a cutting list if there are opportunities to put one or two to use. Here are a few examples of uses of formulas:

CASE GOODS

When building case goods like cabinets and shelving units in my shop, I always make rabbets for bottoms, backs and stretchers in $3/4$ " net or nominal material which leave $1/4$ ".

Length of Bottom, Back, or Stretchers Equals Overall Case Size Minus $1/2$ " With this standard, I always know that the length of the bottom, back or stretchers is the overall case size minus $1/2$ ". That's an easy one.

DRAWERS

How about making drawers? Let's assume that you're making a cabinet with flush, inset drawers. The drawers will slide on runners, and the only other information you have is the opening size and the depth of the cabinet. Your shop standard for drawer making uses $1/2$ " thick material for the sides and back, a $3/4$ " thick front and $1/4$ " bottoms. The sides are joined to the front and back with rabbets cut $3/8$ " deep. Your practice is to leave $1/8$ " clearance for the drawer to fit in the opening. Here are your formulas:

Drawer Front Equals Opening Size Minus $1/8$ "

Length of the Back Equals Length of the Front. Width of the Back Equals Width of the Front minus $1/2$ " (because your drawer bottom slips in from the back of the assembled drawer in a groove that's $1/4$ " wide set up $1/4$ " from the bottom edge of the sides and front).

Length of the Sides Equals the Depth of the Cabinet Minus 1"

(assuming you're using a $1/2$ " back and allow a $1/2$ " space between the back of the drawer and the case back).

Width of the Side Equals the Width of the Front

Width of the Drawer Bottom Equals Length of the Front Minus

$9/16$ " (because the groove in the sides is $1/4$ " deep and the fitting allowance is $1/16$ ").

The Length of the Drawer Bottom Equals the Length of the Side

A series of formulas like these can also be applied to calculating raised panel door parts. All you need to know is the opening size for the door. Then just plug in the numbers to the formula and all the parts will be quickly, easily and correctly calculated.

GETTING TO WORK IN THE SHOP

Machinery Check-Up

If you check your shop machinery occasionally and are confident everything is set up to perform accurately, skip this section. But if you haven't even thought about it since the day you dragged the machines into the shop, or if you don't know for a fact that they're all ready to give you the results you should expect, read on.

Table saws, jointers, planers, bandsaws, shapers, radial arm saws, drill presses, and disk and belt sanding machines not only require periodic maintenance to keep them operating properly; they also need to be checked and reset as needed to keep them running true. To set them properly, refer to the owner's manual and follow the recommended procedures. If you don't have a manual, I strongly suggest you write the manufacturer and obtain one. Your machinery "tune-up" objective is to make sure everything is performing properly.

THE TABLE SAW

For table saws, this means making sure the blade is aligned to

the miter slot and the fence is always parallel to the blade when locked down. In addition, check to make sure the blade is really 90 degrees to the table when the arrow on the angle indicator says it is. Also, make sure the fence is 90 degrees to the table. Can you trust your slot miter gauge for accurate angles? Check it periodically, too.

THE JOINTER

For your jointer, be sure your tables are properly aligned and that the fence is truly at 90 degrees to the table when the indicator says it is. If you use it for bevel cuts, check the 45 degree positive stop and adjust as necessary.

THE PLANER

For your planer, the primary accuracy check is making sure the knives are set properly. After planing a wide board, make sure the thickness is equal on both edges of the board.

THE RADIAL ARM SAW

If you rely on a radial arm saw instead of a table saw, you need to check the alignments frequently. I've never known this machine – regardless of manufacturer or cost – to hold tolerance for long.

Prepare Extra Stock For Setups and Test Cuts

I've made it a habit to prepare a little extra stock when jointing and planing rough lumber for a project. And I always keep fall-off material of any consequence for testing setups along the way to assembly. When I'm using expensive materials or don't have like material for running extra, I use any leftover stock and prepare it to the same thickness as my project calls for. This practice can save lots of time and frustration when I don't have to stop and carefully recreate a spare part starting from scratch.

MAKING TEST CUTS

You've created an accurate cutting list, you know your tape measure or ruler is accurate, and your machines are set true and square. Now all you have to do is make accurate cuts. To ensure you're "right on the money," it's always a good idea to make a test cut on a scrap piece of wood before making the real cut. When you first start this practice, I think you'll be surprised at how often

you re-adjust your saw fence to get the accurate cut you want. And if you think this is just an unnecessary, time-consuming nuisance, remember our earlier discussion about how the little corrections you make now prevent very time-consuming and possibly costly rework time and material later.

TEST SETUPS

When setting up a router, the slot miter gauge on the table saw, a final pass on the planer, or even when using jigs and fixtures, I always test the setup with scrap before machining a real part. Other than sawing to length and/or width, these tests will verify whether or not you'll get the final result you desire. Unlike a test cut on 1/4" scrap on the table saw, it may be necessary to use a spare piece of material that has exactly the same dimension as the part you will machine for your specific project. For example, if you are

Safely Cutting Square

When using the panel squaring method, the same safety rules apply regarding use of the table saw fence. That is, on small parts, don't crosscut lumber when its width is less than its length. The rule applies somewhat less when using plywood or particle board because of the lack of grain direction. Always let safety and common sense prevail in your judgment.

using a drill press to bore a hole to a specific depth, the test part will have to be the same thickness as the actual part. If you are matching setups to mill stile and rail joints for frame and panel doors, you need scrap material of the same thickness as your actual parts. If you are setting up a dovetail jig, you'll want scrap of equal thickness to test your setups.

SQUARING PANELS OR SLABS

If you rip then crosscut a piece of plywood or glue up a slab of lumber, chances are it will not be square. That's because you didn't have a true 90 degree corner to begin with in most cases. In keeping with our dedication to cutting and assembling things square, it's important to know how to make square pieces using your table saw.

Here's how I do it:

STEP 1: When I begin cutting a sheet of plywood, I cut my pieces a bit oversized, say 1/4" to 1/8". This applies to both width and length.

STEP 2: Now that these pieces are of a manageable size, I use a sled that runs in the saw table

Using Stop Blocks

There are just a couple key points to making and using stop or gauge blocks. From a design standpoint, the block should be large enough to be able to clamp firmly. Also, it should contact the part at only a single, usually small point. If you are planning to use it for a long time or a long run, make it out of a sufficiently hard wood.

miter gauge slot to square one corner of the panel. I take the first edge I trim and place it against the sled fence, then make the next trim cut. I then make a light pencil mark in this corner to identify this as the true 90 degree corner. I put this piece aside and continue in this manner until all my plywood panels for my project have a square corner.

STEP 3: Next, I remove the sled and use my table saw fence to trim to finished length and width, always making the finished trim cuts on the opposite edges of my marked, 90 degree corner. As long as your sled fence is 90 degrees to your blade and your table saw fence is parallel to your blade, this is a failsafe, part-squaring method.

CUTTING SEQUENCE

How good are you at planning and thinking ahead? There's a guaranteed method of making sure that all pieces of the same width or length are the same. That's by cutting them on the same setup, without having moved a fence, stop block or other gauging device. To do this you must have your cutting list and your rough-cut parts properly identified and organized. Here's an example. You're making a cabinet and certain parts are by necessity the same dimension. The bottom is the same width as the sides, and the bottom is also the same length as the top stretchers.

Here's the perfect cutting sequence:

STEP 1. Rough cut and square one corner on the sides. Then add 6" to the width of the rough-sized bottom.

STEP 2. Now crosscut the sides and bottom to finished length.

STEP 3. Reset the fence and rip the sides and bottom to finished width.

STEP 4. Now reset the fence and rip two 3" wide stretchers from the fall-off from the bottom. Now you

have sides and a bottom that are exactly square and the same width, sides that are exactly the same length, and stretchers that are exactly the same length as the bottom. They are all precisely the same, because their common dimensions were cut on the same setups.

STOP OR GAUGE BLOCKS

Using a stop or gauge block will ensure the accuracy of repetitive cuts. These simple devices firmly clamped in place are helpful when using a table saw sled, radial arm saw, shaper or router table fence, drill press or even a jointer on occasion. In some circumstances, you can even stack multiple parts for cutting or drilling, thereby saving time. Aside from the obvious checking with a test cut to make sure your stop is correctly set, always make sure it is securely clamped. You may even want to use two clamps at times. It's always a good practice to make sure a stop hasn't moved if you're making many cuts on the same setup. In a production run of 100 parts, the typical checking points would be the following part numbers: 1, 2, 5, 10, 25, 50 and 75.

ASSEMBLING SQUARE

With all you put into your project to ensure accuracy, the last piece of the process is making sure that your parts are assembled square. This ranges from picture frames to cabinets, from drawers to table leg and apron assemblies. With all of your component parts cut square, the assembly process should be a long way toward being square without much additional help. But you must always check for squareness, and there are a few aids in accomplishing this important task.

Checking for Square

Checking for square is easy enough. Use your tape measure or ruler and measure diagonally from corner to corner making sure that both measurements are equal. If they aren't, use a clamp placed along the longer of the corners and slowly close the clamp jaws until the cross corner measurements are equal. One way to help ensure a square assembly is to use hefty, L-shaped corner brackets while assembly is taking place. Make each outside leg of the bracket about 12" to 14" long and 3" to 4" wide. Use a good but inexpensive grade of 3/4" plywood

for material. Obviously, the two legs must form a 90 degree angle. It's a good idea to notch or clip the corner of the L to make it easier to bring the two parts that you're assembling together. Use the bracket by clamping each leg to a part that's forming a corner. You'll find an added benefit in that the clamped bracket adds great stability to the otherwise wobbly assembly, as you continue the assembly process.

While assembling casework, you not only want to make sure the ends are set square to the bottom and stretchers, but that any partitions between the two ends are set 90 degrees to the front edge. If these parts are not sitting in a dado, you must check them with a square.

YOU CAN DO IT!

You know, we often think of habits as bad things when in fact there are both good and bad habits. Getting into the accuracy habit is not only a good thing; it's a great thing. Happy – and accurate – woodworking!

ABOUT THE AUTHOR



Steve Shanesy is the editor of *Popular Woodworking* magazine. Prior to his editorial position, he was a professional cabinetmaker for 15 years, working in and managing high-end, custom furniture and cabinet shops. He was educated in the trade at Los Angeles Trade Technical College, Cabinetmaking and Millwork Department.

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