Cutting Crown Molding

Calculating miter and bevel angles so you can cut crown on compound-miter saws

by Stephen Nuding

A few years ago, I purchased an 8½-in. compound-miter saw. It was light and compact, but had the same capacity for cutting large crown moldings as a regular 10-in. miter saw. Remodeling Victorian homes, I install a lot of crown so this seemed to be the perfect power tool for me.

I eagerly brought the saw to the job and set the miter and bevel angles for 90° corners, as indicated by the instruction manual. When I cut my first lengths of crown, the joints weren't perfect, but I figured that the walls and ceiling weren't perfect either, so with a little shaving here and there I was in business.

The next crown molding I had to install, however, was a larger one, and when I cut it and held it up to the ceiling, I was looking at a pie-shaped gap ⅜ in. wide. What's more, this room had two corners that were 135°, not 90°, and the saw's instruction manual gave no miter or bevel angles for this situation. I soon discovered that throwing miscut pieces around the room in rage and frustration is a very slow and expensive way to complete a job.

By now I was ready to return the saw to the dealer and demand a refund. But in desperation I grabbed the instruction manual one last time. According to the manual, the miter and bevel angle settings were correct for 90° corners when using a standard crown, which makes a 38° angle to the wall. Wait a minute... what if my crown doesn't make a 38° angle to the wall?

Fortunately, my daughter's protractor was in the car, so I was able to measure the angle the crown made to the wall by holding it against the inside of a framing square. The angle was more like 43° or 44°. I checked all the crowns I was installing only to find that none were the same, varying from 35° to 45°.

I finished the day's work as best I could and went home determined to calculate the angle settings for each of the crowns. Using my wife's high school math text to brush up on some trigonometry, I wrote down equations and measurements. I worked late into the night, but couldn't come up with a formula.

I finished the crown job eventually by trial and error, playing with the angles on the saw until they were right. Still, the problem gnawed at me. I spent a lot of late nights scribbling and thinking, but I just couldn't get it.

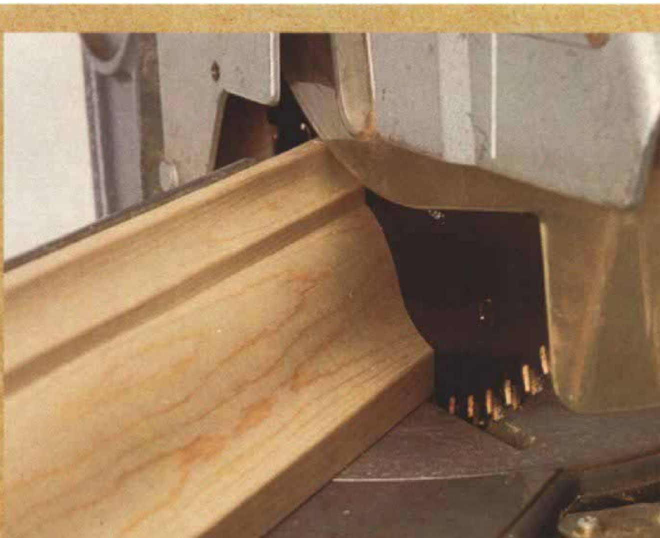
Fortunately, I had hung some French doors in the home of Roger Pinkham, professor of mathematics at the Stevens Institute of Technology. So one Saturday morning, at my request, he graciously came to the house and we pored over my notes. Several hours later, we had it. We could calculate the miter and bevel angles for any crown and for any angle.

So, why use a compound-miter saw?—You are probably wondering why anyone would want to calculate angle settings for a compound-miter cut when crown molding can easily be cut on a regular miter saw with no math at all. With a regular miter saw, the crown is positioned at an angle between the fence and the table (photo below left), but is turned upside down so that the wall face of the crown is against the saw's fence and the ceiling face of the crown lies on the saw's table. The crown is then cut at 45° to create a 90° corner, 22.5° for a 45° corner, and so on. Very simple. (For more on cutting crown molding see *FHB* #51, pp. 64-67.)

Most 10-in. miter saws, however, can only cut crown molding up to about 4½ in. wide. Five and one half-in. crowns are readily available, though, and cutting these requires a 14-in. or 15-in. miter saw—a large, heavy tool. Cutting large crowns on any of these saws also requires the extra step of constructing a jig or fence extension, preferably both.

Even a 15-in. miter saw is not big enough to cut crown molding more than 6½-in. wide, and larger crowns are also available. For instance, the Empire Molding Co., Inc. (721-733 Monroe St., Hoboken, N. J. 07030; 201-659-3222) makes an 8¾-in. crown that I often use.

So unless you want to make a king-size



To miter crown with a standard miter saw, turn the molding upside down and set it at an angle between the fence and table.

To miter crown molding with a compound-miter saw, lay the molding flat on the saw's table.

miter box and cut the molding with a handsaw, you'll have to use one of the new slide compound-miter saws or a radial-arm saw to cut these wide crown moldings (for more on these saws see *FHB* #57, pp. 58-62). With a compound-miter saw, crown molding is laid flat on the saw table (photo right, previous page). No jig or fence extension is necessary. The saws can be smaller for cutting the same size crown, resulting in a lighter tool with a smaller blade, which is therefore cheaper to buy and costs less to sharpen.

Figuring the angles—To calculate the miter and bevel angles for any crown molding, you'll need a framing square and a calculator that's capable of doing trigonometric calculations. These calculators are usually called "scientific calculators." No cause for alarm, though, just think of yourself as a carpentry scientist. I use a Radio Shack model that is out of production now, but a Radio Shack EC 4008 will do nicely and retails for only $13.95.

So, here we go. First let's consider the most common case, the 90° corner. Hold whatever crown molding you're using up to the inside of a framing square as in the drawing right. Measure lines A, D and C to the nearest 16th of an inch. (To convert fractions of an inch to decimals, simply divide the denominator into the numerator. To convert ⅞, for instance, divide 8 into 7 and you get .875.) The miter-table setting (M in our equation), is the inverse tangent of (A divided by C).

$$M = \tan^{-1}(A \div C)$$

To calculate this, divide A by C, and then hit the inverse tangent button ($\tan^{-1}$), or arc tangent button (same thing). In our example, 2.875 (A) divided by 4.8125 (C) = .5974. With .5794 still on the calculator screen, hit the inverse tangent button and you get 30.9° (rounding to the nearest tenth of a degree). This is the miter angle at which to set your saw.

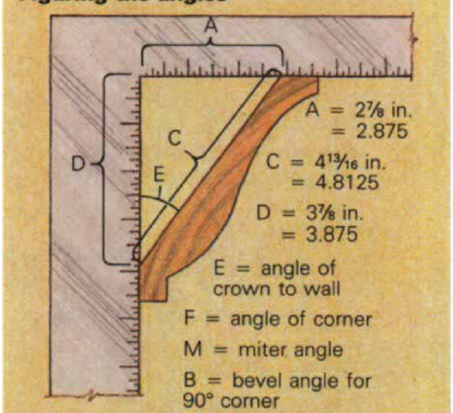
The bevel angle (B in our equation) is the inverse sine of D divided by (the square root of 2) times C.

$$B = \sin^{-1}\left(\frac{D}{\sqrt{2} \times C}\right)$$

To calculate this, multiply the square root of two (done on the calculator) times C. Then divide that into D and hit the inverse sine button, or arc sine (same thing) button on the calculator. Using the values from drawing A, the calculations would go like this: the square root of 2 = 1.41, times 4.8125 (C) equals 6.8059, divided into 3.875 (D) equals .5694, the inverse sine of which is 34.7°. This is the bevel angle at which to set your saw for a 90° corner.

Once you have calculated the miter and bevel angles for a particular molding, you never have to calculate them again as long as you have 90° corners. Jot down the angles somewhere and save a couple of minutes the next time you run that crown.

Figuring the angles



Crown molding varies not only in size but also in the angle that it makes with the wall. So the first step in calculating miter and bevel angles is to measure the crown with a framing square and determine the measurements shown in the drawing above. Then plug those figures into the formulas shown below.

What if you have a wall corner that is not 90°? To make this calculation you'll need a device for measuring the angle of the wall corner. I use the Angle Devisor (manufactured by Leichtung Workshops, 4944 Commerce Parkway, Cleveland, Ohio 44128; 800-321-6840). Whether you are installing inside corners or outside corners, be sure to use the angle of the inside corner (the angle less than 180°) for the equation.

Here's how the equation looks:

$$M = \tan^{-1}\left(\frac{A}{C \times \tan(F \div 2)}\right)$$

If we were to use our crown from drawing A, we would have 135 (F) divided by 2 = 67.5. Hit the tangent button and you get 2.4142. That times 4.8125 (C) = 11.6184. Divide 11.6184 into 2.875 (A), then hit the inverse-tanget button, and you get 13.9° (the miter angle).

For the bevel angle:

$$B = \sin^{-1}\left(\frac{D \times \cos(F \div 2)}{C}\right)$$

Plugging in some real numbers we get: 135 (F) divided by 2 = 67.5, the cosine of which is .3827. Multiply .3827 times 3.875 (D) and you get 1.4829. Divide that by 4.8125 (C), then hit the inverse sine button, and 17.9 appears. That's your bevel angle.

Finally, because the difference of one degree in the miter angle or bevel angle can be the difference between acceptable and unacceptable joints, you must set the angles on your compound-miter saw carefully. Math may be perfect, but measurements and the real world aren't, so slight adjustments may be needed to get an acceptable joint. But by using these equations you will avoid the fuss-and-fiddle approach I first used. □

Stephen Nuding is a carpenter in Hoboken, New Jersey. Photos by Susan Kahn.

Miter angles

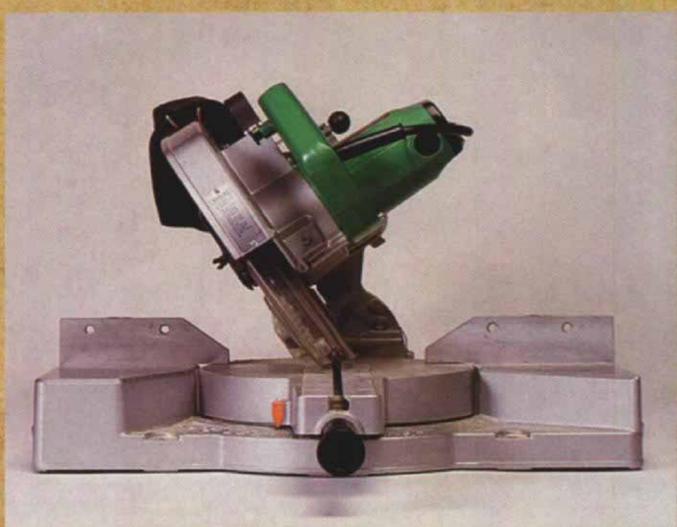
90° corner: $M = \tan^{-1}(A \div C)$

Odd-angle corner: $M = \tan^{-1}\left(\frac{A}{C \times \tan(F \div 2)}\right)$

Bevel angles

90° corner: $B = \sin^{-1}\left(\frac{D}{\sqrt{2} \times C}\right)$

Odd-angle corner: $B = \sin^{-1}\left(\frac{D \times \cos(F \div 2)}{C}\right)$



SEE ERRATA AT END OF ARTICLE

Coping with big crown

Over the years, my partners and I have picked up a few tricks for working with large architectural, or "designer," crown molding. When bidding labor costs, for instance, we closely examine the crown profile. With the crown positioned as if installed, we check to see how closely portions of the profile approach a horizontal plane (drawings below).

If portions dip below the horizontal, the crown cannot be coped and will have to be mitered. The closer it gets to the horizontal, the more that section must be backcut, and the thinner that backcut must be. Obviously, we try to talk whoever is paying for the job into a more reasonable profile.

As this tactic rarely works, we usually let Jerry "Jelly" Reynolds chair the contract negotiations because he is best at tactfully pointing out the countless difficulties of such a job in the most professional businesslike manner. Once the contract is signed, we can get down to work.

Because the crown we install is usually quite large and often hardwood, we do the initial coping with a jigsaw. Tom Franklin, Reggie "the Veggie" Pare, and I have Bosch and AEG saws, but Jelly has a Milwaukee jigsaw, which we've found to be the best for coping crown because the large base plate gives us more control. Lennox (American Saw & Manufacturing Co., 301 Chestnut St., E. Longmeadow, Mass. 01028; 413-525-3961) makes 4-in. bimetal blades (#486J) that fit the Milwaukee and that don't snap.

Let's assume we're installing a crown molding that projects out 3 in. from the wall and down 4 in. from the ceiling. We cut a block $2\frac{15}{16}$ in. by $3\frac{15}{16}$ in. and begin by marking ceilings and walls at all corners—inside and out—and occasionally at mid-span on long runs. Marking $\frac{1}{16}$ in. shy of the actual measurements ensures that at least half of our lines will be covered—even Murphy's law can't change that. Although these lines are merely guides, they give us an idea of where we are.

If the job is fairly big, we will make two sample copes, a left and a right, that will mate perfectly with the rest of the crown while on a perfectly flat surface at an exact right angle at the exact projection we are after. These pieces will be zealously guarded until the end of the job.

In a room like that in the drawings at right, I would put up piece #1 first because it's the longest. I'd butt it to the wall on both sides, cutting the ends with a 2° or 3° angle back toward the top so only the bottom of the crown hits the opposite walls—this makes it much easier to fit into place. With piece #1 up, I typically would head for the shop to do some millwork or preventive maintenance. In addition to being the old man on the crew, I've been blessed with a bad back. Tom often has gout attacks that immobilize his knee and prevent his climbing up and down the planking. Jerry, of course, being a southpaw, sees no logical reason for his coping "right-hand" copes, and he too slinks away, leaving Reggie to finish the job.

With piece #1 up, and the guidelines covered, Reg checks the fit of the sample cope against piece #1 before cutting piece #2. Perfect fit, right? Wrong. Not even close, a big gap up top. So Reg drives up the bottom of piece #1 with his hammer and a beater block, thereby driving out the top and improving the fit of the sample cope, but it's still not acceptable. He takes a piece of crown to the saw, adjusts the saw angle and the position of the molding slightly so that when he makes the cut he removes more material from the concave details (the top) of the crown than the convex (the bottom).

Now his cut will reveal a cope line that's far more accurate than it would have been with a straight 45° and his "standard" crown position in the box. Reg now hogs out the waste with the jigsaw, cuts out the smaller details with the coping saw, notches the fillets and squares off the bottom—all slightly off the line—before his first trial fit. He will then shape it using files, rasps and sandpaper wrapped over a dowel. You never want to rush crown molding because you'll just make your mistakes twice as fast and twice as deep.

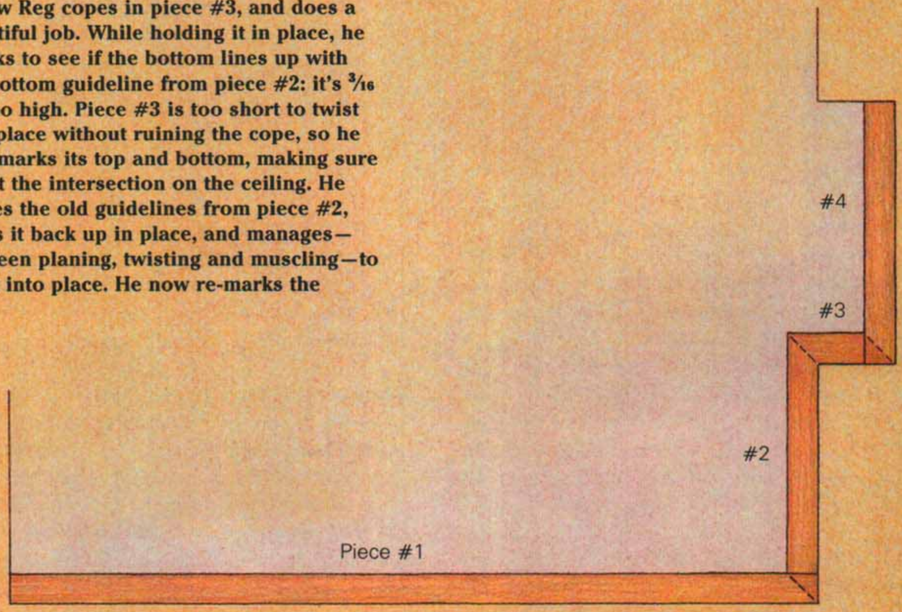
Now that he has the cope finished on piece #2, he will hold it in place and mark new guidelines on the ceiling and wall at the outside corner. He now puts the piece in a safe place, and elects to fit piece #4 next, which he does the same way I did #1.

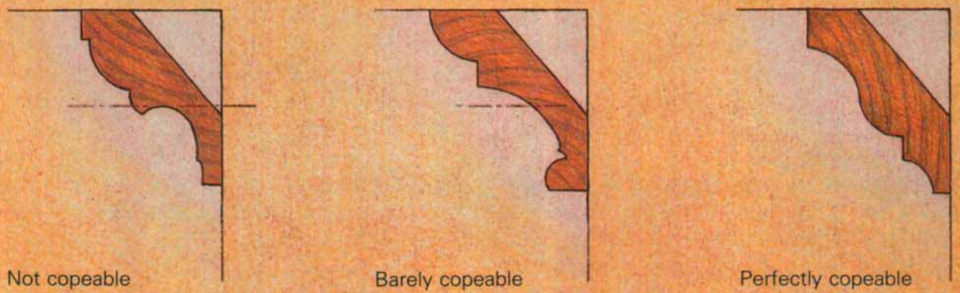
Now Reg copes in piece #3, and does a beautiful job. While holding it in place, he checks to see if the bottom lines up with the bottom guideline from piece #2: it's $\frac{3}{16}$ in. too high. Piece #3 is too short to twist into place without ruining the cope, so he now marks its top and bottom, making sure to get the intersection on the ceiling. He erases the old guidelines from piece #2, holds it back up in place, and manages—between planing, twisting and muscling—to get it into place. He now re-marks the guidlines on the ceiling, establishing the intersection of piece #2 and #3. Then he marks piece #2 top and bottom for length.

Having determined that the corner is square, Reg sets the saw at 45° and cuts to his marks on the crown. He does the same to piece #3, and gets a perfect fit.

If my description of coping with crown seems tedious, it's because it is. But if I were to tell you that it takes longer to explain than to do, I'd probably trip over my nose and break my leg. But take heart; there is help for those days when little molding is going up and the boss is getting antsy—one last trick I'll share with you.

I discovered it quite by accident one day as I was attempting to lace Reggie's health salad with bacon grease (the previous day he had brought me a sandwich from the deli filled with cow fodder, and I was getting even). What I thought was his lunch bag turned out to be a large sack of hand-plane shavings, which he would scatter on the floor when no one was looking. Later, gesturing at them all, he would snivel and whine about all the planing he had to do because of the *%$#*&-#@ walls and the *@@#$%$-&*%@ ceilings...and all that time we thought he was just obsessively tidy, cleaning up so well every day before quitting time. ***—Jim Chestnut, a partner in Wide Turns Const., Pound Ridge, N. Y.***





Drawings: Christopher Clapp

Errata

My compliments to Stephen Nuding for his excellent article on determining miter and bevel angles for the Hitachi compound miter saw (*FHB* #68, pp. 79-81). Please note, however, that the formulas on p. 80 are shown over the photographs in reverse. The miter formula should be the table swing angle, and the bevel formula should be the motor till angle.

—Leigh Freedman, Cypress, Calif.