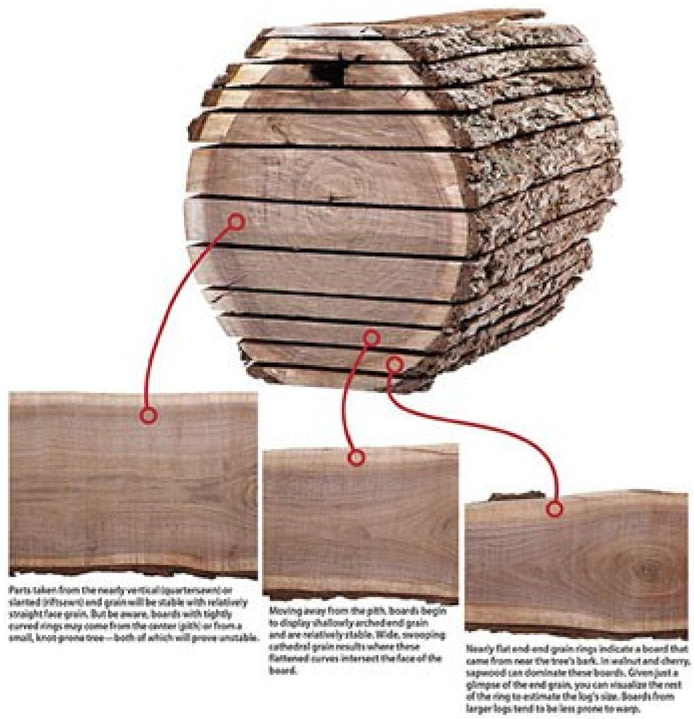
WOOD MOVEMENT CACULATOR:

http://www.woodworkerssource.com/movement.php

The deep, often-dark bins of a hardwood retailer aren't always the best environment for choosing the perfect board for your project. Without unstacking and restacking hundreds of pounds of lumber, your best view of the wood is often a small cross-section of end grain. How much can you really tell about the wood with just that glimpse? We sliced into a walnut log to get some answers.

Want to know what a work-from-home day looks like for WOOD designers Kevin Boyle and John Olson? Hint: It involves this log and a bandsaw mill. woodmagazine.com/loglessons



Like a palm reader who can tell your whole life story by looking at the lines in your hand, you can learn the story of the board from the end-grain lines. As you can see right, reading the curvature of the growth rings lets you estimate the size of the tree, where the board came from in the tree, as well as letting you predict what that means for the grain appearance and stability of the board.

Dealing with wood defects

- • Bow Defect
- • Crook Defect
- • Cup Defect
- • Twist Defect
- • Checks, Shakes, and Knots

Crook Defect

For boards with severe crook, options exist. You can crosscut the board into shorter pieces, then joint each. You also can rip off the crooked edge at the tablesaw using a long carrier board,, Or snap a straight line on the board, cut it with a handheld circular saw, then joint the edge smooth.,,,

Twist Defect

A severely twisted board is difficult to save. You may salvage short pieces, though, by using a combination of the methods described for crook defects...

Bow Defect

Salvage a bowed board by crosscutting it into shorter sections, matching the lengths of pieces to the curve of the board. Test setups or finishes with areas too bowed to produce flat stock. You may be able to create small parts, such as cleats or spacers, from the bowed pieces....

Cup Defect

Rip a wide, cupped board into narrow flat sections, as shown in Photo B, *below right.* Rip each piece slightly wider than you need, then re-rip or joint the edges square to the face. You even can glue these sections back together to create a wide board...

Checks, Shakes, and Knots

Cracks occur at the ends of boards, so you may simply cut off the bad areas. But don't be too hasty. Good narrow pieces often exist on either side of a check.

Shakes, because of their orientation, usually have to be cut off. Be leery of boards with excessive shake. This may be a result of the board simply being dropped on one end, but shakes also can be a sign of improper drying.

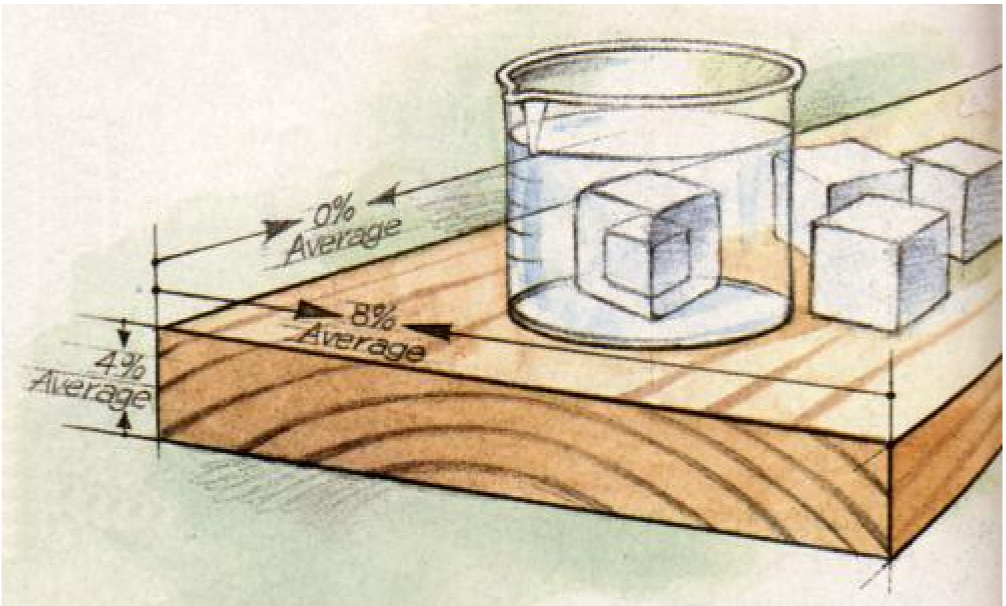
Knots: If they're tightly held in the wood, knots usually pose just appearance problems. Use these boards in inconspicuous places where the knots won't show. Loose knots, on the other hand, may fall out or be pulled free by cutting bits and blades. Cut out and discard areas with loose knots. If you wish to keep the accent of the knot, glue it in place...

Wood Moisture

Even the driest wood can change shape due to moisture, no matter what you do to it. But you can learn what to expect.

Where you'll find the water

Wood remains dimensionally stable if its moisture content is **above** the **fiber saturation point** (FSP). The FSP is the condition where the woo's cell walls are completely wet, but the cavities within the cell walls are dry. If the wood loses moiture from the cell walls, it shrinks. If the cell walls gain moisture, the wood swells.



How wood shrinks Unlike a dissolving sugar cube, a block of wood doesn't behave the same in all directions as it shrinks. As shown in the illustration, wood shrinks most in the direction of the annual growth rings (tangentially). It shrinks about half that much across the growth rings (radially). And shrinkage with the grain (longitudinal) is minimal. The result: Combined radial and tangential shrinkage distorts the shape of any piece of wood because of the difference in the two shrinkage rates and the way the annual rings curve. A number of variables affect how and to what degree wood shrinks, But in general, the denser the wood, the more it shrinks.

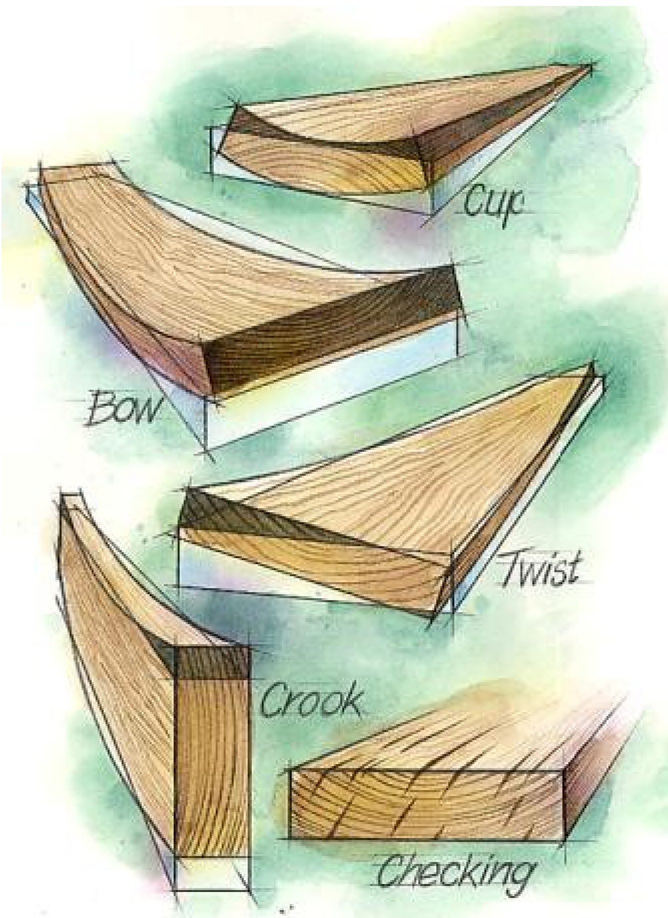
Wood Movement

Take wood movement into account Experience taught woodworkers of old how to deal with wood's dimensional changes due to moisture. The answer was joinery that allowed for seasonal wood movement. And despite today's super-strong glues and moisture-fighting finishes, that's still the answer.

Frame-and-panel construction for cabinet and doors, wall panels, and sections of furniture, for instance, didn't come about by accident. Joiners, as woodworkers were called centuries ago, figured out that a rectangular panel could be maintained in poisition with a solidly secured frame of wood. However, the panel must not be glued or nailed in place in the frame. Instead, it has to "flot" in grooves, free to shrink and swell with changes in atmospheric moisture.

Today, some professional woodworkers talk about "nickel and dime reveals" on flush-fitting cabinet doors and drawers. These refer to the space you should leave between the wood that you expect will shrink or swell -- the doors or drawers -- and the carcase or frame of the piece. "If you build in winter, make the reveal the thickness of a nickel," they say. That leaves room for the wood to swell when the humidity goes up. On the other hand, "Build in summer, use a dime," means that you're allowing for the shrinkage that will come in winter.

Wood shrinkage



What shrinkage does to wood Woodworkers call the change in shape of a piece of wood **warp**. And it takes several common forms, all of which distort the wood.A board has **cup** when it is no longer flat from edge to edge. Cup always occurs in the opposite direction of a flatsawn board's annual growth rings.

Bow, as its name implies, describes the lengthwise curvature of a board -- end to end along its face.

When a board has **crook**, all the curvature runs from end to end along its edge.

Twist means that all of a board's corners won't lie equally flat.

Although not a distortion like any form of warp, **checking** refers to small splits along the grain. You'll most often see checks in the ends of boards, but they can occur on surfaces, too. That's because as wood dries, it loses moisture along its length about 10 times faster than across its width. So end grain dries more rapidly and shrinks faster, causing these small ruptures.

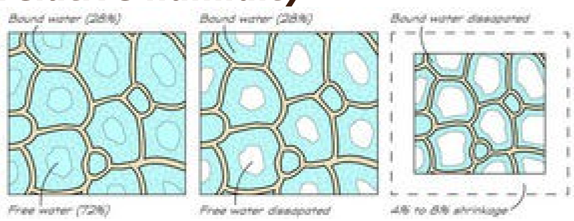
Wood moves. Because of its unique structure, it's constantly expanding and contracting. And you must cope with this movement in every project you build.

MOISTURE CONTENT AND MOVEMENT

Wood moves as its moisture content changes. In a tree that's just been felled, the wood is "***green***" — sap fills the cell cavities. This ***free water*** (as the sap is sometimes called) accounts for 72 percent of the total moisture content, although this percentage may vary from species to species. The remaining 28 percent saturates the wood **fibers** in the cell walls. This ***bound water*** in the fibers causes them to swell, just as a sponge swells when you wet it.

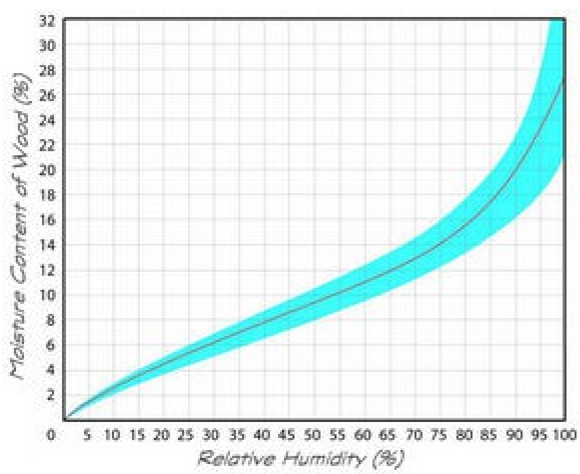
As the green wood dries, the free water evaporates first, then the bound water. The wood is dimensionally stable (it doesn't shrink or swell noticeably) as it loses free water, but once it begins to lose bound water, it contracts.

Wood dries to an average moisture content of between 4 and 11 percent, depending on the area of the country, but it never really comes to rest! The amount of bound water in the wood continually changes with the amount of moisture in the surrounding atmosphere. On the average, wood gains or loses about 1 percent moisture content for every 5 percent change in the ***relative humidity***.



*In green wood, free water fills the cell cavities and bound water saturates the fibers in the cell walls. As it dries, the free water evaporates first, then the bound water. The wood doesn't move until it begins to lose bound water.**

Humidity -- Wood doesn't always move with changes in humidity, just the ***relative humidity***. The relative humidity is the ratio of the actual moisture in the air (absolute humidity) to the maximum amount of moisture the air will hold at its present temperature. The warmer the air, the more moisture it will hold. Because of this, it's possible for the absolute humidity to change while the relative humidity remains the same. If both the absolute humidity and the air temperature rise at the same time, the relative humidity will remain constant — and the wood won't move.



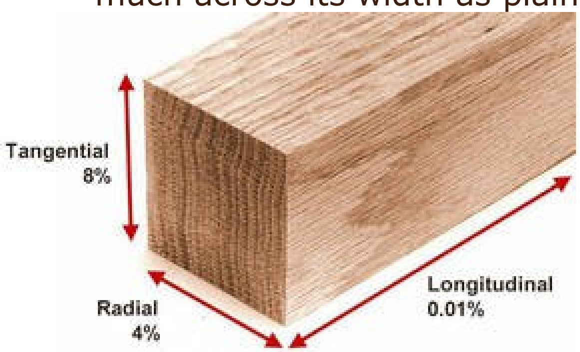
*The moisture content of the wood varies with the relative humidity of the surrounding air, as this chart shows. Once the wood has been dried, the moisture content never again rises above 28 percent (its fiber saturation point) from the effects of humidity alone. For this to happen, the wood must be immersed in water.**

The wood fibers swell as they absorb moisture and shrink as they release it, causing the wood to expand and contract. In the Northern Hemisphere, relative humidity increases in the summer and decreases in the winter. And due to the effects of heating and air conditioning, the relative humidity is generally different indoors than out. Additionally, the relative humidity may vary from one building to another if the indoor temperatures differ. Consequently, wood tends to move with the seasons or whenever you change its location.

DIRECTION OF MOVEMENT

Although it's constantly expanding and contracting, wood does not move equally in all directions. The grain structure causes it to move differently in three different directions.

- Wood is fairly stable along its ***longitudinal*** direction, parallel to the grain. Green lumber shrinks only 0.01 percent of its length as it dries. An 8-foot-long board will move only 3/32 inch.
- Wood moves much more across the grain, ***tangent*** to the growth rings. Green lumber shrinks as much as 8 percent in this direction.
- But it shrinks only half as much (4 percent) in the ***radial*** direction, extending out from the pith along the radius of the growth rings. For this reason, **quartersawn** lumber is more stable than **plain-sawn lumber**. Quartersawn lumber is cut radially and moves only half as much across its width as plain-sawn lumber, which is cut tangentially



Wood is fairly stable along its length, moving only 0.01 percent as it loses its bound water. However, (on the average) it moves 8 percent tangentially and 4 percent radially.

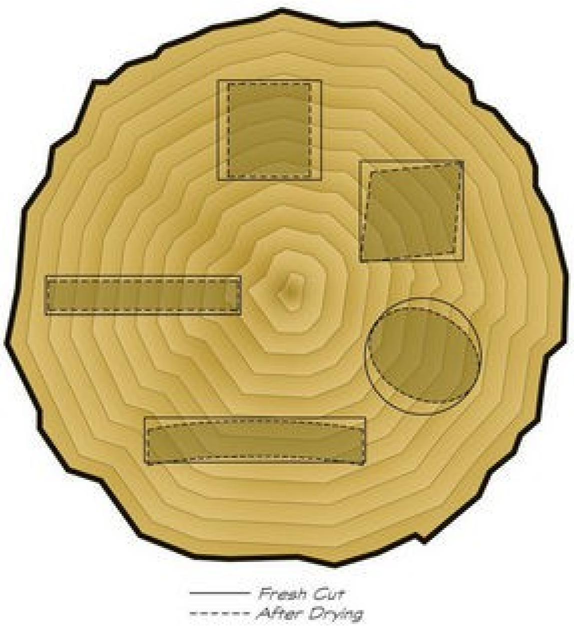
CHANGING SHAPE

The difference in tangential and radial movement has other important consequences. Depending on how it's cut from the tree, a board may change shape as it dries:

- If the annual rings run side to side in square stock, the stock will shrink to a rectangle.
- If the rings run diagonally from corner to corner, the stock will become diamond-shaped.
- Round stock becomes oval as the tangential diameter shrinks more than the radial diameter.
- Plain-sawn lumber tends to cup in the opposite direction of the growth rings because the outside face (the face farthest from the pith) shrinks a little faster than the inside face.

- In quartersawn lumber, both faces shrink equally and the board remains flat.

And there are other forces that may cause a board to move or change shape. Stress sometimes develops in the tree as it grows or in the lumber when it’s improperly dried. Internally stressed wood (called **reaction wood**) moves when you cut it. Cutting relieves some of the stress, and the wood reacts by changing shape. This is quite different from normal wood movement, however. Once the stress dissipates, it no longer affects the wood. But there’s nothing you can do to stop radial and tangential movement. As long as there’s weather, the boards will continue to shrink and swell.



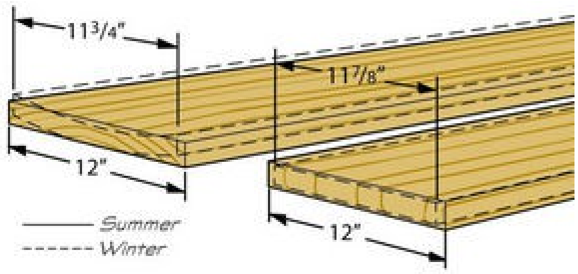
*Because of the difference in tangential and radial movement, boards change shape as they expand and contract. The way in which they change depends on how they are cut from the tree.**

ESTIMATING WOOD MOVEMENT

It’s also useful to know how much a board is likely to move. You must anticipate the movement when fitting drawers and doors, inserting panels in frames, and dozens of other operations.

The rule of thumb is that if the board shows mostly flat grain on its face, allow for 1/4 inch total wood movement for every 12 inches across the grain. If it shows mostly quarter grain, allow for 1/8 inch movement. This will accommodate an annual change of 8 percent moisture content — much more than is common in most areas.

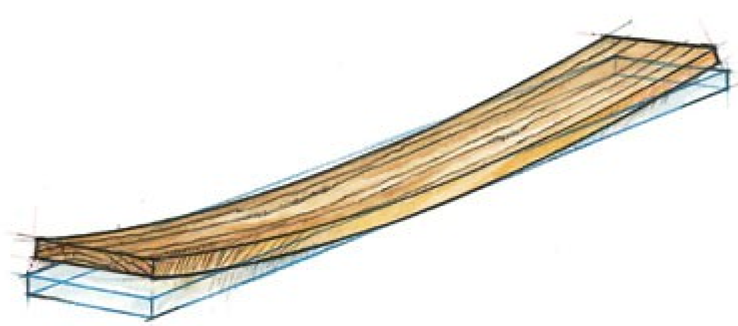
Also consider the time of year. Wood shrinks to its smallest dimension in the winter and swells to its maximum in the summer. The wood in winter projects will expand; the wood in summer projects will contract. In the spring and fall, remember that the wood will expand half your total movement allowance and contract the other half...



*Quartersawn lumber is more stable than plain-sawn, expanding only half as much across its width. Additionally, quartersawn boards remain relatively flat, while plain-sawn boards tend to cup when they expand and contract.**

The best way to deal with lumber defects is, of course, to avoid questionable boards in the first place. But if a board has great grain, is the only one available that suits your needs, or carries a bargain price, don't reject it just because of a few problems. Use the following tricks to get the most from less-than-perfect lumber.

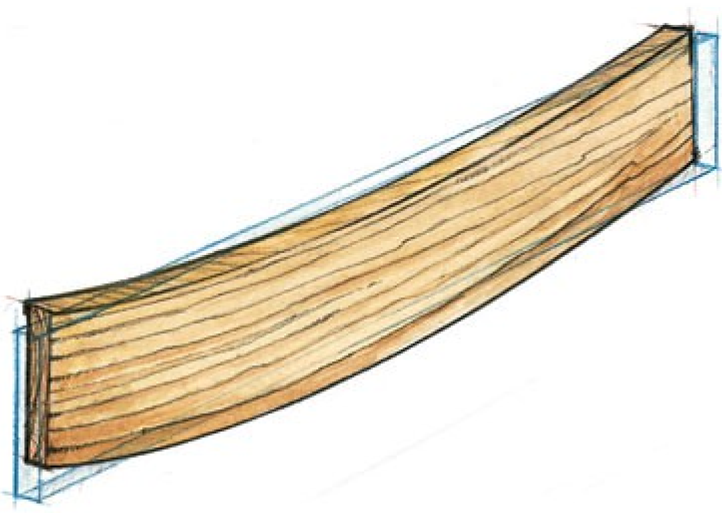
Bow Defect



Bow: A board that rocks from
end to end when laid on one face.

Solution: Salvage a bowed board by crosscutting it into shorter sections, matching the lengths of pieces to the curve of the board. Test setups or finishes with areas too bowed to produce flat stock. You may be able to create small parts, such as cleats or spacers, from the bowed pieces.

Crook Defect



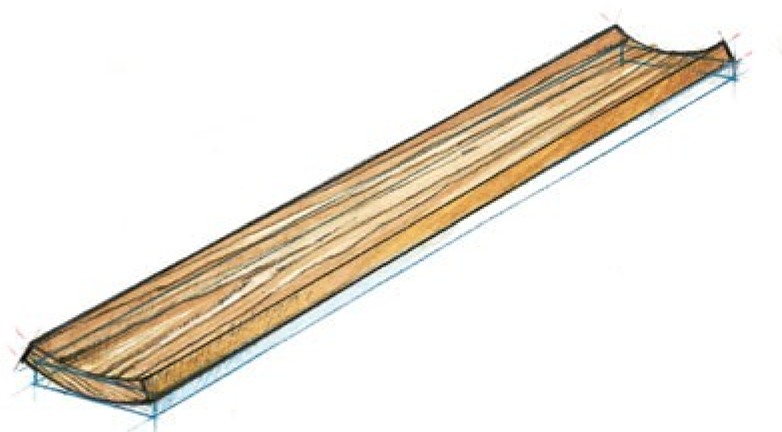
Crook: A board that rocks from end to end when laid on one edge.

How you straighten the edge of a crooked board depends on the severity of the defect. If the crook is mild, run the concave edge over your jointer to straighten it. Use caution to prevent the leading end from catching on the outfeed table.

To put a straight edge on a crooked board, stick it on a long, straight carrier, such as a strip of plywood (about 3/4 x 8 x 60"), using double-faced tape. Guide the carrier along the tablesaw fence to rip off one bad edge.

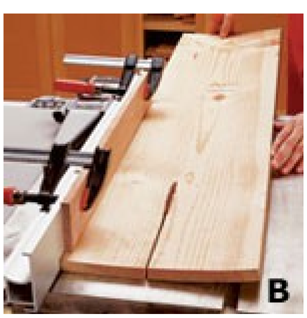
For boards with severe crook, options exist. You can crosscut the board into shorter pieces, then joint each. You also can rip off the crooked edge at the tablesaw using a long carrier board, as shown in Photo A, *right*. Or snap a straight line on the board, cut it with a handheld circular saw, then joint the edge smooth.

Cup Defect

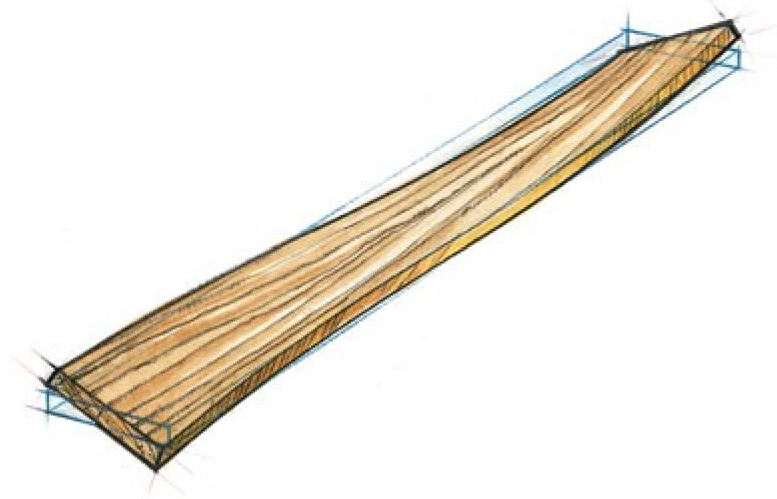


Cup: A board that rocks from edge to edge when laid on one face.

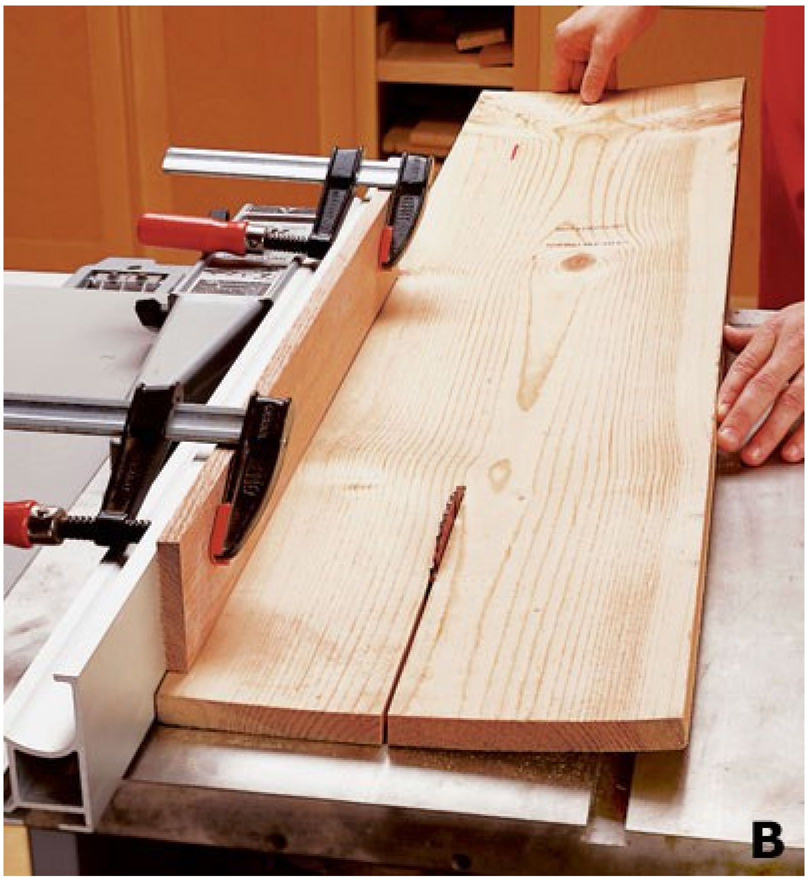
Solution: Rip a wide, cupped board into narrow flat sections, as shown in Photo B, *below right.* Rip each piece slightly wider than you need, then re-rip or joint the edges square to the face. You even can glue these sections back together to create a wide board.



Twist Defect

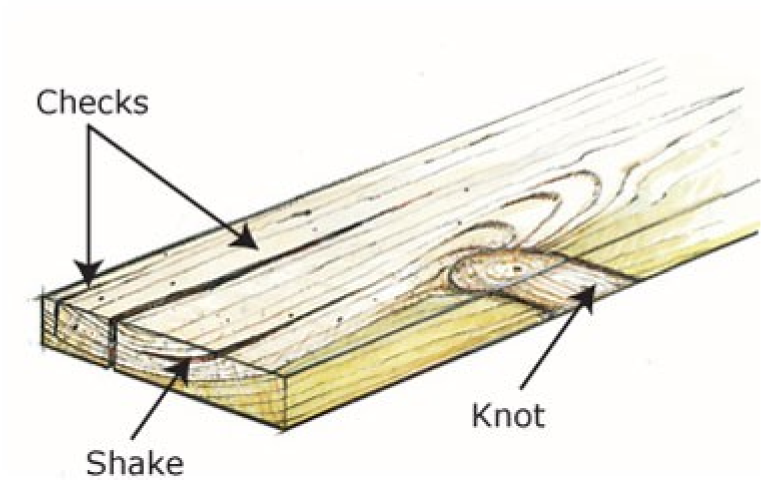


Twist: A board that rests on opposite diagonal corners when laid on one face.



Rip cupped boards with the convex face against the saw table. A scrap clamped to the fence guides the workpiece and holds the portion being cut flatly against the table.

Checks, Shakes, and Knots



Checks, shakes, and knots:

Checks are cracks across the growth rings, and shakes are cracks between the rings. Knots are remnants of branches.

Solution for checks and shakes: These cracks occur at the ends of boards, so you may simply cut off the bad areas. But don't be too hasty. Good narrow pieces often exist on either side of a check.

Shakes, because of their orientation, usually have to be cut off. Be leery of boards with excessive shake. This may be a result of the board simply being dropped on one end, but shakes also can be a sign of improper drying.

Solution for knots: If they're tightly held in the wood, knots usually pose just appearance problems. Use these boards in inconspicuous places where the knots won't show. Loose knots, on the other hand, may fall out or be pulled free by cutting bits and blades. Cut out and discard areas with loose knots.