Why Wood Moves Through All Four Seasons

My first attempt at building furniture was not an auspicious one. I was young and poor, but handy with tools, and rather than buy a kitchen table, I decided to make one. I bought a pile of 2x6s at the local lumberyard, and proceeded to build a jim-dandy table, with a nice glued-up top like the butcher block surfaces I'd seen in stores. It looked great, until winter came—a dry Chicago winter—and the top warped so badly it looked like a primitive dugout canoe. I may have known about tools, but I hadn't yet learned that basic lesson of carpentry and woodworking: Wood moves.

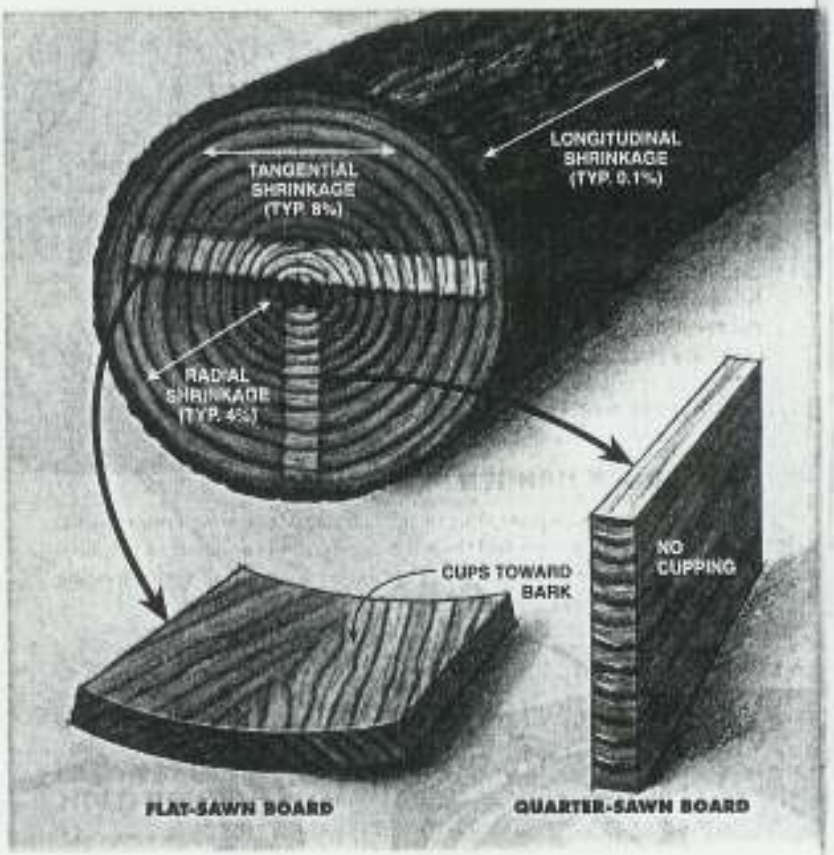
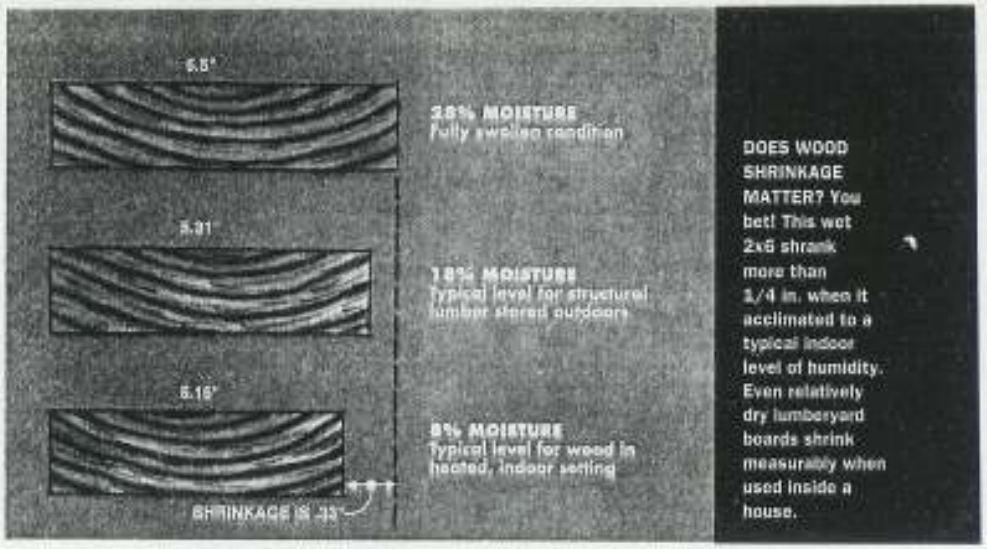


FIGURE A WOOD SHRINKS AS IT DRIES, but not uniformly. It shrinks very little in length, a fair amount radially, and twice that amount tangentially. On a flat-sawn board, one side has more tangential shrinkage than the other, so that side shrinks more and the board cups.

by KEN COLLIER

All through your house, wood—solid wood, that is, not plywood or particleboard—is constantly moving as it gains and loses moisture. You'll find that many of the building details in your house and furniture are designed to accommodate this movement. You can avoid some unpleasant mistakes in your projects if you understand that wood will move. Here's how it works.



RULE 1: WOOD SHRINKS IN WIDTH AS IT DRIES

Like so many other natural materials, wood adapts to its environment. When freshly cut, lumber is full of water, but left alone, it dries out until its moisture level is in balance with the relative humidity of the air around it. And as the wood dries, it shrinks.

Wood that's intended for structural use, like a common 2x4, is typically dried to 19 percent moisture or less. This moisture level is close to being in balance with outdoor air, where structural lumber is stored. Wood for indoor use, such as hardwood flooring, is dried in a kiln to around 7 or 8 percent moisture, so it will be in balance with the average indoor humidity. By storing kiln-dried wood outdoors, some lumber retailers act as if kiln-drying is permanent. Unfortunately, it's not. Boards that were dried to 8 percent moisture can easily rise to 14 percent or more after six months of storage outdoors, even if they're covered. So it's extremely important to let flooring and interior trim "settle" for as long as possible in a heated or air-conditioned house, allowing the moisture level in the wood to equilibrate before installation.

As they dry, boards shrink mainly in width, as shown in Fig. A. The average amount of shrinkage (depending on species) if all the water is removed, is about 1/10 of 1 percent in length, compared to 4 percent radially (perpendicular to growth rings) and a whopping 8 percent tangentially (parallel to growth rings). For many uses, the shrinkage in width won't matter, but when you're using wide boards or when you want tight joints, it will. For example, a 1x10 oak board can easily shrink 1/8 in. in width when it goes from outdoor moisture levels to indoor; that's more than enough to wreck a carefully fitted joint (see Fig. B).

FIGURE C **WOOD MOVEMENT WITH THE SEASONS has to be accommodated whenever solid wood is used in your home. Here are three cases. Using plywood or particleboard essentially eliminates wood movement.**

What does this mean in practice?

- Don't worry about shrinkage in length. An 8-ft. board can shrink only about 1/32 in. in length from moisture loss. That's rarely a problem.
- For interior use, avoid lumber that's been stored outdoors for long periods, especially if it was uncovered. The wood is likely to be at a high moisture level. Even studs, which are narrow and therefore don't shrink very much, can cause problems when they're very moist. That small amount of shrinkage

can cause nail pops and noticeable joints in your carefully taped, sanded, and painted wall or ceiling.

- Trim and flooring material, especially wide boards, should be stored indoors and allowed to settle in its final destination for a few weeks.

Unfortunately, even if your wood is nice and dry when you use it, it'll still move. This is our second rule.

RULE 2: WOOD CHANGES WIDTH WITH THE SEASONS

In most parts of the country, the relative humidity indoors fluctuates dramatically, from humid in the summer to dry in the winter. In these conditions, a piece of unfinished wood stored indoors might go from 4 percent moisture in winter to 14 percent in summer.

Does this make a difference? Absolutely! For example, let's say you made a solid pine front door by edge-gluing boards together. That door could change width by as much as 3/4 in. as the seasons changed. It would stick so hard you couldn't open it in the summer, and there'd be a mighty draft come winter!

That's why most exterior doors and solid-wood cabinet doors are made with frame-and-panel construction (Fig. C). The panel can change width with the seasons, but the door still fits because the frame is made of narrow boards, which change width only slightly. Tongue-and-groove construction in flooring and paneling solves another set of wood movement problems. With floors, if you tried to use wide boards glued together, you'd have a fine-looking floor, but it would produce huge gaps at the edges of the room during the winter. The tongue-and-groove construction splits up the total shrinkage over a large number of small boards.

Another strategy for defeating the movement of wood is to finish it. Most people don't realize it, but one of the primary jobs of a wood finish is to even out the seasonal moisture fluctuation: With a good surface finish like varnish, wood may shift only from 7 percent to 9 percent moisture, instead of 4 percent to 14 percent. That's why, for instance, it's important to finish all four edges of a door as thoroughly as the front and back. This will reduce the tendency of the door to swell and stick.

Finishes don't stop moisture, however; they just slow it down. A piece of furniture might be fine for 30 years in the living room, but if it's stored in a damp basement for a year, the moisture content of the wood will slowly build up, and it might develop splits, loose parts, lifted finish, and other ailments. One of the most annoying of these problems is warping. Which leads us to rule number three.

RULE 3: FLAT-SAWN WOOD CUPS AS IT SHRINKS

If you recall, wood shrinks more in the **tangential** direction, parallel with the growth rings, than it does in a **radial** direction, perpendicular to them (see Fig. A). For most species of wood you will encounter, the difference between radial and tangential shrinkage is about 2 to 1.

Wide, **flat-sawn** boards will cup as they dry because one side of the board has more tangential shrinkage than the other, due to the curving growth rings (Fig. A). When one side of a board shrinks more than the other, it cups. The extreme case is a board cut just to one side of the center of the tree, so

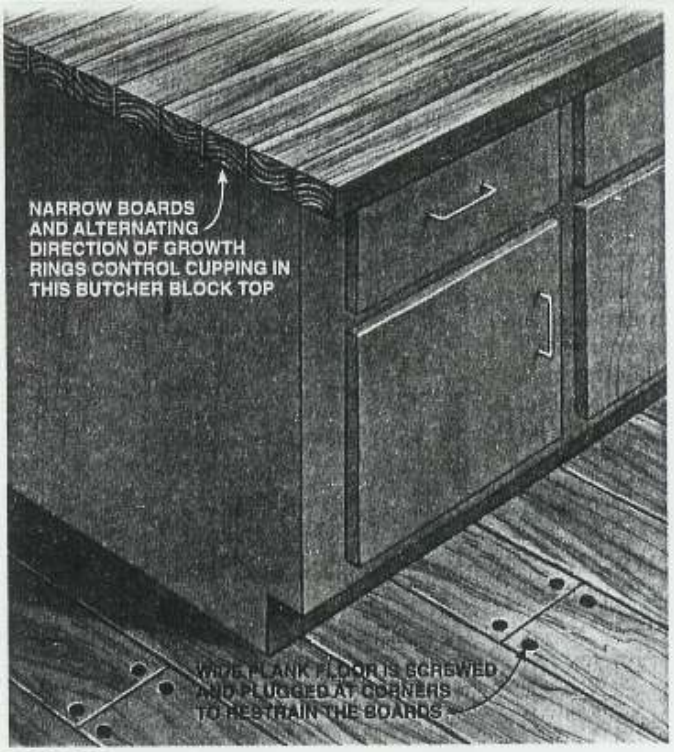


FIGURE D **DESIGNS TO PREVENT CUPPING. The cupping of flat-sawn boards has to be accommodated in construction too. Many times the wood just has to be fastened down securely, but using narrower boards also helps.**

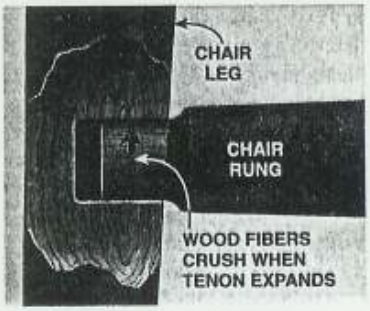


FIGURE E **AS THIS CHAIR LEG SHOWS, wood gets crushed if it swells from moisture but has nowhere to go. When the wood dries, it's smaller than before (a result of "compression set"). This is one cause of loose chair rungs.**

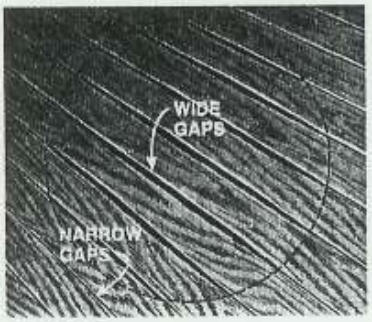


FIGURE F **WHAT CAUSED THE GAPS in this solid wood floor? And why are they only in this small circular area?** (Give up? Check the end of this article.)

that one side of the board has only radial shrinkage, and the other has considerable tangential shrinkage.

Quarter-sawn boards, by contrast, have growth rings perpendicular to the surface of the board and so they stay flat as they dry; the tangential shrinkage is entirely perpendicular to the board surface. Since it's the radial shrinkage that is going across the width of the board, quarter-sawn boards also shrink less in width than flat-sawn boards. Two common residential uses of quarter-sawn lumber are stair treads and lap siding, both of which need to stay flat. You also used to find it in tongue-and-groove fir porch flooring, which was quarter-sawn because of the extremes of moisture it faced. This flooring can also serve as an example of our last rule of wood movement.

RULE 4: IF WOOD CAN'T MOVE, IT GETS CRUSHED

Have you ever been in a well-built old house, where carpenters had clearly spent the time to get everything just so? In spite of that workmanship, the hardwood floors probably had huge gaps between the boards, much bigger than you'd ever see in a modern home. Why? Because of a phenomenon called **compression set** (Fig. E). When wood swells from absorbed moisture, and has no room to move, the wood fibers get crushed—permanently. Then when the wood returns to its normal moisture level, it's permanently narrower. The floor boards in that old house were probably exposed to a summer of extremely high humidity (because homes were not air-conditioned), and they had a thinner finish than our modern varnishes, one that didn't do much to slow the penetration of moisture. The boards swelled against each other and developed a compression set.

Compression set is also a cause of cupping and splitting deck boards. When it rains, the upper surface of the board gets wet and swells, but it cannot move, because the board is nailed or screwed down. The result: Wood cells get crushed, and when the board dries out, the upper surface is now smaller than it was before. If the fasteners are holding tight, this creates small splits in the upper surface of the board ("surface checking"). If the fasteners loosen, the wood cups upward. Either way, the next time it rains, the top surface gets even more wet, and the process increases.

Compression set occurs no matter which way the growth rings are oriented. The only way to prevent the problem is to put a water-repellent treatment on the wood to keep the water from soaking in.

You could make a lot of money if you could figure out a way to stop compression set. It's responsible not just for flooring gaps, but for one of the most irritating little problems on the planet: loose chair rungs. Most of the time it's not teetering back in a chair that makes rungs become loose (contrary to what your mother told you), but the crushing of the rung within its mortise when the moisture level is high (Fig. E). **TFH**

(What's the answer? There was a large potted plant on the floor, which apparently had a moist bottom, because the floor boards under it swelled up and got a compression set. The plant's gone, the floor's been refinished, but the circular pattern of gaps remains.)

FOR MORE INFORMATION

Everything you'd want to know about moisture and wood, as well as wood strength, machining properties and anatomy, you can find in "Understanding Wood" by Bruce Hoadley. The Taunton Press, 1980. $31.95 plus $4 shipping. (800) 888-8286.

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