WOOD BASICS

Wood Composition

Although it's unfortunate, many woodworkers today know very little about the composition and characteristics of wood. To work with wood properly, you must understand its main properties: (1) grain, (2) movement, and (3) strength. Let's begin our understanding of these properties by taking a look at a typical tree.

Parts of a Tree

A tree grows from the center out, forming layers of cells around its circumference. These layers are called *rings* and can be seen when you look at almost any tree stump. At the very center of a tree is the *pith.* Quite often, the pith is much softer than the *heartwood* of the tree, which is the wood surrounding the pith. As a result, the pith is never used in woodworking.

The heartwood consists of dead cells. These cells have ceased to function and no longer conduct or retain fluids and nutrients; thus, the heartwood's only purpose is to add strength and support to the frame of the tree. The heartwood is the part of the tree most often milled into workable lumber.

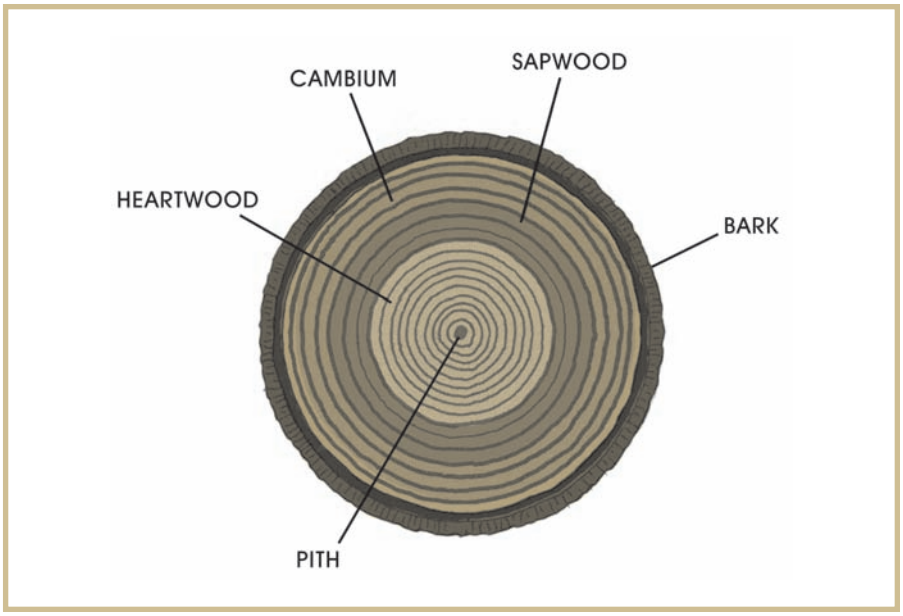
On the outside of the heartwood, you'll find *sapwood.* The sapwood of a tree carries water, minerals, and other nutrients from the ground to the tree's roots and leaves. Sapwood is often distinguished from heartwood by its lighter color.

Directly outside the sapwood is the *cambium.* This is a layer of living cells that produce the wood as the tree grows. Because the cambium is so vital to the growth of a tree, it's protected by an outside layer, called the *bark.*

The cambium grows rather quickly at the beginning of each growing season. As a result, it creates a light-colored wood known as *springwood.* When the season changes and the climate becomes more temperate, the growing process slows and the cambium creates a darker-colored wood called *summerwood.*

Summerwood is harder and denser than springwood. Once the weather turns cool, the cambium goes dormant and doesn't produce any new wood until the beginning of the next growth season. This ongoing cycle of growth can be measured—the actual age of a tree is determined by counting its number of annual rings. Figure 8 shows the different parts of a tree as seen in a cross section of wood.

FIGURE 8—Parts of a Tree



Wood Grain

Trees produce two distinct types of cells. The majority of a tree's cells are very narrow and long, running the length of its trunk. These are referred to as *long grain* or *side grain,* and they produce the grain of the wood. The other type of cells extend outward from the pith, running at a perpendicular axis to the trunk. These are referred to as *end grain.* When you crosscut a board, or cut it against its grain, you expose its end grain. But when you rip a board, or cut it with its grain, you expose its side grain.

The actual types of wood cells differ from species to species, and this difference determines both the grain definition and texture of wood. Trees that have large cells, known as *hardwood trees,* produce wood of a coarse grain texture, while trees with small cells, or *softwood trees,* produce more finely textured woods. In general, hardwood trees produce cells that are much larger than those of softwood trees.

When a tree is cut down and sliced into boards, the cells are sliced open, thus leaving small hollow areas in the wood called *pores.* Some hardwood trees contain a larger number of pores in their springwood than in their summerwood. These are known as *ring-porous* trees. Other hardwood trees contain a more uniform amount of pores throughout the springwood and summerwood. These are called *ring-diffuse* trees. Ring-porous woods have more highly defined grain patterns and are coarser in texture than ring-diffuse woods.

How Wood Is Cut

The actual grain pattern of a piece of wood is often determined by the way it was sliced from the log. Wood mills use several different sawing methods to turn logs into lumber boards. What follows is a discussion of some of the more common methods.

Plain Sawing

Plain sawing is the sawing method most often employed, because it produces the largest quantity of usable lumber from any given tree. First, several boards are sawn from one side of a log. Then the log is rotated 90 degrees and several more boards are sawn off. This process of sawing and rotating is continued until the whole log has been sliced into usable lumber. Plain sawing produces boards that show a flat grain pattern on their face and straight grain patterns on their edges.

Quarter Sawing

Using this method, the log is first cut lengthwise into quarters. The boards are then sliced off of each quarter at an angle between 65 and 90 degrees to the annual rings of the log. Boards cut farthest from the center will produce figured grain, while boards cut nearer the center will display very straight grain patterns. Quarter sawing produces fewer splits in the wood, because the cuts are made parallel with the log's rays. These rays appear as flakes running the length of the boards.

Quarter sawing is more wasteful than plain sawing, but quarter-sawn lumber is more stable than plain-sawn lumber, since it's less prone to warp and twist. This is a good point to remember when you're building a project and you're concerned about the stability of the wood. (Figure 9 shows the grain patterns of quarter-sawn and plain-sawn wood.)

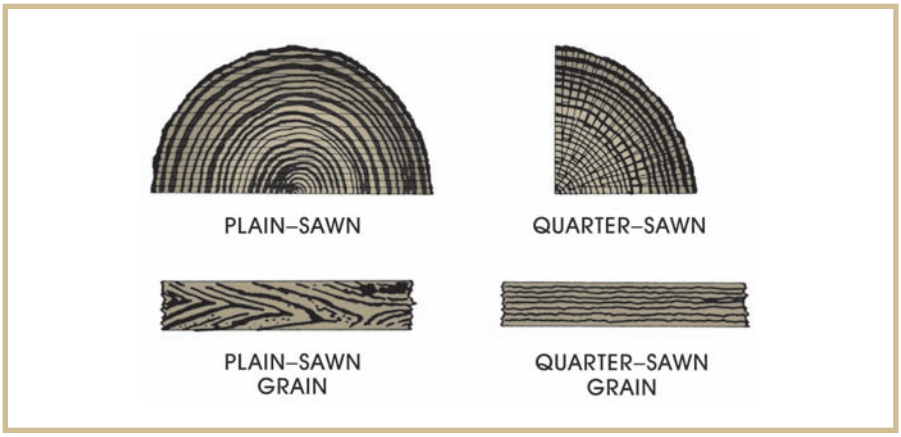


FIGURE 9—Quarter-Sawn and Plain-Sawn Wood

Rift Sawing

Rift sawing is very similar to quarter sawing, in that the log is initially cut into quarters. Then saw cuts are made at a 45-degree angle to the annual rings. This produces a grain that's very thin and runs lengthwise along the board. The wood rays that are apparent in quarter sawing are even longer and more distinct in rift sawing.

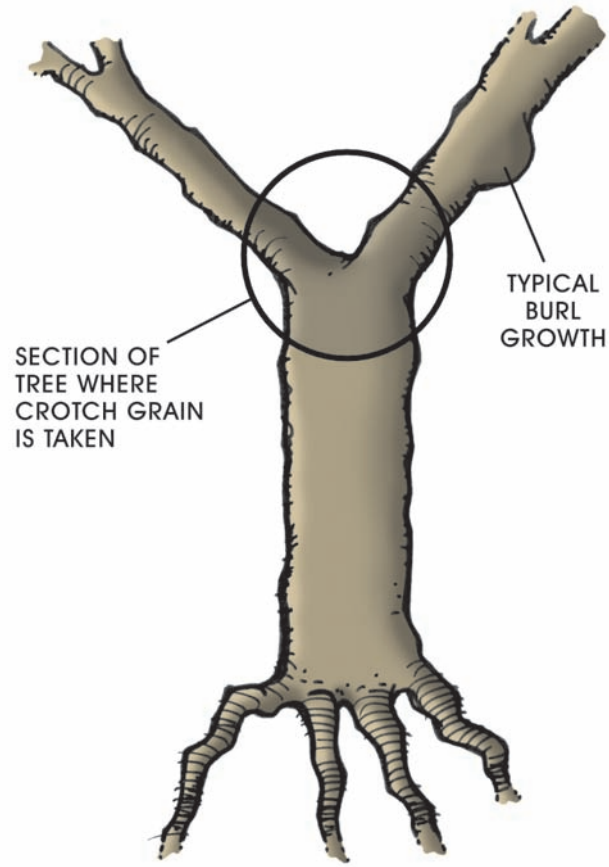
Burl and Crotch Grain Patterns

These two highly figured grain patterns are defined more by where on the log they're cut than how they're cut. A *burl* is a cancerous growth on a tree (Figure 10). It's the bulblike protrusion often seen on a large limb or at the base of a tree. Burls are highly prized by custom furniture makers, woodturners, and other woodcraft artisans because they yield such beautiful grain patterns. The convoluted grain in a burl changes direction and "swirls," producing a stunningly rounded pattern. Walnut, ash, maple, and elm are some of the most commonly used burls for furniture and cabinet work.

Crotches are cut from the top part of a tree, where two large limbs branch off at approximate 45-degree angles from the main trunk (Figure 10). Boards cut from this section produce a highly-figured grain pattern sometimes called *flame,* since the grain design often takes the shape of a flame. Mahogany and walnut are the two most commonly used crotches.

Crotch and burl patterns are among the most attractive grain patterns you'll ever find (Figure 11). Yet beauty almost always has its price. Highly figured woods such as these are very unstable and prone to warp much more than plain-sawn or quarter-sawn lumber. You must take extra care when working with these woods. Also, burls and crotches have become increasingly harder to find; you may be able to obtain them only in veneer form.

FIGURE 10—Locations of Burl and Crotch on a Tree



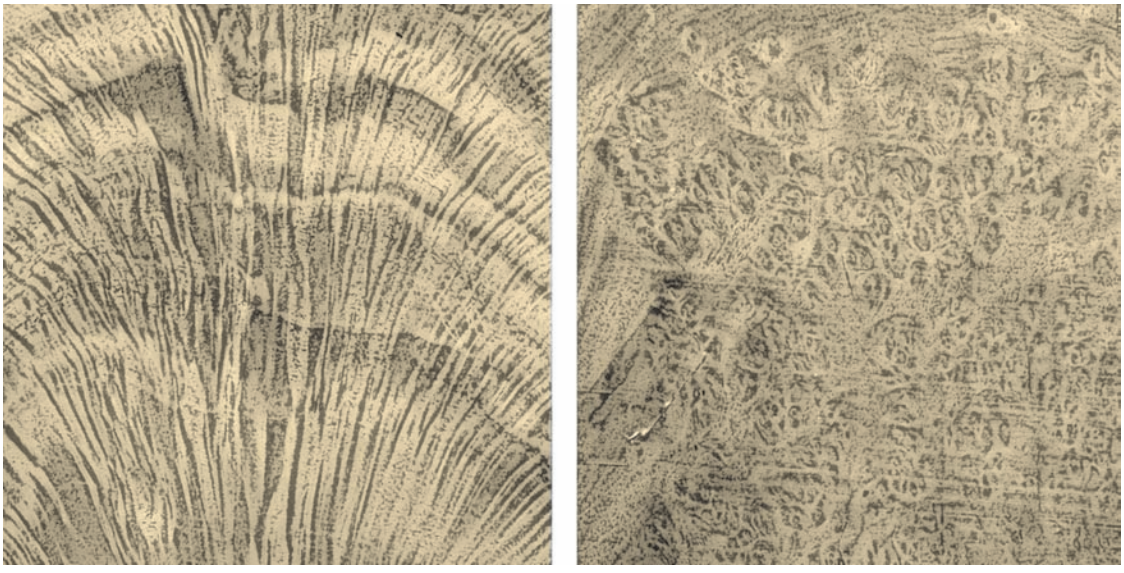


FIGURE 11—Crotch and Burl Grain Patterns

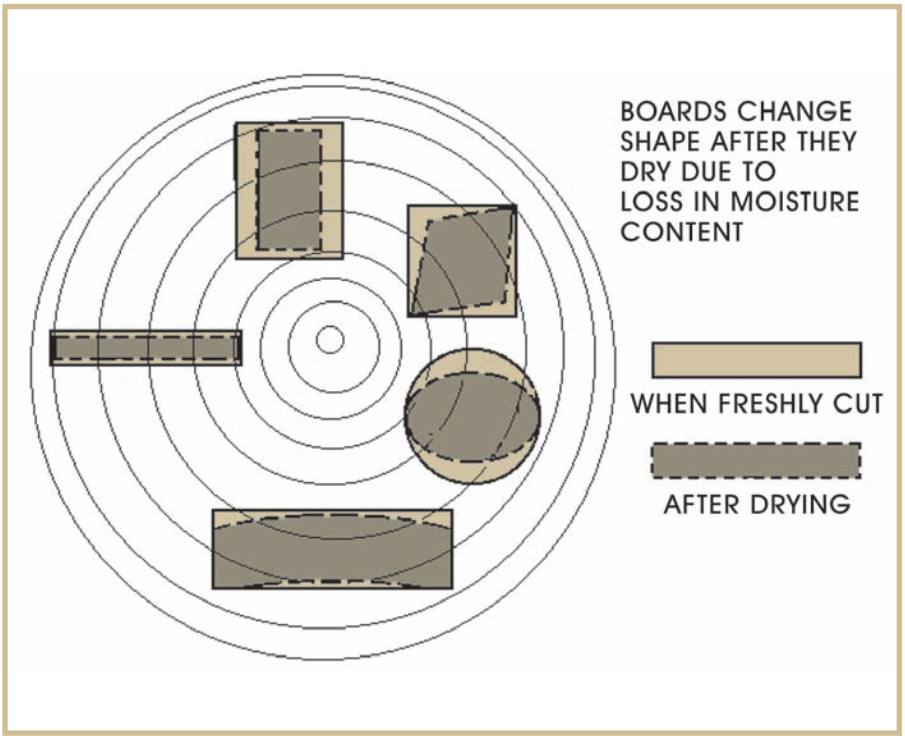
Wood Movement

All wood moves, even after it has been cut, seasoned, and turned into furniture or woodwork. It's important to know just how to deal with wood movement when you're designing and building a project.

Once a tree is cut down, it dies. However, even if the tree was cut down centuries ago, the cells of the wood that were once part of the tree continue to interact with the environment. That is, they continue to expand and contract, depending on how much moisture is contained within them.

How much a board shrinks primarily depends on which way it was cut from the log (Figure 12). Because wood shrinks less when cut in the radial direction (extending out from the center of the log), a quarter-sawn board is more stable than a plain-sawn board. To put it more simply, boards shrink much more across their widths than they do along their lengths.

FIGURE 12—Wood Contraction According to Cut



The gain and loss of moisture needs to be carefully controlled while a board is being seasoned. Extreme, sudden changes in moisture content can cause the cells to expand and contract too quickly. When this happens, the board warps and starts to develop checks, or splits and cracks.

The two most common methods for seasoning lumber are *air-drying* and *kiln-drying*. When sawmills air-dry lumber, great care is taken to keep moisture evaporation and shrinkage at a slow rate. This is achieved

by carefully stacking the lumber so that there's even airflow around each board, and storing the lumber in a covered, well-ventilated room. The kiln-drying method involves the same careful stacking of lumber, but instead of storing the boards in a room, the boards are put into an oven called a *kiln.* This speeds up the seasoning process. Yet the temperature of the kiln is carefully controlled to ensure that the lumber doesn't dry too quickly.

Seasoned lumber that's suitable for use in making furniture, cabinets, or other fine woodcrafts should contain a moisture content of between 4 and 11 percent. Any content higher than 11 percent means the lumber is unstable and too unpredictable to work with.

The most important thing to remember is that even properly seasoned lumber continues to gain and lose moisture. This is why the drawers in your bedroom dresser may stick during the summer and wobble from side to side during the winter.

Composite Materials

Over the centuries, the demand for timber has increased. As a result, it has also become increasingly expensive. The demand has turned into such a frenzy, in fact, that it's directly affecting our ecology. The extinction of many species of plants and trees and the depletion of the rain forests throughout many parts of the world can be attributed to man's ever-growing need for timber. This has brought about the development, in modern times, of such composite wood products as plywood, particleboard, and medium-density fiberboard.

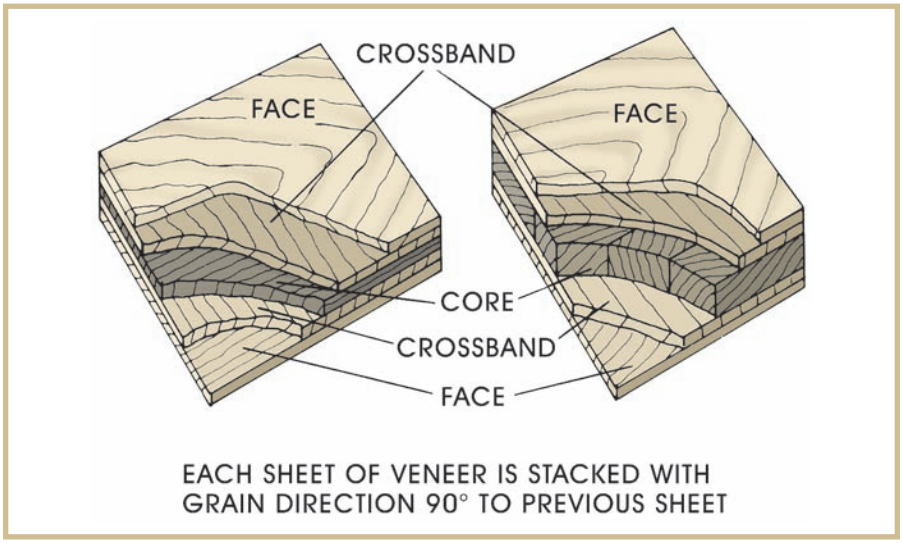
These new materials are very stable and don't expand and contract as easily as solid lumber. Many of them are also waterproof, fireproof, and impregnated with resins and protective chemicals. Composite materials are particularly valuable to furniture makers and carpenters because, as wood products, they come in large sheets. This allows for the coverage of large areas of framing in a short time without the use of multiple boards.

Plywood is the only composite material that's as strong as natural timber. Other composites can't be bent or steamed into different shapes as plywood can. Thus, furniture built from other composites often appears square, lacking curves or varying shapes. In addition, standard fasteners, such as screws and nails, don't fasten composite materials together securely unless special inserts, joint fasteners, or connectors are used in the joint areas.

Most standard plywood panels are constructed from multiple layers of veneer that have been stacked and glued together. This is known as *lamination.* The average sheet of plywood contains five sheets of veneer, each sheet being stacked so that its grain runs perpendicular to the previous sheet (Figure 13). This perpendicular stacking ensures that

any wood movement within the sheet will be minimal, because wood moves more in one direction, namely, against the grain, than in the other direction (with the grain). In addition, this stacking method ensures that the sheet will be strong and rigid. If all five layers of veneer were laminated with the grain running in the same direction, the panel would bend and flex like a single sheet of veneer.

FIGURE 13—Stacking Sheets of Plywood in the Lamination Process



Particleboard is made up of much of the waste left over from the milling and cutting of solid timber. Chips and shavings that were once considered waste are now used efficiently, which in turn helps our ecology.

There are many types of particleboard, and each type is manufactured in different ways. In general, the two basic methods used for producing particleboard are the extrusion method and the mat-formed, flat-pressed method. In the extrusion method, the sheet is formed by forcing wood particles and special adhesives through a small opening. The mat-formed, flat-pressed method involves forming the wood particles and adhesives into a mat. The mat is then put in a hot press, where a predetermined amount of heat and pressure are applied to it.

Medium-density fiberboard, commonly called *MDF,* is a high-quality particleboard. In order to manufacture MDF, flakes are carefully selected and then cut with the grain to a predetermined size and thickness. The flakes are then bonded together with an adhesive that has been specifically formulated for MDF. Medium-density fiberboard is extremely stable and relatively inexpensive, making it an excellent choice for the furniture and construction industries. Much of today's plastic-laminated furniture is made with MDF.

As you can see, composite materials have their advantages and disadvantages. However, you'll find that many of today's fine-furniture makers are now combining the use of solid woods and composite materials in their designs.

Self-Check 2

1. The very center part of the tree is called the
   a. cambium.
   b. sapwood.
   c. pith.
   d. heartwood.

2. Which of the following cutting methods yields the highest quantity of usable lumber?
   a. Quarter sawing
   b. Rift sawing
   c. Plain sawing
   d. Burl and crotch grain-pattern sawing

3. Of the following woods, which is the most prone to warp?
   a. Walnut burl
   b. Plain-sawn ash
   c. Quarter-sawn cut mahogany
   d. Laminated plywood

4. A cancerous growth on a tree is called a
   a. check.
   b. burl.
   c. crotch.
   d. knob.

5. Which of the following materials is manufactured from solid wood veneer?
   a. MDF
   b. Particleboard
   c. Plywood
   d. Polished oak

Check your answers with those on page 27.