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The wood materials used in cabinets and furniture are products of nature and include numerous color hues, grain patterns and other natural characteristics. As a manufacturer of kitchen and bath cabinetry and accessories, Merillat believes there is a crucial need to educate our customers, ourselves and ultimately the final customer in regard to naturally occurring wood characteristics.

Trees are a renewable natural resource. The harvest of mature trees provides wood products for our homes and offices while providing space for the establishment of new forests. The total growth of hardwood trees exceeds the harvest. In fact, our nation’s inventory of growing hardwood is increasing and has been for the past 40 years. This growth in excess of harvest does not release us from the responsibility of wise and effective utilization or our hardwood resource. Approximately 50 percent of the lumber produced is not currently used for furniture or cabinets because it contains characteristics such as burls, knots, stains, and grain distortions.

Responsible marketing and manufacturing of natural hardwood characteristics can extend the hardwood supply while generating economic and environmental benefits for current and future generations.

This guide is designed to maintain and communicate our current standards. By educating our employees, sales force, dealer, and customers, we will be able to promote a wide appreciation and understanding of the color, grain, and natural characteristics of wood. Samples from five commercial lumber groups are studied in this book. Due to the infinite variation in color and characteristics, it is impossible to include every conceivable example.

Merillat Industries, Inc. wishes to thank Woodcraft Industries, Inc. for permitting us to reprint the contents of their publication, “Hardwood Characteristics: A Guide For The Cabinet and Furniture Industries.” ©1993 Woodcraft Industries, the leading hardwood component supplier to the woodworking industry, was the pioneer in the development of this type of documented reference guide for our industry.

The objective for developing this reference guide was to clearly describe and define the numerous natural characteristics of various wood species and to encourage the wise use of our natural and renewable hardwood resources. Woodcraft originally used the hardwood characteristics reference material internally to define the wood specifications in their manufacturing environment. They further saw the benefit of sharing this information with their customers in the cabinet and furniture industries.

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Wood as a Plant

The Trunk and Its Branches
The cross section of a tree shows the following well defined features in succession from the outside to the center: (1) bark and cambium layer; (2) wood, which is most species is clearly differentiated into sapwood and heartwood; and (3) pith, the small central core. The pith and bark, of course, are excluded from finished lumber.

Most branches originate at the pith, and their bases are intergrown with the wood of the trunk as long as they are alive. These living branch bases continue to be surrounded by the wood of the growing trunk and thus loose or encased knots are formed. After the dead branches fall off, the stubs become overgrown and subsequently clear wood is formed.

All growth in thickness takes place in the cambium layer by cell division. No growth in either diameter or length takes place in wood already formed. New growth is purely the addition of new cells, not the further development of existing cells.

Annual Rings
Most species grown in temperate climates produce well defined annual growth rings, which are formed by the difference in density and color between wood formed late in the growing season. The inner part of the growth ring formed first is called “spring wood,” and the outer part formed later in the growing season is called “summer wood.”

Spring wood is characterized by cells having relatively large cavities and thin walls. Summer wood cells have smaller cavities and thicker walls, and consequently are more dense than spring wood. The growth rings, when exposed by conventional methods of sawing, provide the grain or characteristic pattern of the wood. The distinguishing features of the various species are thereby enhanced by the differences in growth ring formation.

Heartwood
Heartwood consists of inactive cells formed by changes in the living cells of the inner sapwood rings, presumably after their use for sap conduction and other life processes of the tree have largely ceased. The cell cavities of heartwood may also contain deposits of various materials that frequently provide a much darker color. All heartwood, however, is not darker. The infiltrations of material deposited in the cells of heartwood usually make lumber cut there-from more durable when exposed to weather.

Softwoods and Hardwoods
Native species of trees and the wood produced by these trees are divided into two botanical classes—hardwoods, which have broad leaves, and softwood, which have needle-like or scale-like leaves. This botanical classification is sometimes confusing, because there is no direct correlation between it and the hardness or softness of the wood. Generally, hardwoods are more dense than softwoods, but some hardwoods are softer than many softwoods.

Medullary Rays
Medullary rays extend radially from the pith of the log toward the circumference. The rays serve primarily to store food and transport it horizontally. They vary in height from a few cells in some species to four or more inches in the oaks, and produce the flake effect common to the quarter sawn lumber in these species.

Sapwood
Sapwood contains living cells and performs an active role in the life processes of the tree. It is located next to the cambium and functions in sap conduction and storage of food. Sapwood commonly ranges from 1/2 to 2 inches in thickness. The maples, hickories, ashes, and some of the southern yellow pines and ponderosa pine may have sapwood 3 to 6 inches in thickness, especially in second growth trees.
Methods of Sawing

Plain Sawing (Flatsawn)
Plain sawing is the most common method of sawing and consequently most lumber is plain sawn, unless specified otherwise. Plain sawn lumber is obtained by making the first saw cut on a tangent to the circumference of the log and the remaining cuts parallel to the first. This method provides the widest boards and least waste, therefore, it is the most economical. About half of the lumber produced by plain sawing is of tangential grain and the other half is of radial grain.

Tangential grain is usually called flat grain and is easily recognized by its cathedral (Gothic arch) effect. Lumber is considered flat grained when the annual growth rings make an angle of less than 45 degrees with the surface of the board.

Radial grain is known as vertical grain or edge grain, and is generally more dimensionally stable than flat grain. Lumber is considered vertical grain when the annual growth rings make an angle of 45 to 90 degrees with the wide surface of the board.

Quarter Sawn
Quarter sawn lumber is produced by first quartering the log and then sawing it perpendicular to the growth rings. All of the boards sawn thus are of radial grain. This method of sawing produces relatively narrow boards and creates more waste. For these reasons (and the additional handling involved) quarter sawn lumber is much more expensive than plain sawn.

Rift Sawing
Rift sawing is very similar to quarter sawing, and has the same advantages and limitations. This method of sawing accentuates the vertical grain and minimizes the flake, common in quarter sawn oak. The angle of the cut is changed slightly so that fewer saw cuts are parallel to the medullary rays, which are responsible for the flake effect.

Availability
Red oak, white oak and the mahoganies are available in quarter sawn lumber. Red oak and white oak are also marketed as rift grain. Some of the softwoods, principally redwood and fir, can be obtained as vertical grain.
**Cherry**

**Species**
- Black Cherry (*Prunus Serotina*)

**Color Variation**
- Nearly white to light red to dark reddish brown

**Wood Properties**
- Moderately hard and heavy, strong, stiff
- High shock resistance
- Fine to medium, uniform grain
- Moderately large shrinkage during seasoning
- Dimensionally stable in use

**Growth Range**

---

**Oak**

**Species**
- Northern red oak (*Quercus rubra*)
- Pin oak (*Quercus palustris*)
- Black oak (*Quercus velutina*)
- Scarlet oak (*Quercus coccinea*)
- Cherrybark oak (*Quercus falcata* var)
- Southern red oak (*Quercus falcata*, var.)

**Color Variation**
- Light tan to pink, to red, to dark brown

**Wood Properties**
- Heavy, hard, stiff
- High shock resistance
- Medium fine, uniform grain
- Large shrinkage during seasoning

**Growth Range**

---
Soft Maple

Species
- Silver maple (Acer accharinum)
- Red Maple (Acer rubrum)

Color Variation
- Nearly white to light gray

Wood Properties
- Moderately heavy, hard, strong, stiff
- Medium shock resistance
- Fine uniform grain
- Moderate shrinkage during seasoning

Growth Range

Hard Maple

Species
- Sugar maple (Acer saccharum)
- Black maple (Acer nigrum)

Color Variation
- Nearly white to slightly reddish brown

Wood Properties
- Heavy, strong, stiff
- High shock resistance
- Fine, uniform grain
- Large shrinkage during seasoning

Growth Range
Effects of Growth Rings

The amount of annual growth influences the “look” of sawn lumber. Growth rings of a tree are distinctive because of the light and dark colors. The lighter portion is usually grown in the spring and is called “summerwood.” The size of the growth rings varies from species to species and even tree to tree depending on many factors including genetics and growing conditions. These two examples have approximately the same growth ring orientation yet look very different.

Hickory

<table>
<thead>
<tr>
<th>Species</th>
<th>Color Variation</th>
<th>Wood Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitternut</td>
<td>Nearly white to dark brown</td>
<td>Very heavy, very hard, very strong, very stiff</td>
</tr>
<tr>
<td>(Carya cordiformis)</td>
<td></td>
<td>Extremely high shock resistance</td>
</tr>
<tr>
<td>Pecan</td>
<td></td>
<td>Fine, uniform grain</td>
</tr>
<tr>
<td>(Carya illinoensis)</td>
<td></td>
<td>Very large shrinkage during seasoning</td>
</tr>
<tr>
<td>Shagbark</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Carya ovata)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Species
- Bitternut (Carya cordiformis)
- Pecan (Carya illinoensis)
- Shagbark (Carya ovata)

Wood Properties
- Very heavy, very hard, very strong, very stiff
- Extremely high shock resistance
- Fine, uniform grain
- Very large shrinkage during seasoning

Growth Range

Wide Growth Ring

Narrow Growth Ring
**Burl Grain**

Burl grain is common in most species and is also known as curly grain, burly grain, fiddleback or figure wood. Various causes of burl grain include knot location, damage to the bark cambium layer, and tree genetics. Burl grain is often a desired characteristic for specialty products, but can be difficult to machine.

**Tiger Stripe / Cross Fire**

This unique grain pattern (also called zebra-wood) is common in red and white oak and both hard and soft maple, as well as other species. Tiger stripe is most often found along with burl grain, which can be difficult to machine or sand. Wood with this grain characteristic is often quite dense compared to the average density of the species.

**Bird’s Eye**

Bird’s-Eye, as seen in this hard maple example, is a small area in the wood where fibers are contorted to form circular figures that resemble birds’ eyes on the surface of the board. It is common in hard maple and rare in other species.
Knots

Bird Peck

Bird peck is shown here in hickory, but is also common in maple.
Woodpeckers produce a small hole, which is the starting point for brown to blackish mineral streak.

Cats Paw

Wood characteristic that has the shape of a cats paw caused by pin knots. Also is most common in cherry.

Pitch Pocket

Pitch pocket (sometimes referred to as gum spot) is common in cherry. It is caused mainly by peach bark beetles and cambium miners. The feeding insects cause injury to the living portion of the bark, leading to the formation of gum spots in the wood as the tree continues to grow.

Knots vary in size, shape, structure, and color. Because of this, it may be the most difficult characteristic of wood to classify. Knots also account for large yield losses in our industry and cause us to buy Select and Better grades of lumber, as opposed to #2 Common grade, at a significant cost increase. Because of these factors, it is important to understand (as best we can) the knot variations.

Closed Knot
A closed knot has a flat face with no openings in the lumber surface.

Open Knot
An open knot may occur in the form of a very small pin-sized hole to a large gaping hole in the lumber surface.

Unsound Knot
An unsound knot, also known as a loose knot, has a portion that will move readily.

Pin Knot
A pin knot is a small, sound, and tight knot.

Sound Knot
A sound knot, also known as a tight knot, is completely solid with no portion of the knot moveable. It is as hard as the surrounding wood and shows no sign of decay.

Knot Cluster
A knot cluster is a grouping of usually small knots.

Bird Peck

Bird Peck

Bird Peck

Cats Paw

Cats Paw

Cats Paw

Pitch Pocket

Pitch Pocket

Pitch Pocket
Ray Flecking

Ray flecking is visible in hardwood species that are quartersawn and have rays. Rays are stripes of cells that extend radially within a tree. These rays primarily store food and transport it horizontally. Red oak and white oak are most noted for this characteristic. The examples show ray flecking with variations in ray widths.

Wide Rays in Red Oak

Narrow Rays in Red Oak

Bark

This example shows a piece of lumber with bark on its outer edge. The outer portion of the bark is the non-living portion which protects the inner living portion from external damage.

Bark Pocket

This example shows a typical bark pocket with a bark-filled hole on the board surface.

Incipient Rot

Rot (also known as decay) is the decomposition of a substance by fungi. This photo of red oak shows incipient rot, which is rot in the early stages, and is identified by a slight discoloration or bleaching of the wood. Rot-causing fungi grow only in wood with a moisture content above approximately 30 percent and cease growing when the wood is dried below 30 percent.
Mineral Streak

A darkened or discolored wood area, caused by minerals which the tree extracts from the soil, can be either mineral streak or mineral stain. Mineral streak appears as a blackish-blue, well-defined streak running parallel with the grain. It is commonly found in maple and birch, and occasionally in oak and cherry. The streak can be measured easily by its length and width.

Air Check

This example shows a piece of red oak with air check or surface check. This type of checking occurs in the early drying stages if too much moisture is removed from the outer portion of the lumber before the inner portion has had a chance to lose moisture and shrink.

Honeycomb

Although not a natural characteristic, honeycomb is common in the industry. This example shows end grain and lumber ripped in half to expose the severe interior honey comb. This occurs when kiln temperatures are raised before the lumber core moisture has been lowered sufficiently.

Splitting or Cracking

Splitting or cracking can occur in any species. Shown here in red oak, it can be minimized by proper end coating of the logs or lumber before they have an opportunity to dry.

Shake

Shake (sometimes called ring shake or wind shake) is pictured here in red oak. The flatsawn portion shows typical shake and the end grain portion shows the ring failure. Shake can be caused by bacteria that infect the living trees. The bacteria, which has a vinegar or rancid smell before drying, weakens the area between the growth rings and may cause shake in apparently sound lumber.

Mineral Streak

Air Check

Honeycomb

Splitting or Cracking

Shake
Glossary

Air Check (p.21) A lengthwise separation of the wood extending across the annual growth rings. It is a result of stresses developed in wood during drying.

Bacterial Infection Lumber (generally red oak) infected with an anaerobic bacterium. This lumber will emit a sour odor and will be susceptible to honeycomb or ring shake during the drying process.

Bark Pocket (p.19) A bark-filled hole on the board surface.

Bird Peck (p.17) Woodpeckers produce a small hole, which is the starting point for brown to blackish mineral streak. Hickory and maple are most commonly affected.

Bird's-Eye (p.15) Small areas in wood where fibers are contorted to form small circular figures that resemble bird's eyes. Bird's-eye is common in hard maple and rare in other species.

Brown Rot Any decay in wood that attacks only cellulose and carbohydrates rather than lignin.

Brown Stain Brown stain is a discoloration of wood that can occur during kiln drying as a result of a change in the color of substances normally present in green softwoods.

Burl Grain (p.14) A swirl or twist in the wood grain that occurs near a knot but does not contain a knot over 1/8” in diameter.

Cambium (p.5) The thin layer separating the bark and wood that contains the living reproductive cells. Through cell division, these cells create additional bark and wood cells.

Caramelized Maple Maple wood has been heated to a high temperature causing its sugars to turn a brownish color.

Cats Paw (p.17) Wood characteristic that has the shape of a cat's paw caused by pin knots.

Closed Knot (p.16) Closed knots have a flat face with no openings in the lumber surface.

Flat sawn / Plainsawn (p.7) Lumber that has grown rings at angles of 0 to 45 degrees to the wide surface of the lumber.

Growth Ring (p.13) The annual production of wood by a tree, consisting of springwood and summerwood.

Grab Hole An opening in a tree or lumber caused by an insect larva.

Heartwood (p.5) The central core of wood in a tree that no longer conducts sap or has living tissues. In some species, the build-up of extractives in the heartwood darkens the wood color in this area.

Heartwood Stain The brownish to blackish color in hard maple that is commonly referred to as stain, although it is not a true stain. Rather, it’s a build-up of extractives causing the heartwood to be much darker in some trees.

Honeycomb (p.21) Checks, often not visible at the surface, which occur in the interior of a piece of wood along the wood rays. Honeycomb is caused by stress built up during drying.

Incipient Rot (p.18) Rot (also known as decay) is the decomposition of a substance by fungi. Incipient rot is rot in its early stages and usually noticeable only by slight wood discoloration or bleaching of the wood. Advanced decay causes the wood to become soft and puffy.

Iron Stain A bluish stain on lumber caused by the chemical reaction between iron and wood.

Knot (p.16) The wood fiber associated with a tree limb or branch.

Knot Cluster (p.16) Grouping of knots.

Mineral Stain Darkened or discolored wood areas caused by minerals the tree extracts from the soil. Mineral stains appear as dark, blotchy areas with undefined boundaries that can turn an entire board darker in color.

Mineral Streak (p.20) Dark red or discolored wood areas caused by minerals the tree extracts from the soil. Mineral streaks appear as blackish-blue, well-defined streaks running parallel with the grain (commonly found in maple and birch, sometimes in oak and cherry). This type of streak can be measured easily by its length and width.

Open Knot (p.16) Knots with open areas on the surface of the lumber.

Paint Grade A lumber grade used primarily for painting. This grade varies from customer to customer and usually includes all sound wood.

Pin Knot (p.16) Knots that are small and tight.

Pitch Pocket (p.17) Openings that run parallel to the growth rings containing resin. Cherry is the most common hardwood species with this characteristic.

Quartersawn (p.7) Lumber that has growth rings at angles of 45 to 90 degrees to the wide surface of the lumber.

Ray (p.19) Stripes of cells extending radially within a tree and varying in height from a few cells in some species to four or more inches in oak. The rays serve primarily to store food and transport it horizontally to the tree. In quartersawn oak, the rays form a conspicuous figure, sometimes referred to as ray flecks.

Riftsawn (p.7) Lumber that has growth rings at angles of 10 to 60 degrees to the wide surface of the lumber.

Rot Rot (also known as decay) is the decomposition of a substance by fungi. Incipient rot is rot in its early stages and usually noticeable only by slight wood discoloration or bleaching of the wood. Advanced decay causes the wood to become soft and puffy.

Sap Stain Bluish-black, gray or brown wood discoloration caused by fungi. The discoloration can also be orange, purplish, or red, depending on the fungus and wood species involved.

Sapwood (p.5) The wood in the tree that conducts water up the tree stem and may contain some living cells. Sapwood may be lighter in color than heartwood due to the lack of extractives.

Shake (p.21) A separation along the grain, the greater part of which occurs between the annual growth rings.

Sound Knot (p.16) A knot that is solid across its face, as hard as the surrounding wood, and shows no indication of decay.

Stain Areas of discoloration that alter wood properties. They are caused by minerals (mineral stain), fungi (sap stain), chemical reactions in the wood (sticker stain), water (water stain), or bacteria (wetwood stain).

Tiger Stripe (p.15) A distorted grain pattern that in certain light resembles the stripes of a tiger.

Tight Knot (p.16) A knot so fixed by growth or position in a sawn board that it is firmly retained in its place.

Unsound knot (p.16) A knot with a portion that is readily movable and may also include areas of decay.

Wetwood Stain Appears as water-soaked gray to brown discoloration within the heartwood. It can be identified in the predryers or kilns by a sweet, fermented, sometimes foul-smelling odor. The water-soaked appearance results from excessive moisture produced by bacteria, sometimes twice the amount of the surrounding normal wood. Due to the high moisture content, areas of wood with wetwood stain shrink excessively in the kiln causing surface checks, end checks, and/or honeycomb depending on the stain location in the board.

White Rot Any decay in wood that attacks both cellulose and lignin. Black “zone lines” sometimes appear in and around the bleached areas. In later stages of rot the wood will become soft, fibrous, and bleached, finally losing strength.

Worm Hole (p.18) Voids in the wood caused by the burrowing action of certain wood-infesting worms. Pin worm hole: not over 1/16” in diameter. Shot worm hole: over 1/16” but not more than 1/4” in diameter. Grub hole: 1/4” and larger.

Worm Track (p.18) Sometimes referred to as pith fleck in maple, these are small, narrow, yellowish to brownish streaks 1/32” to 1/16” wide and 1/8” to 2” long. Worm tracks are caused by the maple cambium miner feeding beneath the bark from the branches to the roots. Their tiny burrows are filled in by new cell growth and become embedded in the wood as the tree continues to grow.

Bibliography


Guide To Wood Species Architectural Woodworking Institute Arlington, Virginia


Technical Data

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<tr>
<th>Species</th>
<th>Density (lbs/ft³)</th>
<th>Dimension Change Coefficient Radial</th>
<th>Dimension Change Coefficient Tangential</th>
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<tr>
<td>Red Oak</td>
<td>42.5</td>
<td>0.00158</td>
<td>0.00369</td>
</tr>
<tr>
<td>Cherry</td>
<td>30.0</td>
<td>0.00126</td>
<td>0.00248</td>
</tr>
<tr>
<td>Hickory</td>
<td>50.5</td>
<td>0.00259</td>
<td>0.00411</td>
</tr>
<tr>
<td>Hard Maple</td>
<td>42.5</td>
<td>0.00165</td>
<td>0.00353</td>
</tr>
<tr>
<td>Soft Maple</td>
<td>36.4</td>
<td>0.00137</td>
<td>0.00289</td>
</tr>
</tbody>
</table>

Dimension change coefficient is the percent change per inch per 1% change in moisture content.

Moisture In Wood Products

Affects of Moisture in Wood
• Any solid wood product will expand over time as moisture and climate conditions change.
• Effects of moisture may include the following: Panel expansion, joint expansion or opening (especially on miter doors), stile bowing, panel contraction which may result in “white line” if finished, and stile/rail expansion.

Southern or Humid Climates
• Southern or humid climates are especially susceptible to expansion due to moisture. Such locations include waterfront properties, coastal regions, and the Gulf coast, particularly Florida.
• Marine applications, such as on boats or yachts are considered high humidity regardless of any resident climate control systems.
• Non-air conditioned homes, regardless of location, are very susceptible to expansion due to moisture.
• Winter and vacation homes should maintain some form of climate control, even in off season.

Tips For Avoiding Moisture Related Problems
• Certain species, primarily Hard Maple, have a tendency to expand more than others. For details on how much certain species may be affected by moisture, reference the chart below.
• If you experience expansion in your doors prior to installation on the cabinet box, they will usually return to normal once the kitchen has been installed in an air conditioned environment.

Potential Wood Movement Chart

<table>
<thead>
<tr>
<th>Species</th>
<th>Width in inches at 5% humidity</th>
<th>Width in inches at 14% humidity</th>
<th>Wood movement in inches caused by 9% swing in moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Oak</td>
<td>12</td>
<td>12.29</td>
<td>0.29</td>
</tr>
<tr>
<td>Hard Maple</td>
<td>12</td>
<td>12.27</td>
<td>0.27</td>
</tr>
<tr>
<td>Soft Maple</td>
<td>12</td>
<td>12.27</td>
<td>0.27</td>
</tr>
<tr>
<td>Cherry</td>
<td>12</td>
<td>12.23</td>
<td>0.23</td>
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<tr>
<td>Hickory</td>
<td>12</td>
<td>12.29</td>
<td>0.29</td>
</tr>
</tbody>
</table>

• The above chart indicates how much a 12” wide panel can move in size depending on moisture. For instance, if a Red Oak cabinet door with a 12” wide panel is at 5% moisture, the panel could expand by more than 1/4”.
• In reading the above chart, it is evident that some species such as Maples, Hickory, and Oaks (primarily White Oak) can move significantly.
• Generally speaking, Merillat manufactures its products at a moisture content level between 6-8%, depending on the season.