

There are a multitude of considerations that apply to selection of a wood species for Architectural Woodworking projects. Interior specifications are primarily driven by aesthetics, budget, finishing characteristics, and stability factors. Exterior specifications have the same concerns but are also complicated by weathering & rot resistance

Aesthetics are an individual designer's choice. It is my hope to provide information that will temper the aesthetic choice with the practical considerations of grades, availability, function, and cost; important factors in project budgeting and scheduling. Some of the technical information presented goes beyond what is necessary for Architects & Designers to make informed choices. It does, however, provide valuable background for understanding the woodworker's trade.

Information presented relative to wood species, their properties, and suitability for various purposes represent my opinions drawn from experience in woodworking. That experience has been in the Northeast. Different climates have different effects on wood. If you were to ask ten Woodworkers about the properties of various woods, you could get ten different answers, such is the nature of the material.

I have also borrowed liberally from two publications with a wealth of information about solid wood and veneer:

Architectural Woodwork Quality Standards Illustrated available from the Architectural Woodwork Institute (AWI), Reston, VA.

Wood Handbook: Wood as an Engineering Material original material from the USDA Forest Products Laboratory (FPL), Madison, WI., printed by the Forest Products Society, and available on-line as a (very large) PDF download.

Information on contacting these organizations is available on the "Resources" page at the end of this paper.

Lumber Manufacture

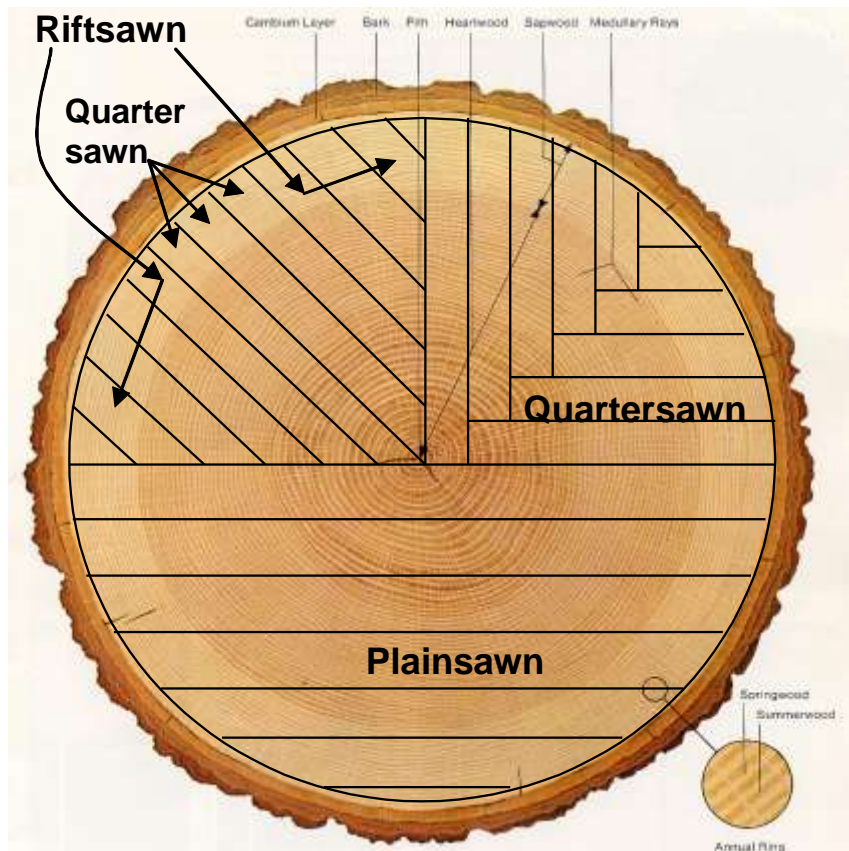
Sawing (lumber) & Cutting (veneer)

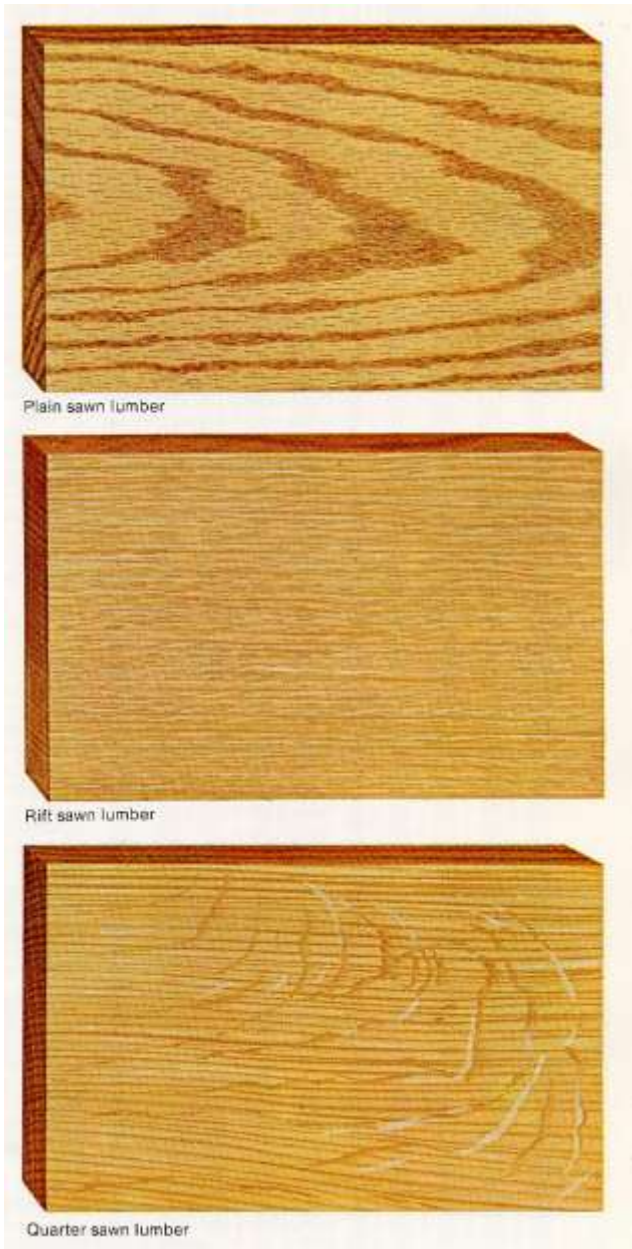
The choice of lumber cut is a matter of, principally; stability for exterior applications, and aesthetics for interior applications.

Plain (Flat) Sawing is the most common method of cutting lumber or veneer because it will yield the most from the log. It produces a broad grain with a "cathedral pattern".

Quarter or Rift Sawing is employed for a variety of reasons. It requires large logs and produces a lower yield, therefore higher cost, than Plain Sawing.

Exterior applications utilize Quartered material primarily for its greater stability in fluctuating environmental conditions. Differentiation between Rift & Quartered is rarely made for exterior work. Historically Redwood, Douglas Fir, and Western Cedars have been commonly available in Quarter Sawn (**Vertical Grain**). While this is still true, Redwood & Fir are now also being sold





plain sawn because of the diminishing supply of logs of sufficient size to effectively produce Vertical Grain material.

Interior applications of Quartered & Rift Sawn materials are primarily aesthetically driven.

Rift Sawing is specified when a uniform straight grain appearance is desired. The annual rings of a Rift sawn board will lie at an angle of ~30-70°, optimally 45°, to the face of the board.

Quarter Sawing produces figured characteristics in some woods; the lateral "flake" in Oaks, more so in White than Red Oak, that is characteristic of much Victorian and Arts & Crafts furniture; a similar, but much less pronounced, flake in Sycamore, Maple, Cherry and Beech; the shimmer of Ribbon Stripe African Mahogany. The annual rings of a Quartersawn board will lie at an angle of ~60-90°, optimally 90°, to the face of the board.

Drying

Most lumber used today is **Kiln Dried**. Kiln drying accelerates the drying schedule as well as allowing much greater control over the drying process. This control produces flatter, straighter lumber with consistent moisture content throughout the lot.

Lumber for exterior use is dried to 12-15% **Moisture Content (MC)**. A piece of wood left outside, or in a barn, in New England, sheltered from direct rain, will reach an **Equilibrium Moisture Content (EMC)** of 12-13%.

Lumber for interior use is dried to 6-8% MC. Wood left in a New England heated interior environment will fluctuate between 5-6% EMC in February and 8-9% EMC in August.

In the process of kiln drying pine, the temperature is elevated to at least 180°F towards the end of the schedule. This "sets the pitch" to keep it from bleeding through finishes.

A copy of the *Wood, Moisture & Warranties – A Technical Bulletin* is included at the end of this paper. It includes some very important information relative to proper environmental conditions for finish millwork.

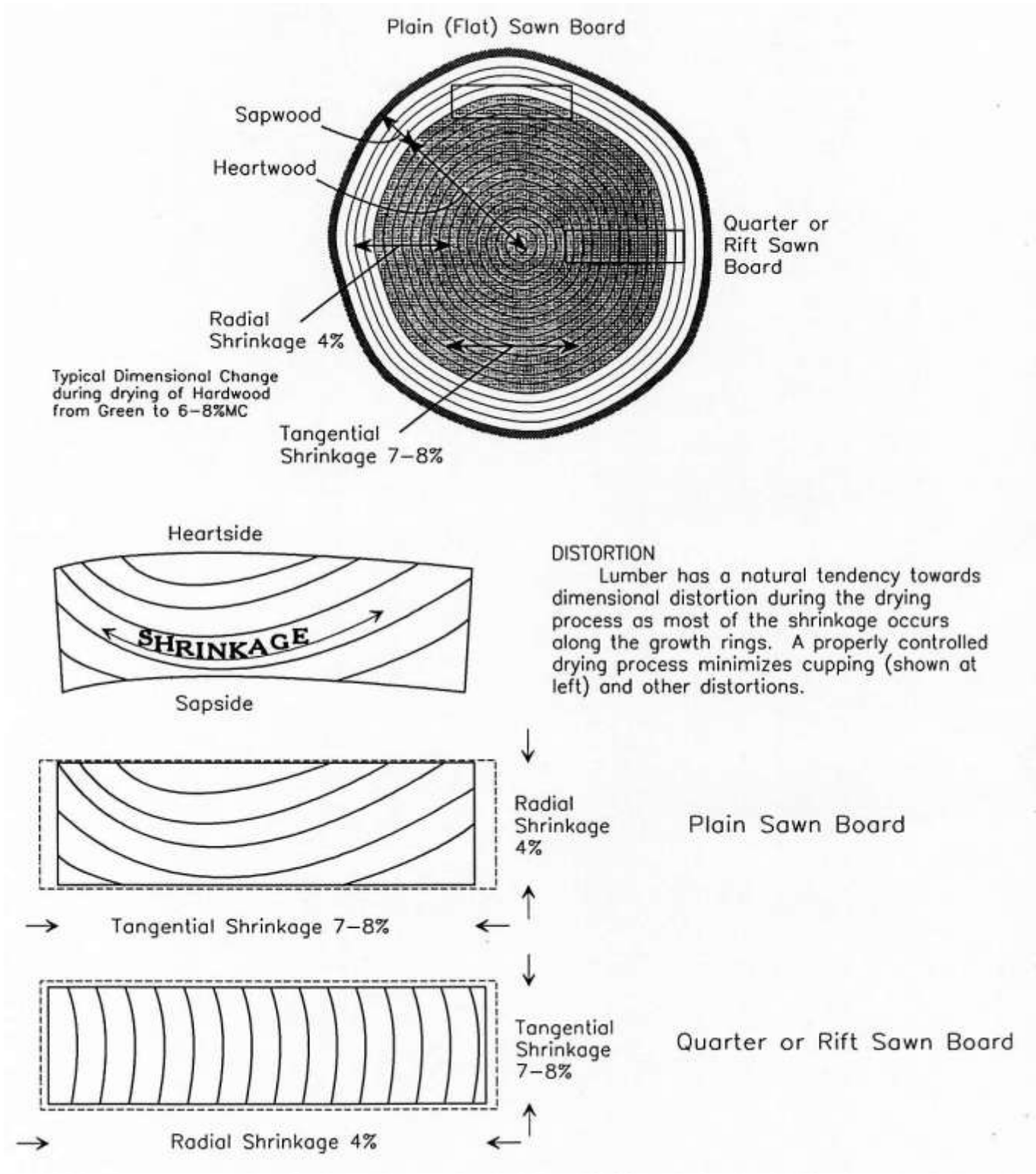
Storage

Material kiln dried to 6-8% and stored in an open shed can be expected to gain ~2% MC during the first 45 days, and ~1%/month after that, during the most humid months in the summer. The comparable rates in a closed shed would be ~0.7%/45 days and ~0.3%/month.

A 6-8% EMC can be maintained in lumber if it is stored in a building or shed that is maintained at 15-25°F above the outside temperature.

When Amherst Woodworking moved its operations to a new plant in 1994, our lumber storage changed from an open front shed to a completely enclosed heated building. All of our materials start to condition to the shop environment upon delivery and, as a result, we experienced a dramatic reduction in moisture content related problems, both in the plant and installed.

Relative Humidity	Equilibrium Moisture Content Table optimally maintained between 6 - 8.5% MC						
	Ambient Air Temperature - Degrees Fahrenheit						
	0%	30°	40°	50°	60°	70°	80°
5%	1.4	1.4	1.4	1.3	1.3	1.3	1.2
10%	2.6	2.6	2.6	2.5	2.5	2.4	2.3
15%	3.7	3.7	3.6	3.6	3.5	3.5	3.4
20%	4.6	4.6	4.6	4.6	4.5	4.4	4.3
25%	5.5	5.5	5.5	5.4	5.4	5.3	5.1
30%	6.3	6.3	6.3	6.2	6.2	6.1	5.9
35%	7.1	7.1	7.1	7	6.9	6.8	6.7
40%	7.9	7.9	7.9	7.8	7.7	7.6	7.4
45%	8.7	8.7	8.7	8.6	8.5	8.3	8.1
50%	9.5	9.5	9.5	9.4	9.2	9.1	8.9
55%	10.4	10.4	10.3	10.2	10.1	9.9	9.7
60%	11.3	11.3	11.2	11.1	11	10.8	10.5
65%	12.4	12.3	12.3	12.1	12	11.7	11.5
70%	13.5	13.5	13.4	13.3	13.1	12.9	12.6
75%	14.9	14.9	14.8	14.6	14.4	14.2	13.9
80%	16.5	16.5	16.4	16.2	16	15.7	15.4
85%	18.5	18.5	18.4	18.2	17.9	17.7	17.3
90%	21	21	20.9	20.7	20.5	20.2	19.8
95%	24.3	24.3	24.3	24.1	23.9	23.6	23.3
98%	26.9	26.9	26.9	26.8	26.6	26.3	26



Grading

Lumber grading rules applicable to the material purchased by a Millworker are established by producer supported associations (see Resources page). Different species fall under the auspices of individual associations. As a result the grading rules differ markedly from specie to specie.

The grading rules that are applicable to installed Millwork are established by the **Architectural Woodwork Institute (AWI)**. The Architect or owner is concerned with the finished product, not the raw material. AWI details the requirements of it's three grades, Economy, Custom, & Premium in the **Architectural Woodwork Quality**

Standards Illustrated. These grades cover quality of machining and joinery, as well as permissible defects, characteristics, sapwood & heartwood, expected size of pieces, and gluing for thickness & width. (For information on AWI Publications see Resources page)

Heartwood & Sapwood

see illustration previous page

Sapwood is the growth rings under the bark that contain the active cells of the tree. These cells conduct the sap and store nutrients. Sapwood is generally white.

Heartwood is the inner rings containing the less active cells. These cells contain deposits that give different woods their characteristic colors. It is also these deposits that give rot resistant woods, such as Redwood, their durability.

Most producer lumber grading rules do not differentiate between heart & sapwood, the exception being Redwood. AWI grading rules do have specifications of allowable percentages of heartwood & sapwood for the species where it is of aesthetic concern.

A plain sawn board will have a "heartside" (towards the center of the tree) and a "sapside" (towards the bark). It is advantageous to apply exterior boards with the heartside facing out. This exposes the more durable wood. If the boards cup, under normal conditions, it will curl with edges to the wall instead of pulling away.

On interior applications whether the heartside or sapside is exposed is determined by aesthetics. With Cherry, a heartside exposure is normally desired, while Select White Maple exposes the sapside. Birch may be specified either way for different desired results. This is discussed further under *Interior Applications - Specification Variation Within a Specie.*

Dimensions

Discussions of thickness are expressed as "**Rough**", what comes off the saw at the mill prior to drying & milling ("dressing"), and "**Net**", the final dimension after drying & milling. Net dimensions are usually 1/4-1/2" less in thickness, and 1/2-3/4" less in width, than rough.

In lumber that is commonly sold rough sawn (mostly hardwoods), thicknesses are expressed in quarters of an inch, i.e. 4/4=1" rough. Most hardwoods are **solid random width & length (RWL)**. It is up to the woodwork manufacturer to yield the required widths for the job.

In lumber that is commonly sold "dressed" or planed to finish thickness and width (mostly softwoods), sizing is expressed per the following examples.

1x4 = 1"x4" rough = 3/4"x3-1/2" finished

5/4x8 = 1-1/4"x8" rough = 3/4"x7-1/4" finished

2x6 = 2"x6" rough = 1-1/2"x5-1/2" finished

If a specific finish thickness is desired, it should be written with inch marks. A specification, on a set of plans, that reads 1x4 will be supplied as 3/4"x3-1/2", using 4/4 lumber. A specification reading 1"x4" should be supplied as 1"x4" full dimension, using 5/4 lumber. In competitive bidding, plans with mixed references for the same item, i.e. 1x4 on one page and 1"x4" on another, and no large scale profile to verify, will most likely be interpreted as the smaller (less expensive) dimension. It is very important to express dimensions clearly so that you do not end up with less than you expected, or conversely, the client is not paying for unnecessary lumber; and the proper material is delivered to the jobsite

Exterior Species

Because different species perform very differently in exterior applications, and this is an area where opinions sometimes vary widely, we will discuss some of them in specific. All discussions of lumbers & their characteristics are in reference to select grade material suitable for high grade Millwork. Grades given are producer grades, for raw materials, not AWI grades.

Pine

The better Pines have good stability, moderate rot resistance, excellent machinability, and good strength characteristics for use in Millwork such as doors, windows, and moldings. It is advisable to preservative treat Pine Millwork prior to painting.

Eastern White Pine is commonly available in rough thicknesses up to 2", and with a little looking up to 3" or 4". Due to limited availability and cost, stock thicker than 1-3/4" net is usually glued up for thickness. Width &, length selection is good also.

Eastern White Pine was used, very effectively, for most exterior Millwork in the Northeast during the past three centuries. The decline in availability of stock with a high percentage of heartwood has reduced its weather resistance. It is still very effectively used in exterior applications with less direct weather contact, such as doors & windows. Applications with a 360° exposure to the weather, such as balustrades, are better specified in an alternate material such as Mahogany or Cedar.

Ponderosa or Idaho Pine are not commonly available in the East and, when found, are usually

already milled for thickness & width. They are the commonly used species in most "stock" millwork, i.e. windows, doors, moldings, etc found at retail lumber yards; but their use for custom millwork in the Eastern states is limited.

Sugar Pine has excellent stability and machinability, but poor rot resistance and is very soft. **Southern Yellow Pine** finds good use in flooring & trim but, being less stable than other pines, is not commonly used in millwork.

Appropriate grades for Millwork:

Eastern White Pine	C-Select D&Better Select (if small cuttings are being used)
Ponderosa, Idaho, & Sugar	C & Better Select

Grading Authority:

Northeast Lumber Mfg. Assoc.
Western Wood Products. Assoc.

Cedars & Redwood

Western & Inland Red Cedars have excellent stability, rot resistance, & machinability and moderate strength. Their properties make them a good choice for decks, railings, balustrades, and moldings. When used in a structural application, such as a railing support, the size of material should be greater than that of a stronger specie. Where a 2x4 of Mahogany would meet requirements, a 4x4 of Redwood would likely be required. Their lower strength qualities make them less desirable for doors and windows.

These Cedars generally come from the West Coast already milled to thickness & width. They are commonly available in thicknesses up to 1-1/2" net, widths to 11-1/4" net, and lengths to 20'. 4x4's, (3-1/2" sq. net), are also commonly available up to 20'. Rough and thicker material is available by mill order or with a little looking.

The availability of **Redwood**, on the east coast is very limited. It has the same characteristics of the Western Cedars.

Alaskan Yellow Cedar has moderate stability & machinability, and excellent rot resistance & strength. It is not actually a cedar but **Pacific Coast Cypress** (*Chamaecyparis Nootkatensis*). It

works well for decks, railings, trellises, and the like. It is possible to get the Select Grades generally required for Millwork, but they usually require a special order with minimum quantities. It has not commonly been used for windows & doors. Under ASTM soil-block testing, it has been found to have superior resistance to decay above ground, and a moderate resistance in ground contact. Commonly available in the 1990's, it now is limited to one or two outlets in New England.

Port Orford (Pacific White) Cedar has qualities that are very similar to Alaskan Yellow Cedar. It's availability in New England is limited to one or two wholesalers. A restricted supply of long lengths makes it less desirable for moldings. This Cedar comes from Western Canada, generally in the same dimensions as Western Red Cedar & Redwood.

Atlantic & Northern White Cedar are principally used in boat building, for siding, and decking. They are primarily produced in 1" rough thickness, generally not a select grade, and have limited availability.

Appropriate grades for Millwork:

Western Red Cedar - A & Better
Inland Red Cedar - D & Better
Port Orford Cedar - C & Better
Alaskan Yellow - C Finish

Grading Authority:

Western Wood Products Assoc.
" " " " " "

Redwood -

CAHVG (Clear All Heart Vertical Grain)
CVG (Clear Vertical Grain - allows Sapwood)
CMG (Clear Mixed Grain - flat sawn, allows Sapwood)

Redwood Inspection Service

Fir, Douglas

Douglas Fir has moderate rot resistance, fair machinability & good strength. It has a tendency to splinter which makes it difficult in making moldings. Relative to stability, Flat Sawn Fir is moderate, and Vertical Grain (Quarter Sawn) rates a "good". It is commonly used in manufacturing of "stock" doors. It is also suitable for windows and moldings, although not commonly used so. It is advisable to preservative treat Douglas Fir Millwork prior to painting.

Fir generally comes from the West Coast already milled to thickness & width. It is commonly

available in thicknesses up to 1-1/2" net, widths to 11-1/4" net, and lengths to 20'. 4x4's, (3-1/2" sq. net), are also commonly available up to 20'. *Rough and thicker material, in select grades, is available only by special order.* Rough sawn Fir is generally sawn very close to, or slightly under, dimension. A 2" rough thickness will only yield about 1-5/8" after milling, making it difficult to use for custom doors that are normally finished at 1- 3/4", thickness.

Appropriate grades for Millwork:

C & Better VG (Vertical Grain)
C & Better FG or MG (Flat Grain or Mixed Grain)
D & Better FG or MG (Flat Grain or Mixed Grain)

Grading Authority:

Western Wood Products Assoc.

Yellow Cypress

The **Cypress** that is commonly available has moderate stability and rot resistance, machinability, and good strength. It has a much higher sapwood content than the legendary "**Tidewater Red Cypress**", and therefore less inherent stability and rot resistance. It is still in common usage for millwork in the Southeast, where it is native. Its usage in New England is limited. We have had some problems with shrinkage and grain lifting, probably due to the moisture content of the lumber shipped to us. In our

experience, at Amherst Woodworking, it has not performed well in exterior applications requiring gluing. The MC should be monitored carefully.

Cypress is normally sawn and dried in 1" & 2" rough thicknesses, and rough widths of 4", 6", 8", 10", & 12".

Limited quantities of **Old Growth Cypress**, with a high percentage of heartwood and tight growth rings is available, see Recycled Woods below. This material usually commands premium prices.

Appropriate grades for Millwork:

FAS (Firsts and Seconds)
S&Btr. (Select & Better)

Grading Authority:

National Hardwood Lumber Assoc.

Mahoganies, Spanish Cedar, Ipé (Pau Lopé), & Cambara

Genuine Mahogany & Spanish Cedar (both from South America) have excellent stability, rot resistance, machinability, & strength. They are very well suited for all types of exterior millwork.

African Mahogany & Sapele are similar to Genuine with a wider color variation and less desirable machining & stability characteristics. Both of these species have seen increased utilization with the dramatic price increase of Genuine, and the limited length availability of Spanish Cedar.

These woods are generally available in rough thicknesses up to 4", with widths commonly 6-10" and occasionally up to 20" (dependant on the specie). Long lengths (13-16') are frequently difficult to find, especially in Spanish Cedar. As of this writing (10/06) we are still able to get ~25% long lengths in Mahogany shipments.

Meranti & Philippine Mahogany are imported southern Asia. They are what most retail lumber yards sell as "Mahogany". They are not a true

Mahoganies, but in fact can be any one of many different species. Both vary in color and density, even in a single shipment, quite a bit. They are commonly available as dressed material in thicknesses up to 1-1/2" net, widths to 11-1/4" net, and lengths to 16'.

The attraction to Philippine Mahogany & Meranti is that they are generally less expensive than Genuine or African and just as well suited for some applications. They are commonly used for decking applications as well as interior trim boards.

Ipé, Cambara & Massaranduba grow in South America, and are imported to the US primarily for the decking market. Because of this, they are commonly available as dressed material in thicknesses up to 1-1/2" net, widths to 11-1/4" net, and lengths to 20'. 4x4 (3-1/2" sq.) is also available. Ipé & Massaranduba are rock hard and extremely decay resistant. Their natural oiliness preclude the

use of a paint finish but they do accept penetrating oil sealers. Neither is well suited for millwork.

Cambara is similar to Philippine Mahogany in its properties. It is also sometimes unflatteringly referred to as "check deck".

Appropriate grades for Millwork:

Genuine Mahogany- Pattern
FEQ (First European Quality)
FAS (Firsts & Seconds)
Spanish Cedar - FAS
African Mahogany - FAS, Ribbon Stripe (Quartersawn)
Philippine, Meranti, Ipé, & Cambara - N/A for Millwork

Grading Authority:

National Hardwood Lumber Assoc.

Teak

Teak has excellent stability & rot resistance, and moderate strength. It machines very well, but the presence of silicates in the grain structure makes Teak very abrasive on tools, thereby sharply increasing milling costs. It is commonly used in boat building. Material cost, as well as milling, is quite high. For this reason it is not generally used in millwork.

Teak is commonly available in rough thicknesses up to 2". Thicker material is available with some looking. Widths average in the 4-8" range, and lengths run mostly 6'-12' with some longer available.

Most of the Teak available in the US is from **Burma** or **Thailand**. It is preferred because of its rich color that is popularly associated with Teak.

There is a limited amount of **Plantation Teak**, grown in **Central America**, available. It is

much lighter in color, and therefore importers have had difficulty gaining its acceptance among consumers. Plantation Teak generally runs narrower and shorter than Asian. Its price is roughly 50% if Asian Teak.

One importer estimates that Plantation Teak would have, roughly, 80% of the durability, for exterior & marine usage, that Asian Teak does. Given that Asian Teak is extremely durable, Plantation would still qualify as very durable.

Freshly milled Teak has a dark splotchy appearance that is quite different from the end product after a 3-6 month exposure to light. There is a copy of an AWI Bulletin on the subject included at the end of this paper.

Appropriate grades for Millwork:

FAS
FEQ (First European Quality)

Grading Authority:

National Hardwood Lumber Assoc.

Other Considerations

Stock that is previously milled, such as Redwood, Western Cedar, Fir, & Meranti, usually has to be re-milled by the woodworker prior to fabrication. This means that a piece of Cedar or Fir that will net 1-1/4" thickness has to be taken from stock that is tallied as 2" rough, whereas Pine, Mahogany, or Teak can be taken from 1-1/2" rough to net 1-1/4", thereby saving material costs.

The best ultimate **exterior finish** for any millwork, whether or not preservative treated, is paint. Transparent finishes degrade more rapidly requiring greater maintenance and exposing the Woodwork to the elements. A useful option for finishing of exterior doors is to paint the outside, giving maximum weather protection; and clear finish the inside, displaying the beauty of the wood.

The text of an article, from "Woodshop News", on **finishing of wood doors** is included at the end of this paper. Although written about doors, it

applies equally well to just about any exterior millwork. It gives an excellent overview of the considerations involved in this very important final step of millwork manufacture.

Preservative Pressure Treating of Millwork is not practical. If done after milling it will distort profiles and likely cause checking & splitting. It cannot be done prior to milling because of toxicity of dust during milling process. Millwork can be effectively preservative treated by brush or dipping, after fabrication. Industry Standards for preservative treatment of finish millwork are specified by the National Wood Window and Door Manufacturers Association (NWWDA) in their bulletin "NWWDA I.S.4-94 Water Repellent Preservative Non-Pressure Treatment for Millwork". Information for contacting the NWWDA is given under "Resources". It is also covered briefly under 100-S-10 of the Architectural Woodwork Quality Standards Illustrated.

Interior Applications

Because selection of a wood specie for an interior application is primarily driven by aesthetics, and that is the purvue of the designer, I will not go into great detail on individual species. However, there are a few useful points to keep in mind for effective specification of wood specie.

The primary concern is to make your choices and write your specifications carefully. Attached is a chart detailing relative availability, costs, and characteristics of various lumbers & veneers. As it indicates, there is a wide range in the cost and availability between species. Make sure that your aesthetic vision matches your clients budget.

Specification Variation within a Specie

There are several North American Hardwood species that can be specified differently, for very different results in appearance.

The White Ash tree has a tan to brown heartwood and a creamy white sapwood.

The Yellow Birch tree has a red heartwood and a yellowish white sapwood.

The Sugar or Hard Maple tree has a brown heartwood with a white sapwood.

They all yield lumber or veneer with sapwood only, sapwood & heartwood, and heartwood only.

A specification of:

“Ash” or “Natural Ash”

“Select White Ash”

“Brown Ash”

“Birch” or “Natural Birch”

“Select White Birch”

“Select Red Birch”

“Maple” or “Natural Maple”

“Select White Maple”

“Brown Maple”

Will result in:

Mixed heart & sapwood, contrasting colors.

More readily available in lumber than veneer.

All sapwood, uniform white.

Most stock ash veneer plywood is select white.

Not readily available.

Mixed heartwood & sapwood, contrasting colors.

90% sapwood, uniform white.

90% heartwood, uniform red.

Mixed heartwood & sapwood, contrasting colors.

90% sapwood, uniform white.

Not readily available in veneer, sometimes in lumber. Prone to drying defects in lumber.

Bamboo & Liptus

Bamboo has recently come to market as a new material in the form of veneers and panels, (plyboo.com or moso.com). It has a very straight grain like quartered maple or sycamore. Experience with the three-ply solid panels seems to show significant movement with humidity changes. We worked on a project, using bamboo veneer, with two other millwork houses. Each shop supplied bamboo cabinets & millwork with panels veneered on MDF core for greater stability. There were delamination problems with each shop's work, and the panels were not all from the same supplier. Bamboo has a waxy feel to it, causing gluing to require special preparation. This material should be specified with caution.

Liptus is a fast growing hybrid of two Eucalyptus trees with color and grain characteristics similar to mahogany. It is a plantation grown product of a joint venture between Weyerhaeuser and a Brazilian company.

Weyerhaeuser's testing rates Liptus' stability similar to North American hard maple, which puts it in the moderate category. Cycle testing rates it similar to mahogany relative to decay resistance. I have always been leery of cycle testing because of skepticism that it truly mimics actual usage situations. Exterior uses should be approached with caution until a track record is established.

Relative to interior applications, it appears to machine well, have reasonable color consistency in the higher grades, and hardness similar to maple. Weyerhaeuser is promoting the availability as good and claims that pricing will be reasonably stable (its price is, again, similar to maple) because they are trying to get the material specified. They also have a major East Coast plywood distributor on board for veneered panels. Further information can be found at weyerhaeuser.com/lyptus.

Recycled Woods

Increasingly, **Salvaged and Recycled Lumbers** are being specified for Architectural Millwork projects. There is a growing variety of species available, in which some truly beautiful material can be found.

The sources are usually either demolition from old buildings; or virgin logs found on lake & river bottoms, having sunk during log drives around the turn of the 19th. century.

The significant species available are **Heart Pine, Chestnut, Fir, Maple, Oak, Birch, Beech, Hemlock, Cypress** and **Pine**. Because the original logs were largely virgin timber, this material has

characteristically tight growth rings and a large percentage of heartwood, an attractive combination.

These woods tend to be very expensive (\$15+/bf.) because of the labor intensity of yielding a good grade of lumber from used beams, or retrieving logs from watery depths. While veneered plywood is certainly not a common item for this type of material, it might be possible to purchase a log and have it shipped to a mill for slicing and laying up into veneered panels.

Further information about Salvaged and Recycled Lumber is available from Amherst Woodworking or your local AWI Member.

Availability Considerations

There are many species of veneer (mostly imported) available that do not have a corresponding ready availability of solid lumber. In many instances the veneers are being used for paneling and do not require any solid wood components. It is best to ascertain the supply of a specie, in solids and veneer, prior to a specification requiring both.

This can also apply to particular cuts. Quartersawn Cherry, Ash, Maple, and Walnut are available in veneer without too much trouble. They are available, but not readily, in lumber form. Quartered & Rift Red & White Oak are commonly available in lumber and veneer.

Color, Finishing, & Ageing

Color changes in wood, especially Cherry & Mahogany, with exposure to oxygen & sunlight. When finished "Natural", with no stain, they both will initially be a bright pinkish color. Over time, exposure to oxygen & sunlight will darken them to the classic rich color for which both are famous. A significant portion of the ultimate change will happen within 12 months, if kept in a sunlit room.

My personal opinion is that waiting for Cherry to age naturally rewards the patient person. The reality today is that most clients want their job to look perfect the day they move in and they want an evenness of color that does not happen naturally.

A fine architectural finish on Cherry involves a

custom mixed wiping stain, sealer coat, scuff sand, and then a dye stain toning coat sprayed over the sealer to even the natural variations in color. It is on top of this that the top coats of finish are applied. In one project at Amherst Woodworking involving a wall of cabinets approximately 7' high by 16' long, our finisher needed to employ four different toning formulations for four different areas of the same wall. All the lumber was from a single shipment and likewise the veneer, but these steps were necessary to meet the customer's expectations.

Lighter woods like Maple will mellow in color over time, but not the same degree of change seen in Cherry.

Wood & Moisture

As mentioned previously under *Lumber Manufacture; Drying & Storage*, it is very important to control the environmental conditions into which raw materials and Architectural Millwork are placed. Relative humidity levels are best maintained between 25-55%. Extremes above or below can cause

damage to woodwork. An adequate HVAC system, capable of controlling the swings in humidity, is an important consideration when making a substantial investment in Architectural Millwork. A copy of *Wood, Moisture & Warranties – A Technical Bulletin* is included at the end of this paper.

Sustainability

The **Tropical Forestry Foundation** (see resources) is supported by trade groups and organizations such as The Nature Conservancy and the World Wildlife Fund.

"TFF's primary mission is to promote sustainable tropical forest management by gathering and disseminating information about its benefits and

by demonstrating and teaching proper management practices."

The **National Hardwood Lumber Association** (see resources) publishes a pamphlet entitled "*Sustainable Forest Policy*", which outlines steps taken by their members in management of the temperate hardwood forests of North America.

Notes to Lumber & Plywood Chart

See the foldout charts on following two pages

Relative Cost

The **first column** gives the **retail price** of a board foot (bf) (12" sq. X 1" thick, or equivalent) of lumber.

The **second column** lists a commonly used **waste factor**. Lumber such as Red Oak, Ash, and Birch are available in a good range of widths & lengths and therefore yield well without excessive labor or cutting waste. A typical waste factor for these species is 50%, meaning that it will require 1-1/2 bf. to net 1 sq. ft. of finish material. This is caused by the waste involved in straightening & trimming edges & ends, cutting around defects, selecting for color & grain, and the fact that lumber never comes right at the size you want.

The nature of Quarter Sawing produces relatively narrow and short lumber. Black Walnut has its own grading rules allowing more defects in an FAS (Firsts & Seconds) board than would be allowed for Oak. Walnut & Cherry require extra trimming to yield heartwood only. All of these examples increase labor and milling waste.

The **third column** is the retail price multiplied by the waste factor, for a truer representation of actual cost comparisons between species.

Plywood cost factors are retail prices per square foot of, typically, 3/4" panels on particle board core, the best core for interior architectural millwork..

Plywood Availability (Code @ chart bottom)

#1 refers to "In Stock" at our plant. These are also commonly available at other Hardwood Retailers and Millworkers.

#2 would indicate readily available at a Wholesaler's warehouse, deliverable to your Millworker's plant within 1-4 weeks.

#3 Almost any lumber species is available to be made up as a veneered plywood. This generally requires minimum quantities and a long lead time (~6-10 weeks). The sources for specialty plywoods are better known to Millworkers than most Retail Lumber Yards.

#4 Some species are not generally used in Architectural Woodwork and are therefore not likely to be available by special order.

Lumber Availability Relative to Thickness (Code @ chart bottom)

Lumber rough thicknesses are expressed in quarters of an inch. 4/4 = 1", 10/4 = 2-1/2". Final dimension after drying and milling is usually 1/4" less than rough thickness. Stock 8/4 and thicker will sometimes require removal of 3/8" thickness to yield a straight board.

#1 refers to "In Stock" at our plant. These are also commonly available at other Hardwood Retailers and Millworkers.

#2 would indicate readily available at a Wholesaler's warehouse, deliverable to your Millworker's plant within 1-4 weeks.

#3 Non stock thicknesses can some times be custom sawn and dried. This generally requires minimum quantities and a long lead time (~6-12 weeks).

#4 Not available.

Hardness

This refers to actual wood density, not to biological classification as a Hardwood or Softwood. (V = Very)

Stability

This is a judgement made from experience. Different species expand or contract variably with a given change in moisture content. Some species will change moisture content more rapidly than others in a given environment. Both of these factors affect stability.

Charts that list shrinkage (USDA Handbook) measure shrinkage from green to KD. This is not necessarily an indicator of ultimate stability in use. Basswood has a very high shrinkage factor from green to KD, but is very stable in use. Poplar has a low shrinkage, but is not as stable as Basswood in use.

KD MC (Kiln Dried Moisture Content of commonly available stock)

Lumber for exterior use is dried to 12-15% MC. A piece of wood left outside, or in a barn, in New England, sheltered from direct rain, will reach an Equilibrium Moisture Content (EMC) of 12-13%.

Lumber for interior use is dried to 6-8% MC. Wood left in a New England heated interior environment will fluctuate between 5-6% EMC in February and 8-9% EMC in August.

Exterior Durability This a judgement of stability and rot resistance.

RESOURCES

The Architectural Woodwork Institute (AWI)
46179 Westlake Drive, Suite 120
Potomac Falls, VA 20165
571-323-3636 FAX 571-323-3630
www.awinet.org

Publishers of the *Architectural Woodwork Quality Standards Illustrated*, the recognized authority for specification standards of Architectural Woodwork, Finish Carpentry, and Wood Doors.

Amherst Woodworking & Supply, Inc.
Copper Beech Millwork (div.)
PO Box 718 30 Industrial Dr.
Northampton, MA 01061
413-584-3003 FAX 413-585-0288
800-532-9110 www.copperbeech.com
E-mail: sales@copperbeech.com

Manufacturers of Architectural Millwork including cabinets, doors, windows, moldings, and monumental fabrications. *The Copper Beech Millwork Book of Moldings*, contains 44 pages of full scale molding profiles. The *Contractor's Price Book* has a priced listing of inventory. Both are supplied free on request.

The Tropical Forest Foundation
Alexandria, VA
703-518-8834 FAX 703-518-8974
tff@igc.apc.org

"TFF's primary mission is to promote sustainable tropical forest management by gathering and disseminating information about its benefits and by demonstrating and teaching proper management practices." The Foundation is supported by trade groups and organizations such as The Nature Conservancy.

Forest Products Laboratory (FPL)
Madison, WI
608-231-9200 FAX 608-231-9592
www.fpl.fs.fed.us

Research laboratory for the US Forest Service. An excellent resource for technical data on North American lumber species.

Forest Products Research Society (FPRS)
Madison, WI
608-231-1361 FAX 608-231-2152
www.forestprod.org

Forest Industry trade research group.

Woods of the World - CD-ROM
Tree Talk, Inc.
Burlington, VT
800-858-6230 FAX 802-863-4344
wow@together.net
www.woodwed.com/~treetalk/home.html

This is a CD-ROM detailing "information on up to 910 wood species and products, covering 95% of all the wood in trade. Common names, uses, distribution, environmental profile, physical & working properties, and mechanical values. Covering all the important species in North America, Europe, Africa, Latin America, and Asia. Full-color pictures. As many as 3,500 species' distribution maps. Products sectors of the more than 135 countries featured on the maps. Searching capability."

The Wood Molding and Millwork Producers Association (WMMPA)
www.wmmpa.com

Establishes standards for production of stock moldings. They have an extensive offering of literature on working with moldings.

Window & Door Manufacturers Assoc. (WDMA)
Des Plaines, IL
847-299-5200 FAX 847-299-1286
www.wdma.org

Sets standards relative to the manufacture of "stock" type doors & windows. Custom and hardwood doors are better specified under the stricter quality standards of the Architectural Woodwork Institute.

The following organizations are responsible for the grading, and/or promotion, of various forest product raw materials purchased by an Architectural Millwork Manufacturer. The grading of the finished product manufactured by the Millworker falls under the rules of the Architectural Woodwork Institute.

California Redwood Association (CRA)
Novato, CA
888-CALREDWOOD
www.calredwood.org

Promotion & technical data. Redwood is graded under the rules of the RIS (listed below)

Fine Hardwood Veneer Association
Zionsville, IN
317-873-8780 FAX 317-873-8788

Promotes the use of veneer. No grading responsibility.

Hardwood Plywood Mfgs Assoc. (HPMA)
Reston, VA
703-435-2900 FAX 703-435-2537

Deals with grading of Hardwood veneered plywood.

National Hardwood Lumber Association (NHLA)
Memphis, TN
901-382-6419 FAX 901-382-6419
www.natlhardwood.org

Recognized grading authority for Hardwood (including Mahogany) & Cypress lumber.

Northeast Lumber Mfgs Assoc. (NELMA)
Cumberland Center, ME
207-829-6901 FAX 207-829-4293

Recognized grading authority for Eastern White Pine, Northeastern framing lumber, & Northern White Cedar.

Redwood Inspection Service (RIS)
Novato, CA
415-382-0662 FAX 415-382-8531

Recognized grading authority for California Redwood

Southern Cypress Mfgs Assoc. (SCMA)
Memphis, TN
901-346-2222 FAX 901-346-2233

Promotes use of Cypress. Cypress is graded under the rules of the NHLA.

Southern Pine Inspection Bureau (SPIB)
Pensacola, FL
904-434-2611 FAX 904-433-5594
www.southernpine.com (Southern Pine Council)

Recognized grading authority for Southern Pine Lumber.

Western Wood Products Assoc. (WWPA)
Portland, OR
503-224-3930 FAX 503-224-3934
www.wwpa.org

Recognized grading authority for Douglas Fir; Sitka Spruce; Western Hemlock; Idaho, Ponderosa, & Sugar Pines; Western Red & Incense Cedars; Port Orford & Alaskan Cedars; and Western framing lumber.

**Tools for Measuring
Humidity & Wood Moisture Content**

Bachrach Sling Psychrometers
portable, accurate RH readings, ~\$90
forestry-suppliers.com

Dixon Temperature & Humidity Recorders
24/7 jobsite recording of RH, \$6-700
dicksonweb.com, 800-323-2448

Delmhorst Moisture Meters
delmhorst.com

Wagner Moisture Meters
541-582-0541

Lignomat Moisture Meters
lignomat.com

6/19/2009

Lumber and Veneered Plywood - Relative Costs, Availability, & Characteristics

Specie (Plain sawn unless otherwise noted)	Retail Cost				Plywood Availability	Lumber Availability Relative to Thickness							Hardness	Stability	KD/MC	Exterior Durability
	4/4 Lumber	Waste Factor	4/4 Lumber Adjusted Cost	Particle Core Plywood		4/4	5/4	6/4	8/4	10/4	12/4	16/4				
Alder, 4/4	\$4.65	1.50	\$6.98	\$3.88	3	2	2	2	2	3	3	4	Medium	Good	8%	Poor
Ash, Natural, 4/4	\$2.80	1.50	\$4.20	\$2.53	3	1	2	1	1	2	3	3	V Hard	Moderate	8%	Poor
Ash, Select White, 4/4	\$3.35	1.50	\$5.03	\$3.22	2	2	2	2	2	3	4	4	V Hard	Moderate	8%	Poor
Basswood, 4/4	\$2.75	1.50	\$4.13		4	2	3	2	2	3	3	4	Soft	Excellent	8%	Poor
Beech, European, 4/4	\$5.20	1.50	\$7.80		2	2	2	2	2	4	4	4	V Hard	Moderate	8%	Poor
Birch, Natural, 4/4	\$4.05	1.50	\$6.08	\$2.12	1	1	2	1	2	4	4	4	V Hard	Moderate	8%	Poor
Birch, Select Red, 4/4	\$7.75	1.50	\$11.63	\$3.64	2	2	4	4	4	4	4	4	V Hard	Moderate	8%	Poor
Birch, Select White, 4/4	\$4.65	1.50	\$6.98	\$2.98	2	1	3	3	4	4	4	4	V Hard	Moderate	8%	Poor
Butternut, 4/4	\$9.30	1.75	\$16.28	\$6.20	3	1	4	3	3	4	4	4	Soft	Good	8%	Poor
Cedar, Spanish, 4/4	\$6.00	1.50	\$9.00		3	1	1	1	1	1	2	2	Medium	Excellent	8%	Excellent
Cherry, 4/4	\$6.40	1.75	\$11.20	\$3.72	1	1	1	1	1	3	3	4	Hard	Moderate	8%	Poor
Hickory/Pecan, 4/4	\$3.80	1.50	\$5.70	\$3.58	2	1	3	3	4	4	4	4	V Hard	Moderate	8%	Poor
Liptus, 4/4	\$6.75	1.50	\$10.13	\$3.64	2	2	2	2	2	4	4	4	V Hard	Moderate	8%	Poor
Mahogany, African, 4/4	\$7.25	1.50	\$10.88	\$3.29	2	2	2	2	2	2	2	2	Hard	Excellent	8%	Excellent
Mahogany, Genuine, 4/4	\$11.05	1.50	\$16.58		4	1	1	1	1	1	2	2	Hard	Good	8%	Good
Maple, Quartered, 4/4	\$7.75	1.75	\$13.56	\$4.03	2	2	3	3	3	4	4	4	V Hard	Good	8%	Poor
Maple, White Hard, 4/4	\$4.15	1.50	\$6.23	\$3.44	1	1	2	1	1	2	3	4	V Hard	Moderate	8%	Poor
Oak, Red, 4/4	\$2.75	1.50	\$4.13	\$2.57	1	1	1	1	1	2	3	4	V Hard	Moderate	8%	Moderate
Oak, Red, Quartered, 4/4	\$4.85	1.75	\$8.49	\$3.10	2	2	2	2	2	4	4	4	V Hard	Good	8%	Moderate
Oak, White, 4/4	\$3.65	1.50	\$5.48	\$3.80	2	1	2	1	1	3	3	4	V Hard	Moderate	8%	Moderate
Oak, White, Quartered, 4/4	\$6.40	1.75	\$11.20	\$4.03	2	2	2	2	2	4	4	4	V Hard	Good	8%	Moderate
Pine, E White Knotty, 4/4	\$1.95	1.50	\$2.93	\$2.51	2	2	2	2	2	3	4	4	Soft	Good	8%	Good
Pine, Eastern White, 4/4	\$5.45	1.50	\$8.18	\$3.60	2	1	1	1	1	2	2	4	Soft	Good	8%	Good
Poplar, 4/4 RW	\$1.75	1.50	\$2.63		4	1	1	1	1	1	2	2	Medium	Moderate	8%	Poor
Sapelle, 4/4	\$6.85	1.50	\$10.28	\$3.10	2	2	2	2	2	2	2	4	V Hard	Good	8%	Excellent
Teak, 4/4	\$27.90	1.50	\$41.85	\$4.65	2	2	2	2	2	3	3	4	Medium	Good	10%	Excellent
Walnut, Black, 4/4	\$8.55	2.00	\$17.10	\$3.81	2	1	2	1	1	3	4	4	Hard	Moderate	8%	Moderate

- Availability Codes
- 1 Stock item at Amherst Woodworking & Copper Beech Millwork and most hardwood dealers
 - 2 Special order 1-4 weeks, likely to involve minimum quantities
 - 3 Special order 6-10 weeks, minimum quantities required
 - 4 Not likely available

Comparative Specie Cost

with Adjustment for Lumber Waste Factors

