Wood is finished to protect and beautify. A finish can make wood more stable, more resistant to abrasion, less susceptible to degradation by chemicals and solvents, easier to keep clean, and more attractive. Wood abrots and releases moisture in response to variation in environmental conditions which can result in dimensional changes leading to problems such as checking and warping. Finishes can slow down the moisture exchange and reduce the movement. A finish can seal the surface and reduce the accumulation of dirt and grime. The natural beauty of attractive woods can be enhanced by proper finishing; the appearance of woods with only modest grain and color can be improved.

Characteristic of wood
Several characteristics of wood can affect the ease of application and the performance of the finished product. Surface hardness can affect durability of wood finishes. The texture of the wood (related to pore size and distribution) may determine if a filler is required to generate a smooth surface. Defects in the wood such as knots generally make the finishing task more difficult and reduce final performance. Initial wood moisture content is very important; the recommended moisture content for interior wood in Iowa is 6 to 8 percent.

Preparing the surface
A superior finish on interior wood cannot be achieved without carefully preparing the surface. Even properly planed lumber must be sanded or scraped to remove minor blemishes and smooth the surface before finishes are applied.

Many woodworkers prefer a hand or cabinet scraper over sandpaper to smooth the wood surface. A scraper can either be pushed or pulled across the surface resulting in ribbon-like shavings. A very smooth, uniform surface can be achieved with a high quality, properly-sharpened scraper in the hands of a skilled craftsman.

Three types of abrasives are generally available for sanding wood surfaces: aluminum oxide, garnet, or silicon carbide. The first two abrasives are often preferred for raw wood sanding, while silicon carbide may be the choice for sanding finishes. Sandpaper comes in a variety of numbered grits from coarse to very fine; some expert woodworkers start with 80 grit paper and gradually move to 180 or 220. Various types of hand sanding machines are available ranging from belt sanders to orbital sanders. However, the final work often must be done by hand. Patching and filling minor cracks and holes with wood putty followed by sanding may also be required.

Work room requirements
An ideal wood finishing room would be dust-free and well-ventilated with carefully controlled temperature and humidity. Although these requirements cannot always be completely met, it is very important to minimize dust problems and provide cross ventilation. If the work room temperature cannot be controlled, restrict actual finishing activities to periods when temperatures are between 60 and 90 degrees F.

Finishing equipment and tools
A variety of application techniques can be used for finishing interior wood surfaces. Even cotton rags can be used for some wood finishing operations; synthetic fabrics are not very absorbent and are not recommended. Paper towels can also be used.

There are generally three different kinds of brushes used in finishing: natural bristle, synthetic bristle, and...
foam. Natural bristle brushes are made from animal hair; synthetic bristles are made from polyester or nylon. Natural bristle brushes do not perform well in water-base stains or finishes; most painters and finishers prefer natural bristle brushes for applying solvent-base finishes. Desirable qualities to look for in bristle brushes are: bristles arranged to form a chisel shape (not cut off square); bristles are tapered (thinner at the tip); and the tip of each bristle is split into several strands. Foam brushes don’t leave brush marks, but may leave ridges at the edge of each brush stroke. Such brushes are inexpensive and are usually discarded after use. Another option for applying finishes to flat surfaces are special pads mounted in plastic or metal holders.

A spray gun is perhaps the most efficient tool to apply wood finishes. An almost perfectly smooth and level coat of finish can be applied to a large surface in a short time. Spray guns shoot a stream of fluid that is broken up into a mist of tiny droplets by air jets—a process called atomization. The two common types of spray guns used in wood finishing are either low volume/high pressure or high volume/low pressure. Best results are achieved when the spray gun is held perpendicular to the surface and moved in a straight line over the wood. Use a spray booth with an explosion-proof fan when applying these finishes.

Types of wood finishes
A large number of wood finishes are available for home shop use. Finishes can be classified as either film-forming or penetrating; film-forming finishes can either be opaque or transparent. Film finishes typically protect better than penetrating finishes because a hard, relatively thick film results. Such finishes also offer more decorating alternatives than penetrating finishes. However, penetrating oil finishes are easy to apply and produce a pleasing natural appearance. Because of these characteristics, penetrating oils have become increasingly popular in recent years.

Penetrating finishes
Four different finishes are sold as “oil” finishes: straight oil (tung or linseed); polymerized oil (tung or linseed); thinned varnish (a wiping varnish); and a blend of straight oil and varnish (often sold as “Danish oil”). Straight oil does not typically perform well as a wood finish, and polymerized oil is expensive and not widely available. Thinned or wiping varnishes offer more protection and are recommended where a glossy sheen or a thicker film is desired. Oil/varnish blends are typically easier to use than the wiping varnish products and are the best choice when a satin or rubbed appearance is desired.

Oil finishes are very easy to apply. For the first coat, flood the wood with the finish using a cloth, brush, spray, or dip. Let the finish remain wet for several minutes; wipe off all excess finish before it becomes tacky. Allow the first coat to cure overnight, smooth any roughness with very fine sandpaper, clean off the dust, apply the next coat, and again wipe off the excess finish. Apply as many coats as desired allowing at least 24 hours of drying between coats. Smooth the final coat; to develop the desired sheen by rubbing.

Although deep penetration may be possible with oil finishes, little protection of the wood surface results. Surface scratches will not be prevented nor will stains or water damage be substantially reduced by oil finishes. In contrast, film forming finishes protect wood by building a film on the surface.

Staining
Preliminary to applying a transparent, film-forming finish stain is often applied to add beauty, richness, depth, and color to the wood. Proper application of stain can smooth natural color variations in wood and even help disguise problem areas. Unfortunately, staining can also cause difficulties; splotching, streaking, color unevenness and even incompatibility with the film finish can result.

The colorant (pigment or dye), the binder (oil, varnish, lacquer, or water), and the thickness of the product (liquid or gel) define the type and the performance of stains. The following types of wood stain are currently on the market: pigment in an oil-based binder, pigment in a varnish-based binder, pigment in a lacquer or short-oil varnish binder, pigment in a ware-based binder, pigment and dye in an oil-based binder, pigment and dye in a water-based binder, asphalt in an oil/varnish binder, and pigment or dye in a varnish or acrylic-based gel.

Pigment colors wood by accumulating in depressions such as pores and scratches; it can also color wood by building on the surface. Dye colors wood by saturating the wood fibers and penetrating more or less equally in all areas. Binder is the glue that holds pigment particles to the wood; the type of binder influences the time allowable to wipe off excess stain. Oil binders cure slowly, varnish and water-based binders cure somewhat faster, and
lacquer binders cure very quickly. Most stains are liquids, but some are sold as gel or pastes. One feature of gel stains is reduced penetration into the wood compared to liquid types.

Several characteristics of wood affect how wood reacts to different types of stain. The size, distribution, and orientation of the pores and the fiber density all influence the way in which woods stain. For example, the pores on maple and birch are too small to hold much pigment so dye stains tend to be more effective. The uneven distribution of large and small pores on woods such as oak, ash, and elm are typically accentuated by pigmented stains; achieving a uniform color across the surface is difficult on such woods. Stains penetrate more easily into end grain than into side grain; this unequal reaction can cause a major difference in stain color. Irregular density of fiber walls is believed to be a primary cause of localized irregular staining (splotching) in pine, cherry, birch and maple.

Stains can either be applied to bare wood or to sealed or partially sealed surface. Soaking the bare wood with colorant emphasizes the wood’s grain, but also may highlights any problems. Applying a stain to sealed or partially sealed wood adds color without highlighting the wood’s figure or problems, but penetration is obviously limited. Wipe, brush, or spray the stain on bare wood (or dip the article in stain). Either wipe off the excess before it dries, or leave a film of stain on the wood. Partially sealing the wood before staining will reduce the contrast between side grain and end grain, reduce splotching caused by variation in surface density, mute the visual impact of the woods natural characteristics, highlight the wood’s pores without changing the color of the wood, make different woods similar in color, or fine tune a color match. The process of staining completely sealed wood or applying a colorant between coats of finish is called “glazing.”

**Filling**

Variation in the size and distribution of pores among different species results in differences in surface texture of wood. Maple and cherry have a smooth even texture, walnut and mahogany have a coarse even texture, and oak and ash have an uneven texture. Large pored woods require filling, if a very smooth surface is desired. There are two primary ways to fill (or partially fill) the pores of wood; use either the finish itself as a filler or apply a separate paste wood filler. Application of several coats of finish (combined with carefully sanding between coats) can fill the pores. Or, special paste wood fillers can be used; these products can be purchased with or without color. By far the most common type used is linseed-oil-and-varnish-based paste-wood fillers. Proper use of such products involves applying a thick coat of filler to the wood surface with a cloth or brush, pushing the filler into the pores with a wide plastic or metal spreader, removing the excess filler by rubbing across the grain with a coarse cloth, wiping lightly in the direction of the grain, and then allowing the filled wood to dry for several days before applying the final film finish.

**Transparent film finishes**

The five common film finishes used in woodworking are: shellac, lacquer, varnish, water-base, and conversion. These types of film finishes have different curing mechanisms: evaporative, reactive or coalescing. Shellac and lacquer cure by evaporation of their solvents—alcohol for shellac and lacquer thinner for lacquer. Varnish and conversion finishes are reactive—these finishes change chemically when they cure. Water-base types are classified as coalescing finishes and consist of tiny dispersions or droplets of a cured reactive finish emulsified in water. How a finish cures (changes from liquid to solid) is related to the performance characteristics. In reactive finishes, molecules crosslink (polymerize) during curing; the resulting film is much more resistant to heat, scratches, and chemicals and is less penetrable than wood finishes that cure by evaporation. However, evaporative finishes cure quickly and are the easiest to rub to an even sheen; this type is also the easiest to strip and repair. Coalescing finishes are difficult to scratch, but this type is easily softened or dissolved by heat and a number of solvents and can be penetrated by water and water vapor.

Consider appearance, protection, durability, ease of application, safety, reversibility, and ease of rubbing when selecting a film forming finish for a particular project. Appearance depends, in turn, on film build, clarity, and color. Protection refers to resistance to penetration of water and the exchange of water vapor. Durability relates to the resistance of a finish to abrasion (scratches or wear), solvents, acids, alkali, or heat. Ease of application depends on the speed at which the finish cures, the mechanism of curing involved, and the availability of spray equipment. Three aspects of safety should be considered: safety to the applicator, safety to the environment during application, and safety to the ultimate consumer. Reversibility refers to the ease...
of repair and removal of the finish. The ease of rubbing a finish to an even sheen is affected by hardness and by the ability of the different coats to fuse.

**Shellac** has excellent resistance to water vapor exchange, provides a superior barrier to staining, can have excellent clarity, and has good rubbing properties. However, this finish has very weak resistance to heat, water, solvents, and chemicals and only moderate resistance to wear.

**Lacquer** is very fast curing, has excellent clarity and depth, and has superior rubbing properties. This type of finish does have a high solvent content, and is only moderately resistant to heat, wear, solvents, chemicals, water, and water vapor.

**Varnish** has excellent heat, wear, solvent, chemical, water, and water vapor resistance and brushes well. However, it can be very slow curing and tends to discolor (yellow) over time.

**Water-based finishes** have minimal solvent fumes, have easy cleanup, are very scuff resistant, exhibit no fire hazard, and are nonyellowing. This type of finish raises the grain of the wood, is only moderately resistant to heat, solvents, chemicals, and water vapor.

**Conversion finishes** possess excellent heat, wear, solvent, chemical, water, and water vapor resistance and are very fast curing. However, these finishes are characterized by a highly toxic solvent and formaldehyde emission resulting in flammable and air polluting fumes; conversion finishes are very difficult to strip and nearly impossible to repair.

Matching a finish to the performance requirements of the application is critically important. One primary consideration in selecting a finish is the type of equipment available. If spray equipment is available, shellac, lacquer, conversion finishes, or water-base coatings may be the best choices. Maximum protection and durability would be provided by a conversion finish; desirable reversibility, clarity, and rubbing qualities are characteristics of lacquer and shellac. Water-base finishes minimize the amount of toxic, flammable, and air polluting solvents and produce a totally nonyellowing coating. If brush applications are the only option, solvent-based polyurethane varnish will provide the most protection and durability followed by phenolic and alkyd varnishes. Brush applied lacquers or shellacs can promote reversibility; water-base finishes can reduce solvent emission problems. Always review the manufacturers recommendations, before applying any type of finish.

### Finishing the finish

The appearance of a quality finish can be greatly enhanced by “finishing” the finish which generally involves rubbing with abrasives usually in combination with a lubricant. The goals are to smooth and level the surface and to generate a softer appearance or a desired sheen. The results achieved by rubbing will be influenced by the type of finish, the level of curing, the type of rubbing abrasives and lubricants used, the rubbing schedule, the cleanup, and the final waxing or polishing. Hard, brittle finishes are easier to rub than tough finishes; varnish, conversion finishes, and water-base coatings are the most difficult to rub. Make sure that the finish is adequately cured; one good rule of thumb is to wait a month before rubbing. Sandpaper is used to cut back the surface and eliminate irregularities, steel wool is used to impart an even satin scratch pattern, and rubbing compounds are used to produce higher sheens. A lubricant (mineral spirits, wax, oil, soapy water) is used with sandpaper and steel wool. Two schedules can be used to rub a finish: level the surface with sandpaper before rubbing with steel wool or rubbing compounds, or skip the leveling and begin with steel wool or rubbing compounds. Carefully clean the surface after the rubbing is complete. Blow the dust off with compressed air or wipe lightly with the grain using a tack rag or a cotton rag dampened with mineral spirits. Finally, apply a paste wax to a rubbed surface to reduce wear.

### Reference

Much of the information in this extension publication came from a 1994 book published by Rodale Press and authored by Bob Flexner entitled: UNDERSTANDING WOOD FINISHING-How to Select and Apply the Right Finish. This 310-page book sells for $27.95.