The Art of Finishing

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There is no mystery about finishing, just lots of hard work. It takes an understanding of what to do and why, a willingness to spend time and effort in preparing the surface, applying an appropriate finishing product and then being willing to "finish the finish." Finishing is much more than just applying some product. Finishing is an art that has 4 "simple" components:

Surface Preparation
Appropriate Finishing Products
Techniques
Finishing the Finish.

Because these are all individual in their application, there are as many different finishes as finishers.

Finish

What is a finish? The simplest definition is anything that **preserves** and **enhances** an item for the **specific application** intended. Therefore consider the environment and application of the object to determine the optimum finish. Seldom is one finish the *perfect* finish.

All the available finishes can be grouped into 2 categories:

1. **Evaporative**
2. **Reactive**

<u>Evaporative</u> type finishes all consist of something dissolved in some solvent such that when applied, the solvent will evaporate away leaving a film of material that provides some preserving and enhancing or beautifying of the surface of the item. This film is a topcoat and doesn't enhance or highlight the grain of the wood. Generally, with repeated applications, the film can be thickened or built-up to increase the protection or beauty or both. For woodturning, the most practical examples of evaporative finishes are waxes, shellacs and lacquers.

Wax is probably the oldest known finish. A wax finish can be made from either natural or synthetic waxes dissolved in natural or synthetic solvents. The earliest wax was probably beeswax dissolved in naturally found turpentine. Modern waxes may have synthetic wax like paraffin dissolved in mineral spirits, both of which are made from hydrocarbons. To make beeswax, simply place a piece of beeswax into a metal container and add a small amount of solvent – either turpentine or mineral spirits. With a lid on to prevent evaporation of the solvent, this can then be placed in the sun to heat and dissolve the wax into a paste. Also, a double boiler or crock-pot works well. Solvent is added until the mixture makes a paste about like stiff peanut butter. Depending on the cleanliness of the beeswax, a wing or leg may be found floating on the surface. While warm, the unwanted parts may be skimmed off the liquid wax. Wax may be used as a finish but it doesn't have much durability and breaks down with handling. For this reason, wax is usually used as the final step in "finishing the finish" to add feel and shine to an item.

Shellac became popular during the time the English ruled the sea. In northeast India, the *Coccus lacca* bug would collect on small twigs of a species of fig tree. Each small bug would bore into the tree and feast as the sap moved up and down the tree. Then the bug would secrete a hard substance out of its skin forming an encrustation or shell. These bugs would congregate by the millions and the secretions would produce a hard, ruby colored encrustation on the limb, up to ½" thick. This gum or resin is commonly called *lac* (meaning 100,000 in Latin). The name comes from shell and *lac*. These were gathered, mixed with arsenic sulfide to speed the melting and placed into long cloth tubes. The tubes had their ends twisted and were held over hot coals to melt the mixture. As the tube ends were twisted tighter, a molten substance was squeezed out of the cloth tube. This was collected and placed in a pan of cold water to solidify into sheets, which were then broken into flakes. It takes approximately 1.5 million bugs to make a pound of shellac flakes. These flakes are dissolvable in alcohol. Typically, a shellac mix is specified as weight/gallon of alcohol. For many applications, a 2 lb cut is specified which means 2 pounds of shellac flakes per gallon of alcohol. This equates to 1 lb/ ½ gallon of alcohol or ½ lb/quart. If you don't want to measure and weigh, then using a pint mason jar, fill the jar half way with flakes and fill with alcohol to make a 2 lb cut.

Shellac produces a very hard surface that will not dissolve easily unless exposed to alcohol. It will water spot if a cold glass sweats on it. An alcohol-dampened rag will remove this water spot. With repeated applications, the surface can be built to produce a high luster. The color of shellac flakes can be used to color the wood or to add patina.

All shellac has some wax in it from the production process. This wax clouds the finish and can be strained out during the mixing process. Also, de-waxed shellac can be purchased. Some recommend using 180 proof drinking alcohol such as *Everclear* but denatured alcohol purchased at a home improvement store works fine. Do not leave the alcohol container open as alcohol tends to absorb moisture readily which will cloud the shellac. Shellac has a shelf life after mixing so watch for clouding or sediment. If you think it has gone bad, discard and mix more.

Lacquer is a relatively modern evaporative finish. Between the 1700s and 1900s, cotton was king around the world, especially in the southern U.S. During the late 1800s, it was discovered that cotton could be soaked in nitric acid to produce nitrocellulose, a highly flammable compound and an important ingredient used in smokeless gunpowder. During WWI, the U.S. produced huge amounts of this cellulose and at the end of the war, had a tremendous surplus. To utilize this surplus, it was discovered that the nitrocellulose would dissolve in a combination of solvents. The resultant cellulose mixture would evaporate the solvents very quickly leaving a hard, durable film. Prior to WWI, the automobile industry used slow drying varnishes on their wooden body frames. This new mixture became especially important to the auto industry with its ability to be sprayed and to dry quickly. Because of its speed of application and its ability to produce a deep luster finish, it became the finish of choice on many automobiles. This mixture was called lacquer and the combination of solvents became known as lacquer thinner.

Today, a new lacquer is available with water as the primary solvent, hence the name water-based lacquer. These still contain a small percentage of organic solvents because they form an essential component for film formation known as coalescing solvents. As these solvents evaporate, they are encapsulated by water that evaporates with them causing minimal health hazard. Thus this water-based lacquer doesn't have the health or fire potential of conventional lacquers but still dries quickly and builds to a nice thickness for turning finishes. A minor problem with being water-based is a tendency to raise the grain during the initial application. Thus a light sanding is required before applying additional coats.

Pros and Cons

Evaporative finishes like shellac and traditional lacquer offer a quick drying and building finish but expose the woodturner to volatile and potentially health damaging solvents over time. Because they are substances dissolved in some solvent, both shellac and traditional lacquer will re-dissolve if the finished surface comes in contact with their solvent. A spilled alcoholic drink can ruin a shellac tabletop and water can spot the surface. Because plastics are made from solvents and continue to out-gas forever, plastic items in contact with lacquer finishing can produce sticky spots on the surface. (There is a reason for coasters after all!) Water-based lacquers will not re-dissolve in water and do not provide the level of health concerns as traditional lacquers, but do require some additional sanding to remove raised grain. With all lacquers, many coats are required to "build-up" a finish.

Reactive finish implies one substance chemically reacting with another to produce a third. Usually, oxygen is what the substance reacts with in most reactive finishes. An exception would be epoxy, which has a hardener or catalyst to start the reaction. As the base substance reacts with oxygen or oxidizes, it produces heat and cures or hardens, from the inside, to produce a surface that preserves and enhances the wood surface. Oil based paint is an example of a finish that cures producing an opaque colored surface. For woodworking, the primary reactive finishes are oils, varnishes and a relatively new application of an adhesive, CA glue. With each coat, these finishes will build to a thickness that enhances the luster and protection of the surface.

Oils by themselves soak into the fibers of the wood and darken or highlight the grain. With time, the oils will react with oxygen in the air (oxidize) to harden and form a moisture barrier thus providing some protection and enhancement. Because of the slowness of curing, oils by themselves make a poor finish. The primary oils available for finishing are boiled linseed oil (BLO) and tung oil. For wooden items that will be in contact with food, mineral oil is a good choice to enhance the look and provide some protection. Mineral oils do need to be renewed.

Varnishes are made by combining resins, oils and a solvent and have been used to preserve wood since the age of the pharaohs. Mummy coffins have been found that were coated with a thick varnish, probably applied with hands or a spatula type device. The Greeks imported a beautiful resin known today as amber from Denmark or France. The name varnish comes from the Greek word *Pheronice*, pronounced with a sound like our *V* for the *Ph*. *Berenice* was the Greek name for the wife of Ptolomy, one of the 4 generals who divided the empire of Alexander the Great at his death in the third century BC. Her hair was golden colored and she vowed that she would sacrifice her golden or amber colored hair on the altar of Venus so her husband the King, would safely come back from a war in Asia. Because the imported resin was the same color as her hair, it was referred to as *Berenice*, which could also be written in Greek as *Pheronice*. In Latin, it took the form of *Verenice*, later changed to *Vernix* which is the root word for the word varnish.

Understanding that craftsmen could not go to their local store and buy a finish, meant everyone had to develop their own type and formula, as well as make it. Recent analysis of *Stradivarius* violins and cellos, valued for their tonal qualities, has shown that although the wood and construction techniques do play a major role in producing the treasured sound, the finish used also contributes to the "voice" of the instrument. For sure, *Stradivarius* used his own formulated form of varnish, probably consisting of local resins, oils and solvents and possibly some secret ingredients that were added to his trade secret, shop made brew.

Today, most varnishes are made with resins from natural fossil gums, linseed oil or tung oil, and turpentine or mineral spirits as a solvent. (Polyurethane varnishes are varnishes made with all man-made resins, oils and solvents or some combination of man-made and natural; they are still varnishes.) These are cooked and driers made from metal oxides are added to speed the curing process. The resins, whether natural or man-made, harden giving the film a luster, brilliancy and resulting durability. In other words, resins give body (thickness) while adding beauty and utility to the surface. In North America, the most used resin is rosin from pine trees. The oils are oxidizing or drying oils that act as a carrier for the resins, to provide elasticity and to be a binder for the gums. These drying oils are the vehicle of the varnish. The solvent is a volatile liquid that makes the varnish more fluid for easier application resulting in a finish that can be applied with a brush and that will let brush strokes flow together. The metallic driers such as red lead, dioxide of manganese or some of the other salts of lead, increase the rapidity of the oxidation of the drying oil with dissolved resins. Finally, varnishes are available for many applications but it is getting more and more difficult to find these specialty varnishes. Spar varnish is still readily available and was developed to make flexing spars and masts of wooden sailing ships more resistant to water. It was made by adding extra oil to give it more flexibility and water resistance. Most natural varnishes have been replaced by synthetic varnishes (polyurethane, etc.). Many synthetic varnishes will have ultraviolet (UV) light protection added for outdoor applications.

Many finishers prefer a tung oil finish, but unless using pure tung oil, which is very expensive and slow to dry, all tung oil finishes are a varnish made with the oil processed from the tung tree nut. Tung oil is often referred to as China Wood Oil and it is claimed that the Great Wall of China is preserved with this oil. Pure tung oil varies in color from pale in high quality oils to dark brown in oils of poor quality and is superior to linseed oil in its drying or oxidizing properties. When combined with rosins from pine tree gum, tung oil produces a varnish that dries faster and harder than varnishes made from linseed oil.

The biggest variant in varnishes is not the type oil used or the solvent but rather the type and amount of resin included. These resins, sometimes referred to as solids, determine the speed that the finish will build and also the amount of coloring the surface will exhibit. The more solids in a varnish, the darker the finish but the quicker and less number of coats required to build the desired thickness. Every brand is different so the woodworker needs to experiment with each to find the optimum finish for his application. For example, a brand with high solid content will not darken dark wood as much as light wood and therefore may be great for walnut but not for maple.

Varnishes may be made in the shop by using a seed varnish for resin and combining the following ratios:

Solvent	2
Oil	1
Resin seed varnish	¼.

If you start with a quart of seed varnish, then you would add 1 gallon of oil and 2 gallons of solvent. Also, BLO may be added to spar varnish using a 50-50 ratio to produce a renewable oil finish with good water repellency.

Cyanoacrylate glue (CA or Superglue) was first developed during WWII by Kodak Research Labs. It was labeled cyanoacrylate and was later marketed as "Eastman 910" by Eastman Company. During the Vietnam War, it was especially popular with the M.A.S.H. units for bonding of human tissue rather than using sutures. As an adhesive, it has a superior bond strength, fast curing characteristics, good storage stability and long bond life. During formulation, CA has stabilizers added to keep the adhesive from curing in the bottle. When applied to a surface, it reacts to the PH level on the surface created by water vapor usually associated with the relative humidity of the air. The moisture neutralizes the stabilizer, starting a curing process that forms a polymer chain bond once the parts are mated together. The structural strength is formed in seconds. Because wood has various levels of PH and moisture, the curing time will vary. An accelerator can produce a chemical reaction rather than a moisture reaction. Too much chemical accelerator can cause the CA to bubble due to excessive heat from the chemical reaction. As a rule, in woodworking, it is best to let CA react with moisture to avoid the foaming action. If an accelerator is required, Commercial Accelerators, acetone, fine water spray or even water with baking soda will change the PH level and start the desired bonding/curing reaction.

In woodturning, CA has been used to bond splinters, fill cracks, adhere wood to glue blocks and for a finish. Because of the rapid curing time, it works best for finishing on small surfaces such as pens.

Pros and Cons

Oils will "pop" the grain of some woods enhancing the overall appearance but because of their slow drying time and tendency to break down when exposed to light and moisture, by themselves they are not a preferred finish. The exception would be mineral oil for surfaces in contact with food products.

Varnishes hold up well over time and provide a good moisture barrier but tend to color the wood, darkening it. This darkening can be a feature on some light woods with open pores such as ash or oak. Synthetic varnishes tend to produce a harder finish, which is not as elastic as natural varnishes. As wood moves over time, this harder finish can crack and chip.

CA provides a very quick finish on small items. Because it hardens so fast, it is not possible to coat a large surface such that a seamless surface appears. Using an accelerant also can produce foaming or bubbles that look abnormal. Eye protection should always be used when applying CA glue.

Preserving in the Container

Both evaporative and reactive finishes can be damaged while in the container. With evaporative finishing, leaving the container open to the air will result in evaporation of the solvents and hence, a change in the concentration of the finish. Usually, solvents can be added back to make up that lost to evaporation.

If most reactive finishes have prolonged exposure to air, the finish product will begin curing or drying in the container resulting in a gummier and gummier finish until eventually, the product will completely harden and can not be reconstituted. To prevent this damage to reactive finishes, the air must be removed from the container. Several techniques exist including transferring the finish to a flexible container and squeezing the air out, putting a balloon in the top of the container and blowing it up to fill the space above the liquid, and adding marbles to the container to raise the liquid level and hence forcing the air out. If exposure to air has already sufficiently occurred, the product may harden anyway producing marbles coated with hardened finish. Air evacuators such as used for wine bottles, work very well. Stores such as *Bed, Bath & Beyond* carry *Vin u Vac,* which consists of 3 check-valve stoppers and a hand vacumm pump for about $16. Using empty wine or beer bottles to store the finish, the air can be sucked out of the top of the bottle and the finish will last a long time. *Bloxygen*, another product that will displace the air, is available from woodworking stores such as *Woodcraft* for about $11. It consists of a pressurized can of a heavier-than-air gas that can be squirted into the container and will form a layer of inert gas between the liquid finish and any air in the container.

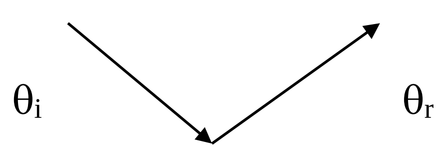
Surface Preparation

Surface preparation is critical to producing quality finishes and can have up to 3 components:

Filling pores
Sanding
Stain/dye.

Before addressing these components, it is helpful to consider some optics. Willebrord Snell, a Dutch astronomer, recognized in the 1600s that when light strikes a perfectly reflective surface, the angle of incidence, θ_i , of the light equals the angle of reflectance, θ_r, as shown in **Fig 1**.

Fig 1.

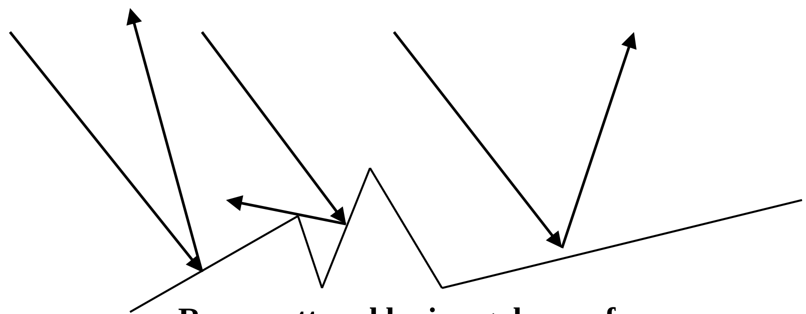


Perfect Reflector

$\theta_i = \theta_r$

When the surface is not a perfectly reflective surface, but rather has many scratches, even very small scratches, the light still obeys Snell's Law and is scattered as each ray of light hits different angled surfaces. See **Fig 2**.

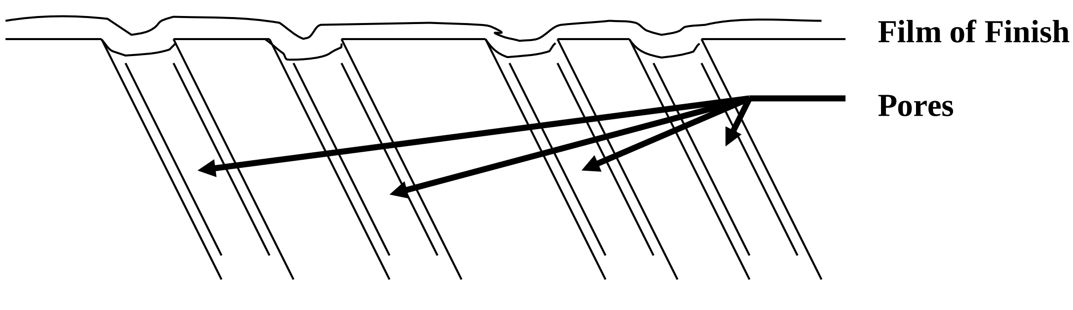
Fig 2.



Rays scattered by irregular surface

Filling the Pores-As you have often heard, wood is like a bundle of straws running with the grain. These straws or tubes carry the nutrients required by the tree. When these straws or tubes come to the surface, like in end grain or on quartersawn oak or ash, you have open pores. If you do not fill and level these openings, then your final finish will sag into these pores and not produce a smooth reflective surface. (See Fig 3.) Many ways exist to fill these pores including commercial fillers such as *Mylands'* sanding sealers with cellulose, varnish and pumice, and wet sanding of reactive finishes. Whatever type filler used, enough should be applied so that when the dried surface is sanded, the pores will be full and level. <u>Sagging pores do not produce a flat surface for finishing</u>.

Fig 3.



Cross section of sagging pores at surface with film of finish

Crack or gap filling can be accomplished with the help of CA glue. CA will stop cracks from spreading as the piece is turned on the lathe. When used with fillers such as dust, coffee grounds, pumice, charcoal or ground stone, CA will fill the crack or gap so it can be turned or sanded level with the surface. Avoid accelerants since they tend to foam the CA leaving very visible white cracks. Also, colored CA glues are available to produce black or brown crack lines.

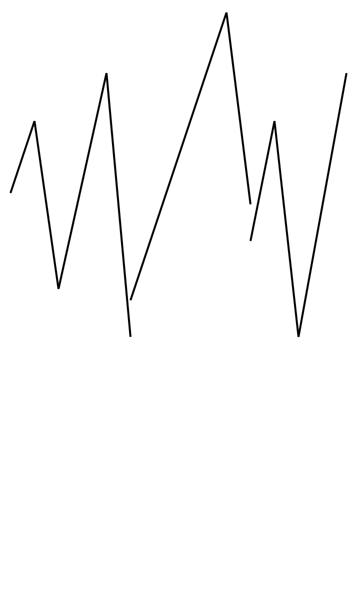
Sanding-Generally, turned items require a uniform and smooth surface to produce an exceptional finish. Uniformity usually comes from turning techniques and results in a surface that flows along gentle curves and has symmetrical patterns. All ridges and dips should be turned away. Shear scraping will also level out ridges and dips.

Smoothness comes from sanding and yes, all woodturners sand their turnings. Several techniques can be employed to enhance the process including power sanding using a drill, sandpaper using a foam-backing pad or sandpaper using a wooden block – all while still on the lathe. On soft or punky wood, it is essential to utilize some type of hard backing to avoid sanding dips into the soft areas. A small block of wood with sandpaper wrapped around it works well because it will “bridge” the soft area, thereby avoiding faster removal of material in the soft area.

If CA glue is used to fill cracks and gaps, it will produce a mount above the desired surface requiring additional turning or scraping to level the surface as much as possible. The block of wood with sandpaper wrapped around it will also work well to level the mount to the surface.

Before discussing sandpaper, consider what is happening during the sanding process. Assuming you start with 100 grit paper, the surface under magnification will look like

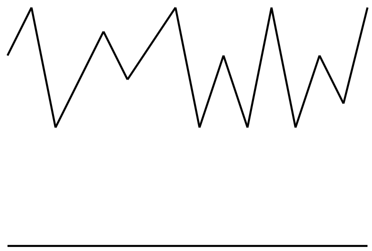
Fig 4.



100 grit

As you progress to a finer grit paper, say 150 grit, the surface will appear as

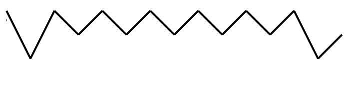
Fig 5.



150 grit

Going one grit finer to say 220 grit, will produce a surface that appears as

Fig 6.



220 grit

As you can see, the progressive sanding with higher grit paper yields smaller and smaller hills and valleys while reducing the thickness of the surface. This is the key to good surface preparation, i.e., progressive sanding to reduce the hills and valleys.

To produce that high gloss finish on any surface, it is essential that the surface be uniform and extremely smooth both before the application of the finish material and after the finish has hardened. So to have this smooth surface before application, the turner must use progressive sanding after the final fine cut with lathe tools. This is accomplished by first sanding in a random pattern and then using higher and higher grit paper. The old adage is still very true, “use your paper like someone else is paying for it.” Don’t just keep on using the same piece as sandpaper wears out and/or clogs. Slowing down the speed of the lathe and power sander will help avoid clogging.

Typically, use the 150% rule to move to finer sandpaper. If starting with 100 grit paper, then 150% calls for using150 grit next. Another 150% on top of 150 grit calls for about 220 grit, etc. Another way to calculate quickly is to take half the current grit and add to get the next recommended grit. Half of 100 grit is 50 yielding 150 grit. Half of 150 grit is 75 yielding about 220 grit. Be careful as you go back and forth between North American and European paper grits. As **Chart 1** (see page 17) shows, the grits crossover at about 220 grit meaning as you go higher and higher in grit, you can’t change back to the other classification without possibly undoing the surface you are sanding. For most applications, starting with 100 girt and sanding through to about 320 grit is sufficient sanding before applying a finish. If the final look is intended to be glossy, then higher sanding to 600 grit may be required. Sanding too fine may prevent some finishes from penetrating and adhering to the surface.

Stain/Dye

More optics-White color is defined as having all the colors of the spectrum. Black is defined as the absence of any colors. When white light hits a surface, some or all the energy is reflected. If this reflected energy is colored, say red, this implies that all colors except red were absorbed at the surface. Reflected color is the light energy not absorbed by the surface.

Stains work by suspending opaque particles of pigments within a binder, usually thinned varnish but may be oil or water-based lacquer. When applied, the varnish acts as a carrier and binder for the particles, depositing them on the surface, in the pores and scratches of the surface and adhering them to the surface. When light hits these particles locked to the surface, they absorb and reflect light energy producing a solid color. Stains are generally used to make a cheaper wood look like a higher price wood, i.e., turn pine into walnut, but are very useful to highlight grain, especially open pore wood such as oak or ash. On furniture, a major problem with stains occurs in corners where the particles tend to pile up making the final finish look very dark in these areas. On turnings, this darkening can occur at the bottom of beads. Applying stain usually consists of wiping on, then wiping off the excess after a few minutes, leaving the stain in the open pores, scratches, etc., without coloring the wood.

Dyes are colored solutions that work by tinting or saturating the surface fibers with color such that selected colors of light energy are reflected. Unlike stains, a binder is not required because instead of particles to reflect light, dyes are molecules that penetrate into the wood fibers and adhere on their own, thus the fibers themselves, not opaque particles, reflect selected colors. More dye penetrates deeper resulting in a deeper and richer coloring. As the wood figure changes, the penetration of the dye varies producing the characteristic fiddleback patterns in curly* maple.

Natural dyes are colored solutions made from leaching the natural color from some organic item in a solution of water, alcohol or some other solvent. Walnut hulls and tea are simple examples of natural dyes. Soaking walnut hulls in alcohol or water will leach the walnut color producing a dark brown walnut dye. Man-made dyes, called Aniline Dyes, were originally obtained in the mid 1800s by treating indigo with caustic potash producing an oil called aniline. These naturally made aniline dyes were predominately used in the textile industry; today the dyes are made from hydrocarbons but still carry the name Aniline Dyes. These hydrocarbon dye powders can be dissolved in water or alcohol to produce a liquid dye. Adding other elements such as iron, tin, chrome, alum, cobalt, etc., can produce other color variations. Mixing of the primary colors (red, blue & yellow) will produce secondary colors. This mixing can be in powder form or liquid. Also, application of one color onto another can produce a secondary color. For example, if blue dye is applied to wood, followed by yellow dye, the result is green.

All dyes are characterized by fading due to exposure to light or UV radiation such as florescence bulbs. The light radiation bleaches the colored wood fibers over time and is called lightfastness. Typically, alcohol dyes will fade the most and the fastest; water-based will fade the least. Metals (called mordants) can be added to the powdered dye to decrease the fading. These metalized dyes are dissolved in glycol ether to make a concentrate that the user can either dilute in water, alcohol or lacquer thinner. This concentrate is often called NGR meaning non-grain-raising. If the concentrate is diluted with water, it will raise the grain but the dye is still referred to as a NGR dye.

Dye application can be either wiped, brushed or sprayed onto the wood. Because the alcohol evaporates rapidly in dyes dissolved in alcohol, it doesn't have a very long open time. This means the user does not have much time to even out the coloring. Wetting using alcohol spray will allow some color adjusting while wetting with more dye will darken the overall color. The rapid drying time of alcohol based dyes is an advantage to woodturners because many coats or different colors can be applied without having to wait for the wood to dry. This drying process can be speeded up by flaming the wet dyed wood with a lighter to burn off the excess alcohol.

Wood may have the dye applied over a large area producing a uniform colored surface or can be applied in small areas to enhance the surface color. Folded paper towels work well for enhancing by dabbing rather than wiping the dye solution. Dabbing with small folded towels and different colors can produce striking surface effects. If different alcohol based colors are applied as an enhancement, an alcohol spray mist will blend the colors where they meet.

Dyes may be used to make toners or colored protective coating finishes. Adding water-based dye to finishes such as Hydrocote water-based lacquer will produce a colored topcoat finish which will build color depth similar to multiple coats of spray lacquer paint on automobiles. Adding alcohol based dyes to a shellac finish will yield colored shellac finishes. Also, oil based dyes are available for tinting oil finishes.

Table 1 presents the advantages and disadvantages of the different type dyes available for turners.

Table 1

Type Dye	**Water-based**	**Alcohol-based**	**NGR**
Advantage	Long Open Time for Color Evening, Good Lightfastness, Deep Penetration, Cheapest	Quick Drying, Good Color Blending	Long Open Time, Best Fade Resistance, Best for Toning/Tinting
Disadvantage	Raises Grain, Long Drying Time	Short Open time, Fading	Some Grain Raising if Diluted with Water, Expensive
Brand	TransFast	Behlen	TransTint, Solar-Lux
Metalized for Fade Resistance			X

Dye Characteristics

Stain Dyes are a stain with dye added to the binder. This results in opaque particles bound in the open pores, grains and scratches while the wood fibers are colored. Most stains purchased from home improvement stores are stain dyes. If you open a container that has been setting a while and there is colored liquid at the top and pigment settled at the bottom, then it is a stain dye.

Stain/Dye Rule: **Stain for Grain**
Dye for Figure

Appropriate Finishing Products

Many waxes are available for woodturners today. These may be in a liquid form, paste or a hard stick such as *Hut* wax which is useful during pen making on the lathe. *Crystal Clear Paste* wax is an excellent paste wax although *Johnson's Paste Floor* wax will also work well. Finally, homemade beeswax may be made as described above. Solid cakes of beeswax may be purchased from woodworking stores and from local beekeepers. Shellac is available in either flake form to be mixed with alcohol or premixed ready to apply. *Zinsser* offers a spray can version called *Bulls' Eye Shellac*. 80% denatured alcohol is available by the gallon from *Home Depot, Lowe's* and many hardware stores. *ShellAwax* is a liquid shellac and wax combination that works well while the piece is still on the lathe. *Behlen* also offers a product for finishing on the lathe called *Master Woodturners Finish*. And *Everclear* may be purchased at your beverage store.

Lacquers are available from many manufacturers including *Deft* and are also available in spray cans. Water-based lacquer is available from *Hydrocote* and is sold by *Highland Hardware* for about $25/gallon. This can be diluted with 20% water to make a thinned version for easy spreading during application and faster drying.

Linseed oil may be purchased economically, by the gallon, at all paint, hardware and home improvement stores. Pure tung oil is available from woodworking supply dealers such as *Woodcraft*.

Varnishes are harder to find today and often are listed as polyurethanes. These poly varnishes are available everywhere while spar varnishes are still available from hardware and home improvement stores. An excellent tung oil varnish is *Waterlox Original* available at woodworking stores such as *Woodcraft*.

When purchasing lacquers and varnishes, always buy glossy. Satin finishes have additives (silica particles) to scatter the reflected light and can not be made glossy without straining the silica particles before application. Glossy finishes, however, can be made satin by using 0000 steel wool to buff before final waxing.

CA glues are available everywhere but can be purchased in larger volumes to save money. These larger volumes should be stored in a refrigerator to increase the shelf life in the container. *Starbond* is one brand available from *CPH International* via mail order or by phone @ 213-382-7788.

Techniques

Techniques vary for application of different finishes and may include brushing, wiping, spraying and wet sanding. Most woodturners don't brush because the surface area is not that large although brushes are useful for detail work or inside hollow vessels. The majority of woodturning finishes are applied by wiping or spraying.

Wiping-Cloth rags are not recommended for wiping of turned items while on the lathe, as the threads can get wrapped around the turning. Soft paper towels work very well. The paper towel is folded and dipped into the finish, then rubbed across and along the grain to get a uniform coverage and penetration into all grooves. Then the excess is wiped off using the same or another towel. On some shellac and lacquer finish products, the lathe can be speeded up and a clean dry towel used to speed the evaporation of the solvent by rubbing with pressure. In this way, many coats can be applied in a short amount of time. If using water-based lacquer, the grain may raise during the initial application and may require a light sanding with 220 grit to remove these raised grains before applying additional coats.

Spraying-Both shellac and lacquer are available in spray cans, which work very well for pieces still on the lathe. The secret to spraying both is to just put a "dusting" of spray on the piece to give a wet look. Holding the spray can about 6 inches away from the piece, while the piece is turning very slowly, works best. As with any spray coating, always start the spray pass off the work and continue past the other end so that start and end spurts don't apply too much. Remember, just a "dusting" or you will be chasing runs. Both shellac and lacquer dry fast so many coats can be applied within a short time.

Wet sanding-When applying reactive finishes such as tung oil varnishes, wet sanding the next coat of finish will help fill pores on open pore woods such as walnut, oak, ash, mahogany, etc. As the next coat is wet sanded, the abrasive cuts the previous coat making a very fine filler that is held in the pores by the current coat of finish. The following is a typical sanding sequence for wet sanding:

1. Dry sand to 320 grit.
2. Apply wet coat of finish and let dry.
3. Apply next coat of finish and use 400 grit wet/dry sandpaper to sand the entire surface, keeping the surface wet with liquid finish. Then let dry.
4. Apply next coat of finish and use 600 grit wet/dry sandpaper to sand the entire surface, keeping the surface wet with liquid finish. Then let dry.
5. Repeat with 800 grit.
6. Repeat with 1000 grit.
7. Repeat with 1500 grit.
8. Repeat with 2000 grit.

These higher grit wet/dry papers are used for auto painting, made by *3M* and available at auto centers and *WalMart*. The end result will be a thick, very shiny, extremely smooth finish, ready for the final step, "Finishing the Finish."

CA as a Finish-With a piece still on the lathe and rotating very slowly, place a wiping wad of paper towel under and behind the piece as you flood the surface with CA from the bottle, moving the bottle along the length of the piece. Apply enough to evenly flood the surface and then remove the paper towel (it is mostly to prevent CA from flying as the lathe turns) and leave it alone until it cures (10-20 seconds). Then repeat for 10-12 coats. The finish is now ready for "finishing the finish" to obtain the best feel and look.

When the occasional run or blotch occurs in a finish, stop and wet sand with 400 grit wet/dry paper using water or mineral spirits as a lubricant. Then either apply another coat of finish or buff.

Finishing the Finish

Most woodturners can apply a product to finish a turning but often fail to complete the finishing process because they don't "finish the finish." Referring back to the description of Snell's Law, after a finish has cured or dried, it will have many small irregularities that will be noticeable to the touch and will scatter light to the eye. "Finishing the finish" will remove these irregularities producing that desired glossy look to the eye and ultra smooth feel to the touch. Today, the woodturner has a choice of 3 major techniques for "finishing the finish":

Classic (hand rubbing with pumice, rottenstone and oil)
Beall **Buffing System** or
MicroMesh.

Classic-This technique has been used to complete the finish on furniture for over 300 years. After the finish is completely dried or cured (which may take a week for some reactive finishes), the surface is rubbed with a soft pad (hard felt) embedded with abrasive material and an oil to lubricate the application. Generally on large flat surfaces like tabletops, the pad is rotated in a figure 8 pattern while pumice is sprinkled on the surface along with drops of oil. The pumice grinds away any dust specks, runs, etc., fills pores and then the excess slurry is wiped off with a solvent such as mineral spirits. This is repeated with rottenstone to produce a gloss shine on the surface. After a final cleaning with a solvent, wax is applied to protect and to give the surface a final feel and shine characteristic of an exceptionally finished piece. Some have complained that rottenstone will lodge in the pores leaving a discoloration to the end product but this is not true if the surface pores were filled during the preparation phase of finishing or during the pumice phase above. See the Feb 2011 issue of **Fine Woodworking** for an excellent article by Vijay Velji about French Polishing.

For turnings, this classic French Polishing method can be very messy if attempted on the lathe.

Beall **Buffing System-**This product, available from many woodturning supply companies, utilizes 3 different buffing wheels that fit on the lathe, individually or in a row. Each wheel has a specific abrasive or wax that is applied to the wheel before buffing the surface of the turning. Below is the buffing process:

1. Allow the finish to sufficiently dry or cure.
2. Install the Tripoli wheel on the lathe and if loaded with dried Tripoli, use a block of wood to remove the dried material while the wheel is turning.
3. While the Tripoli wheel is turning at about 800-1000 rpm, rub the Tripoli abrasive stick against the surface of the wheel. Do not over load the wheel; 5-10 seconds of contact is adequate.
4. Buff the piece at 800-1000 rpm until a uniform haze appears on the surface.

5. Repeat with the White Diamond wheel and stick. The surface should begin to shine.
6. Repeat with the Carnuba wax wheel and stick. The surface should now have the final waxed shine.

Caution: Buffing with excessive pressure against the wheel will spread and distort the wheel fibers. Since the abrasive or wax is only on the outer fibers of the wheel, the polishing action is reduced.

The *Beall* system is quick but if the wheel speed is too fast, the abrasive buffing action can cut through the finish. It is best to operate the lathe at a slow speed. Also, this buffing action does not remove dust specks or runs as well as the classic technique above or the MicroMesh method below.

MicroMesh-This system was developed for removing scratches from plexiglass windshields on airplanes and helicopters and consists of progressively finer and finer abrasives on a cloth backing, starting with 1500 and going to 12000. The process is

1. Allow the finish to dry or cure sufficiently.
2. Hand rub the 1500 cloth using pressure rather than speed. This initial grit should be used to remove any visible or feel-able specks or runs.
3. Repeat with the next higher grit cloth.
4. Continue repeating until the final 12000 grit cloth.

A hard foam-backing pad helps distribute the pressure as you rub the surface. Water or mineral spirits can be used as a lubricant during the rubbing, but the abrasive action is increased and can cause the 1500 grit cloth to cut through the finish. Also, the process can be done on the lathe while the piece is turning but again, this can cut through the finish. Generally, the dry hand-rubbing works best so take it off the lathe, sit down and watch the shine appear during the last 2 cloths. A bench brush works well to clean the cloth.

Several other products may also be used to "finish the finish":

Diatomaceous Earth
Mequiars' Auto Polish and
Howard's Restor-A-Shine Polishing Compounds.

Diatomaceous earth is made from many ground crustaceans from the bottom of the sea. When used with a lubricating oil (such as mineral oil) on a rubbing pad, it acts similar to pumice and will polish the surface.

Mequiars' auto polish is used to "finish the finish" on automobiles and comes in 3 grades. When used progressively, these 3 grades will polish a wood finish to a nice look and feel.

Howard's Restor-A-Shine products are available from Ace Hardware and come in two grades: **Fine (Polishing Compound)** and **Super Fine (Burnishing Cream).** Using first the Fine Polish, then the Burnishing Cream, a wood finish will turn into a smooth and shiny surface.

Wax-A thin coat of wax is applied last to give the final feel and shine characteristic of an exceptionally finished piece. Any wax product will accomplish this but *Renaissance* wax is great to produce a shine and not leave fingerprints. Wax is one case where less is better. Do not apply heavy coats of wax, just 2 fine, thin coats are adequate when followed with hand buffing using a clean soft rag. Always turn the cloth to keep it clean as you buff. Cloths made from old jogging pants work well and provide a coarse side for initial brushing and a soft side for final polishing.

One final combination to get a nice luster, but not a bright shine, utilizes wax applied with steel wool. Using 0000 steel wool, rub the wool in some paste wax of choice, rub the finished surface, then buff with a clean rag when dry. Repeat several times to get a uniform luster on the surface.

Conclusions

Regardless of what anyone may say or any advertisement may claim, finishing is hard work, both in time and effort. Often, what may take a woodturner an hour to completely turn, may take him over a week to finish, especially if he adheres to all the steps listed. But if he is willing to complete his turning with his finest cut, prepare the surface (especially filling the pores), select and apply an appropriate finishing product and go the extra step of "finishing the finish", he can be assured of having a piece to be proud of and that will be the envy of most of the other turners.

References

Coloring Finishing and Painting Wood, Adnah Clifton Newell,1972
Woodturning Design Magazine, Summer 2006
Understanding Wood Finishing, Bob Flexner, 1994
Wood Magazine, October 2004

* The relatively rare curly grain results from abrupt and repeated right and left deviations from the vertical in fiber alignment caused by tree growth in windy and steep slopes. This characteristic is commonly considered an abnormal and a major defect due its loss of strength for other forest products.

Chart 1

SANDPAPER GRIT VARIANCES

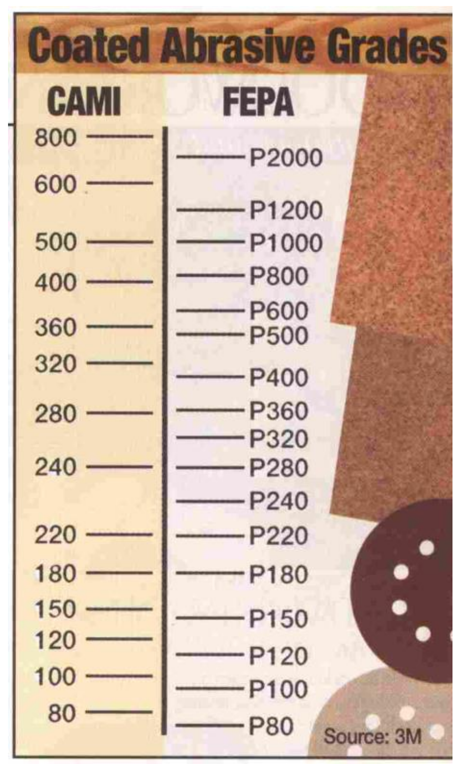
Q: At a woodworking show I bought some sandpaper in the grit numbers I normally use, but the abrasives didn't match the texture of the products from my local supplier. I think the sandpaper I bought is imported. Does that make a difference?

A: Coated abrasives (the technical name for sandpaper) follow one of two common grading systems used in North America: CAMI (Coated Abrasives Manufacturers Institute) and FEPA (Federation of European Producers of Abrasives).

FEPA products are sometimes called "P grade" because that letter prefixes the grit number on the sandpaper. If there's no prefix, you can assume that it's a CAMI-graded product. As you can see in the chart at right, particle sizes in the two systems closely parallel each other up to about 220 grit; then FEPA numbers increase rapidly. If there is a letter after the number, it refers to the weight of the paper or fabric.

Manufacturers may use one or both systems for various lines of abrasives. For example, Klingspor uses the FEPA Scale exclusively, while 3M uses both scales.

A second key difference is that the CAMI standards permit greater variation in particle sizes used within each grade. That may be the texture difference you noticed.



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