



Complete Guide to Wood Finishing



BY BOB FLEXNER

Finishing Overview

Understand the basics.

A wood finish is a clear, transparent coating applied to wood to protect it from moisture and to make it look richer and deeper. This differs from paint, which is a wood finish loaded with enough pigment to hide the wood. And it differs from a stain, which is a wood finish and a colorant (pigment or dye) with a lot of thinner added so the excess stain is easy to wipe off. The remainder just colors the wood; it doesn't hide the wood.

Unfortunately, the term “finish” also refers to the entire built-up coating, which could consist of stain, several coats of finish (a “coat” is one application layer) and maybe some coloring steps—for example, glazing or toning—in between these coats. For some reason, we have only one word to refer to both the clear coating used, and to all the steps used.

Usually, the context makes clear to which is being referred.

Purpose of a Finish

A finish serves two purposes: protection and decoration.

Protection means resistance to moisture penetration. In all cases, the thicker the finish, the more moisture resistant it is. Three coats are more protective than two, for example. Boiled linseed oil, 100 percent tung oil and wax will dry soft and gummy, however, so all the excess has to be wiped off after each application to achieve a functional surface. Therefore, no significant thickness can be achieved. Protection is limited with these finishes.

Finishes decorate by making wood look richer and deeper. The impact is less dramatic on unstained lighter woods such as maple and birch, and greater on stained and darker woods such as cherry and walnut.

Types of Wood Finish

Common categories of wood finish include the following:

- **Oil** (boiled linseed oil, 100 percent tung oil and blends of these oils and varnish).

- **Oil-based varnish** (including alkyd, polyurethane, spar, wiping and gel varnish).

- **Water-based finish** (a finish that thins and cleans up with water).

- **Shellac** (an ancient finish derived from resin secretions of the lac bug).

- **Lacquer** (the finish used on almost all mass-manufactured household furniture made since the 1920s).

- **A large number of two-part, high-performance finishes** used in industry and by many professional cabinet shops.

Wiping varnish is alkyd or polyurethane varnish thinned about half with mineral spirits so it's easy to wipe on and wipe off. You can make your own, or there are a large number of brands, which, unfortunately, are poorly labeled. (Refer to “The Basics of Wiping Varnish” on the magazine web site for more information.)



Polyurethanes. The left section of this panel was finished with water-based polyurethane, which, like all water-based finishes, adds little color to the wood. The finish just makes the wood a little darker (compared to the lighter strip down the middle, which was covered with tape). The right section was finished with oil-based polyurethane, which, like most finishes except water-based finishes, adds some degree of yellow/orange coloring to the wood. Oil-based polyurethane continues to darken as it ages, while water-based polyurethane doesn't darken.



Finish on oak. On this oak panel, a clear finish was applied to the left section, paint to the middle section and a stain and clear finish to the right section.

CONTINUED ON PAGE 58

The primary differences in the finishes are as follows:

■ **Scratch, solvent and heat resistance.** Oil-based varnishes and high-performance finishes provide the best scratch, solvent and heat resistance. Water-based finishes are next. Shellac and lacquer are susceptible to all three types of damage. Oil is too thin to be effective.

■ **Color.** Water-based finishes add little color to the wood. All other finishes (except possibly CAB-Acrylic) add some degree of yellow-to-orange coloring.

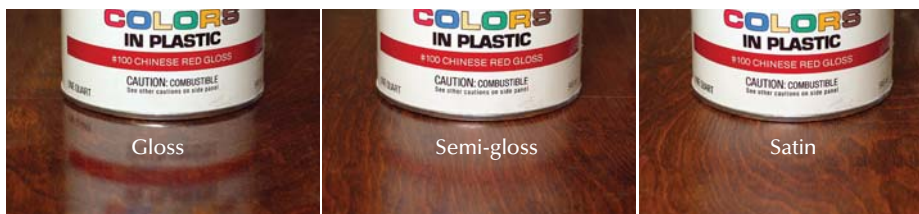
■ **Drying time.** Shellac, lacquer and high-performance finishes dry the fastest. Water-based finishes are next. Varnish and oil require overnight drying in a warm room.

■ **Solvent safety.** Boiled linseed oil and 100 percent tung oil are the least toxic finishes to breathe during application because they don't contain solvent. Water-based finishes (thinned with water and a little solvent) and shellac (thinned with denatured alcohol) are next. Oil-based varnish thins with mineral spirits (paint thinner), which some people find objectionable but which isn't especially toxic. Lacquer and high-performance finishes thin with solvents that are the most hazardous to be around.

Sealing Wood

The first coat of any finish seals the wood – that is, stops up the pores in the wood so the next coat of finish (or other liquids) doesn't penetrate easily. This first coat raises the grain of the wood, making it feel rough. You should sand this first coat (with just your hand backing the sandpaper) to make it feel smooth. You don't need a special product for this first coat unless you have one of two problems you want to overcome.

■ Alkyd varnish and lacquer can gum up sandpaper when sanded, so manufacturers of each provide a special product called "sanding sealer" with dry lubricants added to make sanding easier and speed your work. Sanding sealers weaken the finish, however, so you should use them only when you're finishing a large project or doing production work.



Sheen. A finish can have an infinite number of sheens depending on how much flattening agent is added.

■ Sometimes, there are problems in the wood that have to be blocked off with a special sealer so they don't telegraph through all the coats. These problems are resinous knots in softwoods such as pine, silicone oil from furniture polishes that causes the finish to bunch up into ridges or hollow out into craters, and smoke and animal-urine odors. The finish that blocks these problems ("seals them in") is shellac, and it should be used for the first coat. Notice that, except for resinous knots, the problems are associated with refinishing.

Sheen

Oil-based varnishes, water-based finishes and lacquers are available in a variety of sheens, ranging from gloss to flat. All sheens other than gloss are created by the solid-particle "flattening agents" manufacturers add to the finish. The more flattening agent added, the flatter the sheen. These flattening particles settle to the bottom of the can, so you have to stir them into suspension before each use.

You can get any sheen you want by pouring off some of the gloss from a can in which the flattening agent has settled (don't let the store clerk shake the can) and blending the two parts. Or you can mix cans of gloss and satin to get something in between. You will need to apply the finish to see the sheen you'll get. It's the last coat you apply that determines the sheen (there is no cumulative effect), so you can experiment with each coat.

Finish Application

Oil, wax, wiping varnish and gel varnish can be applied with a cloth or brush, then wiped off. The other finishes are usually applied with a brush or spray gun.

Brushing is simple—essentially no different than brushing paint. Spraying is also simple, but spray-gun care and tuning is more complicated, and spray guns and their sources of air (compressor or turbine) are considerably more expensive than brushes.

Application Problems

Common problems and ways to avoid them:

■ **Brush marks and orange peel.** Eliminate these by thinning the finish 10 percent to 30 percent so it levels better.

■ **Runs and sags.** Watch what is happening in a reflected light and brush out the runs and sags as they occur.

■ **Dust nibs.** Keep your tools, the finish and the air in the room as clean as possible.

■ **Bubbles.** Brush back over to pop the bubbles, or thin the finish 10 percent to 30 percent so the bubbles have more time to pop out.

No matter what the problem, you can always fix it by sanding the finish level and applying another coat. **PWM**

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Wiping Varnish

BY BOB FLEXNER

An excellent finish
for first timers
(and beyond).

Wiping varnish is the finish I recommend you use if you are finishing for the first time. Wiping varnish is a term I coined in 1990 to categorize a large number of very popular finishes that are sold individually under many different names but are actually all the same—oil-based alkyd or polyurethane varnish thinned about half with mineral spirits (paint thinner). Collecting them into a category removes the mystique manufacturers attempt to create and it makes the finish easier to understand. It also



Commercial wiping varnishes. (Top) These are typical commercial brands of wiping varnish sold in home centers and paint stores. (Bottom) These are typical commercial brands of wiping varnish sold in woodworking stores and through catalogs.



Identifying wiping varnish. Because of the uninformative naming, you need a method for identifying commercial wiping varnishes. Unfortunately, you can rarely do this from the label. You will need to put a puddle of the finish on the lid or other non-porous surface and see how it cures. If the product thins and cleans up with mineral spirits and isn't labeled "varnish" or "polyurethane," and it cures hard and smooth after several days in a warm room, it's wiping varnish.

allows us to discuss uniform application procedures that apply to all brands.

Notice from the pictures above that many of the brands of wiping varnish are labeled "tung oil," "tung oil varnish" or "tung oil finish." None of these are tung oil and few have any tung oil in them. Even in the rare cases when a little tung oil is added, it is insignificant and doesn't justify the misleading naming. All of these products are simply oil-based alkyd or polyurethane varnish thinned about half with mineral spirits. (The wiping varnish Waterlox is a phenolic varnish.)

The difference between varnish and oil finishes is that varnish dries hard and can be built up on the wood for better moisture resistance. Oil (boiled linseed oil, 100-percent tung oil and blends of oil and varnish) dries soft so all the excess must be wiped off after each coat. No built-up moisture resistance can be achieved. This is a big difference!

You can distinguish wiping varnish labeled "tung oil" from real tung oil by the following: Real tung oil is always labeled "100-percent tung oil," so far as I know; no brands of real tung oil contain thinner (mineral spirits—usually called



Thin mix. A thin mix of polyurethane and mineral spirits (paint thinner) builds very slowly.



Thick mix. A thick mix of polyurethane and mineral spirits builds much more rapidly and is still thin enough for easy application.

“petroleum distillates” or “aliphatic hydrocarbons” on the label); wiping varnish always contains thinner.

For this exercise on scrap wood you should make your own wiping varnish. You could use a commercial brand, but making your own gives you more control because you can add more or less thinner. You have much more control of the rate of build per coat if you make your own wiping varnish than if you buy a commercial brand. In the picture above left, panel sections are finished with one, two, three and four coats of polyurethane thinned with 75-percent mineral spirits—that is, a one-part polyurethane to three parts thinner.

In the picture above right, the panel sections are finished with one, two, three and four coats of polyurethane thinned with 25-percent mineral spirits—that

is, three parts polyurethane to one part thinner. In both cases, the finish was brushed and left. You can clearly see the faster build using the three-to-one mix. Though I’m going to use a half-and-half blend (similar to commercial brands) for this exercise, I recommend you try the three-to-one mix because it is still thin enough to be easy to apply, and it builds faster. You can always add more mineral spirits if the finish is tacking up too quickly.

Make Your Own

Instead of buying a poorly labeled wiping varnish and taking the risk that you get something else—for example, an oil/varnish blend—just make your own. All you have to do is thin any full-strength, oil-based varnish or polyurethane a quarter-to-a-half with mineral spirits.

What You Need for Applying Wiping Varnish

- ▶ A 16" x 24" or larger sheet of ½" or ¾" veneered plywood or MDF. Any hardwood veneer is OK. You can get this from your scraps, a wood supplier or from one of many cabinet shops (which often throw away pieces this size).

The following items are all available from a home center, paint store or woodworking store or catalog/web site.

- ▶ A pint or quart of gloss, oil-based polyurethane varnish.
- ▶ A pint or quart of mineral spirits.
- ▶ A clean plastic container, coffee can or wide-mouth jar with a lid. (Also likely available in your kitchen.)
- ▶ Latex or other type of protective gloves.
- ▶ Lint-free rags such as old, clean T-shirts, cheesecloth or paper rags (soft white paper towels in a box or roll marketed to painters).
- ▶ A good quality natural-bristle brush (best), or foam brush, or an inexpensive “chip” brush. A width of 2" is easy to use on most projects.
- ▶ A sheet of #320- or #400-grit sandpaper.
- ▶ A small brown paper bag (from the supermarket).



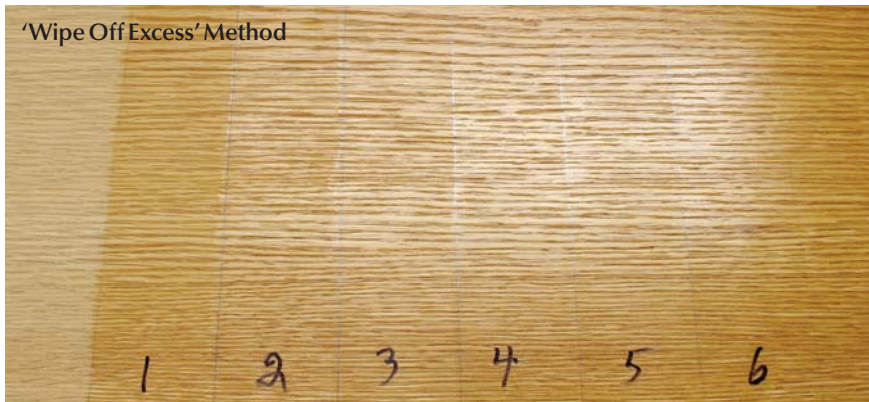
Make your own. To make your own wiping varnish for this exercise/project, pour approximately equal amounts of oil-based, gloss polyurethane and mineral spirits into a clean wide-mouth container.



Be sure to stir. Stir the thinned polyurethane or the two parts will remain separated.



'Wipe Off Excess' Method



'Dry Brush Excess' Method



'Leave Excess' Method



Applying Wiping Varnish

I'm going to show you three methods of applying wiping varnish: wipe off the excess; "dry-brush" the excess; and leave the excess. You can use any of the methods for all the coats or alternate among them. I suggest you try both of the first two methods to see which you like best. You can use the third method on flat, horizontal surfaces.

At left are pictures of one through six coats using each application method. In the upper picture I applied from one to six coats and wiped off the excess after each. In the middle picture I applied from one to six coats and dry-brushed the excess after each. In the lower picture I applied from one to six coats and left them to dry. You can see that wiping off produces the slowest build and leaving produces the fastest build.

"Applying finishes is easy and logical ... [but] don't be impatient."

— Bob Flexner
from 'Wood Finishing 101'

'Wipe Off Excess' Method

Brush or wipe the wiping varnish onto the wood and wipe off the excess. This method produces the best results, meaning that there are no runs, no possibility of brush marks and almost no dust nibs. But the build is very slow, so it takes more coats than the other two methods to get the same look and protection against moisture.



1 **'Wipe off excess' method.** If you choose to brush the finish, the fast, efficient method on flat, horizontal surfaces is to deposit a brush load of the wiping varnish onto the near edge then spread it. Here, I'm using an inexpensive, throwaway bristle brush, called a "chip" brush, because I'm not worried about bristles falling out. They will be removed when I wipe off the excess finish.



2 **Spread the finish.** With a puddle of wiping varnish deposited, spread it end to end. You can use an inexpensive, throwaway, foam brush instead of a bristle brush.



First Coat. The first coat soaks into the wood and seals it when the finish dries. So, even though you intend to wipe off the excess, you should apply a wet coat to all areas and keep it wet for several minutes. Add more finish to areas that become dull due to the finish soaking in. You can use this wipe-off method of applying wiping varnish

to “shine up” other finishes that have become dull (be sure the surface is clean) or to make a brushed varnish or polyurethane finish almost perfect after you have sanded out the brush marks.

Sand Smooth. The surface always feels rough after the first coat. A critical step for achieving a smooth final result is to sand this coat smooth after it dries.

More Coats. Keep applying coats (with six hours to overnight between each) until you're happy with the look of the finish. The procedure for each additional coat is the same. First, you sand and clean the surface as just described. Then you brush or wipe on the wiping varnish and wipe off the excess before the finish dries.



3 Wipe on wiping varnish. The most efficient way to apply wiping varnish when you intend to wipe off all the excess is simply to wipe it on. Wet your rag well with the finish, or pour some finish onto the wood and spread it around with the rag. You want to put on a wet coat so the wiping varnish penetrates well.



4 Wipe off wiping varnish. With the surface well wetted, wipe off all the excess with a dry cloth. (You could also use a durable paper towel.) There's no need to scrub the surface. A little dampness won't hurt anything.



5 Sand first coat. After drying, sand the surface lightly using #320- or #400-grit sandpaper until the finish feels smooth. It shouldn't take much, usually not more than one or two passes everywhere. There's no reason to use a flat block to back the sandpaper. Abrading with sandpaper produces much better results than using steel wool or abrasive pads because sandpaper cuts off while the others merely round over.



6 Feel for dust. After removing the dust with a vacuum, tack rag or dust brush, wipe over the surface with your hand. You'll feel if there is any remaining dust and, as long as it's not much, you'll remove it with your hand. You can clean off your hand by wiping it on your pants leg.

7 Apply more coats. Wipe a damp-to-wet coat of wiping varnish over the entire surface you're finishing. You don't need to make these coats as wet as the first one because the finish can no longer soak into the wood.



8 Wipe off after each. Wipe off the excess finish. You can leave the surface a little damp.



'Dry Brush Excess' Method

Brush wet coats of wiping varnish onto the wood and remove some of the finish with a dry brush. This method leaves more build than wiping off the excess, but still eliminates the possibility of runs and sags.

First Coat. Brush a wet coat of wiping varnish over the surface as in the wiping-off method. You could also wipe on a wet coat with a cloth.

Sand Smooth. It's always critical to sand after the first coat so the roughness doesn't telegraph through each additional coat.

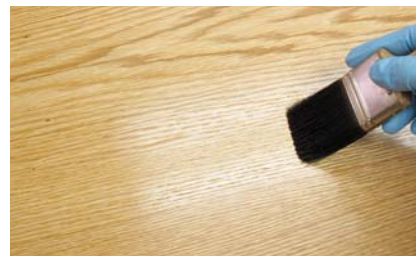
More Coats. All additional coats go on the same as the first. Apply as many as you need to get the look you want, allowing overnight drying for each in a warm room. Be sure to sand each coat smooth before applying each additional coat.



1 **'Dry brush excess' method.** With the surface wet with wiping varnish, dry your brush on a clean cloth.

2 Brush off excess.

Then brush back over to pick up some of the finish. At the beginning, dry the brush after each pass so you pick up the maximum amount of finish. If you decide to go over the surface a second time, you can make several passes before wiping. It's best to use a better-quality bristle brush that won't shed bristles.



3 **Reflected light.** Watch what's happening in a reflected light. Your goal is to get an even thickness of finish without puddles on horizontal surfaces or runs on vertical surfaces.

4 **Sand smooth.** After it's dry, sand the surface with #320- or #400-grit sandpaper. You can use just your hand to back the sandpaper. Make two or three passes everywhere until the finish feels smooth.

There should be very little dust. You may be able to remove it with just your hand, wiping it on your pants leg. But you can use a vacuum, dust brush or a tack rag, then wipe with your hand to check that all the dust has been removed.



5 **More coats.** Brush a wet coat of wiping varnish onto the surface. You don't have to be too careful how you brush because the dry brushing will smooth things out.



6 **Dry brush excess.** With the entire surface wet, begin lifting some of the wiping varnish by brushing over with a dry brush.



7 **Dry the brush.** After each pass, dry your brush on a clean cloth. If you decide to dry-brush the surface a second time, you can make more than one pass before drying the brush. You'll get the feel very quickly.

8 **Vertical surfaces.** The dry-brushing method is perfect for vertical surfaces. You can also wipe off all the excess, of course, but dry brushing leaves a thicker build with each coat without runs or sags. Always watch what is happening in a reflected light (overhead, window or light on a stand) and dry brush to remove any problems you find.



'Leave Excess' Method

Brush wet coats of wiping varnish onto the wood and leave them, allowing overnight drying between each. This can be done only on flat horizontal surfaces such as tabletops because of runs and sags. You can always use the dry-brushing technique to remove excess on edges and other connected vertical surfaces to avoid runs.

First Coat. This is a brush-on-and-leave method of applying wiping

varnish. So it's just like brushing full-strength varnish or polyurethane, or brushing paint.

Sand Smooth. The first coat of finish always causes a rough surface. You need to sand this smooth before continuing to the next coat.

More Coats. Brushing and leaving builds the finish much more quickly than wiping off or dry brushing. But dust nibs are more likely because the finish remains tacky longer. Be sure to

sand lightly between each coat. You're finished when you achieve the look you want.

Finish Up. There are always some dust nibs stuck in the last coat of finish. As long as they are small and there aren't too many of them, you can remove them by rubbing the surface with a brown paper bag. **PWM**

This article is excerpted from Bob's book, "Wood Finishing 101," He's also the author of "Flexner on Finishing" (both Popular Woodworking Books).



1 'Leave excess' method. Deposit a brush load of wiping varnish onto the near edge of the panel. A "brush load" is the bristles dipped about one-third to one-half way into the wiping varnish, lifted out and plopped down on the wood.



2 Stretching out. Stretch the wiping varnish out edge to edge. You don't have to be as careful with wiping varnish as you do with full-strength varnish or polyurethane because wiping varnish levels well. You could even brush across the grain and the finish would still level so you don't see the brush marks.



3 Continue as if painting. Continue depositing the wiping varnish and stretching it out across the surface.

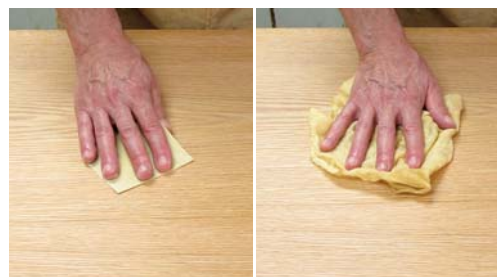


4 Airplane landings. So as not to drag the bristles over the edge and cause runs down the side, use airplane-like landings about an inch or so in from each edge and brush across and off the other side.

5 More coats. After drying, sand the surface lightly using #320- or #400-grit sandpaper until the finish feels smooth (right). It shouldn't take much, usually not more than one or two passes everywhere. There's no reason to use a flat block to back the sandpaper. (Again, abrading with sandpaper produces much better results than does steel wool or abrasive pads.)

Remove the sanding dust with a tack rag, vacuum or dust brush. A tack rag (far right) or vacuum is best because brushing kicks dust into the air; the dust can then settle back onto a freshly applied finish and stick to it.

Just before applying the next coat, wipe over the surface with your hand. You'll remove any remaining dust. Continue with more coats until you are happy with the appearance.



6 Smoothing trick.

A brown paper bag works exceptionally well at removing the roughness caused by fine dust nibs stuck to the last coat. Simply fold the bag and rub the surface. To avoid scratches, it's best to allow the finish to dry to the point that you don't smell anything when you put your nose against the surface and take a whiff.



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Rules for Sanding Wood

Material and finish choice help dictate grit progression.

The objective of sanding wood is to remove mill marks, which are caused by woodworking machines, and to remove other flaws such as dents and gouges that may have been introduced in handling. The most efficient method of doing this is to begin sanding with a coarse enough grit of sandpaper to cut through and remove the problems quickly, then sand out the coarse-grit scratches with finer and finer grits until you reach the smoothness you want – usually up to #150, #180 or #220 grit.

This is a very important concept because it gets past all the contradictory instructions about which sandpaper grits to use. Conditions vary.

For example, a board that has been run through a planer with dull knives will require a coarser grit to be efficient than typical veneered plywood or MDF that has been pre-sanded in the factory. You can finish-sand both of these surfaces with #180 grit, for example, but you might begin with #80 grit on the solid wood and #120 grit on the plywood. It would be a total waste of time and effort to begin with #80 grit on the pre-sanded veneered wood (and you would risk sanding through). So you don't want to begin with too coarse a grit because it will cause you more work than necessary sanding out the scratches.

There's also no fixed rule for how to progress through the grits. Sanding is very personal. We all sand with different pressures, number of passes over any given spot and lengths of time.

Unquestionably, the most efficient progression is to sand through every grit – #80, #100, #120, #150, #180 – sanding just enough with each to remove the scratches of the previous grit. But most of us sand more than we need to, so it's often more efficient to skip grits.

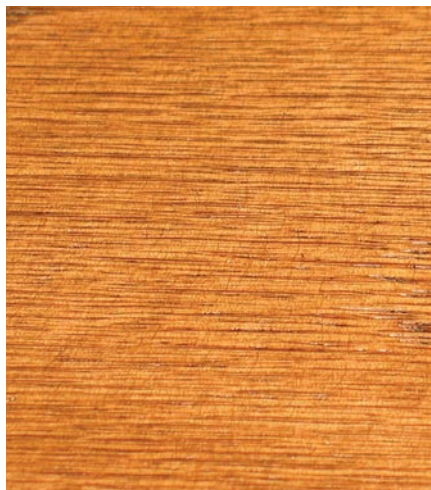
You'll have to learn by experience what works best for you.



Washboarding. The primary reason you need to sand wood is to remove the washboarding and other mill marks caused by machine tools. On this board, the washboarding, which was caused by a planer and has been highlighted with stain, is particularly severe. I think it would have been most efficient to begin sanding with #80 grit.



Cross-grain. Sanding cross-grain tears the wood fibers so the sanding scratches show up much more, especially under a stain. The best policy is to always sand in the direction of the grain when possible. The scratching that does occur is then more likely to be disguised by the grain of the wood.



Squigglies. Random-orbit sanders are more efficient than vibrator sanders, but they still leave cross-grain marks in the wood. I refer to these as "squiggles." The best policy is to sand them out by hand in the direction of the grain after sanding to the finest grit, usually #180 or #220, with the sander. Doing this is especially important if you are staining.



Fine sanding. Sanding finer than #180 or #220 is wasted effort in most cases, as explained in the text. In fact, the finer the grit the wood is sanded to, the less color a stain leaves when the excess is wiped off. In this case, the top half was sanded to #180 grit and the bottom half to #600 grit. Then a stain was applied and the excess wiped off.

How Fine to Sand

It's rarely beneficial to sand finer than #180 grit.

Film-building finishes, such as varnish, shellac, lacquer and water-based finish, create their own surfaces after a couple of coats. The appearance and feel of the finish is all its own and has nothing any longer to do with how fine you sand the wood.

Oil and oil/varnish-blend finishes have no measurable build, so any roughness in the wood caused by coarse sanding telegraphs through. But these finishes can be made ultimately smooth simply by sanding between cured coats or sanding each additional coat while it is still wet on the surface using #400- or #600-grit sandpaper. It's a lot easier doing this than sanding the wood through all the grits to #400 or #600. (See "What Is Oil?" in issue #154, April 2006, for a more thorough explanation of both processes.)

Only if you are staining or using a vibrator ("pad") or random-orbit sander does sanding above #180 grit make a difference.

The finer you sand, the less stain color will be retained on the wood when you wipe off the excess. If this is what you want, then sand to a finer grit. If it isn't, there's no point going past #180 grit. The sanding scratches won't show as long as they are in the direction of the grain.

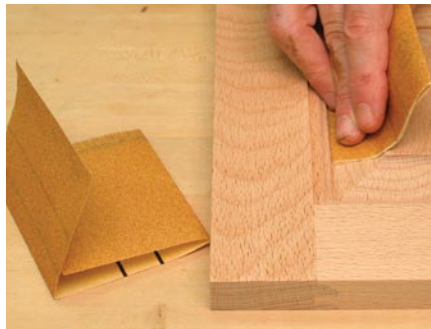
Sometimes with vibrator and random-orbit sanders, sanding up to #220 grit makes the squiggly marks left by these sanders small enough so they aren't seen under a clear finish. Sanding by hand in the direction of the grain to remove these squiggles then becomes unnecessary.

In all cases when sanding by hand, it's best to sand in the direction of the wood grain when possible. Of course, doing this is seldom possible on turnings and decorative veneer patterns such as sunbursts and marquetry.

Cross-grain sanding scratches aren't very visible under a clear finish, but they show up very clearly under a stain. If you can't avoid cross-grain sanding, you will have to find a compromise between creating scratches fine enough so they don't show and coarse enough so the stain still darkens the wood adequately. You should practice first on scrap wood to determine where this point is for you.

Three Sanding Methods

Other than using a stationary sanding machine or a belt sander, which will take a good deal



Hand sanding. The most efficient use of sandpaper when backing it with just your hand is to tear the sheet into thirds crossways and then fold one of the thirds into thirds lengthways. Flip the thirds to use 100 percent of the paper.

of practice to learn to control, there are three methods of sanding wood: with just your hand backing the sandpaper, with a flat block backing the sandpaper and with a vibrator or random-orbit sander.

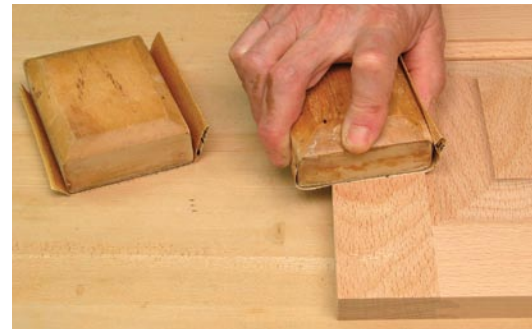
Using your hand to back the sandpaper can lead to hollowing out the softer early-wood grain on most woods. So you shouldn't use your hand to back the sandpaper on flat surfaces such as tops and drawer fronts because the hollowing will stand out in reflected light after a finish is applied.

The most efficient use of sandpaper for hand-backed sanding is to tear the 9" x 11" sheet of sandpaper into thirds crossways, then fold each of these pieces into thirds lengthways. Sand with the folded sandpaper until it dulls, flip the folded sandpaper over to use the second third, then refold to use the third third. This method reduces waste to zero and also reduces the tendency of the folds to slip as you're sanding.

If you are sanding critical flat surfaces by hand, you should always use a flat block to back the sandpaper. If the block is hard (wood, for example), it's best to have some sort of softer material such as cork glued to the bottom to improve the performance of the sandpaper. (I find the rubber sanding blocks, available at home centers, too hard, wasteful of sandpaper and inefficient because of the time involved in changing sandpapers.)

I made my own sanding block. Its measurements are 2³/₄" x 3⁷/₈" x 1¹/₄" thick, with the top edges chamfered for a more comfortable grip. Any wood will work. I used sugar pine because it is very light in weight.

To get the most efficient use of the sandpaper, fold one of the thirds-of-a-sheet (described above) in half along the long side and hold it



Block sanding. The most efficient use of sandpaper when backing it with a flat sanding block is to tear the sheet into thirds crossways and then fold one of the thirds in half. Hold onto the block with your thumb and fingers as shown here. Flip the folded sandpaper for a fresh surface, then open up the sandpaper and wrap it all around the sanding block for a third fresh surface.

in place on the block with your fingers and thumb. When you have used up one side, turn the folded sandpaper and use the other. Then open the sandpaper and wrap it around the block to use the middle.

Most woodworkers use random-orbit sanders because they are very efficient, easy to use, and they leave a less-visible scratch pattern than vibrator sanders due to the randomness of their movement. For both of these sanders, however, there are two critical rules to follow.

First, don't press down on the sander when sanding. Let the sander's weight do the work. Pressing leaves deeper and more obvious squiggles that then have to be sanded out. Simply move the sander slowly over the surface of the wood in some pattern that covers all areas approximately equally.

Second, it's always the best policy to sand out the squiggles by hand after you have progressed to your final sanding grit (for example, #180 or #220), especially if you are applying a stain. Use a flat block to back the sandpaper if you are sanding a flat surface. It's most efficient to use the same grit sandpaper you used for your last machine sanding, but you can use one grit finer if you sand a little longer.

Removing Sanding Dust

No matter which of the three sanding methods you use, always remove the sanding dust before advancing to the next-finer grit sandpaper. The best tool to use is a vacuum because it is the cleanest. A brush kicks the dust up in the air to dirty your shop and possibly land back on your work during finishing.



Power sanding. *Random-orbit sanders are easy to use and efficient for smoothing wood. To reduce the likelihood of the squiggles these sanders produce, use a light touch. Don't press down on the sander. Let its weight do the work.*

Tack rags load up too quickly with the large amount of dust created at the wood level. These sticky rags should be reserved for removing the small amounts of dust after sanding between coats of finish.

Compressed air works well if you have a good exhaust system, such as a spray booth, to remove the dust.

It's not necessary to get all the dust out of the pores. You won't see any difference under a finish, or under a stain and finish. Just get the wood clean enough so you can't feel or pick up any dust when wiping your hand over the surface.

How Much to Sand

The biggest sanding challenge is to know when you have removed all the flaws in the wood and then when you have removed all the scratches from each previous grit so you can move on to the next. Being sure that these flaws and scratches are removed is the reason most of us sand more than we need to.

A lot of knowing when you have sanded enough is learned by experience. But there are two methods you can use as an aid. First, after removing the dust, look at the wood in a low-angle reflected light – for example, from a window or a light fixture on a stand. Second, wet the wood then look at it from different angles into a reflected light.

For wetting the wood, use mineral spirits (paint thinner) or denatured alcohol. Avoid mineral spirits if you are going to apply a water-based finish because any oily residue from the thinner might cause the finish to bead up. Denatured alcohol will raise the grain a little, so you'll have to sand it smooth again. **PW**

Bob is the author of "Understanding Wood Finishing" and a contributing editor to Popular Woodworking.

Home-center Finishing

You can achieve a great finish from commonly available products.

We all love home centers for the good stuff they carry and for their low prices. But home centers cater to the lowest common denominator consumer – that is, they carry only the stuff that has a big market.

The result is that many of the finishing products used on furniture and cabinets, products you read about in woodworking magazines or hear about in woodworking classes, are rarely found in these stores. Examples include very fine-grit sandpapers, dyes, glazes, paste wood fillers, spray lacquers and high-performance finishes such as catalyzed lacquer.

So how do you proceed if you have to do your finishing entirely from the products available at home centers?

It's not all that difficult, really. You're just limited in some of the decorative effects you can achieve – decorative effects you're probably not interested in anyway because you're using the natural color and figure of the wood for your decoration.

With the limited choice of finishing products at home centers, you can still get all the following:

- Protection and durability ranging from minimal to the best possible
- A sheen ranging from gloss to dead flat
- Finishes ranging from amber to colorless
- A near-flawless finish resembling sprayed lacquer
- Elimination of blotching from stains
- A glaze substitute
- A pore-filling option
- The ability to block off problems in the wood.

Marketing

Before proceeding with how to accomplish these objectives, I want to explain how com-



Home-store finishing. You don't have to go to specialty retailers to find finishing supplies; you can produce a quality finish from products readily available at home centers.

panies producing and marketing finishing materials sell their products (how all companies probably sell their products, for that matter).

Finish companies target specific markets. Within any given category – oil stain, varnish, water-based finish, etc. – all companies' products are very similar, if not identical. But because stores and catalogs carry different brands, and because the marketing can sometimes make you believe some brands are somehow better than others, you may think you're getting inferior products at low-end, mass-consumer home centers when you're not.

For example, a big brand name in home

centers is Minwax, while General Finishes and Behlen dominate in woodworking stores and catalogs, and Old Masters is popular in independent paint stores. There are also stores that feature Sherwin-Williams, Benjamin Moore, Pratt & Lambert, Varathane and many other brands.

In addition, some companies target just contractors, others target cabinet and furniture makers, and still others (an entirely different group of companies) target refinishers.

Within any finish category – oil stain, glaze, varnish, lacquer, etc. – all these companies make essentially the same thing. They all have access to the same raw materials, and the instructions for putting these raw materi-

als together are available to everyone, even to you and me if we want them.

So there's nothing at all inferior about the finishing products available at home centers. There's only a limitation of what's available.

From these limited choices, however, you have many possibilities for achieving the results you want.

Protection and Durability

You have control of the amount of protection and durability you get simply by how much you build your finish and by your choice of finish. (See "Test to Find a Durable Finish" at popularwoodworking.com/finishing.)

Protection means resistance to moisture penetration into the wood—in liquid or vapor (humidity) form. All finishes provide better resistance the thicker they are, so the finishes that harden well and can be built up on the wood are capable of much better protection than finishes such as boiled linseed oil, 100-percent tung oil and blends of one of these oils and varnish, that don't harden.

Among the finishes that harden, oil-based polyurethane varnish provides the best resistance to moisture penetration and also the best durability—that is, the best resistance to being damaged by scratches, heat, solvents, acids and alkalis. Polyurethane is almost as protective and durable as the best of the high-performance finishes used in industry.

Following polyurethane in declining order are alkyd (regular) varnish, polyurethane water-based finish, acrylic water-based finish, lacquer and shellac.

But even fresh shellac is considerably more protective and durable than the finishes that

don't harden, as long as you apply several coats. Because shellac loses a lot of hardness and water resistance as it ages in the can, it's best to use it within a year of manufacture. The date of manufacture is stamped on the bottom of the can.

Color

The color you get on the wood is partially contributed by the finish. Finishes differ in how much yellowing or "orangeing" they add.

Amber shellac adds the most orange color. You can use this finish on pine, for example, to create the knotty-pine look popular in the 1950s, or recreate the warmth common on oak trim and paneling original to early 20th-century houses.

Boiled linseed oil and 100-percent tung oil have a slight yellow color to begin with, and then they yellow, or rather orange, significantly as they age. You can use either of these finishes under any other finish to achieve this orangeing as long as you let the oil cure well first. A week or two in a warm room should be adequate.

Oil-based varnishes, lacquer and clear shellac also have a slight yellow tint, which may darken a little with age. But the finish most significant for color is water-based, both polyurethane and acrylic. These finishes aren't, and don't, yellow at all. They are "water clear."

So you would choose a water-based finish for light woods such as maple or ash, or for white pickled woods, if you don't want them to have a yellow tint. You would probably choose one of the other finishes for darker woods because water-based finishes usually make

these woods appear "washed out" unless you apply a stain underneath.

Sheen

It's rare that home centers provide finishes with sheens other than gloss and satin (shellac comes in gloss only), but you can use these two to achieve any sheen you want.

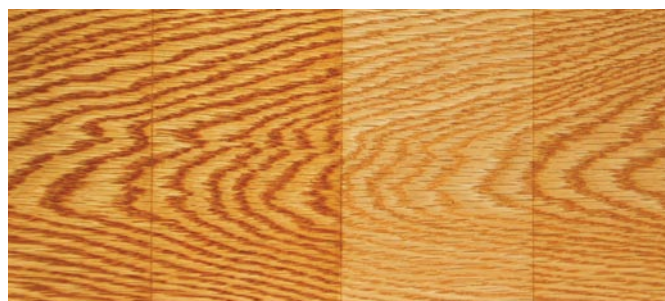
Sheen is the amount of gloss, or reflection, in a finish. If no flattening agent is added—that is, there's nothing at the bottom of the can that has to be stirred into suspension before application—the finish produces a gloss, or sharp image clarity. Manufacturers create satin and flat finishes by adding a flattening agent, which is usually silica. The more flattening agent added the less reflective the finish.



Create custom colors. Keeping in mind that the name of the color on the stain can is merely a manufacturer's interpretation, you can adjust any stain by mixing. You can even mix two or more stains of different brands as long as you stay within one type: oil or water-based. Here, I'm increasing the reddish tint in a "walnut" stain by adding some "mahogany."



Orange effects. Your choice of finish can have a big effect on the color you get, whether or not you have stained the wood. From the left, water-based finish darkens this walnut a little but doesn't add any color; lacquer adds a little yellowing; polyurethane varnish adds a little orange; and amber shellac adds a distinctly orange coloring.



The aging process. Boiled linseed oil and 100 percent tung oil add yellow coloring to the wood initially but then darken significantly as they age. This oak board was finished with three coats of each finish more than five years ago. From the left are boiled linseed oil, 100 percent tung oil, wiping varnish (varnish thinned half with mineral spirits), and a half-and-half mixture of boiled linseed oil and varnish. Notice that the linseed and tung oils have orangeed about the same and that the mixture of oil and varnish has darkened about halfway between that of the oils and varnish alone.



Control sheen. You can achieve any sheen you want just from the gloss and satin varieties of varnish, water-based finish and lacquer offered in home centers. To get a sheen in between the gloss and satin, mix the two. To get a sheen flatter than the satin, pour off some of the finish (as I'm doing here) from a can of satin in which you have allowed the flattening agent to settle, and then mix the two to get what you want.

To get a sheen in between that of gloss and satin within any finish type—varnish, lacquer or water-base—simply mix the two (after stirring the satin, of course). To get a sheen flatter than the satin, let the flattening agent settle (don't let the store clerk shake the can) and pour off some of the top. What is left will be much flatter. You can then mix these to get something in between if you want.

Because it is the top, or last, coat applied that is responsible for determining all of the sheen, you can change the appearance simply by applying another coat with a different sheen. (See "Some Reflections on Sheen" at popularwoodworking.com/finishing.)

Avoiding Flaws

Spray guns can be used to produce nearly flawless, meaning almost perfectly level, sur-



No HVLP necessary. You can use aerosols as an alternative to a spray gun to achieve a level surface. Aerosols are available in polyurethane and water-based finish in addition to lacquer. To get a thicker build with less expense, brush two or three coats, then sand the surface level up to #400 grit and spray a couple of coats with the aerosol.

faces. But you can achieve the same without a spray gun simply by thinning the finish or using an aerosol. The thinner (meaning "thinned") the finish, the better it levels and the faster it dries.

Better leveling means no brush marks. Faster drying means reduced dust nibs.

You can thin any finish to get it to level better, but the easiest to use are the varnishes. All home centers carry already thinned alkyd and polyurethane varnishes. These are sometimes labeled "Wipe-On Poly," but also "tung oil," "tung oil finish" or "tung oil varnish." In no cases do these products (which I call "wiping varnish" because they're easy to wipe on wood) have anything to do with tung oil, but they produce wonderful results nevertheless.

There are three good ways to apply a wiping varnish: Wipe or brush it on the wood

and wipe off all the excess; wipe or brush it on and wipe off some or most of the excess; brush it on and leave it. The more you leave the greater the build but the longer time dust has to settle and stick to the finish.

To get a thick build with fewer coats, brush several full-strength coats of alkyd or polyurethane varnish, sand the surface level up to #400-grit sandpaper, then apply several coats of wiping varnish and wipe off some or most of the excess. You can make the wiping varnish yourself by thinning the same finish you're brushing by half with mineral spirits, or you can use one of the already thinned brands. (See "The Basics of Wiping Varnish" in the November 2005 issue, #151.)

You can also use an aerosol for your finishing. Aerosols are now available in oil-based polyurethane and water-based finish in addition to lacquer and shellac, but they are relatively expensive. Instead of building all your coats with the aerosol, you can brush a couple, sand out the brush marks then use the aerosol of the same type of finish to apply level final coats. (See "Aerosol Spray Finishing" at popularwoodworking.com/finishing.)

Whatever finish you're applying and however you're applying it, always watch it in a reflected light to spot runs as they develop and respread or rewipe to remove some of the excess.

Whatever method you use to get a level surface, rub it lightly with a folded brown paper bag after the finish has hardened to remove minor dust nibs and make the surface feel smoother.

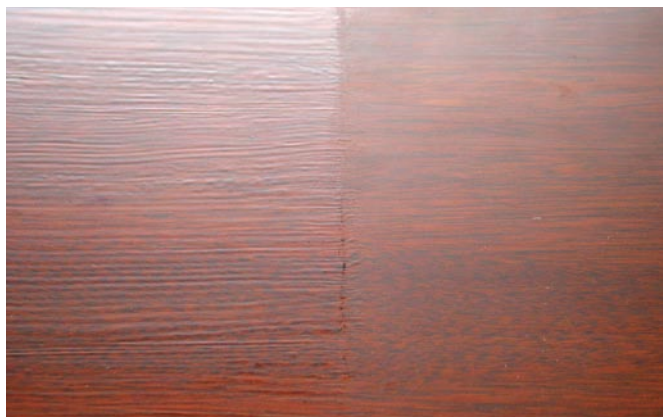
Blotching

Blotching is uneven, and usually ugly, coloration caused by stains penetrating the wood unevenly.

To avoid blotching on softwoods such as pine, use a gel stain. This is a stain thickened enough so it doesn't penetrate. Gel stains ought to be called "pine stain" because they are so effective at eliminating blotching in pine.

On hardwoods such as cherry, birch, maple and poplar, it's more effective to use a washcoat. This is any finish thinned to about a 10 percent solids content. Lacquer is used in industry, but the type sold in home centers is varnish or a blend of oil and varnish labeled "wood conditioner" or "stain controller." You can make your own by thinning any full-strength varnish or blend of boiled linseed oil and varnish with two parts mineral spirits.

Thin to achieve a smooth finish. To eliminate brush marks (shown on the left), thin the finish a quarter to a half with the appropriate thinner and then brush it. If you want to speed the build, brush two or three full-strength coats, then sand the surface level up to #400 grit and apply a couple thinned coats.



When you apply this washcoat, be sure to let it cure at least six hours in a warm room, better overnight, or it won't be very effective. This is different than the directions on the cans, which usually say to apply the stain within two hours.

There is no need to apply a washcoat to woods such as oak, ash, walnut and mahogany that don't blotch. (See "Battling Blotching" at popularwoodworking.com/finishing.)

Glaze Substitute

Colored glazes are used to add highlighting, antiquing or create faux graining over at least one coat of finish. Glazes are rarely available in home centers, but you can substitute a gel stain with excellent results. Glazes and gel stains are essentially the same thing anyway – a thickened stain.

To do glazing, brush or wipe the glaze or gel stain over at least one coat of finish and then remove all the color you don't want using a rag, brush, sponge, graining tool (usually available at home centers), steel wool or any other tool that produces the results you want.

A typical use of glaze on cabinets and furniture is to leave it in recesses to add three-dimensional depth or an antique look. Be sure to apply at least one coat of finish over the glaze after it has dried to protect it from being scratched or rubbed off. (See "Glazes and Glazing Techniques" at popularwoodworking.com/finishing.)

Pore Filling

Some woods look better with their pores filled to create a "mirror-flat" surface. Mahogany is the best example.

Products called "paste wood filler" or "grain filler" (not the same as wood putty or wood filler) designed to achieve this look are rarely available at home centers. But you can achieve the same result by sanding a number of coats of finish down to the deepest level of the pores. You can sand a little between each coat, or you can sand more after you have applied all the coats.

Because we all apply finishes differently, you will have to experiment on scrap to determine the number of coats necessary so you don't sand through.

For the easiest sanding between coats, use stearated sandpaper. Norton "3X" and 3M "Tri-Mite" and "Sandblaster" are all stearated. This means they contain a soap-like lubricant that reduces clogging. You can use your hand to back the sandpaper when sanding between coats, but you should use a flat sanding block on flat surfaces when sanding many coats level.

For the easiest sanding after a number of coats, use black, wet-dry sandpaper with a mineral-oil, mineral-spirits or mixed mineral-oil/mineral-spirits lubricant. Begin sanding with a grit sandpaper that levels efficiently without creating larger-than-necessary scratches (for example, #320 or #400 grit) and then sand to finer grits if they are available.

If finer grits aren't available, apply one more coat of thinned finish (so it will level well), spray with an aerosol or rub the surface with #0000 steel wool. You can use a wax, oil or soap-and-water lubricant with the steel wool to reduce scratching and improve smoothness. (See "Rub to Create a Great Finish" at popularwoodworking.com/finishing.)

Problems in the Wood

Of all the finishes, shellac is easily the most effective for blocking off problems in the wood. The most common problem in new wood is resinous knots in pine and other softwoods. The resin can bleed into the finish and cause it to remain tacky and not cure.

In old (refinished) wood, the most common problems are fish eye (cratering or ridging) and odors from smoke or animal urine. Shellac blocks all these problems so you can then successfully apply any finish over it. If you are using varnish or water-based finish, it's best if you use dewaxed shellac, sold in most home centers as "SealCoat."

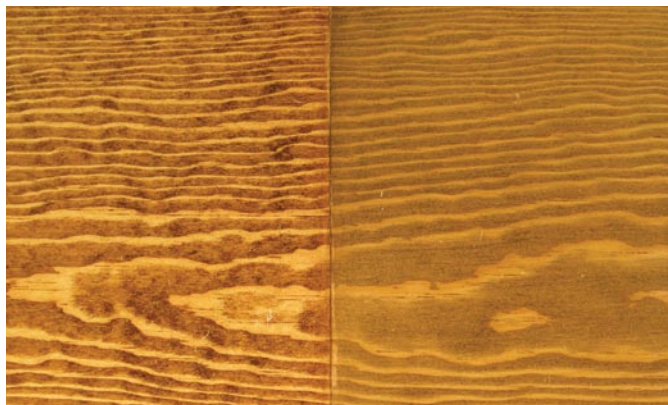
To make your own dewaxed shellac, pour off or decant the shellac from a can of Bull's Eye Clear Shellac after the wax has settled to the bottom. It will take a long time for this to occur on its own, so don't shake the can when you buy it, or thin the shellac with at least two parts denatured alcohol in a glass jar (so you can see it) to get it to settle faster.

If there are no problems you need to block off, there's no reason to use shellac as a first coat. (See "The Case for Shellac" at popularwoodworking.com/finishing.)

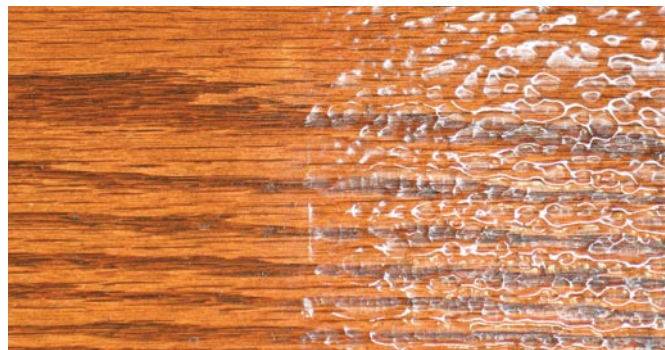
Conclusion

Somehow, a lot of unnecessary mystique is introduced into wood finishing. In reality, however, it is quite simple. This is most evident when you realize all the possibilities available from just the few products stocked by home centers. **PW**

Bob is author of "Understanding Wood Finishing" and a contributing editor to Popular Woodworking.



Eliminate blotching. The easy way to eliminate blotching in pine is to apply a gel stain as I have done to the right half of this pine board. The left side is stained with a liquid stain. Gel stains are so effective on pine they should be called "pine stain."



Refinishing woes. Fish eye (cratering) is one of the most serious problems in refinishing. It's caused by silicone from furniture polishes getting into the wood and causing the new finish to wrinkle when applied. One easy way to avoid fish eye is to block it with a first coat of shellac, applied here to the left side of the board. The only new-wood use for shellac as a first coat is over resinous knots in softwoods such as pine.

The 7 Myths of Polyurethane

Oft-repeated ‘rules’ that are, quite simply, wrong.

All levels of finishing are burdened with myths, but the types of finishes used by amateurs and sold in home centers and woodworking stores suffer the most. Myths about polyurethane are a good example of the problem.

What is Polyurethane?

Oil-based polyurethane is simply a type of varnish. It’s common alkyd varnish made with some polyurethane resin added. Alkyd is the resin used in almost all varnishes and oil-based paints. The polyurethane resin adds scratch, heat, solvent and water resistance to the alkyd varnish.

Pure polyurethanes (with no alkyd resin) are always two-part products. They cure in several ways: With the addition of moisture (an example is Gorilla Glue), with heat (many common plastics), or they are packaged as two separate components that cure after they are mixed (similar to the way two-component epoxy adhesives work).

The two-component polyurethanes are becoming more common in the furniture industry because they perform well and have a very high solids content, meaning less solvent to escape into the atmosphere.

One-component, “uralkyd” polyurethane has become so dominant in the woodworking and home-consumer world that it’s now becoming somewhat difficult to even find old-fashioned alkyd varnish.

Confusion has been added in the last decade or so with the introduction of water-based finishes, some of which combine polyurethane with acrylic resins. These finishes are sometimes labeled “polyurethane,” with no obvious reference to their being an entirely different class of finish, one that performs less well than oil-based polyurethane and has very different application characteristics.



No advantage. It’s not necessary to brush across the grain, as I’m demonstrating here, to work the finish into the wood. The finish penetrates perfectly well by capillary action no matter how it is applied.

This isn’t to say you shouldn’t use water-based polyurethane. Just be aware that it is an entirely different finish – a water-based finish. This article deals solely with oil-based polyurethane.

The Myths

Myths are much more prevalent in finishing than in woodworking because finishes are chemistry, and you can’t always “see” differences in chemistry. For example, polyurethane and lacquer look the same, both in a can and on the wood, even though they have very different characteristics.

In contrast, woodworking is physics. You can see that a band saw is a band saw and not a table saw (even though both have a table) and that a mortise-and-tenon is not a dovetail.

So authors and manufacturers have much more opportunity to provide inaccurate information, intentionally or not, about finishes than about woodworking tools and procedures. And consumers are more vulnerable to misinformation – that is, “myths” – about finishing than about woodworking.

Once a myth gets into print, it’s common for it to be repeated endlessly until it becomes “fact,” simply because everyone says

it. Here are some of the most common myths concerning polyurethane (and varnishes in general).

■ **MYTH #1: Brush across the grain first to work the finish into the wood.** All finishes soak perfectly adequately into the wood no matter how they are applied. They do this by capillary action, the same physical phenomenon that allows water and nutrients to rise from the ground to the top of a tree.

If it were necessary to brush across the grain first, or diagonal to it (as I've also seen advocated) to get the finish to penetrate into the wood, how would a sprayed finish penetrate?

The only benefit gained by brushing first across the grain and then with the grain (to line up the brush strokes with the grain) is to make the thickness of the application more even. But I never have a problem with some areas being noticeably thicker than others anyway.

More important, the longer polyurethane is brushed the more thinner evaporates, and this causes the finish to thicken and brush marks to be more pronounced.

■ **MYTH #2: Thin the first coat 50 percent to get a good bond.** This is an old myth that probably got its start because of poor understanding of the role of primers used under paint, and sanding sealers sometimes used under varnish and lacquer.

Primers do create a better bond for paint because they contain a higher ratio of binder



Bubbles. If you shake a finish vigorously, as I did this jar containing polyurethane (left), thousands of tiny bubbles appear. These can be transferred to the wood by a brush. But bubbles appear on the wood even when you don't shake the finish because of the turbulence caused by the brush movement, as I'm demonstrating here with polyurethane I didn't shake (right). So it's more important to know how to deal with the inevitable bubbles than to follow instructions not to shake.

(finish) to pigment. But finishes are all binder, so they bond perfectly well without a separate product.

Sanding sealers contain a soap-like lubricant that makes the sanding of the first coat easier and faster, so they are especially useful in production situations. But they weaken the bond of the finish, so unless you're doing production work, you're better off not using a sanding sealer.

Polyurethane bonds especially poorly to sanding sealers, so most manufacturers of polyurethane discourage their use. Furthermore, polyurethane sands easily, so there isn't any need for a sanding sealer.

Nevertheless, the existence of primers and sanding sealers (and the recent addition of "SealCoat," a dewaxed shellac from Zinsser, marketed for use as a "sealer" under polyurethane) have created a belief among some that something has to be put under the polyurethane to make it bond better.

And those who believe this have come up with the idea of thinning the finish.

In fact, the only benefit gained by thinning is faster drying. The thinner the layer of any finish, the faster it dries, and the sooner it can be sanded and the next coat applied. So there is a benefit, but it's not improved bonding.

■ **MYTH #3: Never shake the can or you'll introduce bubbles.** A corollary is: Never wipe the bristles over the rim of the can because this will also introduce bubbles into the finish.

This is a very old myth that is more "misleading" than "myth" because it's true but it doesn't matter. I don't know when the myth started, but it is so well established that it's

even highlighted in bold letters on the cans of common brands such as Minwax and Olympic polyurethane.

Sure, if you shake the can, bubbles appear in the finish. And if you then brush the finish, bubbles appear in it. But they appear in the brushed finish even if you don't shake the can. This should be the clue that shaking isn't the critical factor – brushing is.

If the great majority of bubbles are the result of the turbulence caused by the rapid movement of the brush, the way to avoid bubbles could be to brush very slowly to reduce the turbulence.

The published instruction from one author who suggests doing this is to brush one foot every eight seconds and not brush back over. Try it. It's almost impossible to brush this slowly. And not brushing back over to stretch out the finish and thin it on the wood – and also line up brush strokes – leads inevitably to runs on vertical surfaces and build-up on horizontal surfaces wherever you set down a finish-loaded brush.

So you're going to get bubbles if you brush, whether or not you shake the can. The trick is to know how to keep the bubbles from drying in the finish.

Usually, bubbles pop out on their own. But on hot days when the skinning-over occurs faster and traps the bubbles, you may need to help the popping along by "tipping-off" using your brush. Brush lightly back over the finish right after application. (You should do this anyway to line up the brush strokes with the grain.) Most of the bubbles will disappear.

If the tipping-off doesn't work well enough, add 5 or 10 percent mineral spirits to keep



Sanding. Not only does polyurethane not need thinning or a special product to create a better bond to the wood, but it also sands easily on its own without clogging sandpaper.

the finish “open” longer and give the bubbles more time to pop out.

Some brands of polyurethane, such as Minwax, bubble noticeably more than others, but this is rarely a problem because the bubbles tend to pop out quickly.

There are two ways to deal with bubbles that won't pop out. The first is to wipe off the bubbled coat of finish using a rag dampened with mineral spirits, naphtha or turpentine. You can do this for 15 to 30 minutes after application without a problem. You won't damage the coat underneath, and you don't have to get all the polyurethane removed. Simply wipe until what is left is smooth and bubble-free.

The second method is to let the bubbled finish dry and sand it level before applying another coat. Thin this coat enough with mineral spirits so the bubbles have time to pop out.

The disservice caused by attributing bubbles to shaking rather than to brushing is that users become frustrated and lose confidence when they follow directions and still don't avoid the problem.

■ **MYTH #4: Thinning with naphtha makes polyurethane dry faster.** Naphtha evaporates much faster than mineral spirits or turpentine. So the logic behind this myth, which is fairly new, is that the finish will dry faster if the thinner evaporates faster.

But, like all varnishes, polyurethane dries in two steps. The first is evaporation of

the thinner. The second (and much longer) step is the curing, which is the crosslinking brought about by the introduction of oxygen from the air.

When you apply polyurethane, you notice that it stays wet on the surface for a short time as the thinner evaporates. Then the finish goes into a tacky or sticky stage for an hour or longer. This is the length of time it takes for the oxygen-induced crosslinking to occur. Adding a faster-evaporating thinner doesn't speed this crosslinking.

In fact, adding naphtha probably has no noticeable effect on the drying of the finish beyond the impact of thinning described at the end of the second myth.

■ **MYTH #5: Thinning with Penetrol reduces brush marks.** Painters have added Penetrol, a widely available additive, to oil paint for decades to reduce drag and brush marking, especially when painting in hot or cold weather, or in sunlight. But until recently I had never seen Penetrol recommended for use in polyurethane, which is usually applied indoors in more ambient working conditions and brushes easily without drag.

Penetrol is a slow-drying oil product that lengthens the tacky stage of polyurethane and oil paint. This creates more time for dust to

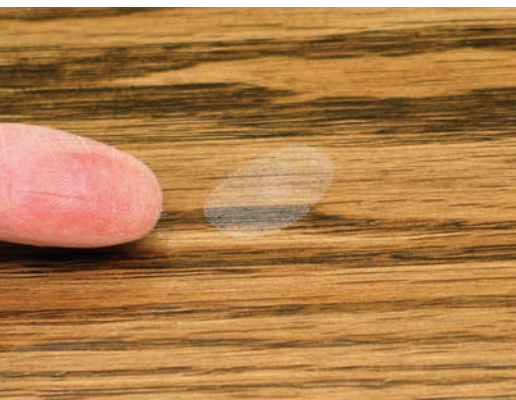
settle and stick to the surface. Painters don't mind because dust isn't a big problem for them, but it is for furniture finishers.

Most woodworkers want their polyurethane to reach a dust-free stage faster, not slower, as evidenced by myth #4. What little benefit might be gained in reducing brush marking is more than cancelled out by increased dust nibs. (If you want to reduce dust nibs, thin the last coat of polyurethane by 25 to 50 percent so it dries faster.)

Additionally, because Penetrol is an oil, it can't help but weaken the durability of polyurethane – though not enough to cause a problem in most situations, so far as I can tell. (See the next myth for the way to eliminate brush marks.)

■ **MYTH #6: Slant the panel to reduce brush marks.** I read this myth for the first time only recently. The idea is to get brush marks to flow together by tilting flat panels such as tabletops 5° or 10° off the horizontal.

Not only is this a tricky procedure that will lead to sagging if you aren't careful to keep the finish thin on the surface (similar to the difficulty brushing vertical surfaces), but the procedure doesn't make any sense. It's not gravity causing one brush-mark ridge to sag into another that reduces brush marking.



Sticky stage. Once the bubbles have popped out, you want the polyurethane to dry as fast as possible to get beyond the sticky stage (demonstrated here by a fingerprint in the finish) so dust nibs are kept to a minimum. Adding faster-evaporating naphtha to the finish doesn't speed the drying of this stage beyond what is accomplished simply by the thinning. You could just as well use mineral spirits.



Penetrol. Adding Penetrol (a widely available additive for oil paint) to polyurethane slows its drying so dust has more time to settle and stick to the finish. Any possible gain in reduced brush marking is more than cancelled out by the added dust nibs.



Brush marks. The way to apply a brush-mark-free finish using polyurethane is to first sand out the brush marks on the next-to-last coat using a flat backing block and a mineral oil, mineral-spirits or water lubricant. Then thin the last coat about 25 percent with mineral spirits so it levels well.

It's gravity evening out the difference between the ridges and the troughs that eliminates brush marking.

Some brands of polyurethane level naturally better than others because of their formulation. But all polyurethanes can be made to level perfectly by adding mineral spirits. So the way to get a brush-mark-free finish is to sand the next-to-last coat level, then thin the last coat enough so it levels well.

The amount of thinner necessary varies with brands. My suggestion is to begin with about 25 percent mineral spirits and adjust from there.

■ **MYTH #7: Scuff sand between coats to get a good bond.** The purpose of this instruction is to create scratches in the surface so the next coat of finish can establish a "mechanical" bond. The finish "keys" or "locks" into the sanding scratches.

This myth is somewhat complicated. The first clue that sanding between coats isn't so critical is that you rarely create scratches everywhere anyway. There are almost always gaps in your sanding – for example, in the pores, in recesses and often just because you aren't being thorough enough.

And yet, the next coat usually bonds well anyway, especially if not a lot of time has gone by between coats. How often have you seen coats of polyurethane separating?

Here's the way to approach sanding between coats: Do it anyway. Polyurethane dries slowly, so there are always dust nibs that should be sanded out before the next coat is applied.



Slant panel? Slanting a panel 5° or 10° is not the way to reduce brush marking, but this has actually been suggested recently. You would have thought furniture finishers working during the last several hundred years would have figured this out if it were true.

For two reasons, pay more attention to doing a thorough sanding if you are using a gloss finish than if you are using one with flattening agents included (semi-gloss or satin). First, even tiny flaws show in gloss finishes, while they are often disguised in semi-gloss and satin. Second, finishes don't "wet" and bond as well to gloss surfaces as they do to dull surfaces. (The dullness in semi-gloss and satin finishes is caused by a microscopically rough surface created by the flattening agent.)

Use a sandpaper grit that removes the flaws efficiently without creating deeper scratches than necessary. I almost always sand with #320 or #400 grit, regular or "P" grade. There have to be big flaws in the surface to require sanding with coarser grits.

I never back the sandpaper with a flat block when sanding between coats to remove dust nibs, though it would be all right to do this if the surface is truly flat. The biggest problem using a flat block is that you are more likely to clog the sandpaper and the clogs, or "corns," will put deeper scratches into the finish that might telegraph through the next coat.

You can also abrade with steel wool or a synthetic abrasive pad, but neither cuts and levels as well as sandpaper.

Conclusion

Brushing polyurethane is not complicated, but somehow authors and manufacturers have succeeded in making it seem so. They have done this by introducing myths into



Scuffing. The main reason to sand polyurethane between coats is to level dust nibs and other flaws, not to create a better bond. This is demonstrated here by the gloss remaining in the pores after sanding the surface. The next coat of finish still bonds in the pores even though the finish there is rarely scuffed.

their instructions. Some of the myths make no sense but do no harm. Others purport to solve a problem, and when following them doesn't help, frustration sets in.

It's unfortunate, but once a myth gets into print, nothing, not even an article such as this, seems to have any impact slowing its spread.

Probably the opposite, in fact. Conspiracy theorists know that merely repeating an "untruth" in order to debunk it tends more to solidify it in the minds of believers. **PW**

Bob is the author of "Understanding Wood Finishing" and a contributing editor to this magazine.

Finishing the 5 Types of Woods

Organize all the woods into categories to determine the best finishing strategy.

Woodworkers choose among dozens of wood species for projects. Unless you've actually used many different woods and experienced how they machine, feel, smell and respond to stains and finishes, you probably find making an intelligent choice confusing. There needs to be some way to organize the woods so decisions are easier.

And there is.

To begin with, you can divide all woods into five large categories: pine and related softwoods; coarse-grained hardwoods; medium-grained hardwoods; fine-grained hardwoods; and exotics.

Traditional furniture is rarely made of pine or exotics, so for simplicity's sake, let's reduce the categories to three: coarse-, medium- and fine-grained hardwoods. And to begin with, let's deal with just the five most common traditional furniture hardwoods: oak, walnut, mahogany, cherry and maple.

Importance of Grain

Grain is the most important indicator for identifying woods. Grain is the open pores or pitting in wood that give it texture. In finished wood you may have to look closely to see the grain because it may have been filled.

Most old furniture was made with one of these five woods, so identifying woods in antiques is fairly easy. If the grain is coarse, the wood is likely oak. If it is fine—that is, if there's no obvious pitting—the wood is probably cherry or maple. If there is pitting and it's finer and more evenly spaced than in oak, the wood is almost always walnut or mahogany.



A fan of woods. Pictured are a number of woods woodworkers choose among for projects. Clockwise from the top are pine, oak, walnut, cherry, butternut, mahogany, ash, gum, soft maple, poplar, chestnut, teak, rosewood and ebony.

To tell the difference between cherry and maple and between walnut and mahogany, the color of the heartwood is key. On an antique you may need to cut a sliver from an inconspicuous place to see its color. On newly milled wood, you can simply look at the color.

If the color of fine-grained wood has a reddish tint, the wood is cherry. If near white, it's maple. If the color of a medium-grained wood is charcoal gray, it's walnut. If reddish, the wood is mahogany.

Keep in mind that oak can have a coarse

grain when plainsawn, or less coarse when quartersawn. Quartersawn oak is usually easy to identify because of its medullary rays.

Additional Woods

Of course, wood identification becomes more difficult when more woods are added. Traditionally, chestnut, elm and ash were sometimes used instead of oak. Each is coarse grained but subtly different. You just have to learn to recognize these differences.

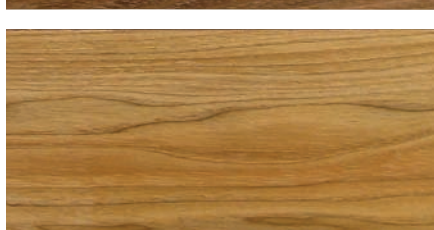
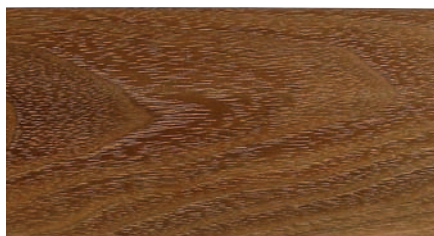
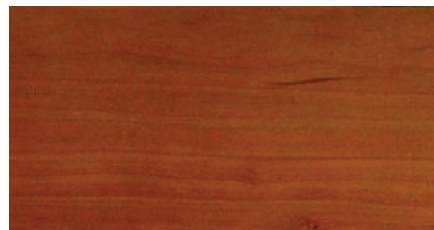
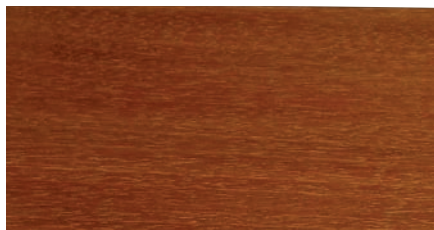
Butternut, hickory and pecan were also used, and their grain resembles walnut and mahogany. Color can help in identification. Butternut is tan; hickory and pecan are tan with a slight pink cast.

There are lots of fine-grained woods in addition to cherry and maple, including birch, poplar, gum, beech, yew and holly. Gum and beech have a color similar to hickory and pecan. Yew is light brown to reddish. The heartwood of poplar has a distinct greenish color, which ages to light brown. The others, and the sapwood of poplar, are near white.

To distinguish between these fine-grained woods, you need to recognize subtle differences in figure. Figure is primarily grain orientation, the appearance of which has a lot to do with the way boards and veneer are cut, but also small distinguishing characteristics such as the flecks in cherry, maple and beech.

Exotic Woods

Mahogany could be classified as an exotic wood because it grows in jungle areas. But



Coarse-grained woods. Common coarse-grained woods include from the top: plainsawn oak, quartersawn oak and ash. All stains and finishes look good on these woods.

mahogany has been used so extensively for so long, it makes more sense to classify it as a medium-grained wood along with walnut, hickory and pecan.

With the exception of teak and rosewood, exotic woods were rarely used until recently, and then usually just for decoration and veneer. Now a wide variety of exotic woods are used for bowl turning, decks and furniture.

Most of these woods are medium-grained, but many are very distinctive in color and figure and therefore fairly easy to identify once you have become familiar with them. I don't have any easy categories that will help.

Finishing the Five Categories

Here are some thoughts about finishing each of the five categories of wood.

Pine and related softwoods have a very pronounced grain—soft, absorbent, white spring growth alternating with hard, dense, orange summer growth. The spring growth absorbs stain well, but the summer growth doesn't. So staining these woods usually reverses the color, making the spring growth darker than the summer growth.

Pine also tends to blotch, which can be quite unattractive.

On the other hand, pine finishes well with any finish, though I don't like oil finishes because so many coats are usually required

Medium-grained woods. Three common examples of medium-grained woods used in wood-working are from the top: mahogany, walnut and butternut. These woods are widely considered the most elegant when their pores are filled. All stains and finishes can be used successfully.

to bring the sheen of the spring growth even with that of the summer growth.

Like pine, fine-grained woods tend to blotch—often in an unattractive way. But sometimes, as with curly, bird's-eye and mottled woods, the blotching is attractive. As I have described often in these pages, you can reduce the blotching by applying a washcoat (thinned finish) before applying the stain, but the coloring will then be lighter.

All fine-grained woods finish well with any finish, but oil finishes require many coats for a nice appearance. Water-based finishes look wonderful on the white woods because they don't add any yellow/orange coloring, but they make cherry look washed out unless a stain is applied under the finish.

Medium-grained woods finish to look the most elegant of all woods as long as the pores are filled. This is one reason mahogany and walnut have long been considered the premier furniture woods.

All finishes except water-based look wonderful on these woods, and water-based also looks fairly good if a stain is applied under the finish.

All stains and finishes also look good on

Fine-grained woods. Woodworkers use a great many fine-grained woods. Examples include from the top: cherry, curly maple and beech. As with most fine-grained woods, these tend to blotch, especially when stained. But the blotching is often considered attractive as with curly maple. Water-based finishes look especially good on the white woods but make darker woods such as cherry look washed out unless a stain is used.

coarse-grained woods. Only quartersawn oak looks good filled. Plainsawn, coarse-grained woods look plastic, in my opinion, when filled. The filled areas are too wide.

Water-soluble dye stains don't color the pores well in coarse-grained woods. If you use a water dye, follow it with an oil-based wiping stain of a similar color, either directly over the dye or over a washcoat, to add color to the pores.

All stains and finishes (water-based with a stain applied underneath) also look good on exotic woods. The common finishing problem with these woods is getting an oil or varnish finish (not others) to dry in a reasonable time because of the natural oily resins many of these woods contain.

To overcome the problem, wipe the surface with naphtha or acetone just before applying the first coat of oil or varnish. Then apply the finish right after the solvent evaporates off the surface. **PW**

Bob Flexner is author of "Understanding Wood Finishing" and a contributing editor to Popular Woodworking.

BY BOB FLEXNER

Refinishing Furniture

Repair, strip and refinish to restore old pieces.

Refinishing is a topic worthy of an entire book. In fact, restoring furniture includes all of woodworking and finishing because all skills may be called into play. In lieu of a book, here are some not-so-random thoughts.

1 ■ Refinishing is a good thing, not bad as suggested by the “Antiques Roadshow.” Furniture with a deteriorated finish usually ends up in a city landfill.

2 ■ There are three broad approaches to refinishing: Make the furniture look new (as the maker or factory intended it to look); make the furniture look old but in good shape (usually with a satin or flat finish and maybe some glaze in recesses); or make the furniture look like something else (for example, change the color). All three are legitimate approaches.



Test for finish. To determine if an old finish is shellac or lacquer, dab on some denatured alcohol or lacquer thinner. Alcohol dissolves shellac. Lacquer thinner dissolves lacquer. I used alcohol here, so clearly, this is shellac.



Stripper types. There are five categories of strippers. From left to right: high-percentage methylene chloride, low-percentage methylene chloride, strong solvent and no methylene chloride, refinisher (no methylene chloride and no wax), and NMP (n-methyl pyrrolidone).

3 ■ In most cases, the first step is to do as much of the wood repair, including regluing, as possible so glue seepage and minor damage occur on top of the old finish rather than on bare wood. Glue seepage and damage are then totally removed with the old finish. An exception is when paint has to be stripped first to see what wood or veneer exists underneath, so it can be matched.

4 ■ Stripping is messy, but it's almost always a lot easier than sanding off an old finish or paint. Stripping also does less damage to the wood and to color that may be in the wood – color that is the result of the wood aging or a stain that had been applied.

5 ■ There are two broad categories of products that can be used to strip old paint or finish from furniture: paint stripper and the solvent for the finish. (Heat guns and caustic lye strippers are very risky on furniture because of the damage they can cause to the wood, veneer and glue joints.)

6 ■ There are five large categories of paint strippers. The primary differences are strength, speed and toxicity, which tend to correspond. From strongest, fastest and most toxic, the categories are:

- High in methylene chloride (labeled “non-flammable” and noticeably heavier).

- Low in methylene chloride (labeled “flammable” with methylene chloride listed as an ingredient).

- Strong solvent, but no methylene chloride (labeled “flammable” with no methylene chloride listed).

Note: Each of the above contains wax that rises to the surface and slows evaporation. This wax has to be washed off the wood with a solvent or strong detergent after the coating has been stripped, or there may be bonding and drying problems with the newly applied finish.

- Refinisher (very similar to strong-solvent, non-methylene-chloride strippers, but without wax to slow evaporation).

- NMP (packaged in plastic containers with n-methyl pyrrolidone listed as an ingredient).

7 ■ Denatured alcohol will dissolve and remove shellac, which was used on almost all furniture finished between the 1820s and 1920s. Lacquer thinner will dissolve and remove lacquer, which was used on almost all furniture finished after the 1920s. Keep the solvent in contact with the finish using wetted rags or paper towels. When the finish has dissolved, wipe it off.

8 ■ It's rare that much sanding is required after the finish has been stripped. Sanding with fine sandpaper is necessary only to check that all the finish has been removed. Any remaining finish will gum up the sandpaper, telling you that more stripping is necessary. Usually, the less sanding the better.

CONTINUED ON PAGE 60

CONTINUED FROM PAGE 58

9 ■ Don't be tricked by remaining stain in the wood. No stripper will remove all the stain, and it's not necessary to remove the stain unless you want to make the color lighter.

10 ■ Use oxalic acid, sold in crystal form as "wood bleach," to remove dark watermarks. Dissolve the crystals to a saturated solution in hot water and brush the solution onto the entire surface. After the solution has dried back into crystal form, wash (don't brush) the crystals off the wood. The crystals are toxic to breathe.

11 ■ You can use stain to create whatever decorative effect you want. But it was rare that pre-20th-century furniture was stained. The darker colors associated with most old mahogany and cherry furniture is the result of oxidation (age). Old walnut usually lightens a little.

12 ■ The most efficient method of applying stain is with a rag or spray gun. Wet the surface thoroughly, then wipe off the excess with a dry cloth.

13 ■ Most 20th-century mahogany, and some walnut and quartersawn oak, had its pores filled when the furniture was made. You need to repeat this filling using paste wood filler (not the same as wood putty), especially on tabletops, when you refinish or the wood will look too raw. Just as with wood putty, it's best to use a colored filler because it doesn't take stain well after it has dried.

14 ■ It's best to apply a thin sealer coat under the wood filler to make the



Finish residue. When stripping a finish, don't be fooled by stain that isn't removed. It's rare that all the stain comes out of the wood. Instead, look for remaining shiny areas that indicate you haven't removed all the finish.

excess filler easier to wipe off and to create a cushion that allows you to sand off any streaks you may leave without cutting into stain or the color of the wood below.

15 ■ A common refinishing problem is "fish eye." The newly applied finish bunches up into ridges or crater-like depressions caused by silicone (which is found in most furniture polishes) having gotten into the wood through cracks in the old finish. Silicone is a very slick oil and isn't fully removed in the stripping process.

There are three ways to deal with silicone contamination: Wash the wood many times with a strong detergent or solvent such as mineral spirits to thin and remove the oil from the pores; seal the wood with shellac to block the oil from getting into the finish; or add silicone ("fish-eye eliminator") to the finish to lower its surface tension so it will flow out level.



Fish eye. It's usually easy to spot the potential for fish eye by brushing the surface with mineral spirits, water or any stain. To avoid fish eye when the finish is applied, the silicone that causes the problem has to be washed out of the wood or blocked with shellac, or silicone has to be added to the finish to lower its surface tension.

16 ■ The final step is to apply a finish. Shellac is a good choice if you want to be consistent with the original finish used on 19th-century furniture. Lacquer is much more versatile than shellac if you are spraying. Varnish, including polyurethane varnish, is the most durable of all consumer finishes. Water-based finish provides easy brush clean-up and reduced odor, but creates a "washed-out" look on darker woods unless you use a stain underneath the finish.

Oil finishes rarely look good on old furniture because oil finishes are too thin on the wood. **PWM**

Bob Flexner is the author of the new books "Flexner on Finishing" and "Wood Finishing 101."

Stripping with alcohol. Shellac can be removed by placing alcohol-soaked rags in contact with the finish for a short time until it's easy to simply wipe off the finish. Lacquer can be removed the same way using lacquer thinner.



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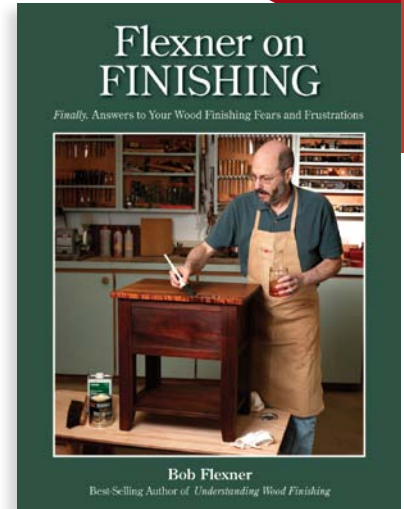
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