Sanding
and
Finish Selection

Prepared for members of the
Baton Rouge Woodworkers Club

v1.0

Pro Tip: Here's something that I accidentally left out of the original presentation…

Save some scrap wood from your project to test your finishing strategy, from sanding to final finish. Even if you've used certain products in the past a change in wood type can alter the outcome in ways you might not anticipate. The goal is to avoid surprises, and this is the only way to do that.

This will not significantly add to your project time as you can work on your project while the various finishing stages dry or cure.

I hope you find this information useful.

Happy Finishing!

Fundamentals of Wood Finishing

What we'll cover today:

- Prepping wood for finishing
- Reactive vs. non-reactive finishes
- Waxes
- Drying oil
- Shellac
- Lacquer
- Water-borne finishes
- Varnish

Fundamentals of Wood Finishing

What we won't cover:

- Catalyzed finishes
- Two-part finishes
- Conversion varnish
- Outdoor finishes
- Stains and dyes
- Sanding sealers and grain fillers

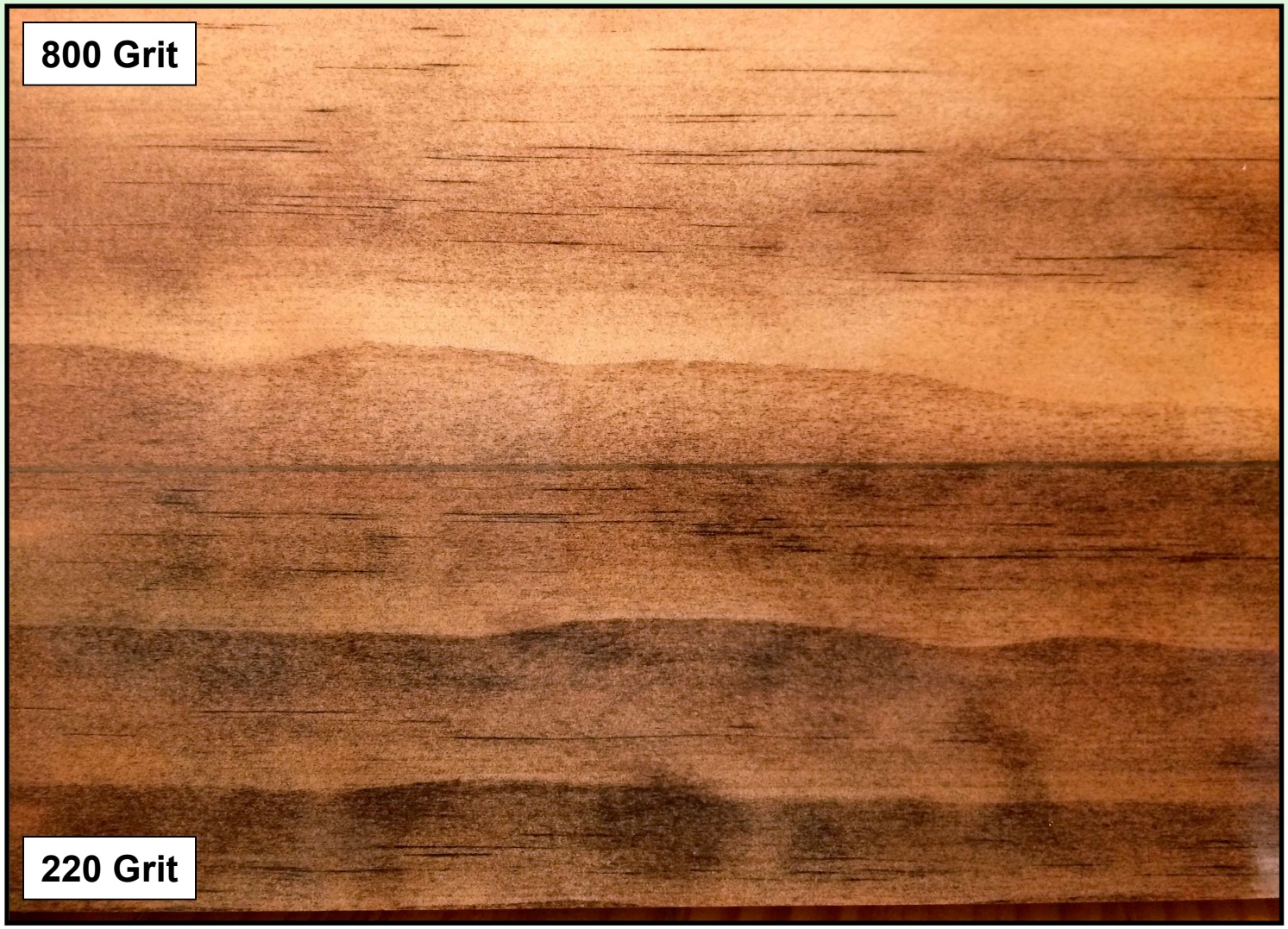
Preparing Your Wood

Tips On Sanding

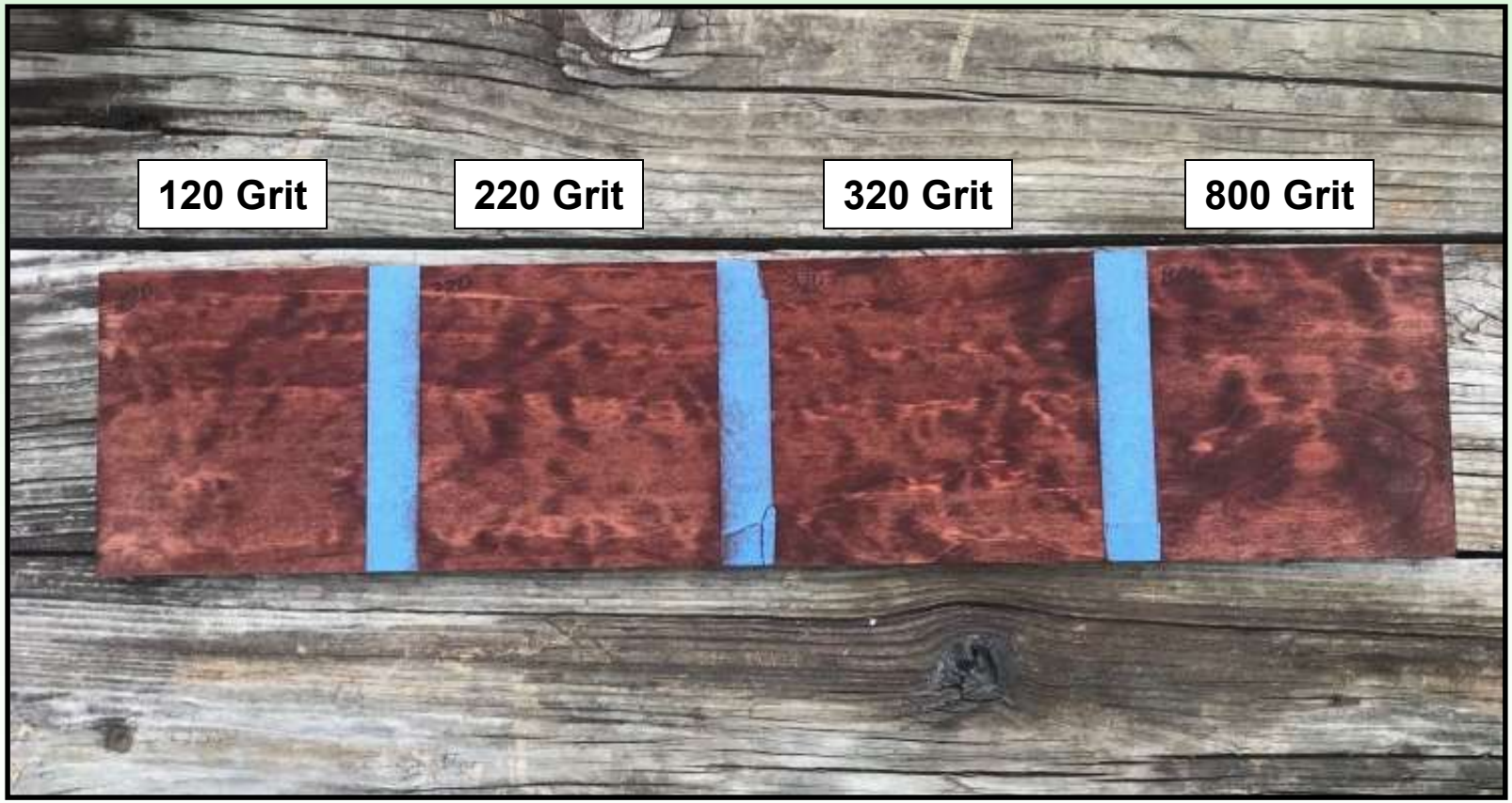
Preparing Your Wood

- Sand in the grain direction, starting with 150 grit sandpaper.
- Follow with 180-220 grit, but no higher.
- Finer grits have smaller scratches, affecting stain absorption and first-coat adhesion.
- Don’t neglect the end grain. Sand it as smooth as everything else to even out stain absorption.
- Watch for glue. Wood with glue on it, even a little bit, will not stain. If dry remove with toluene, xylene, acetone, or lacquer thinner. (in order of effectiveness)
- U.S. vs. European grit numbers

Stain Blocking Using Fine Sandpaper



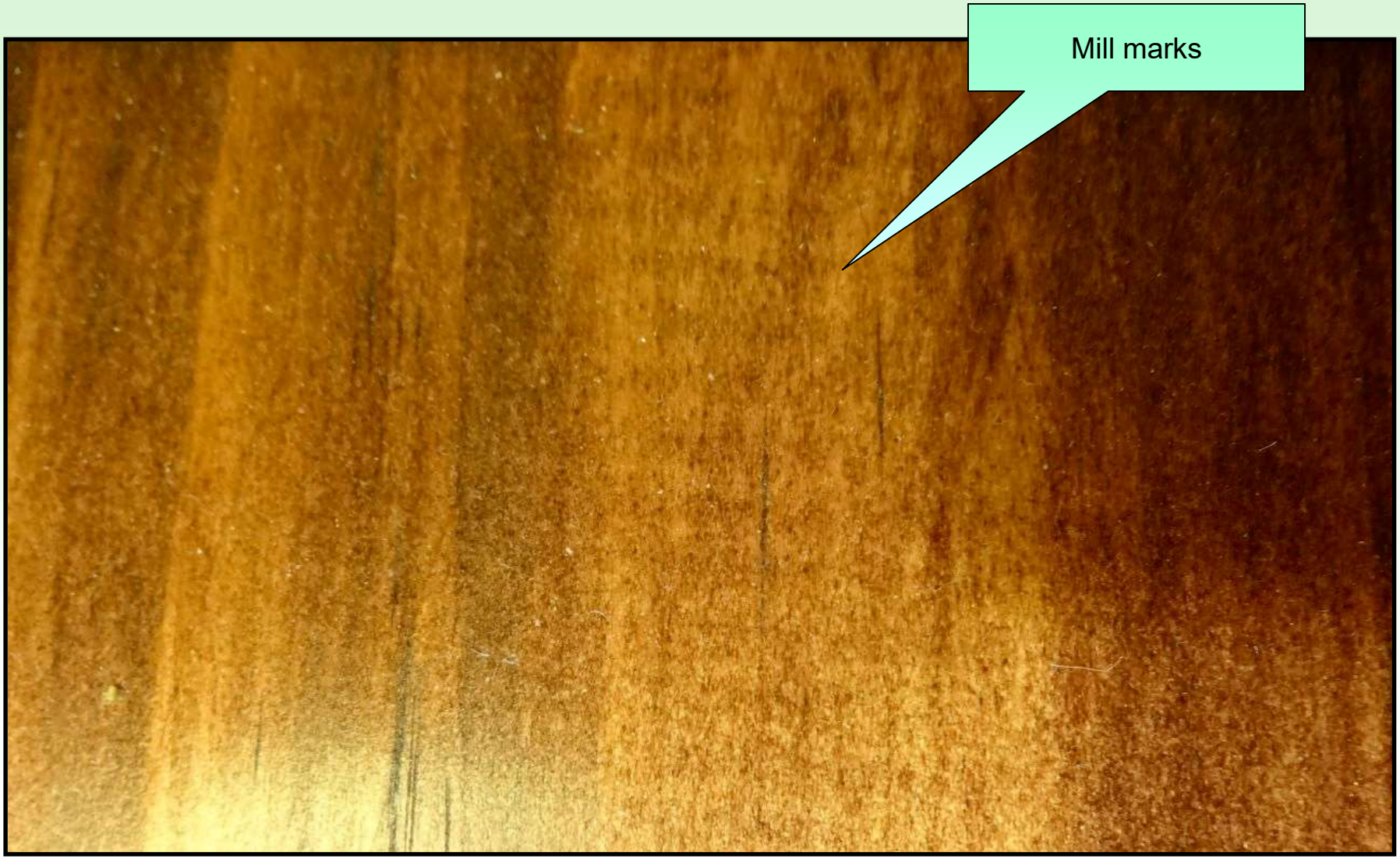
Dye Is Not Blocked Using Fine Sandpaper



Preparing Your Wood

- Scratches, dents, mill marks, and cuts (marking knives) will show up once the stain goes on. At that point it's difficult to fix unless you sand again.
- Try wetting the surface with mineral spirits (oil based finish) or alcohol (water-borne finish) to locate surface defects
- Try getting down low and looking across the surface to see scratches

Mill Marks



Cross-grain Sanding Marks

Sealers

When to use a sealer:

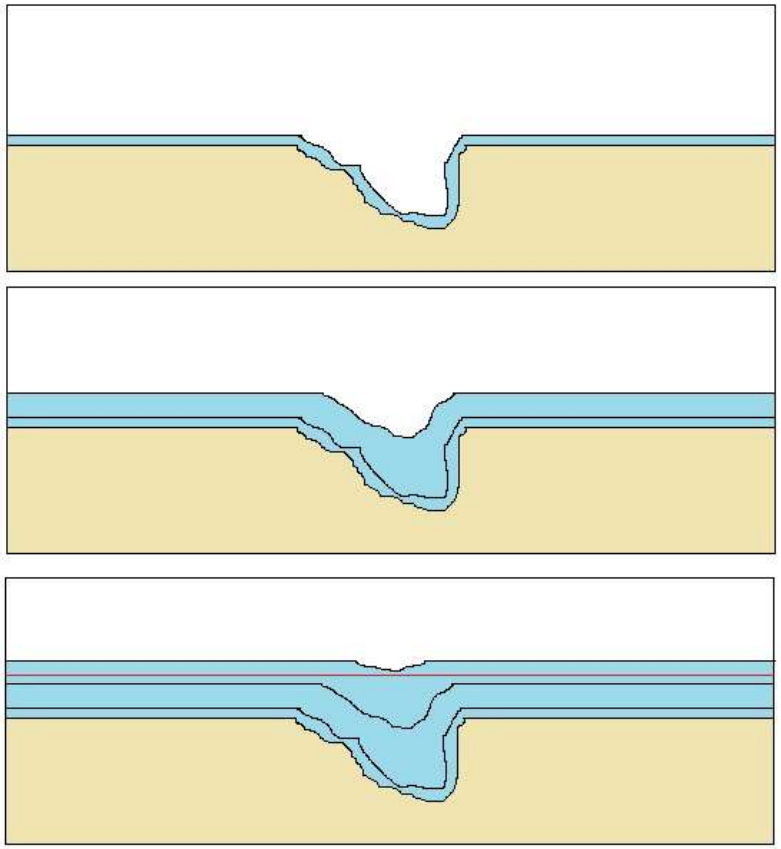
- Lock in a water based dye with de-waxed shellac to keep a water-borne finish from re-dissolving it. Alcohol won't dissolve a water based dye.
- If you need to fix a problem like contaminants in the wood or oily knots

Filling the grain

Filling with finish:

- It's possible to fill grain with your finish alone, but not by just adding more coats.
- To do this apply thin coats and sand down after each coat until your finish fills the grain.
- Be aware that most finishes shrink over time (weeks or even months). Don't be surprised to find that after a period of time those pores begin to become visible again.
- Grain fillers will likewise shrink or you may miss some pores which show up when you finish. Sanding back your finish between coats will usually mitigate the problem.

Fill With Finish




FORMBY'S
FURNITURE WORKSHOP
SATISFACTION GUARANTEED
Traditional
Tung Oil Finish
HIGH GLOSS
A premium protective varnish for classic, hand-rubbed beauty
DANGER! HARMFUL OR FATAL IF SWALLOWED. COMBUSTIBLE
16 FL OZ (1 PT) 473 mL
CLEAR SATIN


ZINSSER
Bulls Eye
Shella
CLEAR
MINWAX
Clear Brushing
LACQUER
• EASY TO USE
• NO SANDING BETWEEN COATS
• BEAUTIFUL, TRADITIONAL FINISH
CLEAR GLOSS
DEFT

Finishes


SIMPLY THE BEST WAY TO FINISH WOOD
Tried & True
Danish Oil
Huile Fini Danois
Polymerized Linseed Oil
One Quart
946 ML


MINWAX
WATER BASED
Polycrylic
PROTECTIVE FINISH
Crystal Clear Finish
Ultra Fast-Drying
Easy Water Clean Up
CLEAR GLOSS
32 fl oz (1 QT) 946 mL

Reactive vs. Non-Reactive Finishes

Reactive	**Non-Reactive (evaporative)**
• Finish cures • Native solvent won't affect cured finish • Requires scuffing between coats • Slow curing time • Cures from top down • Varnishes, catalyzed finishes, oils	• Finish dries • Solvent will dissolve finish • No scuffing between coats • Fast drying time • Dries from the bottom up • Lacquer, shellac, waxes

Then there are **Coalescing** finishes, which are water-borne.

Reactive finishes cure by reacting with oxygen or moisture in the air. Some, like polyurethane, also contain chemical curing agents.

Wax

Types:	Paraffin, Beeswax, Carnuba, Others
Solvent:	Stoddard oil, others.
Durability:	Soft. Poor durability.
Waterproof:	Not water or water vapor resistant.
Chemical resistance:	Poor.
Repairability:	Excellent.
Appearance:	Satin sheen.
Application:	Rub on, buff off.
Safety:	Solvents can be flammable.

Waxes

- They are the least protective of all finishes.
- Waxes serve only to add some sheen to a finish.
- Waxes offer virtually no protection aside from making a surface smooth.
- Some are colored to match the wood so it doesn't show in cracks.
- Waxes are an evaporative finish and contain solvents if they are in a can.

Waxes

- Waxes are of three general types: paraffin (also isoparaffin, called microcrystaline), beeswax, and carnauba.
- **In order of hardness (soft to hard):**

  Paraffin - melts around 130F

  Beeswax - melts around 140-150F

  Carnauba - melts at 180F
- Carnauba is very hard and difficult to buff when used alone.
- Solid carnauba (Hut wax) is used in wood turning and is melted on while the lathe is spinning. (See website article)

Waxes

- Paraffin waxes (Johnson's, Minwax, etc.) can be removed with mineral spirits.
- Waxes do not build up or evaporate. A new coat removes the old coat.
- Good results can be obtained with a power buffer after the wax dries.
- Wax should be put on very thin. Folding a piece of wax in a cloth and letting the wax bleed through is a good way to apply.

Applying Wax

Waxes

Additional thoughts:

- Briwax is popular but contains toluene, although there is a toluene-free version. Toluene will damage a water-borne finish and other finishes that are not completely cured. It's a blend of beeswax and carnauba wax.
- Renaissance Wax - Microcrystaline wax. This is an isoparaffin wax (branched alkanes) as opposed to a typical paraffin wax which is unbranched. Primary use is in care of museum sculptures, armor, swords, etc. Dries hard.

Drying Oil Finishes

Types:	Linseed (flaxseed) oil, Tung oil, soybean
Durability:	Not very hard or tough. Minimal protection from scratches, abuse.
Waterproof:	Almost none. Tung oil has better water resistance than linseed oil.
Chemical resistance:	Poor resistance to solvents.
Repairability:	Easy. Just add another coat.
Appearance:	Close-to-the-wood satin finish.
Application:	Easy. Wipe on. Wipe off excess.
Safety:	Never leave oily rags lying around. They can spontaneously ignite due to accelerating oxidation of the oil.

Drying Oil Finishes

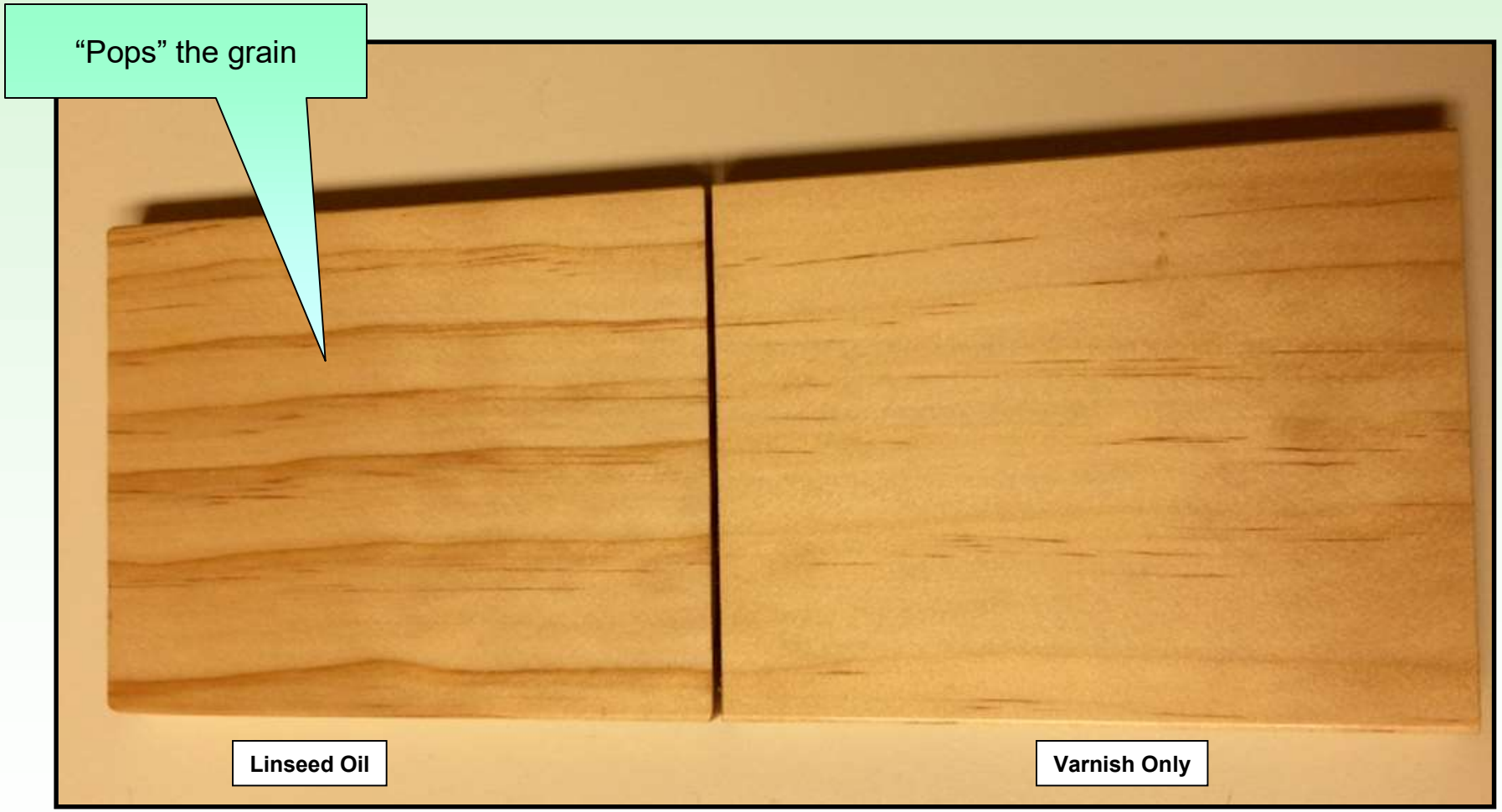
Pros	Cons
• Easy to apply. • Penetrates well. • Shows off the beauty of the wood. • Nice satin finish. • An overcoat of varnish can be applied after 3-4 days for better protection.	• Long cure times. • Poor durability, very little protection. • Too soft to build up a film (except pre-polymerized). • Cannot be removed except by completely sanding the area penetrated by the oil. • Some yellowing or darkening may occur over time. • If you need a glossy finish look elswhere. • Must be wiped dry shortly after application.

Drying Oil Finishes

Linseed Oil:

- Cures through polymerization when in contact with air.
- Linseed oil will make the grain of the wood “pop” and can be used under other finishes that may not do this as well.
- Linseed oil offers virtually no protection against anything. It’s one of the worst finishes in this regard.
- Raw linseed oil will cure, but not fast enough to be suitable for woodworking.

Linseed Oil - Grain Enhancement



Drying Oil Finishes

“Boiled” Linseed Oil:

- Today most linseed is not boiled at all, but chemically modified with metallic driers that makes it cure faster.
- This type will cure to a satin sheen and is very soft.
- It has very poor durability on its own and should be overlaid with a more lasting finish.

Drying Oil Finishes

Tung Oil:

- Pure tung oil will cure, but it takes a long time, several days between coats.
- Tung oil has greater water resistance than linseed oil and even has some resistance to alcohol.
- Tung oil is used to make some varnishes that require high water resistance (marine, table top).

Drying Oil Finishes

Polymerized Oils:

- Tung or linseed oil labeled “polymerized” or “pre-polymerized” has been heated until cross-linking within the oil begins. The oil finishes curing in contact with oxygen.

- This type will form a hard, glossy finish that is more durable than non-polymerized oils and cures fairly fast.

- Apply in very thin coats or cracking can occur.

Drying Oil Finishes

Polymerized Oils:

- Common types of polymerized linseed oil are Tru Oil and Tried and True Danish oil.

- Southerland and Wells is an example of polymerized tung oil.

Drying Oil Finishes

Application Tips (pure oil):

- Less is better. Use a very small amount and rub into wood.
- Allow oil to soak in for a few minutes and wipe off all excess.

This is very important! Leaving oil on the surface may cause the finish to feel tacky or wrinkle.

- Allow finish to cure overnight before adding another coat.
- If you want a more durable finish follow up with an oil-based varnish after several days.

Drying Oil Finishes

Other oils:

- Nut oils (linseed, tung, etc.) oxidize and harden.
- Mineral and vegetable oils (mineral oil, olive, peanut) do not harden.
- Vegetable oils will go rancid if applied to wood.

Shellac

Types:	Flake or premixed.
Solvent:	Denatured alcohol only.
Durability:	Softer than lacquer. Not very durable.
Heat:	Poor. Begins to soften at 150F.
Waterproof:	No.
Chemical resistance:	Damaged by alcohol, ammonia, water.
Repairability:	Reversible with denatured alcohol.
Appearance:	Beautiful. Adds depth to wood.
Application:	Brush, spray, or French polish.
Safety:	Alcohol vapors (flammable, optic nerve).

Shellac may contain wax or be de-waxed. If the container does not say "de-waxed" then you can assume it contains wax.

Shellac

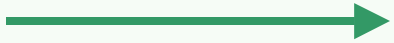
Pros	Cons
• Sanding between coats not required • Damage can be repaired easily • Easy to level sand and polish • Beautiful appearance • Won't yellow • Food safe • Odor free. Excellent for inside drawers, armoires, chests, etc. • Available in colors	• Tends to sag on verticals • Thin with denatured alcohol only • Damaged by ammonia, alcohol, water, and some solvents. • Moderate hardness. Reactive films are harder. • Poor heat resistance • Water causes white ring. • Not available in satin.

Shellac

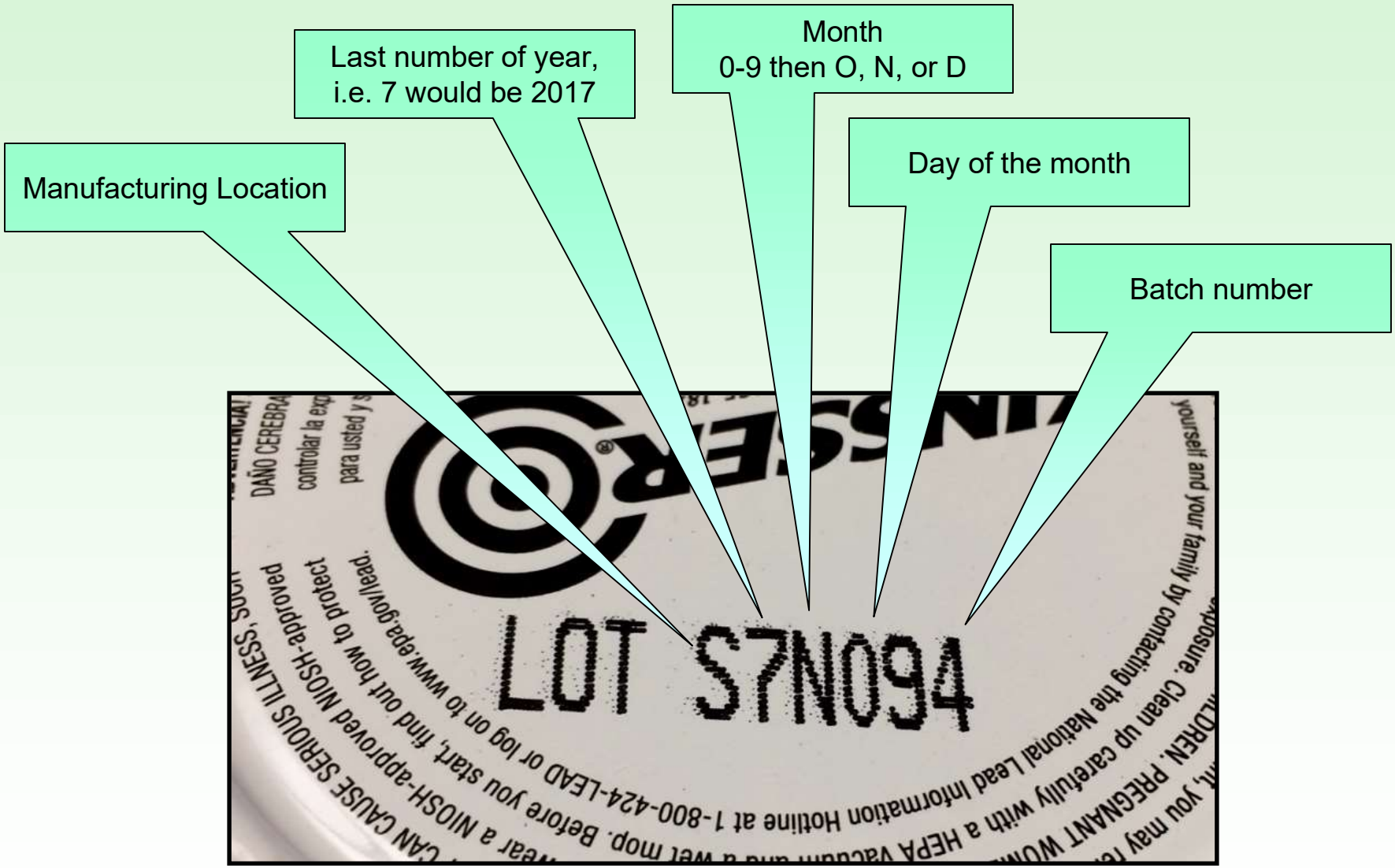
- Shellac is all natural and has no smell after the solvent has evaporated. Perfect for inside drawers or cabinets.
- Dewaxed shellac is an excellent barrier under any finish.
- Shellac concentration is referred to as a “cut”.
- Example: 2lb cut = 2 lbs of flake per gallon of alcohol, etc.
- Zinsser shellac is a 3lb cut.
- Zinsser SealCoat (dewaxed shellac) is a 2lb cut.
- Zinsser spray shellac is dewaxed.

Shellac

- Shellac should only be thinned with denatured alcohol.
- Shellac has a shelf life that starts when the resin is mixed with alcohol, not when you open the can.
- The shelf life for Zinsser shellac and SealCoat is 3 years.
- Heat will cause mixed shellac to go bad faster. Keep it cool.
- Zinsser shellac has a date code on the can.

  Here's how to decode it 

Zinsser Shellac Date Code



Shellac

Application Tips (brushing):

- Use a natural or China bristle brush.
- Avoid over brushing on a warm day.
- Shellac is not prone to bubbles, but if you get some just “tip off” with the brush.
- Clean brushes with 50/50 household ammonia and water. Don’t waste expensive alcohol for this.
- Wait at least a month before placing objects on a shellac finished surface.

Shellac - Mixing Your Own

- Shellac may be bought as solid flakes.
- Multiple colors - Blonde, Super Blonde, Orange, Amber, Garnet, others.
- Keep flakes refrigerated until use. Store in a non-permeable bag or glass jar.
- Use high purity denatured ethanol.

Lacquer

Types:	Nitrocellulose, Acrylic, CAB, Catalyzed
Solvent:	Lacquer thinner only.
Durability:	Moderate hardness, somewhat durable. Poor UV. Damaged by heat.
Waterproof:	Water resistant for short periods.
Chemical resistance:	Damaged by some solvents.
Repairability:	Excellent.
Appearance:	Transparent, high gloss.
Application:	Brush or spray.
Safety:	Volatile solvents. Very flammable. Use in well ventilated area. Wear respirator.

Lacquer

Pros	**Cons**
• Fast drying • Sanding not required between coats • Damage can be repaired • Easy to level sand and polish • Beautiful appearance • Fewer bubbles than poly when brushing	• Tends to sag on verticals • Thin with lacquer thinner only • Needs sealer to avoid contaminants • Nitro lacquers may yellow with age • Toxicity, flammability • Brushing difficult on large projects • Damaged by some solvents • Moderate hardness. Reactive films are more durable. • Fisheye can be a problem

Lacquer

More on types - Nitrocellulose

- Most common. This is what you'll likely find at Lowe's, etc.
- Nitrocellulose is produced from nitrated cotton fibers and other cellulosic materials.
- Nitrocellulose is gives lacquer it's fast drying properties.
- Can be brushed, sprayed.
- May yellow somewhat with age.
- Prone to cracking with age, particularly if finish is overbuilt.
- Avoid extreme temperatures.

Lacquer

More on types - Nitrocellulose

- Nitrocellulose resin alone is not very flexible and does not bond well.
- Therefore, other resins are added to it:

  Alkyd, maleic, acrylic, urethane, vinyl
- These resins all produce different properties such an whiteness and water resistance.
- Plasticizer added to improve flexibility
- Brushing lacquer is nitrocellulose lacquer with a retarder added to it.

Lacquer

More on types - Acrylic

- Synthetic polymer resin developed in 1950s.
- Finish is water white and will not yellow.
- Fast drying.
- Not as prone to cracking if thickness limits are adhered to.
- Must be sprayed.
- Automotive acrylics are not flexible enough for wood.
- Water-borne lacquer is actually made with acrylic resin and is suitable for wood.

Lacquer

More on types - CAB

- CAB (cellulose acetate butyrate) Acrylic lacquer is a mixture of CAB and acrylic resin.
- Does not contain nitrocellulose, so it's completely colorless.
- Less water resistant than nitrocellulose, but remains clear.
- CAB is available in a catalyzed form.
- Spray only.

Lacquer

Application Tips (brushing):

- Use only a natural bristle brush.
- Apply a de-waxed sanding sealer first to avoid fisheyes, etc.
- Keep your hands clean!
- Minimize sagging by thinning with a lacquer thinner.
- Each coat will partially dissolve the previous coat, so no between coat sanding is needed.
- To fix a sag let dry then level sand. Add coat.
- Let dry about 2 hours between coats.
- Cleanup with lacquer thinner only.

Lacquer - The Fisheye Problem

What's "Fisheye"?

- Fisheyes look like small craters in the finish and are usually caused by silicone contamination in the wood.

- Surface tension of contaminant is low so finish pulls back.

Lacquer - The Fisheye Problem

Lacquer

Fisheye can be solved several ways:

1. Use a barrier coat (dewaxed shellac).

> *The reality is that shellac works only if the contamination is not too heavy. With heavy contamination multiple tests proved that neither brushing nor spraying shellac worked unless at least three or more coats are used. This is not advisable when a harder finish is going on top.*

2. Use an additive that contains silicone.
3. Spray several light, dusting coats of lacquer before applying a “wet” coat

Water-borne Finishes

Types:	Acrylic, Urethane, Acrylic/Urethane
Durability:	Tougher than lacquer, not as tough as oil-based poly.
Heat:	Poor heat resistance.
Waterproof:	Not very. About like nitrocellulose lacquer.
Chemical resistance:	Poor resistance to solvents.
Repairability:	Moderate.
Appearance:	Usually water clear. Some have coloring to look like oil-based.
Application:	Moderate difficulty. Bubbles, streaks can be a problem with some.
Safety:	Use respiratory equipment or ventilate well.

Water-borne Finishes

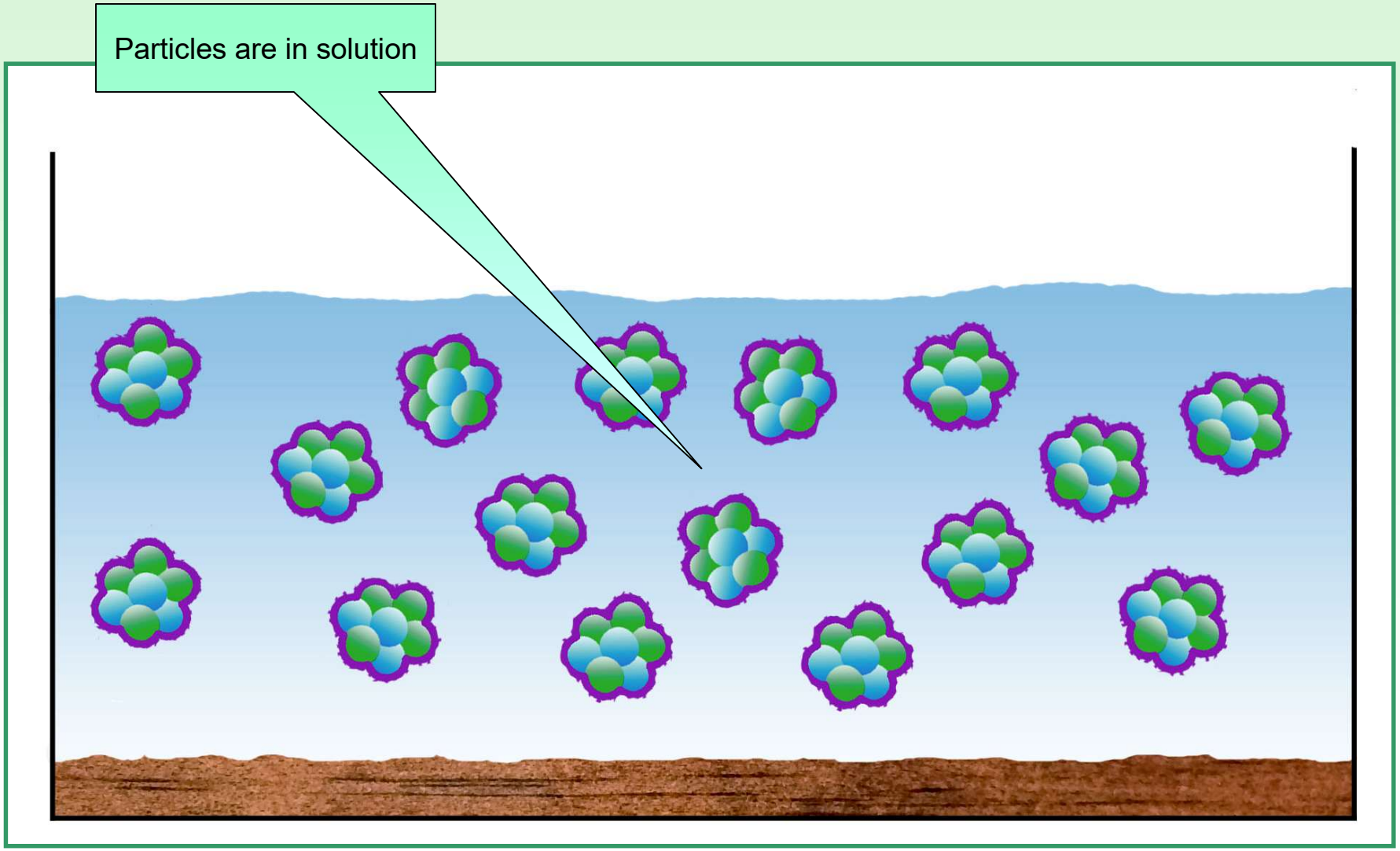
- Relatively new, driven by demand for lower VOCs.
- Not as durable as their oil-based cousins, but getting closer.
- They are typically coalescing finishes using glycol ether as the solvent and water as a dispersant.

Water-borne Finishes

What is a water-borne coalescing finish?

- A coalescing finish contains tiny pre-cured particles of finish that are suspended in a mixture of water and solvent (glycol ether).
- As the water evaporates the solvent makes the particles sticky and they begin to bind together.
- As the solvent evaporates the outside molecules of the softened particles entangle, leaving a solid finish.
- Because the proportions of the components are critical to proper curing these finishes cannot be reliably thinned with water.

Coalescing Mechanism



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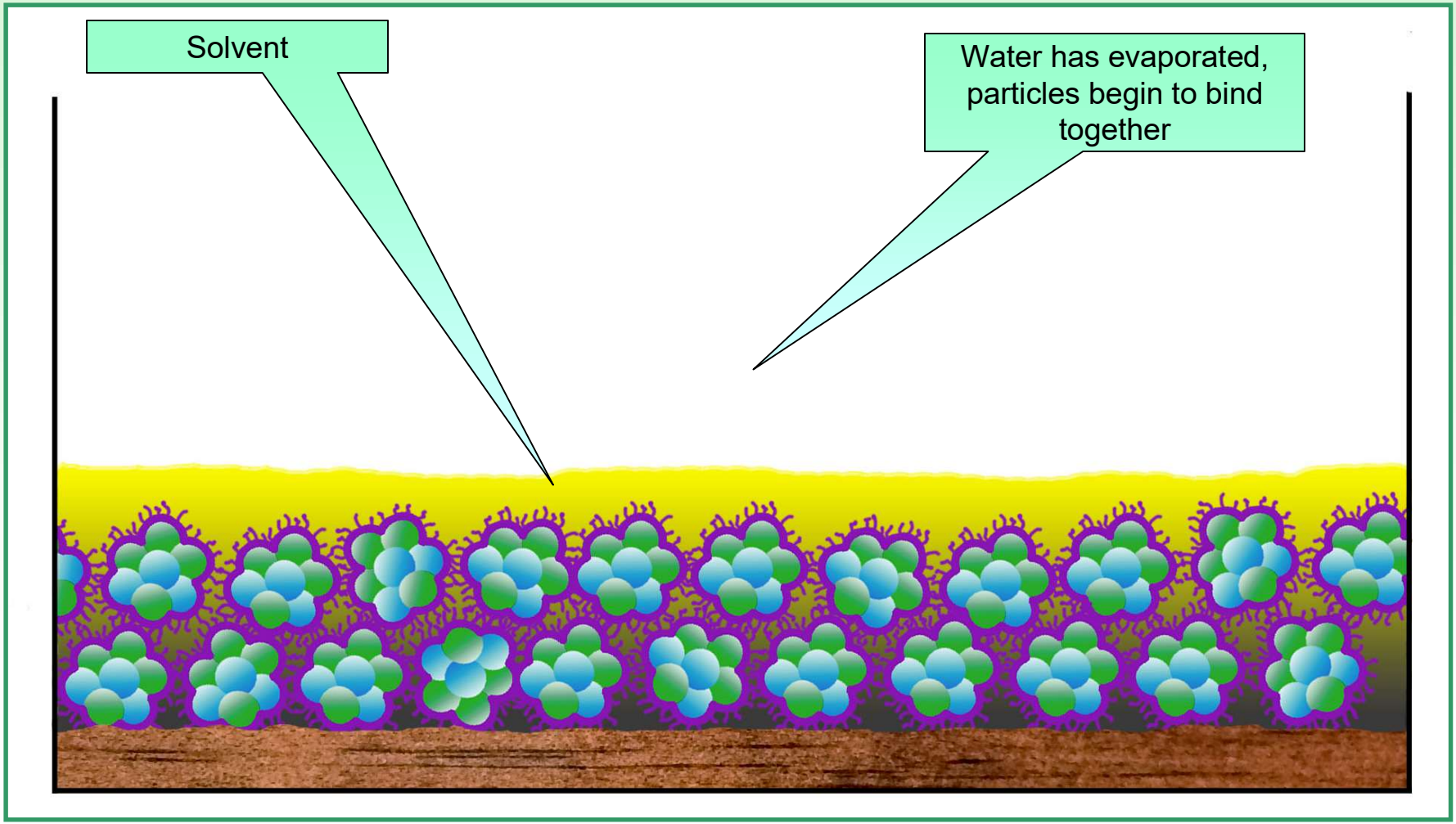
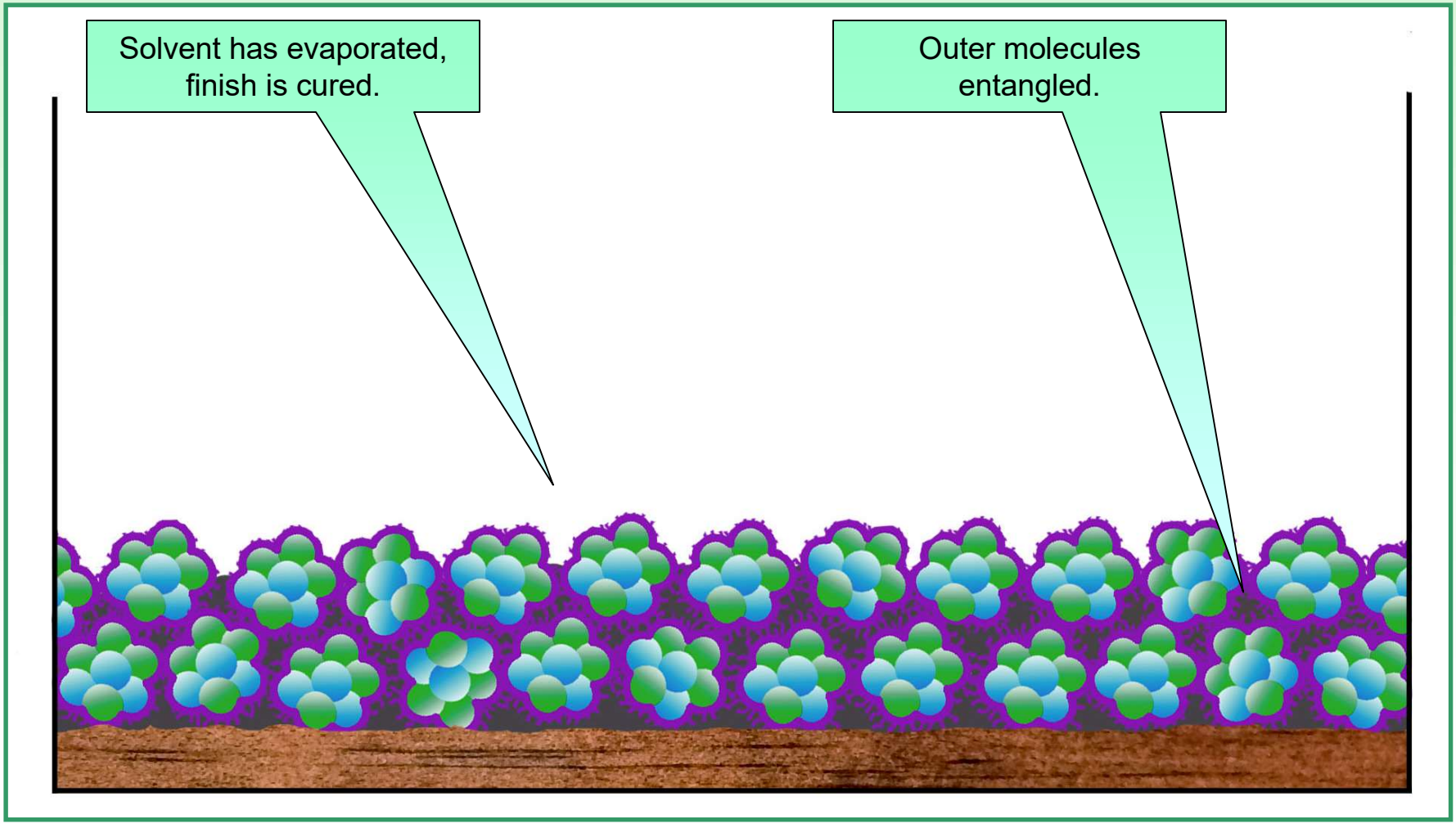


Coalescing Mechanism



Water-borne Finishes

- May be self-crosslinking, which improves durability.
- Some use additional hardener to achieve crosslinking.
- Not always apparent from product labeling.
- Generally dries clear with no yellowing.
- Acrylic, urethane, or a combination of both are common.
- Water-borne acrylic is packaged as “water-based lacquer”.
- More expensive than oil-based finishes.

Water-borne Finishes

Application Tips:

- Will raise grain with first coat.
- Sanding between coats may be necessary if days or weeks have passed since last coat.
- Never use steel wool to buff. It will make black spots in the wood.
- If bubbles are a problem try “tipping off” after brushing.
- Apply when temperature is warm. Cold temperatures affect the ability of the finish to coalesce properly.
- Do not thin.
- Clean brushes with water before the finish dries.

Minwax Polycrylic

- Common example of a coalescing finish.
- Urethane resin is combined with acrylic for toughness, hence the term “poly” in the title.
- May be applied over Minwax oil based stain (except red mahogany).
- Damaged with common household chemicals and solvents, heat.
- Strain through paint strainer to remove bits of cured finish in the can.
- Excessive bubbles in my tests.

Minwax Polycrylic - Poor Heat Resistance

Other Thoughts on Water-borne Finishes

- Technology is changing rapidly.
- There are newer finishes that cure similar to their oil based counterparts (Enduro-Var, others).
- Colored urethane may be used to mimic the amber tone of oil based finishes.
- Water-borne finishes may be picky about application over anything oil-based. However…
- Manufacturers may recommend water-borne finishes over their own oil-based stains after **complete** curing (several days).

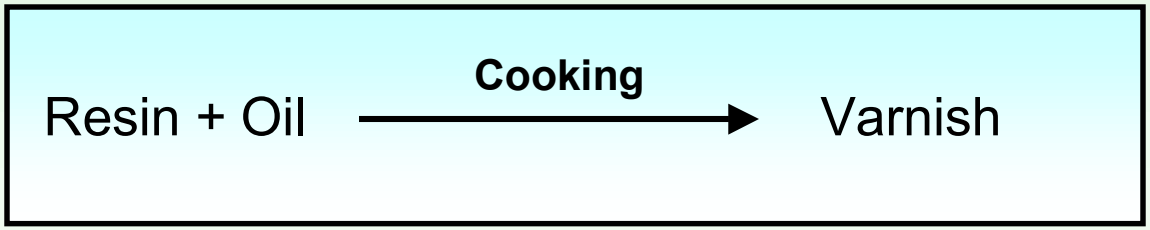
Varnish

Resins:	Alkyd (polyester), phenolic, polyurethane.
Durability:	Hard finish. Durable. Exterior grades have UV protection.
Waterproof:	Good water resistance.
Solvent resistant:	Impervious to most common solvents.
Repairability:	Difficult.
Appearance:	Depends upon type.
Application:	Brush, spray, wipe on.
Safety:	Wear respiratory protection equipment.

Varnish

What is varnish?

- Varnish is made from cooking a resin with a drying oil, and the resulting varnish is dissolved in a solvent such as mineral spirits.



- Varnish is then packaged and sold in many ways.

- Resins include alkyd, phenolic, and polyurethane (alkyd/urethane, called uralkyd). All three are synthetic.

- Drying oils used include linseed, tung, soybean (soya), safflower.

Varnish

Varnish is sometimes classified by oil content:

- The amount of oil used in cooking a varnish will classify it as a long oil, medium oil, or short oil varnish. Long oil varnish has the highest oil/resin ratio, short oil has the lowest.
- Long oil varnishes are softer but more flexible. Spar/marine varnish is a typical application.
- Medium oil varnishes are harder, less flexible. This is the most common.
- Short oil varnishes are very hard, but not very flexible. Commonly sold as “table top varnish” or “rubbing varnish”.

Varnish

Pros	Cons
• Better protection than shellac, lacquer, wax, drying oils, or water based • May be applied in several ways • Available in catalyzed and 2-part form	• Sagging on verticals if brushed • Long cure times • Cannot be easily repaired • Needs abrading between coats • Some can be rubbed out, but only after several weeks.

Varnish

Types of varnish:

- Alkyd varnish - Alkyd resins are typically combined with soybean oil (less yellowing) to create the common varnish found in retail stores. Not as heat or abrasion resistant as its urethane-modified cousin (polyurethane).
- Phenolic varnish - Found in some more expensive long-oil (tung oil) spar and marine varnishes. Tough and flexible. Also formulated as a short-oil varnish which is hard enough for table top use. Waterlox is an example of a high quality phenolic/tung oil varnish. Phenolic varnishes yellow more than alkyd varnishes.

Varnish

Types of varnish:

- Polyurethane varnish - Basically an alkyd resin with urethane added to form a “uralkyd” resin. Most polyurethane varnish is cooked with soybean oil. Good water, heat, and chemical resistance. Most durable finish you can apply by hand. Difficult to rub out. Poor UV resistance.
- Satin or semi-gloss polyurethane varnishes contain a flattener, usually zinc oxide or silica. This can obscure the grain after several coats.

Tip: Use the gloss version until the final coat, then use the semi-gloss or satin finish. That way the grain will show through just fine, but you will achieve a low gloss finish.

Varnish

Wiping varnish:

- This is simply varnish diluted with solvent that may wiped on. You can make your own by thinning 50/50 with mineral spirits
- Coats are applied very thin so more are needed than brushing.
- Has the advantage of not sagging or dripping on vertical surfaces.
- No brush strokes or bubbles to worry about, either.
- This is the only way I apply varnish now.

Varnish

Oil/varnish mixes:

- This is varnish mixed with oil and solvent applied by wiping.
- More durable than a drying oil finish, but softer than varnish alone because of the oil content.
- You can build a film finish, but too thick and it can wrinkle.
- Not as shiny as a pure gloss varnish due to the oil content.
- Cures slowly, giving you plenty of time to work.
- Excess must be wiped off to avoid wrinkling.
- Not as water resistant as pure varnish.

Varnish

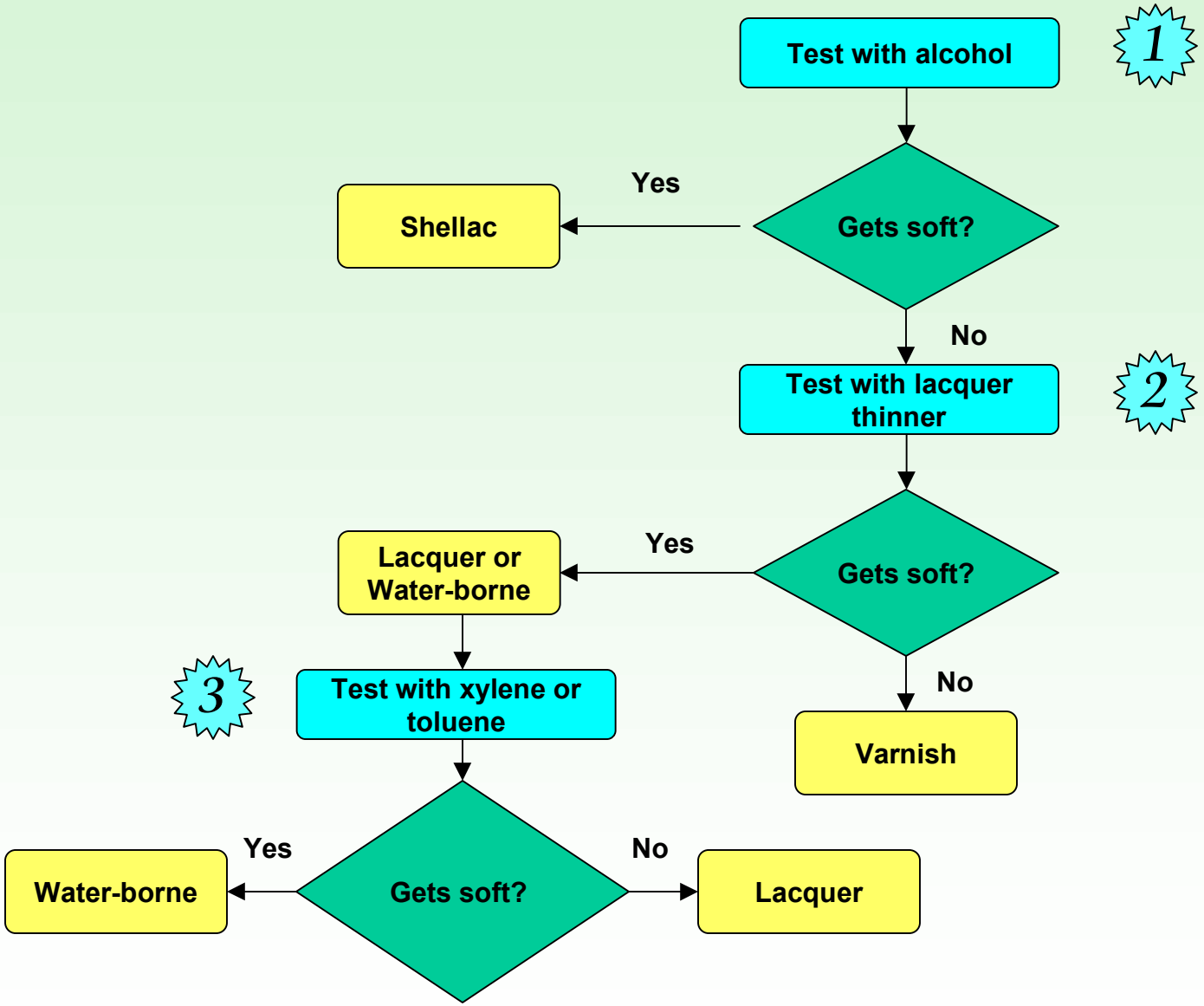
Wiping Varnish	**Oil/Varnish Mix**
Formby's Tung Oil Finish	Watco Danish Oil
Zar Wipe-on Tung Oil	Deft Danish Oil
Val-Oil	Behlen Danish Oil
Hope's Tung Oil Varnish	Maloof Finish
Gillespie Tung Oil	Behr Scandinavian Tung Oil Finish
Waterlox	Minwax Tung Oil Finish
General Finishes Seal-A-Cell	Minwax Antique Oil Finish
General Finishes Arm-R-Seal	Olympic Antique Oil Finish
Daly's ProFin	Velvit Oil
Jasco Tung Oil	Behlen Salad Bowl Finish
	Behlen Teak Oil
	Watco Teak Oil

Varnish

Gel varnish:

- This is similar to other varnish but includes a thixotropic agent to make it thick.
- This agent gives it a satin sheen.
- Basically it's gel stain without the coloring.
- Simple to use - just wipe on and wipe off.
- A nearly perfect finish is obtainable with little effort.

What Kind Of Finish Do I Have?



Finish Comparison

	Clarity	Non-Yellowing	Water vapor resistance	Water resistance	Heat, chemical, solvent	Scratch resistance	Rubbing ability
Shellac (dewaxed)	🟢	🟡	🟢	🔴	🔴	🟡	🟢
Shellac (with wax)	🟡	🟡	🟢	🔴	🔴	🟡	🟢
Lacquer (nitrocellulose)	🟢	🟡	🟡	🟡	🔴	🟡	🟢
Lacquer (CAB acrylic)	🟢	🟢	🟡	🔴	🔴	🟡	🟢
Oil-containing finishes	🟡	🟡	🔴	🔴	🟡	🔴	⚫
Polyurethane (oil based)	🟡	🟡	🟢	🟢	🟢	🟢	🟡
Alkyd varnish	🟢	🟡	🟢	🟢	🟢	🟢	🟡
Phenolic varnish	🟢	🔴	🟢	🟢	🟢	🟢	🟡
Conversion finishes	🟡	🟡	🟢	🟢	🟢	🟢	🟡
Water based	🟡	🟢	🟡	🟡	🔴	🟢	🟡
Wax	🟢	🟢	🔴	🔴	🔴	🔴	⚫

Solvent Comparison

	Mineral Spirits	Lacquer Thinner	Alcohol	Acetone	Xylene	Toluene	Glycol Ether
Shellac		Will dissolve	Will dissolve	Will damage			Will dissolve
Lacquer		Will dissolve	Will damage	Will dissolve			Will dissolve
Varnish		Will damage					Will damage
Water-based		Will dissolve	Wil damage	Will damage	Will damage	Will damage	Will dissolve
Wax	Will dissolve	Will dissolve	?		Will dissolve	Will dissolve	?
Glue (white and yellow)		Will dissolve		Will dissolve	Will dissolve	Will dissolve	Will dissolve

That's it. Happy finishing!