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# PROBLEMS, CAUSES AND CURES

## OF HARDWOOD FLOORS

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## PROBLEMS, CAUSES, AND CURES

# PROBLEMS, CAUSES AND CURES

## Introduction

In a perfect world, this technical manual wouldn't be necessary. Every wood flooring installation would be flawless, every contractor would get paid, and every customer would be happy. Of course, that is not the case. Many variables go into the installation, sanding and finishing of hardwood floors, and sometimes things go wrong. However, even when there is a problem, the floor doesn't have to be a failure. If the cause can be pinpointed and corrected in a timely, professional manner, the contractor still can have a satisfied customer.

## How to Inspect a Floor

Just as no two floors are the same, the inspection process varies for each floor problem. However, there are three basic goals every time you go to inspect a floor: determine what the problem is, find the cause of the problem and recommend how to repair the floor. Sometimes the details on the necessary repair may by out of the scope of your expertise (i.e., joist problems, site drainage).

## Tools for inspection

- **moisture meter(s)** (for wood and concrete)**:** to get an average reading of the flooring moisture content percentage, and also to get an average reading at various levels through the wood floor and subfloor (for the latter, moisture meters with 1⅛-inch pins are commonly used).
- **electronic hygrometer/thermometer:** to measure temperature, relative humidity and dew point.
- **tape measure:** to measure distances, aggregate widths of strips, etc.
- **pocket knife or depth gauge:** can be inserted between boards to determine the wear layer depth.
- **flashlight:** to look in crawlspaces. Also can be used to throw shadows to determine if a single strip is moving up and down.
- **magnetic stud finder:** to locate flooring nails.
- **hammer:** to drive in moisture meter probes and aid in removing flooring samples.
- **blade and Phillips screwdrivers:** to scrape and pry with. Also useful for working on moisture meters.
- **1-inch wood chisel:** to aid in removal of sample materials.
- **thin "feeler gauge" or taper gauge:** both are used to measure the width of gaps. The taper gauge is easier to use.
- **notepad and pen/pencil:** to record data.
- **micrometer:** to measure the width of the materials for comparison to original manufactured width.
- **camera** (digital preferred)**:** to create a visual record of observations.
- **thermometer:** for checking surface temperature. Electronic hygrometers also may do this.
- **string** (about 15 feet)**:** can be pulled taut across boards to determine if the floor is flat.
- **lit magnifying glass:** commonly available at electronics stores, this is useful for seeing scratch patterns and debris on the floor.

## Determine the problem

The first step in the inspection is talking to the client to discover exactly what he or she is unhappy about. Sometimes floors that are a "problem" to the customer look perfectly acceptable to the wood flooring contractor. Such situations often are a case of misunderstood customer expectations.

Although handling complaints from unhappy clients is probably your least favorite aspect of being a wood flooring contractor, there are steps you can take to minimize the grief involved, especially when customers are really angry. Here are some things to keep in mind when meeting with the unhappy client:

- *Listen.* Except for the few "professional complainers" who use complaints to avoid contractual obligations, most clients first need to vent their frustration—and you need to know the problem. So, listen all the way through customers' remarks, even if they become offensive. Clients may feel that to get some attention, they must shout at somebody. Let that happen. Afterwards, they probably will be easier to deal with.
- *Be sympathetic.* Never take a complaint personally—not even a tirade. You can express your concern without taking sides, even if you later must dispute much of the customer's view of the problem. You can't blame the owners for wanting the problem fixed.
- *Be objective.* Do not allow emotions or prior knowledge to get in the way of handling facts as facts. There is no percentage in arguing. Just collect all the facts. By the same token, keep in mind

that a few boards do not always make a legitimate complaint.

- *Log all information.* Keep written records throughout the project, from the first contact through a full inspection. Initially, get all pertinent data such as owner's name, address and phone, plus the same information on the builder, retailer or contractor; what the product is; brand; when purchased; quantity, when installed and when finished. And get a full description of the problem at the outset.
- *Inspect the floor as soon as possible.* Delays can create a second complaint and do little for your credibility. Do not make a snap judgment of the problem and, above all, do not report your findings on the spot to the client, builder, or any other interested party.

## Find the cause

Once you have defined what the problem is, it's time to do the detective work and determine why the problem happened (or still is happening). Sometimes this is cut-and-dried—such as when you see a big footprint in the topcoat. More often, rooting out the cause takes more investigation. The following is a detailed list of standard things to consider when inspecting a floor. Of course, not all details are necessary for every inspection, but they all are possible factors in a problem floor. If you're the one who installed the floor, the troubleshooting may be easier. If you're trying to follow up on someone else's failed floor, it may take a more detailed investigation.

Many of the following questions relate to the most common culprit when dealing with wood flooring problems—moisture. For further information on moisture and wood flooring, refer to NWFA's ***Technical Publication No. A100: Water and Wood.***

### Questions for the client:

- When did you occupy the house/building?
- When was the HVAC system made operational?
- Does the HVAC system operate year round?
- Do you monitor or control the humidity level of the house/building?
- How do you maintain the building environment?
- Are windows open during the year? For how long?
- Do you live in the space year round, or is this a vacation home that is closed up for part of the year?
- How do you clean the floor? What products are used in flooring maintenance?
- When did you notice the problem?
- Where did the problem start?
- How did the problem progress?
- Has the problem worsened since you first noticed it? Stayed the same?
- Has any action been taken to correct the problem? What has been done?

### Questions about the history of the job site:

- When did job site construction begin?
- When were the foundation and framing constructed? When was the roof in place? When were the windows and doors in place?
- If over a crawlspace, when was the earth covered with plastic?
- If over a slab, what is the underfloor and subfloor set-up from the slab to the flooring? Is a vapor retarder in place between the concrete slab and the subfloor? What is the vapor retarder?
- Was the subfloor exposed to adverse weather conditions prior to the roof, windows and doors being installed?
- When was the HVAC system installed? When was it turned on?
- When were the masonry, concrete, drywall, and other wet-work installed and dried?

### Questions about the job site at time of the inspection:

- What is the subfloor? Is it concrete slab or over joists? If it's over wood joists, what is the thickness of the subfloor? Is the subfloor approved for wood flooring application?
- Are there screeds?
- What are the joist materials? What is the spacing of the joists? Are they close enough together to support a flat floor? (Recommendations are that joists be spaced a maximum of 16 inches apart.)
- In a crawl space, is the square footage of the perimeter vents through the foundation equal to 1.5 percent of the square footage of the area within the crawl space? Are vents open to allow proper cross ventilation? Is the relative humidity in the crawl space no higher than it is in the house interior?
- Is the soil within the crawl space properly covered with 6- to 8-mil black polyfilm moisture retarder?
- Is there a 6-mil polyfilm moisture retarder beneath the slab?
- What is the moisture content of the subfloor and what is the relative humidity of the job site? (Ideally, relative humidity should be between 30-50 percent, although it may vary according to geographic region.)
- Is the concrete slab's moisture level suitable for installation? How old is the concrete slab? In a new building, it must be at least 30 days old before you can consider moisture testing.
- Are all major appliances and systems properly vented to release warm, moist air? Visually inspect plumbing in the area where the floor is installed.
- Is there a sense of damp, moist or stagnant air when entering the home? Check the interior with a hygrometer. Are the heating and air conditioning

systems operational? Ideally, temperatures of the subfloor, adhesives and flooring should be over 60 degrees Fahrenheit during installation.
• Are the HVAC systems in place and working? The intent is for flooring be be installed as close to normal living conditions as possible.
• What type of heating is it? Radiant, baseboard, radiator, forced air (electric or gas)? (Baseboard or radiator heat may overdry adjoining flooring; radiant heat may cause problems if the correct procedures were not followed for wood flooring installation.)
• Is the heating system equipped with a humidifier?

### Questions about the home's exterior:

• Check the eave overhang on the building. Is all rain water funnelled away from the foundation?
• Check the gutters and downspouts. Is all rain water properly diverted away from the foundation? During a rain, the depressions below the spouts can fill with water that eventually finds its way indoors.
• Are there raised flower beds or planter boxes adjoining the building's foundation? If so, a special moisture membrane should be installed. Are landscape sprinklers directed away from the house?
• Is there an outdoor pool or body of water elevated above the home's foundation that could overflow or leak into the home's foundation?
• What is the lot's relationship to the street, to the neighboring site, to a nearby hillside, to a nearby pool? The site should be properly graded to divert water away from the foundation.
• Does the driveway slope away from the house?
• Are the roof, windows and doors all in place and weather-stripped?

### Questions about the history of the wood flooring:

• Who manufactured the products (wood flooring, finish, adhesive, etc.)?
• When were the products manufactured?
• Does the manufacturer have records of the wood flooring moisture content at time of shipment?
• When was the wood flooring delivered to the distributor warehouse?
• Was the wood flooring unloaded in a covered warehouse?
• Was the wood flooring completely covered and protected on the truck at time of arrival?
• Did the distributor check the moisture content, grade, and appearance of the wood flooring at time of delivery?
• When was the wood flooring delivered to the job site? Was it in an enclosed delivery truck and protected during transfer to the job site?
• What were the weather conditions when the wood flooring was unloaded at the job site?
• What were the job-site conditions at time of delivery?
• At time of delivery to the job site, what was the moisture content and overall condition, grade and appearance of the flooring?
• Where was the wood flooring placed at the job site? Did it remain there until it was installed?
• Was the wood flooring completely unwrapped/unpacked at time of delivery?
• When did flooring installation begin and end?
• At time of installation, was the job site at or near normal living conditions? What were the environmental conditions of the job site?
• At time of installation, what were the moisture content and conditions/appearance of the flooring and the subflooring?
• Where did flooring installation begin and how did it proceed through the house?
• What are the fasteners? How far apart are they? Were the tools pneumatic or manual?
• What kind of adhesive was used? Was the correct spread rate followed? Was the right trowel used?
• Is there a moisture retarder between the subfloor and flooring? What is it?
• Where did sanding and finishing of the flooring begin and end?
• What is the finish? How was it applied? What was the sanding sequence and finishing process?
• When was the job site occupied?
• Has any action been taken to correct the problem? What has been done?

## Recommend the repair

Complete the full inspection procedure, then assemble your facts for full analysis before deciding the cause of the problem. Then, report your findings in writing. What you say in conversation can be misinterpreted, and almost always is remembered incorrectly. What is written doesn't change, and it doesn't invite argument before you finish your explanation.

If you feel you need more help finding the cause of the problem or determining how to repair the floor, contact your distributor. If necessary, the distributor will contact the product manufacturer for help resolving the issue. Report any progress to the client or builder—in writing, with a copy for yourself—particularly if progress toward resolution is delayed.

# JOB-SITE PROBLEMS

## Buckling

What it is:
The wood flooring becomes separated from the subfloor. It usually is accompanied by cupping and swelling.

Cause:
• Moisture caused by:
- Excessive job-site moisture
- A house left vacant with no ventilation (see "Greenhouse Effect" on page 9)
- Grade conditions
- Pipe leaks
- A wet slab.

Excessive moisture always is the main cause of buckling. Factors that may aggravate the problem include these improper installation techniques:
• For nail-down products, inadequate nailing, incorrect fasteners, incorrect subfloor construction.
• For glue-down products, incorrect adhesive, insufficient adhesive, the wrong trowel, inadequate adhesive transfer (due to over-flashing or not rolling the floor), subfloor separation or subfloor contamination.
• Inadequate expansion space left by the installer.

Cure:
Fix the excessive-moisture condition and allow the floor to dry to normal levels. Spot repair/replacement, reinstallation, renailing and refinishing are some options. In most cases where the flooring has loosened from the subfloor throughout the installation, reinstallation or replacement is necessary.

## Chatter/Wave Marks

What it is:
Chatter marks are consistent sanding imperfections across the grain of the wood varying from ¼ inch to 1 inch apart. Wave marks are two or more "upsets" occurring along the direction of travel of a sander. They generally are 1 to 3 inches from peak to peak.

Cause:
• Most chatter marks are caused by the sanding drum. It may be out of balance, out of round, have hard spots, have incorrect paper installation or have compressed rubber. Also,
- Poor splice/seams on the abrasive belt, drive belts and fan belts
- Running the big machine in the wrong direction (for belt sanders, right to left; for drum machines, left to right)
- Worn pulleys
- Bad bearings in the fan housing
- Loose flooring.
• Most wave marks are caused by imperfections already present on the floor that are transferred through the wheels of the big machine to the sanding job.
• Wheels on the big machine that are out of round.
• Improper electrical hookup—voltage that is too high or low.
• Undulation of the floor from inadequate joist design.

Cure:
First, the problem with the big machine must be determined and fixed. Then, use a hard plate, paper disc or multi-disc sander. A sanding screen only highlights the chatter and causes the floor to dish out. Use a disc sander and hard plate while working right to left, traveling down and back in the same path and working the disc sander at slight angles for the best cut of the unit. Repeat the same procedure, overlapping the last cut one-half the size of the first disc.

Another technique is to do a light sanding with the big machine at a 7-degree angle, then go over the floor again, this time straight.

If using a multi-disc sander, walk slowly with the grain from side to side, always overlapping the unit as you move from right to left. This blends in the floor and prevents deep scratches.

If joist design or loose flooring is the problem, the structural flaws must be corrected before the floor is resanded and refinished.

## Crowning

What it is:
The center of the pieces of flooring appears to be higher than the edges.

Cause:
• While it is theoretically possible that excessive moisture could cause crowning, it is more likely that the floor cupped and then was sanded flat before it could dry and flatten on its own. When the floor boards did dry to a normal condition, their edges had been removed, making them lower than the center of the board. Gaps are generally formed as the flooring dries.

Cure:
First, determine if the moisture content is normal and if all of the crowning from the original cupped condition has occured. After the floor has stabilized, resand and finish.

## Cupping

What it is:
Cupping occurs across the width of the individual pieces of flooring. The edges are high and the center is lower. It generally develops gradually.

Cause:
• A moisture differential within individual pieces of flooring, usually excessive moisture on the underside of the flooring. More subtle cupping can be caused by lack of proper acclimation (this is generally permanent cupping). Potential sources of excessive moisture include:

- Building leaks
- Poor drainage
- Plumbing leaks or overflows
- Leaks from dishwashers or refrigerator ice-making units
- Wet or damp basements/crawlspaces
- Concrete subfloors that have not cured
- Plywood subfloors with excessive moisture
- Poor or no ventilation
- HVAC system not operating.

• Flooring also may cup when a wood floor experiences conditions that cause rapid drying on the surface. This condition occurs with gaps as the flooring shrinks.

Cure:
Never attempt to repair a cupped floor until all of the sources of excessive moisture have been located and eliminated. This can be verified only with a moisture meter that takes readings of the underlying subfloor. As long as the wood is not permanently deformed or damaged, the flooring will return to its original shape and size when the excessive moisture is removed. This may take weeks, months, or even an entire heating season.

Attempting to sand a cupped floor while it is still too wet may cause subsequent crowning when the floor dries. Flooring that does not return to its original shape, even after completing an entire heating season, probably is permanently deformed. (Taking moisture readings at different levels in the wood flooring also can help determine this—if there is a gradient of 1 percent or more between the top and bottom of the boards, they probably are not done drying.) If the boards are permanently deformed, the cupped edges may be sanded off.

For floors that have cupped due to drying, relative humidity should be increased. Relative humidity below 20 percent is considered very dry for wood flooring, and it is suggested that humidification be provided under such conditions.

## Dents

What it is:
A crushed spot in the wood.

Cause:
• High heels.
• Dropped heavy objects.
• Metal tips on furniture legs.

Cure:
If wood fibers are not broken, attempt to draw fibers back up with an electric iron over a dampened cloth. If fibers are broken, remove and repair the damaged boards. The entire floor may need to be resanded and refinished. Institute good floor maintenance procedures, such as removing high heels and using floor protectors.

## Dish Out

What it is:
Areas on the wood floor where softer parts of the wood appear to have been sanded more than other areas. Occurs between areas of annual rings (see also “Shellout/Dishing of Springwood” on page 9) or between mixed species of varying hardness together on a floor, such as in feature strips, borders and medallions.

Cause:
Using the wrong angles while sanding.

Cure:
Resand the floor using a slight angle with the big machine. A hard plate or multi-disc sander may be needed on softer woods.

## Flooded Floors

What it is:
Standing water on the wood floor.

Cure:
Remove the water and dry the floor as quickly as possible. Elevate the temperature, dehumidify and increase air flow using fans. In basement houses, dry from below. In crawl space homes, use exhaust fans.

If the flooding was of a long duration on a surface-finished floor, rough sanding to remove the finish will accelerate drying. Lightly sand at a slight angle of about 7 degrees. Or, use a buffer or orbital sander with a 120-grit screen backed by a soft pad. (Sanding this way should not remove the edges, which could cause crowning later). Do not sand down to bare wood, but rather remove the majority of the finish.

***Do not*** repair the floor until moisture meter readings on the top and bottom of the boards and subfloor are at normal levels. When flooring is stabilized, determine the damage. If the flooring has loosened from the subfloor, repair the necessary areas or the entire floor. If it is cupped, sand it flat. If the floor is flat, fill if necessary and screen and recoat.

If the subfloor is plywood over concrete, it is unlikely that the plywood and concrete subfloor will dry out in a reasonable time. Full removal to concrete usually is best to allow the slab to dry.

In cases where you have determined that the flooring system has not returned to normal levels, do not succumb to pressure from involved parties for a quick fix. If you must proceed, have a full release signed due to the risk of more moisture problems.

## Gaps, Normal

What it is:
Gaps between strips/planks that appear between individual boards and open and close with changes in humidity.

Cause:
• Most normal gaps are caused by seasonal fluctuations in relative humidity—the floor expands with high humidity and contracts during periods of low humidity. This type of expansion and contraction is considered to be *normal* and expected for solid wood floors. In solid 2¼-inch floors, gaps may be the thickness of a dime (½ inch) or wider. Wider boards have even wider gaps.
• Square-edged floors show gaps more than beveled floors, and light-colored floors show gaps more than dark floors.

Cure:
Normal gaps can be minimized by using the HVAC system to control fluctuations in humidity in the building. The use of humidifiers or dehumidifiers can narrow the overall fluctuation range.

## Gaps, Abnormal

What it is:
Gaps in the floor that remain with seasonal change. If some boards appear glued together by the surface finish, see "Sidebonding/Panelization" on page 14.

Cause:
• Edge crush from prior exposure to extreme moisture (especially for solid, flat-grained flooring).
• Hot spots in the subfloor, such as poorly insulated heating ducts, hot water plumbing lines, radiant heating systems, register openings and refrigerator motors.
• Debris between boards during installation.
• Improper nailing/nail position.
• Flooring installed with an excessively high moisture content or over a subfloor with excessive moisture.
• Flooring not installed tightly together to begin with.
• Foundation settlement.
• Improper subfloor materials that will not hold nails.
• For glue-down floors, early foot traffic, incorrect adhesive, the wrong amount of adhesive transferred or used, the wrong amount of flash time for the adhesive, or not using a roller when recommended.

Cure:
Eliminate the cause, then restore normal humidity levels. After the floor has stabilized, use filler in gaps that are small enough to be filled (typically up to 3/32 inch) and recoat the floor. For larger gaps, use a sliver or "Dutchman" to fill in the gap. Pulling up the entire floor and reinstalling may be necessary.

## Grade Problems

What it is:
Unhappiness with the floor due to the appearance of knots, grain pattern, color variation, etc.

Cause:
• Unrealistic customer expectations.
• Ordering mistake by supplier, distributor or installer.
• Poor grading at the mill.
• Improperly labeled product.

Cure:
Replacing the offensive boards may be necessary.

## Greenhouse Effect

What it is:
Floors that shrink or swell due to an abnormal level of humidity in a vacant house.

Cause:
• When houses are closed up with no air flow, several factors contribute to problem floors. Sunlight through windows generates heat, condensation and humidity build in the home, and the floor swells. Then, when occupants return and the heat or air conditioning is run continuously, the floors shrink.

Cure:
After the environment returns to normal, follow cures discussed for cupped floors or shrinkage gaps. In the future, find a way to more carefully regulate moisture in the home.

## Insects

What it is:
A sagging surface or small fresh holes surrounded by white powder in the surface of the flooring.

Cause:
• If the surface of the flooring is sagging, it is likely that termites have created eating corridors beneath the surface. The bugs are white or cream colored.
• If fresh holes about 1/16-inch wide are found, powderpost beetles, or lyctid beetles, probably are the cause. Positive identification of the infestation is necessary and should be performed by an entomologist.

Cure:
For termites, a professional exterminator should eliminate the bugs. Then, structural damage should be repaired. Damaged floorboards should be pulled and replaced. Termite infestation is not related to wood floors, and full cost should be covered by the owner.

For powderpost beetles, determine the extent of damage. If infestation is heavy, handle it the same as the termite extermination above. If it is occasional, especially in new floors, treat the individual openings immediately with insecticide injected by a syringe into the holes. Or, use aerosol insect spray through a straw in the holes. Have the owner watch for evidence of new holes (with little dust piles) and treat again. After two to three months, the holes may be filled.

Almost all wood flooring in North America is kiln-dried, and proper kiln-drying should kill any insect infestations. However, new material quickly may become infested by insects entering through windows, in firewood, etc., and the life cycle from eggs to live insects is very short. Also, check all surroundings for infested wood molding and furniture (especially bamboo, mesquite and ash). If there is evidence of an old infestation in other wood materials, the costs should be paid by the owner.

All oak flooring grades allow the presence of pinworm holes in the face of flooring strips. When flooring containing the pinworm holes is sanded and finished, sanding dust and/or filler sift into the holes. As the finish is applied a film is formed over the holes. With wear, the film breaks and the pinworm holes are revealed. They often are about the size of powderpost beetle emergence holes and sometimes are mistaken for real infestations. The homeowner generally calls in a local pest control firm. Unfortunately, many pest control personnel are not well qualified in identifying insects of this sort, since active infestations seldom occur. As a result, an erroneous identification of a powderpost beetle infestation is made, even if neither the tell-tale ring of white powder nor active adults have been seen.

## Picture Framing ("Halo")

What it is:
The edges of the room appear to be a slightly different color than the rest of the room.

Cause:
• Sanding the edges of a room differently than the field—the edges are either smoother or rougher than the center of the floor, causing the finish and/or stain to appear different.

Cure:
Resand the floor, being sure to use the same sanding procedure on all parts of the floor.

## Shellout/Dishing of Springwood

What it is:
Uneven wear between segments of annual rings.

Cause:
• Heavy traffic.
• Repeated sliding of heavy furniture.
• Water used in maintenance.
• Seen especially in peeled-face engineered products under desks with heavy foot and caster wear.

Cure:
Sand and refinish, then implement better maintenance practices. Change casters to wide, non-marking rubber if necessary.

## Slivers/Splinters

What it is:
Slivers and/or splinters are protruding from the surface of the floor, especially at the edges of the boards.

Cause:
• Unevenness caused by expansion, cupping, subfloor irregularities, edge crushing from expansion or grain raise from moisture.
• Damage during installation associated with nailing.
• Wind shake (associated with annual rings/springwood fractures).
• May tend to occur more frequently in beveled prefinished products and wirebrushed products.
• Improper grading.

Cure:
If a new floor is producing fibers, not splinters, buff vigorously with a commercial buffer and nylon polishing pad.

For slivered bevels, shave off with a razor knife and re-stain.

For expansion, cupping and grain raise, correct the moisture source.

For wind shake, it may be possible to repair the boards using low viscosity, CA (cyanoacrylate) adhesive (such as Super Glue). Apply the adhesive under the seam of the shake. The adhesive will wick down and hold the shake. Because it is clear and nonambering, it can even be used between coats of finish. Or, the boards can be removed and replaced.

## Squeaky/Loose Floors ("Popping")

What it is:
The floor causes objectionable squeaks or other noises.

Cause:
• Movement of the wood flooring system, subfloor system or underfloor supports.
• Inadequate or improper nailing.
• Weak subfloor.
• Improper subfloor material.
• Insufficient or incorrect adhesive.
• Floor subjected to excessive moisture or excessively dry conditions.

Cure:
Noises in only certain areas may be fixed by injecting adhesive into the problem area, screwing the floor down from below, strengthening the subfloor from below or using facenails or screws and plugs. Squeaks also may be lubricated with graphite, wax or baby powder, although such solutions will contaminate the floor for future finishing.

Floors that are noisy and loose throughout the entire area usually have to be pulled and reinstalled, correcting the problem—whether it is caused by the subfloor, fastening schedule or adhesive.

## Sticker Stain

What it is:
Light brown marks that appear on the wood surface, especially on maple, ash or other light woods. They occur across the width of the strip, measure ¾ to 1 inch wide and occur about every 20 to 24 inches down the length of individual strips. (In photo shown, right side of the strip is coated with oil-modified finish; left side is unfinished.)

Cause:
• Discoloration of the rough sawn lumber while air drying or being kiln-dried on stacking strips before being made into flooring.

Cure:
Sticker stain is allowed in second-and-better-grade maple and No. 1 common oak. If the marks will be objectionable to the owner, do not install the flooring. Sticker stain generally does not sand out.

## Unevenness of Entire Floor

What it is:
The entire floor as a unit appears to be uneven.

Cause:
• In a wood joist system, causes include warped and loose subfloors, joists that are warped or fractured, settled support pillars or perimeter foundation settlement.
• In a concrete slab system, a cracked and/or settled slab.
• Uneven subfloor.

Cure:
Structural integrity of the subfloor system is not the responsibility of wood flooring contractors, but they should check the floor for flatness before beginning an installation. A general contractor needs to repair the subfloor before the wood floor can be repaired.

# FINISH PROBLEMS

Although many problems can result with finish, the source is not necessarily the finish itself. Consult the following list for some of the most common problems and solutions. If you have questions not covered here, members can call the NWFA's technical hotline at 800/422-4556 in the United States, 800/848-8824 in Canada, or 636/391-5161 (local and international).

## Alligatoring

What it is:
The finish pulls away from itself, causing ridges in the finish similar to an alligator's skin. This condition can occur in both water-based and oil-modified finishes.

Cause:
- Poor wetting of the finish.
- Contamination of the finish.
- Finish application under cold temperatures.
- Application of a new finish coat before the previous coat has dried.
- Application of a heavier finish coat than is recommended.
- Use of thinners that cause the finish to dry too quickly.
- Application of oil-modified finish over waterborne finish or vice versa when the finish is not completely cured.

Cure:
Screen and recoat after the finish has dried sufficiently.

## Applicator Streaks

What it is:
After the floor dries, marks still are visible from the path of the applicator. It usually is associated more with water-based finishes than other types of finishes, although it may affect other types, as well.

Cause:
- Using an applicator that has hardened spots.
- Improper spread rate—too much or too little finish is applied.
- The finish is not applied evenly.
- Excessive air movement and abnormally high temperatures causing the finish to dry too quickly, resulting in a wet edge of finish being pulled over one already dried.
- Applying a satin or semi-gloss finish that has not been stirred properly.
- Applying finish in directly sunlit areas or other areas that are hot.

Cure:
Screen and recoat after the finish has dried sufficiently.

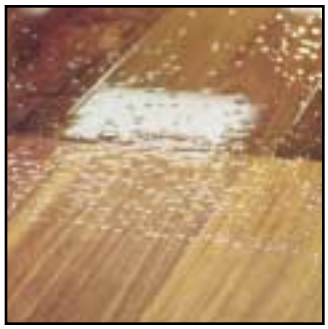
## Bleed Back

What it is:
Occurs when excess stain seeps up from the grain or from the spaces between boards.

Cause:
- Excessive stain application.
- High-viscosity or highly pigmented stain.
- Excessive heat during application.
- Knots or areas that contain higher amounts of sap.

Cure:
Wipe off the excess stain or burnish/buff the floor with a white pad to remove the excess and even out the stain color. Then, let the stain dry thoroughly before applying another coat. If finish already has been applied over bleed-back, a complete resand is required. Trowel filling a floor can help prevent bleed back. Cover windows during application to prevent hot spots on the floor.

## Bubbles



What it is:
Dried bubbles are visible on the surface of the finish.

Cause:
- Soap or some other contaminant was not removed before coating.
- Applying hot oil-modified finish onto a cold floor.
- Applying finish to a hot floor.
- Overworking finish during application.
- Air movement across the floor that dries bubbles into place before they can flow out.
- Floor not screened or sufficiently cleaned between coats of finish.

Cure:
Problems in the topmost finish coat can be screened and recoated, while cases of delamination require complete sanding and refinishing. Cover windows during application to prevent hot spots on the floor.

## Chipping

What it is:
Dried finish separates from the surface in the form of flakes or chips.

Cause:
• Applying a less elastic finish on top of a more elastic one.
• Improper adhesion between coats.
• Spot contamination.

Cure:
Screen and recoat. More than one coat may be needed, or problem areas may be spot-coated before screening and recoating the entire floor.

## Cloudy Finish

What it is:
The finish appears cloudy or milky.

Cause:
• Applying finish over a coat that isn't dry.

Cure:
Screen and recoat, being sure to increase the dry time between coats. Check with a damp rag before reapplication of finish to make sure the cloudiness has disappeared—if the finish appears clear when it is dampened, the problem probably has been eliminated, and the floor is ready to be coated over.

## Cratering

What it is:
Often mistaken for bubbles, this problem resembles craters on the moon.

Cause:
• contamination of the floor or finish.
• application of finish over previous coats that are not dry or have not gassed off.

Cure:
Sand the crater out by hand-sanding, and then screen, pad and recoat. Oftentimes, hand-sanding out the craters will leave an unevenness in the floor. To eliminate low spots, spot finishing the areas may be necessary before the entire floor is recoated. If the problem is severe enough, the floor may need to be resanded.

As a general rule, trowel-filling the floor may help prevent problems due to contaminants in the cracks between boards.

## Discoloration

What it is:
The floor changes color over time. Some areas may darken more than others.

Cause:
• Oil-modified finishes amber in appearance and will yellow even further over time—this is to be expected.
• Wood lying in direct sunlight will change color over time—a natural change.
• Wood also changes color through oxidation, a change that cannot be prevented.

Cure:
Despite the pervasive myth that an oil-modified finish recoated with waterborne finish will stop ambering, ambering of oil-modified finishes cannot be prevented. Shading the floor can minimize lightening. If marks are left on the floor by area rugs or furniture, moving them around can equalize the change in color. Customers should be informed that certain species, particularly cherry and many exotics, will change color greatly as they age.

## Excessive/Early Finish Wear

What it is:
The appearance of too much wear on a relatively new finish.

Cause:
• Improper maintenance procedures that may include failure to fully remove grit from the floor's surface, using water to clean the floor, or using strong cleaners on the floor.
• Pet nails and chair legs may contribute to the problem.
• Not enough finish applied to the floor initially.
• Applying finish over coats that have not had enough time to gas-off and dry.
• Improper sanding procedures—when the floor is left too rough, finish accumulates in the bottoms of the grooves in the floor, leaving little coverage on the "peaks," where the finish then wears through. This may give the appearance of ridges in the flooring.

Cure:
Institute proper maintenance procedures, including regular dust-mopping with an approved wood-floor cleaner, use of throw rugs and use of floor protectors. If improper sanding, then resand and recoat.

## Fisheyes/Crawling

What it is:
A circular, cloudy haze with a clear center. They can measure up to about 1 inch in diameter.

Cause:
• Contamination in the surface—the new coat "crawls" away from the wet or contaminated areas, giving the appearance of fisheyes when the finish sets.
• If the finish container has sat undisturbed for some time and has not been properly agitated, a disproportionate amount of flow and leveling agents may be put on the floor, causing a fisheyed appearance.

Cure:
Screen and recoat.

## Iridescent Finish

What it is:
The finish dries with a metallic, colored cast to it.

Cause:
• Inadequate ventilation during the drying of a coat of finish, causing solvent saturation in the air. The solvent then settles on the floor and is coated over.

Cure:
Screen and recoat using proper ventilation.

## Orange Peel

What it is:
The surface of the finish has a texture that resembles an orange peel.

Cause:
• Rolling a finish that is not designed to be rolled on, causing it to dry too quickly. When that happens, the texture is "frozen" into place before the finish has a chance to flow out and level.
• A finish or substrate that is too cold.
• Use of an improper applicator that causes small bubbles to form in the finish. The bubbles then pop, leaving small dimples in the finish.

Cure:
Screen and recoat.

## Peeling

What it is:
The finish delaminates from the floor in sheets.

Cause:
• Stain or previous finish coat that was not dry.
• Skipping abrasion between finish coats.
• Stain not sufficiently wiped up.
• Improper tacking between coats.
• Surface contamination such as wax or oil-soap cleaners.
• Finishes that are not compatible.

Cure:
Resand and recoat.

## Pin Holes

What it is:
Similar to fisheyes, but very, very small.

Cause:
• A coat of finish being applied over a coat that was not dry.

Cure:
Give the floor sufficient time to totally dry, then screen and recoat using correct dry times between coats.

## Poly Beads

What it is:
Droplets ("BB's") of finish that form along strip edges. They can be soft and sticky when first formed, but will become quite hard if left undisturbed.

Cause:
• Generally associated with a slow drying condition and excessive amount of sealer and/or finish that seeps into cracks.

Cure:
Time will allow the floor to expand and contract, eventually allowing all of the undried finish to surface. When soft, the beads can be smeared, leaving an unsightly appearance that may require screening and recoating. For hardened beads, the solution is to remove them with a sharp edge (i.e. scraper or plastic putty knife) and, if necessary, screen and recoat. Do not attempt to screen the hardened beads, which will cause circular scratches within the finish.

## Roughness/Grain Raise

What it is:
The surface of the wood floor is rough to the touch.

Cause:
• Inadequate sanding, including skipping too many grits.
• Contamination of the finish during dry time.
• Not allowing sufficient dry time for waterborne sealers to flatten.
• Moisture causing the wood grain to rise.
• Not using enough coats of waterborne finish.

Cure:
If a moisture problem is evident, this must be corrected before rescreening and recoating.

## Sidebonding/Panelization

What it is:
The problems appear similar, but are different. With sidebonding, the bottoms of the edges of the individual strips are "glued" together by the finish. It can occur with all types of finish, although it happens more frequently with water-based products. Panelization occurs when the edges of boards are crushed and stick together as a result.

Cause:
• Sidebonding results from the finish seeping down into the spaces between boards and gluing the bottoms together. Usually noticeable only after a drastic decrease in humidity.
• Panelization occurs when the excessive moisture causes swelling of the floor and compression sets, in which the edges of the boards are crushed and stick together.
• Staples that crack the tongue in some areas and not others can give the floor a panelized appearance.
• In residential applications, a wet plywood subfloor that shrinks as it dries also can give the floor a panelized appearance.

Cure:
Restoring normal humidity levels can return the floor to an acceptable appearance. If there still are gaps, see the "Cure" for "Gaps, Abnormal" on page 8. If those methods do not fix the floor, floor replacement may be necessary.

Staining floors can help prevent sidebonding. Consult your finish manufacturer for other preventive steps.

## Stains

What it is:
Discoloration on one area of the floor.

Cause:
• Spilled liquids.
• Pet stains (shown at left).
• Residue from improper cleaners.
• Continual moisture leading to mildew (black), decay (brown/white) or alkaline conditions (white).

Cure:
Cloudy surface finish can be fixed by lightly rubbing with a proper cleaner and buffing, although some stains require screening and recoating. Pet stains sometimes can be fixed by resanding, but frequently require total board replacement. One technique to eliminate pet stains is to apply naval gel (a phosphoric acid gel commonly available at hardware stores) to wick the tannins out of the area. This will not contaminate the floor for future finishing or leave a halo mark, as attempts at bleaching the floor often do.

## Sticky Board Syndrome

What it is:
The finish will not adhere or cure properly on one or more boards.

Cause:
• Excessive tannic acid or pH imbalance in the wood. This is most common with oil-modified finishes and white oak.
• Too much stain, and then finish, applied over very open grain.

Cure:
When one board or several boards scattered throughout the floor will not take stain or finish, the most common solution is to repair the floor by replacing the boards. Or, boards may be taped off (using recommended tape) and scraped or hand-sanded, then coated with a water-based sealer. After proper dry time, they may then be coated with an oil-modified finish.

Trowel filling may help prevent sticky board syndrome.

## Uneven Sheen Levels

What it is:
The sheen of the finish is inconsistent.

Cause:
• Insufficient mixing of finish prior to application.
• Uneven sanding.
• Uneven finish thickness.
• Illusion caused by lighting.
• A contaminated finish applicator, such as a lanolin-rich lambswool applicator that hasn't been thoroughly cleaned.

Cure:
Screen and recoat. If lighting is the cause, discuss with the customer the reasonable inspection position for looking at a hardwood floor—from a standing position under normal lighting conditions.

# APPENDIX

The key to understanding how a wood floor performs requires a combination of knowledge concerning relative humidity, wood science, Newtonian physics, and basic math. Simply stated, the wood-moisture relationship relates relative humidity to wood moisture content to the shrinking and swelling of wood substance when the number of water molecules in the wood fibers changes. It is fairly straightforward once you have mastered the underlying principles.

## The Structure and Composition of Wood

Although a piece of wood looks solid to the naked eye, on the microscopic level it is honeycomb-like, comprised of many individual interlocking cells. In most wood species, the vast majority of these elongated cells are oriented with the longitudinal axis of the tree. The cells have walls made of many long strands of cellulose molecules that are predominantly oriented with the long axis of the cell. There are empty spaces at the center of the individual cells that vary in size. There are many small openings (pits) that pass entirely through the cell walls and interconnect the lumens (cavities) of adjacent cells.

The chemical composition of the cellulose and lignin that form wood are long strands of carbon-based organic molecules. Cellulose is a naturally occurring polymer that has places (bonding sites) on its structure that actually have a magnetic attraction for individual water molecules. It is the gains and losses of individual water molecules at these bonding sites that cause wood to shrink and swell. Since the number of the bonding sites is fixed, there is a limit to the amount of shrinking and swelling that can occur.

## Relative Humidity and the Wood-Moisture Relationship

**Relative humidity** ($R_h$) is the ratio of water vapor actually contained in the air (**Absolute Humidity**: $A_h$) to the total potential capacity of the air (**Saturated Absolute Humidity**: $A_s$). The formula is $R_h = A_h / A_s$. As the temperature of a given volume of air increases, its capacity to hold water vapor also increases. Therefore, as you heat air without adding any water vapor, the $R_h$ drops (it becomes drier). If you cool air without changing the amount of water vapor, the $R_h$ will increase (it becomes more damp). When the air is totally saturated with water vapor, the $R_h$ is 100 percent. When there is no water vapor in the air, the $R_h$ is 0 percent.

The amount of molecular water contained within the cell wall structure of wood is referred to as **bound water**. The structure of the cellulose can accommodate only a limited amount of this bound water. This is referred to as the **Fiber Saturation Point** (FSP). Any additional water contained in wood forms droplets and accumulates in the intercellular spaces and lumens at the center of individual cells and is referred to as **free water**. Since free water doesn't interact with the wood substance, the gain or loss of free water does not cause wood to shrink or swell. When bound water molecules are gained or lost, however, then wood swells or shrinks. There is a direct relationship between $R_h$ and the amount of bound water in wood substance. If a piece of wood is exposed to 100 percent $R_h$ for enough time, it will reach FSP, and if the same piece of wood is left in an environment with 0 percent $R_h$, then all of the bound water molecules will be lost, and the piece will become completely dry, which is referred to as **oven dry** (OD).

The FSP of most wood species averages 28 percent to 30 percent **moisture content** (MC). The MC of wood is defined as the ratio of the weight of the water contained in a wood sample to its oven dry weight. The most accurate method of determining the MC is to weigh a wood sample ($W_i$ = initial weight), then place it in a special laboratory oven until all of the moisture is baked out (usually about 24 hours) and weigh it again ($W_{od}$ = oven dry weight), then calculate MC by comparing the loss of weight to the oven dry weight. The formula is: $MC = (W_i / W_{od}) - 1$.

This special relationship between MC, $R_h$ and dimensional changes in wood is referred to as the **Wood-Moisture Relationship**. As wood loses moisture, it shrinks, and as it gains moisture, it swells. Because of the orientation of individual cells and growth patterns, wood has different shrink and swell factors that depend on the orientation of the cells within each individual piece of wood. Tangential shrink and swell between FSP and OD is approximately 8 percent for most domestic species. Radial shrink and swell between FSP and OD is approximately 4 percent for most domestic species. And longitudinal shrink and swell between FSP and OD is approximately 0.01 percent for most domestic species.

Testing and research also have developed a direct relationship between $R_h$ and MC, and a direct constant relationship between shrinkage and MC. The $R_h$ of the interior of buildings fluctuates based on the interaction of exterior climactic conditions and interior environmental controls. Interior $R_h$ drops in the winter because the exterior air mass contains less moisture. Conversely, the interior $R_h$ increases during the summer, because the exterior air mass contains more moisture. This is why wood shrinks in the winter heating season and swells during the summer months. Wood invariably reaches a state of equilibrium with the $R_h$ to which it is exposed. That is why it is so important that wood be installed under the proper moisture conditions and MC.

For more information on the relationship between water and wood, consult the NWFA's ***Technical Publication No. A100: Water and Wood.***

# INDEX

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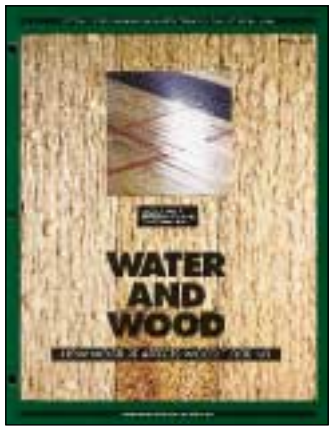
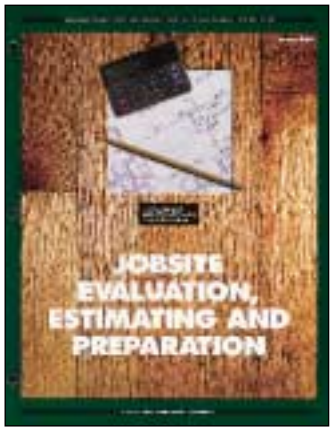
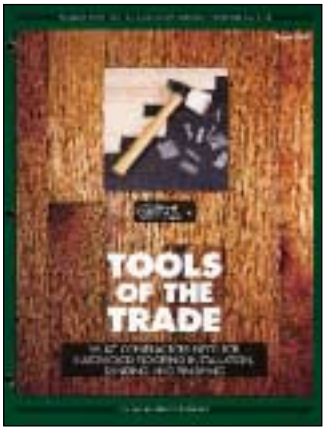
# RESOURCES

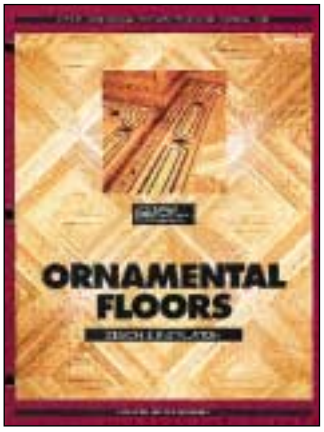
For more technical information, consult the other chapters in the NWFA's Technical Manual Series:








Look for these chapters coming in the future:

*Methods of Installation*
*Repairs/Refinishing*
*Stairs/Vents/Trim*

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