HANDLING COMPLAINTS

TROUBLE SHOOTING

HARDWOOD FLOORING

NOFMA CERTIFIED FLOORING GRADE
NATIONAL OAK FLOORING MANUFACTURERS ASSOCIATION

National Wood Flooring Association

This book is planned for use primarily by wood flooring professionals, as an aid to detecting underlying causes of hardwood flooring problems. Because of its volume and scope, it may be impractical to present this entire volume in support of the inspector's conclusions. Permission is hereby granted to all users, therefore, to copy individual pages relating to a specific problem to be given to the person registering a complaint.

Neither the National Oak Flooring Manufacturers Association nor the National Wood Flooring Association makes any representation that the suggested methods of handling complaints and remedying them will be effective in all instances because of the wide variations in job site conditions in the same area and in different parts of the United States and other countries and neither association accepts any risk or liability for results even when suggestions made herein are followed. Results of corrective actions depend entirely on the ability of the technician making repairs.

A Guide to Identifying and Correcting Common Job-Site Hardwood Flooring Problems.

This manual is a joint publication of the National Oak Flooring Manufacturers Association and the National Wood Flooring Association. It combines the knowledge of a large number of highly-experienced wood floor professionals from all parts of North America, and has passed muster before the talented NWFA Technical and Educational Committee as well as the jointly-sponsored Hardwood Flooring Installation School Committee.

Methods and conclusions suggested herein are thereby judged by the continent's foremost authorities to be a fair and equitable portrayal of probable causes for hardwood flooring misbehavior, and suggested solutions to be the best answers for the ultimate benefit of home or building owners.

It is an unfortunate fact of today's society that many consumers feel they are abused by businesses. Although competitive pressures make this an unlikely conclusion, prompt, objective handling of complaints by an experienced inspector can make him an effective ambassador for his own business and for the entire hardwood flooring industry. To that goal this publication is dedicated.

The thrust of this publication covers primarily new installations; however, many of the problems, causes and solutions can apply equally well to old installations.

INTRODUCTION

The very life of a tree depends on its ability to absorb moisture, and food, from a seemingly benign source -- the earth -- and move that moisture in large volume throughout its structure.

The topmost branch, twig and leaf must be fed by this moisture, as well as all those below. At the peak of each growing season a hardwood tree, like every other vegetable rooted in the ground, contains an almost unbelievable amount of liquid water. Nearly all of this must be removed to make the wood suitable for manufacture into doors, cabinets, furniture, hardwood floors or any item for interior use.

All wood is made up of microscopic cells. As moisture leaves these cells in the drying process the cells shrink in size, somewhat like a tomato vine when it is dried. The overall effect of this shrinkage is duplicated in boards, which are made up of many, many thousands of cells. As hardwood boards dry, they shrink in width and thickness, but not in length.

On the other hand, the little-understood but potent ability of wood to gather moisture from unlikely sources is not destroyed when the wood is cut into lumber. Once fully dry, wood cells can literally absorb moisture from the air, and, in some circumstances, will do so at normal temperatures when the relative humidity is 40-50%. At 65-70% the process begins in earnest. And, in the uncanny logic of Mother Nature, wood expands in direct proportion to the amount of moisture absorbed.

Hardwood flooring is dried to an average of 6-9% moisture content (by weight) before milling is begun. But because no two boards are exactly the same, NOFMA mill inspections allow 5% of the wood outside this range, to a maximum moisture content of 12%. The 6-9% range is the moisture level likely to be the average of all types of wood products used in a normal household environment, assuming usual heating/cooling appliances are used to insure human comfort.

Moisture, therefore, and its effect on wood flooring when added and/or reduced is the usual cause of wood floor complaints. One of the primary purposes of this publication is to help those responsible for inspecting a problem floor to recognize the effects of moisture changes, determine causes, establish responsibility, and recommend the best and fairest repair solution.

The wood floors covered in this edition of the "Hardwood Flooring Trouble-Shooting Manual" are limited to ¾" thick, solid oak floors. Other species -- beech, birch, maple and pecan as manufactured by members of the National Oak Flooring Manufacturers Association are also included. Reference to natural phenomena such as moisture-related problems, and finishes, may also apply to products made by non-NOFMA mills. All references to grading, milling and other standards governed by NOFMA apply only to products made by NOFMA member mills and covered by that association's mill inspection policy.

Situations covered herein begin with floors already installed, and which exhibit the characteristics described. Most floor problems can be avoided, however, by following the installation methods recommended in the NOFMA "Installing Hardwood Flooring" and the NWFA guidelines contained in its "Hardwood Flooring Manual."

SECTION A
DIPLOMACY IN HANDLING COMPLAINTS

Whenever a hardwood floor complaint occurs, the real, legitimate victim is the home or building owner. He or she must live on a floor which has, in the owner's eyes, a major problem with no visible link to any other condition in the home. And whether justified or not, the owner looks with disdain on any attempt to shift responsibility. He usually feels that the floor has failed, so it must be "green" and should be replaced.

The technique of handling the complaint from the moment it is reported can go a long way toward easing the frustration felt by the homeowner. Mishandled, it can feed frustration to the point the complaint cannot be handled equitably.

Here are some basic, common-sense guidelines in dealing with the real victim and others involved in any complaint:

1. *LISTEN!* Except for the few "professional complainers" who use complaints to avoid contractual obligations, homeowners need a vent for their frustration -- and you need to know the problem. So listen all the way through the owner's remarks, even if they become offensive. The owner may feel that to get some attention he must shout at somebody. Let it happen. When it is off his chest, he will probably be much easier to deal with.

2. *BE SYMPATHETIC.* Never take even a tirade personally. You can express your sympathy without taking sides, even if you must later dispute much of the owner's view of the problem. You really can't blame the owner for wanting the problem fixed, and it's no disloyalty to your company nor acknowledgment of responsibility to tell him so.

3. *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. Act like Sgt. Friday: Get all the facts. By the same token, keep in mind that a few boards do not make a legitimate complaint.

4. *LOG ALL INFORMATION,* 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/contractor; what the product is, brand, when purchased, quantity, when installed, when finished. And get a full description of the problem at the outset.

5. *REPORT* the complaint to your supplier if you feel the responsibility may lie there, or if you need some special assistance. Report progress to the homeowner/builder -- in writing with a copy for yourself -- particularly if progress toward resolution is delayed.

6. *INSPECT THE FLOOR* as soon as possible. Delays create a second complaint, not to mention credibility problems. DO NOT make a snap judgment of the problem, and above all DO NOT report your findings on the spot to the home owner or builder, or any other interested party. Complete the full inspection procedure, then assemble your facts for full analysis before deciding the reason for the complaint. Then report your findings *in writing.* What you say in conversation can be misinterpreted, and is almost invariably remembered wrong. What is written doesn't change, and doesn't invite argument before you are finished having your say.

SECTION B
CRACKS BETWEEN BOARDS -- CAUSES

Cracks are the most common cause of complaints on wood floors, and this problem in recent years has been exacerbated by pastel and white (or pickled/bleached) finish colors, which tend to make normal cracks appear much larger than when earth-tone or natural finishes are used.

It is normal for the interior of homes to become dry during heating seasons, for obvious reasons. As explained in the introduction, under this circumstance wood floors also dry out and shrink slightly. Properly made and properly installed wood floors should be expected to have "hairline cracks" between boards in dry months in most areas of North America. Depending on the width of the boards (or parquet members) used, the size of the room and the severity and duration of low outside temperatures (and hence the intensity of heating), the term "hairline cracks" can have various interpretations.

Generally, "hairline cracks" can be considered to be normal if, in strips 2-¼" wide or less:

1. They close up during non-heating months, and
2. They are not wider than the thickness of a dime in some locations, and vary from the thickness of a piece of stationery in most areas to scattered larger cracks up to the thickness of a dime.

Plank or strip floors sometimes "panelize" due to movement of underfloor construction, or if the finish cements individual boards into panels, so that all the shrinkage is concentrated into only a few cracks, with other joints remaining tight together. In this event, the cracks that do appear will be considerably wider than the thickness of a dime.

Plank floors, because of widths involved, and some parquet floors, can shrink individually up to 2½ times as much as 2¼" strip floors. Cracks that result can therefore be much larger than in strip, and still be normal. If the floor expands so that cracks disappear in high humidity seasons, it should be considered normal.

Cracks between ¾" thick parquet units, installed in mastic, can remain near perimeter walls if cork expansion joint filler is omitted (see NOFMA "Installing Hardwood Flooring").

Abnormally large cracks in wood floors, which do not close up in summer months, can have either job-related or manufacturing defects as the cause. Job inspections should be designed to determine which is the case.

B.1 ASSESSING CAUSES FOR CRACKS JOB-RELATED CAUSES

When the complaint is cracks between boards, the moisture content of flooring will normally be quite low. This will no doubt be the case also of the subfloor and joists, although the problem may have been caused by a very moist environment at some earlier point.

Energy-conscious home buyers have, in recent years, demanded building practices sometimes detrimental to wood building components. Vapor retarders, ostensibly made to prevent warm or cool air loss, also seal in the new home's moisture. Literally hundreds of gallons of water used in concrete, masonry, thin-set tile mortar, plaster and many other building components evaporate into the home's interior and take far too long leaving it, thanks to vapor retarders. This will often cause wood flooring to expand before or soon after installation. When this happens, the strips, planks or parquet units close on one another, and if the pressure is sufficient, will literally move sideways, or cause them to crush against one another.

Then, usually when the dry (or heating) season arrives, the total moisture environment changes, and the flooring and underfloor structure will dry out. If the earlier moisture absorption was great enough, the drying season will produce abnormal cracks. And if henceforth the environment remains normal, the cracks will probably never close completely in humid months.

The proof of this scenario is in the moisture content (Step 1 of Inspection Procedures) and measurements taken in Step 2:

MOISTURE CONTENT -- 6 to 9% average of readings, and...

MEASUREMENT CHARACTERISTICS. First, using the 2¼" strip as our example, it is practically impossible to install a set of twenty 2¼" strips tight enough to span only 45". The actual total will be about 45⅛" or more, even when every strip measures exactly 2¼" when installed.

If the flooring was either too moist when installed and was slightly oversized, or went through an expansion after installation, the span will be well over 45⅛", and re-dried individual boards will now measure very close to 2¼". The difference will show up in cracks. And individual boards will often be crushed so their actual width is perhaps 1/32" less than the original manufactured width.

Plank flooring will have all the characteristics described for strip flooring except that under identical circumstances plank will exhibit more movement per board, hence larger cracks. Wide planks are also more likely to be cupped -- a slight amount being normal.

Inadequate nail spacing -- recommended at 10" spacing for strip flooring on ⅝" or thicker plywood and 8" for plank -- can also contribute to cracks. Inadequately nailed flooring has more opportunity to move under pressure, and since each piece stays in the new location caused by sidewise movement, cracks are the result.

Squeaky floors are another indication of floor movement after installation, especially if the subfloor is boards or plywood. Sufficient side movement will loosen nails slightly, resulting in squeaks when foot traffic puts pressure on the floor.

B.2 ASSESSING CAUSES FOR CRACKS MATERIAL-RELATED CAUSES

Another cause of abnormal cracks can be improperly manufactured wood components. This usually occurs because lumber is not adequately dried before the flooring is milled.

NOFMA member flooring mills are operated to produce a product precisely milled to the intended width (i.e. 2-¼") as the product exits the flooring machine. This is the case regardless of the moisture content of the wood being processed.

If the moisture content of the wood is too high when flooring is milled -- generally in the range of 12% and above -- the flooring will later shrink to the range normal for its environment, usually 6 to 9%. In this situation, 2¼" strips will simply become 2-3/16" or thereabouts, leaving cracks between boards. The proof is still in Steps 1 and 2 of the Inspection Procedure: Moisture content will be normal.

MEASUREMENT CHARACTERISTICS. The 45" span used in our earlier example will likely be very near that exact measure -- perhaps a bit over (⅛" to ¼") or maybe even less than 45". But the key is the face width of the boards within the set, some of which will be below the normal 2¼" face width, as indicated previously. The difference will be cracks between boards.

As in the first assessment these principles apply to plank flooring also, except that difference in widths will be proportionately larger in relation to the width of the planks used.

B.3 OTHER CAUSES FOR CRACKS IN STRIP AND PLANK FLOORS

There are several other reasons for cracks in floors, and these have little relationship to job-site moisture problems. Some are:

- *Foundation settlement.* When outside walls settle -- or the center supports under the house's center beam -- the area of the floor actually stretches, causing cracks over joints in plywood subfloors. This can be detected in foundation walls (see Inspection Procedures) or by checking the levelness of the floor.
- *Over-drying above forced air heating ducts.* If cracks are restricted to hallways or other areas above heating plants, etc., check for insulation (see NOFMA "Installing Hardwood Flooring" for correct insulation techniques).
- *Improper subfloor materials.* Nail-holding capability is an imperative consideration in floor installation. If the subfloor does not hold nails, cracks can occur from less-than-abnormal moisture absorption or heavy traffic (see OWB reference in Section H).
- *Heavy vehicular movement, such as fork lifts or trucks in public buildings, factories and commercial buildings.* Flooring installed for normal foot traffic often cannot support heavy loadings without shifting.

B.4 ASSESSING CAUSES FOR CRACKS - PARQUET

Patterned floors made from short pieces of 3/4" flooring are usually glued to the subfloor with a mastic. If the subfloor is concrete, the inspection procedure should determine whether a vapor retarder was installed under the flooring, by removal of a section of the floor if necessary.

A phenomenon peculiar to mastic applied parquet, due to the fact no piece is permanently anchored to the subfloor, is that the floor units move in no particular pattern when they expand. Somewhere near the center of a room, however, one or two sections of the parquet pattern act as the anchor, and all other pieces will move away from anchor points toward the walls. It's for this reason cork expansion joint filler is needed to support the flooring at the walls. This is a special cork with a very resilient binding resin, which acts as a compression spring. It should be cut in small pieces to fit snugly between walls and each unit of parquet. If it is not used, cracks near the walls of the room will be larger than in the center, because there was nothing to push the parquet back as it dried.

Good floor mastics allow slight movement of parquet units without breaking the bond, and in fact stretch somewhat under pressure. Some types will re-tack even after breaking loose. If the parquet units appear (or sound) loose, expansion has probably moved the units too far for the mastic to retain its bond, or perhaps an inappropriate mastic was used.

Parquet with abnormally large cracks during the heating season has no doubt gone through the post-installation high-moisture cycle described earlier for nail-down products, and the proof is established by moisture checks and measurements, much as described for strip or plank floors. (Since many parquet patterns alternate grain direction, movement will occur in all directions, but only 50% as much in any direction as plank or strip.)

B.5 SOLUTIONS -- CRACKS BETWEEN BOARDS

Regardless of what moisture environment a floor has been exposed to, or exists when inspected, removal and replacement of a wood floor to alleviate cracks is usually both unnecessary and self-defeating. New flooring material which has not acclimated to the home's environment is likely to have a different moisture content than is required to remain stable in the home. Handling, storage and shipment of hardwood flooring often exposes it to periods of high humidity, higher, at least, than floors already in place during heating months when the question of replacement is most likely to arise.

All parties involved are usually well advised to leave the offending floor in place and effect repairs if possible. Once an existing floor has been acclimated to a home's environment, it is far more likely to remain stable and, with professional repairs, can regain the appearance it had when new with no loss of service.

NORMAL CRACKS: If truly normal, in the sense the cracks close up in summer months, no repairs are practical. Any filler used to fill up cracks when they appear -- i.e., when the floor is dry -- will be pushed out as the wood expands when it picks up moisture. In the process, fillers, some of which are as hard as the wood, can crush and damage edges of boards. Thus, fillers may cause uglier cracks than those Mother Nature forced on the floors, and the process of filling solves nothing.

ABNORMAL CRACKS: Even floors which have gone through a very high period of moisture absorption, then dried to leave abnormal cracks, can be repaired by a professional so that the cracks very nearly disappear. If the floor has a surface finish (i.e., polyurethane), matching filler should be troweled into all cracks. When dry, the floor can be screened and a new coat of polyurethane applied.

If the polyurethane or other surface finish has been waxed, however, a new coat of finish probably will not adhere. A better solution is to steel wool with No. 00 or finer wool, clean and wax.

In the process of expanding and reshrinking, grain direction in boards may play a role in the evenness of the resulting surface. Boards with vertical (quartered) grain may become higher than adjacent flat-grain boards, thus requiring resanding.

NOTE: If the floor is cupped or crowned, these solutions are not effective. See Solutions for Cupped Floors, Section C.1.

SECTION C
CUPPING OF WOOD FLOORS -- CAUSES

Kiln-dried wood boards which are subjected to moisture only on one side will expand on that side, and will warp by bending away from the moist side. This can be easily demonstrated with a narrow piece of paper; simply moisten one side. The paper will immediately "cup" away from the wet side, creating a convex surface on the wet side and a concave surface on the other side.

Similarly, hardwood flooring will cup for one reason and one only -- from gaining or losing moisture on one side faster than on the other.

Normally when cupping is noticed, the surface of boards will be concave -- edges higher than the center of the boards. This will mean that the backs of the boards are absorbing water vapor, to an extent expansion has begun. If unchecked, heavy expansion may ensue, followed by buckling of the floor. Often, however, only enough moisture is present to cause the cupping, and this will be the extent of damage.

Rapid cupping may occur when an impervious surface finish is applied, cutting off evaporation through the surface. The cause will still be moisture accumulating in the back sides of boards.

Extent of moisture changes will be established by Step 1 of the Inspection Procedure, and readings could approximate the following example:

- Surface of flooring -- 9-10%
- Back of flooring -- 11-12%
- Subfloor -- 13-15%
- Joists -- 14-16%

These are approximations, intended to illustrate that higher readings occur as the insulated moisture meter probes are driven deeper into the construction. Actual readings may be lower or higher, depending on how far the moisture condition has progressed.

Usually when readings like the above are found some evidence of the moisture source will be obvious, especially in a crawl space, when the full inspection procedure is followed. In a basement the moisture source may not be quite as obvious. A sling psychrometer or digital thermometer hygrometer may be needed to establish humidity levels beyond question. (A listing of moisture detection equipment is contained in Appendix A). An observant inspector will usually notice high humidity, however, because the air in the basement will feel cooler than its dryer counterpart in the rooms above. Lack of visual evidence of evaporation below the floor does not disprove its presence by any means. Concrete basement walls and floors are ready evaporators, as can be demonstrated with a moisture meter.

If cupped boards are dried soon enough, they usually return to a flat position. However, if they remain cupped long, the stresses within boards may change to the extent drying will not remove the cupping. (This is more common in wider boards.) In that event, moisture readings taken during the inspection can be at or near normal.

CONVEX CUPPING ("crowning") of the floor surface may also occur for all the reasons previously described, but most often the reason is a different one. It usually follows cupping of the *concave* type, which often occurs before the house is ready for floors to be sanded and finished. If the flooring is sanded with boards cupped and edges high, the high edges of boards are cut flat by the sanding machine if the operator does his job correctly. In profile, after sanding, the boards will then have abnormally thin edges – flat on top, with edges of the reverse side of boards still curved upward, or cupped.

If these boards later dry and flatten to their original position, the thin edges recede, leaving the top of boards convex (edges lower than the centers) and the backs again flat against the subfloor. (Fig. 1).

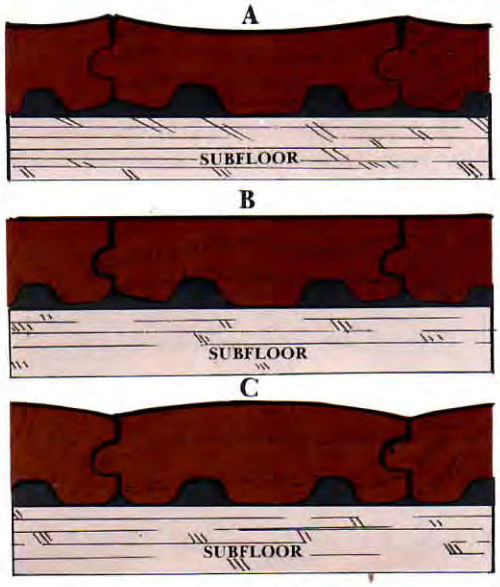

Fig. 1 Cupped floors -- end view. A -- concave face, convex back; B -- same position after surface has been sanded flat; C -- boards have reverted to original shape, but face edges recede, producing a convex surface.

NORMAL CUPPING. Some cupping should be considered normal, especially in wide planks -- 5, 6, 7" and wider -- and particularly in plain-sawn boards. In such boards (as opposed to quarter-sawn; see Fig. 2) the growth rings of the tree travel in a slightly curved pattern from one side of the board to the other. This curved pattern produces, with normal moisture content changes, a slight convex or concave cup, depending on how the rings curve within individual boards.

This type of cupping is usually not noticeable unless the floor is viewed across the boards and against a strong, low light source, such as a patio door or window wall. It is often noticed while the house is still unoccupied but furnishings usually make the cupping seem more normal as the strong light reflection is softened and angles of view are changed.

C.1 SOLUTIONS -- CUPPED FLOORS

Cupped floors have gone through a site-related moisture escalation. Re-dried and repaired, the floor already in place is, in most cases, the best choice for a trouble-free floor in the newly-established environment. Replacing a cupped floor is usually the worst choice, especially if replacement is made before the moisture condition causing the problem has been corrected. The replacement is almost certain to react to the moisture situation by cupping, like the first floor, and the whole process must be repeated.

There are, of course, exceptions, when the only solution is to replace the flooring. But the problem has usually reached a far more serious level before replacement is needed (see Buckled Floors, Section D).

The first step in repairing a cupped floor is to remove the source of moisture. To cure it the source must first be found.

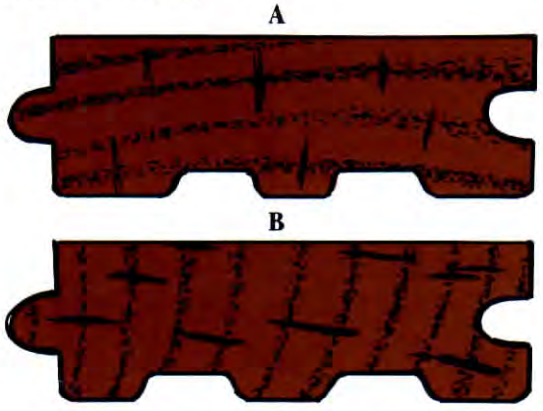

Fig. 2. (A) Plain-sawed boards have grain (the tree's growth rings) flat with the board. Slight curves make wide boards cup slightly. (B) Quarter-sawed boards have grain vertical to the board's wide dimension. Expansion follows the grain direction about 4-1, making quartered boards more stable.

In crawl-space or concrete slab subfloors, be sure all outside drainage moves rainwater away from the house. Water flows through many types of soil almost as rapidly as on the surface of the ground. If the building sits on a hillside the natural flow of water may take it under the foundation in large volume, where some will evaporate. Close this source by installing soil tile on the high side of the building to drain subterranean water around the house. Generally regrade if necessary to move water away from the house.

In crawl-space construction lay 6-mil polyethylene film over the entire area of earth (or concrete or whatever surface exsists), weighted down with bricks to prevent its shifting in a breeze. Be sure the entire area is ventilated *on all walls* and that vents are open. If there are dead ventilation areas provide mechanical means, either temporary or permanent, to circulate air. A humidistat-switched automatic fan, with a tunnel to an outside vent, is one such arrangement; coupling the fan to the air conditioning/furnace fan is also a good arrangement.

In basement construction, the soil drainage solution applies, but it may be necessary to dig out and waterproof the exterior of basement walls, and install drainage near the bottom of footings as well as intermittently up the side of the basement walls. Because of the expense involved this should be considered only as a last resort. Mechanical dehumidifiers in the basement plus summertime ventilation may ease the problem enough to allow the subfloor and surface hardwood to dry.

The next step is to allow the floor and all underfloor construction to dry thoroughly. The process by which hardwood floors take on moisture and expand takes many weeks, unless water in liquid form has been in the picture. By the same token, its removal may also take several weeks, or even months. Once a program of drying has been set up, evidence that it is working can be seen within a short time. Its progress should be monitored by taking moisture readings on a bi-weekly or monthly basis, and no repairs should be attempted until the readings have remained balanced between face and back for 30 days to be sure that cupped floors have flattened as far as they are going to. (Floors with a surface finish react much more slowly to moisture changes.)

WHEN THE FLOOR RE-FLATTENS: If cupped floors flatten when they have dried, new considerations of a complete repair may arise:

Fastenings -- nail installation: The cupping action may have loosened nails to some extent. If so, this will express itself by squeaks or looseness when the floor is walked on. Face-nailing or fastening from underneath with wood screws will correct the problem.

Adhesion -- mastic installation: Some types of wood floor mastic have re-tack properties which will allow the mastic to readhere even after the floor has been pulled loose and reset. If walking on the floor produces popping sounds, or the floor sounds "hollow" when tapped, adhesion has probably been lost. In this event the affected parts of the floor must be removed and replaced to accomplish an effective repair.

If an asphalt cut-back mastic was used originally, the dried-out floor can be removed and replaced (a few pieces at a time), as the mastic can be reactivated with a light spray of kerosene. Headless pins of hardened steel can be used also where mastic adhesion has been lost. These pins can be driven into either wood or concrete subfloors.

Once fastenings are secure, the floor can be filled where cracks exist, and either given a new coat of finish, after screening, or buffed with NO. 00 steel wool, cleaned, and rewaxed. If the original finish was a surface type (i.e., polyurethane), it can be recoated only if it has not been waxed.

WHEN THE FLOOR REMAINS CUPPED after thoroughly drying it has most likely set new stresses and most boards will remain cupped indefinitely. In this case the only practical repair is a complete resanding and finishing job. Cracks should be filled as a normal part of the finishing process and fastenings checked and repaired before sanding.

SECTION D
BUCKLED FLOORS -- CAUSES

Flooring that buckles -- literally pulls away from the subfloor, rising up to several inches in one or more places -- is a bad situation out of control. And there is only one possible reason a floor behaves in this manner: it is being given a massive dose of moisture, usually from beneath the floor.

The homeowner with a buckled floor is usually the victim of a number of bad building practices, some or all of which result in the moisture situation causing the buckled floors. A thorough inspection will reveal most of them. Site preparation, underfloor ventilation, inadequate nailing, or even such obvious faults as water running under the floor, broken water pipes, or flooring installation scheduled before all doors or windows are in place, are quite commonly found where buckled floors exist.

Once a buckling has occurred, the floor will not return to its normal posture without help. Nails which are pulled partially or all the way out of the subfloor will not return and, in fact, hold the flooring away from the subfloor. Mastic-applied parquet will have moved completely out of position. While it will return to its original dimensions, wide cracks and misalignment will remain all over the affected area.

Even though buckled floors are prima facie evidence of massive moisture absorption, a complete inspection should be very carefully performed with detailed notes of all conditions. Without doubt, the building site or other outside conditions create buckled floors, but howeowners sometimes (understandably) react with legal action upon being told the flooring is not at fault. From their standpoint, the *floor* buckled, not the subfloor or screeds, so it *must* be a bad floor. Attorneys care little for your opinion, so you may need extensive proof to prevent an unjustified judgment.

D.1 SOLUTIONS -- BUCKLED FLOORS

The conditions and source of moisture should be self-evident in most inspections involving buckling. Correcting the source of the moisture is imperative whether the floor is to be repaired or replaced.

The drainage problems outlined in Section C, Cupping of Wood Floors, should be examined as possible cures for moisture sources. Poor drainage, creating high rates of evaporation in areas under the floor, can produce an almost unlivable situation in a home, aside from hardwood floor damage. Mildew is a frequent product of high moisture penetration, as well as dimensional changes and warping of doors, door panels, cabinets, molding and most wood products within the home. High interior moisture is usually behind peeling exterior paint, extraordinary condensation on windows and other problems.

A buckled floor very often does not cup; the moisture presence can be so high, and the absorption rate so quick, floor boards will sometimes expand at an almost even rate throughout. Typically, if caught at the peak of moisture absorption, the meter readings will be well in excess of 12-15% in most boards. Underfloor readings will normally be well above this range, and in joist construction abundant evidence of moisture will usually be found in the crawl-space or basement.

D.2 REPAIRS -- EARLY STAGES

When the flooring strips or planks have peaked intermittently -- raised only on one edge of a plank for example, while the other edge remains fastened to the subfloor -- repairs are usually possible provided the source of moisture is corrected immediately and the floor is dried promptly.

The first and imperative move is to ease the pressure on the floor by providing relief at wall lines. Remove base and shoe molding on the walls parallel to the direction of strips or planks and remove the boards closest to walls. These should be left out of the floor until it is dry and general repairs are undertaken. (The flooring will not expand along its length, so only sidewalls require this relief.)

General repairs must include refastening the boards which pulled their nails loose from the subfloor, either by face-nailing in the open grain (to help hide the nail holes) or with wood screws set through the subfloor from below. Buckled floors usually leave cracks when redried because the action causing the buckling also crushes the edges of boards, as well as moving most out of their original position.

Skilled floor finishers can usually fill such cracks so they are undetectable to most observers. If cracks become too wide, however, it is difficult to make filler stick to the wood well enough to prevent disgorging from later normal expansion.

D.3 REPAIRS -- LATER STAGES

When floor components have pulled loose from the subfloor in large areas, such as three, four or more adjacent boards in each area, complete removal of the floor is unavoidable.

If the flooring has or can be redried *on the premises* it is the best choice for replacement, even though extra labor may be necessary to remove the original nails. This is true for two reasons:

First, if the floor has become normally dry while never having left the premises, it stands to reason that the originating problem -- the evaporation or moisture source -- has been dealt with, and the environment can now be considered normal. In this circumstance, the original flooring has now acclimated to the normal environment and is more likely to behave normally in the future.

Second, any new flooring brought in to replace the original will not have gone through this acclimatization process, so it may not behave as well as the original material.

In many cases where buckling has reached the stage where the flooring must be removed, there is no choice but to replace it with new material. Splits, cupping, twists and other damage may make the choice inevitable. In this case the new material should be allowed to acclimate for 7-10 days before it is installed.

SECTION E
SQUEAKY FLOORS -- CAUSES

Although squeaky wood floors are a cause of annoyance, unless the problem originates with an improper subfloor it is usually a minor one and easily repaired.

Mastic-applied parquet almost never develops squeaks, so this chapter deals with nail-down floors.

Squeaks are easy to explain: they come from things rubbing together when they move, usually when someone walks across an affected area of the floor. One common squeak originates with a loose board rubbing against a nail. If the squeak is only in one or two boards it is likely to be in the finished floor. But if the squeak can be heard by treading over an area one or two feet wide it is probably caused by movement of the subfloor.

Very often this happens when a joist below the squeak has "crowned" in the wrong direction -- that is, sways in a downward curve when it dries. This pulls that joist away from the subfloor slightly. The nails holding the subfloor to that joist are pulled out slightly and have become loosened from the grip of the joist. When pressure is applied from above, as when someone walks over the area, the nails move slightly in their seats in the joists, and usually give off a high-pitched protest.

E. 1 SOLUTIONS -- SQUEAKY FLOORS

Dip wood wedges in carpenter glue and gently drive them between the joists and subfloor (or fasten them in place with brads). Don't use wedges to separate the subloor from joists. Another source of squeaks is in the flooring itself. A slightly loose tongue-and-groove match, with less than adequate nailing, or a void under the squeaky area, can allow the flooring boards to rub together.

SOLUTION: If the movement is not enough to see, the best correction may be wood floor wax (paste wax is ideal) worked between the offending boards. If they are too tight this lubricant may not penetrate. Graphite or penetrating oil sprayed on the surface may also work; or dusting with talcum or baby powder can also lubricate the squeak. (If the floor finish is a seal-and-wax type, oil or graphite may discolor the surface.) Where a minute crack is visible between boards, the squeak may originate with the nails holding the flooring to the subfloor. If one or more are loose, face-nailing may be the only answer. Drive nails at an angle (Fig. 3) into the open grain of the wood, as they are far easier to hide here. Another solution is to drive triangular glazing points into cracks between boards to wedge them tight enough to prevent squeaks (Fig. 4). Still another method is to drill a small hole in the crack between boards and squirt carpenter glue in the hole. Fill the hole with a putty stick.

Fig. 3 Face-nailing flooring to remove squeaks and looseness should be at an angle and into a joist or screed. Pre-drilling saves many bent nails.

Fig. 4 Glazing points driven between boards into the tongue of strip can be used as a wedge to stop squeaks in floors.

SECTION F -- OTHER FLOOR PROBLEMS

Dimpled floor surfaces. Hardwood floors with pockmarks on the surface are almost always the result of uncapped heels on ladies' shoes. Heels of various heights are supported by a steel spike the size of a 10-penny nail. When the cap wears out or comes off, this blunt "nail" becomes exposed and is the first part of the shoe to strike the floor as milady strides about. Even a delicate lass of 110 lbs. or so can exert over 2000 lbs. per square inch in the tiny area of the "nail" when she takes a normal stride. This pressure strikes the floor surface like a tiny hammer with each step and no floor surface -- hardwood or other -- will stand up to it for very long without visible damage.

Solution. Where possible recommend recapping all exposed heels to prevent further damage. There is no option on repairing the floor other than to sand and refinish. This is NOT a warrantable situation and neither the floor manufacturer, the installer or finisher can be held responsible.

Underfloor movement. Shrinkage or other movement of the subfloor support system can result in movement of the flooring in certain predictable patterns. Some of the phenomena are:

Cross-pull. This is manifested in flooring strips as planks moving in opposite directions at end joints. In other words, two strips which abut at the end are pulled in opposite directions because one is nailed to a different subfloor board from the other. If the two subfloor boards shrink in opposite directions, cross-pull results, with a crack down the left side of one strip, switching to the right side of the other at the end joint (Fig. 5).

Solution: Treat as recommended for cracks in Section B.

Fig. 5. Cross-pull results when two strips are pulled in opposite directions because of being nailed to different subfloor boards.

Cracks at 10"-12" intervals: When the subfloor is wide boards laid at right angles to the joists and flooring strips are parallel to subfloor boards, cracks will develop at regular intervals in the surface floor as subfloor boards shrink. Cracks will develop at intervals which correspond roughly to the width of subfloor boards.

Solution: Treat as recommended for cracks in Section B.

Depressions or swales: These may result from the surface floor being installed parallel to joists. If a joist "crowns" in the wrong direction and bends downward as it dries it will sometimes pull the subfloor down also. If flooring strips or planks are parallel, they will follow the subfloor (Fig. 6).

Solution: Cut and jack up the offending joist, then bolt 2" x 6"s across the cut to re-stiffen the joist.

On a broader scale, depressions can result from a floor being installed on screeds, or plywood over a badly out-of-level slab. If screeds were installed in mastic, this can also cause a distinct popping sound under foot traffic.

Solution: Remove a section of the floor and replace screeds in the area with thicker screeds.

Humps: These can develop in the middle of a house with no apparent expansion of the wood flooring as a result of jack-knifed joists over girders or beams. This is usually because foundation walls or piers under center beams have settled (Fig. 7).

Solution: Removal of flooring and repair to the subfloor and joists are sometimes indicated.

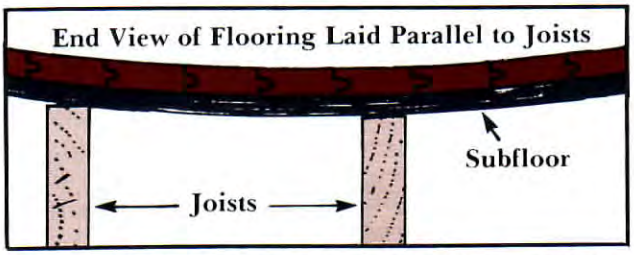

Fig. 6. When surface floor is installed parallel to joists, depressions or swales like this may result.

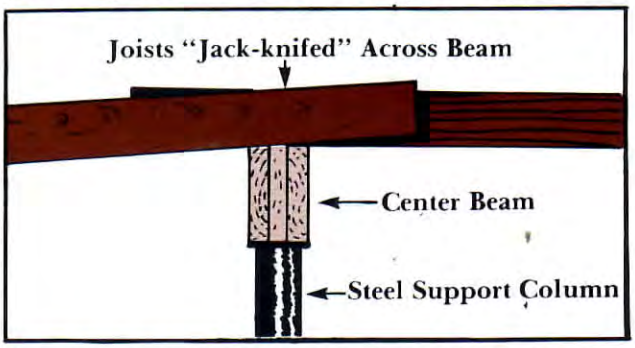

Fig. 7. Jack-knifed joists, illustrated here, can cause humps in the middle of a house when foundation walls or piers under center beams settle.

Open end joints: As discussed in the introduction, wood does not expand or shrink along the length of the grain. Assuming they were tight when the floor was installed, openings at the end joints can only be caused by movement of the underfloor system. Subfloor boards laid at right angles to joists *and* surface flooring with side-wise shrinkage of the subfloor boards could be the cause. Boards laid at a 45 degree angle to joists, or plywood laid in any direction, can cause open-end joints by either shrinkage or expansion. Most often, however, settlement of foundation walls, "stretching" the floor area, will be the cause.

Solution: Treat as recommended for cracks in Section B.

SECTION G -- PROBLEMS WITH FINISHES

Problems with on-site floor finishes can be classified in two obvious types: those that occur during application and those that develop after application. The former appear as those finishes that won't dry or dry too slow or too fast, or exhibit such objectionable characteristics as wrinkling, orange peel, lap marks, alligatoring, blistering, bubbles or craters. After-application problems include scuffing, peeling, delamination, wear or walk-off, darkening of color, uneven color, and light floors that get dirty and won't come clean. While there are other problems that can occur with finishes, these are the most common. What follows, then, is what the trouble-shooter should know to help avoid similar conditions in the future and to analyze and explain to the homeowner or other what happened and, in some cases, corrective action that might be taken.

G.1 -- PROBLEMS DURING APPLICATION

Slow drying. Most finishes dry slowly during periods of high humidity (over 70%) and/or temperatures below 60 degrees, except moisture-cured polyurethane which dries slowly in low humidity conditions. Working in totally enclosed areas keeps solvents or water contained and will cause slow drying in solvent-based finishes and slow drying plus severe grain raising in water-based finishes. Increasing heat or air circulation helps in these situations. Water-based finishes should dry very quickly (at 15 min. set time).

Fast drying. Most finishes will dry too fast in high temperatures (over 80 degrees) and humidity below 30% or when air flow is directly across the surface. Fast-dry can cause brush, roller or applicator marks because the finish material will not have time to flow and level. Preventive measures are to turn on air conditioning to cool the area to about 80 degrees or less, then turn off before finishing. Apply finish early in the day, keep sunlight off the floor (cover windows) and add a retarder, if available, for the product being used.

Wrinkling, alligatoring or blistering. These can result from bottom coats not being dry enough to accept a second coat, or a top coat's solvents eating into weaker or uncured bottom coats. Blisters will sometimes occur in spots and could be from spotty drying of bottom coats. Wrinkling will result as blisters cover a large area of the floor while alligatoring is where very heavy wrinkling results when the top coat not only eats into the bottom coat but actually lifts it from the wood or the floor stain. Prevention requires that stains and seal coats penetrate and adhere and all coats have sufficient air circulation and time to be thoroughly dry.

Orange peeling: The finish resembles the skin of an orange, resulting from the top coat setting too fast on the surface while taking longer to cure beneath. As the bottom drys very slowly the finish surface begins to dimple from the shrinkage. Keeping air flow off a wet surface can prevent this, but it can also be caused by a cold floor.

Bubbles and craters: These can be caused by air, solvents or water coming through the surface after the finish has started to set, evidence of too-fast dry-time. Bubbles are from air or solvent pushing through the film; sometimes they cause pinholes when they burst. Craters are ridges left when bubbles break and the surface finish does not lay back down. Prevention involves adjustment of temperature and air flow, allowing sufficient drying time for solvent release.

Separation of finishes in spots or along cracks. Bare spots are evident. They come from contamination (wax or oils usually) on the surface and/or in between the cracks and this contamination makes the finish crawl away. Wiping spots with lacquer thinner and recoating is often the solution.

G.2 -- PROBLEMS AFTER APPLICATION

Floor scuffs easily. This could be caused from a surface finish of poor quality being used but if a major brand was used it is probably a result of the finish not having cured fully before being subjected to heavy traffic. Total cure time is seven days. Bottom coats, including stain, require ample dry time or trapped solvents will come through the top coat and keep it soft. Dampness or lack of heat also could cause scuff marks. Increase heat and/or air circulation to remove dampness. (Wax finishes exhibit scuffing normally.)

Chipping, peeling and delamination. These are all caused by the finish coat not sticking to the wood or previous stain or coating. Chipping shows as small spots or chips coming off the bare wood surface because it was not clean or the stain used was not dry. Peeling is the same thing on a larger scale.

Delamination is evidenced by coats of finish separating from each other as when a polyurethane scratches and pieces of the top coating flake off. This can be a result of failure to sand between coats or the presence of wax or other contaminates that were not fully removed before applying the finish. If tack rags were used between coats they should be the type the finish manufacturer recommends and/or with the appropriate solvent.

Worn finish. Any floor finish can be worn off by dirt left on the floor. The only ways to prevent this is by keeping grit and grime from entering the area through use of dirt-trapping entrance mats and regular sweeping or vacuuming to remove dirt.

"Walk-off" finish. This is different from a worn finish although it is first seen in traffic areas, but it most often affects bleached, white or pastel colored floors. Excessive use of some bleaches affects the wood, breaking down the surface and inhibiting its ability to hold a finish. Insufficient drying time or too much stain used will cause the finish to "walk off" or peel off once the top coat is scratched through. Floors finished in this manner will also pick up and hold dirt in the soft grain because there is not enough finish applied to seal the wood. The greater the effort to clean it, the dirtier it looks.

Color darkens. The ultraviolet rays of bright sunlight will darken not only the finish but also the wood itself. This is more pronounced if an aromatic polyurethane is used instead of a non-yellowing aliphatic coating.

Uneven color. This can be due to the sanding procedures used by stain applications and wiping techniques, or by applying a finish coat before the stain is fully dry.

Solution. About the only solution to any of the above problems which originate with the finishing materials and their application is to sand the floor and apply a new finish correctly, being sure to follow the finish manufacturer's directions.

SECTION H — OTHER CONSIDERATIONS CONCERNED WITH HARDWOOD FLOORING PROBLEMS

Either kiln-dried boards of NO. 1 or NO. 2 Common Pine or other dense, Group 1 Softwoods or exterior plywood are suitable subfloor materials for nail down strip or plank floors. If plywood, 5/8" (19/32") or 3/4" (23/32") performance rated products are preferred. Also, 3/4" (23/32") OSB is a comparable substrate.

When parquet is the chosen floor the subfloor should be either SE plywood, preferably 5/8" thick or heavier, or boards. Either should have an underlayment of 1/4" or heavier plywood (offsetting seams or on a diagonal) nailed in 4" grids to the subfloor.

Wood-fiber composition panels, commonly referred to as fiberboard, OWB (Oriented Wafer Board), particleboard, or others, are widely considered to be unsatisfactory subfloors or underlayment for any type of hardwood flooring.

According to test results currently available, these types of composition panels expand from moisture, like most any wood product, but do not shrink appreciably when the moisture dries out. In this process, according to one maker's tests, they lose nail-retention power. Hardwood floors depend on lasting nail retention in the subfloor in order to perform well over the life of a home – perhaps 100 years or more. Inadequate nail-holding characteristics should be avoided at all costs.

H.1 POWDERPOST BEETLES

Powderpost beetles (or more properly, Lyctus beetles) can be disastrous when they infest hardwood floors. Tunneling through the wood by the beetles' larvae eats away the core of boards. When an extreme infestation occurs, the larvae can virtually destroy the infested area. Most reports of powderpost beetles are erroneous however, and have a much simpler explanation, without the danger accompanying real infestations. Determining the difference is a simple matter.

Real powderpost beetles are usually first discovered when the adult eats a hole in the surface of the wood from within. The hole will be pin-size (1-3 mm.), and when fresh is surrounded by a tiny ring of white powder. The exit holes are perpendicular to the surface and tunnel walls are the same color as the surrounding wood. Positive identity of the infestation is best left to a qualified entomologist, by submitting an insect specimen (taken when the adult beetle exits the hole), or by removing a board suspected of infestation, for laboratory examination.

In other words, where a powderpost beetle infestation is suspected, capture the insect and have it identified by a professional entomologist before proceeding with any action.

False Alarms. All Oak flooring grades allow the presence of pinworm holes in the face of flooring strips. These holes are in the wood before the lumber is dried and made into flooring. They are often about the size of powderpost beetle emergence holes and are sometimes mistaken for real infestations.

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 traffic, normal expansion/shrinkage, vacuuming, and cleaning the film breaks and the pinworm holes are revealed. The homeowner, seeing them suddenly appear, often assumes some sort of live insect is in the wood, and takes measures to treat the floor, generally by calling 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 and the exterminators have little or no

first-hand experience. As a result an "erroneous" identification of a powderpost beetle infestation can be made even if neither the tell-tale ring of white powder nor active adults have been seen. For protection the pest control operator recommends the most stringent and expensive treatment, usually fumigation. The agent also points out instances of infestation showing extensive damage to all wood articles, not only flooring, in the home, playing on the fears and insecurity of the home owner. Thus the expensive treatment is initiated and the flooring is blamed for the problem. The home owner is sometimes encouraged to recover the cost of the treatment.

For all these reasons it is in the best interest of all connected with the sale and installation of suspected beetle-infested floors to *respond immediately to reports of a powderpost beetle complaint.* The first order of business is to determine whether the report is genuine or a false alarm. If the tell-tale rings of powder and/or adults are not in evidence and have not been noticed by the home owner the report is almost certainly in error. But if the home owner is unconvinced it is best to have the assessment verified by an entomologist. State university entomology departments are a potential source of help in this regard. Or the NOFMA office can submit samples to an entomologist in Memphis for examination for a modest fee.

Sources of infestation. A genuine powderpost beetle infestation can originate somewhere near the house where it occurs, or sometimes in storage areas where flooring is kept prior to job site delivery. Small decorative grapevine wreaths have many times been identified as a primary source of the beetles. Other sources are imported woods made into moldings and other household items, and even bamboo.

Many of these imported items do not require the strict kiln drying schedules used for Oak flooring. Thus it is possible for any stage of the insects to survive the lower temperatures used to dry these wood species. This makes imported wood a prime suspect as a source for beetles infesting any part of a home, particularly with the increased usage of these imported products.

Because of kiln drying practices required in the manufacture of domestic Oak flooring it is impossible for any stage of the insect (egg, larvae, adult) living inside the lumber to survive the kiln heat. The kiln schedule requires temperature much higher and longer than the insects, eggs or larvae can withstand. Most mills also kiln dry all dunnage lumber used in pallets and packaging to insure that no lumber leaving the flooring mill can be a source of powderpost beetles.

The cycle begins as the adult lays its eggs in the open sapwood pores of a suitable hardwood, generally Oak, Ash, Walnut, etc. Diffuse porous hardwoods such as Maple, Beech, and Basswood and all softwoods are not suitable sites for egg laying and are not attacked. Stored unfinished flooring and installed unfinished flooring are tempting targets for egg laying. The longer flooring is exposed in these uncontrolled conditions the greater the opportunity for infestation, so long as the area is accessible to a tiny (⅛" long) flying insect.

Clues to the infestation's source can sometimes be found in the pattern formed by emergence holes in the floor surface. If, for example, emergence holes occur in roughly a circular pattern spanning several boards the infestation almost certainly occurred after the floor was installed. On the other hand, if the pattern is isolated to individual boards with little overlap, and those are randomly spread about the room, the infestation probably occurred before the flooring was installed, either before or after delivery to the job site.

Treatment. After an active infestation is determined, control measures may then be performed. Minor problems, where a few scattered boards have been infested, may simply call for spraying the piece with the proper insecticide killing the active beetles and plugging the flight holes as they appear. *CAUTION:* The insecticide may soften the floor finish. In this case a wait-and-see approach is often recommended since reinfestation is unlikely.

A more extensive problem may require removal of the finish from the infested area and treating with a penetrating insecticide. In more severe cases removal of the flooring from the infested area and treating the exposed surrounding wood with an insecticide may also be an alternative.

The following reasons make reinfestation unlikely so only a minimum treatment, if any, is necessary in most cases. Aging wood is less likely to be a viable source for powderpost (Lyctid) beetles, since the starch content in wood declines with age. A limited number of beetles emerge at one time so that there is difficulty with finding a mate. The finish on the wood clogs the open pores and eliminates suitable egg laying sites. Only hardwood sapwood is considered a viable food source. The low moisture content of the wood within a home slows and prolongs larvae activity so the larvae die before maturing.

Treatment by general fumigation, or the removal of flooring, or the removal of the finish and using a penetrating insecticide, are required only in the most extreme cases where large numbers of powderpost beetles emerge from all areas of the flooring at one time.

Use of insecticides: Consult a qualified applicator for product recommendations and use, follow label directions, and check for interference with finishing materials.

For more detailed information on this subject refer to the NWFA "Hardwood Flooring Manual" or write NOFMA headquarters at the address on this publication.

H.2 -- RESPONSIBILITY FOR HARDWOOD FLOORING PROBLEMS

Allotting the responsibility for misbehavior of a wood floor is sometimes difficult because of the complexity of contributing causes, and the equally complex method of a modern builder's use of sub-contractors for practically every phase of construction.

It is usually convenient for all parties to point the finger of responsibility at the maker of the flooring, because of the "deep pockets" theory of handling such matters -- and because the moisture normally at fault is not obvious to those concerned.

In some cases, of course, the flooring manufacturer *is* responsible. "Heavy" flooring -- manufactured above prescribed moisture content -- mastic failures, and other obvious faults will usually rest in proportionate degree with their producers. But most of the problems with wood floors involve high job-site moisture conditions and sometimes the later shrinkage of flooring elements when a dryer environment removes the effects of this moisture. These conditions cannot be controlled or anticipated by flooring manufacturers, nor in many instances by sub-contractors responsible for installing the wood floor.

The pace of modern building also accounts for many practices which are detrimental to hardwood floors and many other building products. When builders demand that wood floors be put down before all doors and windows are in place, or before concrete and masonry are dry, his customer, the home owner, usually pays for the deed in the inconvenience of putting up with a faulty hardwood floor.

It is the position of the associations sponsoring this manual that each of the firms involved in producing a completed wood floor installation should be responsible for its own mistakes. If flooring is mis-manufactured beyond allowable tolerances its maker should be responsible for the installed, finished cost of that portion of the problem caused by mis-manufacture. Similarly, if the problem is caused by improper installation, the installer should bear responsibility for that share of the problem. And if job-site conditions caused the problem, especially if they were beyond the anticipation of the installer, the builder should bear full responsibility and agree to pay for repairs.

"Ignorance of the law" is no excuse to any of these parties, because it is the business of each to *know and control* those areas of responsibility in his domain, within reason.

SECTION I
COMPLAINT INSPECTION PROCEDURE

This investigation procedure is intended to set a routine most likely to discover all the contributing factors involved in a troublesome floor. Even though certain phases of the inspection are more important to given types of complaints, the thorough inspector will complete the inspection, giving equal attention to each detail. The completed inspection often uncovers surprising and relevant data which could be missed if only obvious problems are checked. Also, the thorough inspector is more likely to find his conclusions accepted.

A thorough inspection should be viewed only as an information gathering activity. Conclusions should not be reached until after all information has been recorded because conflicting data will often develop and should be assessed separately from the actual inspection. (When an immediate action is needed to prevent a worsening situation all parties should be advised at once, of course.)

The following should also be used as a guide for outlining an inspection report form prior to the inspection. Relevant sections can be noted on a pad to be used as reminders during the inspection procedure, with space left to note specific findings.

TOOLS:

- Moisture meter (Fig. 8), preferably of the type which measures concrete or wood MC, and includes 2″ probes on a driver.*
- Sling psychrometer or digital hygrometer/ thermometer for checking humidity.*
- Steel measuring tape with clear markings.
- Calipers, for measuring crack widths.
- Magnetic stud finder.
- Thin metal probe.
- Pen and notepad.
- Flashlight.
- Heavy cotton cord (to check levelness and alignment of runs).
- Camera.

*See Appendix A for a list of moisture and humidity detection equipment.

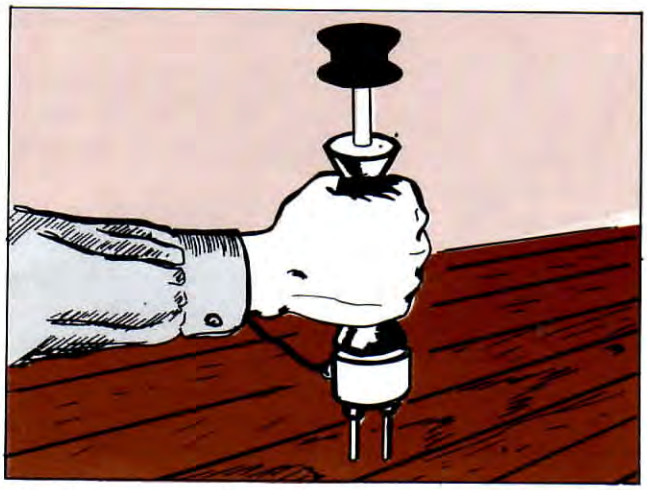

Fig. 8. Long needle moisture meter probes can be driven deep into flooring and substructure with sliding hammer grip.

STEP 1.

Establish moisture content of flooring and subfloor components. Use the long probes to measure, in succession, the moisture content of:

A. The face of the flooring.

B. The back of the hardwood floor, by driving the probes through the flooring ¾". Take this reading about ⅜" from one edge of a plank or strip to avoid driving probes into a hollow-back void. Probes should be along the grain, not across the grain.

C. The subfloor; drive the probes to 1⅛" depth.

In the case of strip or plank installed over screeds, locate screeds with stud finder and get a reading of the screed moisture.

Carefully note the readings and record each in writing. Two readings per board are suggested, and 2-3 boards in a group. Repeat the process in 2-3 locations in each room, *even where flooring is unaffected* by the problem causing the complaint. Later in the inspection process, readings will be taken of the subfloor from below, and of joists. Leave room on your notes to enter these readings alongside those above.

STEP 2.

Establish multiple and individual board measurements, using a steel rule with clear markings:

A. Measure across a predetermined set of boards or strips to establish the aggregate span. On 2¼" strip floors, for example, measure the total width of 20 boards. The span should be about 45".

On planks, measure across a consistent combination of widths which total 30" or more. *For example,* on 3", 5" and 7" planks, measure across 3 sets, which total 45". Similarly, if 3" and 4" planks were used, measure across 6 sets, or 42".

Record each span measurement carefully, *and mark the boards in each set.* For accuracy, do not use the sliding nib on the tape as the starting point; instead, carefully place the 1" mark above the starting edge, and use that as your starting point on the rule for all measurements.

B. Carefully measure each board's width in each set measured above. Record each board's exact width in conjunction with the total span measurement for that set of boards.

Note carefully the condition of the edges of each board. Record any appearance of crushed or splintery edges, whitening of finish, slight ridging of edges, or any other evidence of compression.

STEP 3.

Using the metallic stud finder, locate and record the spacing of nails used to fasten plank or strip floors to subfloors or screeds in the problem areas. The magnet inside the stud finder will point to each nail; mark its location carefully. Mark the location of all nails in a 5-to-7 foot run, and write down the space between each. Repeat on adjacent strips until at least 5 adjacent boards' nail patterns have been recorded. Then repeat the process in 2-3 areas of each affected room.

Recording nail patterns in this manner will establish whether nailing was adequate. NOFMA recommends nail spacing of 10-12" (or closer) for strip flooring on ⅝" or heavier subfloors, or 8" (with alternate nails into joists) for ½" plywood. Planks should have 8" nail spacing regardless of subfloor thickness.

STEP 4.

Using a thin probe with an L-shaped end, check under moldings for adequate expansion space. All ¾" nail-down style floors need a ¾" expansion void under the molding on walls parallel to direction of boards; parquet requires this expansion space on all walls.

MEASURING ¾" PARQUET:

Many ¾" parquet styles are milled to compensate for wood's affinity for expansion across the grain but not along its length. 9" x 9" squares are usually made 1/16" longer than their width across the grain. Smaller units are usually made 1/32" out of square in the same aspect. You must know these manufactured sizes before assessing a problem.

Measuring a span in parquet is done approximately the same way as with strip or plank floors. Record the measurements in conjunction with moisture readings in the same area.

STEP 5. UNDERFLOOR INSPECTION -- CRAWL SPACE:

A. Measure and record moisture readings in the subfloor and joists in several spots.

B. Observe and record conditions under the floor. Look for:

- Muddy areas, and where they are. (Dig under the surface; moist earth dries on top first.)
- Note the presence or (lack of) a polyethylene ground cover.
- The nature of ventilators -- how big, how many, on how many walls, and whether open or closed.
- Condition of insulation between joists, and if it's sagging or disintegrating. Are all openings filled with insulation -- especially near outside walls?
- Rust on floor nails where they protrude from the subfloor.
- Water marks on joists.
- Signs of mildew on joists, sills, foundation, or on the ground.
- Signs of settlement of piers or foundation perimeter walls -- cracks in foundation walls, jack-knifed joists where they cross a center beam.
- Check humidity level with instruments.
- Do air conditioners or ice-maker drains empty under the floor?
- "Alkali blooms" -- white deposits on foundation walls near the ground, or white powder on top of the soil.

UNDERFLOOR INSPECTION BASEMENTS:

A. Check moisture content of joists and subfloor in several spots -- and record carefully.

B. Observe surroundings and record conditions; look for:

- Evidence of flooding -- watermarks on walls, watermarks indicating flooding through windows.
- Condensation on cold-water pipes or rust spots directly underneath, including drips from condensation.
- Rust on nails protruding from subfloor, watermarks on joists.
- A "cool" feeling, indicating high humidity.
- Check humidity level with available instrument.
- Presence (or lack) of dehumidifiers.
- Use of insulation over forced air heating ducts.
- Signs of settlement of the foundation walls or center piers -- cracks in walls, floor near wall line, jack-knifed joists where they cross the center beam.
- Use of space between joists or studs as hot-air plenums, without metal ducts and without insulation.
- Location of furnace in relation to problem in the floor above -- same with central duct run.

In both areas note and measure, at an edge, the type of subfloor used and its thickness, and whether nailed, glued to joists (or both) and its condition.

STEP 6.

Make a general outside inspection, and note the presence (or lack) of gutters and downspouts, splash blocks, the general grade characteristics of the lot, and how the water appears to flow. Note any evidence of water flowing into basement window wells or through vent openings, or pooling on the high side of the house. Look for gaps between foundation walls and backfill, and evidence that surface water drains into the opening.

STEP 7.

Interview the home owner, builder, installer or other interested party to establish:

A. The nature of the complaint.

B. Origin of the flooring product -- the mill and distributor.

C. Size, species and grade.

D. When received by dealer, when delivered, where stored at jobsite, when installed and the date sanded and finished.

E. When the house was started, dried-in, completed, occupied, when heating or air conditioning was turned on.

F. When the problem was first noticed, and how the severity progressed.

G. Problems that occurred during building and floor installation.

H. Type of finish used.

I. Vapor retarder used in walls.

STEP 8.

Through your interviews try to establish whether the following were incorporated into the installation:

A. If resin or asphalt paper was used between subfloor and nail-down surface floor.

B. Vapor retarders laid over screeds or under plywood on concrete slabs, or under the flooring when parquet was used. Alert interested parties that if a controversy develops it may be necessary to remove a section of flooring to prove the vapor retarder's presence.

C. More than one brand of flooring used, and names of the brands. Again, samples may be requested at a later date.

STEP 9.

Close the notebook and return to your office *WITHOUT REVEALING YOUR CONCLUSIONS.* Wait until any samples you have requested are made available, and until you have reviewed *ALL* your evidence in great detail before reaching a conclusion. If you are unsure, call on outside help, perhaps from your supplier.

Report your evidence, as gathered in Steps 1-8 above, *IN WRITING* to all parties. Make the final paragraph of your report conclusions. You may or may not wish to assign responsibility. But if you do, be sure this assessment is fair to all parties. If all your evidence indicates job-site conditions caused the problem, your conclusions must agree, otherwise your whole report will be open to question.

SECTION J -- COMPLAINT INSPECTIONS BY NATIONAL OAK FLOORING MANUFACTURERS ASSOCIATION

One of the services rendered member mills by NOFMA is a "Complaint Inspection" service, where complaints are thoroughly investigated by highly-trained NOFMA experts. This service is available only upon request by a member mill. Because of the expense and waiting time involved it should be considered as a last resort only, when parties involved in a dispute cannot agree on the cause of the flooring problem.

Expenses involve an inspection fee plus travel costs for the inspector. The association is based in Memphis, TN, and inspectors travel from there, most often by air.

The association sets no requirements for how the expenses of a Complaint Inspection are distributed; the member mill is responsible to the association

for expenses on all inspections it requests. It is traditional in the industry, however, that the party demanding the inspection -- builder, dealer or distributor -- is expected to bear the total expense if the flooring is found to be faultless. On the other hand if the flooring product is found to be mismanufactured and thus at fault in the complaint -- or outside the parameters of NOFMA requirements in grade disputes -- the mill is expected to pay the cost of the inspection and make a reasonable settlement of the dispute.

An NOFMA Complaint Inspection is an involved affair, because the resulting report is expected to stand up in court. To call for such an inspection, one must contact the flooring manufacturer which must be a current NOFMA member mill.

SECTION K -- WOOD FLOOR GRADES

Grading complaints on hardwood flooring are rare, and are usually handled before flooring is installed if the question arises. Unless there is a highly experienced grading expert available locally, all grade complaints should be handled by an NOFMA inspector (See Complaint Inspections by NOFMA, Section J), provided the manufacturer is a member of NOFMA.

Prefinished floors made by NOFMA member mills involve slightly different standards, but are based loosely on the unfinished rules.

APPENDIX A

Meters

Companies listed below, among others, are manufacturers of meters for the woodworking industry.

Moisture Meters

MOISTURE REGISTER PRODUCTS DIV.
Aqua Measure Instrument Co.
1712 Earhart Ct.
La Verne, CA 91750-0369
Phone 714/392-5833
Fax 714/392-5838

DELMHORST INSTRUMENT COMPANY
51 Indian Lane East
Towaco, NJ 07082
201/334-2557
1-800/222-0638
Fax 201/334-2657

LIGNOMAT USA, LTD.
14345 N. E. Morris Ct.
Box 30145
Portland, OR 97230
503/257-8957
Fax 503/255-1430

WAGNER ELECTRONIC PRODUCTS
326 Pine Grove Road
Rogue River, OR 97537
503/582-0541
Fax 503/582-4138

Hygrometers and Sling Psychrometers

These are available from laboratory supply houses such as:

ALLIED FISHER SCIENTIFIC
1241 Ambasador Blvd.
Box 14989
St. Louis, MO 63178
314/991-2400

FORESTRY SUPPLIERS INC.
205 W. Rankin Street
Box 8397
Jackson, MS 39204
601/354-3565

APPENDIX B -- TYPICAL INSPECTION REPORTING FORM

(Use this as a guide to preparing your own forms for recording inspection data. Refer to steps noted in Section I of this manual for information to be obtained.)

Complaint Inspection No._____ Date of inspection_____

Owner's name_____

Job address_____

Builder_____

Present during inspection_____

Nature of complaint_____

Brand(s) & distribution of flooring_____

Amount of flooring_____Delivery date_____

Installation start and completion dates_____

Sanding & finishing: start & completion dates, type finish_____

Date residence occupied_____

Certified hygrometer placement & readings (Step 1)_____

Multiple & individual board measurements (Step 2)_____

Parquet measurement (Step 4)_____

Nail spacing (Step 3)_____

Underfloor construction type_____

Underfloor inspection (Step 5)_____

Exterior inspection (Step 6)_____

Use of resin or asphalt paper and vapor retarders (Step 8)_____

Comments of (regarding floor appearance and assement of problem)_____

_____

Comments of (regarding floor appearance and assement of problem)_____

_____

Inspection made by_____

NOTE: The form you employ, based on these suggestions, should be used only for recording data obtained at the job site and through interviews with parties involved. A written report and conclusions (Step 9) should be made based on this information. Be sure to keep the original of this report in your job file.

OAK FLOORING INSTITUTE
NATIONAL OAK FLOORING
MANUFACTURERS ASSOCIATION
22 N. Front St.
P. 0. Box 3009
Memphis, TN 38173-0009
901/526-5016
FAX: 901/526-7022

The National Oak Flooring Manufacturers Association includes in its membership most major manufacturers of hardwood flooring. Since its organization in 1909, NOFMA has served the public and the construction industry by establishing quality standards for hardwood flooring and, through regular plant inspections by staff inspectors, making sure that members' products meet those standards.

NATIONAL WOOD FLOORING
ASSOCIATION
233 Old Meramec Stn. Rd.
Manchester, MO 63021
314/391-5161
U.S.: 1-800/422-4556
Canada: 1-800/848-8824
FAX 314/391-6137

The National Wood Flooring Association, founded in 1985, embraces all segments of the wood flooring industry, manufacturers, distributors, dealers and contractors. Major goals are to increase the wood flooring market share and to sponsor educational and training seminars for members.

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