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Title Memorandum on Visits to Certain Factories  
During October, 1922, to Study Wood Finishing Problems

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Notes Illustrates ~~the~~ ~~the~~ FPL's concerns with  
keeping abreast with industrial applications  
and issues. Demonstrates state of the art, 1920s.



MEMORANDUM ON VISITS TO CERTAIN FACTORIES DURING  
OCTOBER, 1922, TO STUDY WOOD FINISHING PROBLEMS

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During October and November, 1922, visits were made to representative factories engaged in making wooden products requiring finishing by means of paint or varnish, etc. The purposes of the trip were:

1. To become acquainted at first hand with the conditions under which wood finishing is carried out in these industries.
2. To learn the particular purposes which the finishes are expected to accomplish and how nearly these objects are being attained.
3. To discover what troubles are being encountered that might be overcome by experimental work at the laboratory.
4. To make contact with individuals and concerns who may be able to assist us in our work later on.

Visits were made to:

International Harvester Company, the Deering, McCormick, and Weber Works, Chicago, making agricultural implements.

Mr. V. R. Hawthorne, Secretary, American Railway Association, Chicago, concerning the finishing of wooden railway cars.

Kiel Furniture Company, Milwaukee, making tables.

Republic Furniture Company, Milwaukee, making furniture.

Milwaukee Chair Company, Milwaukee, making chairs.

Northwestern Furniture Company, Milwaukee, making office furniture.

Mayhew Company, Milwaukee, making furniture and talking machines.

Crocker Chair Company, Sheboygan, making chairs.

Northern Furniture Company, Sheboygan, making furniture.

Brand & Sons Company, Oshkosh, making office furniture.

Frost Veneer Seating Company, Sheboygan, making theater seats and cheap seats.

Dillingham Manufacturing Company, Sheboygan, making refrigerators, folding chairs and bath room cabinets.

Buckstaff Company, Oshkosh, making caskets and chairs.

Smith-Barnes-Stroeber Company, Milwaukee, making pianos.

Waltham Piano Company, Milwaukee, making pianos.

Bush and Gerts Piano Company, Chicago, making pianos.

Matthews Bros. Mfg. Co., Milwaukee, making special interior woodwork.

Conway Company, Milwaukee, making interior woodwork.

Chas. Abresch Company, Milwaukee, making auto bodies.

Great Lakes Boat Building Corp., Milwaukee, making motor boats and golf clubs.

Gould Manufacturing Co., Oshkosh, making toys.

Adams Elting Company, Chicago, making varnish.

Mr. Walter Murray, Finishing Products Company, Indianapolis, fillers and stains.

A large variety of wood finishes were observed during these trips from the single coat of enamel applied by spray gun to toys to the 8 or 9 coat, hand rubbed surface given to some pianos. The following statements are based upon the observations of the writer during these trips, and the statements of the various men interviewed. Since many of the statements are not based upon data resulting from research they are not to be accepted as final statements of established facts.

#### Toys and cheap seats.

The finishing material for toys must cover uniformly by dipping or spraying in one coat, dry in 24 hours, and not peel off when exposed to the weather. The species used are pine and birch and an enamel finish is employed. Kiddy cars are given a first coat of colored primer followed by one coat of coach varnish. Articles requiring a design in 2 or 3 colors are done in one operation by means of a special stencil and the spray.

Chair seats selling for 7 or 8 cents each require a very cheap finish that can be applied by a machine very similar to a glue spreader. They are given a filler of corn starch and hot water and one coat of varnish.

Theater seats are filled, water stained, buffed on wheels of rattan cane and given a coat of varnish. Folding chairs and tables are finished similarly.

#### Railway cars.

Passenger coaches are now being made mostly of steel. They are painted primarily for appearance rather than for

protection. Wooden freight cars are thought by many to fail mechanically before the wood has a chance to decay, hence they too are usually painted for appearance.

Under present conditions only the cheapest paints will be used for freight cars and this is applied in one coat by spray. After the car leaves the shops it is not likely to be repainted unless it gets into an accident and has to be repaired. A straight iron oxide paint is called for in the specifications, but the paints actually used contain a large amount of filler and are of very poor quality. No paint at all is used inside the car.

The attitude toward painting freight cars at the present time is shown by the fact that many cars are being turned out with no paint at all except the necessary identification marks. The Lackawanna on the other hand is as careful about the painting of freight cars as it is with passenger coaches.

#### Agricultural implements

From the standpoint of the maker of agricultural implements the finish is applied chiefly to help the sales, although the production departments are doing their best to give as durable a finish as possible at a low price. The farmer seems to prefer bright colors. There is also a psychological factor involved in that a machine painted bright seems to weigh less to the farmer than the same machine painted in somber tones. The farmer takes so little

care of his implements that no finish will last more than one season as a rule anyway. Painting for preservation must be done by the farmer rather than by the implement maker.

A great variety of species are used. For many parts they are used indiscriminately, one part that was observed for example consisting of gum, yellow pine, oak, cottonwood and maple. Hubs of wheels are made of birch and oak, spokes of oak and hickory, and rims mostly oak. Axles are all hickory. Bolsters and gears are oak and hickory.

Wheel and gear stock is dried to 8 per cent for regular farm implements, 6 per cent for southwestern or mountain regions. The rest is dried to about 12 per cent.

The finish must be inexpensive. For the most part the materials are applied by dipping. The finishing coats for wagon sides are brushed on because the inside is given only the priming coat. Spraying is considered too expensive because of the amount of material wasted.

The finish consists usually of a priming coat which is long in oil, say 25 to 33-1/3 per cent oil, a second coat shorter in oil or a coat of color varnish and a final coat of spar varnish. At the Deering Works the priming coat is omitted, as they claim, to get equal durability for less cost. The other plants do not concur in this practice.

The materials used are all of an inexpensive grade, but great care seems to be exercised in their selection and claim to get better durability from the lower priced paints and varnishes than from the expensive ones. Extensive

exposure tests are conducted on samples submitted by the makers. Physical and chemical analyses are also made. After a year's exposure, purchases are based on the outcome of the tests. The materials sent in by the manufacturers on these orders are checked against the analyses of the original samples and are rejected if they fail to agree.

### Motor boats

The stern, trimming, and interior of the boats at the plant seen are made of mahogany or cedar with a varnish finish. The wood is filled with a paste filler with which the stain is combined and then given 3 or 4 coats of spar varnish.

Oak, white pine, and spruce are the principal species used for the remaining parts. The interiors are finished with 2 or 3 coats of flat white paint followed by 2 or 3 coats of enamel. The outside of the hulls are given half a dozen coats of "yacht white" a straight white lead paint giving an egg-shell finish. Bottoms are given 3 coats of anti-fouling paint and the inside of the hulls 3 coats of gray lead paint.

Durability is not a primary consideration since these are pleasure crafts which are painted usually twice a year for appearance. The requirements of the finish are (1) it must take patching without showing the line where new paint meets the old, (2) it must wear by chalking to give a good surface for repainting, (3) it must not crack off when abraded, (4) it must be capable of sanding smooth.

### Golf clubs.

The heads <sup>are</sup> of persimmon or dogwood and the shafts of hickory. The finish must (1) look well, (2) keep moisture out, (3) not show marks when hit by the iron heads of other clubs in the golf bag. A wax finish is sometimes applied, but it becomes dull in the retail stores unless polished up occasionally. It is applied best on buffing wheels and the wax has some gums mixed with it. The finish now used consists in staining and filling, and then applying a special shellac mixture made into a paste with oil by means of "padding." The shellac mixture is placed on a cloth pad and rubbed in vigorously. The head is filled, sanded, shellaced, sanded again, given a coat of valspar and rubbed with rotten stone and oil, and finally polished with paraffine oil.

### Refrigerators.

Ash and elm refrigerators are treated first with combined oil stain and filler, followed by two coats of surfacer and one of long oil varnish. They are sanded between coats. The finish must not discolor when in contact with water, and must stand fairly rough treatment.

### Interior wood work

Most interior wood work is installed in the white and finished by the painting contractor. In some cases it is finished before shipping. The finish generally consists of paste filler, stain, if desired, and two coats of varnish the last one being rubbed. Paint and enamel finishes are also

frequently used on interior wood work. Much special work for churches, public buildings, some stores, etc., is finished before shipping. The finishing of this work is carried out very much like the finishing of furniture, both in the variety of finishes used and the methods for obtaining them. It can therefore be discussed under the next heading.

### Furniture.

The most important species to be finished for furniture are oak, birch, maple, gum, walnut and mahogany. Birch and gum are stained usually to imitate walnut or mahogany.

The purposes of finish on furniture are: (1) to enhance the natural beauty of the wood, (2) to enable a less valuable wood to be substituted for a more expensive one, (3) to prevent loss of the beauty of the wood by weathering, (4) to prevent raising of the grain, opening of matched joints, etc. that take place if the wood is not finished, (5) to give a smooth surface that can be easily cleaned, (6) to prevent the surface from rapidly absorbing liquids that may fall upon it, (7) to minimize swelling and shrinking by retarding moisture changes.

A smooth well sanded surface is essential for a good furniture finish. The final sanding should be done shortly before the finishing process begins, as the grain of unfinished wood raises gradually on exposure to the air.

The first process is generally staining. Water stains are most widely used except that golden oak is often finished

with oil stain. In the latter case the stain is often combined with the filler. Water stains have the great disadvantage that they raise the grain of the wood, requiring sanding again before applying the subsequent coats. Since sanding is the most expensive operation in finishing this is a great objection. The water stain is accused by some of opening up glue joints in veneered work and causing trouble with swelling. Other concerns, however, do not experience the latter troubles. Oil stains have the disadvantages of (1) "bleeding" that is the color strikes through the varnish coats laid on top, (2) not giving as uniform coloring, (3) fading more rapidly in the light, (4) not giving as brilliant colors as the water stains. Spirit stains are expensive.

Stains are applied by dipping or brushing. They can be sprayed, but not much seems to be done in this way.

Most "fumed oak" is obtained by water stain rather than by using the fume box. In some cases oak is first sponged with water to "raise the grain", and then sanded before staining. This is too expensive to find very wide use, however.

When water stains are used, the grain is raised more or less and the work must be smoothed before going on. This is done in a number of ways. Usually it is sanded, of course, after allowing the work to dry. Four to 24 hours are allowed for this purpose. A better job results if the piece is given a "wash coat", i. e., a thin coat of shellac before sanding as this causes splinters of wood to break off smooth leaving no fuzz. Instead of sanding, some use a cane rub. In this case the wash coat of shellac must be omitted. The work is rubbed

with waste rattan cane either by hand or with a buffing wheel. Coconut fiber seems to be a still better material for this purpose.

The next process is filling. The purpose of this is to fill up the pores so that the later varnish coats will flow out smoothly and leave no pin holes where the varnish is drawn down into the pores. The requirements of the different woods vary greatly from the very open grained oak to the closer grained birch. The best filler is a paste filler of sillex and oil with the amount of oil varied to suit the requirements of the wood, the closer grained woods having a larger proportion of oil. It is essential that the sillex be ground very fine and preferably "floated." Paste fillers, however, have been very largely displaced by liquid fillers or surfacers. These are a varnish containing pigment to fill the pores. The liquid filler serves also as a "first coater" and where oil stains are used they can be combined in the filler. Liquid filler is usually applied by brush or dipping.

Paste filler is always followed by a coat of shellac to seal the pigment in the pores. With liquid filler this is not so essential, but it seems to be the common practice anyway. In place of the shellac a cellulose lacquer may be used. Some concerns mix, half and half, cellulose lacquer with shellac for this purpose. There is also such a mixture on the market which sells for less than either shellac or cellulose lacquer alone. Both shellac and lacquer are almost always applied by spray.

After a few hours the work is sanded (steel wool is sometimes used instead) and any defects, small holes, cracks, etc., filled with a shellac cement by means of the heated blade of a steel spatula.

The work is now ready to "body up" to the final finish. The procedure varies widely with the quality of the goods and the kind of finish desired. For a wax finish the work needs only one or two coats of wax, and is then rubbed to a polish. Such a finish can be turned out in 2 or 3 days.

For a varnish finish, 1 to 3 coats of rubbing varnish are applied, usually by spray. Some maintain that the spray gives a more even coating than the brush, while others hold the opposite view. There is a tendency for the labor unions to object to the spray on sanitary grounds, but the employers claim that their real objection is to the fact that it turns out work faster.

Usually the work is placed in a kiln over night for the varnish to dry. The temperature varies in different plants from about 80 to 130°F. Usually there is some control of the humidity as well, but there seems to be very little real knowledge of the influence of this factor. The theory that seems to be most widely accepted is the following: Drying of varnish is more rapid at higher temperatures, but if the temperature is too high the rapid evaporation of the volatile constituents causes blistering of the varnish. By increasing the humidity it is claimed that the rate of evaporation at a given temperature is diminished so that a higher temperature can be used without blistering. However, if the humidity is too high, the varnish takes on a dull, muddy appearance.

Too low humidity is said to cause the varnish to dry from the surface down, and too high humidity causes it to dry from the bottom up.

A very important reason for humidity control in varnish drying kilns lies in the swelling and shrinking of wood with moisture changes. This factor is generally overlooked in discussing these questions. When the temperature in the kiln is raised the relative humidity is greatly decreased and the wood begins to give off moisture. This may result in checking of the wood and in blistering of the varnish. The humidity in the kiln should be maintained at such a value as to keep the moisture content of the wood constant during drying of the varnish.

The work should be sanded between coats, but this is not always done. The last coat is rubbed with pumice or rotten stone and water or oil. The water rub is said to be "cooling" and the oil rub "heating." The water rub can be done more quickly after applying the last coat of varnish and it gives a cleaner job, but it cuts more deeply into the varnish and requires more skill in operating. The oil rub can be carried out faster. The water rub is used for the best work. Mechanical rubbers are used on large flat surfaces. Final polish is put on by rubbing over with paraffine oil.

Zapon (cellulose lacquer) finishes are being used more widely. They are applied in place of the varnish.

Enamel finish consists of a first coat short in oil, each succeeding coat containing more varnish. Usually a

last coat of varnish is given. Three to five coats are applied each coat dried 36 to 48 hours.

The time required for finishing furniture varies from 2 days for a wax or Zapon finish to 10 or 12 days. The cost of finishing seems to run about 10 per cent of the total manufacturing cost.

### Pianos

The finishing of pianos is merely a somewhat more elaborate form of the methods used for furniture. A few are being turned out with wax or cellulose lacquer finishes, but the great majority have a polished varnish finish. Staining and filling are done the same as for furniture. A thin coat or two of shellac may be applied. The work is then sanded, after which 3 or 4 coats of rubbing varnish are put on. Varnish is nearly always applied by brush. One to two weeks is allowed between coats of varnish. The work is then "coarse rubbed" with pumice and water and any defects patched with transparent cement. A flowing coat of varnish is then applied, rubbed with pumice and water, "fine rubbed" with rotten stone and water, and finally hand polished. Just before packing it is "oiled off" with paraffine oil and benzine. A "satin finish" is obtained by following the fine rubbing with a treatment with dry rotten stone, brushing it over the work with a fine brush. Finally wipe off with a damp cloth. Oil must not be used on this finish.

### Problems

From the observations made on this trip it appears that most of the problems which interest the wood finishing industries are due to the effort to cut down the cost of finishing by using cheaper materials or more particularly by cutting down the number of coats used and the time allowed for drying. In the majority of cases the solution of the difficulty would be easy if it were not for the pressure to speed up production and cut down the costs.

Finishers are unanimous in saying that the finishes used today are not as good as those employed some years ago when the finisher was given more time and permitted to use better materials. Much of the responsibility for this decrease in quality may fall upon the public because of its failure to distinguish between good and bad finishes in making its purchases. For example, a piece of furniture with a wax finish that required only 4 days in the finishing room may sell for the same price as the same article bearing a good varnish finish that required 10 days and considerably more labor to apply. Under such circumstances there is little to encourage the manufacturer to keep up the quality of his finish.

A great obstacle in the path of progress in wood finishing is the absence of exact definition of the properties desired of the finish or accurate means of measuring how nearly particular material possesses the desired properties. Chemical analysis and physical tests have not been sufficiently closely related to service records to serve as accurate measures of quality.

Exposure tests of small panels are the nearest approach to a means of determining the suitability of different materials, but they require an inconveniently long time to carry out and the conditions of exposure are seldom exactly the same as the service in view. Price being the only characteristic definitely attached to different materials it becomes the chief basis for purchase. Depending on his mental attitude the user either buys the cheaper product because he is not sure that the more expensive one will give him proportionately better service, or he buys the higher priced material on the theory that price is directly proportional to quality.

The problem of finding suitable materials for preventing changes in the moisture content of wood in atmospheres of changing humidity is one whose importance is being increasingly realized.

The following problems have been encountered during the above visits and are listed here without much attempt at systematic classification:

1. Influence of the species of wood on the durability of paint and varnish coats. This can be restated from another point of view as the problem of the proper way to apply paint or varnish to various species to get the maximum service. Differences in the structure of the wood, its shrinkage with change in moisture content, its content of oils, resins, tannin, etc. may affect the coating. Since plywood does not swell and shrink as much as solid wood construction, paint or varnish coatings might be expected to last longer on the former. Similarly the

structure and shrinkage of wood are different on end grain, quarter or flat sawed faces, a fact which may affect the applied coating.

2. Influence of moisture in the wood on the durability of paint and varnish. If the wood is wet, that is, contains free water in the pores and cell cavities it is well known that it cannot be successfully painted. It is not known, however, whether lesser amounts of water in the wood affect the durability of the paint, for example, whether a paint coat applied to wood with a moisture content of 6 per cent will last longer than the same paint on the same wood at 12 per cent moisture content. Probably the factor of greatest importance in such cases is the swelling and shrinking of the wood with change in moisture content, making it advisable to paint the wood at a moisture content corresponding to the average moisture content it will have in service.

3. Influence of the number of coats on the durability of paint and varnish. In some places the attempt is being made to do away with the priming coat by increasing the oil in the second coat. How much this affects the durability is not known.

4. Influence of thinner on the durability. Benzine has very largely replaced turpentine as a thinner in paint and varnish. It is claimed by some that this decreases the durability of the paint. Where paint is applied by dipping it often is thinned more than when applied by brush. This may also decrease durability.

5. Influence of nature of pigment on durability of paint. A number of subdivisions of this problem are already

apparent, including

(a) Straight white lead pigment as compared with lead-zinc-inert pigment.

(b) Best pigments to use when we consider a paint that must be applied by dipping.

(c) Value of "struck colors" as compared with "concentrates."

(d) Best extenders to use with "concentrates."

(e) Value of red lead as compared with other red paints for intermediate coats of dipping paint.

6. How to obtain an opaque finish with high "body" and polish without danger of cracking. This is the problem of auto body finishing, for example.

7. Problems of staining wood:

(a) Ways of getting the advantages of water stains without raising the grain of the wood.

(b) Method of staining heart and sapwood of such species as walnut uniformly in one dip.

(c) Method of bleaching dark wood like walnut so as to take a lighter finish.

(d) Means of getting different pieces of wood like oak, in the same piece of furniture to stain alike. The reasons for this lack of uniformity in the staining of oak is not clearly understood. It is variously attributed to the use of different species in the same piece, differences in the tannin content, in the

relative proportion of "flakes" or of summerwood, in the direction of the wood fibers, or in the direction of the saw cut (plain or quarter sawed).

8. Problems of filling wood properly. The commercial fillers are said to be of very inferior grade. It is probable that the expenditure of more care in filling would result in a better and more economical finish through saving in the more expensive varnish coats and rubbing.

9. Problems of sealer for use over filler. Shellac is expensive and has several disadvantages. In humid weather it becomes milky. When used under varnish and exposed to humid atmospheres it may turn white.

10. Problems of varnishing.

(a) Methods of accelerating drying of varnish. The factors influencing the results obtained in varnish drying kilns are not well understood, particularly the question of the influence of humidity on the rate and manner of drying of the varnish.

(b) Methods of preventing the "printing" of varnish in packing or when people sit upon it.

(c) Method of obtaining a varnish or other polish finish that will not chip easily (for golf clubs, for example).

(d) Reasons for cracking and peeling of varnish and how to prevent it.

(e) Acid resistant varnish finish for toilet seats, etc.

(f) Means of keeping varnished table tops from showing marks when hot dishes are placed on them.

11. A mechanical substitute for hand polishing of pianos.