FACILITIES AND TECHNIQUES
FOR THE
FINISHING OF INDUSTRIAL ARTS PROJECTS

by

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CHAPTER I

INTRODUCTION

During the writer's undergraduate work at Oregon State College there were many opportunities to converse with industrial arts teachers returned for advanced work, and visiting staff members of the summer sessions. Several of these men voiced the opinion that finishing of industrial arts projects presented a problem in school shops.

Professor George B. Cox, in a recent Shop Planning course said, "One of your trouble spots is the finishing room." This same Shop Planning course, of which the writer was a part, visited several schools throughout Oregon, and the general consensus of opinion among shop instructors, when asked, was that finishing of shop projects presented a real problem.

Professor E. D. Meyer remarked that, "The manner in which the finishing of school projects is handled is certainly a major problem."

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Because of these statements, the writer was made more conscious of the problems, and considered an attempt to find a solution for some of them.

The finish of a product -- any product -- more or less determines whether or not it is acceptable. When pupils turn out a good project in the school shop, it is certainly a poor morale factor for it to be subsequently ruined by the application of an inferior finish. In an article which appeared in the *Industrial Arts and Vocational Education Magazine*, Griffin (12, pp. 524–526) stated:

> The proper finishing of woodworking projects made by students in school shops is extremely important and desirable, and it presents a real challenge to all concerned. Unfortunately, it is that part of shop-work which too often is sadly neglected. However, the right finish, correctly and carefully applied to a piece of furniture adds considerably to the beauty and value of it, and instills a great deal of pride and satisfaction in the person who made the piece.

**STATEMENT OF THE PROBLEM**

The problem is two-fold: first, to find what methods and techniques are used in the finishing of industrial arts projects in the school shops of Oregon at the present time; and second, if improvement can be made, to learn in what manner this can be accomplished.
PROCEDURE AND SOURCE OF DATA

The data were obtained in the following manner:

1. Available printed data concerning finishing procedures in industrial arts shops were reviewed.

2. An appropriate questionnaire, composed of twenty-six pertinent questions was drawn up, and was given a trial test in several schools throughout the Salem area.

3. After these trials, the questionnaire was revised in accordance with suggestions received, and was mailed to one hundred industrial arts teachers throughout Oregon, whose names were taken from the 1951 Directory of Industrial Arts Instructors.

4. Upon return of the completed questionnaires, the information was tabulated and used in the completion of this study.

LIMITATIONS

1. The investigation was limited to High Schools and to Junior High Schools throughout Oregon.

2. The instructors to whom the questionnaire was sent were selected from the 1951 Directory of Industrial Arts Instructors which was not entirely up to date. No later directory is available.

3. The investigation was limited to those schools in which woodworking was taught.

4. The investigation was limited to the finishing of woodworking projects exclusive of the use of paints.
TERMINOLOGY

The terms "shop", "woodshop", and "industrial arts shop", found throughout this study all denote that portion of the school in which industrial arts projects are made.

"Wood finishing", or "finishing", is that process whereby coats of various finishes are applied to the projects.

"Project", as used in this survey, denotes articles constructed by the pupil in his industrial arts classes.

"Finish" means a protective and decorative coat applied to the surface of the projects.

"Finishing room" is a separate, enclosed portion of the woodworking shop which is reserved for finishing.

"Drying room" is a separate, heated room in which freshly coated projects are stored for drying.

An "exhaust system" here means a spray booth or some form of exhaust equipment to catch and expel the dust residue of materials blown past the work when spraying.

"Blower system" refers to the method of collecting sawdust and shavings from woodworking machines by use of connecting ducts and suction fan.

Terms relating to spray guns in this study are:

"External-mix" -- fluid and air mixed outside the cap, a suction feed gun.

"Internal-mix" -- fluid and air mixed inside the cap, a pressure feed gun.

"Bleeder type" -- passes air at all times, worked from a small compressor.

"Non-bleeder type" -- cannot pass air until the trigger
is pulled. Used with tank or compressor having pressure control.

Various terms relating to the processes used in the finishing schedule are defined as follows:

"Staining" --- the process of applying stain to an absorptive surface for the purpose of coloring only the surface or the surface layer.

"Sealing" --- the process used to 'tie-down' the stain, and to separate the stain from subsequent coats.

"Filling" --- the process of filling the wood pores and giving a smooth, level non-absorptive surface upon which other finish coats may be applied.
CHAPTER II

REVIEW OF LITERATURE

A review of the available literature concerning wood finishing shows that most of the written material deals with finishing as it is employed in industry. Apparently very little has been written dealing particularly with the finishing of industrial arts projects in school shops. The items written primarily for use in industry can, however, be modified and adapted to fit most of the school shop problems.

In the review summaries which follow, the writer has attempted to arrange the more pertinent items in a useful order. The aim has been to include only those references which will support this study and be of specific benefit to teachers seeking aid in facilities and techniques for the finishing of industrial arts projects.

The reader will note references to the technical contributions of at least two commercial manufacturers of finishing materials. There is no desire to show partiality, but the publications of two manufacturers have been developed for specific help to teachers, while other have made little or no such contribution.

The importance of the finishing of industrial arts projects is stressed by Jeffrey (16, p.9), in the following manner:
Too often we find a well-constructed piece of work poorly finished. Students, as a rule, seem to think that the prime necessity for a good product is costly lumber, and that the piece is finished when they have completed the construction of it. They should learn that it is not so much the kind of wood used in a piece of work that determines its value, as it is the honest construction and careful finishing of it.

Wooddell (28, p.215) also wrote:

It may be observed in many school shops that frequently the wood finishing, which should add to the beauty of the project, is disappointing because it is poorly done. This is probably due to the fact that most school shops do not have adequate facilities for wood finishing.

These authors are among several who find that the finishing of the wood projects in industrial arts is likely to be neglected. H. T. Davey (4, preface v) stated:

All too often good woodwork is seen to have been spoiled by inferior finishing, while domestic jobs, too suffer very much from amateurish efforts. The lack of knowledge of the fundamental principles is largely responsible for these failures and poor work generally, while such results can also be attributed to the use of cheap and also unsuitable materials. Much patience, too, as well as skill, is required in this work.

Broadbent (3, p.116), had this to say:

The value of a project depends a good deal on how attractive it appears. Therein finish assumes its great importance. Acceptable wood finishing is the stumbling block for many amateur craftsmen.
A suggestion in the American Vocational Association Bulletin (l, p.18), for the improvement of instruction in industrial arts recommended:

A list of things pupils should know concerning finishes:

1. The object of finishes.
2. The kinds of finishes in common use; such as stain, oil, wax, shellac, varnish, lacquer, enamel, paint.
3. The durability of different finishes.
4. The conditions or places in which various kinds of finishes may be used to advantage.
5. Materials from which finishes are made.

The same bulletin continued with the following statement:

Woodworking courses have commonly been too narrow, in that the experiences provided have not given contact with a sufficient variety of materials.

Soderberg (25, p.1) wrote:

New finishing materials constantly make their appearance upon the market. Chemical science has contributed greatly to the further improvement of even the well-established finishes as well as to the discovery of new finishes. It must be kept in mind, however, that as new raw materials are being developed, almost daily, the finisher must be constantly alert to learn their properties and to determine their protective coating characteristics. Every finisher should acquaint himself with the constantly changing possibilities in the development of materials for finishing wood. He can hope to achieve an ideal finish only when he keeps informed of the materials available.

Another author who considered finishing of primary importance was Griffith. In his Essentials of Woodworking (14, p.206) he stated:
Finishing is the last and the most important operation on most projects. It can be done satisfactorily only if each individual is willing to care for the finishing equipment while in use, and to clean it and leave it in the proper condition when he has finished with it.

Dirt is the one thing that is likely to spoil most work and to cause the greatest amount of disappointment in finishing. Dirt, in this sense, may be anything from small particles of dust settling on freshly painted or varnished surfaces, to lumps and bits of 'skin' in paint or varnish that has been left uncovered.

Hyler (15, p. 29), in speaking of cleanliness in the finishing room, wrote:

Ordinary cleanliness plays a part. Woodwork coming from the drum sander or other machines should be blown off, or brushed free of sander dust before being brought into the finishing room, the spraying room being isolated from woodworking machines as much as possible. Finishing room floors should be kept clean. In case of a concrete floor especially, it is well to apply a light dressing of oil now and then to keep dust laid. Oil may also be applied in moderation to tops of room fixtures, top surfaces of windows, stools, and like horizontal surfaces to which dust gravitates. Then it can be cleaned up without stirring it into the air afresh.

Soderberg (25, p. 303), on the subject of cleanliness in the school shop, had the following remark to make:

Good housekeeping is essential for efficient operation of any finishing department. It is impossible to produce an excellent finishing job in a dirty, dusty shop.

Frank (7, p. 253) called attention to the importance of cleanliness thus:
The finishing room is but a small part of the school shop, but an important one. Every device which aids in keeping the finishing room clean and orderly is, therefore, to be welcomed.

Since Frank's investigation was limited to schools in which woodworking was taught, one may assume that dust from the woodworking machines presented a major problem in the finishing of projects in these shops.

Wilber (27, p. 290) stated:

Whenever possible, some provision should be made for dust collection, especially from woodworking machines. Where a general dust collection system is not practical, most woodworking machines can now be purchased with individual collectors. These are highly recommended.

Jenkins (17, p. 291) had the following to say about solving the dust problem in industrial arts finishing rooms:

In forty finishing rooms that have been visited during the past few months, instructors all complained about the dust problem.

The vexing question was solved successfully, however, at Redfield, South Dakota, by the use of a cabinet as a drying room. This cabinet covers the entire width of one end of the finishing room. It is deep enough to accommodate a cedar chest or a davenport table. It is divided vertically in three sections, with two sliding doors for each. Ample ventilation is provided by a three-inch transom at the top and bottom of each of the doors. These openings are covered with muslin, the bottom one being protected by a wire-screen of heavy mesh. The shelves in the cabinet are made in the form of grates with one-half inch openings between the strips. These grates are removable and adjustable.
The cabinet is easily cleaned. In addition to controlling the dust problem, it also adds materially in eliminating finger marks from the finished project.

Concerning the dust problem, Pattou and Vaughn (22, p.144) had this to add:

An important thing to consider in any finishing room or drying room is the airtight construction, so that no dust can be carried into the room from the outside to settle on the finished work and thus cause pimples and more labor to rub out. An efficient ventilating system should be installed.

Other considerations for the finishing room are: adequate light, adequate heat, and factors for safety. On the subject of light, Wilber (27, p.288) wrote:

The problem of adequate and effective lighting for the school shop has recently been made the basis for exhaustive study and experimentation. The results of these studies indicate that in only rare instances can sufficient daylight be provided in all parts of a room to furnish adequate illumination for many types of industrial arts work. It, therefore, becomes necessary to depend on artificial lighting. Present thinking and experimental data indicate that fluorescent lighting is desirable for most industrial purposes. It is much easier to approach a condition of shadowless white light similar to good daylight with fluorescent equipment than with any other method now available.

Pattou and Vaughn (22, p.144) added:

The first thing to be considered in the construction of a finishing room is light. Nothing is more necessary to insure perfect matching of colors and avoidance of strain on the finishers' eyes. Furthermore, many skips and rubbed-through places can be
attributed to poor lighting facilities. If possible, there should be light on three sides of the finishing room, and the more wall space given to windows, the better.

If artificial lighting is necessary, and it is on dark days, the room should be so flooded with light, indirect if possible, that few shadows can be noticed. If the ceiling is painted a luminous white, an indirect light will not injure the eyes even though very strong.

Heat is another requisite, and the room should never fall below seventy-five degrees Fahrenheit while work is progressing. Heat should be evenly distributed in the room. Of course, the heat of the drying room should be raised to one hundred degrees Fahrenheit or more for quick oxidization of varnish coatings or enamels. If lacquer or shellac is the finishing coat, it will not be necessary to have extra heat or a special drying system. With these materials coated pieces can be placed in the drying room with just comfortable room temperature, for they dry quickly.

A final consideration for the physical set-up of the school shop is safety. Pattou and Vaughn (22, p.272) had this to say about safety in the finishing room:

Most organic finishing materials are highly volatile and flammable, and under certain conditions, explosive. A spark in the presence of vaporized solvents combined with air in the proper proportion can work havoc to life and property.

They recommended the following for careful attention and management:

1. Storage of materials. Keep flammable products separate and away from finishing area.
2. Leaky containers. Keep a constant lookout for leaky containers not only in the storage room but anywhere in the shop. Leaks cause fumes and the accumulation of materials on the floor which may, when mixed with air, create an explosive combination.

3. Adequate ventilation. Because large amounts of flammable solvents are vaporized in the finishing process, the finishing area should be ventilated adequately both day and night.

On the subject of safety in the school shop, Wilber (27, p.303) took a somewhat larger overview:

Safety is secondary only to the educational criteria. This means that all equipment must be designated and built, and in turn selected and used, with specific reference to the size, height, strength, mental development, and experience of the individuals who are to use it. Thus, the capacity, weight, power, speed, and size of machines for industrial arts classes should be determined by the nature of the pupils who use them.

The same author (27, p.299) made an even more general, but pertinent, statement:

The type, amount and characteristics of equipment in a school shop will have a significant effect on the program which can be developed. If the equipment is adequate and well-suited to the requirements of the teacher and students, meeting the objectives of the course will be greatly facilitated. If, on the other hand, the equipment is inadequate or of a type not suited to the needs of the program, the achievement of desired purposes becomes difficult, if not impossible. The choice of equipment will depend on a number of important factors which must be considered before planning and purchase can begin.

A separate finishing room is justified in a large shop and in one where woodworking
is the predominant activity. It will include bench space, a spray booth with an exhaust system, a turn table, drying shelves or racks, and storage for finishing materials.

Griffith (14, p. 204) wrote:

Many schools have withheld the installation of spray equipment on account of expense. While it is not well to rush into the purchase of expensive equipment without careful thought, there are now a number of small, high-quality spraying machines extremely well suited to the school shop. It is for that reason that a number of schools are now turning to the application of paint, varnish, and lacquer materials with the 'air-brush' or mechanical spray.

A reliable manufacturer of spraying equipment (6, p. 2), recommended the following:

Spray equipment in its most common form consists of three items -- gun, compressor, hose. The gun usually is the item of first importance since it does the actual spraying, but, as a matter of fact, gun and compressor must be considered together so that one will function properly with the other. The alert buyer gets a one-package outfit with gun, compressor and hose exactly mated, thereby assuring best performance.

Broadbent (3, p. 118) said about spray equipment:

For home workshops and small school shops, the small portable outfits are quite satisfactory. Unless the spraying is done in an open shed, it is advisable to have a spray booth with an exhaust fan.

The previously mentioned manufacturing company (6, p. 2), continued:

Spray guns are bleeder type and non-bleeder type. A non-bleeder gun can't pass air until the trigger is pulled. This type gun is used when air is supplied from a
tank or from a compressor having pressure control.

A bleeder gun passes air at all times, thus preventing the pressure of the air compressing outfit building up to a point of popping the safety valve. If you work direct from a small compressor, your gun should be the bleeder type.

Spray guns are either internal mix or external mix, these terms indicating whether air and fluid mix outside the cap or inside the cap. If your gun is suction feed, it will have external mix. Internal mix always involves pressure feed.

Pattou and Vaughn (22, p. 185) wrote:

All first coaters can be used with an air gun and many of them work easier and form a much smoother coat used in this manner. Shellac and lacquer are two of the first coaters that should never be applied with a brush if a spray gun is available. The reason is obvious -- the fast drying of the film does not allow brushing over or lapping of the brush strokes.

From his experience with spray equipment, Deniston (5, p. 280) concluded:

As the 'heart' of production spray-finishing systems, the spray gun is like a precision tool that, to do a job most efficiently, must be used with the proper technique.

In discussing the technique of using spray guns, Newell (19, pp. 308-309) wrote:

Spray gun technique is easily acquired. It requires only a short time for satisfactory service and skill soon follows. It is known, however, that skill with a brush in applying finishes requires time, training and experience. Lacquer application with a brush is a rather difficult
operation at best, even for a skilled workman, and it is still more difficult for a beginner. A home-worker, or a student at school, can soon acquire the experience needed for application of lacquer with a spray gun. Reduction in the time needed for training of an operator of a spray gun is only part of the story. The most important gain is that the spray gun operator can do many times as much work in a day, or he can cover so many more square feet of surface that there is no comparison with brush at all.

Occasionally, in the schedule for finishing industrial arts projects in wood, the first procedure is that of bleaching. As the materials used in this process are extremely dangerous to handle their use in the school shop should be limited and most carefully safeguarded. The subject is included here simply as a possible first step in the finishing schedule.

Deniston (5, p.53) defined bleached finishes as:

Finishes produced by means of chemical solutions that remove or lighten the natural coloring or wood are invariably termed 'bleached' or 'blond' finishes.

A reliable manufacturer of wood finishes (2di, p.8) wrote more fully about wood bleaches:

The two most common bleaches are oxalic acid and sodium bisulphite, and potassium permanganate and sodium bisulphite. In the first instance, the oxalic acid and sodium bisulphite are made up in a 5 to 10% solution in water. In the second instance, the potassium permanganate is made up in a 2 to 10% solution, and the sodium bisulphite in a 5 to 10% solution.

It is the practice to neutralize caustic with 5 to 15% acetic acid solution. The wood is then sponged with clear water to
remove the caustic and salts that were formed. If free caustic is allowed to remain on the wood, it will have a serious effect on the finish applied over it.

In emphasizing the safety precautions necessary when using bleaches, Soderberg (25, p. 113) warned:

Bleaches are very strong chemicals and extreme safety precautions must be exercised during their use. As they are injurious to the skin, wear rubber gloves if swabbing bleach on, and protect your eyes with goggles and your clothes with a rubber apron. If bleach comes in contact with the skin, immediately clean and slush off with soap and water.

In most cases of finishing an otherwise completed project, the first step is usually staining.

Jeffrey (16, p. 16) stated the purpose of staining as:

The purposes of staining are to produce a soft and agreeable color; to match the various shades of the wood; to harmonize the work, in the way of color, with other furniture; and to bring out in varying degrees of depth the natural beauty of the wood which may in its unfinished state be raw and unpleasing to the eye.

Soderberg (25, pp. 104-105) added to this:

Stains are used primarily to produce color rather than to produce a protective coating on the surface. Staining may be defined as the process of applying stain to an absorptive surface for the purpose of coloring only the surface or surface layer. The operation is an ancient art which has been greatly improved by modern science and is today considered to be one of the most critical and important operations in woodfinishing. In order that a finisher may realize the greatest beauty and depth in the finishing of most woods, it frequently becomes necessary for him to use stain.
Stains are used for various purposes. They bring out the beauty of the grain design. Stains used for this purpose must be clear and free from pigment. Stains enrich the color of the wood and change the color of the less desirable woods to imitate the more expensive surfaces. Sap streaks on walnut and other woods are stained to give uniformity to the entire surface before an overall stain is applied. These sap streaks should not be classified as defects and therefore discarded. They merely require a special staining process to make them look like the rest of the surface.

Lowndes (18, p. 814) described various stains as follows:

There are several kinds of stains, each of which is applicable to certain kinds of woods, and to obtaining certain effects of color. The principal ones are oil stains, aniline oil stains, water stains, spirit stains, acid stains, and varnish stains.

Soderberg (25, p. 105) discussed oil stains more fully in his Finishing Materials and Methods, stating:

Oil stains may be classified as penetrating and pigmented. Penetrating oil stains are composed of oil-soluble dyes dissolved in such oils as benzol, naphtha, toluol, or turpentine. These oil-soluble dyes are available in powder form or the stain itself may be purchased ready-mixed in liquid form.

Penetrating oil stains are easy to apply and do not show laps or streaks. These stains combine readily with wood-filler in the making of filler-stains. Oil stain does not raise the grain of the wood, thus eliminating the need for pre-sponging as in the case of water stains.

Penetrating oil stains find very little use in the finishing of fine furniture because of their tendency to bleed into
subsequent coats and fade in strong sunlight. It is necessary, therefore, to seal such a stain coat with shellac or some other surface sealer to minimize the possibility of bleeding.

Pattou and Vaughn (22, p.171) wrote:

Oil stain can be applied with a spray gun or by hand brushing, but, unlike water or spirit stains, must be wiped with waste or soft, clean cloths. In mixing oil stain, it is well to strain the stain before using, and after it has been thoroughly mixed to prevent an insoluble aniline from forming on the surface. If this happens, different shades may be noticed in the finish as a result of wiping particles of aniline over the surface when wiping off.

Griffith (14, p.185) wrote about oil stains as follows:

Each of the principal kinds of stains has its peculiar advantages and disadvantages. Oil-stains are perhaps the most easily applied. They leave the surface of the wood smooth as there is no tendency to 'raise' the grain. But they are expensive, are frequently more apt to fade than water-stains, and the brushes used with them cannot be cared for so easily as with water-stains.

Soderberg (25, p.107) discussed spirit stains in the selection below:

Spirit stains are composed of aniline dyes soluble in alcohol. Their use is limited in furniture finishing because they fade easily when exposed to sunlight. They are used chiefly in touch-up work, as they will penetrate old finishing materials. Spirit stains are difficult to apply evenly and may lift with a shellac sealer coat, giving a muddy effect. They are bleeding stains which may strike through almost any type of finishing material.
The most recently developed stains are the non-grain-raising (N.G.R.) stains, so called because of their minimum tendency to raise the grain. These stains are of the acid dye-base type, a characteristic which gives them the clarity of water stains. The solvents used in non-grain-raising stains are numerous, but such non-aqueous solvents as alcohol, glycol, toluol, acetone, and other ketones are used. Although these non-grain-raising stains do not possess the definite non-bleeding characteristics of water stain, they are superior to oil stains in that respect. Their short drying period does not permit them to penetrate the wood as deeply as does water stain. Non-grain-raising stains can be applied by spraying, dipping, or brushing. Brushing, however, is quite difficult because of the rapid drying of such stains.

A reliable manufacturing company (24, p.12) listed the properties of their non-grain-raising stain as follows:

This is a non-grain-raising stain possessing excellent penetration and offering great depth and richness of color. It is non-bleeding, fast to light. The increased color strength of Liquid Concentrates allows reduction with Artistain Reducer No. R 7 K 28 up to 800 or 900 percent. These colors, when intermixed, will produce any desired shade and should be applied by spray only because of fast drying. Shellac may be added to the Artistain to make a combination Stain Washcoat, or if preferred, a lacquer sealer washcoat may be applied separately.

In the discussion of water stains, Soderberg (25, pp.104-105) has the most comprehensive statement to make:

Water stain makes an excellent stain for removing sap streaks. Providing greater depth in the finished surface is also a possibility through the staining operation. Water stains give the clearest and most transparent results of all the
stains. Because of their slow drying, they have sufficient time to penetrate the wood deeply. Water stains have less tendency to fade than do other stains, and because of the characteristic of their solvent they do not "bleed" into subsequent coats. Water stains are excellent for use in darkening sap streaks.

Water stain has great tendency to raise the grain of the wood and this condition must be taken into consideration and can be eliminated by pre-sponging the wood surface or by applying a wash-coat of shellac. This operation will cause the surface to become rough. Thus light sanding to remove the roughness precedes the application of stain. Great care is required in the application of water stain to avoid laps and streaks. This condition is especially prevalent if stain is applied by wiping, brushing or dipping. Spraying, however, is the best method of application for water stains.

Pattou and Vaughn (22, pp. 167-168) wrote on the use of water stains as follows:

Water stain should be used on all pianos, phonographs, radio cabinets, fine furniture and woodwork exposed to light, especially direct rays of the sun. Water stain should be used also in refinishing these surfaces when a practical and long life of finish is desired. Water stain made from aniline dyes should always be used under a lacquer finish to prevent the bleeding of stain by the lacquer. This cannot be prevented with any other kind of stain excepting the old chemical stains.

Deniston (5, pp. 75-76) added:

Water stain possesses several advantages. It is economical, easy to apply, brilliant, non-fading, non-bleeding, provides a deep yet even penetration, and given an even, clear tone. The fact that water staining
colors the wood so evenly, richly and clearly has made it the standard by which other stains are measured.

The next type of stain to be discussed is wiping stain. Soderberg (25, p. 105) wrote on wiping stain thus:

Pigmented oil stains, or 'wiping stains' as they are sometimes called, are colors ground in oil in solution with linseed oil or some other varnish vehicle.

Pigmented oil (wiping) stains are used extensively in furniture finishing. Their main use is to produce a more uniform finish through the process of wiping and blending of colors. They have little tendency to bleed or fade. It is therefore relatively easy to obtain any desired color or highlighting effect.

Pigmented oil stains are easy to apply. They may be sprayed, dipped, brushed, or swabbed on the surface. After application they are allowed to dry for about thirty minutes and then, with a rag, shaded or highlighted where necessary.

A manufacturing company, previously quoted, (24, p. 12) stated definitely prescribed uses for wiping stains:

Pigmented-type stains are designed for new woods only, or for close-grain re-finished wood if sanded down to the new wood.

Close-grain or soft woods are generally best stained by using pigmented wiping stains. These woods do not require filling to the extent that open-pore woods require. Wiping-stain has a dual purpose in that it stains and fills in one operation.

Shading stains were discussed briefly by Soderberg (25, p. 107) in the following manner:

Shading stains are merely colored lacquers or varnishes (varnish stains) which
are usually applied over a sealer coat to uniform the staining operation. Varnish stains should never be applied over bare wood as a one-coat finishing job.

Deniston (5, p. 88) had more to say concerning the use of shading stains. He wrote:

Shading stains are used on light-colored trim woods, such as maple, birch, poplar, and tupelo, to match them with darker panels or to produce a color contrast. Consisting of a thin lacquer containing dyes or transparent color pigments in small amount, they are usually applied by spray gun over the filler, the sealer, or the first finishing coat. They are used on local areas either for color uniforming or for producing slight color variations which are attractive.

Pattou and Vaughn (22, pp. 174-175) wrote:

Wood fillers are commonly used for staining as well as filling the pores, and especially is this true in regard to walnut. The wood is dark and requires only a little stain to give the desired shade. Filler is employed also in two-tone finishes by using a transparent or natural filler, with just a little color for the light shade, the darker portion to be filled with a dark filler. Oil soluble aniline can be added to the filler to darken it, usually brown or black.

Soderberg (25, p. 107) stated:

Filler-stains, a combination of filler and stain, are never used where a high grade finishing job is required.

In Wood Finishing, Jeffrey (16, p. 20) called attention to the difficulties of staining the end grain of wood. He stated:
It is in this particular that slipshod work may be noticed easily. The ends of wood should be smoothed as carefully as the face surfaces. Remember that this part of the wood will absorb color and filling much more readily than the side grain. It is therefore necessary to use the stain of only half the strength that is used on the face side and edges in coloring the ends of the wood.

The next procedure in the ordinary finishing schedule is that of applying the ‘washcoat’. This was discussed by Deniston (5, pp. 133-134), who wrote:

The operation of sealing wood surfaces, commonly called ‘washcoating’ is one that for years has been the subject of lively debate in commercial finishing circles. Much has been said not only on whether the sealer coat should be applied to stained work before or after the filling operation, but also on whether the surface should be washcoated both before and after filling. There appears to be little question, certainly, that undercoater practice in wood finishing today, as through the years, is subject to considerable variation.

It would appear to be sound logic as well as good practice to seal both the stain and the filler, particularly on high-quality work. If a filler is applied directly over the stain coat, the wood is likely to absorb some of the drying oil used in the filler as a binder; also, if the filler is pigmented, some of the color pigments are bound to affect the stain shade.

The same author, Deniston (5, p. 62) continued on the subject of washcoating with the following:

When woods are stained with water stains, washcoating is invariably required. Its use over non-grain-raising stains is optional; however, a washcoat is generally applied over them in high-grade finishing of furniture to preserve the clarity of
the finish. Occasionally a small amount of stain is added to the washcoat to secure a more even tone or more brilliant color.

The filling of the wood is the next step in the finishing process to be covered. In *Finishing Materials and Methods*, Soderberg (25, p. 108) wrote:

Filling is one of the most important operations in securing an excellent finishing job. Filler may be defined as 'a pigmented composition formulated primarily for the purpose of filling the cell lumina or openings in a surface prior to the application of other finishes'. Proper wood filling accentuates the color and beauty of the grain. Filler also has a tendency to prevent moisture from entering the wood.

Davey (4, p. 27) continued with the description of the filling process in the following way:

Filling is a process employed to stop up the pores of the wood so as to avoid an abnormal absorption of polish, and to secure an unbroken level surface ready to receive the stain or polish. As a general rule, filling is necessary in practically all varieties of timber. The filling of the grain can be carried out before or after staining, but in certain instances it must be done afterwards. For example, in fumed oak the fuming has no effect on the color of the filler, therefore it is obviously easier to match it to the color of the fumed oak afterwards.

A certain commercial company (24, p. 2), manufacturer of wood finishing products, had this to say:

It is necessary to know the porosity of the wood to determine whether or not a filler is required. Whether to use a filler or to eliminate it, depends upon the finisher's judgment as to the porosity
of the wood and the ultimate finish desired by the customer.

The porous hardwoods most commonly used by the furniture industry are mahogany, oak and walnut. The semi-porous hardwoods most commonly used are maple, birch and gum. Pine and redwood are used occasionally, and are non-porous.

Filling should always be used on open-grain or porous hardwoods that may be used in a piece of furniture. Filling does no harm to non-porous or close-grained woods; however, it is absolutely necessary for proper preparation of open-grain woods when a smooth, uniform built-up finish is desired.

Lowndes (18, p. 87) described paste fillers thus:

Paste fillers are used on open-grain woods such as oak, ash, chestnut, walnut, and mahogany. The filler is brought to a stiff consistency by thinning with turpentine, and the color is tested by applying it to waste pieces of wood. Other hardwoods, which do not absorb so readily, such as birch, cherry, and maple, are sometimes filled with paste filler.

Soderberg (25, p. 108) said, concerning paste fillers:

Paste filler may be divided into the conventional 'slow dry' and the synthetic 'quick dry' filler. The conventional, or old type, filler is a linseed-oil base filler. It requires twelve to twenty-four hours of drying before the application of lacquer sealer. This type of filler is easy to work, as the oil base provides a lubricant for the application as well as for the removal of the filler.

With a speed-up in production came a speed-up in the filling operation. The linseed oil in the old conventional-type filler has been replaced by a synthetic resin vehicle of the type
used by paint manufacturers. These new quick-dry fillers are formulated to dry in ten to sixty minutes.

A reliable manufacturer of wood finishes (24, p. 5) recommended the following paste fillers:

(Our) -- Fast-dry Furniture Fillers are supplied in the form of semi-paste. Their characteristics include elimination of shrinkage, avoidance of 'popping', improved adhesion, clear colors, non-graying, ease of wiping and good suspension. These fillers include materials covering the complete range from natural to dark mahogany. These fillers may be applied by brush or spray.

The other type of filler is the liquid: (25, p. 108)

Liquid fillers which contain a small portion of pigmentation are used on medium close-grained woods, such as birch, gum, cherry, maple, redwood and beech.

The procedures for using fillers were rather thoroughly discussed in a brochure issued by the previously quoted manufacturing company (24, p. 5):

Ten to twenty minutes 'set-up' time is required before any attempt should be made to wipe the film. This is usually the time when the surface begins to lose its wet appearance. The filler is then 'padded' into the pores of the wood by wiping it across the grain with tow or soft cloth. Further wiping may be done with rags across the grain, and a final clean-up is done very lightly by wiping with the grain to remove the streaks. Care must be taken, however, to prevent removing the soft filler from the pores.

Do not allow the filler to dry too long before wiping. This practically constitutes a coat of paint which is difficult to remove if too long a period
elapses between application and clean-up.

Desniston (5, p.106) wrote:

Filler wiping requires hard work. It spells a tough job at best -- one which careless operators invariably try to make as easy for themselves as possible. And when that happens, quality of the work obviously suffers, often quite seriously, and is reflected by the final finish. In fact, if filling is not done properly, getting a good finish is virtually impossible.

The same author (5, p.134) defined the process of sealing the following way:

Whether it is to be applied to bare wood that has been sanded smooth or is to follow staining and filling, a sealer still serves the same fundamental purpose. This is to seal the surface of the wood and thereby prevent absorption of succeeding finish coats.

Sealing materials and sealing procedures were described.

Furniture sealers are supplied in both lacquer and varnish qualities. The most popular lacquer sealers are those containing 21% solids, the balance being volatile liquids which are used solely for the purpose of making the material sprayable to carry the solids to the surface.

Varnish sealers -- although not as fast-drying as lacquer sealers -- offer the same protection, and play the same important part as lacquer sealers in the furniture finishing schedule.

Lacquer sealers are almost always applied by spray because of their extremely fast-drying nature, although, in some cases, particularly in small refinishing shops, small sections of arms and legs of upholstered furniture may be coated by brush application for obvious reasons.
Lacquer sealers are applied directly over the dried filler or wiping stain, and may be sanded in 30 minutes to one hour, depending upon the evaporation rate of the thinner used.

Pattou and Vaughn (22, p.202) wrote:

A lacquer sealer is supposed to replace shellac as a first coat material under clear gloss or flat lacquer. The development of these materials are the result of troubles from the use of early developed clear lacquers over shellac. Most of these sealers contain a finely ground transparent pigment that gives body and allows easy sanding of the sealer coat. This first coat material is superior to any on new work under clear lacquer finishing coats.

Deniston (5, p.42) discussed sanding, which is used throughout the finishing process, as follows:

In addition to smoothing and cleaning wood in the white, sanding is utilized at many other stages in the preparation of wood for finishing. It often follows wash-coating and bleaching, and is frequently used to smooth fume-coated and sealer-coated work. In most refinishing jobs, it is also employed not only to remove part or all of the old finish but to smooth the surface in preparation for the application of new coatings.

The final coat given to industrial arts projects in woodworking may consist of any of the following finishes: varnish, shellac, lacquer, wax or oil. Lowndes (18, p.88) explained varnishes briefly:

Generally speaking, varnishes are divided into oil varnishes and spirit varnishes. Oil varnishes are known as short-oil and long-oil varnishes. A short-oil varnish has a minimum amount of oil, such as 5 to
10 gallons to 100 pounds of gum. A long-oil varnish may be made with 20 to 40 gallons of oil to 100 pounds of gum. Short-oil varnishes have greater luster, while long-oil varnishes have greater durability.

A reliable manufacturer of furniture finishes described their line of varnishes: (24, p. 5)

(Our) -- Finishing Varnishes produce relatively the same appearance as lacquers. In some cases, finishing varnishes offer better durability at lower cost than cheaper grade lacquers; however, because of the extremely fast-drying schedule of lacquers, they may be preferred by most furniture finishers.

(Our) -- Finishing Varnishes may be applied by brush or spray -- dry dust-free in from one half to one hour, and dry overnight. Two coats may be applied for best build up and depth of finish.

Pattou and Vaughn (22, p. 204) explained their process of spraying oil varnish:

A special consistency for spraying is made by the different manufacturers and this is recommended, rather than to thin any varnish with turpentine or japan drier. Varnish is sometimes heated for spraying and, of course, it will flow much better if this is done. This material can be heated by steam or hot water as the safest method.

Jeffrey (16, p. 57) wrote:

Much of the success in varnishing is due to correct and suitable conditions. Where a fine finish is desired, the work to be varnished should not be cold. The ideal condition for varnishing is a temperature of from seventy to seventy-five degrees Fahrenheit. The day should not be extremely damp or extremely dry.
The varnish should be of the temperature of the room and the wood. Everything should be as nearly free from dust as it is possible to have it. Wood should not be dusted in the finishing room. If possible, the floor may be sprinkled with water the night before varnishing is to be done so as to settle the dust. Another necessity, and one which is most frequently disregarded by workmen, is a constant circulation of oxygen. Remember that varnish does not literally dry, it 'oxidizes', or takes oxygen from the air in hardening, giving off fumes. Air, while it should circulate freely, should not blow directly upon the work. The room for varnishing should not be very light. On no account let newly varnished work come under the direct rays of the sun or it will be blistered.

In discussing the difficulties encountered in successful varnishing, Lowndes (18, p. 94) stated:

Varnish is a very sensitive material, and is affected by changes in temperature, dampness and cold. 'Blistering' is caused by moisture or oil under the varnish. Exposure to the sun will cause blisters. 'Blooming' is the formation of a bluish-white film on the surface, caused by dampness or frost, excessive driers in the varnish, or gas fumes, such as ammonia or coal gas. 'Cracking' or 'checking' is due to expansion or contraction, and may often be explained by the difference in elasticity of the several coats applied. 'Roping' is the refusal of the varnish to spread evenly to a level surface. The usual cause is low temperature of the varnish or wood, and too strong a draft. 'Specking' is caused by freezing or chilling of the varnish, causing some of the gums to harden.

Newell (21, p. 99) gave some of the reasons that varnish does not dry properly:
1. Application of second coat before the undercoat is perfectly dry.

2. Varnishes that are good will not dry over surfaces that have been handled much with bare hands or that have been in contact with the skin in any way. Greasy spots on chairs must be carefully cleaned before varnishing, or a coat of varnish will not dry.

3. Proper temperature will aid in the drying of varnish. The best temperature for the drying of most varnishes is from 70 degrees to 80 degrees Fahrenheit.

Broadbent (3, p.117) wrote:

Shellac usually is applied as an additional filler after wood filler and, although used as an undercoat for varnish, it is often the final finish. It is the only filler necessary on close-grained wood. It can be purchased in either orange or white colors. The white shellac has a greater variety of uses.

Although shellac provides a hard, fine finish, it cannot be used as the final finish where a project is subject to moisture, because shellac is not waterproof. The secret of successful shellacking is in the application of thin coats. Shellac usually comes mixed four pounds to the gallon. For the first coat, it must be diluted at least one half with denatured alcohol. For finer work, it can be thinned several times more than that. Successful coats are made thicker.

Pattou and Vaughn (22, p.199) supplied this point about shellac:

The same shellac which was used for the first coat can also be used for the second coat. Of course shellac has a low melting point, and is not waterproof, and it would seem to be inferior to lacquer finish in these
two points, if not in others. Lacquer can be applied over a shellac with a perfect knitting coat, as the lacquer will dissolve the shellac to a certain extent before drying. Oil varnish or the cabinet rubbing varnishes can be used over shellac.

One of the difficulties encountered in the use of shellac as a final finish was stated by Pattout and Vaughn (22, p.197) in this way:

One way to prove why shellac turns white is to add some water to shellac varnish and apply it. The film will be cloudy to white, depending on the amount of water in it. If you happen to be in some section where the use of shellac is taboo, as the result of so much rainfall, it is best to eliminate this product entirely and use some of the other undercoaters.

Soderberg (25, pp.40-41) gave a list of precautions about the care and use of shellac:

1. Store shellac away from heat.
2. Never buy more than 90 days' supply at one time.
3. Always store shellac in glass containers.
4. Make sure surface is dry before applying shellac.
5. Never use a water-wet brush.
6. Always keep shellac tightly sealed to prevent evaporation.
7. Never use water to polish shellac.
8. Work rapidly when applying shellac, stroking your brush only one way.
9. Never shake a can of shellac vigorously, as this creates bubbles.

Griffith (14, p.201) wrote the following concerning the use of lacquer as a final coat:

Lacquer, like shellac or oil varnish, can be applied either directly to the
wood, over a stained surface or over a filler. It should not be applied over shellac. Neither should it be applied over oil paints and varnishes unless they are several months old, thoroughly oxidized and the surface is in good condition.

Soderberg (25, p.26) defined lacquer as:

The term 'lacquer' has come to mean a finishing material which dries quickly by evaporation and forms a protective film from its non-volatile constituents. The two new types of lacquer bases, ethyl cellulose and chlorinated rubber, with the addition of oxidizing oils and resins, have increased the solids content to almost equal that of varnish, without materially slowing up the normal drying of lacquer. Cellulose lacquer has several advantages; it is:

1. Quick drying, dries free of dust in from zero to fifteen minutes.
2. Harder, yet has more flexible film.
3. Mar and abrasion resistant.
4. Waterproof.
5. Non-changeable in color while drying.
6. Resistant to a high temperature without becoming soft and tacky.
7. Not easily affected by soap, dilute alcohol, weak acids, or temperature changes.

Pattou and Vaughn (22, p.200) added this warning:

It is seldom proper to use any other material over lacquer, but finish up with lacquer instead for all coats. Of course if brushed, a pulling up of the first coat may result to some extent, and much care must be used in its application in this way, but if sprayed, you may be sure of a good application provided your air gun is in
good working order and the pressure is correct.

Toews (26, p. 308) wrote:

Clear lacquer makes a most satisfactory finish for lathe projects. This type of finish has a definite advantage over a French Polish in that it will not turn white when water or other substances come in contact with the finished surface. It is also a much more durable finish.

Newell (20, p. 42) discussed lacquer finishing processes briefly:

Lacquers for many purposes are now available. Special lacquers can now be obtained on the market for use with a brush, for spray gun application, for furniture and inside use in gloss and dull effects, for exterior coatings which will be durable in the sunshine and wet weather, for undercoats such as sanding sealers, for dipping, for roller spreading, for lacquer enamels in various colors to be used on automobiles and metalwork, and for quite a host of special uses. There is no all-purpose lacquer, consequently the user should know his lacquer before applying it.

The same author (19, p. 310) explained the current shift to the use of lacquer in finishing as follows:

The rapid-drying qualities of lacquer have greatly increased the speed of manufacture and reduced the cost of many surface finishes. Lacquer has entered into many new fields and has displaced varnishes to some extent. Varnishes are, however, still in demand for high-grade, rubbed and polished finishes, and for brush work. As a material for production of metalwork and for soft spray-gun finishing lacquer is now almost supreme.
A short summary of the various lacquers now available in their line of products was given by a well-known company (24, p.6) in the following statement:

(Our) Technical Department has produced an outstanding line of furniture-finishing varnishes and lacquers which will meet the requirements of all furniture manufacturers. The quality of furniture being manufactured, the production methods used, cost factors and other considerations determine the proper finishing coats to be selected. Lacquer finishes are applied by spray, almost without exception. (Our) Finishing Lacquers are supplied in various shades, the most important of which are Gloss, Medium Rubbed Effect and Dull, or practically flat finish. The Bright Medium and Dull Rubbed Effect finishes are known as 'flats' and are used to simulate a hand-rubbed surface. For best build and depth of finish, two or more finishing coats are desirable.

One method of putting the final coat on industrial arts projects is that of French Polishing. This process is, however, very difficult and is not recommended for use in school shops. Jeffrey (16, p.83) warned:

French Polishing is the most difficult of all wood-finishing. At every move the amateur is apt to make a mistake which will irretrievably spoil his polish.

Pattou and Vaughn (22, p.218) discussed French polishing:

In olden times, and even now in Europe, French polishing is used for producing high-polished finishes.
Today this method is too slow and prohibitive on account of the high cost of labor. Of course many pieces are polished by trenching the surface with some of the many products for this purpose, but this is done only in a small way, and the methods used by furniture, and especially piano, factories for polishing are by a process of rubbing with rotten stone mixed with oil or water.

Griffith (14, p.191) described wax finish as a final coat as follows:

An old finish that has recently become popular is that of waxing. It takes the place of the varnish, by which it was supplanted years ago. Wax finish is easily applied and is cheaper than varnish. It will not stand wetting. However, it is easily repaired.

Wax requires a smooth surface and a very thin application for successful results. Too much wax upon a rough surface will produce very ugly, white chalklike spottings as the wax dries. These are especially noticeable upon dark finishes.

Broadbent (3, p.119) added:

Wax polish, while easily damaged, is just as easily renewed and imparts a beautiful satin luster to wood that is difficult to achieve any other way. Wax seems particularly well adapted to such woods as oak, mahogany, and walnut, and aids materially in attaining an antique finish.

The final finish discussed here is the oil finish.

Davey (4, p.106) explained about this finish:

The process of oil polishing is extremely laborious, and takes a great deal of time if really first-class results are required. It is,
nevertheless, a very refined finish and well repays the labor expended in working up the surface. The most suitable woods for treatment by this process are the hard brown woods, oak, mahogany, and walnut being examples to which this class of finish is usually confined. Generally speaking, the process is much easier than French polishing, and results can be very pleasing indeed, provided one has sufficient patience and energy for the work, which is necessarily prolonged.

Broadbent (3, p.119) wrote:

An oil finish, unlike varnish, increases in charm with age. It has a beautiful darkening effect on dark hardwoods and, while slow, is heartily recommended for the student craftsman. It has no rival in bringing out the beauty of walnut.

Jeffrey (16, pp.78-79) added:

At present no furniture company could afford to spend time in using this polish on a large scale. It is long and tedious, and people in general are little able to appreciate its value. Perhaps at some later date there may be sufficient demand for it to make the operation pay for itself, but at present only special jobs are finished in this way. For the student, or the person who makes this art his hobby, oil-polishing has a different aspect. He need not hurry in his work because he is under no necessity to turn his product into money. For the one, then, who wishes to make something beautiful and is willing to spend the time it will take him to do it, I append this chapter.

The process of rubbing and polishing the finished project was discussed by Deniston (5, p.209):

In general practice, it has been the custom to use the words 'rubbed' and
and 'polishing' together to denote
those operations required to pro-
duce surface luster. Actually they
do not mean the same thing.

They cannot, and should not be used
interchangeably, as one -- polishing --
really represents a refinement of the
other -- rubbing -- and when it comes
to imparting luster to an organic-
coated wood surface. The degree of
sheen desired will determine whether
the surface is to be merely rubbed,
or to be rubbed and polished. Polished
finishes are always rubbed, but
rubbed finishes are not always
polished.

A list of materials frequently used in the process of
rubbing is (24, p. 7):

After the final coats of finishing
lacquer have thoroughly dried, they
are often rubbed. A rubbing opera-
tion consists of a good sanding with
360 or 320 wet or dry sandpaper, lubri-
cated with a thinner such as Exolvent
and light paraffin oil mixed half and
half. Following this operation, a
mixture of pumice or rotten stone and
paraffin oil is often used with a
felt block to rub the surface to a
smooth, rich luster.

In order to obtain a higher, uniform
luster, rubbing compound is required.
This is accomplished by first sanding
the finish coat with 320 paper and a
petroleum lubricant, then rubbing
with compound to remove the scratches
resulting from the sandpaper.

A precaution to be observed in the process of rubbing
given by Pattou and Vaughn (22, p. 216):

Care should be exercised in the amount
of rubbing to a given surface, and if
you want to be sure you are not rubbing
too much, count the strokes you make.
on one part of your surface, and when
an inspection proves you have a good
finish, then use the same amount of
rubbing on the rest of the surface
with the same pressure on the rubbing
pad.

Soderberg (25, p. 216) listed the usual materials
needed for hand-polishing as:

Rubber or felt sanding block, 280
and 360 wet dry silicon carbide
finishing abrasive paper, rubbing
oil, rubber squeegee, and furniture
polish.

Machine-rubbing was discussed by Graham (8, pp. 30-32)
in the following manner:

Rubber machines are usually powered
by compressed air or electricity and
are available in both stationary and
portable models. The type of machine
to use is usually determined by the
shop conditions and the size of units.
Rubbing machines are generally divid­
ed into two types: the long-stroke
machines for large flat surfaces,
and the short-stroke machines for
small flat or curved surfaces.

Much of the success in rubbing with
either the long-stroke or short­
stroke machine lies in the condition
and selection of the rubbing pads.
The pads should always be soft, pliable
and free from all dirt, grit or other
abrasive particles which might scratch
the rubbed surface. New pads should
be well soaked in the rubbing lubri­
cant before the abrasive compound is
applied.

Two problems often encountered in the finishing room
are patching and the removal of glue stains. Deniston
(5, p. 38) wrote about glue stains:
Glue stains may be removed with a special two-coat bleach. The first solution, made up of one ounce of oxalic acid crystals to twelve ounces of hot water, is applied to the work with either a black bristle brush or fibre scrubbing brush or sponge. When the surface is nearly dry, yet shows a trace of visible dampness, it is coated with a hyposulphite of sodium solution, one ounce of material to twelve ounces of hot water. It is applied in the same manner as the first solution, and allowed to dry thoroughly.

Additional material about glue stains is (24, p.9):

It has been found that a caustic solution and hydrogen peroxide will not remove all the color of alkaline casein glue from mahogany. A coat of a solution made up of 8 ounces of oxalic acid in a gallon of water, followed by a coat of a solution made up of 6 ounces of sodium bisulphite in a gallon of water may remove the color from the glue. The wood is then bleached with the caustic solution and the hydrogen peroxide solution mixed just prior to the application. The caustic solution is made up of one pound of caustic to one gallon of water. It is necessary to mix these two solutions, as application of the caustic alone will again bring out the dark red stain of the glue.

Patching was discussed by Graham (10, p.25) in the following manner:

In the burning-in or patching operation, the surface to be treated is first sanded and cleaned thoroughly. The defect is opened up to insure a good adherence of the patch and the stick shellac or lacquer is dissolved by the application of a heated knife point to the stick and dropped into the hole or crack. It is very
Important that the burned-in patch be pressed down to prevent air pockets which might lift the patch.

It is better to build up a large patch by several applications than to try to fill it all at one time.

A short summary of the preceding review of literature showed that finishing is a very important step in the woodworking program, and that this last step should not be neglected.

Various problems connected with good finishing were discussed. Among these problems were: dust control in the general shop and in the finishing room; the necessity for adequate light, heat, ventilation, and exhaust systems in the finishing room; the problems connected with care of the finishing equipment, such as brushes, spray-guns and materials.

Quick-drying materials were preferred for use in school shops, and the best method of application of these materials was by spray. Where the slower drying materials were used for the finishing coats, a dust-free room for drying was considered imperative.
CHAPTER III

THE ORIGINAL STUDY

The purpose of this study was the finding of the number and kind of facilities available and the techniques used in the finishing of industrial arts woodworking projects in junior high schools and in high schools throughout Oregon. The data received from both the junior high schools and the high schools were treated in the same manner, inasmuch as the processes used in the finishing of industrial arts projects at the two levels are approximately the same.

In order to obtain the information required for this survey, an appropriate questionnaire was prepared, tried out on experienced industrial arts instructors, revised in the light of these trials, and then mailed to one hundred industrial arts teachers in various schools in Oregon where an industrial arts woodworking department was maintained. Of these one hundred questionnaires, seventy-nine were returned completed. The high percentage of replies is an indication of the amount of interest in the problems of this study. A copy of this questionnaire may be found in the appendix.

The questionnaire was designed to obtain pertinent information about the various factors in the wood finishing programs in use at the present time in these typical shops of Oregon's public secondary schools.
The factors which were considered by this writer to have a definite bearing on the problems under study were: the number of classes taught each day in the shop; the number of pupils in these classes; and the general physical set-up of the shop, including dust control, cleanliness, light, heat and ventilation. Other factors included the set-up of the finishing room, if there was one; its equipment; the methods and materials used in finishing; and the drying facilities. A request was also made for free comments from the instructors concerning the difficulties encountered in their programs. The information gathered for each item in the questionnaire is discussed in the second half of this chapter.

The number of pupils in each class, and the number of classes taught each day would appear to determine, more or less, the amount of activity going on in the shop. If the finishing facilities were inadequate, the number of classes and of pupils involved would have a definite bearing on the quality of the finishing processes used. In order to get at this, and other points of value to the study, the questions used will be repeated and discussed one at a time.

Item I. In the left-hand column, check the periods in which woodworking is taught. Check the number of pupils
in those periods in the right-hand column.

**TABLE I**

**PERIODS AND PUPILS TAUGHT EACH DAY IN THESE SCHOOLS**

<table>
<thead>
<tr>
<th>Number of periods each day</th>
<th>Average number periods per school</th>
</tr>
</thead>
<tbody>
<tr>
<td>354</td>
<td>4.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total number pupils taught each day</th>
<th>Average number pupils taught each period</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,208</td>
<td>20.5</td>
</tr>
</tbody>
</table>

**TABLE I** shows that woodworking is taught for an average of four and one-half periods each day in each of these schools, with an average of over twenty pupils per class. This shows that, in the junior high and high schools of Oregon covered by this survey, there is a well-established industrial arts program which includes a large number of pupils.

Since the wood dust created by the woodworking machines presents one of the larger problems in the wood-finishing room, it was considered advisable to learn whether any provision had been made for the more or less constant and automatic removal of this dust from the school shop. The ideal solution for dust disposal from the woodworking machines is the installation of a blower system.

**Item II.** Is your shop equipped with a blower system for the removal of sawdust and shavings?
TABLE II  
SCHOOLS HAVING BLOWER SYSTEMS  
IN THEIR SHOPS

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>No</td>
<td>77</td>
<td>97.5</td>
</tr>
</tbody>
</table>

The responses show that only two of these woodworking shops out of the seventy-nine replying, were equipped with blower systems for the removal of sawdust and shavings.

The purpose of Item III in the questionnaire was that of finding out the type of heating provided for the shop. Since some types of heating systems circulate the air more freely than others, it was reasonable to suppose that, at the same time, they would circulate the dust more freely also.

**Item III.** What type of heating system is provided for the shop?

TABLE III  
TYPES OF HEATING IN THESE SHOPS

<table>
<thead>
<tr>
<th>Responses -- 79</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam</td>
<td>45</td>
<td>56.9</td>
</tr>
<tr>
<td>Forced air</td>
<td>18</td>
<td>22.8</td>
</tr>
<tr>
<td>Oil</td>
<td>5</td>
<td>6.4</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>13.9</td>
</tr>
</tbody>
</table>

Steam heat was apparently by far the most prevalent type of heating used in the woodworking shops covered by the survey. Any form of heating system will circulate the air to a certain extent. Aside from the dust problem, the temperature of the shop is important to the proper drying of various finishing materials, if these processes are carried...
on in the shop proper.

The type of ventilation also plays an important part in the problem of shop cleanliness, and was considered in the same light as heating. Proper ventilation is most important to the successful application and subsequent handling of finishing materials, if the work of finishing is done in the shop proper rather than in a special finishing room.

Item IV. Check the type of ventilation.

**TABLE IV**

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows</td>
<td>68</td>
<td>86.2</td>
</tr>
<tr>
<td>Air conditioning</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Under the classification "Other", there were two respondents who wrote, "doors only, no windows". Air conditioning, as the table indicates, was used in a very small number of shops.

Another factor to be considered in the controlling of the dust problem in the school shop is the cleaning of the floors. The next item was designed to learn at what time the shop floors were cleaned.

Item V. Are the floors cleaned after each period, at the end of the day, or at some other time?

**TIMES OF CLEANING FLOORS IN SHOPS**

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of period</td>
<td>47</td>
<td>59.5</td>
</tr>
<tr>
<td>End of day</td>
<td>27</td>
<td>34.2</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>6.3</td>
</tr>
</tbody>
</table>
The figures indicated that the majority of the shop floors were swept at the end of each period. In the breakdown under "Other" were found such items as: "once each week", "twice each week", and "three times weekly".

In the literature on woodworking it has been rather definitely established that a finishing room for wood projects and its facilities are distinctly important to the accomplishment of good finishing processes. The writer considered it desirable to find the number of shops that had finishing rooms, the type of equipment with which these finishing rooms were equipped, and the method in which the projects were handled in these rooms.

**Item VI.** If you have a finishing room, is it equipped with adequate exhaust system, adequate light, adequate heat, adequate spray equipment?

**TABLE VI**

<table>
<thead>
<tr>
<th>FINISHING ROOMS IN THESE SCHOOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses -- 66</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Exhaust system</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Adequate light</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Adequate heat</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Adequate spray</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>
A total of forty-four (55.6%) of the shops had no spray equipment at all, even though thirty-one of them did have finishing rooms.

Most of the finishing materials used in a school woodworking shop are light materials, such as lacquers, varnishes and shellacs. The external-mix spray gun is better adapted to the spreading of materials of this sort, while the internal-mix gun is more suited to heavier materials such as leaded paints. In including Item VII in the questionnaire, the writer hoped to determine which of the two types of spray guns was used to the larger extent in these school shops.

Item VII. Is your spray "internal-mix" or "external-mix"?

<table>
<thead>
<tr>
<th>TABLE VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPES OF SPRAY GUNS USED IN THESE SHOPS</td>
</tr>
</tbody>
</table>

| Responses || Cases | Per cent |
|-----------|-------|----------|
| Internal-mix | 25     | 31.6     |
| External-mix | 18     | 22.8     |
| No spray gun| 36     | 45.6     |

The table above indicates that slightly more than half of the finishing rooms in the school shops covered by this survey are equipped with spray guns of the less desirable type.

The non-bleeder type gun is better adapted to use in the school workshop than is the bleeder type gun because, again, it has been proven to be better suited to the handling
of light materials, such as lacquers, varnishes and shellacs.

**Item VIII.** Is your spray gun "bleeder" type or "non-bleeder" type?

**TABLE VIII**

TYPES OF SPRAY GUNS
IN THESE SCHOOLS

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeder</td>
<td>34</td>
<td>30.4</td>
</tr>
<tr>
<td>Non-bleeder</td>
<td>19</td>
<td>24.0</td>
</tr>
<tr>
<td>No spray gun</td>
<td>36</td>
<td>45.6</td>
</tr>
</tbody>
</table>

This table showed that slightly more than half of those shops which were equipped with spray guns used the less desirable type of gun.

The writer considered it desirable to discover what percentage of industrial arts teachers instructed the pupils in the use of the spray gun in finishing their own projects.

**Item IX.** Do the pupils use the spray equipment in finishing their own projects?

**TABLE IX**

PUPILS USING SPRAY EQUIPMENT

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>36</td>
<td>45.6</td>
</tr>
<tr>
<td>No</td>
<td>7</td>
<td>8.8</td>
</tr>
<tr>
<td>No spray gun</td>
<td>36</td>
<td>45.6</td>
</tr>
</tbody>
</table>

The majority, almost four-fifths, of these instructors who have spray equipment available in their industrial arts shops allow the pupils to use the spray equipment in finishing their own projects.

It is believed that a special and planned place for the application of the finish coats is essential to a good
finish job, because of the desirability of dust-free and secluded drying. It was desired, therefore, to obtain an idea of the various places used by industrial arts instructors and pupils for the finishing of their projects.

**Item X.** Are the finishing materials applied: at the pupils' work benches; in a part of the shop used for finishing but not separated from the main area; in a separate, enclosed finishing room; or in other areas (specify).

**ITEM X**

**PLACES WHERE FINISHING MATERIALS APPLIED**

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the work benches</td>
<td>11</td>
<td>13.9</td>
</tr>
<tr>
<td>In part of the shop</td>
<td>11</td>
<td>13.9</td>
</tr>
<tr>
<td>In finishing room</td>
<td>54</td>
<td>68.4</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Those shops which were supplied with finishing rooms (83.5), undoubtedly made use of them for applying finish coats. Those shops which had no finishing rooms (16.5) made use of whatever facilities were available. Apparently, a considerable number left the projects on the work benches for the application of the final coat. Under "Other" these specifications were found: "Separate multiple-use room", "ante-room leading outside", and "wood storage room in separate building".

When the writer included Item XI in the questionnaire, his idea was to learn at what time the finish was applied to the projects -- whether during a comparatively
quiet time, or when there was a good deal of activity going on in the shop. Obviously any finishing coats applied during the regular class period, unless placed in a special drying room, would be exposed to handling at the beginning of the next class, and also to the usual dust accumulation in the air.

**Item XI.** When are "finishes" applied to the project; during regular class period; during a special time set aside for finishing; or at the end of the term which is reserved exclusively for finishing?

**TABLE XI**

**WHEN FINISHES WERE APPLIED IN SCHOOL SHOPS**

<table>
<thead>
<tr>
<th>Responses -- 79</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular class period</td>
<td>75</td>
<td>95.0</td>
</tr>
<tr>
<td>Special time</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>End of term</td>
<td>2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

As TABLE XI indicates, an overwhelming majority of the industrial arts instructors used the regular class period for the finishing of projects. This led the writer to believe that the convenience to the instructor of using the regular class period for finishing, outweighed the possibility of getting a better finish by waiting.

The most common of the various stains used in the preparation of woodworking projects are: oil stain, spirit stain, water stain, wiping stain, shading stain, and filler used as a stain. The equipment with which the various industrial arts shops covered by this survey were supplied had a direct bearing upon the type of stains used on the projects.
Item XII. Check the stains which you use in your finishing schedule.

TABLE XII

STAINS USED BY THESE SCHOOL SHOPS

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil stain</td>
<td>74</td>
<td>93.7</td>
</tr>
<tr>
<td>Spirit stain</td>
<td>11</td>
<td>14.7</td>
</tr>
<tr>
<td>Water stain</td>
<td>18</td>
<td>22.8</td>
</tr>
<tr>
<td>Wiping stain</td>
<td>15</td>
<td>19.4</td>
</tr>
<tr>
<td>Shading stain</td>
<td>11</td>
<td>13.9</td>
</tr>
<tr>
<td>Filler as a stain</td>
<td>48</td>
<td>60.7</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

NOTE: As many respondents indicated that they used more than one of these stains in their finishing schedules, the percentages were figured separately, rather than in relation to one another.

By far the greatest number of teachers showed the use of oil stains. The large percentage of the respondents who use filler as a stain indicates that this material is readily handled, even in a poorly-equipped shop.

The three most common ways of applying stains to woodworking projects in a school shop are by brushing, by spraying, and by wiping.

The information in TABLE XIII was treated in the same manner as that in TABLE XII in that many of these industrial arts instructors used more than one method and, therefore, the percentages were figured separately.
Item XIII. How are the stains applied?

**TABLE XIII**

METHODS OF APPLYING STAINS

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brushed</td>
<td>60</td>
<td>75.9</td>
</tr>
<tr>
<td>Sprayed</td>
<td>11</td>
<td>13.9</td>
</tr>
<tr>
<td>Wiped</td>
<td>60</td>
<td>75.9</td>
</tr>
</tbody>
</table>

Most of the respondents who indicated that they brushed the stains on the projects also used the process of wiping. The instructors who sprayed the stain confined themselves to that process alone.

Since sealer coats on wood projects are designed to be followed by specific finishing coats, it was considered desirable to learn what sealers were used. Sealing is done to tie down the stain and the filler, and to prevent the absorption of moisture by the wood. The sealer coat sands well and, consequently, it affords a smooth surface for the final coats.

Item XIV. Check the type of sealer used: shellac, lacquer, varnish.

**TABLE XIV**

TYPES OF SEALER USED

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shellac</td>
<td>39</td>
<td>49.4</td>
</tr>
<tr>
<td>Varnish</td>
<td>29</td>
<td>36.7</td>
</tr>
<tr>
<td>Lacquer</td>
<td>50</td>
<td>63.3</td>
</tr>
</tbody>
</table>

Lacquer was found to be considerably more in favor for the sealer coat than either shellac or oil varnish.
The method of applying the sealer coat to the stained projects was considered next.

**Item XV.** How is the sealer coat applied?

<table>
<thead>
<tr>
<th>TABLE XV</th>
</tr>
</thead>
<tbody>
<tr>
<td>METHODS OF APPLYING SEALER COAT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brushed</td>
<td>57</td>
<td>72.1</td>
</tr>
<tr>
<td>Sprayed</td>
<td>36</td>
<td>46.2</td>
</tr>
<tr>
<td>Wiped</td>
<td>12</td>
<td>15.3</td>
</tr>
</tbody>
</table>

Many high school woodworking shops which are not equipped with spray guns use both brushing and wiping procedures. For that reason, the numbers and percentages add up to more than the number of basic responses and returned questionnaires. Some sealers, however, because they dry so quickly are difficult to apply by brushing or by wiping. TABLE XIV showed that the large percentage of sealers used were in this class, which indicates a possibility for trouble with these sealers when used by brushing or by wiping.

When compiling the items for the questionnaire, it was considered advisable to differentiate between the final coats used on hardwoods and those used on softwoods in the construction of woodworking projects. To this end, Items XVI and XVII were treated separately.

**Item XVI.** Check the type of "final coat" used on hardwoods: oil varnish, lacquer, shellac, lacquer-base enamel, oil-base enamel, or other.
TABLE XVI
TYPES OF FINAL COATS
USED ON HARDWOODS

<table>
<thead>
<tr>
<th>Responses -- 78</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil varnish</td>
<td>42</td>
<td>53.9</td>
</tr>
<tr>
<td>Lacquer</td>
<td>55</td>
<td>69.6</td>
</tr>
<tr>
<td>Shellac</td>
<td>15</td>
<td>19.1</td>
</tr>
<tr>
<td>Lacquer-base enamel</td>
<td>3</td>
<td>3.8</td>
</tr>
<tr>
<td>Oil-base enamel</td>
<td>10</td>
<td>12.8</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>15.9</td>
</tr>
</tbody>
</table>

The results of this table show that lacquer far exceeds other "final coats" in use with hardwoods. A further study of these returns showed that, in eighteen of the woodworking shops that are not equipped with spray apparatus, lacquer, applied by brush is used.

The twelve final coats included under "Other" can be broken down into: two using wax; two using a plastic finish (not designated); one using either German or English oil for an oil finish; two using special lacquers (not designated); and one using a "commercial floor seal". One respondent used no final coat whatever.

**Item XVII.** Check the type of "final coat" used on softwoods: oil varnish, lacquer, shellac, lacquer-base enamel, oil-base enamel or other.

TABLE XVII
TYPES OF FINAL COATS
USED ON SOFTWOODS

<table>
<thead>
<tr>
<th>Responses -- 77</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil varnish</td>
<td>40</td>
<td>51.9</td>
</tr>
<tr>
<td>Lacquer</td>
<td>45</td>
<td>59.6</td>
</tr>
<tr>
<td>Shellac</td>
<td>25</td>
<td>32.6</td>
</tr>
</tbody>
</table>
TABLE XVII
(continued)

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacquer-base enamel</td>
<td>8</td>
<td>10.4</td>
</tr>
<tr>
<td>Oil-base enamel</td>
<td>30</td>
<td>38.3</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>5.2</td>
</tr>
</tbody>
</table>

One respondent indicated that no final coat was used on softwoods in his shop, and one wrote that "softwoods are not used in the shop".

The miscellaneous grouping titled "Other" in this table can be broken into: one using Fleeto; one using Seal-a-Cell; one using wax-rubbed oil, and one using "two coats of Resz and one or two coats of varnish".

In order to make a comparison and to formulate opinions on the methods used in these industrial arts shops, it was considered necessary to learn the manner in which these "final coats" were applied.

**Item XVIII.** How is the "final coat" applied to the project? Brushed, sprayed, or wiped?

TABLE XVIII

<table>
<thead>
<tr>
<th>METHODS OF APPLYING FINAL COAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Brushed</td>
</tr>
<tr>
<td>Sprayed</td>
</tr>
<tr>
<td>Wiped</td>
</tr>
</tbody>
</table>

As in Item XV, it was again found that some of the instructors who do not have spray equipment available, used both the methods of brushing and wiping to apply the final coat.
One of the most important steps in good finishing is the drying of the completed project. Learning the places in which the projects were left to dry was considered as one of the primary objectives of the survey, because knowledge of the places used for this drying process gave the writer a better understanding of the difficulties encountered by these instructors in the finishing processes.

**Item XIX.** Where is the project left to dry? Pupils' work bench; finishing room; special drying room; some other place (specify).

**TABLE XIX**

<table>
<thead>
<tr>
<th>Places Where Projects Were Left to Dry</th>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work bench</td>
<td>8</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td>Finishing room</td>
<td>55</td>
<td>69.7</td>
<td></td>
</tr>
<tr>
<td>Special drying room</td>
<td>6</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Other place</td>
<td>10</td>
<td>12.6</td>
<td></td>
</tr>
</tbody>
</table>

The results of this tabulation show that the finishing room, where one is available, is by far the most popular place in which to dry the projects. The low number of drying rooms apparently available could be misleading for, included in the category "Other", are such responses as: "special semi-closed racks", "mechanical drawing room", "room used for project storage only", "class locker", "top of storage cabinet", and "lumber room". Any of these places if dust-free, would serve the purpose as well as a drying room -- provided that ample heat and ventilation were
supplied. Of the respondents who use the work benches for the drying of the finished project, six have no finishing room and one uses an ante-room leading to the outside, while the last uses the "finishing area - no door to enclose it".

Rubbing and polishing are used extensively to smooth the surface of finish coats on woodworking projects in order to give the projects the best possible appearance.

**Item XX.** Do you rub and polish the final coat?

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>71</td>
<td>89.9</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>10.1</td>
</tr>
</tbody>
</table>

One respondent stated that he used wax rather than any of the more common rubbing and polishing materials. In another case where no rubbing and polishing was done, lacquer was wiped on as a final coat.

No sharp differentiation was set between the terms "rubbing" and "polishing" in the survey. Several materials are used for the processes of rubbing and polishing, as listed in TABLE XXI. In order to learn which of these materials was most commonly used, the writer included Item XXI.

**Item XXI.** Check the materials used for rubbing and polishing: finishing paper, steel wool, rubbing compound, pumice, rotten stone, or other (specify).
TABLE XXI
MATERIALS USED FOR RUBBING AND POLISHING

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finishing paper</td>
<td>42</td>
<td>54.6</td>
</tr>
<tr>
<td>Steel wool</td>
<td>51</td>
<td>66.2</td>
</tr>
<tr>
<td>Rubbing compound</td>
<td>26</td>
<td>33.7</td>
</tr>
<tr>
<td>Pumice</td>
<td>57</td>
<td>74.0</td>
</tr>
<tr>
<td>Rotten stone</td>
<td>43</td>
<td>58.4</td>
</tr>
<tr>
<td>No finishing material</td>
<td>2</td>
<td>2.6</td>
</tr>
</tbody>
</table>

The two cases in which no finishing materials were used were shops in which no final coats were applied.

The next item in the questionnaire was included for the purpose of learning whether, in the estimations of the instructors, the budgets for the school shops were or were not adequate for the desirable finishing of woodworking projects.

Item XXII. Do you find your budget adequate for the purchase of finishing materials and equipment?

TABLE XXII
BUDGETS CONSIDERED ADEQUATE OR INADEQUATE

<table>
<thead>
<tr>
<th>Responses</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>56</td>
<td>70.9</td>
</tr>
<tr>
<td>No</td>
<td>23</td>
<td>29.1</td>
</tr>
</tbody>
</table>

If the budget was inadequate and did not provide for the proper finishing facilities and materials, unfavorable results in the finishing of projects would be likely.

In order to discover whether the budgets which were considered inadequate by the respondents were also found in the shops in which the finishing materials were not paid for
in any way by the pupils, it was considered desirable to learn in what way the cost of these materials was financed.

**Item XXIII.** Do the pupils pay for the finishing materials used on the projects?

**TABLE XXIII**

<table>
<thead>
<tr>
<th>PUPILS PAYING FOR FINISHING MATERIALS ON PROJECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses -- 79</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

**Item XXII,** (Do you find your budget adequate?) showed that the instructors in twenty-three of the seventy-nine woodworking shops considered their budgets to be inadequate. A further study of the replies of these instructors showed that pupils did pay for the finishing materials used on their own projects in eighteen of these shops, and did not pay for their own finishing materials in five of these cases in which insufficient budgets occurred.

**Item XXIV** was included in the questionnaire for the purpose of getting the opinions of the various industrial arts instructors as to the adequacy of their finishing facilities.

**TABLE XXIV**

<table>
<thead>
<tr>
<th>INSTRUCTORS' OPINIONS ON ADEQUACY OF FINISHING FACILITIES</th>
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<tr>
<td>Responses -- 79</td>
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<td>Yes</td>
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<td>No</td>
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Almost two-thirds of the instructors who are at present teaching industrial arts in the woodworking shops throughout Oregon, according to the results of the questionnaire, believe that their finishing facilities are inadequate.

**Item XXV.** Do you find that finishing is a particularly difficult step for pupils?

**TABLE XXV**

<table>
<thead>
<tr>
<th>INSTRUCTORS FINDING FINISHING DIFFICULT STEP FOR PUPILS</th>
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<td>Responses -- 79</td>
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<td>Yes</td>
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The answers to this item indicate that the proper finishing of industrial arts wood projects is a difficult step to teach in the completion of school projects in the larger percentage of the schools covered by this survey.

Because the writer has heard so many statements about the difficulties encountered in the finishing processes in high school woodworking shops, he believed that the opinions of instructors concerning this difficulty would be valuable in this study. Some of the inadequacies of the facilities in these shops are discussed more fully under Item XXVI, in which the instructors recorded their own comments.

The final item was included in the questionnaire in order to obtain the instructors' opinions of ways in which the teaching of wood finishing programs could be improved. Sufficient space was provided on the questionnaire for their comments.
Item XXVI. Indicate how your program of finishing industrial arts projects might be improved.

Out of the seventy-nine questionnaires returned, ten did not include comments, eight had comments which were inapplicable to the problem, and sixty-one contained definite suggestions for the improvement of the finishing program. A sampling of these comments may be found in the appendix.

DISCUSSION OF DATA FROM THE QUESTIONNAIRE

The following discussion of the items included in the questionnaire is meant to present an over-all picture of what is being done now in the school shops throughout Oregon, and to delineate the strong points, the more desirable methods, and the weaknesses of the finishing methods used. It is hoped that this information can be used to help overcome the difficulties experienced in the teaching of finishing techniques.

The number of pupils in each class and the number of classes taught each day determined the amount of activity going on in the woodworking shop. TABLE I shows than an average of 4.5 classes, with an average of 20.5 pupils in each class are taught each day. These figures show that woodworking is established as a popular course, drawing many pupils, and as such deserves the best in facilities and in the teaching of finishing techniques. Without a suitable final finish the resulting effect of the project is nearly
a total loss to the pupil as well as to the home and the public relations of the school. Finishing should therefore be a major part of any woodworking shop.

Item II. It was found that only two of the seventy-nine instructors in those woodworking shops covered by the survey had shops which were equipped with blower systems for the removal of sawdust and shavings from the shop. Since dust is the enemy of good finishing, it is logical to assume that in those shops not so equipped there would be a dust problem. Of course, since the installation of a blower system is rather expensive for the average school, the writer does not intend to belittle in any way those shops which do not have blower systems, but it is hoped that the findings of this study may be carefully considered in the construction of new shops and in the improvement of shops already set up. Expense is as much a matter of value received as it is of first cost.

Fourteen of these instructors requested information about suitable blower systems, and indicated the need for dust control in their general shops. These fourteen shops which were in need of blower systems, correspond to the 18.2% of the questionnaires in which it was stated that dust control was their biggest single problem. It can be assumed, therefore, that in the shops which were not equipped with blower systems, unless the finishing processes are carried on in a separate and enclosed finishing room, the
dust from the woodworking machines does create a definite problem. The instructors of both the woodworking shops which were equipped with blower systems stated that in their shops the finishing of projects was no problem as far as dust was concerned. The blower systems could well be a contributing factor in these answers.

Item III. Heating in the general shop was found to be quite adequately supplied. A large percentage of the shops (56.9%) were heated by steam. Unless the heat from the steam coils or radiators was distributed by a fan, there would seem to be little disturbance in the air, and consequently little stirring of the ever-present dust. The heating problems in the general shop and in the finishing room have been treated separately in this study. The reason: temperatures in the finishing or drying rooms should, for the proper drying of projects, be maintained at between seventy and eighty degrees Fahrenheit, while the temperature in the general shop should be about ten degrees lower.

Item IV. If the finishing of the projects is done in the main shop rather than in a separate, enclosed finishing room, ventilation in the shop presents another problem in dust control. Two teachers stated that there were no facilities whatever for ventilation in their shops. Another of the teachers whose shops were equipped with ventilation systems mentioned the need of modernization in the system. Many of the other teachers whose shops had no other means of
ventilation other than windows felt the need of more adequate ventilation equipment to control dust and fumes, and to safeguard the health of the pupils.

Item V. In studying the answers to Item V, it was discovered that each of the fourteen respondents who said they swept the floors at the end of each period also stated that they considered dust to be one of the major problems. Debris from the machines in those shops which were not equipped with blower systems undoubtedly presented a serious dust-control situation. Sweeping the floors at the end of each period would undoubtedly add to the amount of dust circulating through the air. Even if the floors were not swept until the end of the day, or at some other time, the activity of stirring the accumulated litter on the shop floor would raise dust into the air. From Items II to V inclusive the information obtained would indicate that, regardless of the physical facilities of the shop, a considerable amount of dust would be present in the air at all times. This dust has an adverse effect on any finishing processes which may be carried on in the shop proper.

Item VI. From the problems connected with the general shop, the writer narrowed the field to those problems which had to do specifically with the finishing room and its equipment. The question for Item VI was designed to give the writer a reasonably accurate idea of the equipment available in the finishing rooms of Oregon high school
woodworking shops. In any enclosure where spraying is done, an exhaust system is really necessary to remove the surplus spray from the room air. This is not only for the purpose of preventing the spray material from settling back on the freshly sprayed articles, but also is it necessary from the standpoints of fire-prevention and health. The thirteen answers which indicated there were no finishing rooms available were segregated as follows: Nine that stated definitely that finishing of the projects was difficult and that their facilities were inadequate. Three indicated that, while their facilities were inadequate, they did not experience overmuch difficulty in finishing the projects. One stated that the projects were not finished in the school shop, but that a local auto finisher sprayed the projects. This latter plan may be good from the standpoint of getting the work done, but it is not good for the pupils' morale. The pupil likes to feel that he has "done it all!" In his comments, the instructor said new spray equipment was to be purchased shortly, so perhaps that unusual situation will not be in effect long.

Adequate light is also a necessity for good finishing. Of the thirty-five shops with finishing rooms which had spray equipment, ten were stated as not having adequate lighting. Of the instructors in these ten shops, five stated that finishing was a difficult procedure for the pupils. The other five wrote nothing on this point.
Proper heating in the finishing room is another item of great importance to good finishing. Lacquers dry quickly and readily at comfortable room temperatures, but oil varnishes require higher temperatures for good drying. Study of the answers from thirty-five shops using spray equipment showed seven without adequate heat. Perhaps this accounts for the fact that four of the seven found good finishing difficult.

Item VII. In discussing the types of spray guns used, it was considered necessary to refer to the types of finish coats applied by use of the different types of guns. It has been conceded generally that the external-mix type of gun is best for the handling of lighter materials such as lacquers, varnishes and shellacs. Those thirty-five shops which use spray equipment can be divided into: twelve using both oil varnish and lacquer for spraying; five which use lacquer and shellac for spraying; eight using lacquer-base enamels, and thirteen using oil-base enamels. Those shops using external-mix guns for the handling of the heavier finishing materials such as leaded paints were only three in number. Of these, two teachers stated they had difficulty in finishing their projects well.

The same analysis is applicable to Item VIII, concerning the use of "bleeder" and "non-bleeder" type guns. For a school shop, a non-bleeder type of spray gun is most desirable. This type of gun can be used only when compressed
air is supplied from an adequate tank and compressor combination, with pressure control.

Item IX. In order to hold the interest of the pupil who is carrying his industrial arts project through the various steps of construction to the completion of the final finish, it is necessary for the pupil to take an active part in each of the successive steps. If the pupil has cut his stock for the project, has planed, sanded, glued and otherwise prepared the work for the finishing coats, he should be allowed to apply these finishing coats and taught to do a good job of it. In thirty-eight schools out of the forty-seven having spray equipment, as shown in Item IX, the instructors allow the pupils to use the spray equipment. There were, however, qualifying statements to this item, e.g.; "only responsible pupils", "only seniors", and "limited use only". It is believed that the use of all the equipment in the school shop teaches the pupils responsibility. They learn new processes of handling tools and materials, which is one of the prime objectives of industrial arts. There is nothing to be said against the use of the spray equipment by the pupils if properly instructed and supervised.

Item X. Aside from the problem of dust control in the shop proper and, in a lesser degree in the finishing room itself, there was considered the problem of applying the finish coats in a place where the danger of finger marks caused by excessive handling of the projects could be avoided.
Item X was intended to establish whether or not the places in which the finishing materials were applied would have any bearing upon the ease or difficulty experienced by the instructor in protecting the recently finished projects from the handling by other pupils, and from spoilage by excessive dust. The eleven cases in which the finish coats were applied at the pupils' work benches showed six in which the instructors stated that getting good results was difficult. In order to arrive at the possible reasons for these difficulties, it was necessary to refer to Items VI and XVI.

Item VI revealed that six of the eleven cases in which the finishes were applied at the work benches had no finishing rooms available. In one case in which finishing was reported to be difficult, no spraying equipment was available in the shop.

Of the four remaining shops in which finish coats were applied at the benches, there were two in which lacquer was brushed and sprayed, one in which oil varnish was brushed and wiped, and one in which lacquer, shellac, and oil-base enamel were applied by spray. If spraying is done in the shop proper dust from the spraying materials is over everything. Of course, if no finishing room is available, and the work bench is the only place on which finishing can be done, then the best must be made of it. Oil varnish does not wipe well at all. It should be flowed on which a first-class varnish brush. Lacquer is very difficult to brush on.
Its fast-drying qualities prevent over-lapping the brush strokes. The instructor who has no finishing room nor special drying facilities should use those materials which present the least difficulties.

The answers to Item XI show that 95% of the schools carry on the finishing processes during the regular class periods. In schools in which no finishing rooms were available and where the finish was applied during the regular class periods, the dust from the shop presented a major problem. The few who did reserve the finishing of the projects for a special time used exclusively for finishing no doubt obtained better results because the shop could be cleaned previously, and dust-producing factors could then be held to a minimum. All of the instructor's time and supervision could then be given to the finishing process alone. This could also apply to those schools in which the projects are held for finishing until the end of the term. Of course these schools would need adequate storage space. No doubt in some cases the pupils would disapprove of waiting until end of the term because they like to take their projects home as quickly as possible. This could be a reason why so few of the instructors follow the practice of holding up the finishing of projects until the closing days of the term.

Items XII and XIII deal with the types of stains used and the methods of their application. These will be discussed together. Oil stain was found to be the most commonly
used of the various stains available in the usual high school shop. The reason for this is probably because it is easily applied by brush or by wiping, and its application is within the ability of even the slowest pupil. The next stain in line of preference is filler used as a stain. This method of using filler as a stain may account for some of the sixty cases which apply stain by wiping. Filler used as a stain might cut down on the time consumed in finishing projects but it does not give the best results. On nice projects, the stain and the filler should be separated by a wash coat, in order to keep the filler from mixing and dulling the color of the stain. One of the most difficult stains to use is shading stain. It must be sprayed on to obtain satisfactory results. Shading stain was used in eleven cases and was sprayed on in eleven cases.

Items XIV and XV are discussed in conjunction, as they are closely related. It was found that lacquer was used extensively as a sealer, and that brushing on was the most popular method of its application.

Many circumstances determined the selection of the sealer and the way it was applied. If the instructors desired a fast-drying sealer and had spray equipment available, their choice would be lacquer. If spray equipment is available at all, lacquer sealer should be sprayed. If no spray equipment is available, lacquer sealer is still preferable to shellac or varnish sealer because of its quick drying
and easy sanding qualities. Shellac has good sealing characteristics but, because of poor sanding qualities and its tendency to whiten on contact with moisture and heat, it should not be used as a sealer if lacquer sealer can be used. Since lacquer and varnish are not compatible, and if varnish sealer is used, then the finish coat should not be lacquer. Of the thirty-five shops which were equipped with spray apparatus, all used lacquer as a sealer. Sixteen of the thirty-five used shellac also, and eight of the thirty-five used varnish.

In the thirty-five shops in which spray equipment was used, it appears that the proper choice of sealer material was made. In those shops in which the sealer coat was brushed on, twenty-three instructors used shellac, twenty used oil varnish, and fourteen used lacquer. Of the three who applied the sealer coat by the process of wiping alone, one used a commercial product called "Seal-a-Cell", one wiped on oil varnish, and the other wiped on lacquer. Neither of these last two materials is adapted for wiping.

Oil varnish should be brushed on with a varnish brush. Under no circumstances could varnish be applied by wiping in a satisfactory manner. This also applies to wiping on lacquer.

Item XVI. Lacquer is shown to be the material most frequently used for the final coat, both in those shops which have spray equipment and in those which do not. Lacquer
offers some advantages over other types of finishes. One advantage is that it dries quickly and, because of the short drying time, is not susceptible to being marred by the adherence of dust. Also because of the quick-drying qualities of lacquer the project is soon ready for storage between classes or for taking home. The main disadvantage of using lacquer where spray equipment is not available is that it is difficult to brush it on without leaving brush marks.

Oil varnish was the second preference for final coats. This material can be applied either by brush or spray. The big disadvantage in using oil varnish is its slow drying time. It is recommended that varnish not be used except in completely dust-free rooms, with a steady temperature of around eighty degrees Fahrenheit. These conditions are almost impossibilities in a school shop because of the constant coming and going of the pupils, with the consequent danger of damage from dust and finger marks. An advantage of using varnish is that it is heavier in body and consequently fewer coats are required than with lacquer.

Shellac was used in fifteen schools reporting in this study. Shellac is not considered a good finish in any situations in which it could be exposed to moisture and heat as it turns white under these conditions. It is also a brittle finish that scratches easily.

Wax was used in two cases in the finishing of hardwoods. Wax is easy to apply, is dust-free, and forms a beautiful
finish, but it does not form a hard surface. Among some of
the "Others" mentioned, one instructor used French Polish.
Although this produces a very lovely finish if properly done,
it is one of the most difficult of all finishes to apply.
French Polish is completely beyond the capabilities of the
ordinary high school pupil with the time allotted to the
shop classes. Since it required years for the old finishing
masters to learn the art of French Polishing, it should not
be included in a shop program except as a related subject.

Item XVII. Softwoods are not usually classified as
choice cabinet woods because their frequently undesirable
grain patterns do not show to advantage through transparent
finishes. They are usually finished with opaque materials,
such as lacquer-base and oil-base enamels, to conceal the
grain patterns.

Item XVIII. The shops in which the method of brush-
ing was used on the final coat were found to use more varnish
than lacquer, but only by thirty-three to thirty; while
those shops which sprayed on the final coat used more lacquer
than varnish by thirty-seven to thirteen. Shellac was brushed
on in twenty-four cases, sprayed on in twelve, and wiped
in three. Lacquer-base enamels were brushed on in seven-
teen cases and sprayed on in eight, while in only one case was
the wiping of this final coat recorded. Probably because
the projects were made from softwoods, the finishing of the
whole project was not considered so important, therefore the
instructor would permit the brushing of lacquer. Many of these projects may have been made for outside use, such as bird houses, weather-vanes, and outdoor furniture.

Item XIX. A drying room, with proper drying temperature (seventy to eighty degrees Fahrenheit), though perhaps considered a luxury in many industrial arts workshops, is thought to be a very important adjunct to the school shop from the viewpoint of providing a place in which the finished projects may dry dust-free. Those instructors who used the quick-drying materials, such as lacquers and shellacs, did not have as much trouble as the others with drying the pupils' projects satisfactorily, but slow-drying materials, such as varnishes, proved very difficult to handle without proper drying facilities.

One of the big problems in the finishing room of the school shop is getting the pupils to clean and care for the equipment. Where the materials are applied by brush, several brushes are required for each of several different types of materials. For example: a brush used for shellac should never be used for oil varnish or lacquer, since shellac brushes are cleaned with alcohol and lacquer brushes are cleaned with lacquer thinner. As one instructor stated, "Keeping brushes clean is our biggest problem." He added, "I never have the boys put the brushes away. I do that, then I know what they go into."

All of these brushes represent a considerable outlay
and replacement item. With an external mix spray gun, the cleaning is very simple and, with proper care, the gun will last for years. It is doubtful that the cost of a spray gun would exceed the amount spent for a selection of the proper brushes. Another point to consider is that an article can be sprayed within a fraction of the time which is required to brush on a finish, and the results of spraying are far superior.

The writer believes it would take less time to instruct a pupil in spraying techniques to a point where he could obtain favorable results, than it would to instruct the same pupil in the different techniques of properly brush-in on the several different types of materials.

Item XX. A large percentage of respondents indicated that the pupils rubbed and polished the final coats. The materials used for this procedure varied with the type of finish applied, and the choice of the instructor. The materials however, do not signify so much as to the effectiveness of the final appearance, as do the experience and skill of the user. Rubbing is one of the most expensive steps in the finishing schedule, for fine furniture.

Eight respondents stated that they did not rub or polish the final coat or, if they did, "only occasionally". To produce really fine work, the final coat should be rubbed and polished; but there are finishing materials which approximate a "dull-rubbed" appearance, thus eliminating
the necessity of rubbing and polishing. If ideal situations prevail, where there is no dust, perhaps one could "get by" without rubbing or polishing, if these special finishes are used. In the rubbing and polishing step, care must be taken not to rub through the coat of finish. With proper supervision and materials, pupils should be able to do this but it requires care and patience.

Item XXII. It was considered desirable for the purpose of this survey to learn whether or not the instructors in these industrial arts shops were operating on budgets which they considered inadequate for the purchase of finishing materials and finishing equipment. Approximately eighty per cent stated that their budgets were adequate yet, in Item XXIV, a percentage of sixty-six said that the finishing facilities in their shops were not adequate. It would appear that these two answers conflict. The discrepancy could be in the original planning of the shop, where the facilities were fixed and no expansion or improvement could be made, or in the lost hope of ever having the conditions improved.

In Item XXIII, eighteen per cent of the respondents indicated that the pupils did not pay for their own finishing materials. It is the belief that pupils should pay for these materials because they will take more personal interest in the finishing processes if they do. They are also less likely to waste the materials. Paying for their own
materials will assist in giving a sense of value and responsibility.

TABLE XXIV, "Do you feel your finishing facilities are adequate?", shows that approximately 66% of the instructors responding to this survey consider their facilities to be inadequate for the finishing of industrial arts projects. Because of the wide variation in answers, it was impossible to arrive at a definite reason for this inadequacy. One possibility is that when the shops were built, no provision was made for a finishing room, consequently the instructors must use makeshift facilities as well as they can. Because of this inadequacy, it is possible that the instructors lose interest, and do not give as much attention to finishing as this process demands.

Item XXV, "Do you find that finishing is a particularly difficult step for pupils?", shows that 62% of the instructors do find finishing difficult for pupils. This percentage closely corresponds with the percentage in Item XXIV, where 66% stated that their shop facilities were inadequate. It would appear that in order to carry on a good finishing program, adequate facilities must be provided.

A well-planned woodworking program should include a finishing room with modern spray equipment. Since wood finishing is an important industry in itself, the finishing of industrial arts projects in the school shops is a fulfillment of one of the objectives of industrial arts
(27, p.43) -- "to provide information about, and -- in so far as possible -- experiences in, the basic process of many industries, in order that students may be more competent to choose a future vocation."
CHAPTER IV

SUMMARY AND RECOMMENDATIONS

In general, the purpose of this study was to determine currently used methods and techniques in the finishing of industrial arts projects in the junior and senior high schools of Oregon. Pertinent data were collected from available literature bearing on this subject. In order to cover a reliable sampling with a reasonable expenditure of money and time, the questionnaire method was used. The questionnaire was designed to gather information about the methods used in finishing, to learn what equipment was available in the schools, and to gain a personal viewpoint from the instructors as to particular difficulties encountered in their finishing programs. The following summary is based upon the responses of the instructors questioned in this survey.

SUMMARY

The data tabulated from the completed questionnaires showed that some sort of finishing program was carried on in all the school shops.

A general summary of the findings follows:

1. There is an average of over four woodworking classes held each day in the schools surveyed. The average size of these classes is approximately twenty pupils.
2. Only two shops were equipped with blower systems for the removal of sawdust and shavings from the woodworking machines.

3. Heat in the shops was found to be quite adequately provided, but many instructors expressed the opinion that the heating of the finishing room was inadequate.

4. Windows were the means of ventilation in sixty-eight of the shops. Two responses stated there were no windows at all, which would indicate that these were basement shops.

5. Floors were cleaned at the end of each period in forty-seven of the cases covered, whereas approximately all of the remaining chose the end of the day for cleaning.

6. Of the sixty-six school shops which had some sort of finishing room, thirty-eight had no exhaust system; twenty-five were inadequately lighted; nineteen had inadequate heat; and thirty-one had no spray equipment. Some instructors stated that, although they had spray equipment, it was inadequate and was not used.

7. Over half of the spray guns in use in these school shops were "internal-mix".

8. Twenty-four of the forty-three spray guns available were "bleeder type".

9. Thirty-six of the forty-three instructors who had spray guns available allowed the pupils to use these guns.

10. Finishing materials were applied to projects at the work benches in eleven shops; in eleven others, a section of the shop was used for the finishing area; fifty-four shops had finishing rooms; and in three shops some other area outside of the shop was used.

11. Seventy-five of the seventy-nine instructors responding utilized the regular class period for application of the finishes, while two used a special time set aside for finishing. Two reserved a period at the end of term for all finishing.
12. By far the largest number (74) of the instructors used oil stain their finishing schedule; water stain was used by eighteen instructors, spirit stain by fourteen, shading stain by eleven. Forty-eight used filler as a stain, and two used other materials not designated as stains.

13. The stains were applied by brushing in sixty cases, by wiping in sixty cases, and by spraying in eleven cases.

14. Lacquer was used as a sealer in fifty cases, shellac in thirty-nine cases, and oil varnish in twenty-nine cases.

15. The sealer coat was brushed on in fifty-seven instances, spraying was done in thirty-six, and wiping in twelve.

16. The types of final coat used on hardwoods ran in this order: lacquer--fifty-five; oil varnish--forty-two; shellac--fifteen; oil-base enamel--ten; lacquer-base enamel--three; "other"--twelve.

17. On softwoods, the preference for final coats was shown to run in this order: lacquer--forty-five; oil varnish--forty; oil-base enamel--thirty; shellac--twenty-five; lacquer-base enamel--eight; "others"--four.

18. The final coats were applied by brushing in fifty-five cases, by spraying in forty cases, and by wiping in seven cases.

19. In eight cases the work bench was used as a drying area. The finishing room was used in fifty-five cases, and a special drying room in only six cases. "Other places" were used in ten cases.

20. Seventy-one of the respondents indicated that, in their shops, the final coats were rubbed and polished.
21. Pumice was used for rubbing and polishing in fifty-seven cases; steel wool in fifty-one; rotten stone in forty-three; finishing paper in forty-two; rubbing compound in twenty-six. In two cases no abrasive materials were used.

22. Fifty-six of the instructors considered their budget adequate for the purchase of finishing materials and equipment, while twenty-three thought their budgets were inadequate.

23. In sixty-five of the shops covered by this survey, the pupils paid for the finishing materials used on their projects, while in fourteen cases they did not.

24. Twenty-seven instructors indicated that, in their opinions, the finishing facilities in their woodworking shops were adequate. In fifty-two cases the instructors stated that their finishing facilities were inadequate.

25. Forty-eight of the instructors reported finishing a difficult step for pupils, while thirty-one stated that the pupils had little or no trouble.

RECOMMENDATIONS

These recommendations are based on the review of literature and technical data applying to this study, and on the data gathered from the questionnaires. It is hoped that the recommendations will be of value in the improvement of conditions in existing shops, as well as in the planning and construction of new school shops.

Because of the expense involved in installing a blower system, it would probably not be practical in many of the existing shops, but dust collectors for the individual woodworking machines should be provided. These
woodworking machines which create the greatest amount of dust, such as sanders and saws, should be placed as far as possible from the finishing room or finishing area. A schedule of floor sweeping should be arranged in order to create as little dust disturbance as possible just preceding, during, or immediately after the time finishing is being done.

The finishing room should be provided with a dust-tight door into the shop proper. A glass partition should separate the finishing room from the main shop so that the instructor is able to observe activities in both rooms. Whenever possible, the finishing room should have adequate natural light. Artificial lights and switches should be of the explosion-proof type. It is recommended that each finishing room be supplied with spray equipment and a spray booth with an exhaust system. The spray gun should be of external-mix and non-bleeder-type. Some of the schools may have a compressor already installed in an adjoining room for other purposes. This compressor could also serve the finishing room with the addition of a small amount of pipe. Compressors and spray equipment of a reliable make, which would be suitable for a school shop, can be purchased for less than $200.00.

There should be means of providing even, controlled heat in the finishing room. The temperature of this room
during class hours should be held at seventy-five degrees Fahrenheit. Because of the stirring of the dust, forced-air heating should be avoided. Open-flame heating should never be used because of the flammable nature of most finishing materials. Electric reflector heaters are likewise to be avoided.

Metal storage bins should be provided for the finishing materials, and all materials of a poisonous nature should be labeled and kept in locked storage. Approved waste cans, with lids that close automatically, should be provided for oily rags.

The writer believes that the pupils should be instructed in the proper use of spray equipment, and should be allowed to finish their own projects. Operation of the spray gun appeals to youngsters. When they do the work on their own projects they are realizing more pleasure and deriving more benefit than if the instructor or some other person did the spraying for them.

In those shops which are not equipped with a finishing room, special steps must be taken in order to control the dust. Drying racks can be made with muslin-covered doors, and shelves of wire or grating to permit the circulation of air. If the project is small, a clean cardboard box with ventilation holes cut in the sides can be placed over it to keep the dust away. Another useful method is
to reserve the last class day in the week for finishing. The shop could then be cleaned and no other activity except finishing be allowed.

Staining of the wood is recommended unless a natural finish is desired. Shading stain should be used on a sealer coat rather than on bare wood, and should be applied by spray only. Where open-grain wood is stained, this process should be followed by application of a wash coat of sealer, then by a filler. Filler used as a stain is not recommended where best results are desired. Spirit stains should be sprayed, but only if an exhaust system is available to remove the fumes from the finishing room. These fumes can be injurious to health.

Lacquer sealer is recommended in preference to either oil-varnish or shellac sealer, because of its quick-drying qualities and its easy sanding properties. If spray equipment is available, the lacquer sealer should be sprayed. However, lacquer sealer can be brushed then sanded smooth. Under no circumstances can it be successfully wiped.

It is recommended that lacquer be used as a final coat on cabinet woods because it becomes dust-free in a few minutes. Oil-varnish could be used successfully if an ideal drying room were available, but it is doubtful that this condition exists in school shops. Shellac is not recommended for a final finish.
For softwoods, lacquer-base enamels are recommended from the standpoint of time saving. Oil-base enamels are probably more durable for projects meant to be used outdoors. The final coats on either hardwoods or softwoods are best applied by spraying.

Regardless of how careful the pupil and instructor may be, dust will settle on the finished project. Where the appearance of the project is of paramount importance, such as in furniture construction, rubbing and polishing is necessary. In projects constructed for use outdoors, such as birdhouses, toys and outdoor furniture, this final step is not necessary.

It is strongly recommended that the instructors keep informed of the new finishing products which are placed on the market from time to time. The alert instructor will experiment with these new products and exploit their possibilities in so far as they are adapted for school shop use.

When new shops are contemplated, or old shops remodeled, much consideration should be given to the construction of a finishing room and its facilities.

If the instructor himself lacks professional training or experience, he should seek competent help and advice, and then supplement his previous work by adequate preparation at a school qualified to give the help needed.
BIBLIOGRAPHY


Dear Sir:

Would you please complete the enclosed questionnaire, which is one of a number sent to various industrial arts instructors throughout Oregon. The data gathered by the replies will be tabulated and used in the completion of a thesis entitled, "Facilities and Techniques for the Finishing of Industrial Arts Projects".

The mailing list for this questionnaire was obtained from last year's directory, and it may not be up to date. If this is so in your case, please pass it on to the appropriate instructor, or return it promptly in the return-addressed envelope.

Thank you for your prompt cooperation. If you so indicate, in the place provided, I will be glad to forward to you an abstract of the thesis upon its completion.

Very truly yours,

Wade M. Anderson, Co-ordinator
Industrial Arts Department
Oregon State College
**APPENDIX B**

School

Location

Instructor

Do you desire copy of abstract? ________________

**QUESTIONNAIRE**

1. In the left-hand column, check the periods in which woodworking is taught. Check the number of pupils in those periods in the right-hand column.

<table>
<thead>
<tr>
<th>Period</th>
<th>No. Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st.</td>
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<tr>
<td>2nd.</td>
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<td>3rd.</td>
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<td>4th.</td>
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<td>5th.</td>
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<td>6th.</td>
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<td>7th.</td>
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</tr>
</tbody>
</table>

2. Is your shop equipped with a blower system for the removal of sawdust and shavings? Yes ____ No ____.

3. What type of heating system is provided for the shop? ________________

4. Check the type of ventilation. Windows _____, air conditioning _____, some other (specify) ________________.

5. Are the floors cleaned after each period _____, at the end of the day _____, or at some other time (specify) ________________.

6. If you have a finishing room, is it equipped with adequate exhaust system _____, adequate light _____, adequate heat _____, spray equipment _____?

7. Is the spray gun "internal mix" _____, or "external mix" _____?

8. Is the spray gun "bleeder type" _____, or "non-bleeder type" _____?

9. Do the pupils use the spray equipment in finishing their own projects? Yes ____ No ____.
10. Are the finishing materials applied: at the pupils' work benches; in a part of the shop used for finishing but not separated from the main area; in a separate, enclosed finishing room; or in other areas (specify)

11. When are "finishes" applied to the project: during regular class period; during a special time set aside for finishing; or at the end of the term which is reserved exclusively for finishing.

12. Check the stains which you use in your finishing schedule. Oil stain, spirit stain, water stain, wiping stain, shading stain, filler as a stain, others (specify)

13. How are these stains applied? Brushed, sprayed, or wiped

14. Check the type of sealer used: shellac, varnish, lacquer

15. How is the sealer applied? Brushed, sprayed, or wiped

16. Check the type of final coat used on hardwoods: oil varnish, lacquer, shellac, lacquer-base enamel, oil-base enamel, or other (list type or trade name)

17. Check the type of final coat used on softwoods: oil varnish, lacquer, shellac, lacquer-base enamel, oil-base enamel, or other (list type or trade name)

18. How is the final coat applied to the project? Brushed, sprayed, or wiped

19. Where is the project left to dry: on the work bench; in the finishing room; in a special drying room; or some other place (specify)

20. Do you rub and polish the final coat? Yes, No

21. Check the materials used for rubbing and polishing. Finishing paper, steel wool, rubbing compound, pumice, rotten stone, others (specify)
22. Do you find your budget adequate for the purchase of finishing materials and equipment? Yes ___ No ___.

23. Do the pupils pay for the finishing material used on the projects? Yes ___ No ___.

24. Under your present setup, do you feel that your finishing facilities are adequate? Yes ___ No ___.

25. Do you find that finishing is a particularly difficult step for pupils? Yes ___ No ___.

26. Indicate how your program of finishing industrial arts projects might be improved. __________________________
______________________________
______________________________
## APPENDIX C

### List of Schools and Instructors Responding

<table>
<thead>
<tr>
<th>Location</th>
<th>School</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany</td>
<td>Albany High School</td>
<td>George Perry</td>
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<td>Astoria</td>
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<td>John Eliassen</td>
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<td>Bandon</td>
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<td>Dale Davis</td>
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<td>Bonanza</td>
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<td>Frank Jones</td>
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<td>Burns</td>
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<td>Central Point</td>
<td>Crater Jr. High School</td>
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<td>Clatskanie</td>
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<td>North Bend High School</td>
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<td>West Linn</td>
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## APPENDIX D

### PERTINENT COMMENTS MADE BY INDUSTRIAL ARTS INSTRUCTORS

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>ALBANY:</th>
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<tbody>
<tr>
<td>Indicate how your program of finishing industrial arts projects might be improved.</td>
<td>&quot;By providing an adequate finishing room with more heat, light, air and space.&quot;</td>
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</table>

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>ASTORIA:</th>
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<tbody>
<tr>
<td>Larger and better equipped finishing room, with spray equipment and special drying room.</td>
<td>&quot;Larger and better equipped finishing room, with spray equipment and special drying room.&quot;</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>BEND:</th>
</tr>
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<tbody>
<tr>
<td>If we had an exhaust system to aid in removing dust from the shop, we could use some varnish finishing. As is, our fan in the spray room draws dust from the shop so lacquer or lacquer-base finishes are best for us.</td>
<td>&quot;If we had an exhaust system to aid in removing dust from the shop, we could use some varnish finishing. As is, our fan in the spray room draws dust from the shop so lacquer or lacquer-base finishes are best for us.&quot;</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>QUESTION</th>
<th>BONANZA:</th>
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</thead>
<tbody>
<tr>
<td>Construction of a finishing room with ventilating fan. Purchase of a spray gun to get smoother finishes. An ample supply of all types of finishing materials.</td>
<td>&quot;Construction of a finishing room with ventilating fan. Purchase of a spray gun to get smoother finishes. An ample supply of all types of finishing materials.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>BURNS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>More adequate space and a means of keeping room clean would greatly help. Also adequate storage of finish materials would aid.</td>
<td>&quot;More adequate space and a means of keeping room clean would greatly help. Also adequate storage of finish materials would aid.&quot;</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>QUESTION</th>
<th>CENTRAL POINT:</th>
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<tbody>
<tr>
<td>More time spent in teaching good methods in finishing, such as the use and care of spray, give students a larger variety of finishes. Need more room to store articles after different coats have been applied.</td>
<td>&quot;More time spent in teaching good methods in finishing, such as the use and care of spray, give students a larger variety of finishes. Need more room to store articles after different coats have been applied.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>CLATSKANIE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A larger finishing room with more space for storing projects while they are drying. Money is needed to carry a larger inventory of finishing materials.</td>
<td>&quot;A larger finishing room with more space for storing projects while they are drying. Money is needed to carry a larger inventory of finishing materials.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>CORVALLIS:</th>
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</table>

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>COTTAGE GROVE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equip finishing room with proper exhaust system and install spraying equipment. Limitation of space is chief reason for not doing so.</td>
<td>&quot;Equip finishing room with proper exhaust system and install spraying equipment. Limitation of space is chief reason for not doing so.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>DAYS CREEK:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need a separate finish room and drying room.</td>
<td>&quot;Need a separate finish room and drying room.&quot;</td>
</tr>
</tbody>
</table>
Elmira: "Need some type of finishing room."

Estacada: "More adequate supply of materials; complete spraying unit; large exhaust fan and spray booth."

Eugene: "More room in finishing room for demonstration to entire class."

Eugene: "A dust-free room, complete with spray booth; more storage for projects in the finish room."

Eugene: "Larger room for finishing and separate room for storing finished projects."

Eugene: "A special finishing room, a longer period than nine weeks."

Finn Rock: "By having a separate room that is not a general thoroughfare from the furnace room to the hall outside. By the installation of adequate ventilation and spraying equipment."

Forest Grove: "Work out a system for keeping brushes clean."

Garibaldi: "Drying room and more finishing materials."

Gresham: "A dust or sawdust collection system would help a great deal."

Jacksonville: "Need more space in finishing room, and more space for project storage after finishing."

Jewell: "An enclosed room away from the dust in the shop and adequate heat and ventilation would be an improvement."

Klamath Falls: "More cabinet and shelf space, fire proof cabinet for paints and varnishes."

Klamath Falls: "1. More storage space for current projects.
2. Have a classroom for related information.
3. Periods longer than the present 42 min.
4. Have an outside entrance to the shop."

Lakeview: "By being able to supply a greater variety of stains and finishes."

Lebanon: "By installing spray equipment, dust-proof room, larger finishing room."
Mapleton: "Better spray equipment. Storage space and spray room. Bigger variety of materials. More detail and emphasis on materials and finishing procedures other than varnish and lacquer."

Marcola: "Spray equipment, heat, light."

Mill City: "With better facilities, and that includes everything — a door on the finish room. One of the reasons for using lacquer is to circumvent the dust problem."

Milton-Free water: "By the use of either portable DeVilbiss or installed controlled spray equipment, plus a drying room. I have a continuous problem of fingerling wet projects. Lacquer, though difficult, has proven the best finish. School boards from on luxury equipment such as spray. Segregation of finishing materials is of great importance, and the greatest headache. A brush used for varnish invariably ends in the lacquer, and vice versa. Instruction and supervision can be the best and this still happens. I wish some solution could be arrived at regarding general finishing processes without the resulting disappointments and headaches."

Milwaukie: "Dust is our big problem."

Milwaukie: "More adequate finishing room, drying room, and storage space considering number of pupils involved."


Oregon City: "(1) larger rooms, (2) finishing and drying room, (3) up-to-date spray booth with ventilating fan."

Oswego: "Spray booth — more space."

Portland: "More space, heated room, need of adequate storage."

Portland: "Spray system, drying racks, or room and better lighting."
Portland: "Exhaust system and more heat for drying in finish room. More storage space for projects while in finishing process."

Portland: "Need to modernize plant and add finish room."

Powers: "Finishing room should be enlarged. Exhaust system is badly needed. Blower system needed. Lighting is inadequate."

Prineville: "Sufficient space so that finish room would not have to be used as storage room. Need to have finish room adequately equipped to permit use of spray gun."

Salem: "A good many projects in softwood go home unfinished to be finished there."

Salem: "Exhaust system around power equipment to keep dust down. Separate drying room for finished projects."

Seaside: "More heat in drying and finishing rooms."

Silverton: "By installing a blower in the finish booth and having more space for projects to dry and having a large steel table for staining."

Springfield: "Spray equipment and booth."

Stayton: "Install the following: (which will be done this summer) air, spray gun, exhaust fan."

Sweet Home: "More space, light, exhaust fan."

Tillamook: "Exhaust system. More dust-proof room, more storage area. Small spray system."

Toledo: "A finishing room; air conditioning; better spray facilities; more adequate cabinets and means to cover more effectively finishing materials from dust and student fingerling."

Waldport: "By having a more adequate place for finishing. Better spray equipment needed."

West Salem: "With a separate finishing room to get away from the dust of the lumber storage."