A STUDY OF FACILITIES AND PROCESSES OF FINISHING
RECOMMENDED FOR INDUSTRY AS COMPARED WITH
FACILITIES AVAILABLE AND PROCESSES USED
IN NINETY-FIVE INDUSTRIAL ARTS SHOPS
IN TEXAS SCHOOLS

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INDUSTRIAL ARTS SHOPS IN TEXAS SCHOOLS

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CHAPTER I

THE PROBLEM AND THE PROCEDURE

Introduction

Too often in the planning of the industrial arts shops very little attention is given to the finishing room. Just why this is, is difficult to conceive because finishing is one of the most important processes of the industrial arts program.

Since the field of industrial art is too vast to discuss generally, it is to the advantage of both the instructor and the student to discuss and study one phase at a time. Two phases of industrial arts are metalwork and woodwork which involve the selection of materials, the actual construction, and the finishing of projects. The ability to select the proper material for a project is essential, as is the craftsmanship used in its construction. The knowledge and use of materials is lost if the student's ability to apply a beautiful finish is inadequate. Too often one finds a well constructed piece of work poorly finished; this in itself classifies the builder as an amateur. Students usually believe that the prime necessity for a good product is costly material, and that a project is completed
when it has been constructed. Students often spend a great amount of time making their project and yet carelessly hurry over the finishing of it.\(^1\)

Students should learn that the proper construction and finishing of a project are as important as the quality of wood or metal which is used. An expensive appearing article may be made of very common material, while other articles made of more valuable materials may be almost worthless in comparison, because of improper finishing. The student should not consider his work completed until he has achieved an appropriate and artistic finish. "Beautiful material is, of course, desirable, but it is never the chief source of value for a piece of furniture."\(^2\)

Statement of the Problem

This is a study of facilities and processes used in finishing wood and metal projects used in industry as compared with facilities available and the processes used in industrial arts programs in one hundred Texas schools.

Reasons Why the Study Should Be Made

The reasons why the study should be made are as follows:

1. At the present time, finishing appears to be the weakest part in the industrial arts program.

2. In most instances the industrial arts instructor will have more problems arising from the finishing room than from any other phase of his teaching field.

3. There is also a need to study the present finishing facilities in order to ascertain the facilities needed in an industrial arts program.

4. There is also a need to review the literature in the field of schoolhousing pertaining to industrial arts in order to determine what is recommended with respect to finishing rooms and facilities.

5. It is necessary to study the preparation of the industrial arts teachers in the area of finishing in order to determine if they are of the opinion that their preparation was adequate.

Purposes of the Study

The purpose of the study is fivefold, as follows:

1. To review the finishing methods used in industrial arts in order to recommend standards necessary to eliminate the present weakness believed to exist in the finishing field.

2. To review the literature in the finishing field in order to recommend practices, processes, and facilities that may be used to reduce cost and to eliminate wastefulness in the finishing room.
3. To study the literature and available programs followed in industrial arts to ascertain the proper facilities needed for an ideal finishing room in the industrial arts program.

4. To review the literature in the field of school-housing to determine the recommended standards for a finishing room in industrial arts.

5. To make recommendations concerning the preparation of industrial arts teachers with respect to their needs in the finishing area.

Limitations of the Study

The study is limited to an investigation of the facilities and processes used in one hundred schools of Texas and a study of the processes and facilities used and recommended for industry.

The study is further limited in that only those processes and facilities used in finishing wood and metal will be treated.

Definitions of Terms

Certain terms pertinent to the study are defined as follows:

"Industrial arts" is a phase of general education that concerns itself with the materials, processes, and products of manufacture, and with the contribution of those engaged in industry. The learning comes
through the pupil's experience with tools and materials and through his ability of resultant conditions of life.

The term "finishing" is the procedure followed to preserve and prolong the life of a project as well as to enhance its beauty.

The term "facilities" as used in the study refers to that part of the building which houses the finishing shop and to the equipment used in applying finishes.

"Industry" as used in this study is an industrial plant devoted to producing products in quantity.

Source of Data

Information concerning finishing processes and facilities was secured from books, magazine articles, and pamphlets of a professional nature pertaining to the field of finishing. Further information was obtained through a questionnaire mailed to various secondary schools in Texas concerning their finishing procedures and facilities.

Treatment of the Data

Included in the first chapter are an introduction, the statement of the problem, the reason for the study, purpose of the study, definition of terms, sources of data, treatment of data, and related studies.

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The processes recommended and the facilities used for finishing wood and metal in industry are discussed in the second chapter. Data were obtained from various sources, interviews, letters, and from books written on the industrial level of finishing.

A review of the recommended facilities and processes for finishing both wood and metal in the industrial arts program is presented in the third chapter. Many of the books reviewed as a source of information are used in numerous high schools as text or reference books.

A presentation and analysis of the facilities and processes used in ninety-five Texas schools are presented in Chapter IV. This information was obtained through the use of questionnaires sent to various schools over the State.

Included in Chapter V are the summary, conclusion, and recommendations of the study.

Related Studies

During the past few years there have been several studies which dealt with housing facilities and equipment for industrial arts programs. Some of these studies include the following:

Marvin D. King conducted a study in 1951, of the lighting conditions that existed in the industrial arts shops of the Fort Worth Public Schools in Fort Worth, Texas. The purpose of his study was to determine whether or not
the lighting met the standards set up by the authorities in the field of school lighting. Although much work had been done to remedy poor lighting conditions in the Fort Worth Schools, there were several shops that did not come up to the standards set up by the authorities. 4

In 1952, Richard G. Strickland made a study of the housing facilities provided for industrial arts programs in eleven junior high schools in seven counties in the Panhandle Area of Texas. The purpose of Strickland's study was to determine whether or not the eleven junior high schools of his study met the standards set up by the authorities in the field of school housing for industrial arts programs. The study revealed that some of the industrial arts programs surveyed did meet the required standards for housing facilities.

In 1953, Irvin M. Rushing made a study which was concerned with the housing facilities provided for industrial arts in three high schools and four junior high schools located at Beaumont, Texas. Rushing's study was made to


determine whether or not the housing facilities provided for the industrial arts programs in the study met the recommended standards as stated by five selected authorities in the field of schoolhousing. When an analysis was made concerning the housing facilities for the industrial arts programs in the Beaumont Schools it revealed that the present housing facilities provided for the thirteen industrial arts shops only partially met the recommended standards for adequate schoolhousing. 6

CHAPTER II

THE PROCESSES RECOMMENDED AND THE FACILITIES USED
FOR FINISHING IN INDUSTRY

The individual industrial plant is constantly kept aware of the fact that it is essential to have the ultimate in every respect for finishing its product. Obviously, the knowledge of this necessity is stimulated by the competitors in their particular field. Even as production costs increase, manufacturers keep seeking equipment which will enable them to reduce their current costs, or at least hold them on a stable basis. In their determination to better their particular product, the manufacturers are constantly experimenting in order to improve the necessary processes involved and to provide more adequate facilities for their activation. Since the use of protective and decorative coatings on practically all types of products have been elevated to their rightful place of importance throughout most industries, progress in the development of better facilities for their application has been greatly accelerated. To present adequately in detail all of the equipment, facilities, tools and instruments used in connection with modern product painting and finishing would be too vast to include in this study; therefore, it will be
necessary to limit the study to only a few of the finishes used in industry, and particular attention will be given to the finishing of wooden and metal products.

Materials and Processes Used in Industry to Finish Products Made of Wood

The actual coating of products in industry is of vital concern to any manufacturer in the production field. In order to understand better just what industry is concerned with in respect to the actual substances used in finishing wood products, it is necessary to investigate a few of the most popular materials used.

The use of lacquer in finishing articles made of wood.—Nitrocellulose lacquers of one kind or another have been used for many years. During World War I, the use of lacquer became very popular. This increased use of lacquer was caused by the need for solvents in processing nitrocellulose explosives and the greatly accelerated research along these lines brought about the much needed knowledge in the field of nitrocellulose chemistry in the post war years. Although the practice of lacquering has been passed down through the centuries, today's lacquer is in no way related to the ancient lacquers.

Lacquer is the fastest drying finish available. The tough and durable finish it provides is easy to sand, rub or patch; for this reason, it is an ideal finish for the industrial world. Lacquer in its transparent form serves much the same purpose as varnish, but it is thinner in substance.

In many instances, the more expensive pieces of furniture are finished with a lacquer application, as it produces a very pleasing effect identifiable by a deep lustre and mellow tones. The use of lacquer in the piano industry is well established.

The various methods used to apply lacquer are easy and economical. They include brushing, spraying, dipping or roller coating. In some instances throughout industry, lacquer is heated before it is applied with a spray gun. These reasons, coupled with the fast drying characteristics and durable finish it provides, places lacquer very high on the list of finishing materials in industry.

The use of varnish in finishing objects made of wood—Varnish may be thought of as a tinted window through which the beauty of the grain of wood can be viewed. Since varnish does not have a pigment, varnish-makers combine resin, oil, thinner, and drier to make a transparent coating.

There are two main types of varnishes: spirit and oleoresinous. A spirit varnish is a solution of a resin, or other film-forming material, in a volatile liquid. When the liquid evaporates, the resin is left behind in the form of a film. Resin is the substance that supplies hardness, durability and gloss.

An oleoresinous varnish is a mixture of cooked drying oil and a resin dissolved in a volatile liquid thinner. When the thinner dries, a film is left which does not dry until oxygen from the air has a chance to complete the drying process. For use in modern industry both types of varnish have driers added to speed up the process of finishing.

Through observation and experimentation, manufacturers have found that varnish is a finish which is capable of absorbing a great deal of punishment without visible marring to the furniture itself. For this reason a large majority of our cheaper grades of furniture is finished with some type of varnish. One of the handicaps of the use of varnish is the time required for it to dry; however, with the use of drying compounds, this problem has been overcome to some extent.

The use of shellac for finishing wood in industry.—
The development of shellac differs greatly from that of

3 Lonore Kent, Paint Power, p. 45.
other finishing materials, for the lac resin has been known since 1500 B.C. The world owes its debt of gratitude for this valuable substance to an insect, almost microscopic in size. This insect known as lakh converts the sap of trees, by sucking it into its body and then excreting it through its pores, into a crustation on the trees. This crustation is commonly called sticklac. The lac is gathered twice a year by the natives and carried to crude mills where shellac is still produced by relatively primitive means.

To most people, shellac is a kind of varnish used in refinishing surfaces, especially floors where a tough durable surface is necessary; however, its use is not limited to refinishing alone. It is realized today that shellac occupies a definite place and has some advantages over all competing finishes. It is definitely conceded by the best finishers, that if the time could be expended on it, there is no finish that has the durability, velvety surface, and the beautiful effects of shellac carefully applied in thin coats. Although many substitutes for shellac have been

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4 George A. Soderberg, Finishing Materials and Methods, p. 33.

5 Ibid., p. 35.


developed, industry, through experience, has proved that for producing a tough durable finish, there is no substitute for pure shellac.  

Recently some manufacturers have recommended that shellac should not be used on floors except as a "sealer-coat" before applying a wax finish. Shellac is a brittle, hard, fast-drying substance which does not penetrate the wood, but forms a thin, impervious coating. It is used by many painters as an undercoating because it seals the pores and keeps the finishing coats of paint or varnish from sinking in. In this way, an apparently full-bodied fine-appearing finish is quickly and cheaply obtained. However, too heavy a coat of shellac will form a hard, smooth surface which will not hold varnish, and "chipping" may result.  

Paint and its uses in the wood finishing industry.-- No one knows when the discovery of paint was made, and so it still remains a mystery shrouded in the mist of distant yesterdays. The fact remains, however, that paint and painting have probably been a custom with mankind almost as long as eating.  

Since it is a common practice to refer to all types of protective coatings as paint, it will be necessary in

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8Pure Shellac, (a brochure, no date given), The Glidden Company.
9How to Paint, No. RF 30-99332, (a brochure, no date given), Sears, Roebuck and Company.
10Kent, op. cit., p. 30.
this study to limit its meaning to a mixture containing a pigment and a vehicle. Pigment is the solid portion of paint which gives it the power to obscure, hide, and color a surface. Vehicle is the liquid part of the formula and contains drying oil, thinner, and drier. 

Broadly considered, paint is a material which is applied in thin films for protection, decoration, sanitation, identification or other functional purposes. The most important function of paint is its resistance to moisture. For a proper painting, wood cells are sealed, thus preventing moisture from expanding the wood. This moisture-resistant factor is vitally important in making house paint withstand various destructive weather conditions. However, ordinary house paint is not satisfactory for interior use on floors. It is always well to use a good floor enamel to paint a floor, as it contains a large portion of varnish, which not only forms a tough surface film, but also produces a beautiful finish. In the use of floor enamels it is well to remember the following, recommended by a leading company.

Floor Enamel: Floors are exposed to more severe wear than any other house surface. To adequately protect

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12 Kent, op. cit., p. 36.  
13 How to Paint, No. RF30-9932, (a brochure, no date given), Sears, Roebuck and Company.
and beautify these surfaces, a paint product of exceptional durability is an absolute necessity.\textsuperscript{14}

Paint is produced in every part of the United States by a total of some 1400 manufacturers. In addition, American paints are of such high quality that they are in demand in foreign countries as well. Each year manufacturers in the United States export 30 million gallons of paint.\textsuperscript{15}

Wood staining in industry.--Staining is a skilled craft developed to a high degree even in ancient times, having been recorded as far back as 1500 A.D.\textsuperscript{16} Although an ancient art, modern science has improved the operation to the degree that staining is today regarded as one of the most critical and important operations in wood finishing.\textsuperscript{17} The object of applying stain is to obtain an even distribution of a desired color.\textsuperscript{18}

For simplicity and convenience, the classification of wood stains used in present day industrial finishing has been established as water stain, oil non-grain raising, and

\begin{enumerate}
\item[	extsuperscript{14}]Scuff Proof Floor Enamel, No. 125330, (a brochure, no date given), Cook's Paints.
\item[	extsuperscript{15}]Kent, \textit{op. cit.}, p. 19.
\item[	extsuperscript{16}]C. L. Deniston, \textit{The Science of Modern Wood Finishing}, p. 70.
\item[	extsuperscript{17}]Soderberg, \textit{op. cit.}, p. 104.
\item[	extsuperscript{18}]\textit{Pure Shellac}, (a brochure, no date given), The Glidden Company.
\end{enumerate}
spirit. Of these three types, the water stain gives the best and most satisfactory medium for the coloring of wood. However, though water stains are usually easier to apply, the same effect can be obtained with oil and non-grain raising stains, if the directions are followed carefully. The pigmented oil stains are practical, stable, and trouble proof. They produce a perfect stained effect on soft and hard woods, have no tendency to raise the grain, are easily applied with brush or cloth, hold their color better than spirit or "penetrating" stains, and are always uniform.

Staining, as a general rule, constitutes the initial step in the finishing cycle. It demands patient study, an experienced eye for color selection and matching, and usually careful application if the desired effects are to be realized.

Before any staining is done, however, it should be decided whether the natural color is satisfactory. In many cases

19 Soderberg, op. cit., p. 104.
21 Pure Shellac, (a brochure, no date given), The Glidden Company.
22 Oil Stains, (a brochure, no date given), Pratt and Lambert.
23 Deniston, op. cit., p. 70.
the natural coloring may be so attractive that no staining is needed to give a pleasing appearance. 24

The primary purpose of stains is to equalize the color of many types of wood and to bring out the full beauty of the grain; however, whenever possible, adapt the color of the stain to the typical shade of the wood. Dark colors should be avoided as they do not bring out the true beauty of the wood. 26

Bleaching of wood.--It is sometimes desirable to remove some of the natural pigmentation in woods, either in whole or in part. This process is known as bleaching, and involves removing the natural coloring matter in wood without causing injury to the wood fibers themselves. 27

Bleach finishes are quite difficult to match, as woods vary from different "runs." In addition to being difficult to use, extreme safety precautions must be exercised in the use of bleaches as it involves very strong chemicals. 28

There has been a trend in recent years to finish wood in lighter and brighter shades than its natural coloring.

25 Lonore Kent, Paint Power, p. 50.
26 Sam Brown, How to Paint with Brush and Spray, p. 6.
27 Soderberg, op. cit., p. 113.
28 Ibid., p. 115.
American walnut, mahogany, and oak are often bleached. The use of bleached woods is very popular in the construction of "modern" furniture, where the pickled or blond finish is preferred. Bleached woods, however, are not as popular today as they were several years ago, as the trend today is toward golden brown wood tones in the clear beauty of the natural wood.

Facilities Recommended and Used to Finish Wood in Industry

Although an industrial plant usually has all the material and best processes known to the trade in finishing, it is at a disadvantage if it does not have the proper facilities to administer these finishes. In the past few years many of the facilities have changed so much as to outdate themselves in a few short months. In the industrial field a plant must keep up with its competitors or it will be forced out of business. With this in mind it will be necessary to study a few of the facilities used in an industrial plant to finish wood projects.

The finishing room.—In most instances the planning of

29 Deniston, op. cit., p. 53.
30 Pittsburgh Plate Glass Co., No. 53, (a brochure, no date given), p. 5.
the finishing rooms of an industrial plant is the combined efforts of many and covers a period of many years of experimentation. It is very important that every detail of the finishing operation be taken into consideration, as nothing can be taken for granted. An efficient finishing room is to be compared with a smooth operating laboratory, for in modern times the application of a finish has been reduced to a very skilled science.

Lighting.—Light and an abundance of it is essential to the finishing room. The quality of light is as important as the quantity. Some manufacturers have made the serious mistake of installing corrugated glass in their windows. This is not so harmful to their products but it causes a depressing effect upon the workman and cuts down on production.

Light coming from the north side so that it remains practically uniform most of the day is recommended. Direct rays of the sun are to be avoided since they tend to bleach and deaden colors. Efficient and effective vapor-proof or explosion proof lights are recommended for the finishing room. These are a very good substitute for daylight and serve to protect the worker as well.

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32 Schmidt, op. cit., p. 21.
Ventilation.--The problem of ventilation in the finishing room is of great importance; in fact, it is essential. The proper system of ventilation not only protects the health of the workers but also serves to insure uniform finishes on all products. The most effective type of ventilating system is one that operates as a complete unit, and not only at each individual station.

Insurance companies are aware of the need for good ventilating systems, and they are inclined to raise rates on the manufacturing companies that do not have proper ventilating systems. The money spent on a good ventilating system will result in more efficient work from safer and happier workers.

The use of spray booths in finishing articles made of wood.--Spray booths are common fixtures in almost all industrial plants as a part of a production line or service department. These booths must be properly ventilated to remove toxic materials from the immediate vicinity of the booths; this should provide the best protection for the employees.


36 Schmidt, op. cit., p. 19.

Most spray booths consist of two solid walls and a ceiling containing efficient and effective vapor-proof or explosion-proof lights. The third wall consists of a solid portion and a water curtain through which paint-laden air is drawn. Equipment moves through the fourth wall which consists of large doors that can be opened for this purpose.\textsuperscript{38}

In general, spray booths can be placed into three classes. In class one, the worker stands outside of the booth with the objects to be sprayed on the inside; in the second class, both the painter and the object being sprayed are completely enclosed in the booth, and in the third class, the booth is automatic and no operator is required. The work is enclosed inside the booth, and a spray gun is mounted to apply the finish automatically. Each of the booths described is equipped with a turntable that allows easy access to all parts of the object being sprayed.\textsuperscript{39}

The control of exhaust and replacement air is very important in the use of spray booths. In most cases an automatic exhaust system is used for the efficient removal of spray vapors from the finishing room. To insure uniformity in the finished products, all elements of the exhaust system should be designed to function effectively as a unit system rather than as a lone machine. One of the many

\textsuperscript{38} Jones, \textit{op. cit.}, p. 148.

\textsuperscript{39} Stern, \textit{op. cit.}, p. 105.
requirements is that the proper velocity of air be pro-
vided at all points in the spray booth. Recirculation of
exhaust air in paint spray booths is only rarely em-
ployed. 40

The spray gun as used in finishing wood projects.—
The spray gun is used almost universally for the applica-
tion of modern finishes in industry. It is an established
part of the manufacturers’ equipment and they are finding
more uses for it every day. The main duty of the spray gun
is to give a protective coating and finish at a maximum
speed and at a minimum cost. To obtain these results it is
very important that the manufacturers select the proper gun
for the job to be performed. 41

The two main types of spray guns that are used today
are the suction, or siphon feed, and the pressure feed.
The suction feed gun has a place in the smaller manufactur-
ing plants but has no place in the larger plants that must
produce on a larger scale. Much time is lost in filling
the container with the finishing material since it holds
only a quart in most cases. (The pressure feed gun is de-
signed so that air forces through the gun all types of
materials, including those of such body that suction feed

40. K. R. Brown, op. cit., p. 120.
41. Spray Gun, (a brochure, no date given), The Devilbiss
Company, p. 2.
application is not possible.) Because of this method, it is the gun used by shops which must rely on larger amounts of production. 42

Processes Recommended and Used to Finish Metal in Industry

The American public's conveniences and necessities, such as the automobile, electrical appliances, office machines, and equipment predominantly are constructed of metal. With this thought in mind, it will be well to present a few of the more popular finishes used by manufacturers today.

The use of flocking in the metal industry. --Commercially, flock might well be described as "lint" or "fuzz." In the beginning a novelty finish, flock has gained in popularity to the extent that today it is considered a standard finish. It is available in rayon, cotton, wool, and animal fiber. The durability of the flock coating depends entirely upon the quality of the adhesive. The most commonly used adhesives today include water soluble glues, natural or synthetic enamels, lacquers, and special adhesives adhering with a rubber base. 44 For use in

42 Soderberg, op. cit., p. 172.
43 Deniston, op. cit., p. 237.
industrial finishing, flock is well suited for functional as well as for decorative purposes. In airplanes, radios, and phonographs it provides a form of sound-deadening, insulation, and cushioning. In automobiles it is used on the rear trunk interiors and inside floor mats. Decoratively, flock is an excellent finish for toy animals, greeting cards, children's games and books, and in the advertising field it is used to improve the decorative effects of counter, showroom, and window displays.45

The use of paint in the finishing of metal products.—Metallic pigments have not been known to the paint industry as long as have the white pigments, such as white lead. Aluminum powder was first manufactured in the United States in the first decade of the twentieth century, and so may be considered a relatively new process, although far advanced at the present time. Because of their decorative and protective qualities metallic paints, which are made from powder flakes of aluminum, copper, zinc, or tin, with the proper varnishes or bronzing vehicle, have been in great demand in recent years.46

Aluminum paint possesses superior hiding power and is also light in weight. The latter adds to its ease of


brushing and constitutes a great advantage in the painting of bridges, aircraft, and battleships, where added weight can present problems. In addition, it is formulated for various other purposes, such as painting water tanks and protecting farm implements and tools, coating metal fences, protecting furnaces, ducts, and piping, resisting heat on hot-water systems, and protecting boilers and steam pipes.

Hammered-effect finishing for metal projects.--
Hammered finishes are so called because of their resemblance to hammered metal. The effect is produced by the incorporation of an aluminum powder in a vehicle which controls the leafing and non-leafing effect in such a way as to create the unique design. Hammered-effect finishing materials are further formulated to dry by air as well as to bake. This method adapts this type of finish to wood and other materials which cannot withstand high baking temperatures.

These finishes are used predominantly in the finishing

47 Ibid., p. 177.
49 Soderberg, op. cit., p. 86.
of vacuum sweepers, portable radios, car heaters, card tabletops, office machines and electrical devices of many kinds.

Wrinkle finishing.—Although classed as a novelty or specialty, wrinkle finishes have developed into one of the most important industrial finishes. Originally, a wrinkle finish was referred to as defective, but from this defective pattern, a new finish was developed.

Wrinkle finishes are very durable and are found on numerous articles such as typewriters, automobile heaters, oil burners, cameras, and many others. To obtain best results, wrinkle finishes should be applied by spraying and drying achieved by oven baking.

The Facilities Used and Recommended to Finish Metal Products in Industry

In industry today, manufacturers are constantly providing new and improved facilities which insure the maximum in efficiency and comfort. In finishing metal products where intense heat is often used, temperatures and ventilation play important roles in planning for the comfort of employees. The improvements in facilities made for spray painting and various new metal finishes are also notable and will be discussed.

50 Rohr, op. cit., p. 34. 51 Deniston, op. cit., p. 244.
The use of the central mixing room in metal finishing.--In many automobile plants and in other industries using large quantities of finishing materials, paints, undercoats, and surfacers reach the operators through pipe lines from central mixing rooms. Mixing and circulating tanks, motor driven agitators and pumps are installed in this room. In the due process of operation, the properly mixed material is pumped into the circulating tanks, from there through pipe lines to all spray stations, making a continuous circuit. The use of the central mixing rooms eliminates the necessity of having paint containers at each booth or spray station.

Electrostatic spraying used in the metal industry.--A relatively new operation in the automotive field, electrostatic spraying is excellent in two important respects: (1) it is a time-saving operation, and (2) there is no loss of paint with overspray. In the past, paint sprayed by hand varied in thickness from 0.0009 inches to 0.0030 inches, but the electrostatic method maintains a steady thickness of 0.0023 inches. Another advantage to this

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52 Heating, Piping and Air Conditioning, (a brochure, no date given), The Devilbiss Company, p. 67.

method is that difficult places are painted equally and without the tiring motion required by hand spraying. 54

Almost any metal article and many non-metallic articles can be coated by the electrostatic spray system. Due to the fact that there is only a relatively small amount of solvent vapor present, the need for an exhaust system has been reduced. Conventional type spray booths are not necessary since there is no appreciable amount of overspray to be exhausted. 55

The layout required for electrostatic spraying in automotive body painting places a battery of nine spray guns in four locations. An electric grid charged with 90,000 volts is at the top of the booth and generates an electrostatic field into which the paint is "lobbed" at low atomizing fluid pressure. The body of the car, being grounded, attracts the paint to the surface. This operation is so effective that in the near future it is hoped that water sanding of the prime coat may be eliminated. 56

**Baking in the metal finishing industry.**—The new trends in the automotive industry have brought with them accessories and extras which are finished in special color

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54Ibid.

55George Murphy, "Making and Painting Car Heaters," *Automotive Industries*, XXIV (July 1, 1954), 104.

enamels and have to be baked. The industry has provided a baking oven flexible enough to handle parts of different sizes such as wire spoke hub caps, grill and bumper guards, license plate frames, and bumperettes. The parts, after traveling through the radiant oven at speeds varying from two feet to ten feet per minute, emerge at a temperature of about 400°F. To allow time for cooking, the conveyor line rises to the ceiling carrying parts overhead. This arrangement saves floor space between the oven and the unloading point. 57

Summary.—Briefly summarizing the material presented in Chapter II, pamphlets and documentary information, furnished by leading manufacturers, were used to show the methods and procedures followed in finishing by industry. Form letters were mailed to prominent furniture manufacturers, paint companies, and finishing equipment manufacturers, asking for any information they might have available concerning modern industrial finishing techniques. The pamphlets and documentary information furnished by these industrialists were incorporated and presented in the second chapter to give, as nearly as possible, a clear picture of modern industrial finishing.

CHAPTER III

RECOMMENDED PROCESSES AND FACILITIES FOR FINISHING
IN THE INDUSTRIAL ARTS SHOPS

The facilities and processes used for finishing projects in industrial arts shops vary a great deal. In many instances the physical plant will determine the processes and facilities used for applying the final coating to a project. The number of students in a class, size of the projects, and the amount of space available for storing projects in the finishing process are only a few of the things that enter into the finishing picture.

In order to get an idea as to what is recommended for finishing, with respect to facilities and processes, ten books were selected dealing with industrial arts. These books are used as textbooks or as reference books in many of the industrial arts classes in Texas. Since woodworking has been emphasized more heavily than metalworking, six of the books were selected from this area. The books selected are as follows:

Gregory wrote a book entitled *Constructive Woodwork for Schools*. This book deals with woodwork for boys from the age of eleven up and is suitable for junior craft
classes as well as senior schools. The proper use of tools is discussed in the first part of the book. Constructional units, proportional units, and lamination of boards are treated in the next chapters. The concluding chapters treat such topics as veneering and inlaying, handles, fittings, and wood finishing. Gregory included five pages on the subject of staining, polishing, and finishing of wood. There are many full-page working drawings designed to help the student in his efforts to construct his projects.¹

Projects in Modern Woodwork by S. H. Glenister. In preparing this book the author had in mind the object of helping the industrial arts instructor to provide a sufficient variety of woodworking projects for use in the second and third year courses of woodwork. Projects described vary from very simple to complex. Although the projects in this book are complex, the subject of finishing received very little attention. A rather short chapter on staining and polishing is the only direct reference to finishing introduced in the book. The book was prepared for direct use by the pupils, and contains working drawings of the processes involved in the completion of the projects.²

William H. Johnson and Louis V. Newkirk combined their

¹A. Gregory, Constructive Woodwork for Schools.
²S. H. Glenister, Projects in Modern Woodwork.
efforts and wrote a book entitled General Woodworking. This book covers the fundamentals of woodworking and presents a basic introduction of carpentry, cabinetmaking, patternmaking, and carving. The projects described are varied and afford the student an opportunity to learn the processes which are fundamental in woodworking. An excellent chapter on wood finishing is included in this book. Such subjects as stains, applying filler, applying shellac, varnish, wax, and lacquer are given a thorough explanation. The content of this book is designed for a two-year course in general woodworking.3

The combined efforts of Verne C. Fryklund and Armand J. LaBerge were used in writing a book entitled General Shop Woodworking. Fundamentals of woodworking are the main topics of discussion in this book. The book is readily adaptable to the unit shop or to the general shop, with more emphasis placed on woodworking.

In this book the subject of finishing, as are the other subjects, is presented in unit form. Lacquer, varnish, shellac, paint, oil stains, and water stains are presented in short, concise units. The material in each unit is very easy to understand. This book is written with the idea that the instructor must teach the operations and the learner must solve the problems of the shop. In this manner

the learner must plan his procedures and perform the manual work properly to complete his project in an acceptable way.

Herman Hjorth wrote a book entitled Principles of Woodworking. In this book the fundamental uses of tools common to all woodworking trades are compiled and introduced in family groups. With these family groups as a basis from which to work, cabinetmaking is emphasized throughout the entire book. The actual operation of tools has been described and written in the form of instruction sheets. Special emphasis is placed upon the method of planning and analyzing various tool operations involved in the actual construction of the projects. One chapter is devoted to the subject of wood finishing. The origin of the finishing materials, the chemical content, as well as the actual application of the materials, are treated.

Woodwork for Secondary Schools by Ira Samuel Griffith and George B. Cox was written primarily for use as a text for the secondary schools. This book includes a treatment of the tools and machines, as well as processes, used in the industrial arts programs. A chapter pertaining to the introductory phases of carpentry is included. A short chapter is devoted to the selection and use of finishing materials.

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4 Verne C. Fryklund and Armand J. LaBerge, General Shop Woodworking.

5 Herman Hjorth, Principles of Woodworking.
equipment and processes. More emphasis is placed on spraying facilities rather than the use of a brush. An excellent chapter on common woods and building materials could be used for a study of the science of trees.\(^6\)

Alfred B. Grayshon wrote a book entitled *General Metalwork*. The primary purpose of this book is to present a course of information and practical projects which will appeal to boys of the Junior High level, in general metalwork. None of the projects included in this book requires much time to finish; therefore, a student will be able to cover a series of projects involving a number of processes of construction and finishing in one term. The subject of finishing metal projects was given very little attention in this book.\(^7\)

F. E. Tustison and Ray F. Kranzusch combined their efforts in a book entitled *Metalwork Essentials*. Designed primarily for beginning courses in metalwork, this book presents working units that provide instructional material for unit shops in industrial arts. Units are composed of elementary experiences selected from a large range of metalworking, which are written on the Junior High level of

\(^6\)Ira Samuel Griffith, *Woodwork for Secondary Schools*.

\(^7\)Alfred B. Grayshon, *General Metalwork*. 
instruction. Particular emphasis is placed on cutting, shaping, forming, fastening, and finishing of the common metals. Such finishing materials as colored lacquer, enamel, wax, shellac, and linseed oil are discussed in their relation to metal finishing.\textsuperscript{8}

\textit{Units in Bench Metal Work} by Robert E. Smith, presents a discussion of the fundamentals that a student is likely to encounter in general metal work. Such subjects as layout, bill of materials, holding devices, files, how to bend cold metal and how to apply an oil, lacquer, enamel, or wax finish on metals are treated. This book lends itself to the second year of metalwork in the secondary schools.\textsuperscript{9}

John L. Feirer wrote a book entitled \textit{General Metals}, to cover the general metal area of a general shop. The manipulative processes of the tools used in metalwork are discussed thoroughly. In addition, such subjects as safety and consumer information about metal are given some needed attention. The subject of finishing is given a very short discussion in one chapter. An excellent book for the last year in high school, the technicality of the book tends to limit it to this class.\textsuperscript{10}

\begin{itemize}
\item \textsuperscript{8}F. E. Tustison and R. F. Kranzusch, \textit{Metalwork Essentials}.
\item \textsuperscript{9}Robert E. Smith, \textit{Units in Bench Metalwork}.
\item \textsuperscript{10}John L. Feirer, \textit{General Metals}.
\end{itemize}
Finishing Materials Recommended for Wood Projects in an Industrial Arts Program

The importance of finishing must be stressed when the process of finishing a project is approached, because a good finish can make a poorly constructed project outstanding in beauty, and a poor finish will detract from the most carefully constructed piece of woodwork. Instructors should recognize the importance of a good finish and emphasize its importance to the students. The time and patience involved in preparing for and applying a finish are two equally important factors to be stressed.

In recommending finishes to use in an industrial arts program, the following are the most popular: lacquer, varnish, shellac, paint, stains, and bleaching. Individual taste enters into the choice of which finish is the easiest to apply and the most satisfactory in appearance. Each of these finishes will be presented in relation to their use in a recommended industrial arts program.

Lacquer as used on wood projects in an industrial arts program.--Lacquer is a complex chemical product composed of nitrate cotton, solvent naphtha, banana oils, alcohol, and other chemicals. It forms a hard durable surface which withstands extreme temperature changes without cracking and checking; however, the chief advantage of the use

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of lacquer lies in the fact that it dries dust free in from one to two hours. It would, therefore, be an ideal finish for use in shops with limited floorspace. The use of lacquer as a finish is not new, as it was used in its early form by the Chinese several hundred years ago.

In the application of lacquer, care should be taken to apply a thin sealing coat of shellac as a base over an ordinary wood filler. Lacquer contains banana oil which includes in its composition some of the same ingredients used in varnish and paint remover. The muddy appearance sometimes seen in a lacquer finish is caused by the lacquer's having dissolved the undercoats applied previously.

The speed found in the drying time of lacquer can be a liability as well as an advantage. Lacquer is best applied with a spraying machine or airbrush, rather than by hand brushing; however, care must be taken in machine spraying since lacquers are very volatile. An exhaust fan and duct should be provided to remove excess lacquer in the air, for lacquer vapor constitutes a fire hazard that even a chance spark from an electric motor could ignite.

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12 Ibid.
13 Fryklund and LaBerge, op. cit., p. 108.
14 Hjorth, op. cit., p. 361.
15 Johnson and Newkirk, op. cit. p. 95.
There are several different types of lacquers, and each brand has a special thinning solvent which is usually not interchangeable with another type of lacquer. In spite of the foregoing disadvantages, lacquer, when applied carefully by hand or spray, is an excellent, durable, and fast-drying finish. In addition, lacquer is available in a variety of colors as well as in a clear transparent finish.  

The use of varnish as recommended for finishing wood in industrial arts programs.—The proper application of varnish is one of the most difficult of finishing operations, and unless certain precautions are taken, a rough ugly surface will result, rather than the smooth surface desired. Varnish is inclined to become dull and to crack with age, and it is also essential that a special, dustproof finishing room be provided for its application. Even in view of these disadvantages, varnish produces a beautiful finish, and is used on the highest grade of cabinet work.

One of the advantages of varnish lies in its workability, for it dries much more slowly than shellac or lacquer, and has a natural tendency to flow and make a smooth surface.

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16 Ibid.
17 Fryklund and LaBerge, op. cit., p. 7.
18 Hjorth, op. cit., p. 362.
19 Johnson and Newkirk, op. cit., p. 93.
Caution should be taken, however, not to brush over the surface too much as this will cause the formation of bubbles.  

Varnish is made from gums or resins, linseed oil, and turpentine, while quick-drying varnishes also contain a drier. There are several kinds of varnish. Some varnishes are used for exterior work, such as spar varnish, and dry quickly; while others are used for furniture, often called "cabinet-rubbing varnishes," and dry slowly. Flat varnish is used for interior woodwork. It produces a dull finish, which can be applied quickly and with much less expense than the rubbed finish.

Shellac and its recommended use on wood projects in an industrial arts program.—Shellac is made by dissolving shellac flakes in denatured or wood alcohol. Usually about four pounds of gum are dissolved to a gallon of alcohol. This proportion is called by professional finishers a "4-pound cut." The shellac flakes have a natural orange-brown color, and thus the original color of shellac is orange. White shellac is produced by a bleaching process.  

20 Ibid.  
21 Hjorth, op. cit., p. 362.  
22 Johnson and Newkirk, op. cit., p. 94.  
24 Johnson and Newkirk, op. cit., p. 92.  
white shellac is the best form for general use, the orange shellac is somewhat tougher and will last longer.\footnote{26}

Shellac is often used as a base coat on pitchy or spongy woods which are to be enameled or painted. This coat keeps the pitch from bleeding through the finish coats and causing discolorations.\footnote{27} One advantage of shellac is that it can be applied directly over a stained surface or over a natural wood. One disadvantage is that although it dries hard, a shellac finish becomes soft and turns white when exposed to moisture.\footnote{28}

The recommended uses of stains in an industrial arts program:\footnote{29}—Stain is applied to wooden articles to tone down the color and to show the grain of the wood more clearly. Often certain species of wood can be stained to imitate another more costly one, providing the grain and texture are similar.\footnote{30}

Stains are classified according to the material of which they are made. The following are the most common:

\footnote{26}{Fryklund and LaBerge, \textit{op. cit.}, p. 107.}
\footnote{27}{Johnson and Newkirk, \textit{op. cit.}, p. 99.}
\footnote{28}{Fryklund and LaBerge, \textit{op. cit.}, p. 107.}
\footnote{29}{S. H. Glenister, \textit{op. cit.}, p. 56.}
\footnote{30}{Hjorth, \textit{op. cit.}, p. 353.}
The most satisfactory stain is the water stain, as it is clear, penetrates deeply, and does not fade. However, one disadvantage is that the stain must be prepared just before it is used.

Dyes of various colors, known as spirit stains, are bought in powder form and mixed with methylated spirits, or alcohol. They are rather difficult to apply as the alcohol evaporates so quickly, and in addition, spirit stains have a tendency to fade when exposed to the light. This type of stain is used predominantly for shading and refinishing old work, as it penetrates more readily than water or oil stains.

Oil stains are satisfactory and are easy to apply. Almost any color is obtainable and they may also be blended together.

31 Hjorth, op. cit., p. 354.
32 Johnson and Newkirk, op. cit., p. 89.
33 Glenister, op. cit., p. 56.
34 Hjorth, op. cit., p. 354.
35 Gregory, op. cit., p. 91.
The acid stains were used extensively in the past, but today are not used very much commercially, as they are dangerous to use and do not produce as good results as the more modern water stains. 36

Paint and its recommended uses in an industrial arts program. --Paint is the most used and possibly the oldest of finishing materials. It is used primarily to preserve and to beautify wood surfaces. 37 However, it can be used on a number of other different surfaces, such as plaster, concrete, brick, and wallboard. Paint is opaque, is available in any color, and has the quality of resisting moisture in any form.

Painted surfaces are divided into two general classes, surfaces with inside finishes and surfaces with outside finishes. 38 The composition of inside paint usually contains more turpentine than linseed oil, as the latter tends to turn yellow. Outside paint is usually prepared with white lead, white zinc, or both mixed with linseed oil and then thinned with turpentine. Raw rather than boiled linseed oil is preferred for outside use.

In the past, paints were mixed only by the expert

36 Hjorth, op. cit., p. 354.
37 Fryklund and LaBerge, op. cit., p. 110.
38 Johnson and Newkirk, op. cit., p. 97.
39 Fryklund and LaBerge, op. cit. p. 110.
painter, but now the best grades can be purchased prepared and ready for use. Paint manufacturing has become one of the leading industries of the United States.

Recommended Facilities for Finishing Projects Made of Wood in the Industrial Arts Program

In many of the industrial arts programs finishing is treated as a stepchild of woodworking. Because of this fact, inadequate facilities are provided. The best efforts of the students and teacher are often wasted because of a crowded shop and finishing facilities that are not suited for the job at hand. Important as the application of a finish appears to be, it should provide enough incentive for the instructor to make an all-out effort to secure modern and up-to-date facilities for his shop.

The finishing room.—The finishing room should be located near enough to the main work shop so that the task of transporting the projects will not be a major one. The ever present hazard of dust must also be taken into consideration. A finishing room should be dust proof with an independent exhaust system to carry off the toxic fumes.41

The size of a finishing room will vary with the possible need at the time the building is constructed. Some

40 Ibid.

forethought should be exercised in forecasting for a gain in future enrollment. E. D. Meyer stated the inadequacies of a finishing room as follows:

Sufficient space is usually provided for classwork in other areas, but storage and drying space for student industrial-arts projects are seldom provided. The shop teacher and students are faced with conditions which compel them to attempt the various finishing operations in a corner of a shop, near dust producing machines or an open door or passageway. Students cannot be expected to produce a very presentable finish under such conditions.

The height of the ceiling is another problem that should receive careful planning. Most authorities agree that a ceiling ranging from fourteen feet to sixteen feet is adequate.

The windows of a finishing room should be on the ratio of 20-25 per cent of the floor space and should extend to the ceiling. They should be located on the north side to eliminate the problem of bleaching from sunlight. If it is necessary to supplement the natural light with artificial light, it is recommended that 30 foot candles be used.

Storage of finishing material.--Because of the organic

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mixtures of finishing materials, they must be stored and handled properly if they are to provide the best results. Finishing materials should not be exposed to extremes of heat or cold as this may harm the material. A temperature of at least 60°F is considered adequate for paint storage rooms. Caution must be exercised to prevent storage of finishing materials near steam radiators, or other types of heating units. Under no circumstances should finishing materials be stored outside. 45

Many problems will be eliminated if the suggestions mentioned are followed when the construction of cabinet space is begun. There should be enough cabinet space to allow proper storage of all the finishing materials used in the shop. 46

Spray equipment.—Almost every other phase of industrial arts has undergone a change in the last few years. The band saw has replaced the turning saw, the lathe that was operated by foot power is gone, the power saw, mortiser and power jointer are pieces of modern equipment now in use in the shop. With such changes taking place in the other parts


of a shop, it is necessary that the most modern equipment be used in the application of a finish.\textsuperscript{47}

For economy and best results it is better in the long run for the school shop to use an air compressor when continuous spraying is to take place. The best external mix spray gun should be acquired. Most spraying defects can readily be traced to an inferior spray gun.\textsuperscript{48} It must be remembered that most of these high school students will not have spraying machines when they have their own homes and should be taught how to put on finishes with a brush.

In applying all finishes by hand, the brush plays as important a part in obtaining a successful finish as does the mixture used or the method of operation followed in its application. In buying a brush, it is well to remember that there is no substitute for quality, and that a good brush will last indefinitely depending upon the type of care it receives.

There are countless types of brushes manufactured today, each with a particular use in the finishing room. One of the more important is the dusting brush, which should always be used to brush off particles of dust and dirt before any finish is applied. It should always be kept clean and should have long, fairly stiff bristles to give the best results.

\textsuperscript{47} E. D. Meyer, \textit{op. cit.}, p. 30A. \textsuperscript{46} Ibid., p. 39A.
Most varnish and paint brushes used are made of bristles set in rubber. However, camels hair, ox hair, and substitute fibers are frequently used.

In taking care of the brush, the most important point to remember is to clean the brush thoroughly before storing it. Ordinarily brushes should be cleaned in the solvent of the paint or finish which has been used. If the brush is used frequently, it is well to store the brush in the solvent as it will keep the bristles pliable and ready for use.49

Materials Recommended for Finishing Metal Projects in an Industrial Arts Program

Since metal is being so widely used and is rapidly replacing wood and other materials, a great need exists to study some of the methods used in finishing metal projects. The durability, strength, and safety of metals are mainly responsible for their increased demand. This general increase in the use of metals makes it desirable for the student to become more familiar with their characteristics.

In recommending finishes to be applied in the metal courses of an industrial arts program, the following processes are the most popular: wrinkle finish, lacquer, hammered finish, wax finish, coloring with heat, and paint and enamels. Each of these finishes will be presented in the light of the metal finishes recommended.

49Johnson and Newkirk, op. cit., p. 87.
The use of a wrinkle finish on metal projects.--Many commercial metal products such as window fans, heaters, sweepers, and metal furniture have a wrinkle finish. In many instances a student will desire a finish of this nature to give his project a professional appearance. With an ordinary baking oven this type of finish can be easily duplicated in the metal shop. The wrinkle finish is of the fast-drying type and has a very good covering quality. This finish is suitable for the shop that has a limited space for drying projects.

The use of lacquer on metal surfaces.--If the original appearance of a metal is desired, this can best be obtained by applying a clear or transparent coating. The most frequently used coating for this purpose is clear lacquer. Copper and brass are very often polished to a high lustre and then preserved with a clear coat of lacquer.

Best results can be obtained by spraying lacquer, since it dries very rapidly; however, good results can be obtained by brushing lacquer on the project. Care must be taken to apply the lacquer rapidly as it sets up very fast, and attempts to retouch a lacquer coating may result in overlapping at the edges which causes an unsightly mar. In most cases.

50 Feirer, op. cit., p. 79.
51 Tustison and Kranzusch, op. cit., p. 105.
52 Smith, op. cit., p. 42.
instances, lacquer will be the less expensive finishing material. A container of lacquer may be left attached to the spray gun indefinitely and then be used again without a loss of material. The lacquer will be ready for spraying without even stirring.

The hampered metal finish.—A plain metal surface that may be uninteresting, even though it has a high polish, can be made more attractive by hammering or peening the surface. The ball-peen hammer is used most extensively in the process of hammering. Each student will be able to exercise his own creative ability in figuring out the design that will be best suited for his particular project. This process also lends itself for use in the small shop that does not have an excess of equipment.

Wax finish on metals.—Many of the metal projects will retain their professional appearance best if they are allowed to remain in their natural color. A wax finish protects the surface without a noticeable change in appearance.

In almost every instance a wax finish may be applied to a metal surface by heating the metal, but if necessary, the wax can be heated and applied to the metal. Either procedure will give a satisfactory result. It is well to keep in mind

53 Meyer, op. cit., p. 482. 54 Ibid., p. 40.
55 Smith, op. cit., p. 42.
that a wax finish is not a permanent one, but is only a temporary arrangement until a better coating can be applied. 56

Coloring with heat as used to finish metal projects.--
Many times the instructor will find himself in a situation where he needs a quick finish for small projects, such as punches, chisels and scribers. Coloring with heat is very acceptable for these articles. The heat can be that from a bunsen burner, therefore eliminating the use of a forge. After the desired colors have been achieved by heating, the articles should be coated with clear lacquer to preserve the colors. 57

The use of paints and enamels for finishing metals.--
In many metal shops, paint and enamel are the favorite types of coating applied to metal projects. This could be attributed to a carry-over from finishing in the wood shop. For the beginner, paints and enamels are easy to apply as well as giving very satisfactory results where an opaque finish is desired. In addition to being easy to apply, they do not dry as rapidly as lacquer and allow the student a chance to retouch his finish. Flat-drying paints or enamels are used most frequently. 58

56 Grayshon, op. cit., p. 231.
57 Feirer, op. cit., p. 79.
58 Tustison and Kranzusch, op. cit., p. 104.
Facilities Recommended for Finishing Metal Projects in an Industrial Arts Program

Frequently the finish of a project is judged by commercial standards and very little consideration is given to the sub-standard conditions under which the finish is applied. As important as the application of a finish is thought to be, an effort to supply proper equipment should be a must for every school administration. Very little emphasis has been placed on the importance of or the type of facilities to be used in the metal shop. This in itself tends to reveal that the facilities have been neglected.

Spray equipment.--Running parallel with materials in importance is the facilities for applying the material that is to protect the surface. In order to keep pace with the faster drying new materials, it is necessary to have faster ways to apply such materials. This has been accomplished by the installation of spraying equipment.

The compressor.--The compressor unit should be equipped with an automatic pressure control and with a pressure switch to cut off the electric motor when the maximum pressure has been reached, to turn it on again when the pressure has dropped below a set figure. Only approved compressors should be used. In almost every shop where continuous spraying is required, pressure feed tanks will provide a
practicable and economical method of feeding air into the spray gun.  

The spray gun.---Many of the complaints discussed in relation to spraying can be traced to a very inadequate spray gun. One demonstration and comparison of the results obtained with an inferior spray gun and those obtained with a superior spray gun will convince the instructor that it is wise to purchase the superior spray gun. The external mix type of spray gun is highly recommended and is preferred because of the greater degree of control of the spray pattern and material.  

The use of brushes in metal finishing.---In finishing metal projects, spray guns and air brushes are generally used; however, in some shops this equipment is not available. In such cases brushes can be and are used to apply a finish of lacquer, paint, or enamel. The form used in hand-brushing metal finishes is much the same as applying a finish on wood by hand-brushing.  

Summary.---The third chapter presents the finishing techniques recommended for use in the secondary schools of Texas. The information was gathered from ten text books recommended and used by the industrial arts departments and from magazine articles written by leading educators in school planning.

59Meyer, op. cit., p. 31A.  
60Ibid., p. 39A.
CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA CONCERNING FINISHING
FACILITIES AND PROCESSES USED IN NINETY-FIVE
INDUSTRIAL ARTS PROGRAMS IN TEXAS

In order to determine the average number of classes taught in woodwork and metalwork, and the average number of students having access to these particular facilities in the secondary schools of Texas, questionnaires were mailed to the industrial arts instructors in schools selected according to their size and location. As nearly as possible an equal number of schools in each size range received these questionnaires. In tabulating the returned forms, it was found that the average number of classes taught each day by the instructors in wood were four, while the average class consisted of twenty-five students. Metalwork instructors taught an average of three classes each day with an average class consisting of twenty students.

Location and Size of Finishing Rooms or Areas for Woodwork and Metalwork

There are differences of opinion in respect to the most suitable location of the finishing rooms or areas for both woodwork and metalwork. Some shops have an adjoining room for this purpose, while others have rooms located down the
hall from the shop proper, or a room set aside upstairs or downstairs in the same building. In some schools it is not convenient to have a separate room at all because of overcrowded conditions in the school or because of small shop classes. In such cases, the instructor set aside an area in the shop proper which is used specifically for finishing projects either in woodwork or metalwork and sometimes both, if the teacher instructs general shop classes. After computing the information received on the questionnaires concerning the location of the finishing room with respect to the rest of the industrial arts shop, the writer found that the results could be presented more advantageously in the following table.

**TABLE 1**

**LOCATION OF THE FINISHING ROOM WITH RESPECT TO THE REST OF THE INDUSTRIAL ARTS SHOP**

<table>
<thead>
<tr>
<th>Wood Shop</th>
<th>Metal Shop</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td><strong>Number</strong></td>
</tr>
<tr>
<td>Adjoining room</td>
<td>69</td>
</tr>
<tr>
<td>Upstairs.</td>
<td>3</td>
</tr>
<tr>
<td>Downstairs.</td>
<td>5</td>
</tr>
<tr>
<td>Same room.</td>
<td>13</td>
</tr>
<tr>
<td>Separate building.</td>
<td>0</td>
</tr>
<tr>
<td>Down the hall.</td>
<td>5</td>
</tr>
</tbody>
</table>
In tabulating the returned questionnaires it was found that the majority of industrial arts shops had access to a separate room for finishing projects in woodwork. This is probably due to the fact that a dust-free room is more suitable in producing a clean, clear finish. Seventy-five instructors reported having a separate room available to students for finishing their projects; while only fifteen did not have access to these separate facilities.

In metalwork classes 50 per cent of the instructors have separate finishing rooms available to the classes for finishing purposes. Finishing materials and procedures used in metalwork as compared with those used in woodwork projects may well have an effect on whether separate finishing facilities are necessary.

In some cases, separate rooms are not available for woodwork as well as metalwork classes. In such instances, most instructors set aside a different area in the shop that is used expressly for finishing purposes. Twenty-five woodworking instructors have this type of facility available for students as compared to 19.3 per cent who have no specific area set aside for finishing, and the same is true in metal work, the proportion being about 5 per cent higher.

The floor space available either in the form of a separate finishing room or area, varies a great deal. This probably is because of the number of students enrolled in woodwork classes, or because of the housing conditions of the
school itself. The range in the number of square feet per room or area was from 60 to 280, and is generally in accord with the number of students enrolled in the woodwork classes.

In metalwork, where projects are generally small and classes run comparatively less in number with respect to students than woodwork, the average finishing area is smaller. The range in number of square feet was from 20 to 124, or an average of 70 square feet per area.

The storage facilities available in the finishing room for student projects are also an important aspect to be considered in the planning of a finishing room. Although the area reported as being available appears adequate for the students at the time they are finishing their projects, space was reported as being limited for storing these projects afterwards for any length of time. In woodwork classes, forty-seven instructors reported they had enough space available for the extended storage of projects, while forty-eight reported they could not conveniently keep projects in the finishing room over too long a period of time. In metalwork classes, approximately two thirds of the instructors reported they did not have adequate storage space available in the finishing rooms for the storage of students' projects.
Facilities Available for Finishing Wood and Metal Projects in Ninety-Five Industrial Arts Programs

If finishing is done effectively, the finishing room must be relatively free of dust. In answer to the question, "Is the finishing room relatively free of dust?" sixty of the instructors, or 63.2 per cent, reported they thought the finishing room they used for woodwork was relatively free of dust; and six instructors, or 37.5 per cent, thought the metal finishing room free of dust.

The nature of the work done in a finishing room makes good lighting facilities a necessity. If there is not enough natural light, it is necessary to supplement it with artificial light. Sixty-four woodshop instructors, or 67.4 per cent, reported that they thought their finishing rooms had adequate lighting. In the metal finishing room only ten instructors, or 61.9 per cent, considered the lighting adequate for proper finishing.

Ventilation is a very important factor to be considered in an industrial art shop. The proper type of ventilation is more important in the finishing room. In response to the question, "Is the finishing room equipped with an exhaust fan?" forty-five of the instructors, or 47.5 per cent, reported that the finishing room for woodwork was equipped with an exhaust fan. While in the metal shop six instructors, or 37.5 per cent, reported that the finishing rooms were equipped with an exhaust fan.
Storing of material is a problem for the industrial arts instructor. A question designed to ascertain what facilities were provided to store finishing materials was included in the questionnaire. Table 2 shows the type of facilities used for storing finishing materials in wood and metal finishing rooms. In the woodshop finishing rooms, 54 instructors reported they stored their materials in cabinets, while 42 instructors used a combination of cabinets and open shelves. In the metal shops, 14 of the instructors used a combination of open shelves and space under the work benches for storing finishing material.

**TABLE 2**

**FACILITIES USED FOR STORING FINISHING MATERIALS IN WOOD AND METAL SHOPS**

<table>
<thead>
<tr>
<th>Wood Shop</th>
<th>Metal Shop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of Facilities</td>
<td>Number of Instructors Using</td>
</tr>
<tr>
<td>On Open Shelves</td>
<td>42</td>
</tr>
<tr>
<td>In Cabinets</td>
<td>54</td>
</tr>
<tr>
<td>Under the Workbenches</td>
<td>11</td>
</tr>
</tbody>
</table>

The best equipped industrial arts shop does not guarantee a beautiful finish on projects if the proper materials are not available to the student. The size of the finishing
room, type of projects most commonly constructed, storage space available, and the number of students in a class are determining factors in the selection of the materials to be used. Table 3 presents a tabulation of the materials most commonly used for finishing projects made of wood.

<table>
<thead>
<tr>
<th>Material</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filler paste</td>
<td>89</td>
</tr>
<tr>
<td>Water stain</td>
<td>30</td>
</tr>
<tr>
<td>Oil stain</td>
<td>72</td>
</tr>
<tr>
<td>Spirit stain</td>
<td>29</td>
</tr>
<tr>
<td>Shellac as a sealer</td>
<td>65</td>
</tr>
<tr>
<td>Sanding sealer</td>
<td>46</td>
</tr>
<tr>
<td>Pumice</td>
<td>57</td>
</tr>
<tr>
<td>Rotten stone</td>
<td>39</td>
</tr>
<tr>
<td>Brushing varnish</td>
<td>72</td>
</tr>
<tr>
<td>Spraying varnish</td>
<td>32</td>
</tr>
<tr>
<td>Brushing lacquer</td>
<td>40</td>
</tr>
<tr>
<td>Spraying lacquer</td>
<td>40</td>
</tr>
<tr>
<td>Brushing shellac</td>
<td>55</td>
</tr>
<tr>
<td>Paint</td>
<td>53</td>
</tr>
<tr>
<td>Oil</td>
<td>39</td>
</tr>
</tbody>
</table>

Information showing the types of materials or processes used in the finishing of metal projects is presented in Table 4. Lacquer, enamel, and the hammered finish were considered the most popular type of finish in the metal shop. Bronzing, electroplating, and blueing were less popular as finishes for metal.
TABLE 4

MATERIALS OR PROCESSES MOST COMMONLY USED TO FINISH METAL PROJECTS

<table>
<thead>
<tr>
<th>Material</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacquer</td>
<td>15</td>
</tr>
<tr>
<td>Enamel</td>
<td>15</td>
</tr>
<tr>
<td>Bronzing</td>
<td>1</td>
</tr>
<tr>
<td>Hammered</td>
<td>15</td>
</tr>
<tr>
<td>Electroplating</td>
<td>1</td>
</tr>
<tr>
<td>Plating</td>
<td>1</td>
</tr>
<tr>
<td>Blueing</td>
<td>6</td>
</tr>
</tbody>
</table>

In respect to the spraying equipment found in the average finishing room, the instructors were asked to check the equipment listed on the questionnaire which was available in their finishing room. The differences in equipment found in the various industrial arts shops did not vary to a great extent and the majority of the shops were well equipped for finishing projects. Twenty-five schools did not have any spraying equipment available; however, these schools had a comparatively low enrollment and the industrial arts classes were proportionately small. In such instances, brushing and rubbing finishes, which are applied by hand, are more practical for smaller groups.

A spray gun was available in the majority of the woodworking and metalworking finishing rooms. Approximately one-half of the woodshops equipped with a spray gun were also equipped with a spray booth. A high percentage of the
finishing rooms were equipped with air compressors and air storage tanks. Portable spraying equipment was usually found in conjunction with a finishing room having a spray gun and booth. In addition to the aforementioned finishing equipment respirators, regulators, and vapor proof lights were available in many of the industrial arts shops.

The metalwork instructors also were asked to check the same list of spraying equipment to ascertain what equipment was available to the students in finishing their projects. The results and comparison are presented in Table 5.

**TABLE 5**

**SPRAYING EQUIPMENT AVAILABLE IN THE FINISHING ROOM**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Wood Shop</th>
<th>Metal Shop</th>
</tr>
</thead>
<tbody>
<tr>
<td>No spraying equipment</td>
<td>25</td>
<td>No spraying equipment 4</td>
</tr>
<tr>
<td>Spray gun</td>
<td>59</td>
<td>Spray gun 10</td>
</tr>
<tr>
<td>Spray booth</td>
<td>25</td>
<td>Spray booth 4</td>
</tr>
<tr>
<td>Vapor proof lights</td>
<td>29</td>
<td>Vapor proof lights 7</td>
</tr>
<tr>
<td>Air compressor</td>
<td>58</td>
<td>Air compressor 11</td>
</tr>
<tr>
<td>Air storage tanks</td>
<td>29</td>
<td>Air storage tanks 8</td>
</tr>
<tr>
<td>Portable spraying</td>
<td>28</td>
<td>Portable spraying equipment 5</td>
</tr>
<tr>
<td>equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respirators</td>
<td>24</td>
<td>Respirators 4</td>
</tr>
<tr>
<td>Regulators</td>
<td>37</td>
<td>Regulators 6</td>
</tr>
</tbody>
</table>

In regard to safety measures taken in the finishing rooms, the instructors were asked whether a fire-proof
container was available to the students for disposal of waste rags. In the woodwork shops there were twice as many finishing rooms which had the containers as compared to those that did not. In metalwork classes, however, the percentage was very low in regard to the finishing rooms not having fire proof containers.

In the questionnaire the instructors were asked to give their opinion as to whether they believed they received adequate preparation in the area of finishing in their college preparation. Sixty instructors reported they believed their college preparation had been adequate. The thirty-five who indicated that their college instruction had been inadequate suggested practical courses in finishing and refresher courses designed to keep industrial arts instructors abreast of the new methods and procedures of finishing currently being developed.

Chapter IV presents the information received from ninety-five industrial arts instructors in Texas concerning the facilities available and the finishing procedures and materials used in their particular schools. The information was obtained from a questionnaire mailed to industrial arts teachers. Ninety-five of the questionnaires were returned complete and these were compiled in order to ascertain the most common finishing procedures taught and the finishing room facilities available. The instructors were asked their opinion concerning the adequacy of their college industrial arts courses in finishing.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine the extent to which the finishing facilities and procedures used in industrial arts programs in the secondary schools of Texas were similar to those recommended and used in industry. The study was limited to an investigation of ninety-five secondary schools which included industrial arts in their curriculum. The study was further limited in that only the finishing of wood and metal products were treated. Data were obtained through a questionnaire which was mailed or presented in person to the industrial arts instructors in the secondary schools of Texas. The data included information on the facilities provided, materials and equipment available for finishing projects and the procedures actually followed in applying a finish.

Information concerning industrial finishing was obtained from letters mailed to leading manufacturers of paint, furniture, and finishing equipment requesting any literature which they might have available concerning industrial finishing. Subsequently the data obtained from the questionnaires and from the industrial literature were tabulated, presented and analyzed to determine whether the
refinishing facilities and processes used in the industrial arts programs in the secondary schools met with the recommended requirements and how they compared with modern industrial finishing rooms. Conclusions were drawn from the data and the analysis and recommendations were made in accordance with the situations based upon the findings of the study.

Conclusions

The following conclusions were developed after a study of the data that were presented:

1. The majority of the finishing rooms in the industrial arts shops are located adjacent to the shop proper.

2. The average finishing room covers approximately ninety-five square feet and is adequate for the average number of industrial arts students participating in the shop courses.

3. Only a very small percentage of the industrial arts shops have sufficient space available for storing finishing material.

4. Sixty-seven per cent of the industrial arts instructors reported that in their opinion the lighting was adequate in the finishing rooms where they taught.

5. Ventilation was reported as being adequate in only 47 per cent of the industrial arts finishing rooms.
6. In order to attain natural lighting, the finishing rooms in most industrial plants are located on the north side of the building, where lighting remains uniform most of the day.

7. Industry recommends and uses an effective type of exhaust system for ventilation purposes, which operates as a complete unit rather than at individual points around the plant.

8. The facilities available for finishing have a direct effect on the type of finish applied.

9. A majority of the instructors reported they had access to spray equipment for finishing purposes.

10. Of the industrial arts shops having access to spray equipment, only 12 per cent of them reported that the equipment was in good working condition.

11. Woodwork is predominantly taught in the secondary schools and metalwork is not emphasized to a great degree.

12. The materials most commonly used in finishing wood projects were filler paste, oil stain, and brushing varnish.

13. The most popular processes and materials used in finishing metal projects were lacquer, enamel, and the hammered effect.

14. A majority of the instructors were of the opinion that their college preparation in the area of finishing was adequate for their needs.
15. The majority of the instructors who did not believe they received adequate preparation in the field of finishing in their college courses recommended occasional refresher courses in this area.

16. Only 50 per cent of the finishing rooms were equipped with fire proof containers for waste storage.

17. Finishing facilities in the majority of the industrial arts shops studied are adequate and meet the requirements as set forth for secondary industrial arts departments.

Recommendations

1. More industrial arts courses pertaining to the actual finishing procedures, and courses which include the individual characteristics of each finish, should be offered by institutions of higher learning.

2. Institutions of higher learning preparing teachers should offer periodic refresher courses designed to keep industrial arts instructors adequately informed as to new materials, finishing procedures, and finishing equipment.

3. There should be more emphasis placed on metalwork, the materials used, the finishes available, and procedures followed in finishing of metal projects.

4. Colleges preparing industrial arts teachers should stress the importance of the proper finishing techniques to prospective industrial arts teachers before they teach.
5. Housing facilities for industrial arts programs should be planned so as to provide additional space for storing projects for extended periods of time.

6. Closer contacts should be maintained by industrial arts teachers with industrial finishing plants, in order that new procedures, materials, and equipment can be observed, analyzed, and adapted, if practical, to industrial arts classes in the secondary schools.
SAMPLE QUESTIONNAIRE

Dear

I am making a study of facilities and processes of finishing in industrial arts programs. An effort has been made to construct this questionnaire in such a manner that it will require a minimum of your time to supply the data. Your cooperation in this study will be greatly appreciated.

I can assure you that names of individuals and institutions will be kept strictly confidential. Supplementary comments and statements you wish to make concerning facilities and processes used in your teaching program will be appreciated.

Yours very sincerely,

Al Brank
Graduate Student

Name of School________________________Instructor_________________________

1. How many classes of Industrial Arts do you teach each day in woodwork? (___) Metalwork (___)

2. What is the total number of students that you teach in woodwork? (___) Metalwork (___)

3. Do you have a separate room that is used for the finishing of projects? Woodshop Yes__No__; Metal shop Yes__No__

4. If you do not have a separate room for finishing, do you have an area set aside for finishing projects? Wood shop Yes__No__; Metal shop Yes__No__

5. What is the approximate size of the finishing room or area? Wood shop_____sq. ft.; Metal shop_____sq. ft.

6. Where is the finishing room located with respect to the rest of the industrial arts shop?

   Wood shop                               Metal shop
   Adjoining room___                        Adjoining room___
   Upstairs________________               Upstairs________________
   Downstairs________________             Downstairs________________
   Same room________________             Same room________________
   Separate building__                   Separate building__
   Down the hall___                      Down the hall___
   Other location___                     Other location___
7. Is the finishing room equipped with an exhaust fan?  
Wood shop Yes____ No____; Metal shop Yes____ No____

8. Is the finishing room, or area, of sufficient size to permit the storing of projects for a period of time?  
Wood shop Yes____ No____; Metal shop Yes____ No____

9. How are the finishing materials stored in each of the shops?  
Wood shop  
On open shelves____  In cabinets____  Under the work-benches____
Metal shop  
On open shelves____  In cabinets____  Under the work-benches____

10. Is the finishing room relatively free of dust?  
Work shop Yes____ No____; Metal shop Yes____ No____

11. Is the industrial arts shop in which you teach equipped with a fire proof container for waste rag storage?  
Wood shop Yes____ No____; Metal shop Yes____ No____

12. Is the finishing room lighted adequately?  
Wood shop Yes____ No____; Metal shop Yes____ No____

13. How is the finishing room equipped with respect to equipment? Check the items that are present.  
Wood shop  
No spraying equipment____  Spray gun____  Spray booth____  Vapor proof lights____  Air compressor____  Air storage tanks____  Portable spraying equipment____  Respirators____  Regulators____
Metal shop  
No spraying equipment____  Spray gun____  Spray booth____  Vapor proof lights____  Air compressor____  Air storage tanks____  Portable spraying equipment____  Respirators____  Regulators____

If the above items are present are they in good working condition? Yes____ No____
14. Check the materials and processes you most commonly use to finish metal projects?

- Lacquer
- Electroplating
- Enamel
- Plating
- Bronzing
- Blueing
- Hammered

15. Check the materials you most commonly use to finish wood projects?

- Filler paste
- Brushing varnish
- Water stain
- Spraying varnish
- Oil stain
- Brushing lacquer
- Spirit stain
- Spraying lacquer
- Shellac as a sealer
- Brushing shellac
- Sanding sealer
- Oil
- Paint
- Shellac, as a sealer
- Oil
- Rotten stone
- Others

16. Do you believe that you received adequate preparation in the area of finishing in your college preparation?

- Yes
- No

17. If the answer to the above question is no, please list the type of preparation and experiences which you believe would prepare industrial arts teachers in the area of finishing.
BIBLIOGRAPHY

Books

Brown, Sam, How to Paint with Brush and Spray, Chicago, Popular Mechanics Press, 1951.

Crewdson, Frederick M., Spray Painting, Chicago, Frederick J. Drake and Company, 1943.


Articles


"Ceiling Heights in School Shop Planning," Industrial Arts and Vocational Education, XL (September, 1953), 211.


Murphy, George, "Making and Painting Car Heaters," Automotive Industries, XXIV (July 1, 1954), 104.


Bulletin

Advertising Brochures

**Heating, Piping and Air Conditioning**, (a brochure, no date given), DeVilbiss Company, Toledo.

**How To Paint**, No. RF30-99332, (a brochure, no date given), Sears Roebuck and Company, Chicago.

**Oil Stains**, CC105E, (a brochure, no date given), Pratt and Lambert, Chicago.

**Pittsburgh Plate Glass Company**, No. 53, (a brochure, no date given), Pittsburgh Plate Glass Company, Pittsburgh.

**Pure Shellac**, (a brochure, no date given), The Glidden Company, Cleveland.

**Scuff Proof Floor Enamel**, No. 125330, (a brochure, no date given), Cook's Paints, Kansas City.

**Spray Gun**, (a brochure, 1954), DeVilbiss Company, Toledo.


Unpublished Material

