

A COMPARATIVE STUDY OF CLEAR WOOD FINISHES

by

JACK LEON KUGLER

B.A., Seattle Pacific College, 1952

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Industrial Engineering and Industrial Arts

KANSAS STATE UNIVERSITY
OF AGRICULTURE AND APPLIED SCIENCE

1959

TABLE OF CONTENTS

	Page
INTRODUCTION.	1
TYPES OF FINISHES	2
APPLIED TESTS	4
Liquid Color.	4
Storage	5
Dust-free Drying Time	5
Self-Leveling	6
Applied Color	6
Unrubbed Finish	7
Abrasion Resistance	7
Water Test.	8
Chemical Resistance	9
Build Up.	9
Sun Test.	10
Thinner or Cleaner.	10
Cost per Gallon	10
Coverage.	10
CONCLUSIONS	11
ACKNOWLEDGMENT.	13
BIBLIOGRAPHY.	14
APPENDIX.	16

INTRODUCTION

During the period of the last decade, chemistry has become an increasingly important part of the finishing industry, resulting in the development of new types of finishes. Shellac and varnish, and the combination of the two in the form of an undercoat and a finish coat, were in the past the only methods used in clear finishing. Woods were often stained heavily before the application of the finish, thus hiding their natural beauty.

With the advent of contemporary furniture construction came the rise of natural wood finishing. Shellac and varnish were inadequate because of their physical properties. They changed color with age, dried slowly, and did not provide satisfactory chemical resistance. Through chemical processes, new types of finishes have been developed which are better suited to the specifications required by furniture manufacturers.

Not many courses have been offered by teacher-training colleges in finishing materials. The information concerning finishes which Industrial Arts teachers do receive comes as a result of their working with them in their regular woodworking classes.

After four years of dissatisfaction with the types and quality of finishes obtained on student projects in the writer's school system, it was decided to make a comparative study of clear wood finishes with the hope of finding the ones best suited to school shop purposes.

The finish selected should be of a type which could be

applied by the students. Many times the finish was applied by the instructor because the student did not have the experience necessary to produce a finish of high quality. This was especially true when spray equipment was used. Since the student had no experience, the teacher must apply the finish to produce satisfactory results.

TYPES OF FINISHES

Basically, there are three types of clear finishes available for use today. These include shellac, oleoresinous varnishes, and synthetic varnishes. Shellac is produced as a by-product of a small insect found in India and southeastern Asia. This insect sucks the sap of certain trees and their bodies convert the sap into a resinous substance which they deposit, forming a crust on the twigs and branches. This resinous substance is gathered, washed, and, after processing, becomes shellac as we know it. Oleoresinous varnishes come from natural resins known as copal gums. These copal gums are found on decayed pine trees. The natural gum is mixed with drying oils such as linseed or tung oil and becomes varnish.

A synthetic varnish or resin is a man-made resin, created by chemical combinations of compounds in duplication of one of nature's products. Synthetic resins are synonymous with plastics. The composition of synthetic varnishes is quite similar to that of oleoresinous finishing material with the exception of the resin. At first these resins were of the alkyd type, but since

the first discovery of alkyds, many other synthetic resins have made their appearance.

In recent years synthetic varnishes have become strong competitors of natural gum varnishes and, in some instances, are replacing them. Once in the field of synthetic varnishes, chemists have experimented until we now have many types of finishes available for our use today.

One of the most widely used synthetic resin varnishes is nitrocellulose lacquer. This finish is made by dissolving the short fibers of cotton in a solution of nitric and sulphuric acid. When the cotton is nitrated to about 11 to 12 per cent, the acid is drawn off, the material is treated with boiling water, and it is then dehydrated with alcohol under pressure.

Wood lacquers are formulated to produce gloss, semi-gloss, and flat finishes. Gloss lacquers are most commonly used in furniture finishing. The characteristics of a good gloss lacquer are (1) excellent leveling or flowing quality, (2) high solids content, (3) ease of rubbing and polishing, (4) ability to retain gloss, (5) ability to resist print or mar, and (6) water and alcohol resistance.

The finishes used in this testing were obtained by writing to companies which manufacture finishing products, and explaining the nature of the research problem. These companies were selected from McCray's Blue Book, and Thomas' Register of Industries. A total of 51 companies were contacted, with response from 20. These 20 companies furnished a total of 71 finishes, 61 of which were

tested. Those omitted were not recommended as wood finishes, but were suited for plastic or metal finishing.

Five different kinds of wood were selected on which to test the properties of each finish. Walnut, oak, cedar, white pine, and fir plywood were used. These woods were chosen to represent a cross section of what might be found in the school shop. Walnut was chosen because of its beauty and to determine if the finish would cover or enhance its natural beauty. Oak was chosen because of its extreme porosity. The finish applied to each oak sample was checked to observe whether the finish filled the pores. Cedar was selected for its color, in order to learn if the finish would cover or bring out the color. White pine was chosen because of its light color, and to determine if the finish discolored the pine. Fir plywood was used because of its undesirable ability to soak up finish. Three coats of finish were applied to each sample. This number of coats was applied even if the manufacturer recommended two, for the sake of uniformity in the build-up test.

The finishes were applied as directed by the manufacturer, with spray equipment or brush as specified. The method of application was noted on the chart. If the manufacturer recommended reducing the finish, or prescribed an undercoat, this was carried out on the samples.

APPLIED TESTS

Liquid Color

After obtaining samples of all finishes, the first step was

to determine the liquid color of the finish as it came from the can. This was done by pouring the finish into a one and one-fourth ounce cup. The color was then noted and recorded.

Storage

These same cups were then used in the storage test. Each cup, when filled one-half full, was set aside and exposed to the air to observe when spoiling would begin. Close watch was kept of the finishes; the number of hours or days required for the first signs of spoiling to appear was recorded on the chart.

Dust-free Drying Time

Upon application of the third coat of finish, the time of application was noted. Each sample was then carefully watched to observe the time required for that finish to dry, dust-free. When the finish was no longer sticky, or was not catching dust, the time was again recorded, and the original time was subtracted from this, giving the dust-free drying time. Because of the lack of control of dust in most school shops, the finish which requires a long drying period is prone to become rough. This necessitates rubbing the finish with steel wool, or a combination of oil and pumice stone. Those finishes which became rough from dust during this test were numbers 2, 4, 5, 6, 7, 8, 9, 14, 22, 23, 24, 25, 27, 31, 32, 35, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, and 51. The tests showed that varnishes required the longest drying period and, consequently, dried with the roughest surface.

However, it should be noted by studying the chart that certain synthetic varnishes dry rapidly enough to eliminate this problem to a great degree. Those which dry in fewer than 15 minutes are considered to have good drying qualities.

Generally, lacquers, especially those which are sprayed, dry the most rapidly. This not only produces a smoother surface, but allows a second or third coat to be applied in a short period of time.

Self-Leveling

After the finish was applied and allowed to dry, the smoothness of that finish was carefully checked. All finishes which required more than two hours to dry collected enough dust particles to cause them to feel rough to the touch. However, the self-leveling test was an attempt to determine if the finish would flow on smoothly after brushing or spraying. This was done by placing it in a strong light source so that the refraction could be studied for distraction. While in the strong light source, the finish was also studied for brush marks, orange peel, or other defects of the finished surface.

Applied Color

The color of each wood sample was noted before and after application of the finish. Some finishes produced no noticeable color change. This is desirable in producing a finish which will bring out the full beauty of natural wood. Other finishes darkened or yellowed the wood as noted in the chart.

Over a period of years, it is the normal tendency for a finish to darken. This was not included in the testing because of the shortness of the available testing period. It is the intention of the author to keep the finished samples of wood, and to observe them from time to time to determine the extent of darkening which takes place over a period of years.

Unrubbed Finish

The first coat of finish was applied and, after drying, was rubbed down with 0 (medium) steel wool. This same procedure was used on the second coat. The last coat of finish was not rubbed so that the gloss of the finish might be observed.

Abrasion Resistance

Application of three coats of finish having been made, the samples were placed in storage for two months. After this time allowing for the finishes to harden, they were subjected to an abrasion test. This test was conducted with the use of a pointed tool to which weights could be added. When the added weight caused the tool to scratch the finish, the number of grams of weight was noted on the chart. The abrasion resistance ranged from 20 to 270 grams. The average abrasion resistance was 92.9 grams. The high gloss varnishes, as a group, were more easily marred than those of less gloss.

Water Test

Each sample was subjected to water tests. The first test was made by putting ten drops of water on the finished surface. The water dried on most of the surfaces before any damage was sustained. A second test was conducted in which a piece of cloth was kept saturated with water for a period of 24 hours. The cloth was then removed and the sample examined to determine the effects of the water.

Chemical Resistance

Chemical compounds or other substances ordinarily found in the normal household were applied to each finish to determine if damage to that finish would be sustained. A small amount of each substance or chemical was placed on the finished samples and allowed to dry. The damage caused by the chemicals or substance was then noted on the chart. The chemicals and substances are numbered below as they are numbered on the chart. The type of damage sustained to the finish is noted with each.

1. Acetic acid softened the finish; it is found in vinegar.
2. Boric acid spotted or softened finish; it is used as a food preservative, or a disinfectant.
3. Citric acid spotted the finish. It is found in fruit juice.
4. Hydrochloric acid spotted the finish. This acid is found in the stomach. The percentage of acidity in the stomach is 0.5 per cent; this percentage was used on the finishes.
5. Lactic acid bleached and softened the finish. This acid is found in sour milk.

6. Ethyl alcohol softened the finish; this is found in liquors.
7. Menthyl alcohol softened the finish; it is found in paint solvent.
8. Ispropyl alcohol softened the finish; it is found in rubbing alcohol.
9. Lighter fluid softened the finish; it is a petroleum product.
10. Sodium hypochlorite discolored the finish; this is found in laundry bleach (Clorox).
11. Detergent spotted the finish; it is used for washing dishes and clothes.
12. Coffee spotted the finish.
13. Tea spotted the finish.
14. Alkali solution discolored or removed the finish; this was a baking soda solution.

Build-Up

The wood samples used were surfaced to three-eighths inch thickness and cut into a size which could be easily handled and stored. The sample was then sanded, using a floor model belt sander. All wood samples were then measured with a micrometer caliper to determine the thickness in thousands of an inch. This measurement was recorded on each sample, and the exact spot of measurement was marked so there would not be a variation caused by irregularities of the wood. After the third coat of finish was applied and sufficient time allowed for drying, the samples were again measured and the finish thickness or build-up was recorded in thousandths of an inch.

Sun Test

The finished wood samples were placed in the direct sunlight for a period of seven days. One-half of each sample was covered with an opaque substance. The change in color of the samples was noted on the chart.

Thinner or Cleaner

The thinner or cleaner used for proper preparation and application of finishes was taken from the manufacturer's recommendations. The type of cleaner or thinner for a certain finish may be obtained by studying the chart.

Cost Per Gallon

The cost per gallon of finish was obtained from the manufacturers or suppliers. No price was available for some types of finish because of their special nature. The manufacturers would quote prices only if 100 gallons or more were ordered.

Coverage

Coverage was taken from the can, or obtained by writing the manufacturers. Most manufacturers pointed out that coverage depends upon several factors -- method of application, porosity of the surface, degree to which the wood soaks up finish, and the variations of the individuals who do the actual application.

It was pointed out that more area can be covered by brush

than by spray, and that the second and third coats of finish will cover more area than the first.

CONCLUSIONS

The finishes adopted by the individual teacher will depend upon his own evaluation of his finishing needs.

After completion of the research, the author recommends the following finishes as best: Dull finishes, chart number 50, flat chemical-resistant varnish, and chart number 56, clear flat lacquer. Number 50 was first choice because it can be applied with a brush. Number 56 dries more rapidly, but requires spraying; thus, it is not so good for student application. Since one of the criteria for the selection of the best finish was that it could be applied by a student, flat chemical-resistant varnish was rated first choice.

Three semi-gloss finishes were considered good. All may be applied with a brush and are listed below in one, two, three order:

- (1) number 34, sheen coat.
- (2) number 10, deft.
- (3) number 60, loxit.

Four gloss finishes were chosen as best. Only one brushing lacquer was selected, chart number 30, Crystalac Brushing Lacquer. Since this finish can be applied by the student and compares very favorably with the spray lacquers, it is rated best for school shops. The other three spray finishes chosen follow in order:

- (1) number 17, water white lacquer.
- (2) number 20, clear gloss lacquer.
- (3) number 26, water white gloss lacquer.

It is hoped that this study might aid the teacher in the selection of finish or finishes which will most nearly satisfy the requirements of his school shop.

ACKNOWLEDGMENT

The author wishes to acknowledge his sincere appreciation to Professor E. G. Darby, major advisor, for his help in the preparation of this study. Without his assistance this study would have been much more difficult.

Appreciation should also be expressed for the generosity of the commercial companies who supplied material and information for this study.

BIBLIOGRAPHY

Books

- Fryklund, V. C., and A. J. LaBage. General Shop Bench Woodworking. Bloomington, Ill.: McKnight and McKnight Co., 1955.
- Martin, R. L. Lacquer and Synthetic Enamel Finishes. New York: Van Nostrand Co., Inc., 1940.
- Modern Plastics Encyclopedia. New York: Plastics Catalogue Corp., 1949.
- Newell, A. C., Coloring, Finishing and Painting Wood. Peoria, Ill.: Chas. A. Bennett Co., Inc., 1949.
- Shellac. Calcutta, India: Angelo Brothers, Ltd., 1956.
- Soderberg, G. A. Finishing Materials and Methods. Bloomington, Ill.: McKnight and McKnight Co., 1959.
- Wampler, R. H., Modern Organic Finishes. New York: Chemical Publishing Co., 1946.
- Wint, R. F., and F. E. Pieck. Modern Developments in Cellulose Lacquer. Wilmington, Del.: Hercules Powder Co., 1952.

Periodicals

- Adams, R. C. "Varnish Versus Lacquer for Furniture Finishing." Industrial Finishing, 22:76. March, 1946.
- Broadman, A. "Alkyd Resins." Organic Finishing, 7:38-42. March, 1946.
- Close, G. C. "Synthetics in Industrial Finishing." Industrial Finishing, 22:28-40. February, 1956.
- Cordon, E. B. "Shellac, Its History, Manufacture and Uses." American Painter and Decorator, 16:20-21. June, 1939.
- Engel, E. "A Survey of Some Synthetic Resin Coatings." Organic Finishing, 17:22. July, 1952.
- Kennedy, P. S. "Recent Developments in Wood Finishes." Mechanical Engineering, 67:212. March, 1946.

Niedt, D. A. "The Amazing Epoxies." American Painter and Decorator, 33:12-17. October, 1956.

Patterson, J. R. "Silicone Resins in Finishes." Organic Finishing, 6:33. April, 1947.

Wampler, R. H. "Shellac in Wood Finishing." Industrial Finishing, 24:86-92, October, 1948.

APPENDIX

Table 1. Chart of applied tests.

Name of Finish	Liquid Color	Storage	Under coat	How Applied	Dust free Drying Time (Hours and Minutes)	Self Leveling	Applied Color	Unrubbed Finish	Sun Exposure S-small change M-medium " L-large "	Abrasion Resist- ance	Water Resistance	Chemical Substance Resist- ance	Build up	Thinner or Cleaner	Cost per Gallon	Coverage Per Gallon
1. Orange Shellac	Dark Brown	3 Hours	None	Brush	1:11	Poor	Dark Tan	Gloss	Darkened M	50 gr.	Discolored	1-2-3-4 5-6-7-8 10-11-13 14	.004	Alcohol		Not available
2. White Shellac	Light Tan Cloudy	2 Days	None	Brush	8:30	Poor	Clear	Gloss	Darkened M	50 gr.	Discolored	1-2-4-5 6-7-8-10 11-13-14	.004	Alcohol		Not available
3. Amar Varnish	Light Brown	5 Days	None	Brush	1:08	Good	Very Yellow	High Gloss	Darkened S	30 gr.	No effect	5	.006	Turpen- tine	\$8.30	Not Available
4. Bakelite Resin Varnish	Light Brown	5 Days	None	Brush	8:25	Poor	Very Yellow	High Gloss	Darkened M	90 gr.	No effect	5	.004	Turpen- tine	\$8.30	Not Available
5. Water Clear Varnish	Clear	2 Days	None	Brush	8:27	Good	Clear	Gloss	Darkened M	60 gr.	No effect	5-10-14	.006	Turpen- tine	\$5.90	Not Available
6. Cabinet and Rubbing Varnish V-11	Brown	2 Days	None	Brush	5:17	Poor	Yellow	High Gloss	Darkened M	60 gr.	No effect	5-6-7-8 10-11-12 13-14	.003	Turpen- tine	\$4.50	500-600 sq.ft.
7. Exterior Spar Varnish V-33	Dark Brown	2 Days	Reduce	Brush	5:30	Fair	Yellow	High Gloss	Darkened M	60 gr.	No effect	1-5-6-10 11-14	.004	Turpen- tine	\$5.70	500-600 sq.ft.
8. Extra Polishing Varnish V-99	Brown	2 Days	None	Brush	12:42	Fair	Yellow	High Gloss	Darkened M	60 gr.	Discolored	2-5-6-7 10-11-14	.004	Turpen- tine	\$4.90	500-600 sq.ft.
9. Seat and Floor Varnish V-77	Light Brown	6 Days	None	Brush	11:21	Fair	Yellow	High Gloss	Darkened M	40 gr.	Softened	5-6-7-10 11-12	.004	Turpen- tine	\$5.70	500-600 sq.ft.
10. Deft	Cloudy	No Spoilage	None	Brush	1:35	Very Good	Clear	Satin	Darkened M	80 gr.	No effect	1-5-6-7-8 9-10-11	.007	Lacquer Thinner	\$7.10	350 sq.ft.

Table 1 (cont.)

Name of Finish	Liquid Color	Storage	Under coat	How Applied	Dust free Drying Time (Hours and Minutes)	Self Leveling	Applied Color	Unrubbed Finish	Sun Exposure S-small change M-medium " L-large "	Abrasion Resist- ance	Water Resistance	Chemical Substance Resist- ance	Build up	Thinner or Cleaner	Cost per Gallon	Coverage Per Gallon
11. Alcohol Resistant Lacquer A-79	Tan Clear	4 Days	Sanding Sealer	Spray	0:02	Very Good	Clear	Satin	Darkened S	80 gr.	No effect	5-6-7 11-14	.003	Lacquer Thinner	\$3.45	400 sq.ft.
12. Clear Gloss Lacquer #778	Tan Clear	No Spoilage	Sanding Sealer	Spray	0:07	Very Good	Clear	Gloss	Darkened S	120 gr.	No effect	11	.004	Lacquer Thinner	\$3.45	400 sq.ft.
13. Clear Lacquer #301	Light Brown	4 Days	Sanding Sealer	Spray	0:04	Good	Clear	Gloss	Darkened M	160 gr.	No effect	6-7-8 14	.002	Lacquer Thinner	\$3.25	400 sq.ft.
14. Gloss Furniture Varnish #17R	Brown	2 Days	None	Brush	10:14	Good	Dark	Gloss	Darkened L	60 gr.	No effect	5-10-11 14	.005	Turpentine	\$4.75	400 sq.ft.
15. Super Kamex Gloss	Light Tan Clear	4 Days	None	Brush Spray	0:10	Very Good	Clear	Gloss	Darkened M	100 gr.	No effect	6-7-8-11	.005	Special Brush Thinner	\$4.95	400 sq.ft.
16. Superior Gloss Lacquer #401	Light Yellow Clear	2 Days	Sanding Sealer	Spray	0:04	Very Good	Clear	Gloss	Darkened S	80 gr.	No effect	6-10-11	.005	Lacquer Thinner	\$3.45	400 sq.ft.
17. Water White Lacquer #1323	Light Tan Clear	7 Days	Sanding Sealer	Spray	0:06	Very Good	Clear	Gloss	Darkened M	240 gr.	No effect	5-11	.003	Lacquer Thinner	\$3.45	400 sq.ft.
18. A.C.Varnish	Clear	5 Days	None	Brush Spray	1:30	Good	Clear	Gloss	Darkened L	80 gr.	Softened	1-2-10 11-12	.003	Lacquer Thinner	\$3.83	Not Available
19. Brushing Lacquer	Light Yellow Clear	No Spoilage	Sanding Sealer	Brush Spray	0:51	Good	Clear	Semi-Gloss	Darkened M	120 gr.	Softened	1-5-7 11-14	.003	Lacquer Thinner	\$4.00	Not Available
20. Clear Gloss Lacquer #217	Clear	No Spoilage	Sanding Sealer	Spray	0:10	Good	Clear	Gloss	Darkened L	150 gr.	No effect	3-5-10 11	.005	Lacquer Thinner	\$2.75	Not Available

Table 1 (cont.)

Name of Finish	Liquid Color	Storage	Under coat	How Applied	Dust free Drying Time (Hours and Minutes)	Self Leveling	Applied Color	Unrubbed Finish	Sun Exposure S-small change M-medium " L-large "	Abrasion Resist- ance	Water Resistance	Chemical Substance Resist- ance	Build up	Thinner or Cleaner	Cost per Gallon	Coverage Per Gallon
21. Flat Varnish	Brown Cloudy	2 Days	None	Spray	3:00	Good	Clear	Semi-Gloss	Darkened M	80 gr.	Discolored	10-11-14	.004	Turpen- tine	\$7.11	450-600 sq.ft.
22. Rubbed Effect Varnish	Brown	4 Days	None	Brush	1:10	Good	Yellow	Satin	Darkened S	100 gr.	Discolored	1-3-5-6 7-8-9-10 11-13-14	.004	Turpen- tine	\$7.11	450-600 sq.ft.
23. Clear Gloss Varnish #975	Brown	4 Days	None	Brush	2:40	Poor	Darkened	Gloss	Darkened S	120 gr.	No effect	5-14	.003	Turpen- tine	\$4.33	600 sq.ft.
24. Quick Dry Floor Seal #551	Brown	2 Days	None	Brush	0:57	Poor	Very Yellow	Gloss	Darkened M	60 gr.	No effect	5	.005	Turpen- tine	\$2.95	500-600 sq.ft.
25. Satin Finish Varnish #973	Brown Cloudy	4 Days	Reduce	Brush	2:43	Good	Darkened	Dull	Darkened S	40 gr.	No effect	6-7-8 10-11-14	.005	Turpen- tine	\$4.03	600 sq.ft.
26. Water White Gloss Lacquer #1450	Light Yellow Clear	No Spoilage	Sanding Sealer	Spray	0:10	Very Good	Clear	Gloss	Darkened S	80 gr.	No effect	1-6-10	.005	Lacquer Thinner	\$2.55	200 sq.ft.
27. Supernite Varnish	Brown	2 Days	None	Brush	5:32	Poor	Very Yellow	High Gloss	Darkened M	80 gr.	No effect	2-5-7 12-14	.005	Turpen- tine	\$9.00	600 sq.ft.
28. Cellulose Acetate Lacquer #RL-14538	Clear	7 Days	None	Spray Brush	0:15	Good	Clear	Dull	Darkened M	70 gr.	No effect	1-4-6-7 8-10-11 14	.002	Solvent X	Not Available	Available
29. Clear Acrylic Lacquer #RL-15443	Clear	7 Days	None	Spray Brush	0:15	Very Good	Clear	Semi-Gloss	Darkened L	100 gr.	No effect	1-6-7-8	.003	Lacquer Thinner	Not Available	Available

Table 1 (cont.)

Name of Finish	Liquid Color	Storage	Undercoat	How Applied	Dust free Drying Time and Minutes)	Self Leveling	Applied Color	Unrubbed Finish	Sun Exposure S-small change M-medium " L-large "	Abrasion Resistance	Water Resistance	Chemical Substance Resistance	Build up	Thinner or Cleaner	Cost per Gallon	Coverage Per Gallon
30. Crystalac Brushing Lacquer #Y-2840-A	Light Yellow Clear	No Spoilage	None	Brush	0:25	Very Good	Clear	Gloss	Darkened M	70 gr.	No effect	5-6-10	.004	Lacquer Thinner	\$5.33	500 sq.ft.
31. Epoxy Resin Solution #RL-12272	Clear	No Spoilage	None	Brush	15:00	Poor	These Tests Omitted Because of Orange Peeling of Samples					These Tests Omitted Because of Orange Peeling of Samples				
32. Exterior-Interior Spar Varnish #28-RV-2	Brown	2 Days	None	Brush	7:50	Good	Very Yellow	High Gloss	Darkened S	50 gr.	No effect	5-6-7-10 14	.007	Turpentine	Not Available	Available
33. White Shellac #U-16-3	Cloudy	2 Days	None	Brush	0:45	Good	Darkened	Semi-Gloss	Darkened L	100 gr.	Discolored	4-5-6-7-8 10-11-13-14	.003	Alcohol	\$4.25	500 sq.ft.
34. Sheen Coat Varnish	Dark Brown	2 Hours	None	Brush	0:07	Very Good	Clear	Dull	Darkened M	120 gr.	No effect	6-7-10 11-14	.003	Lacquer Thinner	\$4.25	400 sq.ft.
35. Clear Acetate Lacquer #13130	Clear	No Spoilage	None	Spray	0:44	Good	Clear	Semi-Gloss	Darkened S	120 gr.	No effect	6-7-8-10 11-12	.002	Solvent	\$4.50	315-400 sq.ft.
36. Clear Wood Lacquer #6205	Light Yellow Clear	No Spoilage	Sanding Sealer	Spray	0:24	Good	Clear	Gloss	Darkened M	140 gr.	No effect	1-10-14	.002	Lacquer Thinner	\$3.20	315-400 sq.ft.
37. Barard Table Top Varnish #47	Medium Brown	4 Hours	None	Brush	6:13	Fair	Very Yellow	High Gloss	Darkened S	60 gr.	No effect	1-5-14	.004	Turpentine	\$8.25	500 sq.ft.
38. Lin Glo Varnish	Light Brown	7 Days	None	Brush	6:07	Very Good	Yellow	High Gloss	Darkened M	40 gr.	No effect	2-4-5-6-7 8-10-11-1 13-14	.004	Turpentine	\$6.75	600 sq.ft.

Table 1 (cont.)

Name of Finish	Liquid Color	Storage	Under coat	How Applied	Dust free	Self Leveling	Applied Color	Unrubbed Finish	Sun Exposure	Abrasion Resist-ance	Water Resistance	Chemical Substance Resist-ance	Build up	Thinner or Cleaner	Cost Per Gallon	Coverage Per Gallon
39. Marine Spar Varnish	Light Brown Clear	4 Days	Reduce	Brush	2:30	Good	Darkened	High Gloss	Darkened M	40 gr.	No effect	2-5-6-10 12-13-14	.006	Turpen-tine	\$8.80	500 sq.ft.
40. Satin Finish Alkyd Varnish #3175	Brown Cloudy	1 Day	None	Brush	6:10	Very Good	Clear	Satin	Darkened L	80 gr.	Discolored	2-5-6-7 8-10-11 14	.003	Turpen-tine	\$7.55	500 sq.ft.
41. Clear Interior Dull Finish	Light Brown Cloudy	4 Days	None	Brush	5:54	Good	Clear	Dull	Darkened M	100 gr.	No effect	4-14	.003	Turpen-tine	\$7.10	400-500 sq.ft.
42. Self-Leveling Luster Finish	Light Brown Clear	4 Days	None	Brush	8:17	Poor	Clear	High Gloss	Darkened S	120 gr.	No effect	5-10	.004	Turpen-tine	\$7.20	400 sq.ft.
43. Brushing Lacquer #2710	Tan Clear	No Spoilage	Reduce	Brush	0:38	Good	Clear	Gloss	Darkened S	100 gr.	No effect	1-5-7-10 11-14	.006	Lacquer Thinner	Not Available	560 sq.ft.
44. Plastic Finish	Light Brown Clear	5 Days	None	Brush Spray Roller	3:00	Good	Clear	Gloss	Darkened S	60 gr.	Softened	5-10	.004	Lacquer Thinner	\$7.50	700 sq.ft.
45. Clear Finishing Varnish	Light Brown	4 Days	None	Brush	3:31	Very Poor	Darkened	Gloss	Darkened M	40 gr.	Softened	1-5	.003	Turpen-tine	\$6.90	500-700 sq.ft.
46. Durmo Satin Varnish	Tan	5 Days	None	Brush	3:22	Good	Darkened	Satin	Darkened M	60 gr.	No effect	1-5-6-7-8 9-10-14	.004	Turpen-tine	\$7.25	700 sq.ft.
47. Durmo Seal Floor Finish	Light Brown	2 Days	None	Brush	9:35	Very Poor	Darkened	Gloss	Darkened M	80 gr.	Softened	5-10	.005	Turpen-tine	\$5.10	400-500 sq.ft.
48. Durmo Spar Varnish	Brown	4 Days	None	Brush	10:10	Poor	Darkened	Gloss	Darkened M	40 gr.	Softened	1-5-14	.003	Turpen-tine	\$8.65	500-700 sq.ft.

Table 1 (cont.)

Name of Finish	Liquid color:	Storage:	Under: coat:	How Applied:	Dust free: (Hours and Minutes):	Self Leveling:	Applied Color:	Unrubbed: Finish:	Sun Exposure: S-small change M-medium " L-large "	Abrasion: Resist-ance:	Water: Resistance:	Chemical: Substance: Resist-ance:	Build up:	Thinner: or: Cleaner:	Cost per: Gallon:	Coverage: Per Gallon:
49. Clear Varnish #414	Brown	4 Days	None	Spray	1:00	Poor	Very Yellow	High Gloss	Darkened S	50 gr.	Discolored	1-5	.005	Turpen- tine	\$3.80	200-250 sq.ft.
50. Flat Chem- ical Resist- ant Varnish #2-504	Clear	6 Days	None	Brush	0:32	Good	Clear	Dull	Darkened S	80 gr.	No effect	1	.004	Lacquer Thinner	\$3.50	200-250 sq.ft.
51. Souarn Flat Lacquer #4-452	Light Yellow Cloudy	No Spoilage	None	Spray	0:35	Good	Clear	Dull	Darkened S	180 gr.	No effect	1-11	.002	Lacquer Thinner	\$3.25	150-175 sq.ft.
52. Super Water White Gloss Lacquer #3-428	Clear	7 Days	Sand- ing Sealer	Spray	0:44	Good	Clear	Gloss	Darkened S	120 gr.	No effect	1-6-7-8	.003	Lacquer Thinner	\$3.50	150-175 sq.ft.
53. Synthetone Gloss #1-646-A	Clear	30 Days	None	Brush	0:55	Good	Clear	Gloss	Darkened M	30 gr.	No effect	4	.003	Lacquer Thinner	\$3.50	200-250 sq.ft.
54. Clear Firzite	Light Brown Clear	6 Days	None	Brush	4:33	Good	Darken- ing Tendency	Gloss	Darkened L	80 gr.	Discolored	1-2-5-6 7-8-10	.002	Turpen- tine	\$5.75	500-600 sq.ft.
55. Stanilac	Light Yellow Clear	No Spoilage	None	Brush	2:22	Good	Clear	Gloss	Darkened S	160 gr.	No effect	6-7-8	.002	Lacquer Thinner	\$7.95	350-400 sq.ft.
56. Clear Flat Lacquer #135	Yellow Cloudy	4 Days	Sand- ing Sealer	Spray	0:04	Very Poor	Clear	Dull	Darkened S	140 gr.	No effect	6-7-8 10-11	.002	Lacquer Thinner	\$3.10	300 sq.ft.
57. Clear Gloss Lacquer #125	Light Yellow Clear	4 Days	Sand- ing Sealer	Spray	0:03	Very Poor	Clear	Gloss	Darkened S	270 gr.	No effect	7-10	.004	Lacquer Thinner	\$3.00	300 sq.ft.

Table 1 (concl.)

Name of Finish	Liquid Color	Storage	Under coat	How Applied	Dust free Drying Time (Hours and Minutes)	Self Leveling	Applied Color	Unrubbed Finish	Sun Exposure S-small change M-medium " L-large "	Abrasion Resist- ance	Water Resistance	Chemical Substance Resist- ance	Build up	Thinner or Cleaner	Cost per Gallon	Coverage Per Gallon
58. S.G.Clear Lacquer #166	Light Yellow Clear	4 Hours	Sanding Sealer	Spray	0:11	Good	Clear	Semi-Gloss	Darkened S	140 gr.	No effect	10	.003	Lacquer Thinner	\$3.10	300 sq.ft.
59. Water White Clear Gloss Lacquer #702	Light Yellow Clear	No Spoilage	Sanding Sealer	Spray	0:13	Good	Clear	Gloss	Darkened M	120 gr.	No effect	10	.003	Lacquer Thinner	\$3.20	300 sq.ft.
60. Loxit	Clear	2 Days	Reduce	Brush	0:21	Very Good	Clear	Gloss	Darkened M	140 gr.	Discolored	1-4-5 10-11-12	.001	Loxit Thinner	\$6.95	350-400 sq.ft.
61. Speed-e Wood Bar Top Finish	Light Yellow Clear	No Spoilage	None	Brush	0:28	Good	Clear	Semi-Gloss	Darkened M	160 gr.	No effect	1-5-6 7-11	.002	Lacquer Thinner	\$6.95	350-400 sq.ft.

CHART SHOWING DRYING TIME OF FINISHES

Time in 15 minute intervals	Finish Numbers
12:00	8, 31
11:00	9
10:00	14, 48
9:00	47
8:45	--
8:30	2
8:15	45, 42
8:00	--
7:45	32
7:30	--
7:15	--
7:00	--
6:45	--
6:30	--
6:15	37
6:00	38, 40
5:45	41
5:30	6, 7, 27
5:15	--
5:00	--
4:45	54
4:30	--
4:15	--
4:00	45
3:45	--
3:30	46
3:15	--
3:00	4, 44
2:45	25
2:30	23, 39, 55
2:15	--
2:00	--
1:45	10
1:30	18
1:15	--
1:00	1, 3, 22, 49, 53
45	19, 24, 33, 35, 52
30	61, 43, 50, 51
15	28, 29, 30, 36, 60, 59, 11, 12, 13, 15, 16, 17, 20, 26, 34, 56, 57, 58

CHART SHOWING ABRASION RESISTANCE
OF FINISHES

Grams Weight to mar finish	Finish Numbers
290	--
280	--
270	57
260	--
250	--
240	17
230	--
220	--
210	--
200	--
190	--
180	51
170	--
160	13, 61, 55
150	2
140	36, 60, 56, 58
130	--
120	12, 19, 23, 34, 35, 59, 42, 52
110	--
100	10, 15, 12, 29, 33, 41, 43
90	4
80	11, 16, 18, 26, 27, 40, 47, 50, 54
70	23, 30
60	5, 6, 7, 8, 14, 24, 37, 44, 46
50	1, 2, 32, 49
40	9, 25, 38, 39, 45, 48
30	3, 53
20	21

NAMES OF COMPANIES FROM WHICH FINISHES WERE OBTAINED

Finish Number as on chart	Companies
1 - 5	American Asbestos Products Co. West 80th and Nickelplate RR Cleveland 2, Ohio
6 - 10	Broadhead-Garrett Co. 4560 East 71st Street Cleveland 5, Ohio
11 - 17	M. L. Campbell Co. 2909 Chrysler Rd. Kansas City 15, Mo.
18 - 20	Cook Paint & Varnish Co. P.O. Box 389 Kansas City 41, Mo.
21 - 22	Davis Paint Co. 1311 Iron Street Kansas City 16, Mo.
23 - 25	DeSota Paint & Varnish Co. Box 186 Garland, Texas
26	U. J. Dolan & Co. 1830 N. Laramie Ave., Chicago 39, Ill.
27	The Garland Company 3748 East 91st Street Cleveland 5, Ohio
28 - 33	The Glidden Co. Third & Bern St., Reading, Penn.
34	Grand Rapids Wood Finishing Co. 53-71 Grandville Ave., S.W. Grand Rapids 2, Michigan
35 - 36	Lacquer Specialties Inc., 249 Ave. P Newark 5, New Jersey

37 - 40 Patterson Sargents Co.
 2324 Jefferson St.
 Kansas City 8, Mo.

41 - 42 Rezwood-Tones Inc.
 Box 142
 Springdale, Penn.

43 - 44 Sears Roebuck & Co.
 Chicago 7, Ill.

45 - 48 Seidlitz Paint & Varnish Co.
 Kansas City, Mo.

49 - 53 Southern Varnish Co.
 Roanoke Ave. Extension
 Roanoke, Virginia

54 - 55 U. S. Plywood Corp.
 55 W. 44th
 New York 36, N. Y.

56 - 59 Walter Wurdack Inc.
 4944 Fyler Ave.,
 St. Louis 9, Mo.

60 - 61 Zynolite Products Co.
 1646 S. Vermont Ave.,
 Los Angeles 6,
 California

A COMPARATIVE STUDY OF CLEAR WOOD FINISHES

by

JACK LEON KUGLER

B. A., Seattle Pacific College, 1952

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Industrial Engineering and Industrial Arts

KANSAS STATE UNIVERSITY
OF AGRICULTURE AND APPLIED SCIENCE

1959

The author, having noted an inadequacy in the available information concerning finishes for wood projects in his school system, has made a comparative study of these finishes, testing them for the suitability in the school shop.

An examination of the three basic types of clear finishes was made: shellac, oleoresinous varnishes, and synthetic varnishes. The production, processing, and use of each was studied. Synthetic varnishes seem to be replacing the natural varnishes and shellac because of their leveling quality, solids content, ability to retain gloss, abrasion resistance, and stain resistance.

Sixty-one different finishes were tested, using five different kinds of wood with each finish.

Eleven separate tests were conducted with the purpose of discovering the finishes best suited for use in woodworking classes. The first test was made to determine the liquid color of each finish. Samples of each were then exposed to the air for the storage test, to determine the spoiling time. The third test was made to determine the dust-free drying time following the application of the third coat of finish. The tests revealed that varnishes required the longest drying period, whereas certain synthetic varnishes dry rapidly. Following this test, the smoothness of each finish was checked.

The color of each wood sample was noted before and after the finish application. The less change in color the more desirable the finish.

A test was then conducted to determine the gloss of the unrubbed finish. The samples were next placed in direct sunlight,

and any change in color was noted. They were then placed in storage for two months after which time they were subjected to an abrasion test. Weights added to a pointed tool were used to determine the abrasion resistance of each.

Each sample was also subjected to water tests, one in which drops of water were allowed to dry on the finish, and a second in which an area of the finish was kept saturated with water.

The next test conducted was to determine the chemical resistance of each finish. Fourteen substances and chemicals were used: acetic acid, boric acid, citric acid, hydrochloric acid, lactic acid, ethyl alcohol, menthyl alcohol, isopropyl alcohol, lighter fluid, sodium hypochlorite, detergent, coffee, tea, and alkali solution.

The samples were finally tested for build-up. Each was measured before and after the application of finish, and the measurements were recorded.

The cost per gallon and coverage of each finish was obtained from the manufacturers and noted.

Conclusions were drawn as to the finishes best suited for school shop woodworking projects.