1928

Informational and vocational mathematics

BOSTON UNIVERSITY

GRADUATE SCHOOL

Thesis

~~A STUDY IN~~ INFORMATIONAL AND VOCATIONAL MATHEMATICS

Submitted by

Hubert Ervin Redding

(Th.B.; Atlantic Union College, 1923; B.R.E.,1926)

In partial fulfilment of requirements for

the degree of Master of Arts

1928

TABLE OF CONTENTS

~~Study in~~ Informational and Vocational Mathematics

. Study in Informational and Vocational Mathematics

Informational

In making this study I am taking as a standard an ordinary eight room house, thirty feet long, twenty-four feet wide, and twenty feet in height, that is, to the eaves. The house has a two-pitch roof, and therefore two gable ends, eight feet high. (p. 51)

Occasionally a building has irregular lines. In most cases of this kind, a fixed set of rules for measuring or painting would be confusing and unnecessary detail. In general, the same is true regarding porches, bay windows, fancy trimmings, etc.

For the purpose of this study it is assumed that this is a new house and the estimates made are for the cost of painting the first time.

Cost of Painting, Original

Three coats of paint should always be applied to a surface which has never been painted. The first coat is called the priming coat and is thinner than the two following coats. It is good business to put on the third coat because it costs only a third more and will last twice as long.

There are two big items of expense in connection with any painting job; the first is material, and the second is labor. Of these two items, the cost of labor is by far the greater. However, the kind of material used enters very materially into the gross expense when the lasting qualities of the job are taken into consideration. Although authorities differ somewhat in regard to what constitutes "the best paint", yet for general purposes all painting material may be divided into three classes: first, best materials; second, medium grade; and third, poorest grade materials.

Best Materials

Nearly every one thinks of lead and oil whenever the subject of painting is mentioned. In fact, this has been the standard for years, and it is hard to find anything better providing good grades of lead and oil are used. Zinc Oxide is regarded by some as superior to white lead as a pigment.[1] But when used alone. pure zinc oxide forms a very brittle surface on the wood. and because of this it easily "chalks" or flakes off. Possibly it would be proper to mention here that white lead when used alone, is regarded as being too soft by some authorities. At the same time men who have had the largest experience in putting on paint know that is not practically true.

Positively the best oil to use for outside woodwork is raw linseed oil. To this should be added as much dryer as necessary. Linseed oil is also prepared by boiling, and it may be used satisfactorily on outside woodwork without dryer.

1. New Jersey Zinc Co. (40-40-20)

"Boiled linseed oil is particularly desirable for paint to be used on metal. plaster. concrete, and stucco".[1] It is well to bear in mind that when speaking of boiled linseed oil that the genuine oil is meant. There are oils on the market sold for boiled linseed oil which in reality are raw oils with dryer added. The danger is that a cheap grade of dryer may have been used and possibly too much was added.

There is no reason why white lead should not be practically pure. It is usually prepared by the "Parkes"[2] process which consists briefly of skimming the lead at low temperature which removes the copper and other impurities which have higher solidifying points. The lead is then drawn off into reverberating furnaces and the temperature raised very high. While the lead is stirred the arsenic and certain other impurities are oxidized. These impurities are skimmed off as dross.

1. Handbook of Painting
2. Painter's Magazine--Nov. 1926

At this point the lead may contain silver, gold, zinc, and even traces of copper. To remove these the lead is now poured into desilvering kettles where metallic zinc is added in minute quantities. The zinc unites with everything but the lead and rises to the top, and the temperature being lowered, solidifies and is removed. The remaining zinc is oxidized by placing the purified lead in a reverberatory furnace and is skimmed off.

Lead thus purified is one of the purest metals in the industries. Less than .06 of one per cent is the demand for use in white lead. To be exact, what is known in the trades as "ordinary corroding" lead is not less than 99.9424 per cent pure. White lead with impurities such as copper is objectionable as a pigment. It will be readily seen, however, that there is no excuse for anything but pure white lead.

Zinc Oxide is the finest of the paint pigments in general use. It is so fine that the highest power microscope must be used in order to see the outline of the individual pieces. This makes it a desirable pigment because the finer the particles the thinner the coating that can be applied. and consequently the more surface can be covered by a unit quantity of material. Although there are two methods of preparing zinc oxide, the principle is essentially the same which consitss of the oxidation of vaporized metallic zinc which insures a pure product. "Not only is zinc oxide being used now in largely increasing quantities from year to year, but it has been so used for nearly two hundred years." [1]

It may be of interest to quote from an English paper on paint pigments presented before a meeting of chemists and scientists.[2] In the data presented the author gave his determination of the hiding power of various pigments. The figures in the following chart tell their own story:

1. Painters Magazine--Nov. 1926
2. "Zinc as a Pigment
   New Jersey Zinc Sales Co.

HIDING POWER OF PIGMENTS

Pigments Tested	C. C. of Vehicle per gram of Pigment at Painting Consistency	Weight of Pigment (grams) required to hide	Relative Hiding Power of equal masses
Lithopone (1)	0.61	2.00	100.0
Lithopone (2)	0.55	2.28	87.8
Zinc Oxide	1.07	2.56	78.1
White Lead	0.42	3.88	51.6

From this table it is clearly evident that zinc oxide is a better pigment as far as hiding power is concerned, but for reasons previously mentioned it is not desifable except when mixed in small amounts with some other kind of pigment. Some painters put in small amounts--possibly one pound of zinc with twenty pounds of lead--to make a firmer film.

Lithopone is a recent addition to the pigment family.[1] In reality it is a combination of several ingredients. It usually contains from twenty-seven per cent to thirty per cent as zinc sulphide. "Lithopone is made by pouring together very pure solutions of Barium Sulphide and Zinc Sulphate. The Lithopone forms immediately in this mixture of liquids as a combination of Zinc Sulphide Barium Sulphate. This white slime is then separated from the liquid, washed, burned, washed again, wet ground, dried, and dry ground before packing. It is a dense white pigment, and, if properly made, shows no reaction

1. "Zinc as a Paint Pigment"
   New Jersey Zinc Sales Co.

when exposed to sulphur or sulphur gases." [1]

Lithopone has several advantages in that it is very white and almost as fine as zinc oxide. It is practically unaffected by light and moisture reactions. While this is properly classed with the zinc pigment, it is nevertheless a meduim grade production. This will be mentioned again under medium grade materials.

Turpentine has been the standard thinner for paints for years. It is indispensable to the painter. It is a product of the southern pine produced by a distillation process. There are two kinds of turpentine. the so-called gum spirits of turpentine and steam distilled wood turpentine. Both kinds are now considered to be uniform in properties and are held to the same specification (U. S. Govt. Master Specification for Turpentine--No. 7b).

"Gum Spirits of Turpentine consists almost entirely of a single chemical; namely, Alpha Pinene,

1. Zinc as a Paint Pigment.

about 95%. The remaining 5% is composed of higher boiling Terpene Hydrocarbons. Steam Distilled Wood Turpentine contains, in addition to Alpha Pinene, Dipentene. Dipentene is very closely allied to Pinene, but has been found to have higher solvent power for most of the gums or resins used in varnish manufacture and likewise have been found to produce a more stable dispersion of the pigments used in paint and enamel manufacture. It also has a higher oxygen absorbing power than Pinene and should tend to increase the oxidation of drying oils."[1]

"In the distillation of the crude turpentine obtained from steaming the pine wood chips it is possible, through fractional distillation, to produce a turpentine which is composed almost entirely of Pinene and Dipentene."[2] Turpentine readily oxidizes when stored with access to the air and becomes thicker and more viscous. In this oxidized condition the residue on evaporation is considerably increased.

1. C. F. Kinney, Mgr.--Technical Service
   Hercules Powder Co.
2. " " " "

"Spirits of turpentine is believed to owe its superiority as a paint thinner to its property of absorbing oxygen from the air, the drying of paint being due to the absorption of oxygen from the air by the linseed or other drying oil, forming a hard insoluble film of linoxyn. It is said that turpentine acts as an oxygen carrier, transferring oxygen from the air to the linseed oil, and finally adding to the paint film the nonvolatile residue left after evaporation, which also acts like a drying oil."[1]

There are other thinners on the market, but they are hardly worth mentioning because of their inferiority. Unprincipled painters have been known to use even gasoline as a thinner.

The cost of painting a house with the best grade of material would be about $4.25 per gallon for white paint.[2] The colored paints are usually 25 cents a gallon cheaper with the exception of green which is a little more than white paint. This is the retail price

1. a. "Turpentine" U. S. Govt. Bulletin #898
   b. "Volatile Thinners" by Pickard
      American Paint Journal Co.--St. Louis

2. April--1927

of ready-mixed paint. If one mixed the paint himself, that is bought the lead, turpentine, oil, dryer, and possibly a small amount of zinc, the cost per gallon would be less. The saving would range between twenty-five cents and seventy-five cents per gallon. Of course, the time consumed in mixing the paint is not reckoned in this estimate.

Labor

The cost of a first class painter varies slightly in various states and in different cities in each state. It is safe to assume that in order to get first class service, one would have to pay at least one dollar per hour. In some cities painters get the same wages that are exacted by carpenters or other skilled workmen.

In having a house painted the job is usually let out by contract rather than by the hour. There are several reasons for this. In the first place a man knows just what the job will cost him while he assumes no responsibilities. Another reason is that it usually costs less by the contract than by hiring by the hour.

Another item of expense is brushes. On a two-color job, at least three brushes are needed; one wide brush, about three and a half inches which is used for putting on the main color; a smaller brush, about two inches, is used for the trimmings; a third brush called the sash brush is used for the windows. Brushes wear out quite rapidly, in fact, on large houses it usually requires a new set of brushes for every job. The prices vary from thirty-five cents, the price of a sash brush, to $2.50 for a good grade three and a half inch brush.

Medium Grade Material

The cost of a painting job where medium grade material is used is approximately one fourth less in cost than a first class job. A good medium grade paint can be bought for about $3.25 a gallon.[1] This

1. April--1927

would consist of lead, oil, and a small amount of turpentine or dryer. This kind of paint is the kind that is used in the majority of cases. A recent addition to the list of prepared paints is known as 40-40-20.[1] It is prepared by the New Jersey Zinc Company. The formula is as follows:

"XX" Zinc Oxide..................	40%
"Albalith" (Lithopone)...........	40%
Silica...........................	10%
Magnesium Silicate...............	10%
	100%

"The pigment mixture is designed to produce a high grade exterior white paint when combined with the right proportions of pure linseed oil, turpentine and dryer. Careful and elaborate tests show that it is a superior paint in color, clearness of tint, brightness, and permanence of color and tint. It chalks gradually and leaves an excellent surface for repainting."[2]

1. "40-40-20" New Jersey Zinc Co.
2. " " " " " "

This paint is growing rapidly in popularity at the present time. It was designed primarily to compete with white lead. and it seems to be a fair rival. Referring to the formula, it may be said of Silica and Magnesium Silicate that their value is nil except to fill the paint can. The value of this paint lies chiefly in the zinc which it contains.

In regard to medium grade labor there may be a saving in the first cost, but it is a question whether there is a saving in the long run, that is, how well the paint endures as far as proper application is concerned. By medium grade painters we must consider the large class known as journey men painters. Although they do good work and might even belong to a Union in some instances, yet they are not master painters. One might possibly save as much as twenty cents an hour at the most by employing this class of painters. This might vary in different parts of the country.

There would not be a very large saving by getting medium grade brushes for a painting job of any size. Poorer bristles are used in a medium grade brush, and they are usually shorter in length. In general, medium grade brushes may be purchased at about 25% lower than first grade brushes.

Poorest Grade Materials

When we speak of poorest grade materials the way is immediately opened for a flood of "just as goods" and substitutes. There are so many imitations that only a few samples may be mentioned. In regard to white lead there can be no imitation. However, it is often adulterated with such material as whiting, silicates, barytes, chalk, etc. This gives a"body" so called to the paint and "covers well" temporarily. The lasting qualities of such an adulteration may easily be guessed. These cheapest grade paints may be bought at an average price of two dollars per gallon.[1]

In place of pure linseed oil, fish oil is sometimes used and various grades of mineral oils. Such oils usually produce a paint of very inferior quality. A house painted with such material is apt to peal in a short time. The saving is uncertain.

Turpentine substitutes may be procured at about ninety cents per gallon. This is at a saving of approximately sixteen per cent. Some of these substitutes are very satisfactory.

The cheaper grade brushes may be procured at a saving of approximately sixty per cent of the cost of the first grade brush. However, every painter knows that what is saved in the initial outlay is more than offset by the loss in time in spreading the paint. Cheap brushes are characterized by poor, short bristles which are prone to come out easily to the annoyance of the painter. Usable brushes may be obtained in the ten and twenty-five cent stores. Needless to say, no real painter ever uses one of these.

Labor

In the class of poorest grade painters the majority are amateurs or those who paint from necessity or fancy. The saving on labor of this grade is difficult to estimate. Unquestionably the initial expense is very low, possibly seventy-five per cent or more of what a first class painter would demand. Much painting is done by this type of painter. Housewives contribute to this list by their ingenious and interesting devices to renovate. It is probably true that in the majority of instances the ordinary jobs about the home, shop, or shed may be creditably performed by this type of painting. Of course there are no figures available, but it may be deduced that about one fourth of the prepared paint is used by representatives of this class.

Repainting

There are two theories regarding painting outside woodwork. The first theory is that a house shall be painted one coat every two or three years. There is one advantage in this in that a house always looks fresh, and the woodwork is thoroughly protected. The argument against it is that it is more expensive while those who advocate its benefit claim that it is cheaper in the long run. A house well painted in the first place might go for three years if painted with either best. or medium-grade materials. A house painted with the poorest grade materials would certainly need repainting by the end of two years in order to thoroughly protect the wood.

The second theory is that a house should be painted two coats when necessary to repaint at all, approximately every five years. This is the custom in general use. As a matter of fact, a house painted well with two coats of paint will go some times as long as eight or ten years without the wood taking serious injury. Of course, the cost for labor is more in putting on two coats than putting on one, but not twice as much, because in putting on one coat, greater care must be exerted; and the paint is applied a little thicker.

Cost

The cost for putting on one coat of paint can be determined by the following formula:

100 pounds pure white lead

3½ gallons pure raw linseed oil

1 pint pure turpentine

1 pint pure drier

This would make about six and a half gallons of paint and should cover four thousand square feet one coat. This would be enough to paint the house described on page 51 of this thesis. In fact, there would probably be some paint left over. This formula is for medium-grade material. The only way it could be improved would be by adding zinc thereby increasing the cost relatively more than the value. The cost of putting on the medium-grade materials is determined as follows:

100 pounds white lead------------	$13.25
$3\frac{1}{2}$ gallons pure raw linseed oil---	3.95
1 pint pure turpentine------------	.09
1 pint pure drier----------------	.07
	$ 17.36

6.5 gallons @ $17.36 = $2.67 per gallon.

The cost of labor for putting this paint on would be approximately forty dollars. Of course, these figures, especially the labor, are subject to many modifications. The cost for first class painters would not be much more than this--hardly worth mentioning. The poorest class of painters is subject to such a tremendous fluctuation that the cost of this grade of labor cannot be approximated with any degree of accuracy.

The cost of painting a house when two coats are applied is estimated by the following tables:

100 pounds white-lead

2 gallons pure turpentine

1 pint pure drier

This formula makes seven gallons of paint which should cover about 4,200 square feet, one coat. This is for the first coat in repainting outside wood. The following forula is for the second coat:

100 pounds white-lead

4 gallons pure raw linseed oil

1 pint pure turpentine

1 pint pure drier

This formula makes about seven gallons of paint which should cover about 4,200 square feet, one coat. These two formulas would make enough paint to cover two houses, nearly, of the size mentioned on 51.

The cost of putting on these two coats of paint is estimated as before:

100 pounds white-lead-------------	$13.25
2 gallons turpentine------------	2.22
2 gallons linseed oil-----------	2.26
1 pint drier--------------------	.13
	$17.86

7 gallons of paint @ $17.86= $2.55 per gallon.

Second Coat.

100 pounds white-lead-------------	$13.25
4 gallons pure raw linseed oil--	4.52
1 pint pure turpentine---------	.09
1 pint pure drier--------------	.07
	$17.93

7 gallons ofpaint @ $17.93= $2.56 per gallon.

In painting the house described on page 51. two coats. about 7.2 gallons of paint would be required. It would cost approximately sixty dollars for labor to apply this paint.

Thest estimates are based on the current market prices of April 1927. They may be used in comparing the approximate cost of a one and two coat job. No attempt has been made in this study to estimate the cost of repainting the cheapest grade material. As estimated earlier in this paper the cost of a poorest grade painting job could be safely figured at fifty per cent of the cost of a medium grade job. This is estimated by comparison as no figures are available in this class.

"Painting a house these days is a serious matter--particularly from the pocketbook point of view. It costs real money. The facts about paint must be learned or we find ourselves out several hundred dollars with nothing to show for it but a temporary coating on the house and a bad temper."[1]

It would probably be well to mention in this study a certain kind of paint called "Barreled Sunlight." It is manufactured by the U.S. Gutta Percha Paint Co., Providence, Rhode Island, and is growing rapidly in popularity as a white paint. The formula

1. "When White is White"
New Jersey Zinc Co.

for making this paint has not been published for the public. It is mentioned in this article mainly because of its popularity and the general assumption among painters that it is not made according to the usual paint formulas.

II. VOCATIONAL

The painting industry has become a large profession. It is estimated that there are twenty-five thousand master painters in the United States and about one hundred thousand journeyman painters.[1] Yet, very little has been done to provide for the training of painters. As a profession, painting offers to the master painter a salary comparing favorably with that earned by the average professional man. In the Painter's Magazine of February 1927, there is recorded a survey made by a vocational superintendent in a mid-western town.[2] He found that the average professional man in that city was earning between twenty-five hundred and three thousand dollars a year. A master painter could earn this amount in a year only under unusual conditions. Painting is a seasonal occupation; yet, it offers adequate financial inducements to the boy who would learn this trade.[3]

1. Estimation by Editor of "Painter's Magazine"
2. Harvey L. Freeland
   Supervisor of Industrial Education in Nebraska
3. U.S. Census 1920 shows 25,000 less journeyman painters than in 1910-"Painter's Magazine"-Feb.,1927

At present there seem to be few schools where one may learn painting as a trade. The General Motors Company recently opened a school for auto painters. because of a scarcity of skilled painters and finishers. These trained men will be used in their own plants, and the training is for a definite branch of the painting industry. New York state is offering twenty-five one[1]-thousand dollar scholarships to men and women of requisite training who wish to become teachers in trade schools.[2] This opens the way for the training of skilled teachers for painting as well as other trades. Salaries in New York range from eighteen hundred to thirty-five hundred dollars a year. This places the trade's teacher on the same plane with the teachers of the so-called liberal arts.

Michigan has done much to develop vocational training, but as far as can be determined no provision for training painters has been made. The same is true of California and certain other states which are well

1. Painter's Magazine--Nov., 1927.
2. " " " "

developed in certain kinds of trade schools.[1] Bulletins from the Department of Commerce, Washington, D. C., mention nothing regarding the training of boys who wish to become painters. It seems that there is no reason why an opportunity should not be given for students to learn this trade as well as carpentry, mechanics, etc. The modern trend in education is to fit one for the practical duties around the home. It is just as essential to know how to paint a door as it is to nail on a shingle.

The following quotation is typical of the painting situation as understood by the average layman of to-day:

"Painting is an art and there are many things about the art of painting which require study, observation, and constant practice. It always pays, therefore, to hire an experienced painter if one is available. The superior knowledge of the man who 'knows how' is worth the little extra money it may

1. Bulletins from Dept. of Public Instruction Lansing, Michigan.

cost to go without him. Do not, however, allow yourself to be deprived of the advantages of made-to-order paint simply because a painter who knows how to mix white-lead and linseed oil into paint is not within easy reach as is the case sometimes in the smaller towns."[1]

While there is much truth in the above paragraph, it does not follow that this condition must persist. The cloud of mysticism should be still further cleared away from the fields of knowledge. Already there are signs of a new psychology in this field. The following quotation is significant:

"Every man should know something about protective paint. Sooner or later he will find his knowledge useful. It may result in the saving of many a dollar."[2]

When such an attitude of mind is adopted, the way is opened for the establishment of schools where our future citizens may be better informed in

1. Handbook of Painting
2. "Dixon's Silica-Graphite Paint"

what to us has been fog.

Learning the Trade

It has been said that paint-making was first an art, then a trick, but has now become a science. Paint has been used since the earliest recorded time, but it has taken modern science to bring it to its present state of usefulness and beauty.[1]

First of all, it is to be understood that a paint consists of two parts--the vehicle, which is an oil, and the pigment. Where the vehicle is a slow-dring oil, then what is known as a drier is added.[2] The pigment, strictly speaking, refers to the color matter. The body of paint refers to the consistency or thickness. This depends primarily upon the white-lead, andsecondarily upon the amount of oil used to dissolve it. Drier refers to a special liquid, rich in oxygen which caused the paint to form a film quickly. "Driers consist of combinations of metallic salts, xuch as red lead, with linseed oil, resins, or

1. "When White is White"
   New Jersey Zinc Co.

2. "Dixon's Silica-Graphite Paint"
   Joseph Dixon Crucible Co.

both. When these combinations, in which the oxygen is held rather feebly, are mixed with linseed oil, some of the oxygen is taken up by the oil, and in this manner the drying action is much hastened.

When the salts are added to the oil, while maintained at a relatively high temperature for a length of time, a product called boiled linseed oil is obtained, in which the drying action is approximately the same, as if driers had been added cold to the raw oil. By either method, oil may be made to dry in as few as six or eight hours, where the raw oil alone requires as many days.

It should be borne in mind, however, that extreme rapid drying is invariably accompanied by a loss of permanency, and we would warn against those paints which are warranted to dry in eight and twelve hours. Such rapid drying should be resorted to, only in such special cases where it is understood that durability is to be sacrificed."[1]

1. "Dixon's Silica-Graphite Paint"
   Joseph Dixon Crucible Co.

The painter's tool is the brush. It is well to become acquainted with it. A good paint brush is usually made of imported bristles, generally from China. The better brushes are made with the bristles set in hard rubber. This prevents them from coming out. A good paint brush is never made of bristles of the same length and stiffness, for after the flag or split ends have worn off through use, the brush would fail to spread the paint properly.[1] As the brush wears down the flag ends of the shorter bristles come into use and continue the efficient life of the brush over a long period of time. In order to do a good job the paint must be well rubbed in, and this requires a good grade of bristles.

The following rules should be borne in mind relative to the care of brushes:

1--Don't put a new brush in water. Water caused a new brush to become flabby amd may cause "fingering."

2--Don't allow paint to work in the heel or close

1."Bubristo Brand Brushes"
Hanlon & Goodman Co., N. Y.

to the ferrule. This causes flaring of the bristles.

3--Don't allow the brush to stand on the ends of the bristles. This causes the flag end of the bristles to curl or bend and the brush will not spread the material properly.

4--Don't allow the paint to harden in an old or new brush. Keep the bristles pliable by cleaning out thoroughly in turpentine or benzine and then dip in linseed oil if the brush is to be laid away for a time. After dipping in linseed oil wrap evenly in paper. If the brush is used daily leave it in the material being used or remove as much of the material as possible, dip in linseed oil and place flat on a board.

5--Don't allow water to reach the handle as the wood will swell and burst the ferrule.

6--Don't expect a good bristle brush to stand the burning effect of newly slacked lime or acids. If

, in lime the brush should be thoroughly washed out daily to prevent the bristles from being destroyed.

7--Don't condemn a new brush because a few loose hairs come out. Special machines are used to clean out the loose bristles. If the brush is twirled rapidly between the palms of the hands or beaten against the edge of a table all the objectionable loose bristles will be removed.

8--There is no economy in cheap brushes. Get a good brush and keep it good, and it will repay the user by giving good results.[1]

1. "Bubristo Brand Brushes"
   Hanlon & Goodman Co., N. Y.

Usually the first time one tries to put on paint he thinks he is doing a very good job, and considers it almost fun for a short time. It takes an experienced eye as well as hand to put on paint so that it looks even. It is this experience that determines the skill of the painter, as a rule.

Besides having a well trained eye, it is equally essential that the wrist be trained to rub the paint in evenly and thoroughly. The pores of the wood must be filled, and it takes pressure and strength to do it. There is a difference between simply "putting it on" and rubbing it in properly. It can be readily seen that the man who claims he can put on enormous quantities of paint in a day may be able to do as he states, but anything quickly put on will often readily come off. Many jobbers, that is, amateur painters, who go into business simply for the money they can make, often make a prominent point of the amount of surface they can cover in a day. Of course, this reduces the first cost,

.but in the long run such a job usually proves unsatisfactory.

Time to Paint

Briefly, have your painting done in warm, dry weather, and under conditions where the paint will have time to set thoroughly before dirt or flies can get on it.[1]

Paint technologists have generally agreed that Spring is not necessarily the best time to paint. The coming of Spring rains is uncertain and melted snow and ice are apt to leave dirt and moisture on the sides of the house.

Because of variations in seasonal conditions it is very difficult to lay down rules as to exactly when to paint. The weather in late Summer and early Fall is generally good. Late Spring, after the rainy season is over and before the dust and insects of Summer fill the air, is also a satisfactory time. Never paint when the temperature is below 40 degrees Fahrenheit.

1. "When White is White"
New Jersey Zinc Co.

Wherever paint is to be applied, be sure the surface is clean. It must be free of dirt, dust and grease to insure the paint staying on. Surfaces previously painted should be wire-brushed, scraped or burned off wherever the old paint is loose or scaling. Dry, powdery surfaces should be sandpapered. The regular use of 40-40-20, properly applied, makes possible a great saving in this preliminary work. When it comes time to repaint, the surface is in good condition owing to very gradual surface chalking.[1]

Do not paint a wet surface. It is economy not to start too early in the morning. Let the dew, frost and dampness get out of the wood before you begin. Never paint in a heavy, wet, foggy atmosphere or while the surface is still wet from rain. Putting paint on under these conditions is almost certain to result in blistering, scaling, and peeling.

Stir your paint thoroughly before using it. If it has to be thinned be sure it is well mixed before adding

1. "When White is White"
New Jersey Zinc Co.

the thinner. The proper way to mix a new can of paint is to pour off all the liquid vehicle on top immediately when the can is opened. Add a little of this liquid to the remaining paste and stir it thoroughly with an upward, circular motion. Continue this procedure until all the liquid is used up.

Putting on the Paint[1]

"Brush out" the paint well. That is put it on thin with plenty of pressure. This gets the oil down into the wood and makes the paint stick on. Paint applied thick is apt to remain soft under the surface causing premature checking.

Put three coats of paint on new wood. You cannot get satisfactory results with less. The first coat (priming coat) fills the pores of the wood. The second coat levels up any flat spots where the primer did not satisfy the "suction" of the wood and gives hiding power to the job. The third coat finishes the job and gives you the brilliant white surface that looks well

1. "When White is White"
New Jersey Zinc Co.

and lasts long.

In repainting, the number of coats is dependent upon the condition of the old paint. Two coats is the general rule. One coat will do if the foundation coat is sound and in good condition, and the color the same.

The majority of paint troubles originate through some condition that interferes with the normal course of drying of the paint while still wet. These abnormal conditions usually demand a reduction in the amount of oil and an increase in the amount of pure turpentine, and sometimes drier. The two chief abnormal conditions to be met are; first, low temperatures; and second, resinous woods.[1]

Painting at Low Temperatures[2]

Low temperatures during or following application slow the drying and may cause trouble. Frosts are particularly disastrous and painting should not be undertaken when the temperature is likely to produce a frost. Paint that must stand a temperature below

1. "40-40-20"
New Jersey Zinc Co.
2. " " " "

55 degrees Fahrenheit before it is dry should carry less oil and a larger percentage of pure gum turpentine and drier. Substitute turpentine should not be used.

Resinous and Sappy Woods[1]

Resinous woods slow down the drying time of paint applied directly on them. Besides this, they resist the proper penetration of the paint. Resinous woods that are encountered in outdoor painting and which require special care are:

Red, White, California, Oregon, and Washington Cedar.

Hard or Yellow Pine.

Douglas Fir or Oregon Pine.

Redwood.

Cypress.

Pitch Pine.

In general, in priming these woods, to secure penetration, more pure turpentine is required and less oil than suggested in the thinning directions.

1. "40-40-20"
New Jersey Zinc Co.

The use of one pint of solvent naphtha or toluol (exceptionally strong solvents for resins) to the gallon of priming paint, is recommended. This is especially true in priming cypress. The best procedure we know to insure against trouble arising from resins is to allow the work to stand unpainted in order to "air out" from two to four weeks. Any checks or cracks that may appear can readily be puttied after the priming coat has been put on.

This treatment of "airing out" applies equally well to sappy and unseasoned woods, and what has been said about priming resinous woods applies in general here. Although a wood may appear so dry that it is spongy, it often carries injurious amounts of resin, sap, or water. This is especially true of cedar.[1]

It is not always possible to control the kind of atmosphere which will sweep over a building. At anytime some factory, sewer, or gas plant may fail to function properly and the paint be subjected to a bath which will discolor it. The only remedy against

1. "40-40-20"
   New Jersey Zinc Co.

discoloration is to use some paint with pigment other than white lead--zinc for instance.

Learning to Estimate and Figure.

There are many factors which enter into the cost of painting a building. In this study only the major items will be considered. These points cover the average painting job thoroughly. In other words, it makes much difference whether one plans to be a master painter or if he simply wishes to be able to do work around his own home. The major factors will be considered under the four following sub-topics:

1. Condition of Building

   Old woodwork usually requires much more paint than new; and again, wood that has not been painted for many years naturally requires much more paint than does wood that has been painted comparatively recent. Certain kinds of wood require more paint than others on the priming coat.

The painter may exercise his own discretion in using a larger or smaller quantity of oil according to whether the wood is oil-absorbing, such as white pine, poplar and basswood, or less permeable, such as yellow pine, cypress, spruce and hemlock. The painter may find it advisable, in rare cases, to increase the quantity of turpentine for extremely sappy or resinous woods. Where this is done a corresponding decrease should be made in the specified amount of linseed oil.[1]

Surfaces to be repainted must be considered as to condition. whether very dry or not, whether the surface is rough or smooth etc. Some wood is more porous than others and consequently absorbs more paint.

2. Materials

Briefly considered, all one needs to paint with is a can of paint and a brush. If, however,

1. "Handbook of Painting"
National Lead Co.

one is going to learn the trade, he must learn how to mix paint. The steps to be taken in mixing white lead paint are:[1]

1st. Take the proper amount of white-lead required by the directions which follow. "Break up" or soften it in a large pail with just enough oil to bring it to a workable paste. Use a wooden paddle to stir.

2nd. Add tinting colors, if the paint is to be tinted, mixing them thoroughly into the white-lead.

3rd. Put in drier. Stir thoroughly.

4th. Add the remainder of the oil required by the formula. Stir thoroughly.

5th. Put in the turpentine.

Stir until the whole mass is thoroughly mixed. Strain through wire or cloth screen. The paint is now ready to apply. The materials have already been mentioned.in an earlier part of this treatise.

1."Handbook of Painting"
National Lead Co.

Labor

The cost of labor is dependent upon too many variables to be expressed on a cost-unit basis. The cost of applying different paints, of approximately equal spreading capacities, should be about the same for any given surface. If anything, the paint which is spread out the farthest requires the most labor. The labor cost of painting is extremely variable. It may be as low as fifty cents per thousnad square feet on flat roofs, with cheap and inexperienced men--or it may go as high as three or four dollars on bridges and buildings, where only skillful and careful men are employed. Much depends, too, upon the way the paint is brushed out.[1]

In learning to estimate and figure the cost of labor, or the time it would take to do a certain job, there is only one safe guide, and that is experience. It has been approximated that a man could average to spread one gallon of paint in eight hours but while

1. "Dixon's Silica-Graphite Paint."
Joseph Dixon Crucible Co.

this might be a safe principle for one man to follow, it might mean disaster to another. Again, some painters figure that a man can cover six or seven hundred square feet of surface a day, on an average. However, these estimates are so unstable, and there are so many factors that enter into such calculations that hardly a man would venture to put his ideas in print. Experience is the only solution of the labor problem.

Losses

The losses in the painting industry, as far as house painting is concerned are due largely to weather conditions, careless help, and depreciation of apparatus. Once in a great while a painting job has been known to peel or "chalk off", which of course must be rectified if only a short time has elapsed since painting. This would mean a real loss because it would mean doing the job over again, but as stated before, such a misfortune happens very rarely, probably never with a master painter. The losses due to weather are usually caused by rains or frosts. Very seldom does the sun cause blistering. Sudden showers often wash off wet paint to the loss of the painter. In colder weather it sometimes happens that the paint freezes before drying, and this may spoil the job.

Losses due to depreciation are not very heavy as a rule. Brushes wear out quite rapidly, and of course are a loss when worn out.

The amateur painter may make a mistake in putting on the second or third coat too quickly. Allow plenty of time between the coats for the paint to dry. Exterior work should be allowed to dry from two to four days before the next coat is applied and interior work at least twenty-four hours.

Another way in which there may be a loss due to inexperience is in getting paint to the right consistency. Even ready mixed paints often need altering, usually thinner. Paint that is too thin will run.

How Much Paint? Easy Method.

For those who do not wish to go to the trouble involved in figuring out the measurements of a building in detail and who are content to know the approximate amount of paint needed, the following method will suffice.[1]

First measure the girth of house in feet and multiply by height in feet to eaves. If there is a gable, multiply width of gable in widest place by half the height of gable in highest place Add the quantities and divide result by 600 (approximately the number of square feet one gallon of white-lead paint will cover.)

This gives the number of gallons of paint needed for the body of house, one coat.

Multiply the number of gallons thus found by the number of coats you wish to apply. The result is the total gallons of paint you will need.

If a house has only medium trim(window frames

1. "The Handbook on Painting"
National Lead Co.

4 inches wide or less, cornice about 9 inches extension, porch posts rather slender), count 2/5 gallon or 3 1/5 pints of paint for every 100 feet of trim. If trimming is of more massive style (say window frames six inches, heavy veranda pillars 30 inches in circumference), figure 3/5 gallon or 4 4/5 pints to every 100 feet.

For every gallon of paint you will need the following quantities of ingredients:

White-lead................14 pounds
Pure raw linseed oil......1/2 gallon
Pure trupentine...........1/7 pint
Pure drier................1/7 pint

How Much Paint? More Accurate Method

The extra area to be painted and the quantity of paint needed can be ascertained by employing the detailed rules which follow. If approximate calculations will do, follow the quicker method of figuring described previously.

To calculate the square feet in one end, multiply height from foundation to eaves by width.

In diagram which follows: 20(height) X 24 (width) gives 480 square feet.

Multiply by 2 to get number of square feet in both ends, or in this case, 480 X 2 gives 960 square feet.

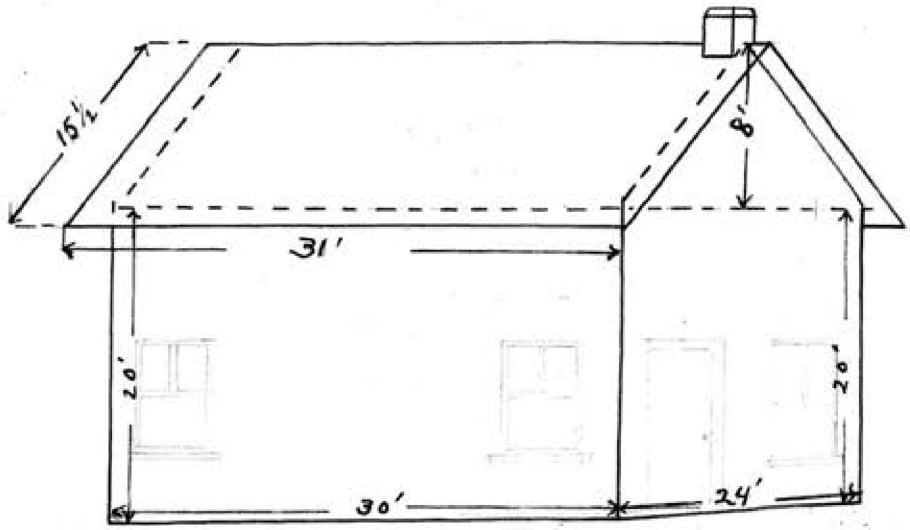
To calcualte the square feet in one side, multiply height from foundation to eaves by length.

In diagram: 20(height) X 30 (length) gives 600 square feet.

Multiply by 2 to get number of square feet in both sides. (in this case 600 X 2 gives 1200 square feet).

To calculate the square feet in gable, multiply one-half the height of gable by distance between eaves.

In diagram on following page: 4 feet (1/2 of 8 feet, height of gable) X 24 feet (distance between eaves) gives 96 square feet.


15½'
31'
8'
20'
20'
30'
24'

If there is another gable of the same shape and size, multiply by 2 to get the number of square feet in both gables, (in this case 96 X 2 gives 192 square feet).

When gables differ considerably in size they must be measured separately and the results added together to get the number of square feet in all the gables.

Add square feet in ends, sides and gables and the sum is the number of square feet of surface to be painted.

In diagram: 960 and 1200 gives 2352 square feet to be painted.

If roof is to be painted, the paint will probably differ from that used on the body of the house and the measurements should therefore be kept separate.

Multiply length by distance from comb of roof to gutter.

In diagram: 31 (length) X 15½ (distance from comb of roof to gutter) gives 480½ square feet.

Multiply by 2 to get the number of square feet in both sides of roof (in this case 480½ X2 gives 961 square feet).

The preceding directions can easily be followed where the building is regular in shape like a box.

Occasionally, however, a building has irregular lines. In most cases of this kind, to lay down a set of rules for measuring would be to inflict unnecessary and confusing detail. If there is a large wing, figure the wing as if it were a separate building, but allow, of course, for painting only three sides. If the house is very irregular or confusing it would be advisable to follow the short cut method or "easy method" which has been previously described.

III. Mathematics Needed.

Just how much arithmetic should be taught to the boy who plans to become a painter depends upon what class of painting he wishes to enter. Roughly speaking there are three classes of painters:

I--Amateur

This includes trades-school apprentices, those learning the trade by experience and the "lunch-hour"[1] method, also many who pass as first-class painters.

II--Journeyman

Trades-schools are gradually defining this term as a painter who ia able to sub-contract and do first class work apart from the business end.

III--Master

This includes the majority of men practicing painting as a profession at the present time. However, they belong to this class rather by profession than by ability. The trades-

1. Method by which all information was passed on until very recently. Called "lunch hour method" because it was at the lunch period that the tricks and arts of the trade were discussed.

> school is establishing the master-painter as a professional business man, contractor of ability, and skilled in the art, mathematics, and science of his profession.

The boy who wishes to become a painter but who finds arithmetic difficult has nothing to worry about from that standpoint; for he may become a first class painter, join the union if he chooses, and command a standard wage without the knowledge of a single fundamental process. Of course he must be skillful in the actual application of paint to a surface with a brush, and it would be convenient, at least, to be able to keep account of the time for checking. It is fairly certain that anyone capable of applying paint satisfactorily could set down on a time card the number of hours he worked each day without any trouble.

Generally speaking, the ability of the pupil would determine his class in painting. Probably the same arithmetic outline would serve for those who would become journeymen or master painters. Those who excelled would probably fall into the latter class as a rule. The Boston Trade School is doing good work along this line with no attempt at classification, but letting the pupil's ability determine his place in life. This school teaches the students in the Painting Department the following in connection with the Mathematics of the trade:

1. Liquid Measure
2. Mensuration
3. Linear and Square Measure
4. Square Root
5. Proportion

The head of the Painting Department reported that the most of this was taught in the class of general mathematics where no particular references were made to painting.

A thorough acquaintance with the fundamental processes is essential. Liquid measure would include problems such as how many quarts in one gallon, six gallons, etc. This would of necessity be very elementary work.

Mensuration would include the usual problems of areas of surfaces, particularly the rectangle, triangle, and circle. Linear and square measure should be taught in connection with mensuration.

The value of square root is highly questionable. It was mentioned only once in all data gathered. It might be used in finding the length of an inaccessible gable-end where only the width and height could be conveniently measured. This is very unusual, however, and most contractors depend upon judgment built up by experience rather than by complicated mathematical formula. In fact, "judgment is more important than figures in painting industry".[1]

Generalizations:

1. Very little mathematics are needed for a

1. Mr. England
   Boston Trade School

boy to become a successful painter.

2. Painting has not been taught long in Trade Schools. (Two new schools opened in 1927-1928)

3. No correlation of subject matter.

4. No consensus of opinion as to what should be taught.

5. Very few available text-books in this field.

The data obtained on the mathematics required check as follows:

School No.	Related Work	Formula	Areas	Propor-tion	Square Root	Esti-mating	Funda-mentals
1	None						
2	None						
3		*	*	*			
4		*	*	*	*	*	*
5		*	*	*		*	*
6	None						
7		*			*		
8	None						

One school had a very elaborate program of required mathematics covering a period of two years.

In this school, the pupil must be at least sixteen years of age and have the equivalent of six-grade education as a minimum.

The course of applied mathematics outlines as follows:

First Year

1a (First Term)--Arithmetic. Fractions, decimals, squares and square root, cubes, areas. volumes. Percentage. proportion, discount. English and metric systems of weights and measure.

1b (Second Term)--Elementary geometry. Chiefly the measurement of angles. chords, and arcs; areas of triangles, rectangles. circles, and irregular figures; cubic contents of tanks, bins, cylinders, cones. and other bodies.

1c (Third Term)--Algebraic formulae. Simple fundamental processes involving one or two unknown quantities so far as these are necessary in the handling of formulae commonly found in handbooks and books of reference for tradeworkers or in the solution of useful geometrical problems.

Second Year

2a (First Term)--Elements of plane trigonometry. Simple problems involving the measurement of angles. slopes. oblique forces. wind pressures, resultant of forces. inaccessible heights, distances, etc.

2b (Second Term)--Mechanics. Problems involving the laws of the lever, wheel and axle, inclined plane, screw, wedge, etc. expansion and contraction of solids, liquids, and gases; water pressures; horsepower of pumps and engines, friction, etc. (In connection with work in applied science.)

2c (Third Term)--Building Trades--Areas of various shapes and sizes.

The data obtained from painters and contractors by the questionaire method tabulate as follows:

Mathematics needed by a master painter (contractor)

Addition	Frequency
1. Keeping time of help	5
2. Figuring amount of paint used	5
3. Estimating height of building	5
4. Estimating total cost	4
5. Figuring overhead	1
6. General banking	1

Subtraction	
1. Figuring losses	5
2. Paint returned	5

3. Amount of stock used----------------5
4. Time lost--illness, weather, etc.----3
5. Figuring profit---------------------4

Multiplication

1. Area of surface---------------------5
2. Estimating amount of paint needed----5
3Days required to do the job-------------5
4Total cost-----------------------------5
5. Insurance--Compensation--Liability----1
6. Number yds. can be done in 8 hours----1
7. " linear feet can be done in 8 hrs.--1

Division

1. Estimating time required for a part of the crew to do a certain job------------------------------4
2. Alloting profits-------------------------------4

Many of the replies simply stated that the contractor (master painter) needed all the arithmetic he could learn. While this statement is far-fetched, it indicates a consensus of opinion that arithmetic is invaluable to those who lead or excell in this industry.

In striking contrast are the data relative to the mathematics needed by the "ordinary" painter. The following table shows the requirements for a man to become a successful painter:

Addition

1. Making out time slips--------------------2
2. Adding pounds and quarts of paint--------1
3. Proportioning colors in mixing-----------1
4. Estimating " " " -----------1

Subtraction

1. Making out time slips--------------------1
2. Credit stock returned---- ---------------1

Deducting losses----------------------------1

Work to be left out ------------------------1

Multiplication

1. Multiply hours of labor by rate----------1
2. Prices on different kinds of stock-------1

Division

1. Division of square yards------------1

It will be readily seen that this is a minimum amount of arithmetic, yet fifteen replies were to the effect that a man could be a very successful painter without any knowledge of arithmetic. In verification of this, one man was found doing the work of a master painter who never finished six grades of a grammar school.

Valuable data were obtained from Henry B. Kelley, Chairman of the Committee on Trade Schools in Massachusetts. He says: "The consensus of opinion is that exclusive of the business and bookkeeping end of affairs, there is no need of more than a grammar school grade of arithmetic as the measurement of surfaces and ordinary estimating are taken up there". This includes the master painter, but those who make up the mass of journeymen painters need even much less arithmetic. Some trade schools reported that no attention whatever was given to arithmetic. Possibly this is a little extreme, but then again, just notice the number of painters to-day who make no use of arithmetic except in reckoning their wages--possibly.

PROBLEM

Mr. Brown wishes to have his house painted. It is a standard two-story house, thirty feet long, twenty-four feet in width, and twenty feet high, that is to the eaves. The house has a two-pitch roof and, therefore, two gable-ends, eight feet high. There are thirty-one full size windows, 6' by 3', and two half-size windows. The full size windows have six panes of glass in the upper frame and one full light in the lower frame. The house is to be painted two coats, all white, including the sashes. He asks a contractor, Mr. Smith, to give him an estimate on the job.

Procedure:

Mr. Smith, the contractor, first estimates the area of the surface to be painted. The distance around the house multiplied by the height to the eaves, gives the area in square feet. In this case, the distance around the house is 30+ 30 + 24 + 24 = 108 feet. 108 X 20 (height) = 2160.

There are two gable ends. The area of a gable is found by multiplying the width (at the eaves) by $\frac{1}{2}$ the height (highest point above eaves, usually to the comb). Thus, $24' \times \frac{8'}{2} = 96$. So there are 96 square feet in the gable-end. Two gables = 192 square feet. Total area = 2160 + 192 = 2352 square feet.

The area of one window is $6' \times 3'$ or 18 square feet. There is the equivalent of thirty-two windows of this size so the total area of windows is 32 X 18 = 576 square feet. Net surface = 2352 - 576 = 1776 sq. feet.

One gallon of paint will cover approximately six hundred square feet of surface. 1776 ÷ 600 = 3 – or three gallons for one coat; six gallons for two coats. He allows one extra gallon for the sashes and to avoid running short of paint. This makes a total of seven gallons.

For the first coat, he mixes $3\frac{1}{2}$ gallons of paint as follows:[1]

50 lbs. white lead--------------\$6.50

1 gallon pure raw linseed oil--- 1.10

1 gallon pure turpentine--------1.20

$\frac{1}{2}$ pint pure drier----------------.15

Total \$8.95

For the second coat he mixes $3\frac{1}{2}$ gallons of paint according to the following formula:

50 lbs. white lead---------------\$6.50

2 gallons pure raw linseed oil-- 2.20

$\frac{1}{2}$ pint pure turpentine----------- .20

$\frac{1}{2}$ pint pure drier--------------- .15

Total \$9.05

Total cost of paint = \$8.95 + \$9.05 = \$18.00

A crew of 3 men will need brushes as follows:[2]

3------$3\frac{1}{2}$"-------@ \$2.00 = \$6.00

3-----sash brushes @ 35¢ = 1.05

1-lb.-putty for windows @10¢ .10

Total \$7.15

Total cost of stock = \$18.00 + \$7.15 = \$25.15.

1. Page 22.

2. New brushes are profitable except on old or rough work.

Labor

There are no rules for figuring labor costs. There are too many factors involved. However, an approximation may be made as follows:[1]

One man can average to paint 250 square feet in a day where the surface is good and there are no windows or trimmings to bother. So Mr. Smith figures that the plain surface of the house can be painted by one man in approximately eight days.

$1776 \div 250 = 8 -$ or 8 days.

He estimated that it will take one hour for each full window, or for the 32 windows, 32 hours or 4 days.

It costs Mr. Smith one dollar an hour for a painter so he easily figures that the total number of hours would be 12 days $\times$ 8 hours = 96 hours, or a cost of \$ 96 for labor.

Total cost of stock, \$25.15 plus cost of labor, \$96.00 = \$121.15.

On a job of this size a contractor usually allows

1. See page 45.

fifteen or twenty dollars extra for use of ladders and losses due to rain etc., so he tells Mr. Smith that he will do the whole job for $140.00

The procedure outlined above is accurate, but as stated previously in this study, no one should attempt to estimate the cost of painting a house on a basis of the figures given in the foregoing problem. There are too many variables such as rain, stagings, labor, surface, etc., to make plain figures reliable.

Method of Study

Over four hundred letters were written in making this study which includes data from every state in the United States. Besides the correspondence, hundreds of pages of printed matter were ananyzed and classified according to the plan of study.

The outline of this research is given below:

Informational.

1. Data from painting jobs.

This includes first hand information derived from actual painting conditions and interviews with painters.

2. Data from paint manufacturers.

This was a valuable source of information. Letters were written to about fifty of the largest and best known paint manufacturers in the country. Companies furnishing the more valuable information are included in the bibliography. By a careful selection of material, repetition was avoided and information chosen which was the most clearly and accurately stated.

3. Data from paint publications.

Such material constituted a valuable part of the information in this study and includes magazines, gobernment bulletins, state vocational department studies and outlines, research publications made by manufacturers, etc. Only that data was selected which applied definitely to this particular phase of information.

The section of this study dealing with vocational mathematics was especially difficult in several ways. In the first place, a large amount of correspondence was necessary to find sources for these data, and in the second case, there was such a divergence of views and opinions on this subject. Again, there has been no attempt to standardize such information and no one seems to know what the other fellow is doing. This phase of the research was conducted on the following plan:

1. Opinion of authorities
2. Opinion of painters
3. Trade school courses
4. Data from painting jobs

Opinion of Authorities

This includes data obtained by questionaire from contractors, also by interviews with men engaged in trade schools offering painting. In several instances, opinions of experts engaged by large coporations are used in summarizing.

Opinion of Painters

This information was also obtained by questionaire and interview. One hundred questionaires were sent to contractors and painters in greater Boston. Many personal interviews were made.

Trade School Courses

Letters were written to forty-five trade schools in the United States. It was found that many of these schools offered no courses in painting as such, and no valuable data was obtained from such schools. References are made only to those schools offering definite instruction in this field.

Data from Painting Jobs

Such data were not only interesting but also valuable in checking on the various publications and questionaires. Practical demonstrations have modified the conclusions given in this study so that mere theory has been reduced to an absolute minimum.

Conclusion:

1. States giving no course whatsoever in painting---34
2. States giving definite courses available data---- 7
3. States giving courses in painting of indefinite value----- 7

This includes courses just started in 1928, also schools in which wood-finishing is a subordinate part of a wood-working course.

The seven states reporting data of value together with the schools are listed as follows:

1. Indiana--Indianapolis Public Schools.

2. Iowa--Industrial, Trade, and Part-time Schools.

3. Massachusetts--(a) Boston Trade School
Parker Street
(b) Fall River Public Schools
Dept. of Vocational Education

4. Michigan--(a) Detroit Public Schools
(b) Grand Rapids Public Schools

5. Missouri--David Rankin Jr. School of Mechanical Trades. St. Louis.

6. New York--Murray Hill Trade School, N. Y. City.

7. Virginia--(a) Hampton Normal& Agricultural Institute, Hampton, Va.
(b) The Miller Manual Labor School
Albermarle, Va.

SUMMARY

This study has been made primarily for the purpose of placing in a comprehensive form the essentials of ordinary house painting in such a manner that it may be taught to the boy in school, fitting him better for the responsibilities of life. This study has been a step into an unexplored field--unexplored as far as the possibilites and teachable subject matter are concerned. The material molding the thought of this thesis has been procured largely from primary sources; that is, bulletins, periodicals, pamphlets, and advertising matter published by various paint manufacturing companies. A handful of truth here and there has made this study possible.

There is much remaining to be done in this field, but this is the beginning of what may become important subject matter to the student of to-morrow.

BIBLIOGRAPHY

1. Monroe, Lederer & Taussig
   Philadelphia, Pa.

2. Joseph Dixon Crucible Co.
   Jersey City, N.J.

3. Parnall Paint Co.
   Philadelphia, Pa.

4. The New Jersey Zinc Sales Co.
   160 Front St.
   New York City

5. Hercules Powder Co.
   954 Market St.
   Wilmington, Delaware

6. U.S. Gutta Percha Paint Co.
   21 Dudley St.
   Providence, R. I.

7. Hanlon & Goodman Co.
   Belleville, N. J.

8. The Martin-Senour Co.
   Chicago, Illinois

9. Benjamin Moor & Co.
   Paints, Varnishes, & Muresco
   New York City

10. National Lead Co.
    131 State St.
    Boston, Mass.

11. The Painter's Magazine
12 Gold St.
New York City
(Publications of 1926, also Jan., Feb., and March copies of 1927.)

12. State of Michigan
Department of Public Instruction
Bulletins on Vocational Education

13. Federal Board for Vocational Education
Washington, D. C.

14. United States Government
Master Specification for Turpentine
Federal Specification Board
Specification No. 7b(Revised August 7, 1926)

15. The Paint Man's Pocket Library
Volatile Thinners
American Paint Journal Co.
St. Louis, Mo.

16. Official Digest
Federation of Paint and Varnish Production Clubs)
J. B. Heckel, Jr., Editor
509 The Bourse
Philadelphia, Pa.
(Bulletin No. 25, July 21, 1922.)

17. American Painter & Decorater
St. Louis, Mo.
Issue of February 1925

18. Handbook on Painting
National Lead Co.
Boston, Mass.

19. Boston Trade School
    Boston, Mass.

20. Indianapolis Public Schools
    Vocational Department
    Indianapolis, Indiana.

21. Department of Vocational Education
    Des Moines, Iowa.

22. Detroit Public Schools
    Grand Rapids, Michigan

23. Grand Rapids Public Schools
    Grand Rapids, Michigan

24. David Rankin Jr. School of Mechanical Trades
    St. Louis, Missouri

25. Murray Hill Trade School
    New York City

26. Hampton Normal & Agricultural Institute
    Hampton, Virginia

27. The Miller Manual Labor School
    Albermarle, Virginia

28. Department of Vocational Education
    Portland, Oregon

29. Director of Evening School
    East High School
    Salt Lake City, Utah