AN ABSTRACT OF THE THESIS OF

-------Leverne Brandstatt------for the- M.S.- in- Ind. Arts Ed.
(Name) (Degree) (Major)

Date Thesis presented---June 1939-----

Title---"The Status of Practical Electricity in the High---
-------Schools of Northern California: A Proposed Program"---

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Abstract Approved: ----(Major Professor)----

The purpose of this study was to determine the type of
instruction and the extent to which practical electricity was
being used as a shop subject in the high schools of Northern
California. The attitude of the shop instructors and students
toward electricity was sought so that some idea could be
obtained as to the desirability of electricity as a shop subject.

This study was conducted by the use of questionnaires.
One was first sent to the principals of the high schools
in which some form of shop instruction was part of the curricu-
um. Sixty-six questionnaires were sent out and fifty-three,
or about eighty percent, returned. Approximately half of the re-
ponses indicated some form of electricity was being taught in
the high school shops.

A second and more extensive questionnaire was then
sent to the shop instructors of the schools previously
contacted. Of the sixty-six sent out forty-one or about sixty-
two percent, were returned. The replies were analyzed carefully
to determine existing conditions.

The results of this study seem to indicate practical
electricity is a definite part of the industrial arts program
in the majority of high schools of Northern California. There is
general agreement that electricity compares favorably with other
shop subjects in popularity among students. It also appears
evident that a course in electricity would materially improve
the industrial arts program of the schools where it is not now
a shop activity.

Other findings of the study are:

1. The electrical instruction in most of these school
shops is given for industrial arts objectives.
2. In all but two instances, courses of study constructed by the instructors are used as teaching guides.

3. Most of the instructors used texts or references and several asked for suitable material on this subject.

4. Projects were used twice as often as exercises in teaching electricity and all the instructors but four indicated difficulty in securing satisfactory projects.

5. The average number of students per class is sixteen and the period of instruction is six hours per week, five weeks per semester. The courses are from one to two semesters in length.

6. All instructors except nine had special training in electricity and only three of these nine were teaching this subject.

7. The number of students per class and the length of the instruction period is much the same as the ideal established by the opinions of the instructors.

In no case did the responses bring evidence that questioned the advisability of establishing practical electricity as part of the industrial arts program in these schools.

In view of the findings made in this study it is recommended that:

1. In schools where electricity is not a shop subject or is given at irregular intervals, a definite course in electricity be organized and made a part of the industrial arts program, to be given either as a unit shop experience or as part of the "general shop" subject-matter.

2. Instructors seek the aid of their principals or supervisors in constructing a course of study.

3. Several books in this field be reviewed by the instructors in order to select a suitable text or reference.

4. Whenever possible, projects be selected to give the student the "knowing" as well as the "doing" side of electricity. The instructor should be on the alert for this type of material in current books and periodicals.

5. Instructors who have not had training in electrical work should include such a course in their summer school program.

6. The trends of electricity in industrial arts be kept in mind when developing a course in electricity.
THE STATUS OF PRACTICAL ELECTRICITY
IN THE HIGH SCHOOLS OF NORTHERN CALIFORNIA: A PROPOSED PROGRAM

by

LAVERNE BRANDSTATT

A THESIS

submitted to the

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MASTER OF SCIENCE

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The writer wishes to express his appreciation to Professor George B. Cox, Head of the Industrial Arts Department, for the valuable aid and guidance received; also to professor R. J. Clinton, of the School of Education, for his willing assistance; and to the instructors of Industrial Arts in the High Schools of Northern California for the interest shown and the information they have furnished.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Purpose of the Study</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Procedure in the Study</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Limitations of the Study</td>
<td>7</td>
</tr>
<tr>
<td>II</td>
<td>THE STUDY</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Detailed Analysis of the Replies to Questionnaires</td>
<td>8</td>
</tr>
<tr>
<td>III</td>
<td>SUMMARY AND RECOMMENDATIONS</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>BIBLIOGRAPHY</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>APPENDIX A, Letter and Questionnaire to High School Principals</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>APPENDIX B, Letter to High School Shop Instructors</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>APPENDIX C, Questionnaire to High School shop Instructors</td>
<td>51</td>
</tr>
</tbody>
</table>
THE STATUS OF PRACTICAL ELECTRICITY IN THE HIGH SCHOOLS OF NORTHERN CALIFORNIA: A PROPOSED PROGRAM

CHAPTER I

INTRODUCTION

With the present standard of living in the United States, electricity in the average home has become a necessity rather than a luxury. Since electricity plays such an important part in our daily lives, it would seem that the high school should give the student some instruction in practical electricity as a part of his general education. The school shop is perhaps the best place to give the practical applications that might well be an outgrowth of the principles covered in the physics classes, thus increasing the functional correlation between these two areas of the secondary education program. Willoughby (9:7) says:

Elementary Electrical Construction is one of the most valuable and most interesting phases of industrial arts because it deals with such a large number of devices, materials, and principles vital in everyday life of the modern boy; it offers an excellent opportunity to stress safety and care in the use of equipment and home appliances; it creates a desire on the part of the boy to study science and it provides a practical basis upon which to proceed. Electrical construction is also the basis of many interesting and profitable vocations both of a technical or engineering nature and of the types commonly known as trades. This work should have a place in every modern curriculum.

Electricity has been introduced into the high school curriculum in two departments: science and the industrial
department. The science department teaches electricity as pure science and theory with little or no activity.

In the other extreme the industrial department often teaches electricity only by activities or projects, giving little time to theory. The solution to this situation is probably an industrial arts program in a "general shop" setting. This program would give the elementary science and theory of electricity by using projects whenever possible and by using demonstrations with required reading when projects would not supply the needed information.

Perhaps many shop instructors do not teach electricity because it is unlike most of the other shop subjects. As an example of this fact, woodwork or metal work has many skilled manipulative or "doing" operations to be learned, while the manipulative operations in electrical work are few, simple and readily mastered. The information or "knowing" units in wood or metal fit in very nicely with the manipulative operations and are easily learned by the student while he is making a project. In electrical work, however, the information units do not work in well with the projects so they must be given in an academic manner, which the average shop instructor is reluctant to do.

Concerning this situation the "Standards of Attainment" Bulletin (6:39) states:
Elementary electrical work contains very few learning units involving any considerable degree of manipulative skill. Most of the manipulative operations are very simple and readily learned. They involve such things as splicing wires, removing insulation, soldering, connecting to binding-posts, insulating, and the like, which, together with certain standard methods of construction, constitute the learning units involving doing. The more fundamental learning units involving the principles of flow and transmission of current, the characteristics of current, and the methods employed in making it serve our purposes are essentially matters of information, and do not involve manipulative skill.

Probably if more shop instructors understood this fact, practical electricity could be presented in a more effective manner.

As the newer trends in industrial arts education seem to be stressing the "knowing" along with the "doing" side of a subject, practical electricity may become a definite part of every student's general education.

The term "practical electricity" as used throughout this thesis is to distinguish the electricity taught as a shop activity from electricity taught in physics or general science courses. The term does not mean shop-taught electricity with vocational objectives only, but any electrical instruction that is given in the school shop by recognized shop methods.

PURPOSE OF THE STUDY

The purpose of this study is to determine the type of instruction and extent to which practical electricity
is being used as a shop subject in the high schools of Northern California. The attitude of the shop instructors and students toward electricity is sought so that some idea may be obtained as to the desirability of electricity as a shop subject.

If it is found that electricity does have a part in the high school shop program, a suggested course of study will be set up, which it is hoped will be of benefit to all of the schools where electricity is or may become a shop activity.

PROCEDURE IN THE STUDY

The first step in collecting the material for this study was the preparation of a brief questionnaire\(^1\) which was sent to the principals of the high schools of Northern California\(^2\) in which some form of shop instruction was part of the curriculum. The selection of these schools was made from the California School Directory (1:95-212). Sixty-six questionnaires were sent out and fifty-three or about eighty percent returned. Of the fifty-three responses, twenty-five or about one-half indicated some form of electricity was being taught in the high school shops. This number was considered sufficient to make further study worth while.

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1 Copy of questionnaire in appendix "A".
2 The chart on p. 5 shows the location of these schools.
Chart I  Showing geographical distribution of schools participating in this study.
The study was continued by constructing a more extensive questionnaire and letter of transmittal which were sent to the shop instructors of the same schools covered by the original questionnaire. The returns from the second questionnaire were not as high as for the first. Of the sixty-six sent out, forty-one or about sixty-two percent were returned. The results were analyzed carefully to determine existing conditions. Replies from both the principals and shop instructors showed sixty of the sixty-six schools were represented.

After the results of the questionnaires were analyzed and recorded, material was gathered for use as a guide in constructing a course of study. A part of this material consisted of courses of study used in teaching electricity in shops under the direction of special industrial arts or vocational education supervisors. These sample courses of study were requested of schools recommended for that purpose by the Chief of the Bureau of Trade and Industrial Education, California State Department of Education. The schools selected were located in Sacramento, Berkeley, Oakland, Alameda, San Francisco, San Jose, and Los Angeles.

1 Copy of letter and questionnaire in appendix "B" and "C".
State courses of study in electricity from Oregon, Michigan, Indiana and New York, and the American Vocational Association bulletin on "Standards of Attainment in Industrial Arts Teaching" were also used as guides for constructing the course suggested in this thesis.

LIMITATIONS OF THE STUDY

This study is limited to the high schools of Northern California (north of Sacramento) where some form of shop work is part of the curriculum. Because of the differences in population and finance schools from the remainder of the state were not used. This study is based upon the reports of instructors teaching industrial arts or vocational shop subjects at the present time in the above mentioned schools.

A few of the instructors seemed to be confused about the meaning of the first and second questions, marked the questionnaire "no", and then added notations which made their responses definitely "yes". Perhaps if these questions had been worded differently the number of shops reported as offering electricity might have been slightly higher.
CHAPTER II
THE STUDY

The results of these questionnaires are taken from schools distributed over Northern California and should be a fair representation of the conditions existing in that part of the state.

Questions 11, 13, 14, 15, and 16 in the second questionnaire are of a type that cannot be answered from direct evidence but must be answered from the experiences of the instructors and are therefore opinions. The purpose of including such questions is to determine the trend of thought in regard to shop electricity in this area. As only instructors of vocational or industrial arts subjects are included in this study the opinions are decidedly from a school shop standpoint.

The questions follow in order, accompanied by the replies and interpretations.

Detailed Analysis of Replies to First Questionnaire

1. Is electricity a subject of instruction in your school shop?

Replies: yes, 25; no, 28.

As the purpose of this questionnaire was to determine the feasibility of further study, this first question was the most important. The replies indicated about one-half of the shops offered electrical instruction, so the study
was continued.

2. If so is it offered for:
   Industrial arts objectives? ..... 18
   Vocational trade objectives? ..... 7
   not checked, 4.

These replies indicate most of the electrical instruction now available in Northern California is for industrial arts objectives. Four of the replies were checked to show that electricity is taught for both objectives. This would seem to indicate that a course of study designed for industrial arts objectives in the general shop would be of value to any of these schools either as part of the industrial arts program or for pre-vocational training.

3. Are individual instruction sheets used as a teaching aid in shop electricity?

   Replies*: yes, 7; no, 16; not checked, 2.

4. Are individual instruction sheets used as a teaching aid in other shop classes?

   Replies: yes, 14; no, 30; not checked, 9.

The answers to these two questions indicate instruction sheets are not being used very extensively as a teaching aid in these schools at the present time. Concern-

* The response to this question was naturally limited to those schools including electricity as a part of the offering. The total was 25.
ing the value of instruction sheets Selvidge (7:5) says:

The instruction sheet is a teaching device of great value where directions are to be given or where general principles of facts are to be presented to members of a group who are unequal in attainment, ability or aptitude. It has found quite general application in the school shop, the science laboratory, and in industry, but its value is not confined to those fields. It is, perhaps, the most efficient and economical system of individual instruction yet devised. It permits independent progress among the members of a group and makes it possible to take into account individual differences. The favor it has found in shop and laboratory is not because the individual differences among pupils are greater in such work but because the differences are more readily recognized and more effectively dealt with.

Newkirk and Stoddard (5:48) emphasize this further by saying:

Individual instruction sheets containing organized instructional material for the use of individual pupils have taken a prominent place in shop instruction. They are absolutely essential to the teaching of a well-organized general-shop course.

Detailed Analysis of Replies to Second Questionnaire

1. Is electricity a subject of instruction in your shop?

Replies: yes, 23; no, 18.

It is interesting to note that replies of the shop instructors gave a greater percentage of affirmative answers than did the replies of the principals. In three cases there were conflicting replies where the principals answered "no" and the instructor answered "yes". The shop
instructors' answers were used in the study. Perhaps the reason for this difference is due to the lack of shop supervision by the principals. A study by Stiles (3:27) showed this condition to exist. Stiles says:

The results of this study show that very few of the teachers of industrial arts included in the study receive much supervision from their principals. The principals seem to leave this part of the educational program almost entirely in the hands of their teachers.

Counting the replies from both questionnaires there are twenty-nine schools that offer electrical instruction and thirty-one that do not. This leaves only six of the schools from which no answer has been received. As these figures show about half of the schools now include electricity as a shop subject, it would appear that this subject should have a definite place in the curriculum of all of the schools. This statement is supported by the answers to question thirteen.

2. Is it offered for industrial arts objectives? 11
Vocational trade objectives? ................. 2
Farm shop ........................................ 11
not checked, 2.

The replies shown here are quite different from the ones given to the same question in the first questionnaire. This difference is probably due to the misunderstanding by the principal of the terms "industrial arts" and "vocational trade". To some extent it may be due to lack of supervision of the shop department, as stated before.
The replies of the shop instructors, that only two of the schools actually conduct a vocational program in electricity, is in agreement with the writer's personal knowledge of the schools in that part of the state.

While electricity instruction given in the farm shop is not a part of the industrial arts program, the aims and the objectives are very much the same. A course of study in electricity for the general shop would meet the needs of both the industrial arts and the farm shop students and furnish pre-vocational training as well.

3. Do you follow a course of study?

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<tr>
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Apparently the only courses of study used in these school shops are those made up by instructors. It is doubtful if all shop instructors are qualified to construct a course of study that would serve the needs of the students to the best advantage. From the California State Department of Education it was learned there is no state course of study in industrial arts or vocational education. The organizing of these subjects is left entirely to the city supervisors and the teachers. This arrangement works very well in Central and Southern
California, but in the northern part of the state where there are no special supervisors the shop instructors must use other means to secure a course of study. In regard to the average teacher independently constructing a course of study Douglass and Boardman (3:318) say:

In the smaller schools there are but few teachers in each department, and the opportunities for a division of labor among individuals or committees are not present. Courses of study constructed under these conditions are likely to be little more than "scissors-and-paste" affairs—the assembling of sections from courses of study prepared for use in other schools. As a result, they are, in many instances, lacking in balance and adjustment to objectives, if not actually duplicative or badly arranged. They are most certain to indicate a lack of clear vision of the possibilities of education, and consequently may be inferior to any one of a number of textbooks that may be adopted for use.

4. Name of text or references used. 11
   If none please check. 7

   not checked, 5.

About half of the instructors indicate they use a text or reference, but how the rest conduct classes without these aids is a matter of speculation. Concerning the selection of a textbook Douglass and Boardman (3:317) say:

In the smaller high schools, and even in most of the larger schools, course-of-study construction is largely a matter of textbook selection. Once the text is selected, the course of study for the year is largely determined. The materials in the text may be arranged, supplemented, or given a different emphasis, but in practice these are usually relatively minor adjustments.
Perhaps more texts or references would be used if the instructors knew where to locate them. The fact that five instructors asked for lists of texts, references or other printed material suited for the electric shop supports this idea.

5. Do you use projects? ..... 15
   or exercises? ............ 8
   not checked, 4.

One of the aims of industrial arts is to use projects rather than exercises in teaching operations and information. In the course of study in industrial arts for the secondary schools of Oregon (2:17) is this statement:

"For the most part the method of instruction employed in the industrial arts program should center about the project plan."

The responses to this question indicate a fairly satisfactory condition in this respect.

6. Do you have difficulty in securing satisfactory projects?

Replies: yes, 14; no, 4; not checked, 5.

There is probably more informational content in electrical work, than manipulative content, in proportion to other shop subjects. For this reason it is more
difficult to secure projects which cover the objectives of the course. In selecting projects or jobs for electrical work Willoughby (9:12) says:

The teacher of elementary electrical construction in the junior high school or grammar grades should study carefully the lists of things which the boy should be able to do and the things he should know at the close of the junior high school period and select from the list of references the material which will be most valuable for use by the pupils in gaining the abilities and the knowledge ..................................................

When considering new jobs for his shop, the teacher should analyze each one carefully to see if it can be justified on the basis of the lists before he includes it in his course of study. In connection with each proposed job he should list the processes involved in doing the work and the information topics directly related to it. If these are commensurate with the time required to complete the job, it should be accepted; if they are not, some other job should be selected.

Any other response to this question would have invited further investigation.

7. Average number of students per class.

Replies: average, 16; range, 6-26. not checked, 5.

In the various writings on industrial arts reviewed, no direct discussion was found referring to an ideal number of students for an industrial arts class. Different references seem to indicate a range from ten to forty pupils with the median between twenty and twenty-five. The condition shown by the replies to the question seems normal. With classes of this size there is an excellent
opportunity to do individualized teaching.

8. Number of hours per week for average class. 
   average range
   6  2-20

   Length of course in weeks per semester.
   5  2-18

   Length of course in semesters. 
   replies
   1 semester .... 8
   2 semesters .... 10
   not checked, 5

The twenty hours of class work per week given here came from the vocational classes where that amount of time is required by law. An average of six hours per week or about one hour per day is generally accepted to be sufficient time for industrial arts purposes. A course taught an average of five weeks per semester works very well in the general shop program. The length of a course in semesters depends upon the objectives and local conditions.

These replies indicate electricity is taught about the same length of time as other shop subjects.

9. Is electricity as popular with the students as other shop subjects?

   Replies: yes, 15; no, 4; not checked, 5.

   The large number of affirmative answers to this question indicates electricity to be as popular as other
shop activities and for this reason it deserves a place in the shop program equal to other subjects.

In the four cases where the students did not like electricity the reasons given were: too much outside study required; hard to understand; projects not popular; and afraid of electricity. The instructors of these classes have all had at least a year-sequence of practical electricity in college. Probably with a little more effort on their part these objections could be overcome.

10. Have you had special training in electricity?

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<td>Practical</td>
<td>9</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
</tr>
<tr>
<td>None</td>
<td>9</td>
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</table>

not checked, 4.

The college training of these instructors ranged from a single unit course to a degree in electrical engineering. The practical experience ranged from six months to twenty years. Only three classes were being taught by instructors who had no special training in electricity.

Nine instructors had some type of training in electricity but were not giving electrical instruction in their shops. Several of them gave reasons for this, which were: shop building not completed; no electric power in community; not approved by the administration; no opportunities for this work in the community; no equipment. The last two
reasons may be questioned because any community where
electricity is available would offer the student an
opportunity to repair home appliances. Most shop budgets
could be arranged to provide for the small amount of
equipment necessary to start a class in electricity.

11. Do you believe that practical electricity is a
worth while shop subject?

Replies: yes, 33; no, 0; not checked, 8.

12. Has electrical instruction been offered previ-
ously and discontinued in your school?

Replies: yes, 0; no, 34; not checked, 7.

13. If you do not now teach electricity do you
believe it would be suitable for your school?

Replies: yes, 15; no, 2; not checked, 3.

The responses to these three questions seem to show
that electricity is looked upon with decided favor as a
shop subject.

Both of the negative replies to the last question
came from instructors who had had no training in electric-
ity. The reasons given were: school too small and no
electric service in the community. In each case interest
was shown by asking where references and other material for teaching electricity could be found.

With this favorable attitude of the shop teachers toward electricity there does not seem to be any reason, except lack of initiative, why this subject could not be an active part of the industrial arts program in Northern California.

14. Please check the items that you believe would be necessary to organize or teach practical electricity.

| A course of study                      | 23 |
| Job or instruction sheets             | 23 |
| Suggestions and help of a supervisor  | 5  |
| Modern projects and exercises         | 39 |
| Special demonstration material        | 27 |
| Special work benches                  | 14 |

not checked, 3

These replies are from all of the shop instructors whether or not they taught electricity. The results are in close agreement with conditions as shown to exist by the answers to questions three and five.

Modern projects, a course of study, and instruction sheets appear to be considered the most essential in teaching a course in electricity, with special demonstration material and work benches being next.

Only five of the forty-one instructors indicated the help of a supervisor would be necessary in organizing
a course of electricity. This apparent negative attitude towards supervision would seem to indicate a weak supervisory organization in the smaller schools, a condition shown to exist by Stiles' (8) study on this subject. This may not be a very desirable condition. Regarding the value of supervision in constructing a program Douglass and Boardman (3:315) say:

In the matter of curriculum adjustment the supervisor has an important part to play. It is extremely doubtful that within the present professional generation the level of the rank and file of teachers in professional training, insight, and background, can be sufficiently elevated to insure that, without guidance by better qualified teachers, they will make the most desirable readjustments in the materials which they teach.

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<td>15. What is the minimum number of hours per week you would advise for a</td>
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<td>2-6</td>
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<td>class of electricity?</td>
<td></td>
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<tr>
<td>Minimum number of weeks per semester?</td>
<td>16</td>
<td>3-18</td>
</tr>
<tr>
<td>Length of course in semesters?</td>
<td>2</td>
<td>1-4</td>
</tr>
<tr>
<td>not checked, 6.</td>
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A comparison of the conditions as they are and as the instructors suggest they should be, is shown by the answers to this question and number eight. The results are much the same with the exception of the number of weeks the course is to be given. This difference is probably due to the fact the instructors had unit shops
in mind when answering the last question. Sixteen weeks or about one semester would be needed for a unit shop while five weeks, as given in question eight, is sufficient for the general shop.

16. What would you believe to be the maximum number of students per class?  
   The ideal number?  
   not checked, 6.

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A great many factors influence the ideal size of a class. The number of students that would be practical in one school could not possibly be considered in another. The ability of the teacher, the size of the building, the amount and arrangement of equipment, the organization of courses, and the attitude of the students all influence the size of a class.

As there appears to be very little written on this subject perhaps the opinions of these instructors may be considered indicative of the correct size of a class for that part of the state. The average of fourteen students per class as an ideal does not differ greatly from the size of the present class of sixteen as shown by question seven.
CHAPTER III
SUMMARY AND RECOMMENDATIONS

Summary

The results of this study seem to indicate practical electricity is a definite part of the industrial arts program in the majority of high schools of Northern California. There is general agreement that electricity compares favorably with other shop subjects in popularity among students. It also appears evident that a course in electricity would materially improve the industrial arts program of the schools where it is not now a shop activity.

Other findings of the study are:

1. The electrical instruction in most of these school shops is given for industrial arts objectives.

2. In all but two instances, courses of study constructed by the instructors are used as teaching guides.

3. Most of the instructors used texts or references and several asked for suitable material on this subject.

4. Projects were used twice as often as exercises in teaching electricity and all the instructors but four indicated difficulty in securing satisfactory projects.

5. The average number of students per class is sixteen and the period of instruction is six hours per
week, five weeks per semester. The courses are from one to two semesters in length.

6. All instructors except nine had special training in electricity and only three of these nine were teaching this subject.

7. The number of students per class and the length of the instruction period is much the same as the ideal established by the opinions of the instructors.

In no case did the response bring forth satisfactory evidence that questioned the advisability of establishing practical electricity as part of the industrial arts program in these schools.

Recommendations

In view of the findings made in this study which bring out the fact that practical electricity has an important place in the industrial arts program of the schools surveyed, it is recommended that:

1. In schools where electricity is not a shop subject or is given at irregular intervals, a definite course in electricity be organized and made a part of the industrial arts program, to be given either as a unit shop experience or as part of the "general shop" subject-matter.
2. Instructors seek the aid of their principals or supervisors in constructing a course of study.

3. Several books in this field be reviewed by the instructors in order to select a suitable text or reference. A list of books on electricity is given at the end of this chapter.

4. Whenever possible, projects be selected to give the student the "knowing" as well as the "doing" side of electricity. The instructor should be on the alert for this type of material in current books and periodicals.

5. Instructors who have not had training in electrical work should include such a course in their summer school program.

6. The trends of electricity in industrial arts be kept in mind when developing a course in electricity. Mr. Frank C. Moore, director of industrial arts, Cleveland, Ohio discusses these trends (4:137) by saying:

I rather hesitate to approach this subject of electricity because I have seen it in so many different ways in industrial arts shops throughout the country. I think the trend will be toward general electricity but not bell wiring and splicing as exercises. I believe that bell wiring and splicing go back toward the old-time manual training instead of ahead toward the new industrial arts.

I think the emphasis will be on the making of projects—boy projects, interesting projects, problems requiring that the fundamentals of electricity be used in correlation with wood and metal, so that when the boy has finished a given project, it fills a need for him.
In electricity, as in many other fields, we have chosen projects from the adult standpoint rather than from the viewpoint of the boy himself. We must remember that boys are interested in shocking machines, in crystal sets, in motors if they actually run something—but not in motors themselves. We must realize that in this field, as in all other fields, boy interest, boy aptitudes, and boy abilities are the controlling factors when it comes to the selection of projects to be covered.

A course of study is suggested which, it is hoped, conforms to these trends. It is not presented as a model of perfection to meet all needs, but rather as a guide to better results in teaching electricity. The course of study is designed for use in a class that meets one hour a day, five days a week, one school year. A "general shop" program would not devote as much time to a single subject so the instructor should modify the content to meet the time requirement. The course of study is intended for classes in the ninth and tenth grades but may be expanded to meet other age groups.

**General Objectives**

1. To give the student fundamental technical and practical knowledge of electricity.
2. To provide experiences that will broaden one's vocational horizon.
3. To increase the student's awareness of vocational possibilities.
4. To develop industrial appreciation.
5. To contribute to general education objectives.

**Specific Objectives**

1. To give the student practical and fundamental theory of electricity by textbook and laboratory.
2. To stimulate vocational and avocational interest by constructing simple electrical devices.
3. To enable the student to contribute to the upkeep of the home by repairing electrical appliances.
4. To develop some skill in the use of tools and materials common to the electrical trade.
5. To give the student some knowledge of opportunities and requirements in a few electrical occupations.

**Types of Instructional Units**

1. Units of information.
   a. Things the student should know.

2. Unit operations.
   a. Things the student should be able to do.

3. Job units.
   a. Things the student should be able to make or repair.

**Units of Information**

The following units of information cover most of the previously stated objectives. These units may be
arranged to form an individual progress chart. As several books on trade or job analysis explain the construction and use of these charts they will not be discussed here. Individual information sheets may be written covering each unit, or, as in this case, the information may be located in references by the page number following the unit. The names of the references used are given at the end of this group of units.

Whenever a given unit of information cannot be exemplified by a project it should be incorporated in some practical experiment that will give the student an opportunity to see a reasonable application.

A. Nature of Electricity. (r1:25)
   1. Characteristics and use of direct current.
   2. Characteristics and use of alternating current.
   3. Characteristics and use of static electricity.

B. Magnetism. (r1:11)
   1. Properties of a natural magnet.
   2. Properties of a permanent magnet.
   3. Laws of magnetism.
   4. Properties of an electro-magnet. (r1:140)
      a. Induced current.
      b. Transformers. (r1:173)
      c. Condensers. (r1:170)
C. Sources of Electricity. (rl:33)
   1. Construction, principle and use of dry cells.
   2. Construction, principle and use of wet cells.
   3. Construction, principle and use of storage batteries. (rl:199)
   4. Construction, principle and use of generators. (rl:154)

D. Fundamental Measurements of Flow. (rl:47, 70)
   1. Voltage.
   2. Amperage.
   3. Resistance.
   4. Ohm's law.
   5. Principle of electric meters.

E. Some uses of Electricity.
   1. Lighting.
   2. Power.
   3. Heating.
   4. Communication and transportation.
   5. Advertising.
   7. Remote control.
   8. Testing and inspecting.

F. Materials and Devices. (rl:65, 83)
   1. Principles and types of electrical conductors. (rl:33)
2. **Principles and types of insulating material.** (rl:31)

3. Types and sizes of electric switches.

4. Types and sizes of electric receptacles.

5. Types and sizes of electric fuses.

6. Types and sizes of incandescent lamps.


11. Principle and use of photo-electric cells.


G. **Tools.**

1. Correct names, kinds and uses of tools used in electrical work.

H. **Trade Terms.**

1. Trade terms used in common electrical work.

2. Correct names of common electrical materials and devices.

I. **Safety Precautions.**

1. Danger of live wires.

2. Fire hazard due to careless wiring.

3. Danger of improper insulation.

4. Danger of overloading a line.

5. Proper use of electrical appliances and equipment.

6. Danger of poorly constructed joints.
The unit operations stated here represent most of the things a student should be able to do in elementary electricity. They may be arranged in the form of an individual progress chart and be used in conjunction with the units of information. The instructor may formulate
his own instruction sheets or they may be purchased in commercial form. There are several books and groups of job sheets published which cover these operations.

Several types of instruction sheets are shown following the list of unit jobs.

A. Planning a Job.
   1. Read a wiring diagram.
   2. Plan a simple circuit.
   3. Make a wiring diagram.
   4. Plan the procedure of a job.
   5. Make out a bill of material.

B. Cutting Wire and Removing Insulation.
   1. Cut wire using electrician's pliers.
   2. Cut large wire using hack saw.
   3. Remove insulation using pliers.
   4. Remove insulation using a knife.

C. Splicing.
   1. Make a rat tail splice.
   2. Make a tap splice.
   3. Make a fixture splice.
   4. Make a western union splice.

D. Soldering.
   1. Solder a splice.
   2. Solder a terminal.
   3. Solder a lug.
4. Use a soldering copper.
5. Solder with a flame or torch.

E. Taping.
1. Tape splices.
2. Tape lugs.
3. Use rubber and friction tape.

F. Wiring.
1. Uncoil wire without twisting.
2. Attach wire to a binding post, screw or terminal.
3. Secure wire to backing.
4. Take up slack in wire.

G. Circuit Construction.
1. Plan and construct a simple bell circuit.
2. Connect dry cells in series.
3. Connect dry cells in parallel.
5. Plan and construct a simple light circuit in parallel.
6. Plan and construct a light circuit with a dimming device.
7. Plan and construct a buzzer-bell circuit.
8. Plan and construct a three wire return call circuit.

H. Electric Cord Construction.
1. Remove insulation from lamp cord.
2. Remove insulation from heater cord.
3. Tie an underwriter's knot.
4. Attach a split plug to an electric cord.
5. Attach a brass shell socket to an electric cord.
6. Attach an appliance plug to an electric cord.
7. Attach a feed-through switch to an electric cord.

I. Trouble Shooting.
   1. Test and replace fuses.
   2. Test batteries.
   3. Detect and remove trouble in a bell circuit.
   4. Test with a voltmeter.
   5. Test with an ammeter.

J. Current Measuring.
   1. Measure voltage.
   2. Measure amperage.
   3. Determine resistance.
   4. Determine watts.
   5. Read a watt hour meter.

K. Shop Maintenance.
   1. Repair and maintain electrical tools and devices.
   2. Repair and maintain tools and equipment
      1. Dress a screwdriver.
      2. Service a blow torch.
      4. Sharpen a twist drill.
5. Sharpen a wood chisel.
6. Sharpen a cold chisel.

Job Units

The following jobs contain most of the preceding instructional units and are arranged in groups with similar characteristics. The groups are not necessarily arranged in order of importance nor as they should be given but may be changed to meet the needs of the class. These jobs should be presented in connection with projects rather than as exercises.

A. Circuit Construction.

1. Draw a wiring-diagram and construct a simple bell circuit.
2. Draw a wiring-diagram and connect dry cells in series, test voltage and amperage with meter.
3. Draw a wiring-diagram and connect dry cells in parallel, test voltage and amperage with meter.
5. Draw a wiring-diagram and construct a light circuit in parallel.
6. Draw a wiring-diagram and construct a light circuit with a dimmer.
7. Draw a wiring-diagram and construct a buzzer-bell circuit.
8. Draw a wiring-diagram and construct a three wire return call circuit.
9. Draw a wiring-diagram and construct a three way light circuit.
10. Install a bell transformer in a 110 volt circuit.

B. Electric Cord Construction.
   1. Plan and construct an extension cord for lighting.
   2. Plan and construct a heating appliance cord.
   3. Plan and install a feed-through switch in an appliance cord.
   4. Remove and renew the cord in a bridge, floor or table lamp.

C. Magnetic Device Construction.
   1. Plan and construct an electromagnet.
   2. Plan and construct a buzzer.
   3. Plan and construct a simple electric motor.
   4. Plan and construct a simple telegraph system.
   5. Plan and construct a simple transformer.

D. Repair and Service Jobs.
   1. Repair an electric toaster
   2. Repair an electric waffle iron.
   3. Repair an electric iron.
   4. Repair an electric hot pad.
   5. Repair an electric grill or plate.
   6. Service or repair an electric fan.
   7. Service or repair a vacuum cleaner.
   8. Service or repair other motor appliances.
The following books have been reviewed by the writer and found to be adaptable for teaching practical electricity. They are grouped according to general content. There are many additional books suitable for references other than those given here.

**Information, Instruction, and Job Sheets:**


**Occupational Information:**


**Projects and Information:**


Science:


Wiring and Circuit Construction:

Instruction Sheets

The accompanying instruction sheets demonstrate a means of presenting the instructional units to the student. There are different types of instruction sheets for various purposes, Selvidge (7:8) explains them by saying:

It will contribute greatly to the clearness of thought and discussion if we can come to an understanding of what is meant by instruction sheets. "Instruction sheet" is a general term applied to written or printed instructions, quite generally issued in loose-leaf form. Job sheets, operation sheets, information sheets, and lesson sheets are special forms of the instruction sheet. These special forms differ somewhat in method of organizing the material and in special purpose, but the general aim of bringing to the student definite instruction in a permanent form is the same in all of them. They usually are based on the results of an analysis of a trade or vocation. This analysis may be on the basis of jobs or it may be on the basis of the units of instruction. When the instruction sheets deal with the units of instruction they usually are divided into three groups: those giving instructions for performing manipulative operations, called operation sheets; those dealing with topics of information, called information sheets; those dealing with assignments for reading or observation, called assignment sheets. When the instruction sheet outlines and tells how to do each step of a complete job, whether it is one of the almost numberless jobs of a trade or an isolated and unrelated job such as repair work about the home, it is properly called a job sheet.

Further information on the construction and use of instruction sheets may be had by reference to Selvidge, R.W. "Individual Instruction Sheet, How to Write and How to Use Them." (7)
ELECTRICITY

How to Attach a Split Plug to a Cord

INFORMATION:

The attachment cord for electrical appliances has a plug at one end which permits connection to an electrical receptacle or outlet. These plugs are made in two pieces and come apart; they are called split plugs.

Good connections must be made to the binding screws or "arcing" may take place, causing the wires to burn or perhaps blow a fuse.

PROCEDURE:

1. Separate the plug by pulling it apart with the hands.

2. Put the cord through the cap with the end toward the prongs Fig. 1 and tie an underwriters knot about 2 inches from the end. (see operation H-1.)

3. Remove about 3/4" of insulation (see operation B-3) and twist the strands of each wire together using the thumb and forefinger.

4. Bring each wire around a prong Fig. 2 and fasten it to a binding screw. Wrap the wire around the screw in the same direction that the screw is turned to tighten.

5. Hold the cap in one hand and pull the knot down in the space provided for it between the prongs.
Questions:

1. Why bring the wire around the prongs?

2. Why are the strands of the wire twisted together?

3. Why should the wire be wrapped around the binding screw in a certain direction?

References:

Willowghby -- General Electrical Work.
ELECTRICITY

Electrical Symbols

When drawings or wiring diagrams are made the draftsman uses certain figures or symbols instead of words to represent wires and electrical devices. The draftsman and electrician have agreed upon which symbol shall represent a certain electrical device in a wiring diagram. Following are a few symbols that one should know when making or reading simple electrical diagrams:

- Ammeter
- Ground
- Battery
- Lamp
- Bell
- Motor
- Buzzer
- Push button
- Connected wires
- Resistance
- Crossed wires
- Rheostat
- Fuse
- Single pole switch
- Generator
- Transformer
- Voltmeter
QUESTIONS:

Why are symbols used instead of words in wiring diagrams?

REFERENCES:

Dragoo -- General Shop Electricity
Oregon State College
Department of Industrial Arts
Corvallis

ELECTRICITY

How a Dry Cell Battery is Constructed

YOUR JOB:

To find out how a dry cell battery is made and make a written report.

DIRECTIONS:

1. Obtain a worn out dry cell from your instructor.
2. Obtain a hack saw from the tool rack.
3. Fasten the dry cell in a vise.
4. Saw the cell in two sections, cutting lengthwise but not through the center rod.
5. Replace the hack saw to the tool rack and clean the bench and vise where you were working.
6. Make a sketch of the half with the center rod attached.
7. On the sketch locate and name the following parts:
   a- terminals, b- sealing compound, c- sand,
   d- negative electrode, e- positive electrode,
   f- active material, g- blotting paper, h- outside cover.
8. In your report answer the following questions.

QUESTIONS:

1. What is the metal of the outside case? Why?
2. What is the center rod made of?
3. What is the active material made of?
4. Why is paper put on the inside of the metal case?
5. Why is the cell sealed?
6. Is a dry cell really dry?

REFERENCES:

Baxter -- Electro-Craft
Dragoo -- General Shop Electricity
General directions:
1. Read carefully the entire job sheet before starting job.
2. Make a list of the tools and materials needed for job.
3. Have the list checked by the instructor.
4. Have instructor check work before testing with current.

Specifications:
Install bell transformer in a branch circuit that is not controlled by a light switch. Place the transformer where it may be inspected easily or renewed and will not be hit or covered up by other objects.

Information:
Bell transformers are used in place of a battery for furnishing current for bells, buzzers or other devices requiring low voltage. They change the 110 volt house current to 8 or 10 volt current used for door bells.

Directions:
1. Select the proper place in a branch circuit for the transformer. BE SURE CURRENT IS OFF BEFORE STARTING JOB.
2. Remove about 1" of insulation from wires of transformer and branch circuit. Scrape wires bright. See operation E, B-3
3. Mount transformer with screws through base in a position where the wires will reach the branch circuit. The wires of the transformer may be spliced to lengthen.
4. Attach wires of the transformer to wires of the circuit using a tap splice. See operation E, C-2
5. Solder and tape the splices. See operation E, D-1
6. Have your instructor check your work, then turn on the current and test the transformer.
QUESTIONS:

1. What is the advantage of a transformer over dry cells for furnishing current for bells and buzzers?
2. Why should the transformer be placed in a circuit that is not controlled by a light switch?

REFERENCES:
Willoughby -- House Wiring
Petersen -- Fundamentals of Electricity
BIBLIOGRAPHY


APPENDIX "A"

Card Questionnaire to Principals
Dear Sir:

At Oregon State College a survey is being made to determine the type of instruction and the extent to which practical electricity is being used as a shop activity.

As your school is an important unit in this work, it will be greatly appreciated if you will check on the attached card the situation as it exists in your school.

Your response will be regarded as confidential. If you prefer, the attached card need not be signed.

Oregon State College
Dept. of Industrial Arts
L. E. Brandstatt
Coordinator

1. Is electricity a subject of instruction in your school shop? (yes) (no) IF NOT PLEASE ANSWER #4.

2. If so is it offered for:
   Industrial arts objectives .......___
   Vocational trade objectives .......___

3. Are individual instruction sheets used as a teaching aid in shop electricity? ............(yes) (no)

4. Are individual instruction sheets used as a teaching aid in other shop classes? ............(yes) (no)
APPENDIX "B"

Letter to High School Shop Instructors
Dear Sir:

Electricity is being used more and more in everyday life. In view of this fact it is generally believed that the school should give the student information about practical electricity as a part of his general education. Perhaps the best place to do this is in the school shop.

With this idea in mind the writer is making a study to determine the type of instruction and extent to which practical electricity is being used as a shop activity. A few weeks ago cards were sent to the principals of all of the high schools in Northern California in order to determine the number of schools offering electricity as a shop subject. On the basis of the number of affirmative answers received it was decided to send questionnaires to the shop instructors of all of the schools. By this means it is hoped information will be received that may be used in constructing a program which will be of benefit to all of the schools where electricity is or may become an educational activity.

It will be appreciated if you will check on the enclosed questionnaire the situation as it exists in your school. A SUMMARY OF THE RESULTS WILL BE MAILED TO ALL WHO COOPERATE IN THIS STUDY.

Your response will be regarded as confidential and neither you nor your school will be identified in the results of this study. Your name and address will be needed if you want a summary of the results.

If these questions do not concern your shop but do apply to another shop in your school will you kindly pass them on?

Sincerely yours,

L. E. Brandstatt
Coordinator
APPENDIX "C"

Questionnaire to High School Shop Instructors
QUESTIONNAIRE TO SHOP INSTRUCTORS

1. Is electricity a subject of instruction in your shop? yes, or no___.
   IF NOT PLEASE ANSWER #10 & following.
   IF SO please answer all questions that apply to your school.

2. Is it offered for industrial arts objectives___, vocational trade objectives___, or farm shop?___.

3. Do you follow a course of study? State___, County___, City___, your own___, or none?___.

4. Name of text or references used..................
   If none please check___.

5. Do you use projects___, or exercises?___.

6. Do you have difficulty in securing satisfactory projects? yes___, or no___.

7. Average number of students per class___.

8. Number of hours per week for average class___, length of course in weeks per semester___, and length of course in semesters___.

9. Is electricity as popular with the students as other shop subjects? yes___, if not why?

10. Have you had special training in electricity? College term hr.__, semester hr.__, years in practical trade___, other___, or none___.

11. Do you believe that practical electricity is a worth while shop subject? yes___, or no___.

12. Has electrical instruction been offered previously and been discontinued in your school? no___, if so why?

13. If you do not now teach electricity do you believe it would be suitable for your school? yes___, if not why?
14. Please check the items that you believe would be necessary to organize or teach practical electricity. A course of study__, job or instruction sheets__, suggestions and help of a supervisor__, modern projects and exercises__, special demonstration material __, special work benches__.

15. What is the minimum number of hours per week that you would advise for a class of electricity? __, and minimum number of weeks per semester__. Length of course in semesters? __.

16. What would you believe to be the maximum number of students per class? __, and the ideal number? __.

Any instruction sheets or other aids used by you will be more than appreciated if you wish to send them.

Please use the reverse side of this sheet for any remarks or comments that are necessary.

Please return to L. E. Brandstatt, Corvallis, Oregon