AN EXAMPLE OF THE SELVIDGE
TECHNIQUE OF ANALYSIS APPLIED
TO ELEMENTARY WOODWORKING
ON THE JUNIOR HIGH
SCHOOL LEVEL

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A Thesis Presented for the
Degree of Master of Arts

By

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OHIO STATE
UNIVERSITY

THE OHIO STATE UNIVERSITY
1929

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Approved by:

[Signature]
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PART I

INTRODUCTION
ACKNOWLEDGMENTS.

The present thesis attempts to apply the "Selvidge technique" of analysis to the writing of operation sheets in elementary woodworking for junior high school students. Selvidge's two books, *How to Teach a Trade* and *Individual Instruction Sheets: How to Write and How to Use Them*, have been drawn on constantly for example and for ideas. The contact with Professor R. W. Selvidge through his books and by personal interview and correspondence when permission to use the technique was secured, is gratefully acknowledged and well appreciated.

To my colleague, Professor F. C. Whitcomb of Miami University, is due great appreciation for his assistance and counsel in the actual writing of the operation sheets, and for his cooperation in permitting them to be used in the Industrial Arts classes of the William McGuffey Junior High School.

To Dr. W. H. Stone of The Ohio State University is due sincere appreciation for his encouragements and helpful suggestions in developing this thesis. My contact with Dr. Stone, both as a student and as a friend, has meant much to my professional growth.

My indebtedness to Dr. W. E. Warner of The Ohio State University for his willing assistance in the preparation of this thesis is beyond my power of expression. He has given generously to my many calls for suggestions and help. His intensive and accurate scholarship rendered his criticisms invaluable.
CHAPTER I

THE PLACE OF INDUSTRIAL ARTS
IN A SCHEME OF EDUCATION

Aims of Education.--Aims of Industrial Arts Education.--Summary of
Industrial Arts Objectives in the Junior High School.--
Place of Aims and Objectives in this Study.

The justification of Industrial Arts education in a scheme
of education may seem on the surface unnecessary. However, the mere
fact that a subject has found its way into the curriculum is not con-
clusive proof of its value. A subject may be introduced to bring about
some specific aim or objective, but as the curriculum grows and develops,
and as social conditions and needs become modified, that specific aim
or objective may entirely disappear, or be better realized through some
other instructional material. Such subjects as Greek and Latin may be
used to illustrate this point. They were introduced first as practical
subjects, later justified on the basis of formal discipline, and today
are an inheritance of tradition.

AIMS OF EDUCATION.

Curricular material can no longer be justified on the basis of
tradition alone. Education is not merely a process of handing on to the
present generation what previous generations have produced. Dewey (6, p.
21) says that "education is the enrichment of life." Bode (2, p. 172)
defines the purpose of education in that it should strive to "secure the
liberation of intelligence for the improvement of human life." If we are
to accept these aims of education of two of the leading thinkers of to-day, all phases of education must be justified upon the opportunities they offer for the "enrichment of life" through the "progressive liberation of intelligence."

AIMS OF INDUSTRIAL ARTS EDUCATION.

Troxel (20, p. 3) in conversation justified Industrial Arts of "life-activities" in the elementary school with the following objective; "an intelligent understanding of the industrial society in which children of the elementary school play a part." She would provide an opportunity for the boys and girls of this group to participate in the "life-activities" which come within their experiences, and to "study the relations of raw material to finished product, and the many social and economic problems that are involved." This follows very closely the program of industrial arts as defined by Bonser and Mossman (2, p. 5) in their statement of its educational application in the elementary school which follows; "A study of the changes made by man in the forms of material to increase their value and of the problems of life related to these changes."

Warner (16, p. 10) states the "Primary Controlling Purpose" of industrial arts education in the Junior High School as "Developmental Experiences through manipulative and other activities introductory to the various accessible phases of the world's industrial work." He further states specific objectives in part that refer to content and method, such as: "Exploratory or finding studies;" "Better choosers and users of industrial products;" "Avocational activities of adolescent youth in
the pursuit of hobbies," and "General guidance values." The diversified activities of the general shop are rapidly being accepted as a workable application of the philosophic concepts suggested above.

The aim of industrial arts in the Senior High School seems to be two fold. Snedden (16, p. 56) states them as follows: "Definite trade training" and "expanding and deepening the amateur interests that may transform in later life into advanced forms of developmental and re-creative activities." Snedden (17, pp. 70-71) further justifies Industrial Arts in a scheme of education in his statement of conditions which it must help prepare the pupil to meet. In short, he says "man stands in a two fold relationship to the world; he is a producer of utilities, and also a consumer. As a producer, he writes books or constructs machines, or produces wheat, or builds houses or heals the sick, or conveys travelers; and for any of these activities he can be trained. As consumer, however, he is inspired by books, served by machines, nourished by bread, sheltered by houses, healed by physicians, and carried by railroads, and for the wise and profitable exercises of these activities he can also be trained." If Industrial Arts is to function in the life of the pupil, it must train in the proper selection and use of industrial products, as well as the skills necessary to their production.

The aim of Industrial Arts in College is quite obvious by direct preparation for teaching. This aim is definitely set forth in the general statement of the purpose of the offerings in the various college catalogues. A good illustration of this aim is formulated in The Ohio State University catalogue for 1929-30, pages 45 to 50, and is as
follows: "The offerings of the Department of Industrial Arts Education at The Ohio State University are designed to prepare men and women for positions as teachers, supervisors, and directors in the various phases of Industrial Arts Education in Elementary, Junior and Senior High schools; or in the many similar positions now offered in industry."

Justifications for teacher preparation in Industrial Arts Education are sighted by Warner (12, Chapter VII). He charges the colleges with "the responsibility for progress in Industrial Arts education through teacher preparation."

SUMMARY OF INDUSTRIAL ARTS OBJECTIVES IN THE JUNIOR HIGH SCHOOL.

Objectives of industrial arts education for boys between twelve and fifteen years of age, which were stated earlier in the chapter may be summarized as follows:

1. Extensive exploratory experiences.
2. Industrial appreciation and understanding as an aid to an intelligent choice and use of industrial products.
3. Development of avocational activities in the pursuit of hobbies.
4. Educational and life guidance through extensive exploratory experiences and study.

PLACE OF AIMS AND OBJECTIVES IN THIS STUDY.

Aims and objectives of education, particularly of industrial arts education, are set up in this chapter as a guide for preparing instructional material, and as a means for developing criteria for judging values and outcomes of instructional methods.
CHAPTER II

FROM VALUES AND OBJECTIVES TO CONTENT AND METHOD

Methods, a Function of Values and Objectives.—Educational Psychology and Objectives.—Industrial Arts Materials.—Method and Material Presented in this Thesis.

METHODS, A FUNCTION OF VALUES AND OBJECTIVES.

In the preceding chapter certain industrial arts objectives for the junior high school were proposed. If the pupils of this group are to realize "exploratory," "developmental" and "avocational" values, methods must be adopted that will provide an opportunity for each pupil to experience and study the various vocational activities that come within his experience. Method is concerned also with content since it utilizes the selected material as a medium through which it strives to produce desirable outcomes. Method then in industrial arts may be expected to change as objectives and content change.

EDUCATIONAL PSYCHOLOGY AND OBJECTIVES.

Educational psychology is a prime factor in formulating and controlling objectives. Early objectives of education, such as neatness, honesty, accuracy, and coordination of hand and eye, were entirely in accord with the faculty psychology of that time. The aim of all education was to develop the various faculties of the mind, which when developed would transfer their powers freely to various problems and situations. This type of psychology fostered such methods as were used
in part by Salomon (13) in his system of Educational Sloyd. He organized his instruction around fifty models constructed in wood. The models were classified and arranged logically according to construction difficulty and were executed by all students in this order. The models were analyzed into eighty-eight formal exercises. Both written and oral instruction were given. The aims were (pp. 82-86) "To train the eye and sense of form. To develop dexterity of hand, and develop touch, cleanliness, neatness, attention, and interest."

Modern educational psychology has disproved faculty psychology and the automatic transfer of training. Human behavior is not so easily controlled. Objectives in industrial arts education have shifted from faculty training to "exploratory," "developmental" and "occupational" values through a broad and varied study and participation in occupational activities. The learner has been freed from the monotonous execution of logically arranged formal exercises or projects, and is privileged to explore a vocation at length. Not only does modern educational psychology demand a method that offers greater freedom to the individual, but it insists also that provision be made for individual differences of interest and ability.

The Selvidge (15) method for teaching industrial arts conforms to these demands of modern educational psychology. This method starts with a job or vocational activity, (such as blacksmithing, plumbing, or woodworking,) as a teaching unit and analyzes it into units of doing called operations. The method provides an opportunity for the student to make his own logical organization of the operations for the partic-
ular phase of the occupation he is experiencing. Learning aids are also provided in the form of individual instruction sheets. Four different kinds of sheets may be used: Operation Sheets, Instruction Sheets, Job Sheets, and Assignment Sheets. These sheets may be supplemented by oral instruction or by demonstration. Such a method places the learner on his own resources and furnishes him with instructional material whereby he can "explore" a trade with a minimum of lost motion. Effective teaching in large classes is also facilitated by this method, since the instructional material is prepared in advance and can be organized and used by the pupil with very little help from the teacher. Troxel (20) has carried this pupil activity still further in her "life-activity" classes in the teaching of elementary industrial arts. Her Study of Maple Sugar* is an example of modern educational methods. The technique is a combination of pupil and teacher purposing. The project was develop-

* The following headings which were kept on a large poster displayed on the bulletin board directed the study.

I. Guidance Suggestions.
   a. Why use this particular study?

II. The Activity.
   a. A brief diary of how the activity grew, beginning, problems, questions, interest, and accomplishments.

III. Outcomes.
   a. Attitudes, habits, and appreciations.
   b. Skills and techniques.
   c. Knowledge—"That serves as a tool."
   d. Individual cases.
   e. Lead on interests and activities.

IV. Formalized Subject Matter.
   a. English, geography, mathematics, history, science, nature study, composition, and health.

V. Helps.
   a. Sources of information.
   b. Equipment and material.

VI. Evaluation.
   a. Successful methods and evaluations.
oped in the third grade, and grew out of a study of foods of the pioneers of Ohio. It was maple sugar season and the project was suggested by the pupils. The method was supplemented by excursions to the sugar camp to experience the different activities there. Inquiries were made at the stores as to the form and value of the sugar that was being sold. And finally, maple sugar was made on a small scale in the class room. The concept of maple sugar was far richer and meaningful than it could possibly become through study alone. The incidental learning in formal subject matter in nature study, geography and composition was drawn from life situations. Similar studies of Bread, Shipbuilding, Brick, Homes, or Furniture might be made in junior high school groups or by individuals. This method provides a technique for developing and exploring a trade. The Selvidge technique provides information and directions for experiencing the actual trade.

INDUSTRIAL ARTS MATERIALS.

The materials used by industrial arts education will through necessity be restricted by: allotted time, facilities and environment, and the relative value of available materials. It is quite obvious, however, that unless an opportunity is provided for an extensive participation in a great number of occupational activities, the "exploratory," "developmental," "guidance" and "avocational" values will not be fully realized. Such materials as wood, metal, paper, pottery, textiles, electrical appliances, paints, and colors are at present being used in industrial arts laboratories. These materials have been organized into "course
activities" and are studied and experienced not only as a material, but also in their relations to other materials and to industry. The comparative use of these materials is illustrated by Warner (21, p. 21) in a summary of "course activities" reported by 294 shop and drawing teachers in sixty-three junior and senior high schools in Ohio, outside of Cleveland. A total of twenty-nine different "course activities" were listed. Wood was used in fourteen different courses reported with a frequency* of 753; paper was used in seven course activities with a frequency of 421; and metal was reported in nine course activities with a frequency of 313. Not only was wood used in a greater number of course activities with a higher frequency than any other material, but it was also used in the activity that was reported by the greatest number of teachers. The wide use of wood in industrial arts has no doubt resulted from its extensive use in industry. The Fourteenth Census of the United States (Table #1, page 421, Volume X) lists 702,555 people employed in all branches of the manufacture of lumber. The production of metal was next in importance, as shown by the Census (Table #3, page 332, Volume XI and Table #2, page 310, Volume X), which showed a total employment of 468,817 people in all branches.

In the changing of these raw materials into usable commodities, wood again offered employment to the greatest number of people. The comparative number of people engaged in changing the form of these two most used materials is shown in Table #4 (page 36, Volume IV), which lists all persons ten years of age or over engaged in each specific occupation.* The frequency of a material was computed by the present writer from Warner's material by totalling the number of teachers reporting course activities in which the material was used.
Blacksmiths, iron and steel workers, and other metal workers total 1,018,921 people, while carpentry and the lumber and furniture industry employ 1,207,991 people. This does not infer that activities involving the production and use of lumber should be experienced by the learner to the exclusion of all other materials, but is proof that the "Change made by man in the form of wood to increase its value" should be studied and experienced by the pupils of the junior high school.

**MATERIAL AND METHOD PRESENTED IN THIS THESIS.**

The extensive uses of wood in industrial arts education as well as in industry warrants its selection as the material used for the application of the Selvidge technique. This technique was selected because it is both a teaching method and a learning method. Stone (18, p. 322) says that "it seems to be both the logical and psychological method of analysis for training the skilled mechanic as well as the youth who wishes to master an operation or the entire trade." The Selvidge method also conforms with modern educational psychology in that it provides for individual instruction, it utilizes large learning and teaching units, and demands that situations simulate as closely as possible actual life problems.

The Unit Operation Sheet of the Selvidge technique is presented because it provides specific directions that may be used by the learner as he is experiencing the actual doing side of the occupational activity, and because it enables the learner to experience the trade with a minimum of lost motion, thus enabling him to explore a greater number of activities.
PART II

THE UNIT OPERATION SHEET
CHAPTER III

SELECTING AND PREPARING UNITS OF INSTRUCTION.

Analyzing an Activity.---Basis for Selecting Instructional Units.---Units Selected for this Thesis.---The Selvidge Comparative Analysis of Woodworking.

The analysis technique is not a new method of selecting and grading instructional material. It has been used in all phases of education. The technique is comparatively simple once the teaching or learning activity is defined.

ANALYZING AN ACTIVITY.

Analysis technique is the breaking up of the activity into small units. These units represent the things that must be known and the things that must be done in the experiencing of the activity. This list of units may be compiled through observation, or participation in, the activity.

The observer or participator, however, must be extremely familiar with all phases of the activity. Charters and Whitney (4) used the questionnaire method in preparing their comparative analysis of secretarial duties and traits. The most common method of reducing an activity to its units, however, is the analysis by a specialist in the course activity that is being analyzed. This method produces an all-inclusive list of units. These units must be evaluated and selected or rejected on the basis of their adaptability and use in a specific situation.
BASIS FOR SELECTING INSTRUCTIONAL UNITS.

The learner and his objectives must be given first consideration in the selecting of the units. A pupil in the trade school, whose objective is to master a trade or some phase of the trade, will need to experience it in all of its various technical units, especially if he is to become a skilled craftsman. The learner in the junior high school, however, profits by experiences in the trade to the extent of orienting himself. For this learner, the units of instruction may be larger and less technical. A group of units taken from the Selvidge comparative analysis of the woodworking trade, (which is given later in this chapter,) may be used to illustrate this point. Four units are as follows: "Adjust a plane," "Plane surface true," "Plane an edge square with face," and "Plane end grain." These are all quite necessary for the young tradesman, but for the learner in the junior high school who wishes only to explore the trade, a larger unit such as "How to square stock to size" is more desirable.

It may be necessary to reduce the number of units of instruction still further for use in the junior high school. Time allotted to industrial arts as well as facilities for experiencing the units play a large part in determining which units may be used. Then there is also the question of relative values, both social and educational. Time may not permit the studying of all the desirable units for which facilities are available. Some units must be omitted and should be discarded on the basis of the least social and educational value to the learner.
UNITS SELECTED FOR THIS THESIS.

The Unit Operations presented in the next chapter were selected from the following list by application of the above mentioned criteria. The Selvidge comparative analysis of instructional units in the curricular activity of woodworking is as follows:

1. Read drawing and make bill of material.
2. Check material.
3. Design-form, proportion, finish.
4. Measure and divide spaces with rule.
5. Use pencil for marking.
6. Check lay-out.
7. Use try-square for laying out square cuts.
8. Saw to a line.
9. Use try-square for testing.
10. Square up a board.
11. Adjust a plane.
12. Plane surface true.
13. Plane an edge square with face.
14. Plane end grain.
15. Make a butt joint.
17. Use a marking gage.
18. Lay out pattern on stock.
19. Lay out and plane chamfer.
20. Lay out duplicate parts.
22. Trim with a chisel.
23. Use a brad awl.
24. Use dividers and compass for laying out curves.
25. Drive and draw nails.
26. Lay out a hexagon.
27. Lay out an octagon.
28. Use spoke shave.
29. Use a scraper.
30. Use sandpaper.
31. Apply stain.
32. Oil finish.
33. Apply shellac.
34. Pume.
35. Apply wax.
36. Apply enamel-paint.
37. Fasten with screws.
38. Apply varnish.
40. Tongue and groove.
41. Make dado or gain.
42. Make a housed joint.
43. Make a rabbet joint.
44. Make a half-lap joint.
45. Make a dowel joint.
46. Make a mitre joint.
47. Make a glued spring joint.
48. Use a router.
49. Prepare glue.
50. Glue up work.
51. Use hand screws and clamps.
52. Use a T-bevel.
53. Simple upholstering.
54. Use coping saw.
55. Fasten with bolts.
56. Put on hinges.
57. Put on locks.
58. Put on cupboard latches.
59. Put on drawer pulls.
60. Put on ball catches.
61. Lay out and cut blind mortise and tenon joint.
62. Lay out and cut hunched mortise and tenon joint.
63. Make and fit a drawer.
64. Lay out and cut a dove-tail joint.
65. Fasten stiles between rails.
66. Cut an edge mould.
67. Lay out and cut taper.
68. Do shaping and forming.
69. Lay out rails.
70. Apply decorations.
71. Make inlays.
72. Fasten pediments.
73. Make and fit cabinet door.
74. Make duplicate parts.
75. Lay out and make simple jigs.
76. Make drawer slides.
77. Set mirrors.
78. Set glass in cabinet work.

One other check may be applied to a master list of units of instruction in producing the best list of units for a given grade level and a particular locality; namely, the frequency of the different units on the spot sheet as used over a period of time by different groups of the same grade level in the same community. If the results of this check are to be of any value in selecting instructional units, each group must use the master list of operations in the same way and be guided by the same objectives.
CHAPTER IV

UNIT OPERATION SHEETS IN ELEMENTARY
WOODWORKING ON THE JUNIOR HIGH SCHOOL LEVEL

Plan Used in Constructing the Sheets.--Pupils Record Sheets.--How to Use the Sheets.--Unit Operation Sheets.

PLAN USED IN CONSTRUCTING THE SHEETS.

The Unit Operation Sheets presented in this chapter are constructed on the Selvidge (15) plan. Elementary woodworking in the junior high school is the trade used, but the technique is equally applicable to any vocation. The unit operations are not arranged in any logical order, and should not necessarily be introduced in any sequence of performance difficulty.

PUPILS RECORD SHEETS.

The Analysis Sheet conforms in the main with the Selvidge technique, but the provision made for classifying operations which are to be used as new or repeated was suggested by the Salomon (13, p. 82) technique. It provides a record form whereon each pupil keeps an accumulative record of operations experienced, both intensive and extensive. It is helpful in guiding the pupil in his selection of new projects that will carry him into new operations.

HOW TO USE THE UNIT OPERATION SHEETS.

The Unit Operation Sheets are designed to be used as construction helps or references by the pupil as a need or desire demands. They
are not presented in any sequence and should not be organized or taught in a logical order. The learner's contact with the material comes after he has selected his project. He first uses the analysis sheet to organize his procedure, after which he familiarizes himself with the directions for performing any new operations. The instructor's help is solicited only after all other sources have been exploited. After carrying the project through to completion, the pupil records on the spot sheet each operation which he performed.

UNIT OPERATION SHEETS.

Twenty-six unit operation sheets in elementary woodworking, illustrating the Selvidge technique on the Junior High School level follow.
ANALYSIS SHEET

Instructions: First - Check at the left each unit operation involved in the job. Place the check in the new column if you are performing the operation for the first time and in the repeated column if you have previously performed the operation.

Second - Place in column at the right the numbers of each unit operation checked in the order in which you will perform them.

Third - Read carefully the directions for performing each new operation and any repeated operation if you are not entirely familiar with the procedure.

<table>
<thead>
<tr>
<th>New Operations</th>
<th>Repeated Operations</th>
<th>UNIT OPERATIONS</th>
<th>Order to be Performed</th>
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<tbody>
<tr>
<td>1. How to Make a Shop Drawing</td>
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<td>2. How to Select Material and Make Out a Stock Bill</td>
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<td>3. How to Lay Out Work</td>
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<td>4. How to Sharpen Edge Tools</td>
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<td>5. How to Sharpen a Saw</td>
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<td>6. How to Cut Out Material</td>
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<td>7. How to Square Stock to Size</td>
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<tr>
<td>8. How to Shape and Form an Irregular Member</td>
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<td>9. How to Bore Holes</td>
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<tr>
<td>10. How to Join With Glue</td>
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<tr>
<td>11. How to Join With Nails and Screws</td>
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<tr>
<td>12. How to Lay Out, Cut, and Assemble Butt Joints</td>
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<td>13. How to Lay Out, Cut, and Assemble Halved Joints</td>
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<td>14. How to Lay Out, Cut, and Assemble Mitered Joints</td>
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<td>15. How to Lay Out, Cut, and Assemble Grooved Joints</td>
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<td>16. How to Lay Out, Cut, and Assemble Mortise and Tenon Joints</td>
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<td>17. How to Prepare Wood for Finish</td>
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<tr>
<td>18. How to Fit Hardware</td>
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<td>19. How to Glaze a Sash</td>
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<tr>
<td>20. How to Apply Stain</td>
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<td>21. How to Apply Wood Filler</td>
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<td>22. How to Apply Varnish</td>
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<tr>
<td>23. How to Apply Paint and Enamel</td>
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<tr>
<td>24. How to Cane an Opening</td>
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<tr>
<td>25. How to Weave Fiber and Splints</td>
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<tr>
<td>26. How to Do Upholstering</td>
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Checked by ___________________________
Elementary Woodworking

SPOT SHEET

Name ______________________ Grade ____________

Instructions: List each job completed in vertical column marked jobs completed. Check under each job the unit operations involved as indicated by the Analysis SSHEET.

<table>
<thead>
<tr>
<th>Jobs Completed</th>
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Unit Operations

1. How to Make a Shop Drawing
2. How to Select Material and Make Out a Stock Mill
3. How to Lay Out Work
4. How to Sharpen Edge Tools
5. How to Sharpen a Saw
6. How to Cut Out Material
7. How to Square Stock to Size
8. How to Shape and Form an Irregular Member
9. How to Bore Holes
10. How to Join With Glue
11. How to Join With Nails and Screws
12. How to Lay Out, Cut, and Assemble Butt Joints
13. How to Lay Out, Cut, and Assemble Halved Joints
14. How to Lay Out, Cut, and Assemble Mitered Joints
15. How to Lay Out, Cut, and Assemble Grooved Joints
16. How to Lay Out, Cut, and Assemble Mortise and Tenon Joints
17. How to Prepare Wood for Finish
18. How to Fit Hardware
19. How to Glaze a Sash
20. How to Apply Stain
21. How to Apply Wood Filler
22. How to Apply Varnish
23. How to Apply Paint and Enamel
24. How to Cane an Opening
25. How to Weave Fiber and Splints
Operation. No. 1  
Elementary Woodworking

HOW TO MAKE A SHOP DRAWING

Directions:
1. Make several small end and front view sketches of your idea or mental picture. Vary the design and proportions until a pleasing combination is affected. (Fig. I).

2. If the project is small and simple of construction the rough sketch, with a few dimensions added, will answer for a working drawing I (Fig. II).

3. If the project is complex a more complete drawing is necessary. The mechanical orthographic drawing, to scale, is best adapted to shop construction. Detail all joints and irregular modelings that are not clearly shown on the elevations.

4. List both detail and over all dimensions, also any explanatory notes, that will aid in construction.

5. Check the drawing:
   a. Is the shape completely described by the assembly, and detail views?
   b. Are all views drawn to proper scale?
   c. Is the size of each member accurately described by the dimensions and notes?
   d. Are the joints and the method of construction in accord with good shop practices?

References:
Wood and Smith "Prevocational and Industrial Arts", pp 72-75.

Questions:
1. Why is it necessary to make a shop drawing?
2. Why is orthographic drawing best adapted to shop use?
3. Why detail a shop drawing?
4. Why list both detail and over all dimensions?
Operation No. 2

HOW TO SELECT MATERIAL AND MAKE OUT A STOCK BILL.

Directions:

A. How to Select Material for Your Project.
1. Select the kind of wood that will best meet the utility and constructional requirements.
2. Outside projects such as—dog-house, rose trellis, window box, etc., require a durable wood that will take paint (white pine, poplar, cypress, etc.)
3. Inside projects such as—end table, reading lamp, radio cabinet, chest, etc. require a wood with an attractive grain and a texture that will take a good finish (walnut, oak, birch, mahogany, etc.).
4. Select a kind of wood that will match or harmonize with the furnishings where the project will be used.

B. How to Make Out a Bill of Material.
1. List the dimensions of each piece used as designated on the blank bill. If a bill is not provided, list in the following order: thickness (in inches), width (in inches), and length (in feet or inches). Example $\frac{3}{4}''$ (thickness) x 6'' (width) x 2' (length). Proceed the dimensions by the number of pieces of the same size. Example: "4 pc. 2'' x 2'' x 30''. Add any description of the pieces that is called for or desired.
2. Compute the amount used in some standard unit of measure. Square foot, board foot, running foot, or bundle. Boards $\frac{1}{2}''$ thick or less are figured by the sq. ft. Boards over $\frac{1}{2}''$ thick are figured in Bd. ft. Stock having small cross section such as, lattice strips and molding, are figured in running ft. Shingles and plastering lath are figured by the bundle. Use the following formulae in figuring board measure.

1. Bd. ft. = (thickness)$^2$ x (width)$^2$ x (length)$^3$ + 144.
2. Bd. ft. = (thickness)$^2$ x (width)$^2$ x (length)$^3$ + 12.
3. Figure thickness: (a) from $\frac{3}{4}''$ to 1'' as 1''.
   (b) from 1'' to $\frac{3}{4}''$ as $\frac{1}{2}$''.
   (c) from $\frac{1}{2}''$ to 2'' as 2''.
   (d) over 2'' figure exact thickness.

3. List all hardware and finishes in space provided on stock bill. If no order is suggested list as follows: 2 - $1\frac{1}{2}$'' wire brads.
   6 - $\frac{1}{2}$'', #8 R. H. B. wood screws.
   1 coat, walnut water stain.
   2 coats, flat varnish.

References:
Noyes, "Handwork in Wood", pp. 41.

Questions:
1. What kind of wood is best suited for a row boat?
2. Why list lumber dimensions in this order: thickness, width, and length?
3. Find cost of 2 pc. of oak $\frac{3}{4}''$ x 9'' x 30'' at 20¢ per Bd. ft.
Operation No. 3

Elementary Woodworking

HOW TO LAY OUT WORK

Directions:

A. Measuring:

1. Lay off all short distances with the rule. Hold rule on edge and mark the distance with a knife or sharp pencil. Use any other divisions on the rule rather than those at the end.

2. Lay off a series of short distances without moving the rule. (Fig. I.)

3. Lay off distances of any extent with the framing square, tape line or any special measuring stick.

4. Measure always along on edge or on a center line. A straight line is the shortest distance between two points.

B. To Lay Out Lines at Right Angles to a Working Face of Edge.

1. Use the try square on small pieces. Mark a working face and a working edge and square always from one of these marked surfaces.

2. Hold the beam of the square firmly against the marked edge or face and scribe along the top of the blade using a knife, scribing awl or sharp pencil. (Fig. III) Use knife or scribing awl for fine work.

3. Use the framing square for larger work. Hold blade against marked surface and scribe along top of tongue.

4. When squaring a line around the board scribe lines first on working face and working edge.

C. To Lay Out Lines Parallel to an Edge.

1. Use marking gauge for accurate work. Adjust the head on the beam to the required distance from the spur. Check with rule. Hold work firmly using vise if necessary.

2. Press head of marking gauge firmly against working edge. Roll tool backward until spur scrites lightly and push gauge steadily from you. (Fig III)
Operation No. 3

3. For less accurate laying out the pencil gauge may be used. When lines are to be near edge use pencil and finger (Fig. V). When lines are to be gauged at a greater distance from the edge use pencil and rule. (Fig. IV).

D. To Lay Out Oblique Lines.

1. On small work use the sliding T-level. Set movable blade to required angle and scribe line with knife or sharp pencil. Use protractor or framing square in setting the T-level.

2. Use framing square for laying out cuts on such work as rafters and stair stringers. (Fig. VI).

E. To Lay Out Irregular Shapes.

1. Use the dividers or compass for small arcs or circles. Adjust the points. Place one point at the designated center and hold tool lightly at top. Lean compass slightly forward while drawing curve. (Fig. VII).

2. Symmetrical shapes are best laid out from a center line. Scribe lines at regular intervals across surface at right angles to this center line. Lay off on each line the width of the pattern at this particular point and trace outline through these points.

3. Irregular shapes can also be laid out full size on paper or cardboard and transferred to the work.

II. References:


III. Questions:

1. Why hold the rule on edge while measuring?
2. Why not re-set the rule for each short measurement when laying out a series of distances?
3. In scribing a line, why push rather than pull the gauge?
4. How would you adjust the T-level to an angle of 45° using the framing square?
5. How would you lay out an angle of 30° or 60°?
Operation No. 4  Elementary Woodworking

HOW TO SHARPEN EDGE TOOLS

Directions:

A. How to grind edge tools.

1. Clamp tool firmly in tool holder. Adjust holder to give the desired bevel. This bevel will vary for different tools and different kinds of work. Grind plane and chisel bits to 20° for working hard woods as, walnut and oak. Grind same bit to 15° for working soft wood, as, white pine and bass wood.

2. Before starting grinding wheel raise cutting edge of tool from grinding surface. The grinding wheel should revolve toward edge being ground. (Fig. I). A washing liquid, kerosene or water, should flow over grinding surface while tool is being ground.

3. Lower cutting edge of tool to grinding surface. Apply slight pressure but do not crowd tool.

4. Move tool in a slow oscillating motion across width of grinding surface (Fig. II). This will bring the entire cutting edge of broad tools in contact with grinding wheel.

5. Inspect tool often. Grind until all nicks are removed and cutting edge is continuous.

B. How to Whet edge Tools.

1. Moisten the surface of stone to be used with light oil. (Kerosene preferred.)

2. Lay tool flat on stone, bevel side down as in grinding. Gradually raise tool until the oil is expelled from under cutting edge.

3. With tool at this angle, push it straight forward across stone. Raise tool clear of stone on return stroke. Continue to whet at this angle until a slight secondary bevel is formed.

4. Remove wire edge by placing tool on stone, flat side down, and drawing it toward you once or twice.

5. If a very keen edge is desired, strop tool on leather strap after whetting.
Operation No. 4

6. If cutting edge is broad, turn tool at angle until entire edge rests on surface of stone. When whetting such tools as draw knife, hold tool stationary and rub oil stone over cutting edge.

7. Rock the outside bevel gauge while whetting. Remove wire edge with slip stone.

8. Whet inside bevel gauge with slip stone.

C. How to Sharpen Scraper Blade.

1. Clamp blade in vise, edge to be sharpened upward.

2. Draw tile edge straight and square. Round blade slightly at the corners (Fig. V).

3. Remove blade from vise and rub filed edge over oil stone until smooth. Hold blade perpendicular to surface of stone while whetting. Lay blade flat on oil stone and dress each side until wire edge is removed (Fig. VI).

4. Reclamp blade in vise, and turn edge with a polished hard steel rod or burnisher. Oil the burnisher slightly and place it squarely across blade. Lower one end about 15° and rub with a firm even stroke three or four times across edge of blade (Fig. VII). Lower opposite end of burnisher and repeat the operation. A small bur should be formed along the entire edge.

Reference:
Smith and Wood, "Prevocational and Industrial Arts", pp. 28-34.

Questions:
1. Why use water or oil on the surface of a grinding wheel?
2. Why should the grinding surface revolve toward the edge being ground?
3. Why moisten the surface of the whetting stone?
4. Why raise the tool clear of the stone on the return stroke when whetting?
5. Why remove the wire edge on any tool?
6. Why round the scraper blade slightly at the corners?
Operation No. 5
Elementary Woodworking

HOW TO SHARPEN A HAND SAW

Directions:

A. To Joint Teeth.

1. Clamp saw in saw vise, teeth up and projecting about two inches above vise.

2. Use a saw jointer or rub a mill file lengthwise over top of teeth until they are reduced to the same level. (Fig. I).

B. To Set Teeth.

1. Use a saw set. Adjust the beveled-disc anvil to give the proper set. The numbers on anvil correspond to points per inch.

2. Place saw set over saw and tighten gage setscrew. Move saw set until a tooth that is to be set away from you rests squarely on the anvil. Close the grips, slightly bending the top half of the tooth outward. Set every alternate tooth to same side of saw. Reverse saw and set remaining teeth to opposite side.

C. To file Teeth.

1. Clamp saw in saw vise near handle, teeth projecting about one-half inch above vise. Use a triangular file. Select a taper that is suited to the teeth. (See file chart). Hold handle of file with right hand. Hold point of file with thumb and forefingers of left hand.

2. Place file on first tooth at proper angle as directed under (4) below and assume an easy position as this angle must be maintained throughout the filing. (Fig. II). Shape teeth by filing on cutting edge.
3. File only those teeth that are set toward you. Push file across tooth with straight even stroke. File should touch lightly the adjacent tooth. Lift file from saw on return stroke. File every alternate tooth until they are well shaped, uniform, and sharp. Reverse saw and file remaining teeth.

4. When filing rip saw hold file perpendicular to plane of saw.
When filing cross-cut saw lower handle of file about 15° and swing to right or left about 20° as you file the front of the tooth. (fig. 3)

D. To Side Dress Teeth.

1. Remove saw from vise, lay flat on edge of bench and rub oil stone lightly over sides of teeth.

References:

Smith & Wood "$Provocational and Industrial Arts$" pp. 4-6

Griffith, "$Essentials of Woodworking$" pp. 22-23

Noyes, "Handwork in Wood" pp. 68

Questions:

1. Why reduce all teeth to the same level?

2. Why bend the points of the teeth?

3. Why not hold the file perpendicular to the plane of the saw while filing a cross-cut saw?

4. Why side dress the tooth?
Operation No. 6

Elementary Woodworking.

HOW TO CUT OUT MATERIAL.

Directions:

A. To cut Stock to Width.
1. Always cut stock to width before cutting to length. Select a rip saw of a size and grade suitable for the work.
2. Place board on saw horse or clamp in vise. When using saw horse hold board with left hand and knee (Fig. I).
3. Lay out work allowing 1/8" for planing. (See operation No. 3).
4. Grasp the saw handle firmly extending the index finger (Fig. II). Start saw with a short slow dragging or pulling stroke. The second stroke is a light pushing one. Gradually increase length of stroke until a full even movement is obtained. Guide saw on starting strokes by holding thumb of left hand against blade (Fig. I). When kerf is started guide saw by twisting handle or bending blade. The plane of the saw should be perpendicular to the surface and the cutting edge should make a 45° angle with it. Do not force saw. Saw kerf is always on waste side of line.
5. Clamp small pieces in vise. If work is narrow, clamp with broad side parallel to vise screw and at an angle (Fig. IV). If work is wide, clamp with broad side parallel to front of bench, waste stock outside of vise (Fig. V). Saw as directed above. Use "handy" saw for thin work.

B. To cut Stock to Length.
1. Select a cross-cut saw of a size and grade suitable for the work.
2. Make necessary layouts. Hold board on saw horse, bench hook, or clamp in vise. Saw as directed above (A - 4).
3. If work is held on bench hook or clamped in vise, the broad surface should be parallel with top of bench. Use a back saw or "handy" saw. Start saw near toe and when cutting edge has entered the wood sufficiently to hold saw gradually lower handle until blade is horizontal (Fig. III)

C. To Saw Curves and Scrolls.
1. Select a turning, compass, or coping saw as the nature of the work demands. Clamp wood in vise or on vertical support. Bore a hole in waste wood for starting saw on inside scrolls.
2. Start saw with light stroke tension saws cut on the pull stroke, compression saws cut on the push stroke. Turn saw by twisting handle or frame. If a sharp turn is necessary, slowly turn the saw without advancing it.
Operation No. 2

D. To Saw Angles.

1. For small stock use the miterbox. Set saw at required angle, hold work in box and saw as directed above for back saw (E - 3).
2. Place large work on saw horse. Use a cross-cut saw as directed above (A - 4).

References

Smith and Wood, "Prevocational and Industrial Arts" pp. 4-8.

Questions

1. Why start the saw with a slow dragging stroke?
2. When would you twist the handle and when would you bend the saw in guiding?
3. In sawing to width, why not clamp the waste wood in the vise?
Operation No. 7.  

Elementary Woodworking.

HOW TO SQUARE STOCK TO SIZE.

Directions:

A. Plane working face true.

1. Place wood on top of bench, hold with bench stop or clamp with tail vise. (Fig. 3)
2. Plane surface with jack or smooth plane. Test for high spots with edge of plane or blade of try square. Continue to plane and test until the surface is true. In beginning a stroke, pressure should be applied to knob of plane, but as plane is pushed along board an equal amount of pressure is applied to both knob and handle and as the plane nears the end, greater pressure is applied to the handle. Mark this face "F" (fig. 1.)

B. Plane working edge.

1. Clamp wood in vise working face out.
2. Plane edge with jack or jointer plane. (fig. II) Edge must be straight with working face. Mark this face "E".

C. Plane one end.

1. Clamp stock in vise or hold on "shooting board," use block plane. If stock is held in vise plane from either edge toward the center (fig. 4). If shooting board is used place stock on board working face up. Turn plane on edge and plane entirely across the end. (fig. 5). Continue to plane and test until the end is square with the working face and working edge.

D. Cut and plane to length.

1. Saw to approximate length, (6-8)
   Plane as directed under "G" above.
E. Dress to width.

1. Rip to approximate width (6-A)
   a. Plant as directed under "B" above

F. Plane to thickness.

1. Gauge the desired thickness entirely around the stock, gauging from the working face. Plane as directed under "A" above.

References:

Wood and Smith "Prevocational and Industrial Arts" pp. 0-11.

Griffith "Essential of Woodworking" pp. 35-45.


Questions:

1. How test a surface for wind of high spots?

2. Why not plane entirely across the end of the board when holding the stock in the vise?
Operation No. 8

Elementary Woodworking.

HOW TO SHAPE AND FORM AN IRREGULAR MEMBER.

Directions:
A. Irregular on One Surface or Two Opposite Surfaces.
   1. Plane board to thickness and joint one edge straight and square
      with working face.
   2. Cut piece accurately to length.
   3. Lay out shape of member on working face. (Fig. I).
   4. Saw all inside openwork first. Bore a small hole in which to start the
      saw. (Fig. II).
   5. Saw roughly to shape using scroll saw. (See operation No. 6 - c).
   6. Work members to shape with spoke shave or any other cutting or
      smoothing tool that will function.

B. Irregular on two adjacent surfaces.
   1. Surface working face and working edge.
   2. Cut piece accurately to length. Plane to width and thickness.
   3. Lay out the shape on two adjacent faces. (Fig. III). Cabriole leg.
   4. Saw roughly to shape the two largest surfaces withdrawing saw each time
      before cut is quite finished. The clamping pieces will preserve the layout
      for the other side or sides and help hold the stock level for sawing.
   5. Saw other surfaces to shape and finish as directed under A - 6 above.

References:


Questions:

1. Why cut stock to length before modeling?
2. Why cut out the open work before modeling?
3. Why make all measurements from the working edge when not using a pattern?
Operation No. 9  
Elementary Woodworking

How to Bore Holes

Directions:

1. Locate the center of each hole and punch or drill a small guide hole for the spur of the bit.
2. Select the proper kind and size of bit. Fit bit in brace.
3. Determine the angle of bit in relation to the surface of the board and clamp board so that the brace may be held either vertically or horizontally. Hold stock rigid, using vise if size and nature of the work will permit.
4. Place the spur of the bit on indicated center and adjust brace and bit to desired angle (Fig. I). Steady head of brace by resting your body against the hand that grips the knob. Sight bit from two directions at right angles to each other (Fig. II). It is sometimes necessary on very accurate work for one person to operate the brace and bit and another sight the angle. Use a try square in testing vertical boring (Fig. III).
5. To withdraw bit from hole, give the brace a full turn backward, then pull straight out. Use care not to tear wood at mouth of hole.
6. In through boring, withdraw bit as soon as the spur begins to break through; reverse the work and finish boring from other side. A piece of waste wood clamped on back of board will also prevent splitting when bit comes through (Fig. IV).
7. Use a bit gauge for accurate depth-boring. If a gauge is not convenient turn brace until lips of bit are just ready to cut. Measure distance from surface of board to bottom of chuck. The brace may then be turned until this distance is diminished the desired depth of the hole. A short block may be cut to this length and used as a measuring stick (Fig. II).

References:
Noyes, "Handwork in Wood" pp. 85-86.

Questions:
1. Why punch a small hole as a center for boring?
2. Why give the brace a full turn backward when withdrawing the bit?
3. Why not bore entirely through the stock from one direction?
Operation No. 10  

**Elementary Woodworking**

**HOW TO JOIN WITH GLUE**

A. Edge to Edge Gluing.

**Directions:**

1. Plane one surface of each piece true and out of wind. Indicate by arrow the direction in which each piece must be planed.
2. Joint edges that are to be joined straight and square with working face.
3. Clamp one piece in vise working face out and jointed edge up. Place other board upright on this edge working face out and arrow pointing in same direction. Inspect the joint by sighting through. If necessary plane the high spots on each board until joint is tight and the marked surfaces are in the same plane. Mark the joint as indicated in Fig. I.
4. Joint all edges that are to be joined as directed under #3 above.
5. Arrange pieces in order on glue table. Cut several small pieces of waste wood to use between clamp of jaws and work. Set clamp and assemble dry. Remove clamps and arrange them so they may be quickly applied. Spread hot glue hurriedly over edges to be joined and clamp immediately. Work fast, use clamps on both sides tightening alternately. Never attempt more than two joints in one set of clamps. If work is in wind clamp a cleat at each end using hand screw clamps. Work should remain in clamps for at least five hours.
6. If dowels are to be used proceed as directed above until the pieces are ready to glue. Clamp two adjacent pieces back to back in vise, arrows pointing same direction and edges that are to form the joint up. Locate position of dowels (8 to 10 inches apart). Square lines across and gauge center line (Fig. II). Bore holes to receive dowels at these points. The depth of the hole should be about three times the diameter of the dowel. The diameter of the dowel should be at least one half the thickness of the board. Counter sink the hole slightly. Prepare all edges that are to be joined, in this manner. Cut dowels about one eighth of an inch shorter than combined depth of the two holes. Point both ends slightly and saw a kerf on one edge of dowel (Fig. II). Prepare the joint for gluing as directed under #6 above and insert dowels just before clamping.

B. End to End Gluing.

1. Plane the ends that are to be joined until they fit tight and true.
2. Size the joint with thin glue and permit to harden. Scrape off sizing down to the wood fiber. Glue again and clamp.
3. If any type of fastening is to be used with the glue it should be applied before the glue sets.
Operation 10

C. Building Up Work
1. Plane surfaces to be glued true and out of wind.
2. Arrange the pieces with the annual rings curving in opposite directions (Fig. III).
3. Adjust several hard wood screw clamps to the proper width.
4. Rub glue hurriedly over all surfaces to be joined and clamp. Use a clamp about every four or six inches. The jaws of each clamp should be parallel when clamped. (Fig. I).
5. Remove clamp after six or eight hours.

D. Gluing Frame Structure.
1. Divide work into small units. Adjust beam clamps and clamp each unit dry. Joints must be snug and true. Refit if necessary.
2. Remove clamp and arrange them near at hand. Assemble smallest unit first. Spread glue hurriedly over all joints and reclamp. Test work, adjust clamps until it is square about wind. Use diagonal brace or clamp if necessary to pull work square. Permit the work to dry at least six hours.
3. Assemble the units, following directions and precautions listed above.

References:
Wood and Smith "Technical and Industrial Arts", pp. 95-96.

Questions:
1. Why use clamps alternately on opposite sides when gluing edge to edge?
2. Why countersink the holes for the dowels when they are used in a glued joint?
3. Why size an end grain?
4. Why should the annual rings curve in the same direction in built up stock?
5. Why divide assembling into small units?
Operation No. 11

How to Join with Nails and Screws.

Directions:

(a) Fastening pieces of wood together with nails.
1. Locate position of nail. Stand so that you can see along edge of piece into which you are nailing.
2. Grip hammer handle near end. Hold nail with thumb and first finger. Set nail in position and start with light stroke of hammer. Increase force of stroke as nail is driven. (Fig. I)
3. Drive head of nail flush with wood for rough work. For fine work stop just before head is flush and finish driving with nail set. Sink head slightly below surface if hole is to be filled.
4. Use wrist motion for light nailing, wrist and elbow for medium nailing, and wrist, elbow and shoulder for heavy nailing.
5. If there is any danger of splitting, drill hole slightly smaller than the nail.
6. To withdraw nail, grip with claw of hammer and try over block placed under head of hammer. (Fig. II).
7. Too nailing is driving nails on a slant to produce a clamping effect. (Fig. III).

(b) Fastening with screws.
1. Locate position of screw on piece against which head of screw will bear. Bore hole through this piece the size of the screw shank. Counter sink this hole if flat head screw is to be used. (Fig. IV) If screw head is to be hidden or covered counter bore to desired depth before drilling hole for shank of screw.
2. Place this piece on piece to which it is to be joined and mark position of screw. Bore hole in second piece the size of the root diameter of the threads on screw, and almost as deep as screw will be driven.
3. Assemble pieces and start screw with fingers. Select a screw driver that fits snugly into slot on screw head (Fig. V) and turn screw until pieces are drawn tightly together.

If screw is turning extremely hard, remove it and drill the hole in second piece deeper or larger. Screw applied to threads will make screw turn easier. If second member is soft wood and screw enters end grain, dip threads of screw in glue before driving, or insert hard wood dowel at right angles to screws. (Fig. VI).

References:

Wood and Smith - "Vocational and Industrial Arts", pp. 26-27 and 42-47.
Noyes - "Handwork in Wood", pp. 94-97 and 125-127
- Operation No. 11

Questions:

1. Why not attempt to change the direction of a nail after it has entered the wood by pounding it sidewise?

2. Why not counter sink the hole for a round head screw?

3. Will the small hole in second piece need be as deep in soft wood as in hard?

4. Why will screws not hold strongly in end grain?
ELEMENTARY WOODWORKING

Operation No. 12  How to Lay Out, Cut, and Assemble Butt Joints.

Directions:
(a) Laying out and Cutting Joint.

1. Cut, shape, and form both members. Saw or plane end of abutting member until it is square or true with other member. Various types of mechanical fasteners are used either with or without glue. Nails, screws, dowels, and bolts are the most common.

2. If screws are used, mark position of the abutting member and bore the holes as directed in No. 11.

3. If draw bolt is to be used, clamp both members as they are to be joined and bore hole in both members (Fig. 1). Bore or mortise cavity for nut in abutting piece.

4. If dowel is to be used, and the end is to show on one member, bore holes as for draw bolt. If dowel is to be hidden locate position of hole on one piece, and by superposition transfer them to the other piece. (Fig. II) Bore holes from marked face of each piece.

(b) Assembling the Butt joint.

1. If nails are used assemble as directed in No. 11.

2. If dowels, screws, or bolts are used, assemble first without glue and check for squareness. If not square, refit joints until they are true.

3. If rigid joints are desired use glue and clamp as directed in No. 10.

References:
Wood and Smith - "Vocational and Industrial Arts," pp. 20-23.

Questions:
1. How do you know when your joint is true?
2. What is superposition?
3. How would you check an assembled project for squareness?
ELEMENTARY WOODWORKING


Directions:
(A) Laying out and Cutting the Cross-lap Joint

1. Plane stock to width and thickness in one piece. Cut both members to length. Square ends. Mark working face of each member.

2. Lay off from one end of each member the nearer edge of each groove. Square this line across working face of one member and opposite face of other member.

3. Place first member across second member at line drawn, working faces up. Mark width of groove on lower member (Fig. I). Through this point square line across face. Extend these lines down the adjacent edges.

4. Set marking gage about one half the thickness of the stock, and with head of gage against working face, gage between the extended lines on both edges for depth of groove (Fig. II).

5. Place this member in vise or on bench hook and saw inside of line down to gage line.

6. Remove material between saw kerfs and above gage line with chisel or router plane. Pare across grain.

7. Fit the second member into this groove (Fig. III). One edge coinciding with line drawn and mark width of groove on second member. Continue to lay out and cut groove in this member as directed under 3, 4, 5, and 6 above.

(B) Laying out and cutting the end-lap joint.

1. Prepare stock as directed under A - 1 above.

2. On the face opposite working face of one member measure back from one end the width of stock. Square a line through this point and extend it across the two edges. (Fig. IV)

3. Set marking gage to one half the thickness of stock and gage depth of groove. Hold head of gage against working face.

4. Place member vertically in vise and remove waste stock, using the back or "handy saw," and keeping just inside of lines. (Fig. V)
5. Place this end in position on working face of other member and scribe width of groove (Fig. VI). Extend these lines down the edge of this member. Draw lines between extended lines using same setting of plane as for first member, and holding head of plane against working face.

6. All modifications of end lap joints are laid out and cut in this order.

(c) Assembling the Dovetail Joints.

1. If these joints are to be used in rough construction, assemble without glue and fasten with nails or screws. (Operation No. 11) if the joints are to be used in cabinet construction they should be fastened with glue.

References:
Wood and Smith, "Practical and Industrial Arts," pp. 96.

Questions:
1. Why lay out the joint on the working face of one member and the side opposite this face on the other member?

2. Why give the depth of the groove from working face of each piece, when one is laid out on side opposite the working face?
ELementary Woodworking

Operation No. 14   How to Lay out, Cut, and Assemble Mitered Joints.

Directions:
(a) Laying out and cutting joint.

1. Plane stock to width and thickness in one piece, if practicable.

2. Adjust sliding T bevel to desired angle and lay off the ends of one member using a knife or sharp pencil. Square line down edges.

3. Place stock on bench back, or clamp in vise. Saw very carefully to the line using bench saw. If miter box is used, set saw to proper angle and hold piece firmly against back of box. To adjust mitre saw, press thumb clamp at front of box and swing from carrying saw through desired number of degrees indicated by protractor attached to bed of box.

4. Plane or pare with chisel abutting ends until miter is true.

(b) Assembling the miter joint.

1. Many mechanical fasteners are used in assembling mitered joints—nails, dowels, slip-feather, corrugated fasteners, etc. Glue is usually used on interior work but never on outside, unpainted work.

2. Use miter clamp, or assemble around a form. If joint is to be nailed, bore holes through one piece slightly smaller than the nail. Drive nail until it projects slightly. Place this member slightly above position on second member. (Fig. I)

Finish driving nail drawing members into exact position. If dowels are to be used, gauge center lines on mitered faces. Place working faces of members together with miters coinciding, and square across mitered faces, locating holes (Fig. II). Bore holes at right angles to mitered faces (Fig. III) Cut dowel slightly shorter than depth of holes. Apply glue, insert dowels, and clamp. If end of dowel is not objectionable, bore hole perpendicular to one member (Fig. III) Insert the dowel. The slip-feather may also be inserted after joint has been glued.

References:
Woods and Smith, "Prevocational and Industrial Arts" page 90.

Questions:
1. Why get out stock in one piece?
2. Why can't both cuts on a piece of molding be used?
3. Why not glue outside work?
Operation no. 15

How to lay out, cut, and assemble grooved joints.

Directions:

(A) Laying out and cutting grooved joints which extend along the grain.

1. Plane stock to dimensions and shape.

2. Gauge width of groove on working face or working edge as desired and depth on end. Gauge width of rabbet on working face and depth on working edge. (Fig. I).

3. If groove is continuous throughout piece, remove waste wood with combination or rabbet plane. If not continuous, use chisel.

(B) Laying out and cutting grooved joints which extend across the grain.

1. Plane stock to dimensions and shape.

2. Lay out dado or ga in rising try square or sliding T-bevel, scribing with knife. Gauge depth of dado on edges.

3. If groove is entirely across piece, remove waste wood with combination plane, or saw along line to required depth and remove wood with chisel or router plane. If groove extends only part way across piece, saw along side lines until saw kerf reaches depth and length lines. (Fig. II). Remove wood with chisel and router plane, finishing side cuts with chisel or by stop sawing.

(C) Assembling grooved joints.

1. Prepare each member for finish by scraping and sanding.

2. Assemble with glue. If a mechanical fastener is needed, use nails or screws. Check and test work for squareness. Permit to remain in clamp until glue sets.

References:

Wood and Smith, "Prevocational and Industrial Arts", pg. 90.
Moos, "Handwork in Wood", pp. 157-158.

Questions:

1. Why not use a combination plane for a groove that is not continuous throughout the piece?
2. When would you use a sliding T-bevel to lay out a dado?
3. Why prepare the wood for finish before assembling?
Operation no. 16

How to Lay Out, Cut, and Assemble Mortise and Tenon Joints.

Directions:

(A) Laying out and cutting tenon.

1. Work material to size and shape. Mark working face and working edge.

2. Measure back from end of piece the length of tenon. Scribe a knife line through this point and extend it around piece, holding beam of square always against working face or working edge.

3. Lay off on working face the width of tenon and on working edge, its thickness. Adjust marking gage to each distance and gage lines across end, back edge and face to shoulder line. (Fig. I). Hold head of gage, always, against working face or working edge.

4. Clamp member vertically in vise, and with a fine rip saw cut all faces, sawing just outside gage lines and to the depth indicated by the shoulder lines. Place member on bench hook, or clamp horizontally in vise and cut the shoulders (Fig. II). Use back saw and cut accurately to the line, sawing on waste side.

5. Layout and cut all tenons regardless of size or shape, as directed above.

(B) Laying out and cutting mortise.

1. If mortise member is to be tapered or molded, work stock to size in the square and lay out and cut mortise before shaping member.

2. Locate position of mortise and mark its length. Through these points scribe pencil lines across the piece. Mark width of mortise. Adjust marking or mortise gage and scribe lines through these points between cross lines. (Fig. III). Check layout by superposing upon it the tenon just cut. If laying out a through mortise, scribe the lines describing its length, across three faces and gage width of mortise on opposite faces.

3. Clamp member on top of bench or in vise. Bore vertical holes inside the mortise lines to required depth of mortise. Use an auger bit slightly smaller than width of mortise and bore holes as closely together as possible. (Fig. IV). Pare out remaining wood with chisel. The sides of mortise should be perpendicular to the face. If cutting a through mortise work from both sides with both auger and chisel.

4. Assemble joint. It should fit snugly but should not be driven. Enlarge mortise if joint is too tight.
5. If mortises are cut on adjacent faces they should join and the ends of the tenons should be mitered. (Fig. 7).

(C) Assembling joint.

1. The through mortise and tenon is sometimes keyed. This wedge-shaped key fits into a mortise cut near the tenon. (Fig. VI) Glue is not used.

2. The slip tenon (Fig. VII) is assembled from the end. Use glue.

3. The blind mortise and tenon may either be wedged, pinned or nailed, or assembled only with the use of glue.

References:

Wood and Smith, "Pre-vocational and Industrial Arts". p. 90.

Questions:

1. Why hold bench of try square and head of marking gage always against working face or working edge?

2. Why rip cheeks of tenon before sawing shoulders?

3. Why should the walls or sides of the mortise be perpendicular to the face?

4. Why work from both sides when cutting a through mortise?

5. Why scribe length of mortise with pencil?
Operation No. 17

Elementary Woodworking

HOW TO PREPARE WOOD FOR FINISH

Directions:

1. Check the surface to make sure all tool marks were removed, before assembling. Scrape any unsatisfactory surface.

2. Scrape surplus glue from around joints, using chisel or scraper. Remove glue from surfaces that are to be finished, before it sets. Use cloth wrung from hot water.

3. Restore the grain bruised by dents by covering with damp cloth and applying a hot pressing iron or piece of metal. Fill cracks or holes with plastic wood, or by inlaying a small piece of wood that matches the grain. A paste made by mixing fine sawdust with glue may be used. Small holes are filled after the wood is stained, with putty colored to match.

4. Remove grease spots by rubbing with cloth moistened with benzine. Remove pencil marks with sand paper or rubber eraser.

5. Smooth with No. 1 sand paper. Use a sand paper block and sand in the direction of the grain. Rub out bad spots first, and finish with long uniform strokes. Go over surface the last time with No. 00 or No. 000 sand paper. Care must be taken not to round off too distinctly the arrises. However, sharp corners should be removed with fine sand paper backed with the fingers.

6. Brush dust from work, and inspect carefully to make sure the surface is smooth and uniform. Repeat four and five until the surface is sufficiently smooth for the type of finish to be used.

References:


Questions:

1. Why remove surplus glue from surface before it sets?
2. What are the advantages of removing tool marks before assembling?
3. When would you use sawdust and glue as a crack filler?
Elementary Woodworking.

Operation no. 18

How to Fit Hardware.

Note: No attempt is made in this operation sheet to give specific directions for fitting any of the various kinds of lock, latches, etc. The following directions are given only as a procedure to be followed wherever hardware is used.

Directions:

1. Assemble project and prepare surface for finish. Allowance must be made around doors and drawers for thickness of finish.

2. Lay out and cut all maims and mortises for hinges, locks, casters, etc.

3. Fit all decorative plates and handles. Drill holes for their fastening. Use screws whenever possible.

4. Remove all hardware that will interfere with staining and polishing.

5. Stain and finish project through to final polishing. Attach all hardware and trimming, and apply final polish.

References:

Wood and Smith; "Vocational and Industrial Arts", pp. 49-57.
Griffith, "Essentials of Woodworking", pp. 130-134.

Questions:

1. Why attach any hardware before finishing?
2. Why not attach all hardware before finishing?
3. Why locate hardware and drill holes for attaching it before finishing?
Elementary Woodworking

Operation No. 19  
How to Glaze a Sash

Directions:

1. Place sash flat on top of bench or saw horses, rabbeted side up. Rabbet should be clean and true.

2. Prime rabbet with thin outside paint or linseed oil.

3. Place window glass on a true surface. Score on glass the exact size and shape of pane, using a glass cutter, square and straight edge. The scored line should be continuous and reach from edge to edge (Fig. I). Do not re-score a line. Slide glass to edge of surface and break along scored line by washing down on projecting piece (Fig. II). Lightly tap under side of glass directly below scribed line with glass cutter to aid in breaking. (Usually glass can be secured the proper shape and size.)

4. Fit pane in sash and secure with glazier points. Tap point flat on sash and drive well into wood with a heavy chisel or any flat tool. Use points six to eight inches apart. (Fig. III).

5. Mord some putty to the consistency of dough, adding a few drops of boiled oil if necessary.

6. Slice off small quantities of the putty with a putty knife and work it into the rabbet, covering the glazier points. Pressure should be applied to knife as it is drawn along, forcing the putty into all cracks leaving a smooth surface. (Fig. III)

7. Allow to dry for about twenty-four hours, then cover putty and sash with priming coat of paint.

References:
- Ericson, "Glass and Glazing", pp. 44-64.

Questions:
1. Why prime sash before glazing?
2. Why should the rabbet be clean and true?
3. Why not re-scribe a line with a glass cutter?
Operation No. 20  
Elementary Woodworking

HOW TO APPLY STAIN

Directions:

1. Select kind of stain best suited for work to be done, (penetrating oil stain preferred). Select also desired color, or produce desired color by mixing two shades of the same kind of stain. Dry color that is soluble in the stain thinner may also be used.

2. If water stain is to be used, sponge surfaces first with warm water. When dry sand lightly with No. 000 sand paper, sanding with the grain.

3. Pour sufficient stain to cover work into a clean container. Select brush of proper size. (1 in. for small surfaces, 2 in. for table or stool, 3 in. for interior finishing.) Make sure it is clean. Try stain on small sample of scrap wood same kind as used in project. If stain is too dark, add thinner. (Water for water stain, boiled linseed for oil stain, alcohol for spirit stain.) If too light, add a little dry color or a similar stain of darker shade.

4. Brush dust carefully from work. Dip bristles of brush about one-third of their length into stain. Wipe out surplus on edge of container. Stain inside corners and recessed surfaces first. Stain from top down; do top last--brush with grain--use long, uniform stroke. Brush from unstained surface toward stained surface. Work from inside toward edge. Wipe stain from all surfaces before it dries with soft cloth.

5. Stain end grain lightly and wipe off immediately. A coat of thin shellacs applied to end grain before staining will prevent it from becoming too dark.

6. Permit the stain to dry thoroughly before applying another coat of finish.

7. Return all unused stain to the supply can. Clean small container and brush using the stain thinner. Then wash both container and brush in soap and water. Place stain can, container, and brush in proper places.

References:

McGee and Brown, "Instruction Units in Woodfinishing", pp. 8-15.
Operation No. 20

Questions:

1. What is the best kind of stain to use on pine, poplar, oak?
2. Why try stain on small sample of scrap wood?
3. How would you make oil stain lighter?
4. Why begin at top and stain down?
5. Why wipe off surplus stain?
Operation No. 21  
Elementary Woodworking

HOW TO APPLY WOOD FILLER

Directions:

A. Paste Filler.

1. Brush and wipe all surfaces free of dust.

2. Place enough prepared filler for work in a container and reduce to proper consistency by adding thinner (benzine or naphtha). If color is desired, add oil stain.

3. Select a medium stiff bristled brush of proper size. Apply freely and brush well into pores of wood. Brush with the grain. Cover entire surface of small work, allow to whiten or dull, and rub off across grain. Use burlap or sea moss to rub off filler. Use a stiff dusting brush, or stretch burlap over the end of a pointed stick to remove filler from inside corners. Clean surface immediately with a soft cotton cloth, wiping with the grain. Large projects must be divided into units; such as top, end, or side for filling.

4. Permit filler to harden at least twenty-four hours before covering it with another coat of finish. Surface should be sanded lightly with No. 000 sand paper before applying shellac or varnish over paste filler.

5. Clean brush in naphtha or benzine, squeeze out several times, and wash thoroughly in soap and water. Return any unused filler to filler can.

6. If filler becomes too hard to rub off, remove with cloth moistened with naphtha or benzine.

B. Liquid Filler.

1. Clean surface (as for paste filler) free of dust and lint.

2. Regulate temperature of room to about 70°F. Open one or two windows slightly to facilitate ventilation, but avoid draughts.

3. Select soft bristle brush, camel hair preferred, of size suitable for work. (1 in. brush for small work: 2 in. brush for large surfaces). Pour a small amount of shellac into a container. (White shellac for clear filler, orange shellac for colored filler, or when work must withstand excess moisture—as outside work or patterns). Thin shellac with alcohol, wood preferred; denatured may be used. The consistency depends upon
Operation No. 21

the nature of the work to be filled. Stock shellac should be reduced as follows: First coat, four parts alcohol to one of shellac; second coat, equal parts of alcohol and shellac; third and each additional coat, use stock shellac.

4. Inspect brush before dipping it into shellac to make sure it is clean. Work denatured alcohol into brush and squeeze dry before using. Dip bristles about one half their length into the prepared shellac. Wipe lightly on inside of container and apply brush to surface. Brush with the grain. Work rapidly with long light strokes. Apply shellac evenly, but brush as little as possible. Pour any unused shellac in waste can. Clean brush and container with alcohol, and wash in soap and water. Return all material to the proper place.

5. Permit each coat of shellac to dry thoroughly before applying another coat. Test for softness by sanding lightly with fine sand paper, No. 000. If shellac is dry, the paper will not glaze over. First coat should dry at least two hours, and each succeeding coat at least twelve hours, depending upon the temperature and humidity of the atmosphere. Sand each coat lightly with No. 000 sand paper, after it is thoroughly dry before applying another coat of finish. Steel wool may be used, if precautions are taken to remove all small particles of the wool from surface before applying another coat of finish. All sanding and rubbing down should be done outside the finish room.

References:

Mc Cee and Brown, "Instructional Units in Wood Finishing," pp. 16-26.

Questions:

1. Why should the surface be well cleaned before applying wood filler?
2. Why are thin coats used for first and second coats of liquid filler?
3. Why brush paste filler on with the grain and off across the grain?
Operation No. 22  
Elementary Woodworking

HOW TO APPLY VARNISH

Directions:

1. Examine the surface to be varnished. Make sure that the preceding coats in the finish (if any) have prepared the surface for varnish, and that they are thoroughly dry. Rub down lightly with fine sand paper No. 000 if the surface is rough or grainy. Brush or wipe all dust from surface to be varnished.

2. Pour into a clean, small container enough varnish for first coat. If applied over shellac, use stock varnish. If used without an undercoat, thin with pure turpentine (one part turpentine and six parts varnish) and mix thoroughly.

3. Varnish should be applied in a warm room (75°F.). The room should be clean and free from dust. There should be circulation in the room, but no draught. The finisher's clothing should also be dusted before he enters the finishing room. Stock varnish will flow much freer if it is about the same temperature as the room. A safe way to warm varnish is to set the can in a pan of hot water (not boiling). Select a soft hair brush of proper size (one and one-half to two inch brush for small projects) and work it out in a little clean turpentine.

4. Dip the brush into the varnish filling the lower one-fourth of the brush and set varnish in brush by tapping it against inside of container. Flow varnish on freely, brush sparingly. Work fast with long firm strokes. Finish by brushing in the direction of the grain. Cover all surfaces well, brushing from the center of the surface toward the edge. Wipe varnish from brush over edge of container and brush out excess varnish, sags and runs. Set aside to dry. The time required for drying or oxidizing will depend upon the temperature and humidity of the air, and upon the ventilation of the room. Forty-eight hours will be required under the best of conditions. If the air is moist and cool and the temperature is low, (40°F. to 60°F.), many hours longer will be required. Pour any unused varnish into waste can. Clean container and brush thoroughly in turpentine, squeezing brush out several times, and wash both in soap and water. Return brush and container to proper places.

5. After first coat is thoroughly dry, test with finger nail for hardness. Rub lightly with No. 0000 sand paper or No. 00 steel wool; rub in direction of grain. Precautions must be taken on the arrises
Operation No. 22

to prevent rubbing through the finish. Back sand paper with fingers. If this first coat of varnish is to be the final coat, rub down with No. ETT imported pumice stone. For gloss finish, use paraffin oil with the pumice, and for dull eggshell finish, use pumice dry and rub lightly. Use a rubbing felt or pad for rubbing when using pumice. The size and shape of the pad will depend upon the surface to be rubbed. (Use small flat pad 2 x 4 inches for flat surfaces, and a pad shaped to fit for curves or molded edges.) Pumice should always be sifted onto the surface of the pad through a cheesecloth bag. Rub in the direction of the grain wherever possible. Proceed cautiously; clean a portion of the surface occasionally with cheesecloth and inspect for polish and pits. Rub only long enough to produce the desired luster and surface. Clean surface thoroughly with cheesecloth or chamois skin.

6. If a second or third coat of varnish is desired, use stock varnish and apply as directed in 2, 3 and 4 above.

7. Rub down final coat as directed in 5 above.

8. Polish a varnished surface with polishing oil. Moisten a cheesecloth pad in polishing oil. Wring the cloth to remove excess oil and rub surface in a brisk circular motion. Rub in this manner until the desired polish is produced, and finish with long, light strokes in the direction of the grain. Spirit off the surface with a soft cloth moistened in alcohol. Precautions must be taken not to use too much alcohol, as it will break down the varnish. Wring the cloth quite dry and form it into a soft pad. Brush it across the surface with light, even strokes; do not permit it to stop on the surface as it may produce a spot. Wax is sometimes used for a polish (paste and liquid). Wax is applied sparingly to the surface with a piece of cheesecloth and permitted to partly dry. (Time will depend upon the condition of the wax, and upon atmospheric conditions. At least 30 minutes should be allowed for drying.) Polish with a soft cloth, rubbing first in a circular motion, and finishing in the direction of the grain.

References:


Operation No. 22

Questions:

1. Why work varnishing brush out in clean turpentine before using?
2. Why prepare only enough varnish for one coat?
3. How will you know when you have rubbed through the varnish? How can it be repaired?
4. Why sift the pumice through cheesecloth?
Operation No. 23  Elementary Woodworking

HOW TO APPLY PAINT AND SHELLAC

Directions:

A. Applying Outside Paint.

1. Remove grease and dirt from surface. Remove loose paint from old work using scraping knife, steel brush or sand paper. Never apply paint over wet surface.

2. Size all knots and pitch streaks with orange shellac. Permit sizing to dry before priming.

3. Prepare priming coat by mixing thoroughly three quarts of raw linseed oil and one quart of turpentine with a gallon of mixed paint.

4. Apply this priming coat lightly, brushing it well into the surface. Paint in horizontal strip entirely across surface. Start near the center of a small area, with a brush full of paint. Brush out over uncovered surface, gradually releasing pressure toward end of stroke. Completely cover each area as rapidly as possible. Allow priming coat to dry from three to five days. Paint must be dry underneath as well as on surface—test hardness with thumb nail. Coat priming coat on old painted work.

5. Fill all nail holes, cracks, or breaks in the surface with putty.

6. Prepare second coat by reducing a gallon of mixed paint with a quart of turpentine.

7. Apply second coat as directed under (4) above. Allow five to eight days to dry, depending upon the mixture of the paint and weather conditions. Test as in (4) above.

B. Applying Inside Paint.

1. Clean and smooth the surface.

2. Apply thin coat of shellac (equal parts of prepared shellac and alcohol). Allow two to five hours for drying, and sand lightly.

3. Prepare priming coat by mixing two quarts of boiled linseed
Operation No. 23

oil and one quart of turpentine, with a gallon of undercoat of similar shade as finished color.

4. Apply as directed under A-4 above. Allow from two to five days to dry and sand all rough spots.

5. Prepare additional body coats by adding a small amount of turpentine to the under coat. Apply, allow to dry, and sand as directed above.

6. Flat paint should be flowed on freely, gloss paint should be brushed out thoroughly.

C. Applying Enamel.

1. Temper first coat of enamel with an equal part of undercoat. Brush out evenly. Allow from two to five days to dry. Sand out rough spots.

2. Apply succeeding coat as enamel comes from the can. Take same precautions as directed for a varnish finish.

References:

Wood and Smith, "Prevocational and Industrial Arts," pp. 53-55.

Questions:

1. What would be the effect if paint were applied over grease and dirt?
2. What would be the effect if paint were applied over a wet surface?
3. Why size all knots with shellac?
4. Why is the priming coat reduced with turpentine and oil?
5. Why use raw oil in outside and boiled oil in inside paint?
6. Why not brush a flat paint as thoroughly as a gloss paint?
7. Why temper first coat of enamel with undercoat?
How to Cane an Opening. Directions:

1. Scribe border line on face of frame one half inch from inside. Locate holes on this line, one at each corner and at mid-point of each side. Divide intervening space on border line into equal spaces. (One-half inch for superfine, five eights of an inch for fine fine, and eleven sixteenths of an inch for fine cane.)

2. If the frame is circular or elliptical cut pattern from card board, exact size of frame. Scribe border line and erect center lines. Divide each center line into equal spaces approximating the distance required for cane to be used. Through these spacings, draw lines at right angles to the center line. Each line that crosses the border line marks the position of a hole. (Fig. I) Transfer this layout to frame by superposing pattern upon frame. Mark position of hole with scribing or brad awl.

3. Bore holes through frame at points marked. (Three-sixteenths of an inch for superfine, fine fine, and fine cane, and one-fourth of an inch for all cane larger than fine). Counter sink each hole on both sides.

4. Shape several round pegs from soft wood to fit holes.

5. Soak cane in warm water until pliable (three to five minutes).

6. Hold cane glossy side up and insert end through second hole from a corner. Force peg in hole to secure cane.

7. Thread other end of cane strand through a hole directly opposite the starting hole. Pull strand through, draw tight, and insert another peg.

8. Bring end of strand up through an adjacent hole. Stretch strand across seat parallel to first and through hole adjacent to starting hole. Draw tight, but do not stretch cane. Insert peg.

9. Continue this procedure until frame is covered. (Fig. II). The second peg back may be removed and used again. Keep the cane straight, glazed side up. Secure ends of new
10. Stretch another layer of parallel strands across the opening over first layer and at right angles to it.

11. Over top of this layer of cane, stretch a third layer identical with first.

12. Weave a fourth layer of strands in same direction as second. (Fig. IV)
Weave each strand over the strands of first layer and under the strands of third layer. Keep always on the same side of strands in second layer. Use scribingawl to open holes if they become filled.

13. Weave fifth layer diagonally. Start at second hole on one side and go to second hole on adjacent side. The strand must pass under the strands of first and third layers and over the strands of second or fourth or vice versa. The strand must be so woven that it will slip between the two cross weaves (Fig. V).

14. Weave sixth layer at right angles to the strands of the fifth. Follow directions under (12) above (Fig. VI). This strand completes the weave.

15. Bind edge on face side by lacing a binder can over holes. Lace binder at each hole. Bring a strand of cane up through a hole over binder and down through same hole. (Fig. VI). Continue until binder is laced entirely around opening.

B. Applying Cane Webbing.

1. Prepare the frame by cutting a groove 1/4" wide and 3/16" deep entirely around frame 1/2" from inside edge. If frame is rectangular, cut groove rounding at corners. (Fig. VII).

2. Cut webbing 1/2" larger than shape formed by outside edge of groove.

3. Soak webbing in warm water until pliable (five to ten minutes).

4. Place webbing on frame, adjusting lines of pattern to parallel center lines of frame. Force ends of webbing into groove, using a slim tapering wooden wedge and a mallet (Fig. VII). Drive the webbing into groove at mid-points of each side and work toward corners. Trim ends of cane
that project above groove at lower outside corner of groove with chisel or knife.

5. Spread glue in groove (cold glue preferred) and drive rattan spline of proper size into groove. (Soak spline in warm water five to ten minutes before applying.)

References:


Questions:

1. Why space the holes for cane weaving the same distance apart?
2. Why start diagonal strand near one corner?
3. Why is it necessary for the fifth strand to slip between one and two and three and four?
4. Why drive webbing into groove at midpoints first?
Operation No. 25  Elementary Woodworking

HOW TO WEAVE FIBER AND SPLINTS

Directions:

A. How to Weave Fiber.

1. Round off arrises of frame.

2. Fasten cord on inside corner of frame. (Use screw or brad.)

3. Pass strand over around and under rail (Fig. I).

4. Pass strand over around and under adjacent rail (Fig. I).

5. Stretch strand across frame to opposite side, passing it over around and under rail (Fig. I).

6. Pass strand around adjacent rail as in (4) above.

7. Stretch strand across opening to opposite rail and repeat 3-4-5 above. Continue with this procedure until entire frame is covered, adding lengths of fiber as needed. Join ends on under side with weavers knot. When frame is rectangular in shape the ends become covered before the sides. Finish by weaving from side to side, threading the strand through at the center (Fig. II). Compress these strands as they cross at the center one-half their diameter. Stuff space between top and bottom of seat with paper or rush as weaving progresses. Finish by varnishing both sides.

B. Weaving Splints.

1. Round off arrises of frame. Soak splints about 5 minutes in warm water.
2. Fasten end of splint on inside of frame near one cover (Fig. III). Use upholstering tacks.

3. Wind splints in one direction around frame in close parallel strands until entire frame is covered. To splice splints, cut notches about one inch from end of each splint and secure with cord.

4. Weave the cross strand under and over one, two or three as the pattern demands.

5. Finish by varnishing or staining. (Varnish preferred).

References:


Questions:

1. Why round all arrises for fiber or splint weaving?
2. Why stuff the space between layers in fiber weaving?
3. Why not stretch splints tightly?
Directions:

1. Prepare opening by gluing in corner blocks and rounding edges on edge of opening. Project should be stained, filled, and varnished.

2. Cover opening with either wood or webbing. If wood is used, screw or nail it to frame. If webbing is used, fold end of webbing back about one inch and tack to far side of frame. Stretch webbing across frame, using stretcher. (Fig. 2)

3. Apply webbing in both direction, interweaving the cross strips. (Fig. III)

4. Tack medium weight burlap over wood or webbing. Use 4 oz. tacks about two inches apart. Cut burlap about one and one-half inches larger than frame on all sides.

5. Prepare upholstering material, either hair, moss, or tow, by shaking or picking until it becomes fluffy.

6. Twist or roll apart of this material into a half inch rope. Place this rope on outside arris of frame and turn the burlap edge back over it. Tack close to arris. Fig. IV.

7. Place stuffing. The material should be about one inch thick when compressed, with slight crown in center. Cover with thin layer of cotton.

8. Over this filling, stretch and tack muslin cover. Determine outer limits of final upholstering material and slip tack the muslin cover about one half inch inside. Begin tacking at middle of each side and work toward corners. Slit corners if necessary to fit around leg or post. Remove tacks and readjust cover until surface is smooth and even. Tack muslin permanently, beginning at center and proceed as directed for slip tacking.

9. Cut final covering approximately to size. Place, and proceed as directed for slip tacking muslin covering. Keep tacks in line, and so placed that they will be covered by the binder. When covering smooths out, finish tacking and trim edge straight.

10. Tack trim or binding in place. Start at one corner and stretch gimp across one side, slip tack at corner. If gimp makes a square turn, fold under forming a miter. Insert an upholstering tack. Stretch gimp in this manner, entirely around frame. Fasten in place with upholstering tacks placed about an inch and one-half apart.
B. **How to Do Spring Upholstering.**

1. Prepare frame or box at least one half as deep as springs are high.

2. Determine number and location of springs. Form base for springs by securing slats, or cross webbing, webbing across bottom of frame. (Fig. V)
   (Leave and stretch webbing as directed under A-2 above.)

3. Set spring in place, bent end up, and fasten to base. Use wire stykes to fasten springs to slats. Set springs to webbing with heavy cord.

4. Tie down springs, using spring twine. Run strings from front to back, from right to left, then diagonally. (Fig. VI) Wherever cord crosses spring or cord, the two are tied. The center of seat should have slight crown.

5. Cover top of springs with two or three thicknesses of medium burlap, and tack securely to top edge of frame. Draw burlap down smooth but do not relieve tension from spring twine.

6. Place stuffing evenly over entire frame, fluffing as directed under A-7 above.

7. Tack muslin or cover over stuffing as directed in A-8 above.

8. Apply final upholstery material as directed under A-9 and 10 above.

9. Tack a piece of denim or muslin over bottom of frame.

**References:**
- Godd and Smith, "Vocational and Industrial Arts" pp. 69-71.

**Questions:**
1. Try remove sharp edges of frame?
2. Try to remove cross strips of webbing?
3. Try lay small roll of webbing over outside edges of frame?
4. Try to cover frame center toward corners?
5. Try tie down the springs?
PART III

VALUES
CHAPTER V

A CRITICAL EVALUATION OF THE SELVIDGE TECHNIQUE
AND OF THE UNIT OPERATION SHEETS

The Selvidge Technique is a Teaching Method.--The Technique Conforms to Modern Theories and Trends in Industrial Arts.--Values of Unit Operation Sheets.

THE SELVIDGE TECHNIQUE IS A TEACHING TECHNIQUE.

The Selvidge technique of analysis embodies first of all a teaching method. It provides individual instructional material in definitely defined units called instruction sheets. The assignment sheet introduces the problem and suggests procedure and methods for its solution. The Job Sheet presents specific directions for doing a given work job. The Information Sheet is a compilation of the most vital or important items of information on various units of tools, materials, or equipment. The Operation Sheet consists of specific directions for performing the doing units in any occupational activity. This latter type of instructional sheet is presented in Chapter IV in the curricular activity of elementary woodworking.

THE TECHNIQUE CONFORMS TO MODERN THEORIES AND TRENDS IN INDUSTRIAL ARTS EDUCATION.

The Selvidge technique not only provides instructional aids, but presents also a method for using them. This method conforms with modern theories and tendencies in industrial arts education. Warner (12, p. 8) shows by a trend analysis the contrast between earlier and
modern practices in industrial arts. His analysis indicates a change in emphasis from "manipulative exercises" to "activities of observation, construction, recreation, investigation, experimentation, and evaluation." This analysis also shows that outcomes are judged by "habits, knowledge, appreciations, attitudes, skills and abilities," rather than in terms of "the skillful hand and the cultured mind." The flexibility of the Selvidge technique makes it applicable to any of the above named activities, and the nature of the instructional material lends itself to the realization of the many varied objectives. The material in each individual sheet is logically arranged, yet the learner is free to make his own organization of the units into a plan for attacking and solving his own particular problem. Modern trends in education have also produced larger classes, and the analysis technique has enabled the industrial arts teacher to better organize his material and to teach more effectively.

VALUES OF UNIT OPERATION SHEETS.

The Unit Operation Sheets presented in Chapter IV illustrate but one phase of the Selvidge instructional material. The sheets were prepared as helps or reference for the learner and not for definite teaching units. Through specific directions they shorten the time necessary to experience the different phases of elementary woodworking. They contribute directly to the formation of good habits of skill and technique, which may develop an interest in some phase of woodworking that will grow into a vocation or an avocation. The activities incidental to the use of the sheets, such as excursions to saw mills, lumber yards,
furniture factories, furniture repair shops, houses under construction, and furniture stores, supplemented by observation of film stories of the different lumber and furniture industries, provide an excellent opportunity for the broadening and deepening of the pupil's interest in the industry and its commodities.

Finally the operation sheets place each pupil on his own initiative. He can use the material independently of the other members of the class, and may explore and experience the course activity as rapidly as his interest and ability will permit. They provide for each pupil an opportunity to become an aggressive and intelligent participant in the activity of elementary woodworking.
PART IV

APPENDICES
APPENDIX A

GLOSSARY.

1. ACTIVITY--The study, observation, or participation in any one of the various phases of industry.

2. ATTITUDE--A feeling or mental state.

3. CONTENT--The material used in a course activity.

4. COURSE--One of the several subject units that make up a curricula, as English composition, general science, and woodworking.

5. CURRICULA--A subdivision of a program of studies that includes the instructional materials of a given phase of education, as English, social science, and Industrial Arts.

6. EDUCATION--The preparation of the individual to adjust himself to the social and economic problems of our changing civilization.

7. FUNCTION--To be effective; to be of use in later experiences.

8. GENERAL SHOP--An organization which offers the learner an opportunity to experience and explore a number of trades in the same shop.

9. HABIT--An attitude or inclination for the performing of some specific act brought about by frequent repetition of the act.

10. HANDY SAW--A trade name used to designate a thin double edged bench saw.

11. INDUSTRIAL ARTS--"As a subject for educational purposes 'industrial arts' is a study of the changes made by man in the forms of materials to increase their values, and of the problems of life related to these changes." Bonser and Rossman (3, p. 5).

12. INTELLIGENCE--The ability to profit by past experience.

13. INTEREST--A natural or stimulated feeling toward some object or situation.

14. METHOD--An organized procedure.
15. OCCUPATION—Pertaining to one of the major subdivisions of industry.

16. PRACTICAL—A concrete situation in a natural life setting.

17. SHOOTING-BOARD—A device used as a guide for planing the end or side of a board.

18. SKILL—The knowledge of some specific ability and the expertness in the execution or performance of it.

19. TECHNICAL—Pertaining to the offerings in a shop or laboratory.

20. TECHNIQUE—The best method for doing a particular thing.

21. TRADE—A subdivision of an occupation including only mechanical employment.

22. VOCATION—A trade or occupational pursuit to which one devotes a major portion of his time.
APPENDIX B

SELECTED BIBLIOGRAPHY.


Outline

An Example of the Selvidge Technique of Analysis
Applied to Elementary Woodworking on the Junior High School Level.

Part I. Introduction.

Chapter I. The Place of Industrial Arts in a Scheme of Education

1. Is there a place for Industrial Arts in education?
   a. Aim of education.
      i. Dewey—"The enrichment of life."
      ii. Boda—"The progressive liberation of intelligence."
   b. Aims or objectives of industrial arts education.
      i. Elementary.
         Troxel—"Life activities." An intelligent understanding of the industrial society of which the child is a part.
      ii. Junior High School.
         Warner—"Developmental experience through manipulative and other activities introductory to the various accessible phases of the world's industrial work."
      iii. Senior High School.
         Snedden—1st, "Expanding and deepening amateur interests;" 2nd, "Definite trade training."
   iv. College.

The Ohio State University catalogue, 1929-30:
"To prepare men and women for positions as teachers, supervisors, and directors, in the various phases of Industrial Arts Education in Elementary, or Junior or Senior, High School; or in the many similar positions now offered in industry."
1. Criteria for selecting the units.
   a. On basis of comparative analysis.
      i. Used Selvidge's Analysis of the woodworking trade as a basic list.
   b. On basis of relation to seventy-eight different operations.
      i. Objectives of learners who will use the material.
      ii. Age and general schooling of the group for whom the unit operation sheets are prepared.

2. Prepared Unit Operation Sheets in Elementary Woodworking on Junior High School Level.
   a. Number of units.
      i. Selected from master list used above.
         (Selvidge's 76 operations.)
   b. Record sheets used with unit operation sheets.
      i. Analysis sheet.
         An organization sheet whereby the pupil will learn to select unit operations necessary for the working out of his individual project, and to arrange them into a working plan.

3. Spot Sheet

   The pupil's accumulative record of his participation in the various unit operations of the occupational activity which he is experiencing.

Part III. Values

Chapter V. A Critical Evaluation of the Selvidge Technique and of the Unit Operation Sheets.

1. Desirable traits of the Selvidge technique.
   a. It is a teaching method.
2. Summary of Industrial Arts objectives and their place in this study.

Chapter II. From Values and Objectives to Content and Method.

1. Factors influencing method.
   a. Objectives
      Methods are judged by their outcomes in terms of objectives.
   b. Educational psychology.
      Psychology shapes and molds objectives.

2. Organization of curricular experiences.
   a. Instructional techniques and methods.
      i. Salomon
      ii. Selvidge
      iii. Troxel

   a. Basis of use
      i. In school
      ii. In industry
   b. In relation to environment.
      i. Allotted time
      ii. Facilities
      iii. Relative values
         Social
         Economical

Part II. The Presentation of the Unit Operation Sheets.

Chapter III. Selecting and Preparing Units of Instruction.
b. It conforms to modern theories and tendencies in industrial arts education.

c. It is one method for selecting industrial arts material for educational purposes.

2. Desirable Outcomes of the Unit Operation sheets as shown by their use.

a. They contribute directly to the realization of junior high school objectives.

i. Make possible the exploration of a greater number of activities. Specific directions save time. Organization reduces lost motion.

ii. Place the learner on his own initiative. Makes him an aggressive learner.

iii. Are conducive to the formation of good habits of technique.

iv. Provide an opportunity for trade foundation.

v. Add meaning and appreciations to industry because of contact through observation and participation in the various activities in which wood is used.

Part IV. Appendices.

A. Glossary of terms.

B. Selected Bibliography.