T H E S I S

on

UNIT INSTRUCTION SHEETS AND A COURSE OF STUDY BASED UPON AN ANALYSIS OF BENCH W O O DWORKING AS A SCHOOL ACTIVITY

Submitted to the

OREGON STATE AGRICULTURAL COLLEGE

In partial fulfillment of
the requirements for the
Degree of

MASTER OF SCIENCE

by

Vernon E. Shipp

May 15, 1933

APPROVED:

[redacted]

Professor of Industrial Education

[redacted]

Chairman of Committee of Graduate Study

A C K N O W L E D G M E N T

The author wishes to express his sincere appreciation to all those who have helped to make this thesis possible: To Mr. H. O. Bjerg, Instructor in Industrial Arts, Arizona State Teachers College, Flagstaff, whose advice was followed in continuing graduate work at Oregon State College; to Mr. E. D. Meyer, Instructor in Industrial Arts, Oregon State College, under whose instruction the trade analysis chart was developed; and specifically to George B. Cox, Professor of Industrial Education, Oregon State College, under whose able direction and guidance this thesis problem was completed, including the instruction for the formulation of the Unit Instruction Sheets.

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

GENERAL INTRODUCTION

GENERAL INTRODUCTION

Purpose of Thesis

Industrial Arts is being taught, in one form or another, in all school levels from kindergarten through the senior high school and college. It is generally admitted, however, that the problems of purpose and methods center about the school level at which the boy is first introduced to technical industrial arts courses on a departmental basis. Generally speaking this contact comes at the junior high school or early four-year high school level.

According to our present school set-up the first contact in the field of industrial arts is very often made by the student upon entrance into the four-year senior high school. It is, then, the purpose of this thesis to outline, in general, a proposed course of study and procedure to be followed in the ninth grade or first year of high school work. This same outline, with minor modifications, may be followed in the junior high school if the program provides for the first contact with industrial arts at that level. In either case, this period is thought of as the one most suited to exploratory functions and enrichment of experience through contact with a wide field of activities.

The purpose is not to standardize instruction unduly nor to impose a rigorous program on any school, but simply to place at the disposal of the instructor a workable, organized, feasible plan of teaching industrial arts in our present day schools.

General Statement of Problems Facing Teacher

Woodworking courses in the schools have often been too narrow and the experiences provided have not given contact with a sufficient number of materials and operations. Too often this has been the fault of the instructor because he has not been able to take in the full scope of the field and to teach those things that should be taught.

The teaching of a subject or trade activity always involves the solution of many problems concerned with subject-matter, equipment, and procedure. Before a satisfactory organization can be set up or a beginning can be made in any subject, the instructor must decide:

1. What to teach
2. How to teach it

It is assumed that woodworking, or any industrial arts activity for that matter, has an organizable subject-matter content. Consequently, in the organization of classroom content and procedure the teacher's responsibility will fall into three fields of activity. First, he must analyze accurately the subject or trade activity he is to teach; secondly, he must select intelligently from the total results of the analysis those things that are basic and fundamental to that subject; thirdly, he must teach the selected "operations" economically and scientifically with the least waste of time, equipment, and material.

One author has said, "The test of the professional skill of the teacher rests on his clarity of vision relative to the total possibilities of the trade or subject he is teaching, and on his skill and

accuracy in the selection and teaching of that part of the total in the subject or trade which the present particular group or individual under instruction needs most. Thus the teacher's professional skill is accordingly made up of three large factors: analysis, selection, and teaching".[1]

The instructor will find in the analysis, selection, and organization of material that it is impossible to teach every "operation" of a subject or trade activity in the time usually allotted to industrial arts work in the secondary schools. The particular items selected will, therefore, depend somewhat upon the objectives of the course and upon the time allotment. If the primary industrial arts objective of exploration for guidance is to prevail in a given situation, then a greater number of different trade activities should be included, with a consequent decrease in the number of operations that might be selected from any one activity. If the purpose is trade training, more emphasis is placed on developing a degree of skill in the fundamental and basic operations of one trade, with a consequent increase in the number of operations to be selected from that particular trade.

Proposed Procedure

The methods of teaching and of learning when skill is the important objective are different from what they would be when the objective is exploration and industrial information, or reasoning in the solution of a problem. On the other hand, if there is a considerable mixture of the two, one or the other will probably suffer. The important thing

[1]Bowman, C. A.--Graphic Aids and Occupational Analysis - p 15.

is that the instructor keep both phases constantly in mind and recognize that the most efficient teaching, in either case, can be done when the work is segregated to allow the use of the procedure best suited to each set of objectives.

It is, therefore, the purpose of this thesis to indicate a technic of analysis and selection of subject-matter suitable for use in any form of shop teaching, whether vocational or general in nature, and then to show a plan of organization and presentation of subject-matter for bench woodworking in the ninth grade or junior high school level. The out-look at that grade level would naturally be non-vocational and the objectives would be those of industrial arts rather than those of trade vocational work.

CHAPTER I

AIMS AND OBJECTIVES

Chapter I

AIMS AND OBJECTIVES OF INDUSTRIAL ARTS

In attempting to develop a course of study for any subject or trade activity, no part is more important than a definite and clear statement of aims and objectives.

The aims and objectives of any industrial arts course is somewhat dependent upon the controlling purposes and needs to be met. The ages of the students to be taught and their previous experience will also have a bearing upon the objectives. However, within certain limits it is true that certain aims are fairly well accepted by most authorities for:

1. The elementary school
2. The junior high school
3. The senior high school
4. College (to a minor degree)

No set of aims or objectives could be entirely confined to any one of these ages or groups. There is bound to be some over-lapping and variation dependent upon the vision of the instructor and controlling factors peculiar to different school set-ups. However, it can be definitely said that the aims and objectives, both general and specific, should be flexible and applicable to most any situation that the instructor will find facing him.

I. Elementary School Aims and Objectives

Briefly, the aims for teaching Industrial Arts in the elementary school are based on three large approaches, namely:

1. The study and manipulation of materials used by man both in the past and present.

2. A means of self-expression for the child

3. A means of stimulating the pupils and creating greater interest in the academic subjects by correlation with industrial arts activities.

A good foundation for later efforts can be made through the use of the above approaches. The activity in the first division may be developed under the following headings: (1) food; (2) clothing; (3) shelter; (4) utensils; (5) records; (6) tools and machines. In developing the second division the aim is to allow self-expression through purposeful activity. For the third division, correlation should be made with the regular academic studies of geography, history, arithmetic, and others required in carrying out the manipulative work in the elementary grades.

II. Junior High School Aims and Objectives

The aims in the junior high school may vary to a certain extent, but in general there is a large degree of conformity, at least in regard to the major objectives. The primary controlling purpose of the industrial arts program in the junior high school is "Developmental experience through manipulative and other activities introductory to the various accessible phases of the world's industrial work".[1]

In the aims listed below, the order of appearance is based some-

[1]Snedden, D. and Warner, W. E.--Reconstruction of Industrial Arts Courses, p 10.

what upon the frequency with which they appear in professional literature, and in the expressions and terminology of teacher-training institutions, supervisors, and instructors.

GENERALLY ACCEPTED OBJECTIVES OF INDUSTRIAL ARTS IN THE JUNIOR HIGH SCHOOL:

1. To give opportunities for satisfying the desire to do things with tools and materials.

2. To afford opportunities for exploring or trying out a variety of occupational fields as a means of discovering occupational aptitudes.

3. To give experience with common tools and materials considered generally useful to all. ("Handy-man abilities")

4. To furnish a body of technical knowledge concerning industrial work, and the materials used in industry.

5. To lay a basis for intelligent selection and use of industrial products from the standpoint of both fitness and construction.

6. To develop an appreciation of the work of the men who labor in the industrial world, and a wholesome attitude toward their tasks.

7. To present a field of possibilities for worthwhile leisure time pursuits.

8. To widen the student's knowledge of occupations through auxiliary studies and related information.

9. To develop appreciation of economic relationships in industry and business through special study and productive experience.

10. To prolong the educational life of certain students who are encouraged, by these special activities, to remain in school.

11. To give vocational or semi-vocational training to a limited group (0-16%) in order to meet the needs of those who will leave school at an early age.[1]

[1]Ericson, E. E.--Teaching Problems in Industrial Arts - p 294. (Portions in parenthesis added for explanatory purposes.

Briefly summed up, these objectives are as follows:

1. Exploration
2. Educational guidance
3. Vocational guidance
4. Consumer's knowledge
5. Industrial information
6. Social habits and attitudes
7. A degree of skill
8. Practical (handy-man) abilities
9. Avocational values[2]

Exploration for guidance purposes seems, therefore, to be the major objective in setting up a program of industrial arts for the junior high school.

III. Senior High School Aims and Objectives

In the senior high school there seems to be less agreement on the common objectives and aims among the authorities or leaders, however the foregoing objectives for the junior high school should apply equally well with the following items to be added:

1. Further guidance of a more specific nature.
2. Further exploration and avocational opportunities.
3. Vocational preparation for a specific trade or industrial pursuit for those who plan to drop out early or enter a trade at the end of their high school experience.
4. Formation of desirable personal and social habits

[2]From a chart on Public Secondary Education prepared at Oregon State College, 1932.

5. Development of a degree of skill in tool or machine processes commensurate with the ability of the pupil and incidental to the completion of a project or activity which seems to have "educational" value.

While the vocational, technical, and specialization factors are stressed more in the senior high school, the extent of this emphasis is often questioned. The degree of specialization and the vocational objective will be governed somewhat by the local situation.

IV. College Aims and Objectives

The author is not familiar with any list of uniform aims or objectives for the college level. In addition to all of the foregoing aims the following will apply in varying degrees, depending upon the type of school and the ultimate ends to be served:

1. Further specialization

2. Technical training

3. Teacher-training

According to a study made at Oregon State College in 1933[3] the industrial arts program as offered by the colleges over the United States varied to a great extent, however, the above named objectives include the major controlling factors in the teaching of the industrial arts program at the college levels.

As mentioned before, it is not likely that all persons will agree on any one set of objectives. A significant factor, however, is the general under-current of agreement among the specialists or leaders in

[3]Wagner, Merlin--Unpublished manuscript on Place of Industrial Arts in Higher Education, Oregon State College, 1933.

the field. The peculiar aspect of the present situation seems more and more to bring to the foreground the avocational and handy-man-abilities as important objectives for the secondary school level. These objectives are especially important in this day of shortened working hours and increased leisure, as witnessed by the rapid growth of home workshops and the wide use of leisure time in productive or semi-productive avocational work. The only other objectives more uniformly accepted as of first importance are exploration and guidance at the junior high school level.

CHAPTER II

TRADE ANALYSIS

Chapter II

TRADE ANALYSIS

I. Need of Analysis

In order to determine with a greater validity what is to be taught in a subject or trade, a careful analysis of that activity should be made. By means of the analysis the shop teacher will have the key to the method by which he can improve the quality and effectiveness of his teaching. No shop teacher, to do successful teaching, can escape organizing his work on the basis of some plan of fundamental learning units, regardless of the course of study to be followed or the methods of teaching to be employed.

II. What is Trade Analysis?

By analysis of a trade is meant the listing of all the things a person must know if he is to be proficient in the complete subject or trade. Every operation involving skill or requiring instruction should be listed. The unskilled operations, and those requiring no related information, need not be listed since the list would far exceed the essential things needed in the analysis. The teacher who does not have such a list is likely to go astray and waste much valuable time in teaching the unessential things of the subject or trade activity.

"This list of learning or teaching units may be classified into three principal groups:

1. Things the boy should be able to do
2. Things the boy should know
3. What the boy should be

The first group involves manipulative skills, knowledge of procedure, and construction processes. The second group involves information concerning qualities and characteristics of materials and other matters of general interest in the field. The third group involves attitudes and habits which affect the success of the individual. The latter may perhaps be somewhat the same for all subjects or trade activities."[1]

Many instructors encounter difficulty in discriminating between things to be done and things to be known. However, there is a distinct difference in most cases and much will depend upon the skill exhibited by the teacher in the discrimination that he may exhibit in the selection of the manipulative and informational topics.

III. How to Analyze a Subject or Trade Activity

The analysis of a subject or trade activity can be done best by an instructor with a well-trained analytical mind. In making a graphic analysis of a subject or trade activity the following general procedure can be followed to advantage:

Procedure

Step No. 1. The first step in the analysis is to name the major field, trade, or industry to be analyzed. Example: Woodworking.

Step No. 2. Divide that field, trade, or industry into its component parts. Example: Carpentry, cabinet making, pattern making, etc., are major divisions of Woodworking.

Step No. 3. Name the subdivision (if any) common to the major divisions. Example: Bench woodwork and machine woodwork are common to the major divisions mentioned above.

[1]Report of the Committee on Standards of Attainment in Industrial Arts, American Vocational Association - December, 1931.

Step No. 4. Delimit the analysis by selecting that one subject or trade activity, either major division or subdivision, to be concentrated upon. Example: Bench woodworking.

Step No. 5. Gather all possible data and information available on the subject to be analyzed. Classify this data under three major fields:

1. Where men work

2. What men do

3. What men must know

Step No. 6. List the major groups or "blocks" of work under "what men do". Example: Planing, sawing, gluing, etc.

Note: A Block is defined as a group of teaching jobs having a common set of learning difficulties, or groups of subject-matter involving similarities of processes, or materials, or tools, and presenting the same level of learning difficulties.

Step No. 7. List every type of "operation" found in the various blocks under "what men do". Arrange them in a tentative instructional order, dependent most likely on the order in which they probably will be taught. This order may be revised to meet any new situation that may arise.

Note: "Operations may be defined as--manipulative units of work requiring skill in their execution and recurring frequently in various jobs, always involving essentially the same elements of information and skill irrespective of application."[2]

Step No. 8. List all the related technical information necessary for teaching the trade, classifying it in the various blocks under "what men must know". Show, where possible, some relationship to the parallel manipulative operations. Example: Safety-first, trade terms, materials, science, etc.

Step No. 9. Reduce this data to chart form, showing the complete analysis in a manner similar to the graphic analysis chart shown in Chapter II.

IV. Advantages of the Graphic Plan of Trade Analysis

1. This plan of analysis furnishes the instructor with a graphic

[2]Cox, George B.--Unpublished manuscript on Instruction Sheet Writing, Oregon State College, 1931.

means for scrutinizing the total possibilities of that subject or trade activity and selecting pertinent and representative basic "operations" from the total that is to be taught.

2. Typical jobs can be run through the cart, checking the operations involved in numerical sequence, thus denoting the order of performance. The parallel informational topics can be checked to show direct relationship with the manipulative operations.

3. The chart shows graphically the distinction between the manipulative operations and informational material employed in the teaching procedure.

4. It forms the basis of a "difficulty" scale, assuming that the number of operations involved may be an indication of degree of difficulty in executing the job or project.

5. It reveals to the student his own capacities and offers an excellent opportunity for him to develop the habit of carefully analyzing and planning any piece of work before beginning its execution.

6. It permits the instructor to more accurately place a new student with previous industrial arts training by having that student check those basic operations already learned.

7. The graphic analysis chart presents to the student a definite list of the things he must be able to do and the things he must know, which takes the mystery out of the comprehensive scope of work he is to undertake. It gives him an idea of what is involved in the set-up of the whole field in such a manner as to show relationships advantageously.

GRAPHIC ANALYSIS CHART

ON

GENERAL WOODWORKING FOR A SCHOOL SHOP

CHAPTER III

METHODS OF INSTRUCTION

Chapter III

METHODS OF INSTRUCTION

I. Determining the Methods of Instruction

After the content of the course has been selected, the next step is to determine the method of teaching. The four methods most commonly used by shop teachers at the present time are:

1. The demonstration method
2. The lecture method
3. The project method
4. The use of instruction sheets

No one of the above methods should be used exclusively, but the skillful teacher will correlate them all in such fashion as will best meet the conditions under which he is teaching. The relatively large classes found in so many of our present-day school shops, and the varying rates of speed at which the individual students work, make the old methods of class procedure inadequate. This is especially true in the "general shop" type of organization for the junior or senior high school.

Various methods have been devised and employed to meet these changing conditions. The individual instruction sheet is one of the devices that has been developed in order to improve instruction under the teaching conditions found in the "general shop" type of organization.

II. Instruction Sheets

An instruction sheet is an attempt to put down in writing and by

means of illustrations the information necessary to perform an operation or to do a job. "The instruction sheet is a teaching device of great value where directions are to be given, or where general principles or facts are to be presented to members of a group unequal in attainment, ability, or aptitude. It has found quite general application in the school shop, the science laboratory, and in industry, but its value is not confined to those fields. It is, perhaps, the most efficient and economical system of individual instruction yet devised. It permits independent progress among the members of a group and makes it possible to take into account individual differences."[1]

III. Basis of Instruction Sheets

The development of the instruction sheet is based upon the idea that any subject or trade activity may, by analysis, be divided into certain fundamental or basic units and that instructions may be so written for these units as to permit individual progress through the various units in keeping with the ability of the individual student. The instruction sheet does not displace the instructor but merely changes the character of his duties and enables him to use his time more efficiently, rendering service to the individual student when and where it is most needed. The instruction sheet should, therefore, present very carefully planned and prepared instructions based upon a careful analysis of the subject to be taught. This method of instruction has been used quite extensively in industry and in recent years

[1]Selvidge, R. W.--Individual Instruction Sheets - p 5.

has been used to a very distinct advantage in the school shop.

IV. Kinds and Classification of Instruction Sheets

Several kinds of instruction sheets have been developed. For convenience they may be classified under two broad groups:

1. Those dealing with basic instructional units irrespective of application.

2. Those dealing with complete jobs irrespective of basic units involved.

The following outline will show the relationship of the different types of instruction sheets:

The Instruction Sheet[2]

- I. Sheets based upon units of instruction
  - 1. Operation sheets
  - 2. Information sheets
  - 3. Assignment sheets
- II. Sheets dealing with jobs as units
  - 1. Job sheets

I. "Sheets Based Upon Units of Instruction

1. Operation Sheets. Those instruction sheets that tell how to perform the manipulative processes or operations we wish to teach.

2. Information Sheets. Instruction sheets that deal with items of information, or simple statements of fact.

3. Assignment Sheets. Instruction sheets, often composed largely of questions designated to direct observation, reading, and drill.

II. "Sheets Dealing With Jobs as Units

1. Job Sheets. Instruction sheets that tell how to do complete jobs which may involve a number of operations or units of instruction are called job sheets. They are especially designed to secure production. They also may be used for small unrelated jobs requiring little skill, such as home mechanics."[2]

[2]Selvidge, R. W.--Individual Instruction Sheets - p 9.

V. Writing of Instruction Sheets

It should be entirely within the range of the ability of a well-trained shop teacher to write his own instruction sheets, especially in specific cases for which they cannot be obtained commercially. The following outlines will show briefly the procedure in writing the different kinds of instruction sheets:

1. Outline for operation sheets.[3] "A summary of the essential steps in writing an operation sheet may be stated as follows:

a. State the title in very specific terms

b. List all the steps involved in performing the operation and arrange them in order

c. Write the instructions for performing each step as simple directions for doing

d. Use illustrations liberally

e. Ask questions, if necessary to bring out the reasons for doing things in a certain way

f. Give one or two good, available references, if needed."

2. Outline for information sheets.[4] "The outline for writing information sheets may be briefly stated as follows:

a. State the topic clearly and definitely in the title.

b. State briefly the facts and information concerning the topic.

c. Choose questions with the definite purpose of directing thought and discussion to the practical application of the information.

d. Give one or two good references."

3. Outline for assignment sheets.[5]

[3]Selvidge, R. W.--Individual Instruction Sheets - p 41
[4]Selvidge, R. W.--Individual Instruction Sheets - p 51
[5]Selvidge, R. W.--Individual Instruction Sheets - p 55

a. A definite statement of the topic or assignment

b. A very clear statement of the principles involved

c. Abundant illustration of the application of the principle. (There need be no fear that the illustrations will make the problems too easy.)

d. A series of well selected problems involving the application of the principle to provide drill and practice.

4. Outline for job sheets.[6]

a. The name of the job

b. The requirements of the job (specifications)

c. Information that may be needed in doing the job

d. Procedure, step-by-step directions, for doing the job

e. List of tools and materials required for the job

f. Checking the work on the job

g. Questions concerning the job

h. References

The following form will show the mechanical set-up for the operation and job sheets, the two types most used and best adapted to the school shop:

Essential Elements of Good Operation or Job Sheets[7]

1. Descriptive Title: Clear Statement of the unit operation or the job

2. Information Paragraph: Specific Information necessary to:

a. The forming of a background for judgment or understanding of the procedure.

b. The introduction and understanding of technical terms closely related to the operation or job.

[6]Selvidge, R. W.--Individual Instruction Sheets - p 63
[7]From a form used by the Industrial Arts Department, Oregon State College.

c. The proper selection of new tools and/or materials to do the operation or job.

3. Procedure: A brief statement of steps within the operation or job, listed in the order of performance.

4. Illustrations: Intermixed freely with procedure as necessary.

5. Suggestions or Cautions: about the work or personal safety.

6. Generalizations (where possible), suggesting application of instructional elements to different situations.

7. Questions, designed to check on the pupil's understanding of the work and to lead to further study where necessary.

8. References: A carefully prepared list of available references that will give additional information to those needing or seeking it.

The mechanical arrangement of the instruction sheet should present an interesting and attractive appearance. Each step should be set off as a distinct division. Use short sentences that are clear and to the point. Avoid superfluous material of any kind.

VI. Advantages of Instruction Sheets

Some of the many advantages of the use of instruction sheets in the school shop may be summed up as follows:

"1. Instruction sheets are a means for offering a greater variety of work in the shop. Such variety could not be covered by individual personal instruction.

2. They save the time of the teacher. The time so saved can be used effectively in perfecting organization and in other phases of the work.

3. They save time of the students that would otherwise be used in waiting for attention of the instructor.

4. Interest of students is maintained, because they can proceed with the work without waiting for demonstrations and personal instructions.

5. They furnish printed directions to be followed. Success in a great number of occupations depends upon ability to understand and follow directions set forth in this way; consequently the practice is of high importance.

6. Students are left on their own resources in carrying out the

work. The habit of 'leaning on the teacher' at all times does not produce an adequate sense of independence. Our schools are now being criticized by industry for failing to develop initiative and self-reliance.

7. Instruction sheets are of great value as an aid to and follow-up of the demonstration. They eliminate the need for copying directions and thus enable students to concentrate upon the processes demonstrated. They also serve to establish uniform checking levels in the progress of the work.

8. If standard instruction sheets are used, it is likely that they are better organized with reference to procedure and other material than would be the oral instructions of the teacher.

9. They assist the teacher who might not be expert mechanically with reference to all phases of the work. Such shortcomings on the part of the teacher are unavoidable in the early stages where a great variety of operations are covered."[8]

Specific examples of instruction sheets of several kinds will be found in Chapter IV dealing with the instructional units in the course of study for Bench woodworking in the ninth grade.

[8]Ericson, E. E.--Teaching Problems in Industrial Arts - pp 67-68.

CHAPTER IV

COURSE OF STUDY FOR NINTH GRADE

WITH UNIT INSTRUCTION SHEETS

Chapter IV

COURSE OF STUDY FOR NINTH GRADE

I. Purpose

The three preceding chapters of (1) Setting up the aims and objectives, (2) Analyzing the subject or trade activity, and (3) Determining the methods or devices of teaching, lead directly up to the course outline to be followed by the teacher in presenting the subject-matter. The actual function of any course of study should be to define for the teacher the scope of subject-matter to be covered and to indicate the order in which the various units are to receive attention.

In this ninth grade course of study for bench woodworking, it is assumed that the student has had no previous departmental contact in the field of industrial arts. The student may have contacted some form of expressional industrial arts in the elementary grades but at the secondary school level the industrial arts program takes on an entirely different aspect. The informal manner which has prevailed in the teaching of the expressional industrial arts in the grades is replaced in the secondary school level by vitalized subject-matter and methods which appeal to the interest of the boy.

II. Basis for Organizing the Course

The approach to the organization of subject-matter into a course of study may be accomplished in various ways. After the basic manipulative operations of bench woodworking have been determined, through use of the analysis chart (see Chapter II), then the determination of the sequence of these operations and methods of teaching forms the

basis for a logical approach in the organization of the course of study.

Methods involved in teaching the subject-matter content or unit of instruction has a very definite place in any course of study. In this specific case the "operation" forms the basis for the unit of instruction. One of the best and most commonly used teaching procedures employed in the teaching of a trade activity is the project method. A project, insofar as the teaching of industrial arts is concerned, may be defined as a unit of work based upon a group of manipulative operations and related technical information, the application of which results in a completed educational contribution of value to the pupil, and capable of holding his interest to the end. More often than not the pupil's aim is a physical object but the teacher's aim should be an educational change as well. In most cases, both the physical and the educational phases of the project must be present in order to make possible the highest type of teaching in the industrial arts work. This method of teaching necessitates the selection of projects involving the basic and fundamental manipulative operations to be taught at any particular level.

Exercises are often used as a basis of teaching the selected operations. However, in this course of study, only the first project is to be used as an exercise. This exercise will serve as a basis for placing the beginning students. Other projects will be optional, within restricted groups, insofar as the project selected will serve the ultimate ends to be achieved.

III. Criteria for Selection of Projects

In setting up criteria as the basis for selection of projects in

the teaching of bench woodworking the following items must be taken into consideration:

1. Aims and objectives
2. Fundamental and basic operations in the particular trade activity
3. Interests of boys
4. Community appeal
5. Utilitarian value and usage
6. Size of teaching unit
7. Sequence of work
8. Cost of materials used

The outline of projects to follow will be affected by these criteria as well as by the aims and objectives already set up for the field of secondary education. The reader should not assume that the suggested outline imposes a definite series of projects as a hard and fast course of study. A desirable feature of any course of study is flexibility. It should be flexible insofar as it can be applied and used in different situations, especially when the varying time elements and individual differences within the different classes are to be taken into consideration. In this case it is flexible to the extent that it will allow a relatively wide choice of projects within each instructional group.

Since there is such a wide variation in the amount of time allotted to the teaching of industrial arts work in various parts of the country, no attempt has been made to set definite time limits on the various groups of instructional units. Approximate time limits are given, however, in terms of clock hours of actual work for each project.

IV. Grouping of Projects

The following instructional groups suggest projects that might well be taught in the beginning course in woodwork for the ninth grade. Under each group is listed the principal manipulative operations to be taught with a suggested list of projects involving those operations. In each group the most typical of the projects has been underlined and a drawing provided.

GROUP I

Principal Operations Involved

Squaring up mill-planed stock. No definite dimensions set but stock to be squared with the minimum amount of material removed.

Note: This may be an exercise motivated on the contest basis. Each boy will be given a piece of soft wood 1" x $5\frac{1}{2}$" x 12" as nearly alike as possible. Each piece will be graded according to the size and squareness of the finished product, the largest board receiving the highest grade. This gives the teacher a basis of "placing" each student soon after he has entered the class.

Time allotment - approximately 3-5 hours.

Project: Cutting board

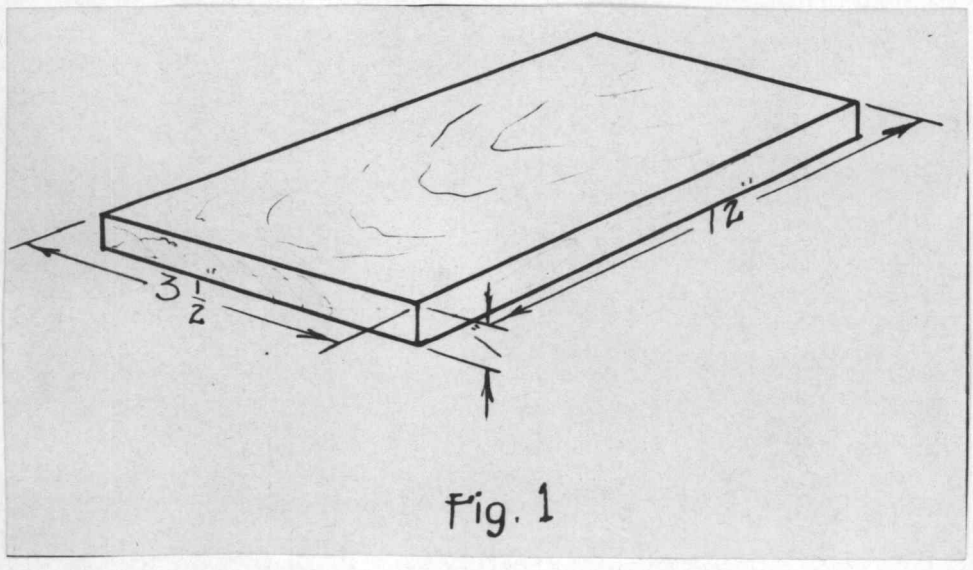


Fig. 1

GROUP II

Principal Operations Involved

Squaring up mill-planed stock, simple straight work including butt joint, chamfering, boring, laying out, and finishing to two dimensions. Fastening with screws.

Time allotment - approximately 6-8 hours.

Projects:

1. Broom holder, 2. game board, 3. counting board, 4. ring toss, 5. key rack.

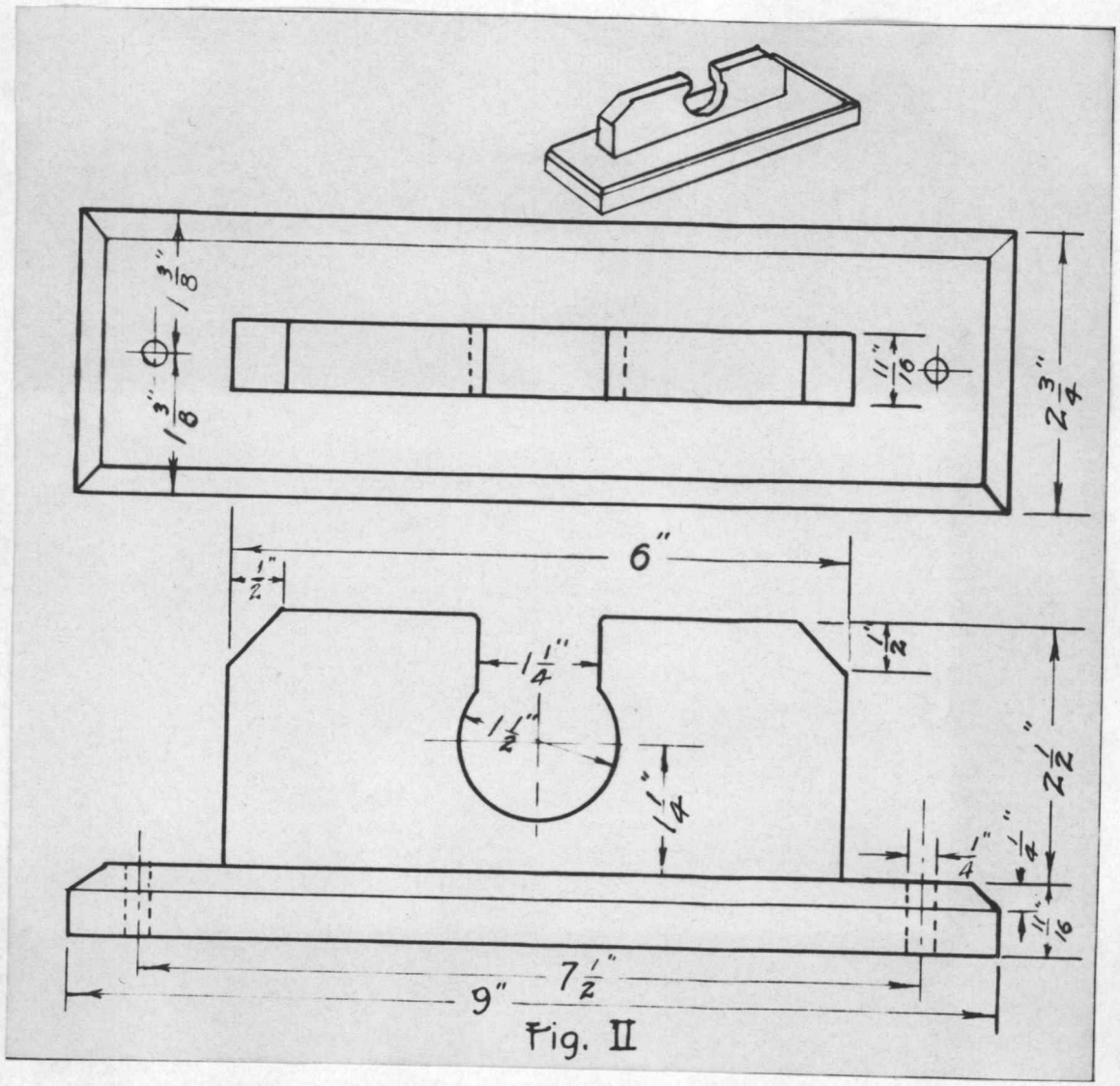


Fig. II

GROUP III

Principal Operations Involved

Laying out and working curved edges and cylindrical surfaces.

Time allotment - approximately 7-9 hours.

Projects:

1. Neck tie rack, 2. towel roller, 3. coat hanger, 4. simple shelf, 5. sleeve board, 6. waste basket.

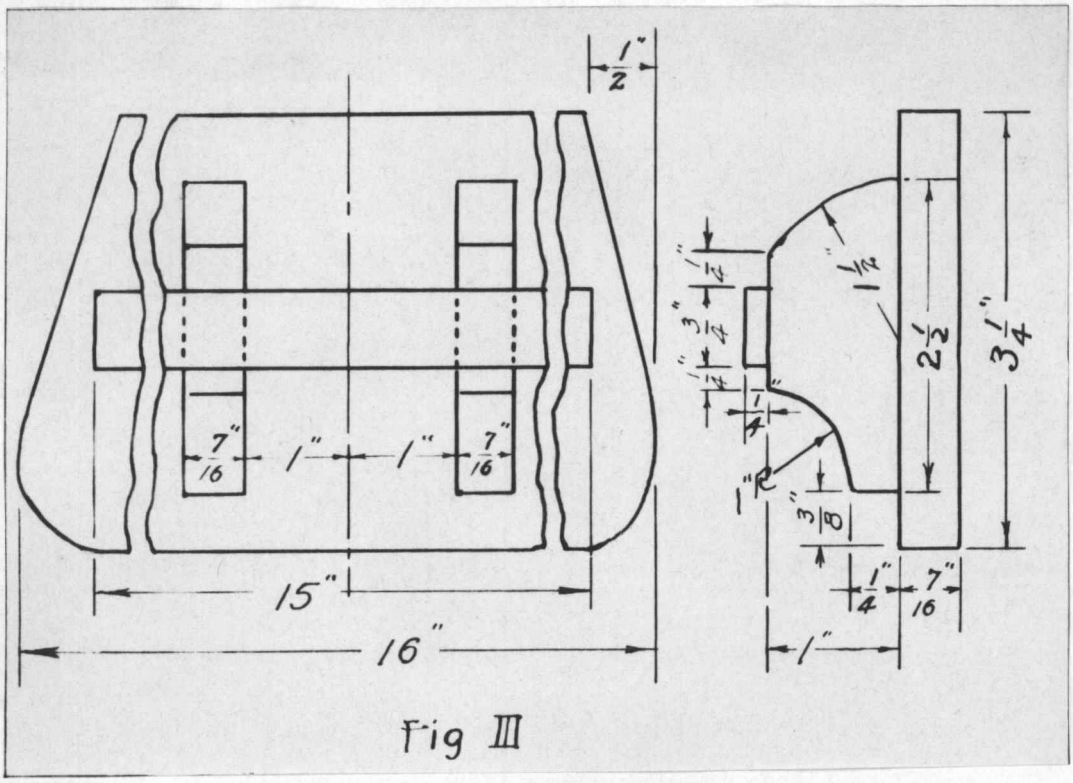


Fig III

GROUP IV

Principal Operations Involved

Squaring stock to three dimensions, butt joints, fastening with nails or screws, duplicate parts, assembly.

Time allotment - approximately 10-14 hours.

Projects:

1. Knife and fork box, 2. bird house, 3. window or porch box, 4. nail box, 5. book shelf.

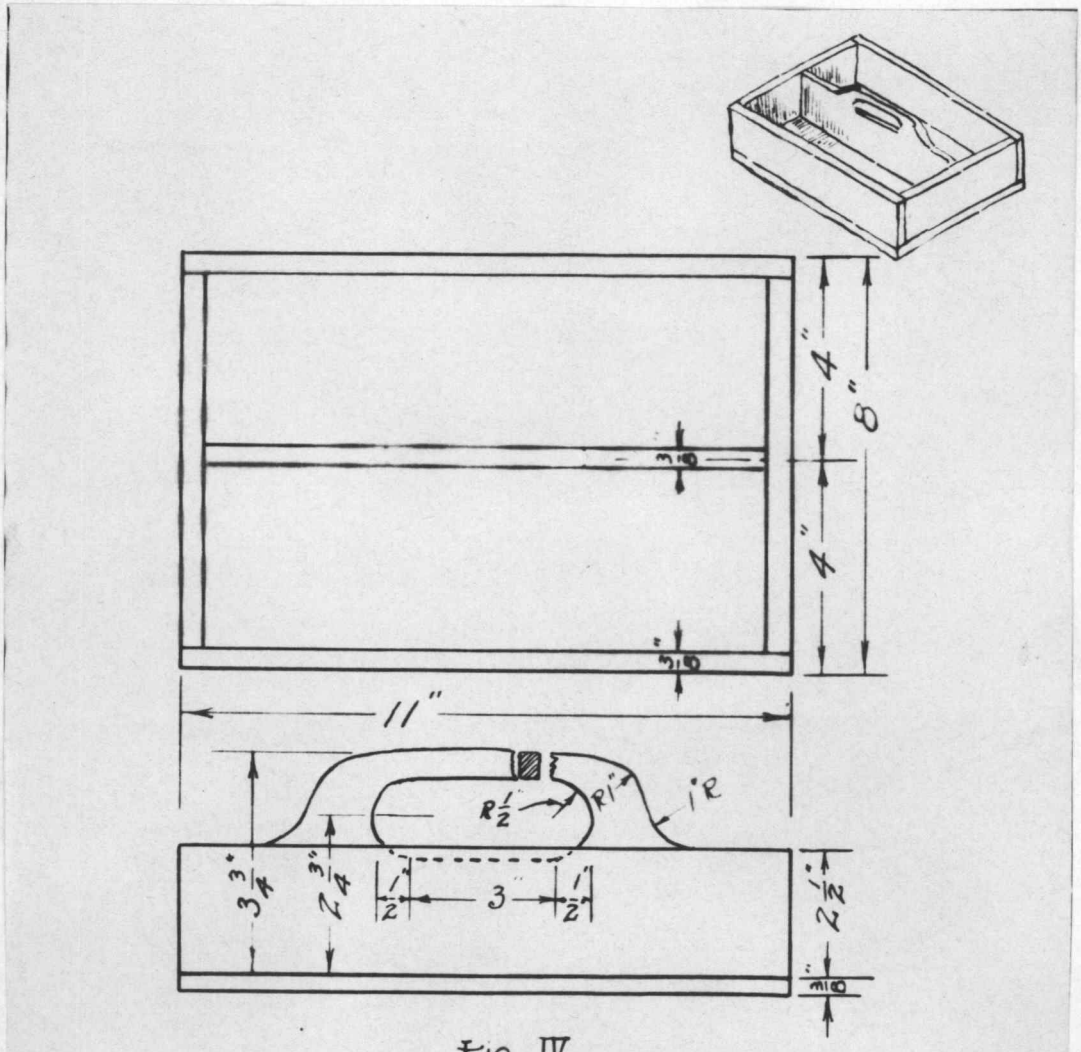


Fig. IV

GROUP V

Principal Operations Involved

Duplicate parts, dado or cross-lap joint, geometrical design,

Time allotment - approximately 22-28 hours.

Projects:

1. Taboret, 2. magazine stand, 3. table lamp, 4. smoking stand,

5. waste basket.

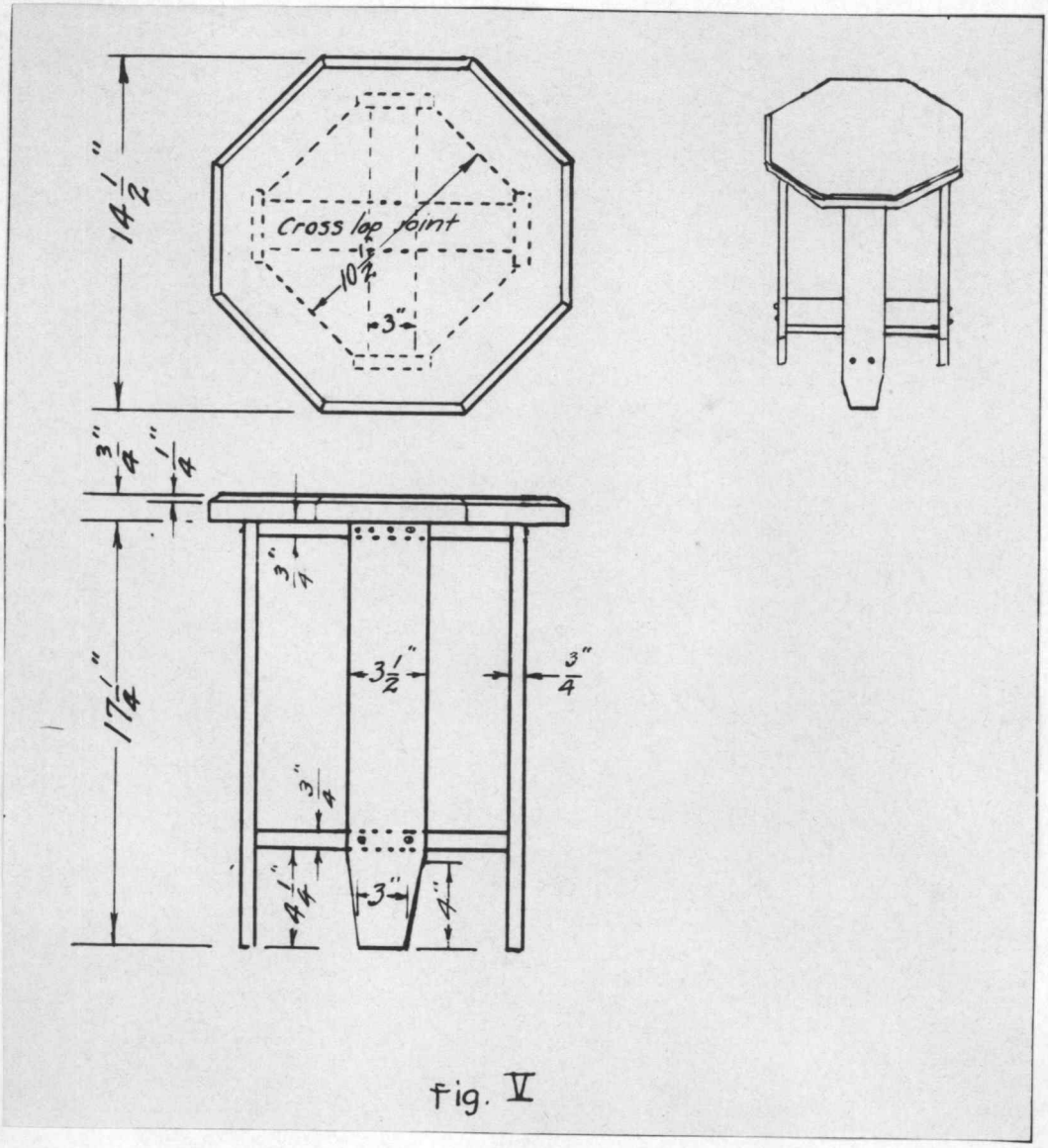


fig. V

GROUP VI

Principal Operations Involved

Dowel joint, mortise and tenon joint, miter joint, gluing.

Time allotment - approximately 25-35 hours.

Projects:

1. Boy's table, 2. footstool, 3. jewel box, 4. pedestal, 5. picture frame.

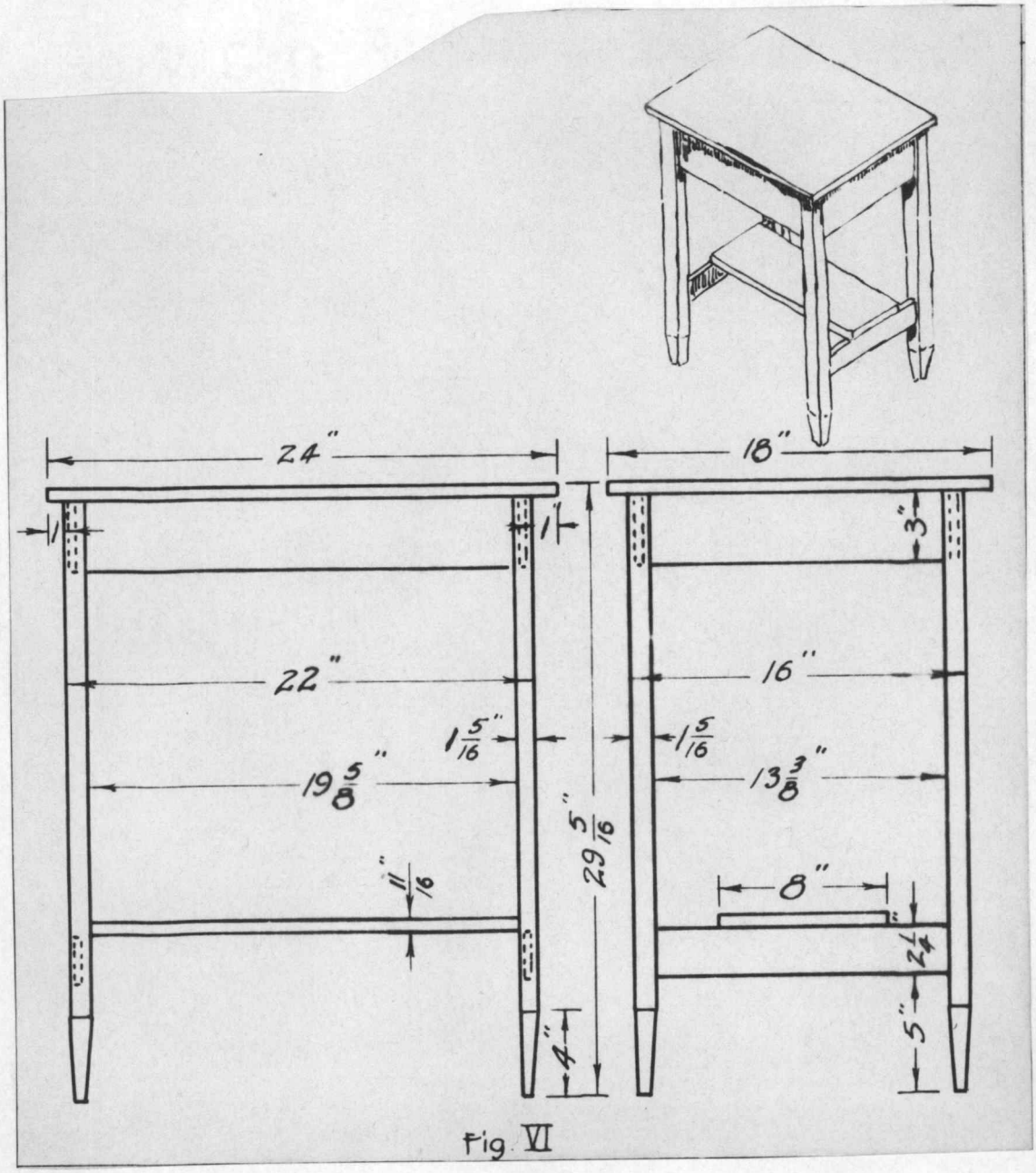


Fig VI

GROUP VII

Principal Operations Involved

Joinery and simple furniture construction.

Time allotment - approximately 30-40 hours.

Projects:

1. Smoking cabinet, 2, telephone table, 3. piano bench, 4. side chair, 5. end table.

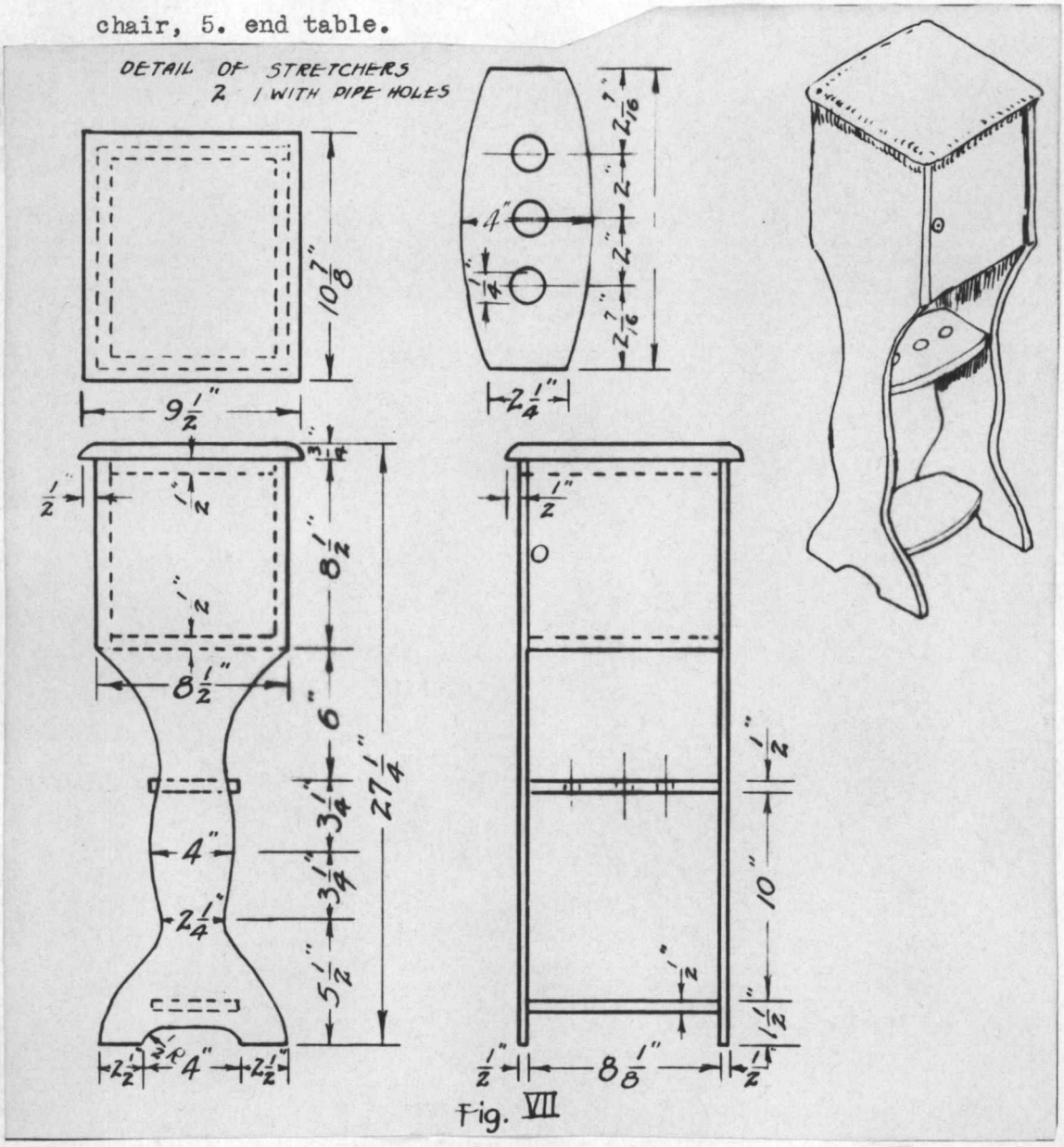


Fig. VII

GROUP VIII

Principal Operations Involved

Appreciation of design, structural and decorative.

Time allotment - rest of year. As enriched curricula for the superior student.

Projects:

Optional advanced projects in furniture construction, involving structural design, contour enrichment, and surface decoration, to be selected by the student and teacher.

V. Suggestions for Enriched Curricula

It has been the purpose of the author in presenting this outline of instructional units to give briefly a group of projects which involve the basic operations that seem to fit the needs in terms of the aims of this particular school level. The differences in the ability to work and think on the part of students is recognized and the content of the course so adapted that it will meet these individual differences. There should be minimum essentials to be acquired by all, in this case at least one project from each instructional unit being required. An enriched curricula can be given the superior student through greater opportunity for student planning, additional projects within each group, or original projects of his own choice that serve the ultimate ends to be attained.

VI. Representative Unit Instruction Sheets

It is obvious that a complete set of instruction sheets, covering

all the operations and items of information listed in the analysis chart, could not be written in the time allotted to this thesis. It was possible, however, to select a few operations and items of information from the more important units of instruction and to submit representative operation, job, information, and assignment sheets covering those items. Consequently, the instruction sheets which follow are only representative of the work to be covered, and it is assumed that the complete series of sheets, covering all phases of the manipulative operations to be taught, as well as the related technical information, will be made available to the students as the need arises. A collection of such sheets, all organized and presented in the same style as will be used in the classroom, is presented on the following pages.

Information WW1

BENCH WOODWORKING

How to Read a Working Drawing

INFORMATION:

A working drawing is a dimensional drawing or sketch which contains all the information necessary for the construction of a project. This form of drawing is the standard language of the draftsman and architect but should not be limited to that group alone. It should be understood by all connected with, and interested in, technical industries since the situations calling for ability to read drawings greatly outnumber those calling for ability to make them. To become familiar with this language we must know the alphabet, the grammar, and the composition, and be familiar with the accepted symbols, conventions, and abbreviations of mechanical drawing.

PROCEDURE: Kinds of dimensional drawings:

1. Orthographic Projection.

In orthographic projection the object is usually represented by at least two distinct views and some times by three or more. This kind of drawing forms the basis of practically all working drawings. However, other kinds may be used since this type is often difficult for the untrained person to visualize the object in full detail. Figure 1A shows an orthographic projection of three views of a rectangular block.

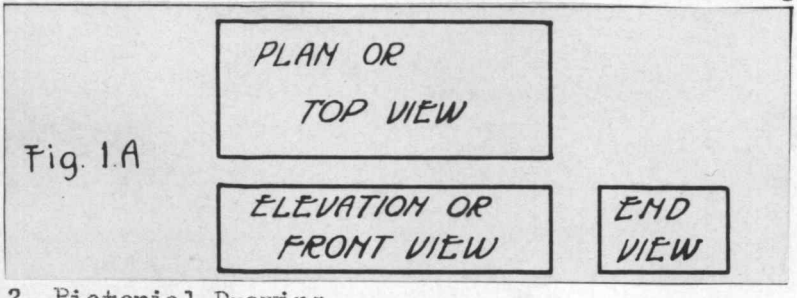


Fig. 1A

2. Pictorial Drawing.

A pictorial drawing is a single drawing representing the object with three visible surfaces. It gives a better pictorial representation of the object which makes it easier for the pupil to visualize. The two types commonly used are the isometric and oblique. The isometric shows three faces, all inclined to an angle with the plane of the paper as shown in Figure 1B. The cabinet oblique drawing, as shown in Figure 1C also shows three faces, however, one of which is parallel to the plane of paper. The receding lines are shortened in order to present a better picture of the object.

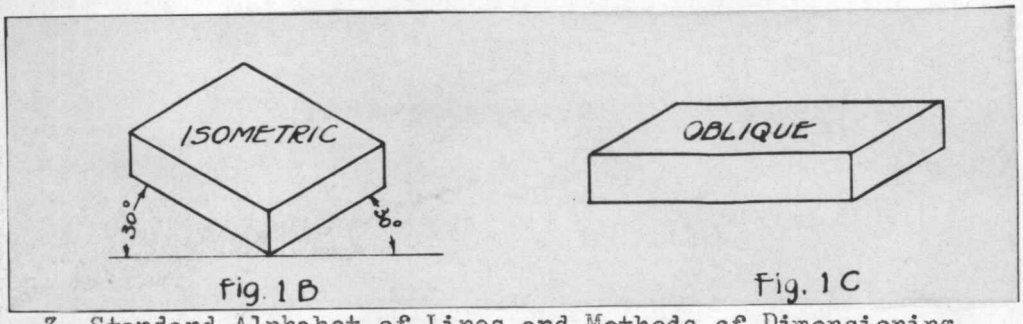
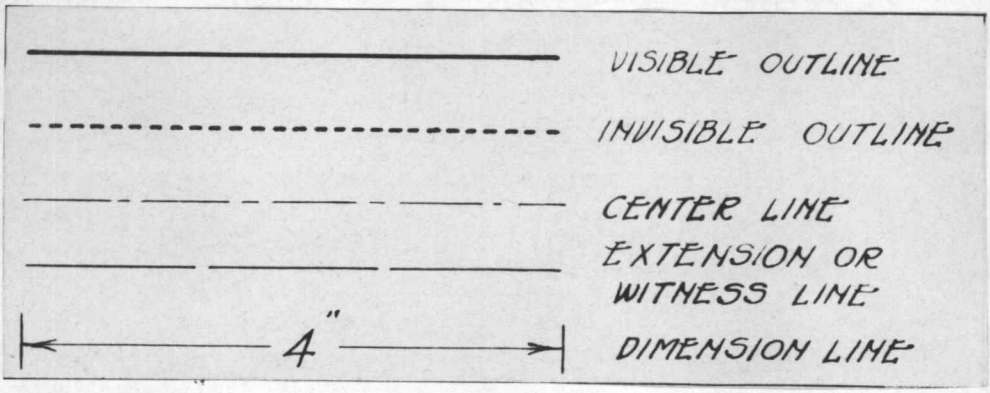


Fig. 1B Fig. 1C

3. Standard Alphabet of Lines and Methods of Dimensioning.

In order to read a working drawing the standard symbols and conventions of mechanical drawing must be understood. Figure 2 shows the most common lines used in a working drawing.



A solid line represents the visible outline of the object.

A dotted or short-dashed line represents the invisible outline.

The center lines are drawn by alternate long and short dashes. Round holes are usually located where the two center lines intersect at the center of the hole.

Extension or witness lines are fine, long-dashed lines extending from the outline of the figure (but not touching it) to indicate the limits of the dimension line.

Dimension lines are fine, solid lines terminated by arrowheads, used to indicate distances between points or lines. They are often broken in the center to allow insertion of figures stating the dimensions. Note where the arrows terminate for exact dimensions.

The following table illustrates the accepted method of indicating standard dimensions most commonly used in dimensioning a working drawing. The dimensions are given in inches, feet, or a combination of the two.

14 in. - Fourteen inches	4'-0" - Four feet
15 - Fifteen inches	2'-4" - Two feet four inches
16" - Sixteen inches	5'-6" - Five feet six inches

Where the space is too crowded to indicate the dimension in the regular manner, the method shown in Figure 3A is used. The radius of curvature of an arc is dimensioned as in Figure 3B. The figures show the radius of the arc in inches.

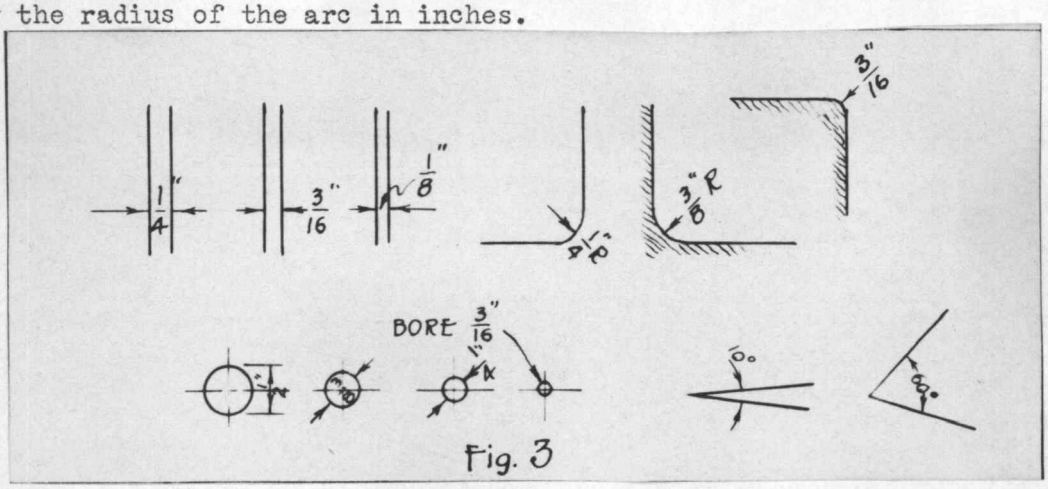


Figure 3, Methods of dimensioning: A, limited spaces; B, Arcs; C, Circles; D. Angles.

Circles are dimensioned as in Figure 3C, the figures representing the diameter.

Angles are indicated in degrees as in Figure 3D.

Refer to working drawings on pages 26-32 for practice in reading working drawings, noting the following points:

1. The type of drawing
2. Number of parts in the object
3. Thickness, width, and length of object
4. Radius of rounded corners
5. Diameter of holes
6. Depth and Width of dadoes
7. Dimensions from center lines

Information WW1

QUESTIONS:

1. What is the purpose of a working drawing?
2. Name the common types of working drawings.
3. How do orthographic, isometric, and oblique drawings differ?
4. What are the advantages of each?
5. In reading a dimension, what is meant by 4'-2"?

REFERENCES:

1. Engineering Drawing - French, T. E. Chapter XII
2. Instructional Units in Hand woodwork - Brown and Tustison - Unit 2.

Formulated by Vernon E. Shipp

Operation WW2

BENCH WOODWORKING

Figuring a Bill of Material

INFORMATION:

A bill of material is a written order with all the necessary specifications for obtaining the exact kind and amount of material needed. A bill of material is commonly called a "mill bill" when wood is the only material wanted. The making of such a bill gives training in the reading of drawings, in dimensioning and ordering of lumber, and in figuring board feet and costs of lumber.

PROCEDURE:

1. Visualize separately each part that will go into the finished project.

2. Make a cutting bill; that is, list all of the pieces in the project, giving their exact dimensions as taken from the drawing.

3. Make a bill of material (mill bill) from the cutting bill, listing all specifications and measurements just as the material is to come from the mill, lumber yard, or supply room. Cover the following points:

a. Number of pieces: Frequently several pieces on the cutting bill will be combined to form one large piece on the mill bill. (See operation sheet WW4.)

b. Thickness in inches: The following are standard thicknesses available in rough and mill-planed lumber:

Rough lumber - 1", 1 1/4", 1 1/2", 1 3/4", 2"
Mill-planed lumber - 13/16", 1 1/16", 1 5/16", 1 9/16" 1 3/4"

c. Width in inches: Standard widths for soft wood are in even inches. Widths for hard woods are not standard and include fractions of an inch.

d. Length in feet and inches: In a mill bill inch and foot marks are not used. Example: 2 x 6 x 6-0; means 2" x 6" x 6'.

e. Specifications: This includes the kind of material, rough or finished, the finishing being designated by abbreviations as follows: S - surface or side; E - edge; J - joint: Numerals 1, 2, 3, or 4 indicate the number of surfaces to be mill-planed. Example: S-2-S, J-1-E means

surface 2 sides and joint one edge.

f. Number of feet, board measure: A standard board foot is 1" x 12" x 1" = 144 cu. in. To compute board feet multiply the thickness in inches by the width in inches, by the length in feet and divide by 12; or if all three dimensions are in inches, divide by 144.

g. Price or rate per board foot is taken from price list.

h. Cost of each piece. The cost of any piece is represented by the price multiplied by number of board feet.

i. Total cost of lumber. This is the sum of the cost of all items or pieces in the bill of material.

4. General information. In figuring a bill of material blanks are generally available to record the data listed above. In this case no provision is made for hardware and finish material. Hardware can be listed piece by piece. The finish can be computed roughly by doubling the number of board feet in the project, multiplying the result by the number of coats of any given finishing material, and then further multiplying by the cost per coat of that material, as follows: Stain - ¼¢; Filler - 1/2¢; wax - 1/4¢ - Lacquer or oil varnish 3/4¢.

QUESTIONS:

1. What is a bill of material?

2. What is the formula for figuring board feet?

3. What is meant by "S-4-S"? J-2-E?

4. What order should be used in stating the dimensions?

5. What would be the cost of a board 2 x 6 x 10-0, S-2-S, at 20 cents ft.?

REFERENCES:

1. Instructional Units in Hand Woodwork - Brown & Tustison
2. Trade Customs of the Hardwood Lumber Business- White Brothers.

Formulated by L. A. Lovegren
and Vernon E. Shipp

Operation WW3

BENCH WOODWORKING

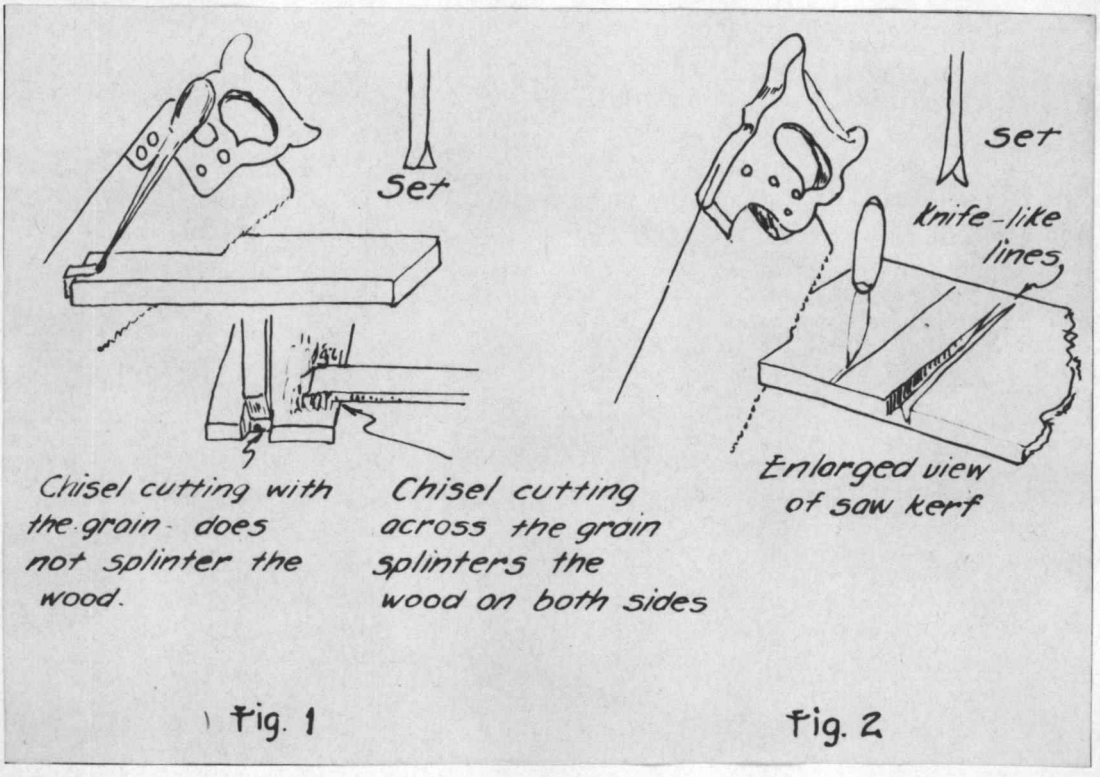
Sawing to A Straight Line

INFORMATION:

Sawing is one of the most common operations in woodworking. The saws most commonly used may be divided into two classes--those that cut across the grain and those that cut parallel to the grain. The former are known as cross-cut saws, while the latter are called rip saws. The distinguishing difference between the two classes is in the shape of the teeth. The teeth of the cross-cut saw have sharp points and their cutting action resembles that of a series of small knives. The teeth of the rip saw resemble small chisels, the cutting action taking place at the lower edge of each tooth and at the bottom of the saw kerf, rather than on the sides as in the case of the cross-cut saw.

PROCEDURE:

1. Select the proper saw, according to whether the cut is to be along the grain (rip saw) or across the grain (cross-cut saw). See figures 1 and 2 for additional help, or Information Sheet WW7 for more complete details.



2. Place the board to be cut on a saw horse or other convenient support.

3. Grasp the handle of the saw firmly in the right hand, with the thumb and index finger touching opposite sides of the handle. Figure 3.

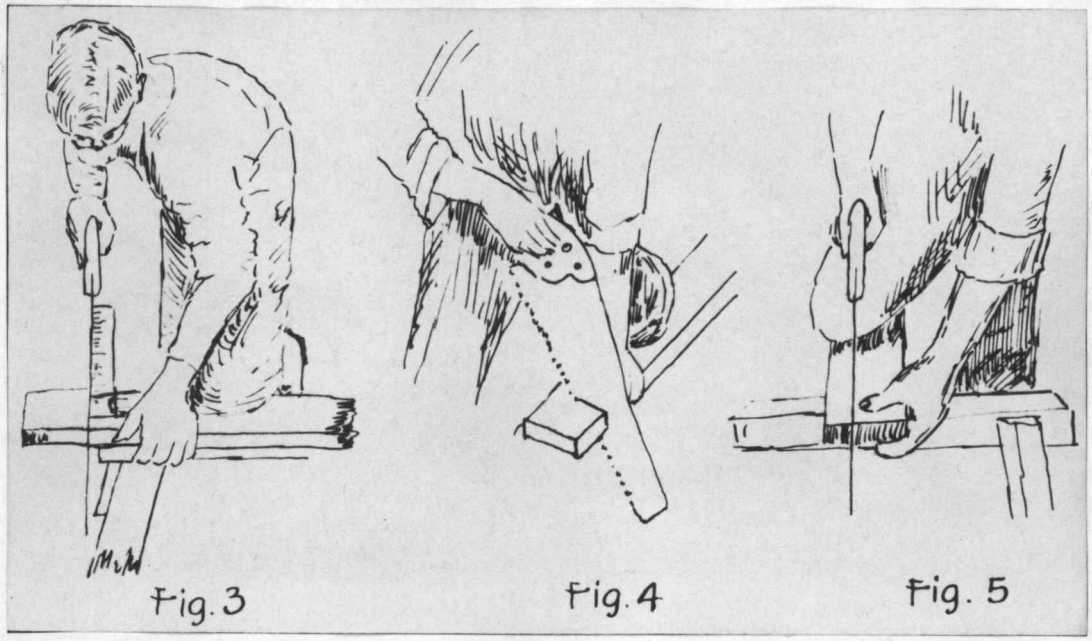


Fig. 3 Fig. 4 Fig. 5

4. Hold saw blade at right angles to board in order to insure a square cut.

5. The saw should also be held so that the line of the teeth makes an angle of 45° with the surface of the board.

6. Draw the saw up one or more times, with the thumb of the left hand guiding the blade on the wood where the cut is to begin. Draw slowly and carefully. Figure 5.

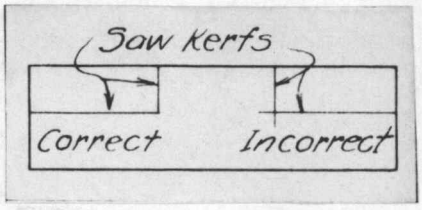
7. The saw kerf should be made just outside the line, leaving only enough wood to finish exactly to the line. This generally requires 1/16 to 1/8".

Note: In some cases it is desirable to saw "exactly to the line". This is especially true in certain forms of joint work and in carpentry. In such cases the saw kerf should be placed in the waste stock, but with one side of the saw cutting through the center of the knife line or mark. Do not "straddle" the line with the saw kerf.

8. Test to see if the cutting is at right angles to the board by carefully sighting above or to one side of the saw, or by using a try square. See Figure 3.

9. When approaching the finish of the cut, saw slowly and hold the board with the left hand so that the piece will not drop and split off an arris.

10. When sawing to a corner do not let saw kerfs cross beyond that corner. Bring handle of saw up until the line of the teeth is at right angles to side of board. Ripping is usually done first in such cases.



CAUTIONS:

1. Always start the saw with a light upward stroke. This allows it to start the cut without jumping.

2. Hold the saw firmly, after the preliminary cut is established, so that it will cut in a straight line.

3. Use a long, slow, easy stroke, allowing the saw to cut with only slight pressure applied.

4. Be careful not to pinch or kink the saw. Careless use will easily ruin a good saw.

QUESTIONS:

1. What is a saw kerf?

2. What is the purpose of "set" in a saw?

3. Why keep your eye in line with the saw and in line with the mark on the board?

4. What is meant by the phrase, "This saw has eight points"?

5. If the saw "got off the line" how would you guide it back?

REFERENCES:

1. Essentials of Woodworking - Griffith - pp 22-26
2. Prevocational and Industrial Arts - Wood and Smith - pp 4-8

Formulated by R. B. Kidder and L. O. Wiggins

Revised by Vernon E. Shipp

Operation WW4

BENCH WOODWORKING

Getting Out Stock to Rough Working Size

INFORMATION:

Getting out stock to rough working size presents an opportunity for real thinking. There are few operations in the making of simple projects that give better opportunity for individual planning and in no place is there greater opportunity to practice real, worth-while economy in cutting or in the use of material. Use your wits and save your wood!

PROCEDURE:

1. Select the proper kind and grade of stock to be used for the project.

2. After careful examination of the stock bill and the blue print determine the required thickness and the best width of stock from which to cut the pieces desired.

3. Combine widths and lengths of different pieces so as to best fit them to the widths and lengths of the boards available.

4. Make a mental picture of how the pieces are to be marked off on the board selected.

5. Mark the pieces according to your best mental picture, laying off the cutting size of each one with pencil and square. Check measurements.

6. Examine critically to see if a better or more economical arrangement can be made. See examples below for suggestions of savings that can be made by good planning.

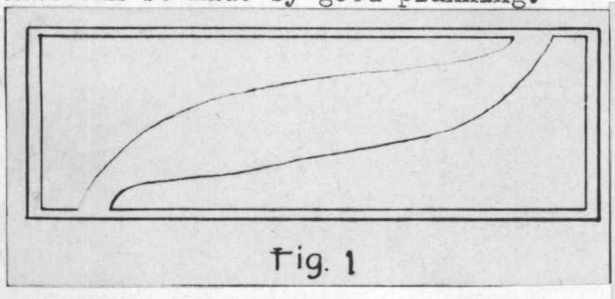


Fig. 1

Figure 1 takes a longer board than Figure 2. Figure 2 takes a wider board than Figure 1. Which is the most economical? Why?

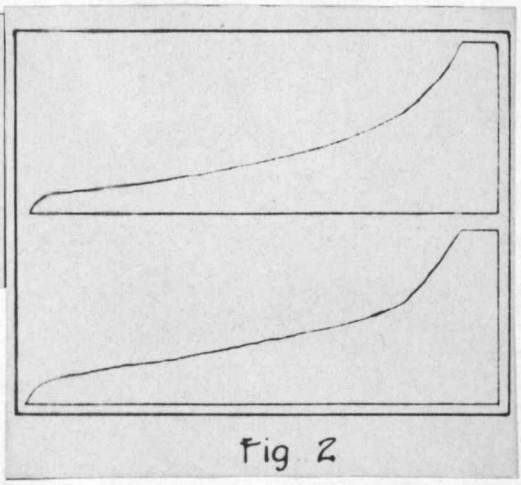
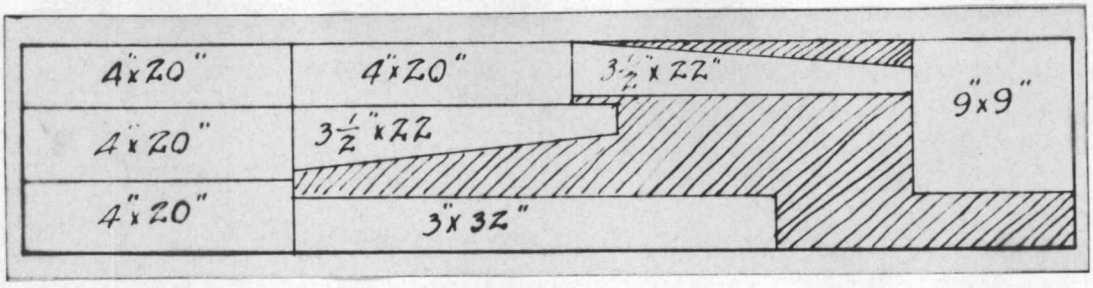
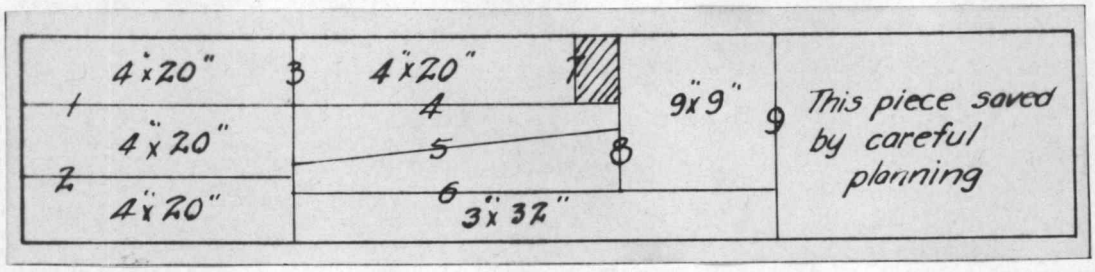


Fig 2



Wasteful method -- Shapes laid out at random -- No thinking involved. Used 71" of stock. Shaded area represents waste.



Carefully planned layout -- Used 51" of stock for same job as above. 20" saved by a little thoughtful planning! Does it pay?

7. When you are sure that all is right, go ahead. In case of doubt have instructor check with you.

8. Cut to convenient lengths if too large to handle well. These cuts must be made so as not to waste material, as at lines 3 and 9 above.

9. Rip to widths required (rip saw). Hold side of saw blade at right angles to board. Use long strokes. Do not kink saw. Keep on the line!

10. Cut to lengths as indicated by lines. (Cross-cut saw). Do not let saw kerfs cross beyond corners!

SUGGESTIONS:

The number at the various lines in Figure 4 indicates the order in which these lines should be sawed.

Operation WW4

QUESTIONS:

1. Is all of the ripping done at once in Figure 4?

2. Why has this order of sawing been suggested?

3. How is the board held for sawing?

REFERENCES:

1. Essentials of Woodworking - Griffith. Topics 10, 11, 12.
2. Projects for Beginning Woodwork and Mechanical Drawing - Griffith - p 25.

Formulated by Geo. B. Cox
Oregon State College

Operation WW5

BENCH WOODWORKING

Planing Flat Surfaces

INFORMATION:

The purpose of planing is to (1) Remove excess wood, and (2) To make smooth and true surface. A planer or jointer leaves mill marks or ripples on boards. In the best work these must be removed by hand planing or scraping before the piece is assembled. The longer the plane bed the more nearly perfect the straight surface will be. Choose the proper plane for the job. See Information Sheet WW8 on Planes and Planing.

PROCEDURE:

1. Adjust the plane to take the proper depth of cut. The shaving should be about the thickness of a piece of newspaper. Take a finer cut when finishing than when roughing down. The finishing cut should be very thin in order to assure a smooth and true surface.

2. Fasten the work in a convenient position.

a. If planing the edge of a board it is probably best to clamp it in the vise.

b. If planing a broad surface of a board use the bench stop or bench hook to keep the board from sliding off the top of the bench.

c. If planing an end of a board, either fasten it in the vise or hold it on the bench hook as shown in Figure 1.

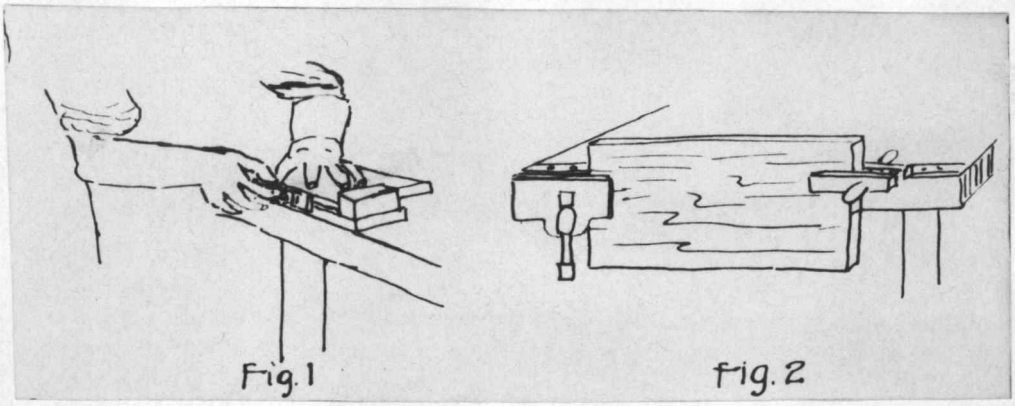


Fig. 1

Fig. 2

d. If planing the edge of a very large piece, such as a table top, it is best to fasten one end in the vise and to support the other end with a hand screw. See Figure 2.

3. Plane "with the grain" to avoid roughing up the surface. See Figure 3.

4. Test flat surfaces for straightness with the back edge of a try-square blade or other straight-edge. Test across the grain, with the grain, and along both diagonals. See Figure 4.

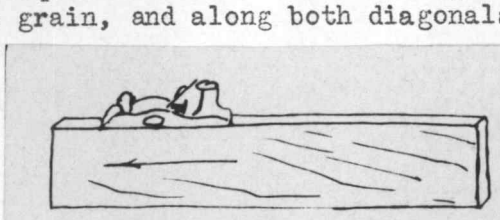


Fig. 3

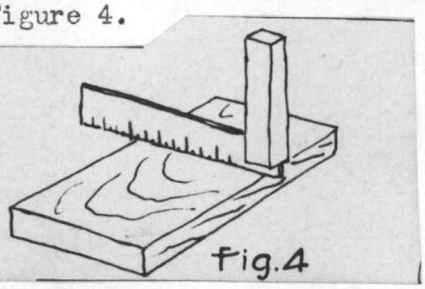


Fig. 4

5. Plane off the high parts as indicated by a straight-edge test until this test gives an equal distribution of light over the whole surface.

6. Test the edge for straightness by sighting along it or by use of a square-blade or straight-edge. Also test for squareness to the working face. See Figure 5.

7. Test the end for straightness and for squareness to both the working face and the working edge.

8. When planing chamfers or narrow edges, steady the plane by extending the fingers beyond the plane bottom and using them as a guide on the board.

SUGGESTIONS:

1. Place the pressure on the toe of the plane when starting a cut and on the heel when completing a cut.

2. When planing end grain, do not plane clear across the board. Plane from both edges to the center. This avoids splitting or splintering at the corners.

Note: Sometimes this may be overcome by making a small chamfer on the corner. See Figure 6. In many instances this method is inadvisable, however.

3. A plane often cuts better if a shearing cutting action is employed. This is done by holding the plane at an angle to the direction of movement of the plane. See.Figure 8. This is particularly useful on curly-grained stock.

Operation WW5

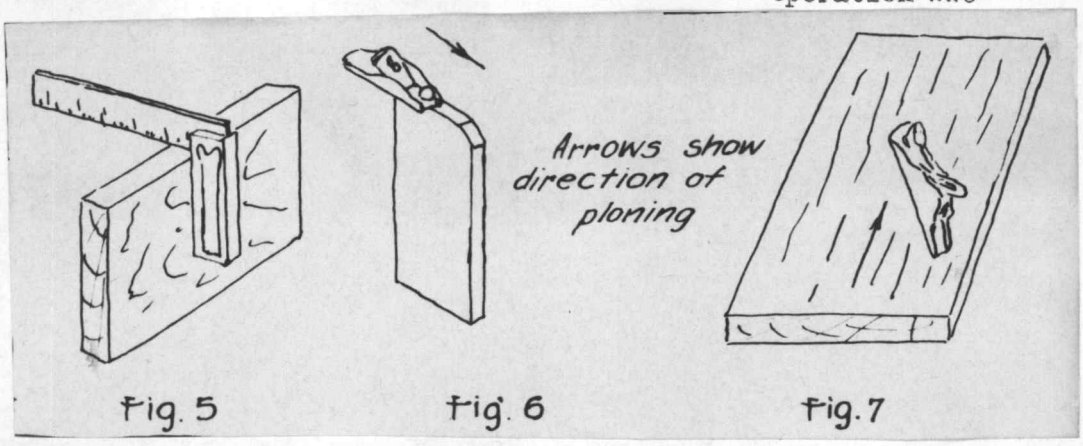


Fig. 5 Fig. 6 Fig. 7

QUESTIONS:

1. Why use a plane with a long bed when joining the edges of long boards?

2. Why not plane entirely across the end of a board?

3. What is (a) wind? (b) warp?

4. Under what conditions is it advisable to chamfer the board when planing end grain? Should this be practiced for the general run of work?

5. To what is the term "face side" applied?

6. What is meant by cross planing?

REFERENCES:

1. Essentials of Woodworking - Griffith - pp 42-50
2. Principles of Woodworking - Hjorth - p 70-72
3. Instructional Units in Hand Woodwork - Brown & Tustison - pp 66-83

Formulated by Bruce J. Hahn

Revised by Vernon E. Shipp

Operation WW6

BENCH WOODWORKING

Squaring a Board to Dimensions

INFORMATION:

A rectangular board has six surfaces, hence the six steps in squaring it to dimensions. Two of these surfaces are called "BROAD-SIDES", two are called "EDGES", and two "ENDS". The six steps in planing these surfaces, and in laying out the size of the board, are outlined below. The order given is that which will give the most accurate work in the shortest time, allowing for the minimum number of accumulative errors.

PROCEDURE:

1. TRUE THE WORKING FACE.

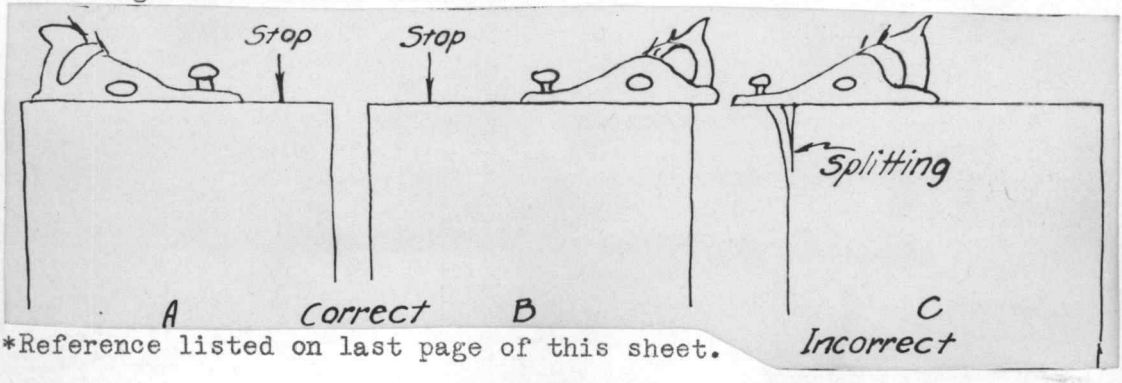
Select and plane one broad side smooth and true, testing it lengthwise, crosswise, and diagonally. (Reference #1, pp 39, 42)*. When completed, this is called the "WORKING FACE", "WORKING SIDE", or "FACE SIDE". Mark it with one light pencil mark so as to indicate that it is finished.

2. JOINT THE WORKING EDGE.

Joint one edge (straight and square) with working face. Test for both squareness and straightness. (Reference #1, pp 41, 44.) When completed, this becomes the "WORKING EDGE". Mark it --, two light pencil marks.

3. SQUARE ONE END.

Plane one end square with working side and working edge. When planing end grain it is necessary to cut across the wood fibers. Since they separate more easily than they cut, the fibers at the far edge will split off if the plane is pushed all the way across the board. To avoid this splitting the plane should not be pushed all the way across the end but the stroke should be stopped as indicated in the sketches below. The board can then be reversed and planed from the other edge in a similar fashion.



*Reference listed on last page of this sheet.

Note: All measurements should hereafter be made from one or another of the three surfaces (WORKING FACE, WORKING EDGE, SQUARED END) that have just been finished.

4. SQUARE SECOND END -- LENGTH.

Measure from the squared end and mark the required length. (Knife and rule, with rule held on edge.) See Figure 1.

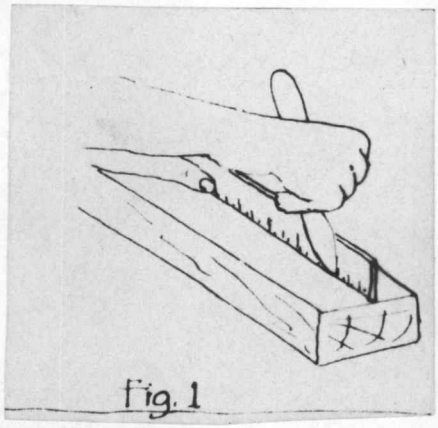


Fig. 1

Score a knife line around the board at the point marked, using try square and knife, with the beam of try square held firmly against the marked face and edge. (Reference #1, pp 11, 47.)

If there is much extra length it may be sawed off, sawing approximately 1/8" away from the knife line. Hold side of saw at right angles to face of board. Use bench hook for holding work if board is small. Saw-horses are best for long boards. Plane carefully to center of knife line. Test frequently to determine whether end is square with the working face and edge.

5. JOINT SECOND EDGE -- WIDTH.

Set marking gage to required width and gage a line on the working face, parallel to working edge. Hold head of gage firmly against working edge, with gage rolled forward so that the pressure comes on the lower arris of beam instead of on the point of the spur. If too much pressure comes on the spur the gage line will not be straight. See position in Figure 2. Note that the spur just barely touches the wood. Suggestions for holding gage and board are given in Figures 3 and 4.

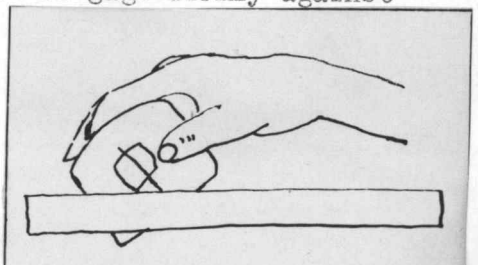


Fig. 2

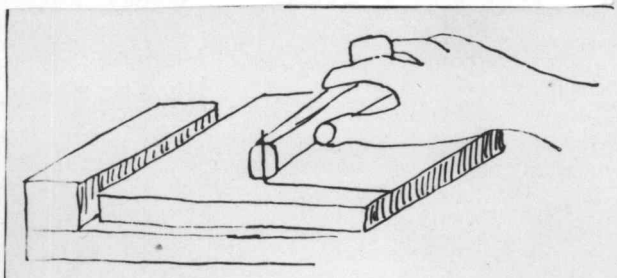


Fig. 3

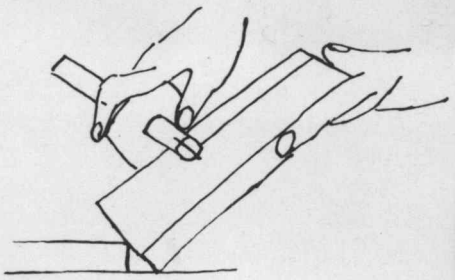


Fig. 4

If there is much extra width it may be ripped off, sawing approximately 1/8" away from the gage line. Hold side of saw at right angles to face of board. (Reference #1, pp 22-25.)

Plane carefully to center of gage line. Test frequently to determine whether edge is square with the working face.

6. TRUE SECOND BROAD SIDE -- THICKNESS.

Set marking gage to required thickness and gage a line on each edge, parallel to the working face. Head of gage should be held firmly against the working face. Use same precautions for holding gage as in step 5 above.

Plane carefully to gage lines, testing for straightness across the grain. The gage lines will insure straightness along the grain if one is careful in working exactly to the center of these lines. (Reference #1, pp 45, 48.)

REFERENCES:

1. Essentials of Woodworking - Griffith - (Pages indicated in directions above.)
2. Hand Work in Wood - Noyes - pp 72-75.
3. Prevocational and Industrial Arts - Wood and Smith - pp 93-95.

Formulated by George B. Cox
Oregon State College

Information WW7

BENCH WOODWORKING

Hand Saws

GENERAL DEFINITION:

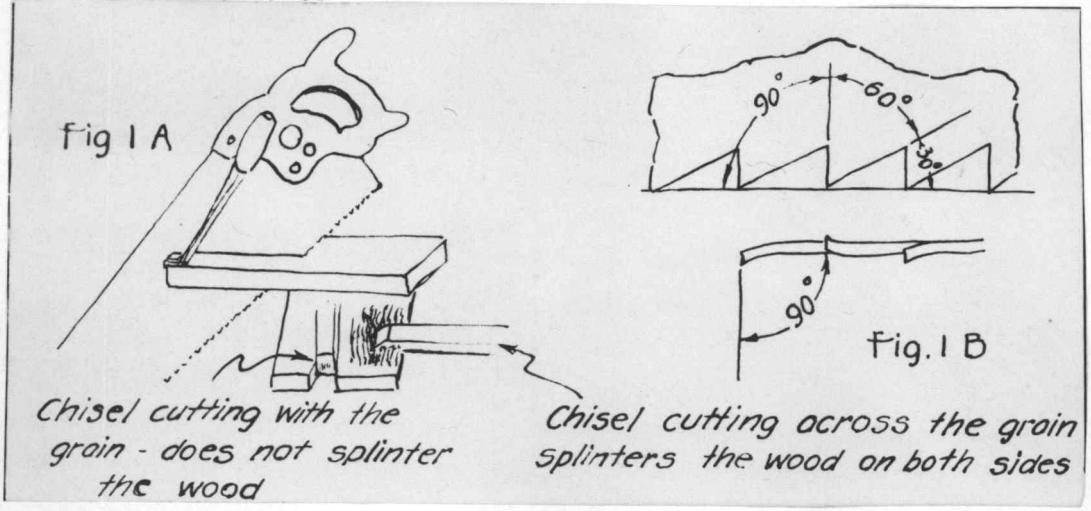
A saw is a thin, flat blade of steel with teeth arranged along one edge for the purpose of cutting wood, metal, or other material. The object in using a saw is to cut through a piece of material along a thin line. The efficiency of the saw depends upon the smoothness and narrowness of the saw track or kerf, and upon the ease and speed with which the cut is made.

CLASSES OF SAWS:

The saws most commonly used fall into two broad classes according to whether the teeth are arranged for cutting across the grain of the wood or parallel to the grain. Cross-cut saws are those with teeth shaped for cutting across the wood fibers, while rip saws are those whose teeth are shaped for most efficient cutting along the grain.

THE RIP SAW:

The teeth of the rip saw may be thought of as a series of chisels set in two parallel rows, each over-lapping the other slightly. Each tooth is filed to a sharp edge, which at each stroke chisels off a small chip or bit of sawdust from the end of the wood fibers. The shape of the teeth of the rip saw and their cutting is illustrated in Figure 1. It will be noticed that the filing line of a rip saw tooth (Figure 1B) is at right angles to the side of the saw blade, and that the front edge of the tooth is perpendicular to a line passing through the cutting edges. This saw operates very well along the grain of the wood but if used to cut across the grain it tears the wood fibers, leaving a rough jagged cut.



THE CROSS-CUT OR HAND SAW:

The cross-cut saw differs from the rip saw in that the teeth are filed with side bevels, and the front face of each tooth becomes a sharp edge rather than a perpendicular face. The bevels are clearly shown in Figure 2, and the line at B indicates the angle at which the file is held with reference to the side of the saw in order to form these bevels. This angle is reversed on each alternate tooth so that the bevels alternate from one side to the other on successive teeth. The result of filing at this side angle is to produce sharp, knife-like points at the extreme lower ends of the teeth and cutting edges along their sides, rather than broad, chisel-like cutting edges at the lower ends as in the case of the rip saw.

The cutting action of the cross-cut saw is best compared to that of a series of small knife points, and is partially illustrated in Figures 2 A. The sharp points of the teeth score knife-like lines across the face of the board. These lines are gradually deepened by the cutting edges on the sides of the teeth and the material between them chipped out by the body of the tooth as the saw cuts its way through the wood. The fibers of the wood are thus severed across their length, and split out from between the sides of the saw kerf by the forward motion of the saw. A well sharpened cross-cut saw leaves a reasonably smooth cut, which in hardwood sometimes even has a polished appearance.

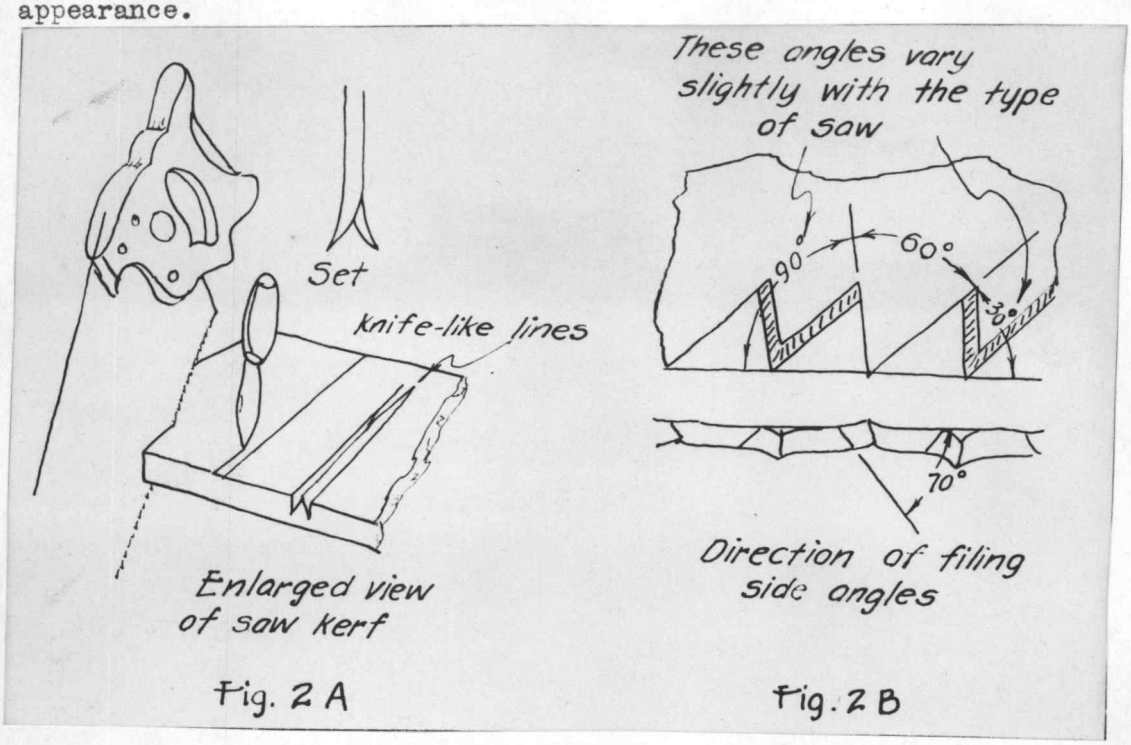


Fig. 2 A Fig. 2 B

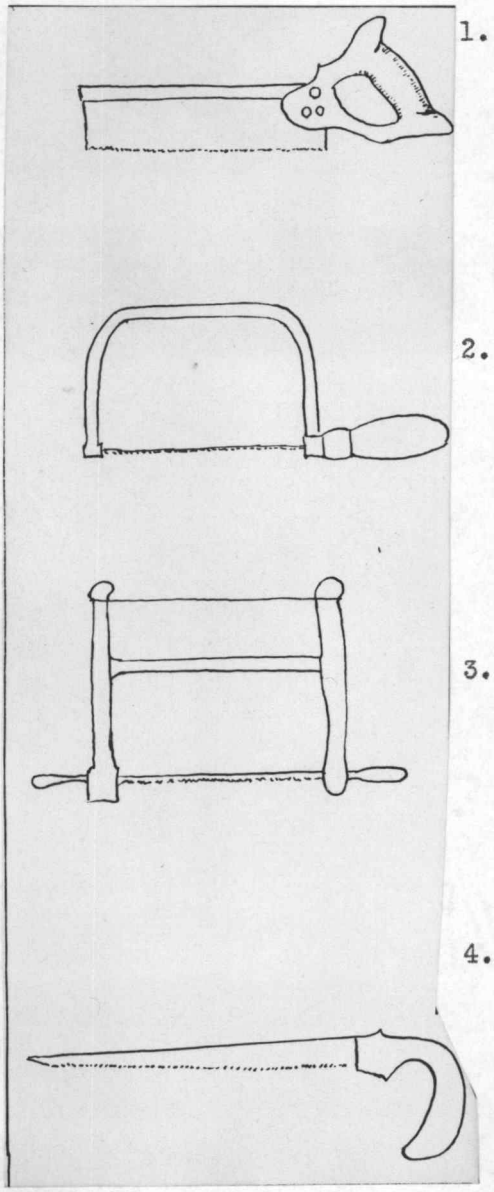
The action of a cross-cut saw is like two knives, the points of the teeth scoring two parallel cuts and the body of the teeth dragging

out the chips from between.

The cutting action of a rip saw is like that of a series of chisels, each tooth cutting a small chip and forcing it out at the end of the kerf as the saw moves forward.

VARIETIES OF SAWS:

While all wood-cutting saws can be classified under the two broad groups of ripping or cross-cutting, there are many varieties of shapes and sizes within these classes, each designed for a special purpose. Some of the more common varieties of these special saws are described below:



1. BACK SAW.

   A fine-toothed cross-cut saw with a much thinner blade than the hand saw. For additional stiffness the blade is reinforced with a steel rib along the back edge. Used for fine work and for accurate cutting. Length of saw blade ranges from 10 to 16 inches.

2. COPING SAW.

   A very fine saw blade stretched tightly between the two ends of a "U" shaped steel frame. The blades vary somewhat in size but are most commonly about 1/32" thick by 1/16" wide and six inches long. This saw is used for cutting short curves in thin wood.

3. TURN SAW, WEBB SAW OR FRAME SAW.

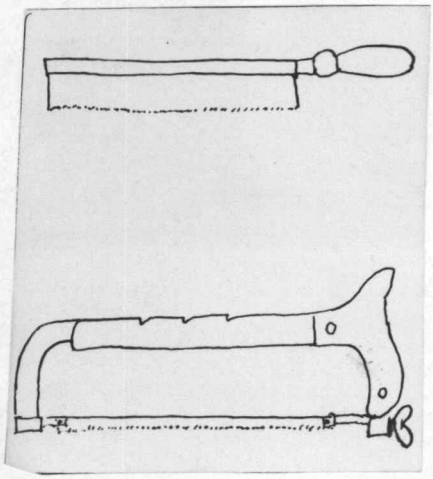
   Quite similar in some respects to the coping saw but has a heavier blade and a larger, wooden frame. Blades are usually about 1/16" x 1/4" x 18". Used for sawing curves when the work is too large or stock too heavy for coping saw.

4. COMPASS OR KEYHOLE SAW.

   A small, pointed saw blade with a handle similar to a hand saw. Blade is narrow and tapering but rather thick and stiff. Used for sawing curves and holes in places where the Coping or Turn saw could not be used because of their frames.

5. PANEL SAW.

A fine tooth cross-cut saw used for careful or delicate finishing work. It ranges from 14" to 24" in length, with a thin tapered blade and a handle that gives an easy grip and control to the saw. Very similar to the hand saw, except smaller.



6. DOVETAIL SAW.

A fine-toothed cross-cut saw resembling a Back saw, but much smaller and with a different handle. Blade usually 6" to 8" long. Used for fine work, especially the cutting of dovetail joints.

7. HACK SAW.

Not a wood-worker's saw but so frequently used as to be described here. A thin blade, usually about 3/64" thick x 1/2" to 3/4" wide, stretched between the two ends of a stiff metal frame. Blades range from 8" to 14" in length and are made of especially hardened steel similar to that of a file. Used for cutting metal of all kinds, except hardened tool steel. Blades are brittle, as well as hard, and must be used with caution to avoid breakage.

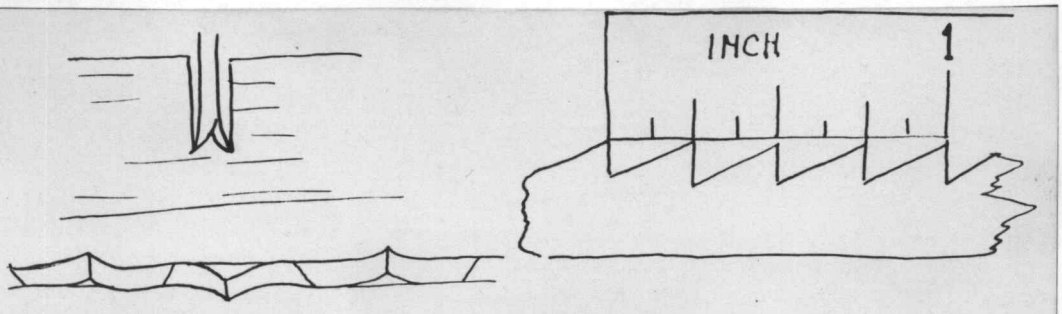
TECHNICAL TERMS:

1. SET.

The alternate bending applied to the teeth of a saw, one tooth bent to the right, the next to the left, so that the kerf is wider than the thickness of the blade. The amount of the set is the amount of the bending of each alternate tooth and is determined by the class of work and the kind and dryness of the wood to be cut. Hard, dry wood requires less set than soft, wet, or spongy wood.

2. POINTS PER INCH.

An indication of whether the saw has coarse or fine teeth, according to the number of points to the inch. The number of points is always one point greater than the number of teeth. See figure 10.



Set- Alternate bending of teeth to give clearance in kerf.

Fig 9

Fig 10

3. TOE AND HEEL.

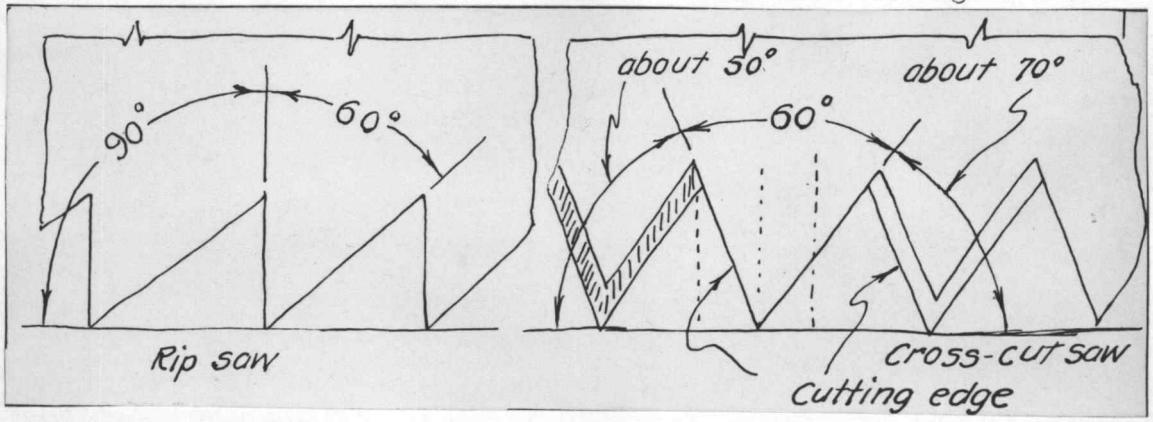
The heel is the handle end of the line of teeth while the toe is the opposite end.

4. KERF:

The track left in the wood by a saw cut is referred to as the kerf. If the saw is properly sharpened and fitted, the kerf is slightly wider than the thickness of the blade. This difference in width is for the purpose of reducing friction on the sides of the saw, and is caused by the set of the teeth. (See Figure 9.)

5. PITCH OR RAKE.

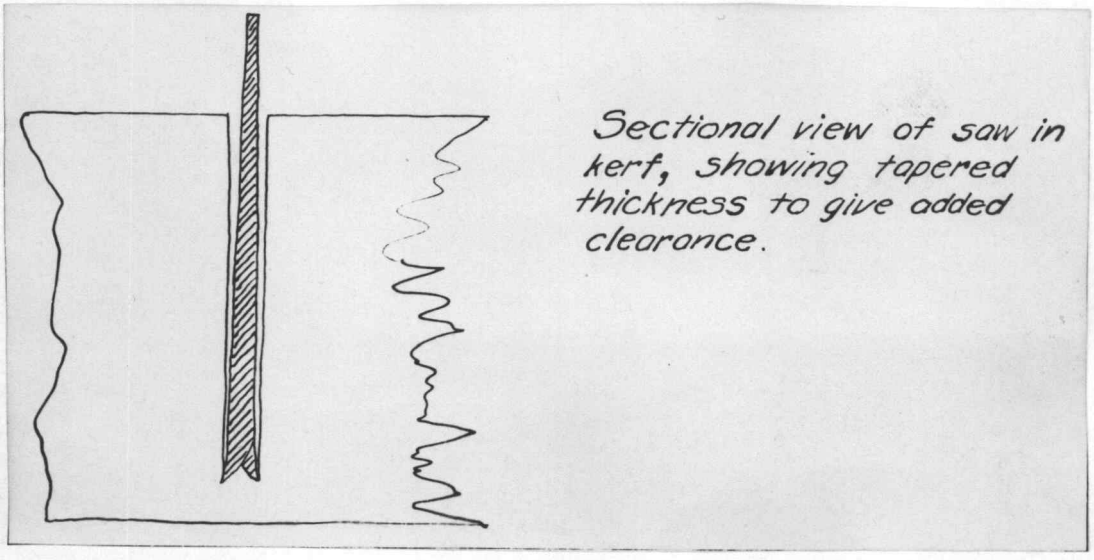
The slant of the front edge or face of the teeth with reference to a line passing through their points. The angle of pitch of the rip saw is 90° while the pitch given a cross-cut saw tooth is usually about 75° or about one-third of the whole width of the tooth. See Figure 11.



6. TAPER GRINDING:

Special grinding giving tapered thickness to saw blade. Back edge

is thinner than toothed edge. See Figure 12. This permits saw to run free with less set.



Sectional view of saw in kerf, showing tapered thickness to give added clearance.

QUESTIONS:

1. Name the parts of a saw.

2. What does the number on the heel of a saw indicate?

3. How do you detect a sharp saw?

4. What may cause a saw to jerk or vibrate and how can it be remedied?

5. What is meant by "jointing" a saw?

6. Explain the procedure in sharpening a saw.

7. Why is "fitting a saw" a difficult operation?

REFERENCES:

1. Hand Work in Wood - Noyes - pp 62-68
2. Tool Manual for School Shops - Disston - Chapter III
3. How to Work with Tools and Wood - Stanley Tool Company - pp 28-35

Formulated by Russel B. Kidder
Revised by Vernon E. Shipp

Information WW8

BENCH WOODWORKING

Planes and Planing

INFORMATION:

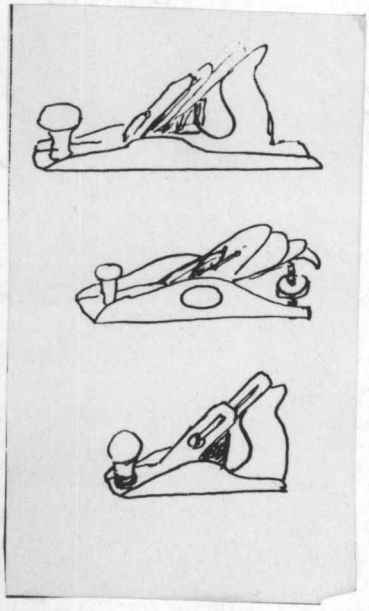
The plane is really a form of chisel set in a rigid frame. A good example of this is the adjustable chisel gauge shown in Figure 1. The early plane consisted of a simple blade of steel which was held in a hole in a block of wood by means of a wooden wedge driven in from above. See Figure 2 and Stanley charts on History of the Plane. Modifications of this elementary type of plane still exist as moulding planes, etc. Improvements were gradually made in the materials and mechanics of the plane until we now have many different sizes and kinds made of iron or steel almost entirely. Each kind is designed for a particular type of work and is better for that work than any other kind.

Fig. 1 Fig. 2

PURPOSE:

In general, the purpose of planing is (1) to remove excess wood and (2) to make a smooth surface. A planer or jointer leaves mill marks or ripples which must always be removed by hand planing or scraping before the piece is used in a good piece of work.

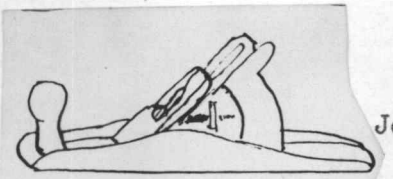
VARIETIES:



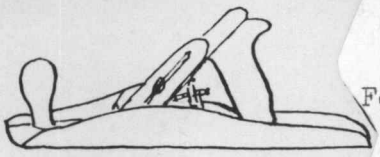
Jack Plane--Used for general woodwork, anything from rough carpentry to the finish cut in fine cabinet work. It is the most common and most useful plane we have. Common length is 11 to 15".

Block Plane--Used for small work and for end grain. It is adapted to end grain because the blade forms a more acute angle with the work than does a Jack plane blade. Length $3\frac{1}{2}$ to 8".

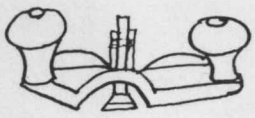
Smooth Plane--For purposes similar to that of the Jack plane as it is used in the shop, primarily for smoothing operations where smoothness is more important than straightness. Length $5\frac{1}{2}$" to 10".



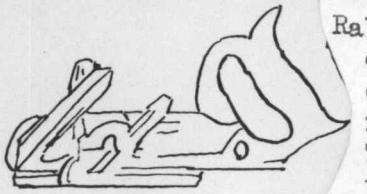
Jointer Plane--For long work where a straight surface is required. The longer the bed the fewer small irregularities will be left by the plane. Length 22 to 30".



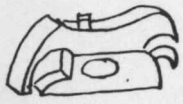
Fore Plane--For the same purpose as the jointer plane. Length 18 to 20".



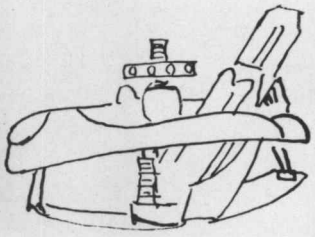
Router Plane--For making grooves, recesses, dadoes, panels, etc.



Rabbeting Plane--For cutting rectangular recesses or rabbets such as that on the back of a picture frame. When a guiding fence is attached it is called a filletser plane. The dado plane is another modification of the rabbet plane, having the blade at a 70° angle from the side instead of perpendicular to it.

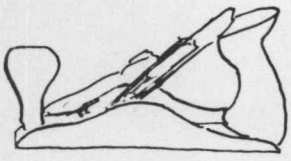


Bull-nose Plane--For working in corners. It is a small plane with the blade very near the front end. It can also be used as a rabbet plane.

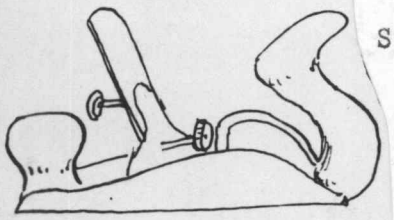


Circular Plane--For smoothing convex or concave curves of moderately large radius. It has a flexible steel bed which is adjustable for various arcs. See Operation Sheet on Planing Curved Surfaces.

Spokeshave--For curves of nearly any common size, either concave or convex. It is essentially a plane with an extremely short bed.

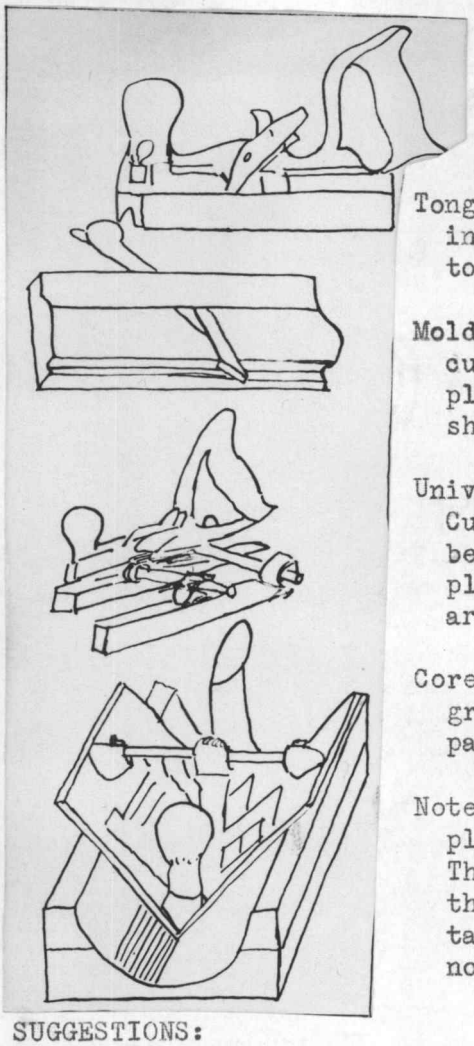


Scrub Plane--For roughing off and removing wood rapidly. The blade has a very pronounced crowned cutting edge. Length 10-12".



Scratch Plane--or Scraper Plane--For scratching surfaces to give a good gluing surface as in veneer work or to scrape down finish surfaces. The blade is often a scraper on one end and toothed on the other and is reversible.

Information WW8



Tonguing and Grooving Plane--Used for matching or joining boards edge to edge with the tongue and groove joint.

Molding Plane--For making moldings or small curves. It is a very elementary form of plane and is made in a wide variety of shapes. It is usually a wooden plane.

Universal Plane--For a great variety of uses. Cutters such as molding, matching, sash, beading, reeding, flutting, hollow, round, plow, filletser, and other special cutters are available.

Core-box Plane--For making semi-circular grooves or channels. It is used mostly in pattern making.

Note:--There are many other special kinds of planes other than those mentioned above. Their uses are limited, however, and since the above list is representative and contains the more common cones the others will not be discussed here.

SUGGESTIONS:

1. There is a plane for each type of job. Be sure to use the proper one.

2. Do not take too heavy a cut. Especially when finishing, lighter cuts should be taken.

3. Be careful not to plane against the grain.

4. When planing end grain, plane from both sides to the center to avoid splintering or splitting the corners. See Operation Sheet WW6.

QUESTIONS:

1. Name and locate the parts of a plane.

2. How and in what position should the cap-iron be?

3. How should one determine when the plane iron is sharp?

4. What two adjustments are there on the blade of the plane?

5. When are the following planes used: Jack? Block? Smooth? Jointer?

6. What is the shape of the cutting edge of the Jack plane iron?

REFERENCES:

1. Essentials of Woodworking - Griffith - pp 31-50
2. Hand Work in Wood - Noyes - pp 69-83
3. Prevocational and Industrial Arts - Wood & Smith - pp 9-12
4. How to Work With Tools and Wood - Stanley

Formulated by Bruce Hahn and W. T. Rounds

Revised by Vernon E. Shipp

Information WW9

BENCH WOODWORKING

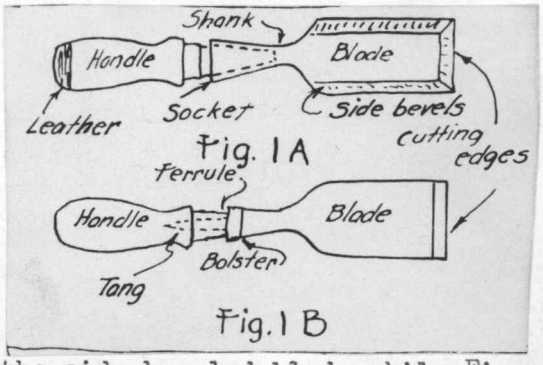
Chisels and Gouges

GENERAL DEFINITION:

Chisels are generally classified into two large classes according to the way their handles are fitted into the blades.

Figure I A illustrates the socket type of chisel. The wooden handle is fitted into a socket at the upper end of the blade.

Figure I B shows the other method of attaching the handle, which type is known as the tanged chisel.



Note: Figure I A illustrates the side beveled blade while Figure I B shows the straight edged blade. The former is somewhat lighter and neater in appearance.

In general, the socket chisel is used for heavier work, and its handle is usually tipped with leather to better withstand blows when being driven. The tanged chisels are somewhat lighter, have a better balance, and are preferred by many workmen for light chiseling and paring.

CLASSES OF CHISELS:

Chisels differ in many respects and may be further classified according to length, width, and use.

A. In respect to length of blade.

1. The butt chisel

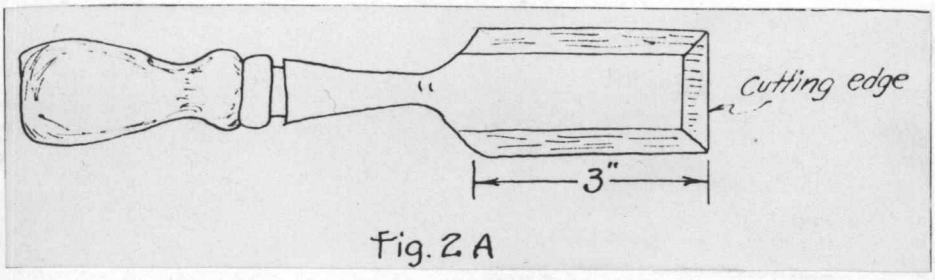


Figure 2A illustrates the socket butt chisel. The blades of these chisels measure three inches from cutting edge to shoulder. This type of chisel is a light duty tool generally used in light work on fairly broad accessible surfaces; i.e. gaining for butt hinges on door jambs, etc.

2. The pocket chisel

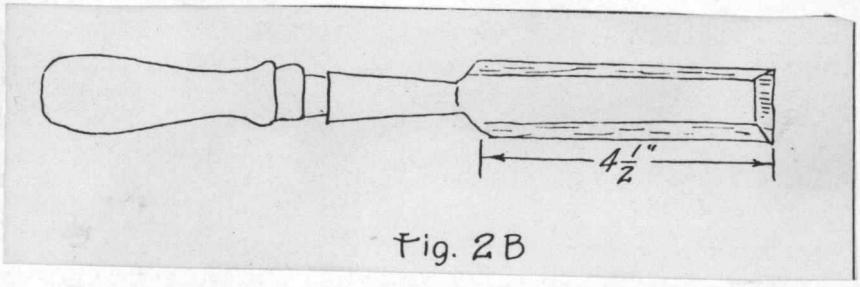


Fig. 2B

Figure 2b illustrates the pocket chisel with a blade of four and one-half inches measuring from cutting edge to shoulder. This is a heavier type of chisel and is the one most generally used for ordinary paring.

3. The firmer chisel.

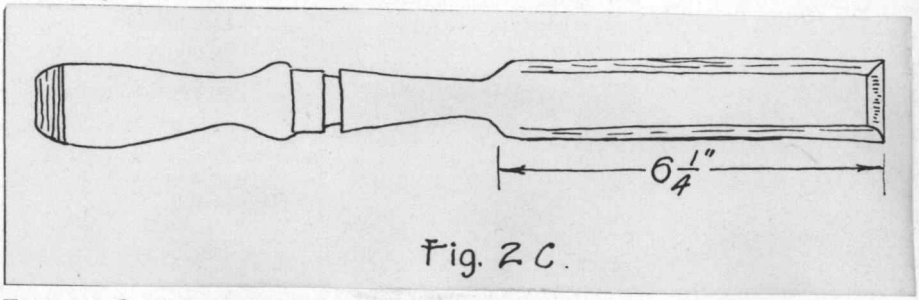


Fig. 2C.

Figure 2c illustrates the firmer type of chisel with a blade of six and one-fourth inches measuring from cutting edge to shoulder. It is still more substantial chisel, adapted to medium heavy work.

4. The framing chisel.

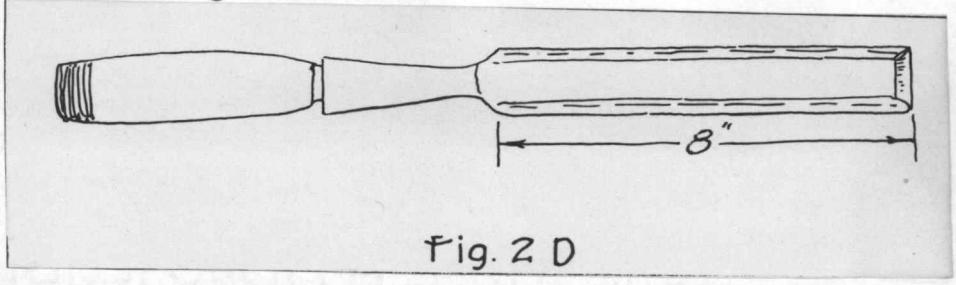


Fig. 2 D

Figure 2d illustrates a framing chisel with a blade of eight inches measuring from cutting edge to shoulder. A heavy duty chisel adapted to heavy work and used where deep cuts are necessary. May be used to cut mortises.

Note: Any of the foregoing chisels may be obtained in the socket type. All except the framing chisel may be obtained in the tanged type.

B. In respect to size. (Width)

The size of a chisel is indicated by the width of the cutting edge. Chisels may be obtained in all widths, varying by eighths from one-eighth to two inches inclusive.

Note: The cutting edge of a chisel is ground to about 25° angle.

C. Special chisels:

1. Corner chisels

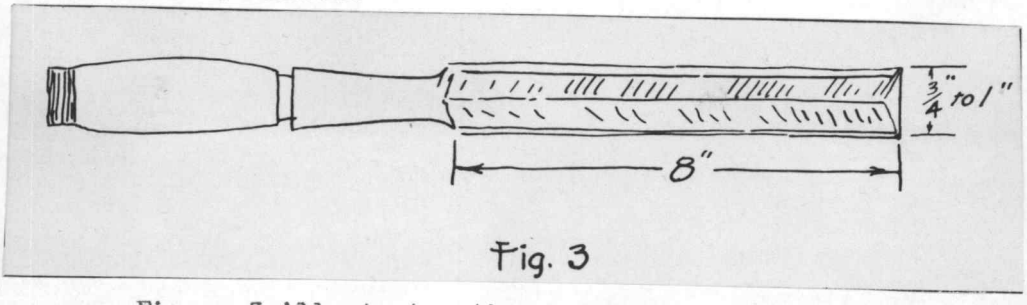


Fig. 3

Figure 3 illustrates the socket corner chisel which has a right angle blade. It is adapted for corner work, measures seventeen inches over-all, and comes in two sizes with three-quarter inch and one inch blades.

2. Mortising chisel

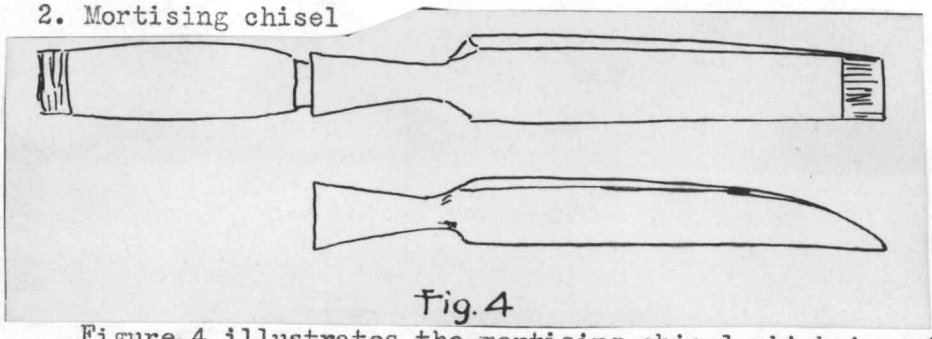


Fig. 4

Figure 4 illustrates the mortising chisel which is a heavy duty tool, adapted to withstand severe strain as in framing or mortising where deep cuts are necessary and pressure is applied to break and remove chip.

3. Slick

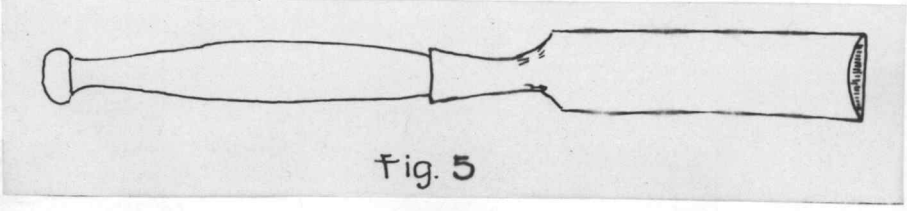


Fig. 5

Figure 5 illustrates the slick which is any chisel having a blade wider than two inches. The regular sizes are $2\frac{1}{2}$", 3", $3\frac{1}{2}$", and 4" wide and measuring 30 inches overall. They are adapted for use on large surfaces where a great deal of material is to be removed.

4. Gouges

Gouges are also classified as either socket or firmer types, depending upon their construction. Gouges are similar to chisels, differing in that they have rounded cutting edges and blades. They are further classified as inside bevel or outside bevel gouges.

a. Inside bevel gouge.

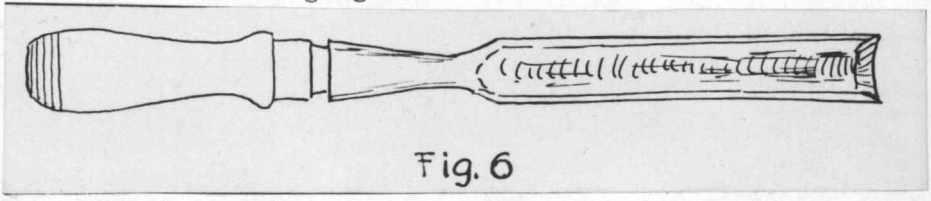


Fig. 6

Figure 6 illustrates the inside bevel socket type of gouge.

b. Outside bevel gouge.

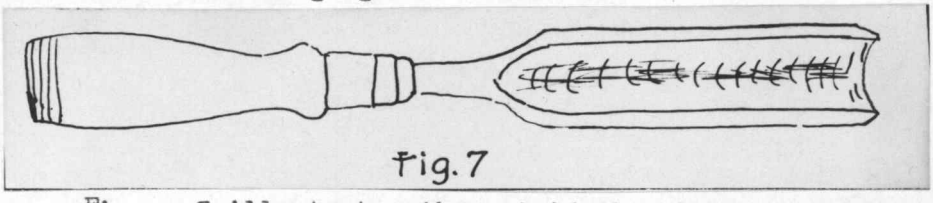


Fig. 7

Figure 7 illustrates the outside bevel tanged type of gouge.

Note: The size of gouges is determined by measuring the straight distance between the corners of cutting edge. They may be obtained in widths, varying by eighths, from one-eighth to two inches.

c. Bent shank gouge.

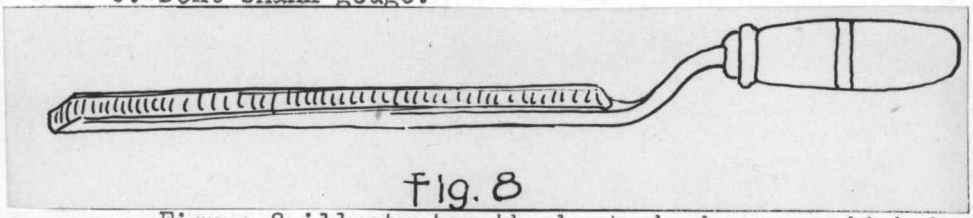


Fig. 8

Figure 8 illustrates the bent shank gouge which is of advantage in giving room for the hand where grooving is to be done on flat surfaces.

Information WW9

PARTS OF A CHISEL:

The parts of a chisel are: the blade, on the end of which the bevel is ground; the shank, which is the upper narrow part of the blade; the socket, which is the upper end of the blade shaped like a hollow cone, and into which the tapered end of the wooden handle fits. In tang chisels the shank ends in a sharp point called the tang, which is driven into the end of the handle. The bolster on the shank prevents the tang from entering further. The ferrule fits over the lower end of handle to prevent splitting.

QUESTIONS:

1. Name and describe the two classes of wood chisels in common use.
2. What are the parts of a chisel?
3. How is the size of a chisel measured?
4. How is a chisel forced into the wood?
5. What is the rule of paring in reference to the grain?
6. How does the gouge differ from the chisel?

REFERENCES:

1. Tools for the Woodworker - Catalogue No. 29, Greenlee Tool Company, Rockford, Illinois
2. Essentials of Woodworking - Griffith
3. Educational Charts - Stanley Tool Company, Nos. 120-121
4. How to Work With Tools and Wood - Stanley Tool Company
5. Principles of Woodworking - Hjorth

Formulated by Vernon E. Shipp

Job WW10

BENCH WOODWORKING

Making a Cutting Board

INFORMATION:

This is an exercise in which mill-planed stock is used, with no finished dimensions set. The piece is to be squared with the minimum amount of material removed. This exercise forms the basis for a very good beginning project in woodwork. It may be motivated on the contest basis. Each boy is to be given a piece of soft wood 1 x $5\frac{1}{2}$" x 12", all as nearly alike as possible. The grades are given according to the size and squareness of the finished product, the larger board receiving the better grade.

GENERAL DIRECTIONS:

1. Read the job sheet carefully and study accompanying drawings.

2. Make a list of tools and materials necessary to do the job.

3. Make a list of operations to be followed.

4. Have your operation schedule and list of tools and materials approved by the instructor before starting work.

PROCEDURE:

1. Select the best broad side and mark it with an X near the edge to be planed next. This side is hereafter to be called the working face.

Note: Secure approval of instructor before proceeding to next step.

2. Plane one edge straight and square to working face, taking off as little material as possible. When completed mark it XX. This is then called the working edge.

Note: Secure approval of instructor before proceeding to next step.

3. With beam of square held successively against working edge and working face, scribe a knife line across one end of the piece. Plane to the line, removing only enough material to square the end with the working edge and face. Test carefully with try square.

Note: Secure approval of instructor before proceeding to next step.

4. Repeat step number three on other end of piece, always testing from working face and working edge.

Note: Secure approval of instructor before proceeding to next step.

5. Lay out second edge with marking gauge, measuring from working edge and setting gauge at greatest width possible. Gauge a line on working face parallel to working edge, and plane to gage line. Test for squareness with working face.

Note: Secure approval of instructor before proceeding to next step.

6. Turn in to instructor for grading after all steps have been completed.

Caution: Always test and measure from working face and working edge. Test frequently for squareness and straightness.

QUESTIONS:

1. What caution should be used in planing end grain?

2. Why make all measurements or tests from working edge or face?

3. How thin a shaving should be taken off with the plane?

4. Why use a knife in marking across the grain?

REFERENCES:

Operation Sheets on Squaring a Board to Dimensions, and Planing Flat Surfaces.

Formulated by Vernon E. Shipp

Job WW11

BENCH WOODWORKING

Making a Broom Holder

GENERAL DIRECTIONS:

1. Examine the sample shown in the exhibit.

2. Read the entire job sheet and make your job plan by listing the operations in the order in which you will do them.

3. Make a list of the tools and materials required for the job.

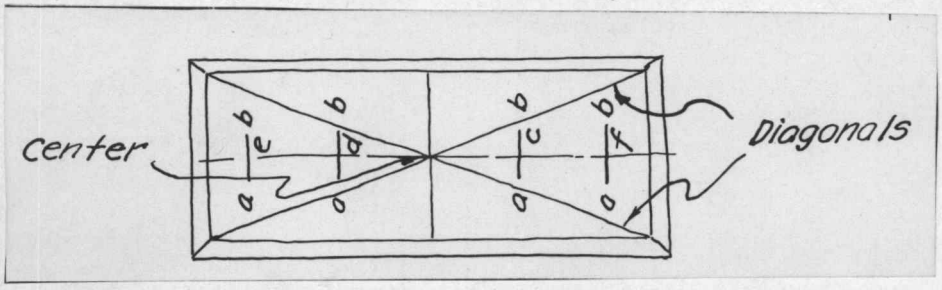
4. Have your job plan and tool and material list checked by the instructor before proceeding with the job.

DIRECTIONS:

1. Square the pieces of lumber to dimensions. (See Sheet 3.)

2. Chamfer the board which is to be used for the back of the holder.

3. Locate center of board by drawing the diagonals as shown in Figure 1. Make light pencil marks as heavy ones are hard to erase.



4. Square a line across the board through center.

5. Measure off on each side of center line 1 3/4 inches and 3¼ inches to locate position of holes for screws.

6. Make light lines through these points as lines a-b, c-d, etc. in Figure 1.

7. Place spur of marking gage on center of board and move head of gage along the beam until it comes up against the edge of the board. Tighten the thumb screw.

8. Make light gage marks across lines a-b at points c-d-e-f, marking at those points only.

9. Drill 3/16" holes at points c,d,e, and f.

10. Countersink holes c and d from the rear of board. Do not countersink those at e and f.

11. Locate the center of the board that is to be used for the front of broom holder by drawing diagonals the same as was done on the back board.

12. Square a light line around this board, through the center.

13. Select the edge that is to be toward the front and measure back 1/2 inch from each front corner along both arrises as shown in Figure 2.

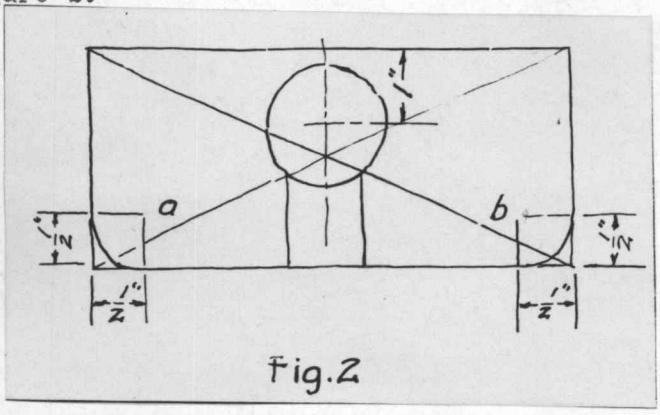


Fig. 2

14. Square lines from these points across the edge and ends of board.

15. From each end of these lines square lines so they will meet as shown at points a and b, Figure 2.

16. Use the points where these lines intersect (points a and b) as centers and with a compass set at 1/2 inch draw curves at corners on each side of board.

17. Saw along outside of curves with a coping saw or compass saw.

18. With a sharp chisel, using a vertical paring cut, round corners down to compass mark.

19. Measure along the center line 1" from back edge of board to locate center of large hole.

20. With expansive-bit, bore a hole $1\frac{1}{2}$" in diameter. Caution: Be sure to place a piece of waste stock in the vice back of the board and clamp board so that the large bit will not split it.

21. Measure along front edge of board 5/8 of an inch on each side of center line and from these points score lines with a sharp knife, carrying them across the edge and sides as far back as the $1\frac{1}{2}$" hole.

22. Saw on the inside of those lines.

23. Smooth end grain to lines with paring cut of chisel.

24. Measure along back edge of board 1 3/4" on each side of center line.

25. Square lines across the edge at these points.

26. Set marking gage at 5/16 inch and gage a light line along the center of edge.

27. With a 1/8 inch drill bit, drill holes where the gage lines intersect the lines which you squared across the edge.

28. Assemble pieces by putting in screws. Use 1¼ inch No. 9, flat head bright wood screws.

29. Erase all pencil marks and sandpaper project.

30. Have your project examined by instructor and then apply a simple finish. (See Job Sheet on To Stain, Fill, and Varnish.)

QUESTIONS:

1. What are diagonals?

2. What do we mean when we say that two lines intersect?

3. What would be a point of intersection?

4. How do you countersink holes?

Formulated by J. J. Orr

Revised by Vernon E. Shipp

Job WW12

BENCH WOODWORKING

To Stain, Fill, and Varnish

INFORMATION:

Finishes are applied to wood surfaces in order to preserve and beautify them. There are many different kinds of finishes in use, however those most commonly used in the school shop are varnish, enamel, and paint. Varnish and enamel are generally for inside work, such as furniture and inside trim, while paint is used for outside finishing. In most cases the procedure in finishing will be to stain (unless a natural finish is desired) then fill with a paste or liquid filler, and varnish.

GENERAL DIRECTIONS:

1. Read the job sheet carefully.

2. Make a list of the materials necessary for the job--brushes, finishes, etc.

3. List the procedure to be followed.

4. Secure approval of instructor before proceeding on job.

PROCEDURE:

1. Sand.

For new work go over the wood carefully and see that the surface is thoroughly free of tool marks, mill marks, greasy spots, or superfluous glue. Plane or scrape the surface and then finish up with #00 sand paper. Sand with the grain at all times.

2. Stain.

Select the stain to be used (a penetrating stain is recommended for student use) and pour enough stain of the color desired into a clean enameled cup or suitable container. Try out the stain on a scrap of the same kind of wood, scraped and sanded in the same way as the project. When ready to stain the project dip clean brush into the stain about one-third the length of the bristle, wipe lightly across edge of container, and brush lightly with the grain, along entire surface to be covered. Stain inside corners and recessed parts first, beginning at the top and working down. Work out toward the arrises. Work carefully but thoroughly. Do not go back to touch up a surface that has partially dried. Avoid "laps" and "runs". Wipe off with a

clean cloth soon after application to remove surplus stain and produce a uniform shade over entire piece.

3. Fillers--for coarse-grained wood.

Fillers are used to fill the wood pores, and thus give a smooth, level, non-absorbent surface on which other finishes may be placed. Use only paste filler corresponding to the color of the wood. Liquid filler may be used on close-grained woods such as pine and fir, but paste filler is recommended for coarse-grained woods such as oak, walnut, and mohogany. Thin the paste filler with "turp" or benzine to a consistency like coffee cream. With a stiff-bristled brush force the paste into the pores of the wood and allow to dry until it has a dull appearance, (approximately twenty minutes). Rub off surplus filler with a rag or gunny sack by rubbing across grain. Allow it to dry for twenty-four hours.

4. Apply a coat of thin oil varnish.

All varnishes are used to form hard, protective, transparent coverings that will protect the wood without hiding its natural color. The temperature of the varnishing room should be between 70-80°, and the room should be free from dust. Select a perfectly clean container and pour into it the amount of varnish needed. Wipe the surface to be varnished and see that it is perfectly clean. With a good varnish-brush spread or "flow on" an even coat of varnish, brushing with the grain. Remove any runs by re-brushing and thereby leave a thin, smooth coat of varnish. Allow forty-eight hours for drying, and sand lightly to remove nibs. Use #6/0 paper, or fine steel wool.

Note: Shellac dries more rapidly and may be substituted for the first coat of thin oil varnish. Use Orange shellac, thinned with alcohol, for the darker colors and white shellac for the lighter colors.

5. Apply second coat of varnish.

Sand lightly with 6-0 sand paper or steel wool to remove nibs. Do not sand the arrises. Repeat the above operations for succeeding coats until the desired surface is obtained. Rub and polish the last coat with pumice stone for dull finish and Rottenstone for highly polished finish.

6. To re-varnish old work.

If finish is not too badly marred, sand it lightly and apply varnish as in No. 5. If varnish is to be removed, apply varnish remover with a brush and allow to stand until varnish is soft. Remove the varnish with a dull putty knife or with burlap. Clean surface with turpentine. Sand, if necessary, and stain again to the desired color.

Job WW 12

Varnish as in previous steps. A color-varnish, stains and varnishes at the same time and may be used on a refinish job.

QUESTIONS:

1. What are the purposes of wood finishes?
2. What is the purpose of fillers? Waxes?
3. What is meant by open and close-grained woods?
4. Why should brushes be kept clean?
5. How can surplus varnish be "picked up"?

REFERENCES:

1. Essentials of Woodworking - Griffith
2. Principles of Woodworking - Hjorth
3. Job Sheets in Practical Woodwork - Brown & Tustison

Formulated by Vernon E. Shipp

Job WW13

BENCH WOODWORKING

The Relation of Art to Bench Woodworking

INFORMATION:

Since the appearance of the completed project is so important to successful work, provision for the development of appreciation and good taste in the selection and design of projects should be a fundamental item in a well-rounded course in woodworking. At least three important factors enter into the designing and making of a good project in the wood shop: first, utility; second, construction; third, contour and surface enrichment. Since bench woodworking offers such a vast opportunity for the development of art expression, then certain fundamental and basic art principles can at least be followed in the process of teaching art appreciation. Those untrained in the principles of art as applied to construction would do well to look up the answers to the following questions in the references given at the end of this sheet:

QUESTIONS:

1. In a study of proportions, what should be the relation of the primary mass to the height, width, and/or length of:

   a. minor parts in relation to the primary mass

   b. surface decoration such as carving, inlaying, etc. to the primary mass or its parts

   c. contour enrichment

2. In designing rectangular projects, why should ratios of 1:1 and 1:2 be avoided?

3. If the primary mass be divided by a horizontal line, should both masses be the same?

4. Why should the center mass be dominant if the primary mass is divided into three spaces by horizontal lines?

5. When the primary mass is divided into two divisions by a vertical line, what proportion is best?

6. What caution should be exercised in the use of free curves?

7. Why should exact repetition of curves be avoided?

8. What is the danger in the over-emphasis of continuous curves?

9. How do slight breaks in curves add to the interest and variety?

10. Why avoid the use of parts of the circle?

11. What cautions should be exercised in the use of equal measures for designing outlines?

12. How should curved and straight lines meet when used in certain enrichment?

13. When should carving or inlaying be used as a surface decoration?

14. What purpose do bands and borders serve in surface enrichment of a project?

15. What is a free ornament?

16. Why is simplicity the keynote of good taste and good design?

REFERENCES:

1. Industrial Arts Design - Varnum, William H.
2. Design and Construction in Wood - Noyes, William
3. Woodwork in the Junior High School - Roberts, William E. - Chapter 3.

Formulated by Vernon E. Shipp

CONCLUSIONS

CONCLUSIONS

In conclusion, it has been the purpose of the author in presenting this thesis to indicate a technic of analysis and selection of subject-matter suitable for use in any form of shop teaching, as well as to present a course of study that has a workable, organized plan of procedure for a specific case.

The first thing necessary in setting up a course of study is to set up the aims and objectives which are the major controlling factors in the execution of any course of study. In this case, a brief outline has been given of the aims and objectives of industrial arts for the elementary school, junior high school, senior high school, and college levels, showing briefly the relationship as well as the differences found at each level.

A technique of analysis and selection of teaching content from the whole trade activity has been indicated by use of the trade analysis chart. This plan of analysis furnishes the instructor with a graphic means of scrutinizing the total possibilities of the subject or trade activity to be taught. From the total content listed by analysis, the pertinent and representative basic operations can be selected much more readily.

Any good course of study should deal with the methods involved in teaching that course of study. A technique of teaching shop work has been indicated here through use of the individual instruction sheets, with a brief outline concerning the different kinds of sheets and their uses. The individual instruction sheet is one of the de-

vices that has been developed in order to improve instruction under the teaching conditions found in the "general shop" type of organization. A brief outline for writing the sheets most commonly used in the shop has been given for use when the instructor finds a need for sheets that cannot be obtained commercially.

Finally, a course of study for bench woodworking has been set up for the secondary school level, in this specific case being applicable to the ninth grade. The course of study is accompanied by working drawings of the representative projects selected by the author within each instructional unit. It is not within the scope of one thesis to completely finish all the operation, job, information, and assignment sheets possible within the bench woodworking activity. However, representative operation, job, information, and assignment sheets are submitted, covering a selected group of operations and items of information from the more important units of instruction. The method of organization and teaching as set up in this course of study might be applicable to most any shop subject or trade activity. Through the technique indicated the teacher should be able to increase the effectiveness of instruction, especially when properly correlated with his own personal efforts.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Allen, Chas. R. The Instructor, The Man, and the Job
   J. B. Lippincott Company, Philadelphia, 1919

2. Bowman, Clyde A. Graphic Aids in Occupational Analysis
   Bruce Publishing Company, Milwaukee, Wisconsin, 1924

3. Selvidge, R. W. How To Teach A Trade
   The Manual Arts Press, Peoria, Illinois, 1920

4. Selvidge, R. W. Individual Instruction Sheets
   The Manual Arts Press, Peoria, Illinois, 1924

5. Griffith, Ira S. Correlated Courses in Woodwork and Mechanical Drawing. Manual Arts Press, Peoria, Illinois, 1924

6. Griffith, Ira S. Essentials of Woodworking
   Manual Arts Press, Peoria, Illinois, Revised by Geo. B. Cox, 1931

7. Roberts, William E. Woodwork in the Junior High School
   Manual Arts Press, Peoria, Illinois, 1930

8. Snedden, David, and Warner, William E., and others, Reconstruction of Industrial Arts Courses. J. J. Little and Ives Company, New York, 1927. (Teachers College, Columbia University)

9. Vaughn, Samuel J., and Mays, Arthur B. Content and Methods of Industrial Arts Courses
   The Century Company, New York and London, 1924

10. Ericson, Emanuel E. Teaching Problems in Industrial Arts.
    The Manual Arts Press, Peoria, Illinois, 1930

11. Friese, John F. Exploring the Manual Arts
    The Century Company, New York and London, 1926

12. Schweickhard, Dean M. Industrial Arts in Education
    The Manual Arts Press, Peoria, Illinois, 1929

13. Struck, Theo F. Methods and Teaching Problems in Industrial Education. John Wiley and Sons, Inc., New York, 1929

14. Hjorth, Herman. Principles of Woodworking.
    Bruce Publishing Company, Milwaukee, Wisconsin, New York and Chicago, 1930

15. Tustison, F. E., and Brown, Arthur B. Instructional Units in Hand Woodwork. The Bruce Publishing Company, Milwaukee, Wisconsin, New York, and Chicago, 1930

BIBLIOGRAPHY

(Continued)

16. Industrial Arts and Vocational Education Magazine, Vol. No. 14-22, 1925-1933

17. Industrial Education Magazine, Vol. No. 26-34, 1925-1933

18. Report of Committee on Standards of Attainment in Industrial Arts Teaching. American Vocational Association Bulletin, December, 1931

19. Jones, Walter B. Job Analysis and Curriculum Construction Bureau of Publications, Teachers College, Columbia University, New York, 1926

20. Bobbitt, Franklin. The Curriculum Houghton-Mifflin Company, Chicago, 1918

21. Charters, W. W. - Curriculum Construction The Macmillan Company, 1923