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BOSTON UNIVERSITY

SCHOOL OF EDUCATION

MANIPULATIVE WOODWORKING TEST

Submitted by

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In Partial Fulfillment of the

Requirements for the Degree

Master of Education

1953

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CHAPTER I

INTRODUCTION

The purpose of an achievement test is to ascertain what an individual has learned, specifically, in the field being tested. In Woodworking it is found that the available published tests are of the paper and pencil type. These tests measure the student's knowledge of woodworking by having him indicate correct methods and procedures on paper, either by making a sketch or selecting the correct answer from a group of possible answers. It is very doubtful whether these tests can determine the ability of the student to perform specific operations, such as, sawing to a line, or drilling a hole the right size for a particular job. The language factor is also important; many students can ably do the work but they cannot explain or describe what to do, and, conversely, there are students who can lucidly explain procedures but are unable to perform adequately.

In this study the word operation is used to indicate one specific job done with a specific tool, such as using a cross-cut saw to saw to a line. With each tool there are different operations to which its use is particularly related. With some tools more than one operation can be performed.

Statement of the Problem

The purpose of this study is to try to develop a manipulative Woodworking test that will indicate the student's ability in the use or application of tools and materials in the basic woodworking operations. Lists of these operations can be found in many woodworking texts, several of which are listed in the bibliography. One in particular is Curriculum in Industrial Arts.[1] These lists always include operations, such as the following: using a crosscut saw, using a hammer, drilling a hole, boring a hole, and planing a surface.

Justification

To the writer's knowledge there is no published manipulative test in Woodworking that actually involves the selection of the proper tools and their correct application in practical situations.

Some of the reasons advanced as to why such manipulative tests have not been developed are as follows: (1) they are time consuming, (2) they are expensive to administer, (3) no immediate need for such a test can be seen, and (4) such a test has no basic value. Of these statements the latter undoubtedly have a psychological, rather than a factual, background. When the beginning of Industrial Arts and the men who have been teaching in that field are considered, some insight

[1] Anthony, Willis B., Curriculum in Industrial Arts, Fitchburg, Mass., 1936.

into this reasoning might be found. Most of the early Industrial Arts teachers, and many who are now still teaching, came from the ranks of the craftsmen. They were men who were particularly skilled and who took pride in their work and the end product. Their thinking has been that the evidence of the student's handwork, or project, was all the test that was needed in woodworking.

To counteract this thinking this premise is advanced. There should be available a manipulative woodworking test that can be used to determine the strengths and weaknesses of the student in the use of tools and materials in the basic woodworking operations.

The need for a test of this type becomes more apparent in the following situations:

1. To assist the teacher in determining the specific area where the student needs help.

2. To ascertain which students are capable of progressing more rapidly.

3. To determine the ability of a student entering from another school.

4. To assist the teacher in developing a Course of Study that will fulfill the needs of all the pupils who come into his classroom.

All of these situations can be more effectively and objectively taken care of by the use of a test of the type this paper is attempting to set forth. If these situations can be solved by the use of a specific ability test, then we shall be much closer to fulfilling the needs of the pupils.

The placement of a new pupil, who is entering an advanced class, is often a problem because of the pupil's inability to evaluate his own capabilities in woodworking. This leads to much wasted time and material when the student begins work on something he is not capable of doing. The manipulative test would, in this situation, indicate the student's ability, and he therefore could be given work that was commensurate with his ability.

CHAPTER II

REVIEW OF RESEARCH

In a review of the available material in Industrial Arts and Industrial Arts testing the writer was unable to locate a test of the type this study advocates.

The available tests are of the paper and pencil type involving the knowledge of the operations and their application. While these tests have their place in Industrial Arts, it is evident that they cannot evaluate the ability to perform. Certainly, if we are to teach Woodworking operations, we should have the means to evaluate the student's ability to perform those operations.

1. Paper and Pencil Tests

The paper and pencil test is not new to Industrial Arts. We even find that the essay type of question was being used at one time. In present-day shop practice the objective type test is the most practical and most widely used for two reasons: (1) many students who are vitally interested in mechanical work are not interested in essay writing; and (2) the ability to write essays does not necessarily indicate efficiency in this type of work.[1]

[1] E. E. Ericson, Teaching the Industrial Arts, Manual Arts Press, Peoria, Illinois, 1946, p. 206.

Of the typical objective tests of the information type are those wnich accompany the text Instruction and Information Units for Hand Woodworking.[2] These tests, each of wnich contains one hundred items and cover a specific section of the text, utilize all of the objective type of questions, i.e., true and false, matching, multiple choice and completion.

2. Manipulative Ability Tests.

Individuals with a high degree of mechanical aptitude usually are readily educable in the mechanical fields. On the other hand, individuals with low mechanical ability seldom react to even the best of instruction in the mechanical fields.[3]

There are many mechanical, or manipulative, ability tests wnich have predictive value as to success in the mechanical fields. Among these tests are the following:

Stenquist Assembling Tests of Mechanical Ability. There are three series in this group, all of which consist of mechanical objects to be assembled. This test was published in 1921, so the models of objects illustrated are not always similar to present-day items. The Minnesota Assembly Test is

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[2] J. H. Douglas and R. H. Roberts, Instruction and Information Units for Hand Woodworking, McCormack-Mathers Co., Wichita, Kansas, 1932.

[3] H. A. Greene, A. N. Jorgensen, and J. R. Gerberich, Measurement and Evaluation in the Secondary School, Longmans, Green and Co., New York, 1943, p. 460.

a revision of the Stenquist and is more up to date. The revision is suitable for selecting those who are able to assemble quickly several common objects.

Detroit Manual Ability Test. This test consists of three parts: (1) assembling nuts and bolts, (2) block packing, and (3) block placing. This test was developed to measure manual ability and is suitable for selection for complex manual dexterity.

Mechanical Comprehension Test. This test consists of sixty pictures presenting mechanical problems. The solution requires an understanding of physical principles. It measures a higher type of mechanical ability than do most tests and is, therefore, very good for guidance and selection in work that requires a high level of understanding of mechanical principles.

The research done in this study has further borne out the writer's contention that there is definite need for a manipulative woodworking test. Many authors in the fields of Industrial Arts and General Education are concerned that evaluation is all too often regarded as the end product and not as a means to an end, that of further growth.[4] The teaching-learning cycle is never complete until the teacher is fully aware of what each student has achieved.[5] The development of a cer-

[4] H. H. Giles, S. P. McCutcheon, and A. N. Zechial, Exploring the Curriculum, Harper and Bros., New York, 1942, p.305.

[5] R. O. Billett, Fundamentals of Secondary School Teaching, Houghton Mifflin Company, Boston, 1940.

tain degree of manipulative skill is an objective of most Industrial Arts courses and usually the only method of evaluating the student's work is to grade the finished project. That this method is not defensible is evident in the number of different grades that would be given the same project by different teachers.[6] The development of more effective measuring instruments must follow as more exact definitions are given to skills and information in Industrial Arts instruction.[7]

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[6] G. O. Wilber, Industrial Arts in General Education, International Textbook Co., Scranton, Pennsylvania, 1948, p. 316.

[7] Greene, Jorgensen and Gerberich, *op. cit.*, p. 456.

CHAPTER III

PROCEDURES

Constructing the Test

The construction of the test posed three problems: (1) the selection of the operations to be measured, (2) the time length, which would also control the number of operations which could be included in the test, and (3) the scoring values, or scoring techniques, for each item.

The time limit of the test is established in that it should not go beyond one class period. Considering that many schools have periods as short as forty minutes, the test itself should not take more than one half hour, with the remainder of the time taken up with the necessary administrative details.

Drawing on the writer's experience and consulting authoritative lists[1,2,3] it was found that there are from sixty to seventy basic woodworking operations which can be included in a list of operations suitable for seventh through twelfth grades.

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[1] W. B. Anthony, Curriculum in Industrial Arts, Fitchburg, Massachusetts, 1936.

[2] H. Hjorth, Principles of Woodworking, Bruce Publishing Co., Milwaukee, Wisconsin, 1930.

[3] A. G. Brown and F. E. Tustison, Instructional Units for Woodworking, Bruce Publishing Co., Milwaukee, Wisconsin, 1930.

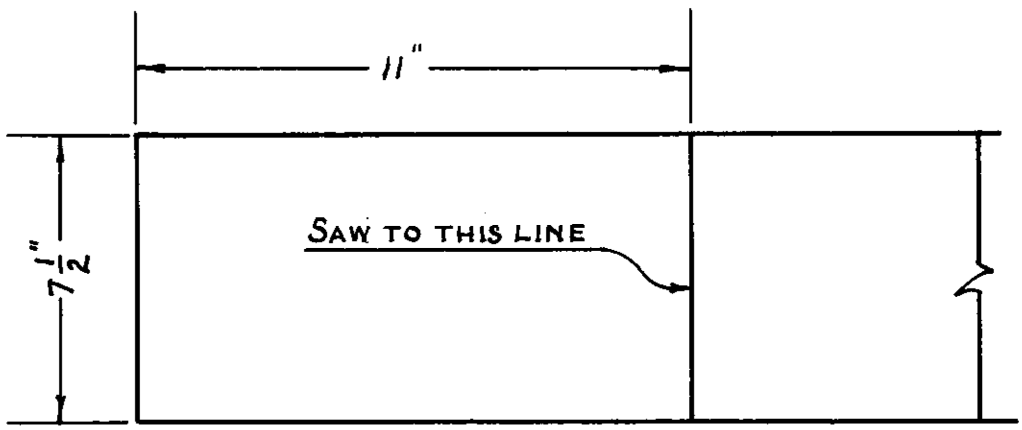
To ascertain which of these sixty to seventy operations were to be used the following procedure was used: ten projects that were currently being used in the writer's shop, ranging in difficulty from the eighth to the eleventh grades, were analyzed to determine which operations occurred at least once in the construction of each project. If the operation occurred in at least five of the projects, it was considered as being suitable as an item for the test. An analysis of the method used is given in Table 1 below.

Table 1. Tabulation of the Occurrence of the Selected Test Items in a Group of Woodworking Projects Varying in Difficulty from the Eighth to Eleventh Grades.

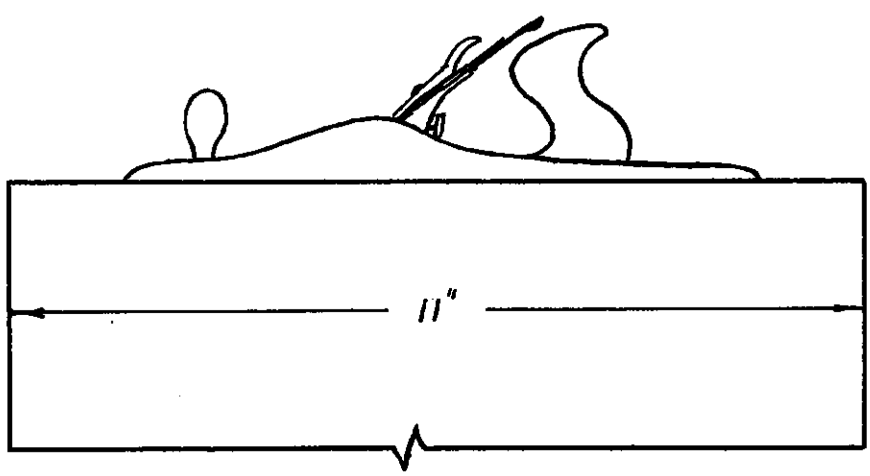
	Colonial Footstool	Clothesline Winder	Corner Shelf	Wall Shelf	Pump Lamp	Coffee Table	Drop Leaf Table	Colonial Bookcase	Cobbler's Bench	Cedar Chest
Cut to a line with a cross cut saw.	X	X	X	X	X	X	X	X	X	X
Joint a board.	X	X	X	X	X	X	X	X	X	X
Plane end grain.	X	X		X	X	X	X	X	X	X
Cut to a line with a rip saw.	X	X		X	X	X	X	X	X	X
Use a marking gauge.	X	X			X	X	X	X	X	X
Plane a chamfer.	X				X		X	X	X	X
Select and drill the first hole for a No. 10 F.H. screw.	X				X	X	X	X	X	X
Select and drill the second hole for a No. 10 F.H. screw.	X				X	X	X	X	X	X
Countersinking.					X	X	X	X	X	X
Counterboring.	X					X	X	X	X	X
Boring a hole through wood.		X			X		X		X	X
Drive and set a brad.		X	X	X	X	X	X	X	X	X
Laying out and cutting a dado with a back saw.			X	X			X	X	X	X
Chiseling out the dado.			X	X			X	X	X	X

MANIPULATIVE WOODWORKING TEST

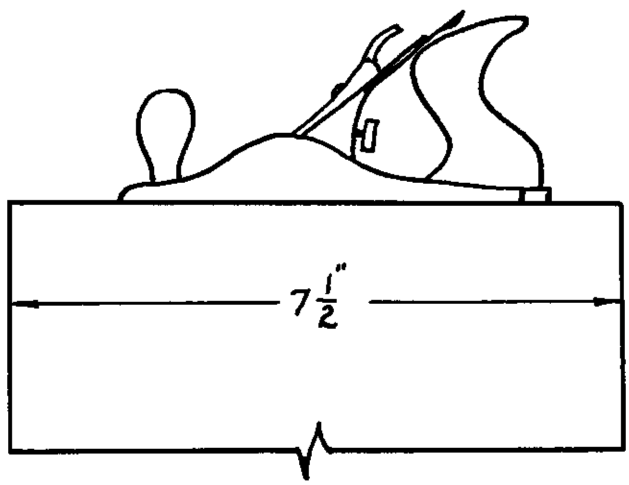
Test Item No. 1. The student is given a board seven and one half inches wide and at least two feet long. The student is told, "From the left end of the board measure and mark off eleven inches. From this mark square a line across the board and then saw to that line."



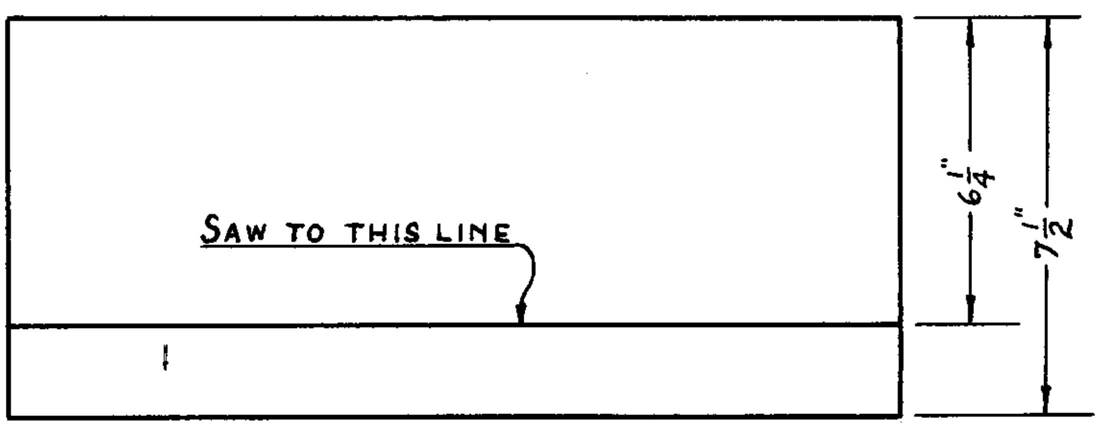
Test Item No. 2. The jointing operation is done on one edge only. The student is told, "Joint one edge of the board straight and square."



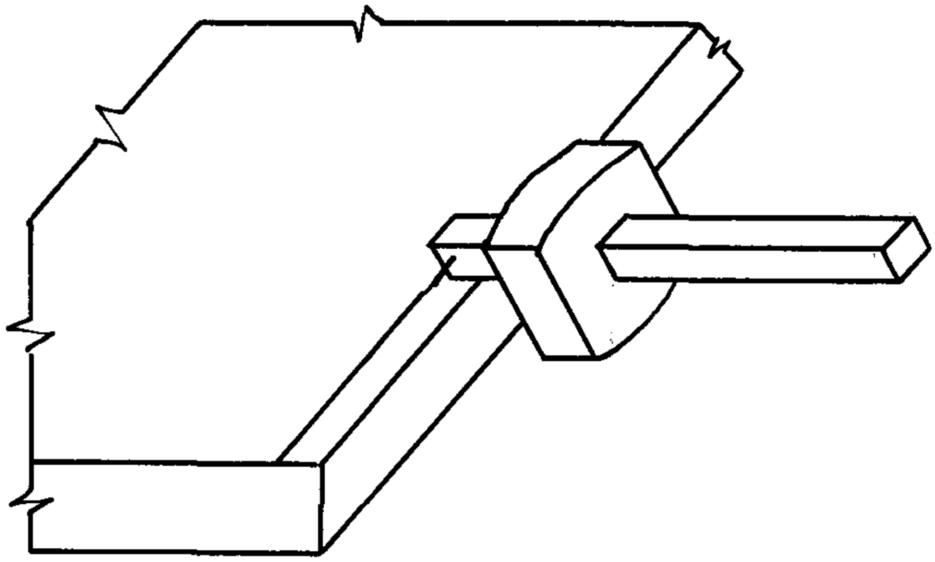
Test Item No. 3. The operation, planing end grain, is done on the end opposite the one the student has sawed himself. The student is told, "Select the end of the board that you did not saw. Plane that end straight and square."



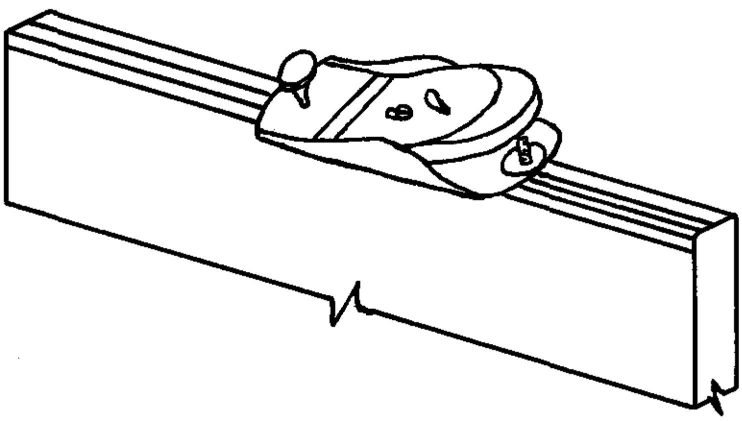
Test Item No. 4. The rip sawing operation is done in the following manner: The student is told, "Measure and mark a line six and one quarter inches from, and parallel to, the jointed edge of your board and then saw to that line."



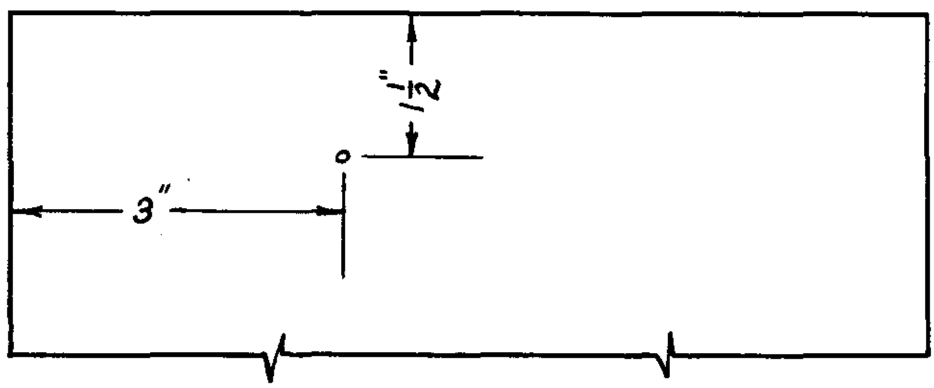
Test Item No. 5. In using a marking gauge, the fifth operation, the student is told, "Set your marking gauge and mark out, on the jointed edge of your board, for a one quarter inch chamfer."



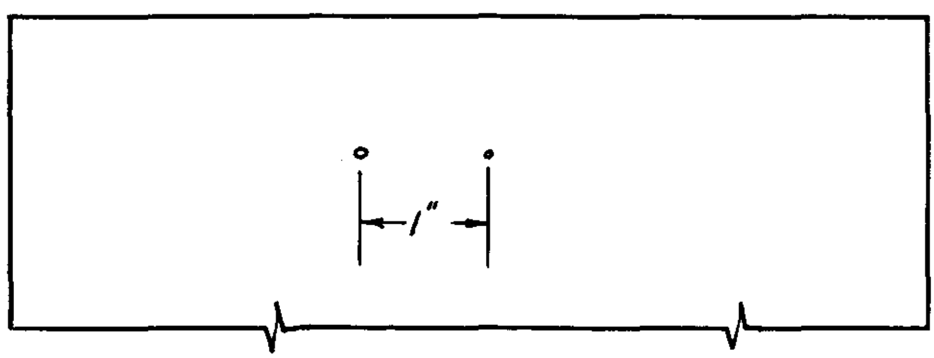
Test Item No. 6. The chamfer is planed in operation number six. The student is told, "You have just marked out for a one quarter inch chamfer. Now plane that chamfer with the plane that you think will do the best job."



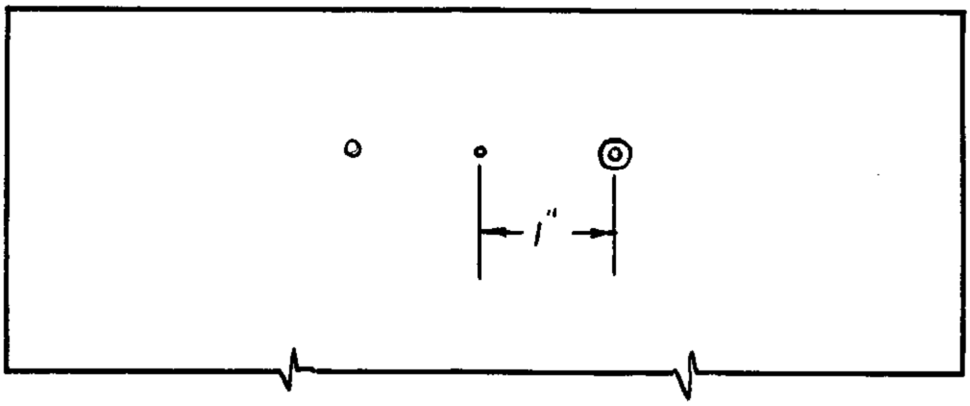
<u>Test Item No. 7</u>. For operation number seven the student is told, "Hold the board with the jointed edge on top, place a pencil mark about one and one half inches down from the top and three inches in from the sawed edge. Now select the proper drill for the first hole for a Number 10 flat head screw and drill a hole where you made the pencil mark."



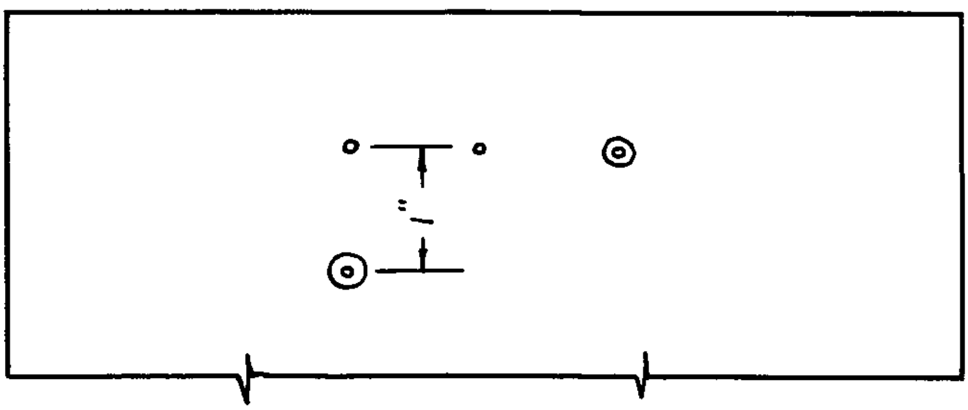
<u>Test Item No. 8</u>. Drilling the second hole for a Number 10 flat head screw is operation number eight. The student is told, "Put a pencil mark about one inch to the right of the hole you have just drilled. Now select the proper drill for the second hole for a Number 10 flat head screw and drill a hole on the mark you have just made."



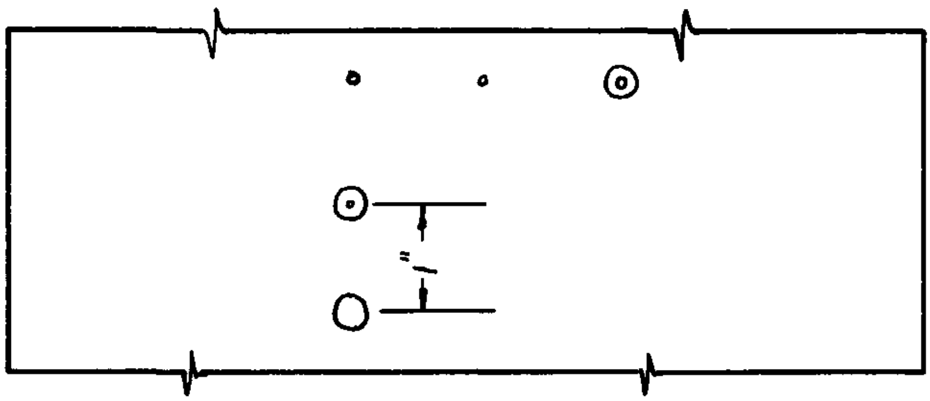
<u>Test Item No. 9</u>. Countersinking a hole is the ninth operation. The student is told, "Make another mark about one inch to the right of the hole you just drilled. Now drill a first hole for a Number 10 flat head screw and then countersink the hole to the proper depth."



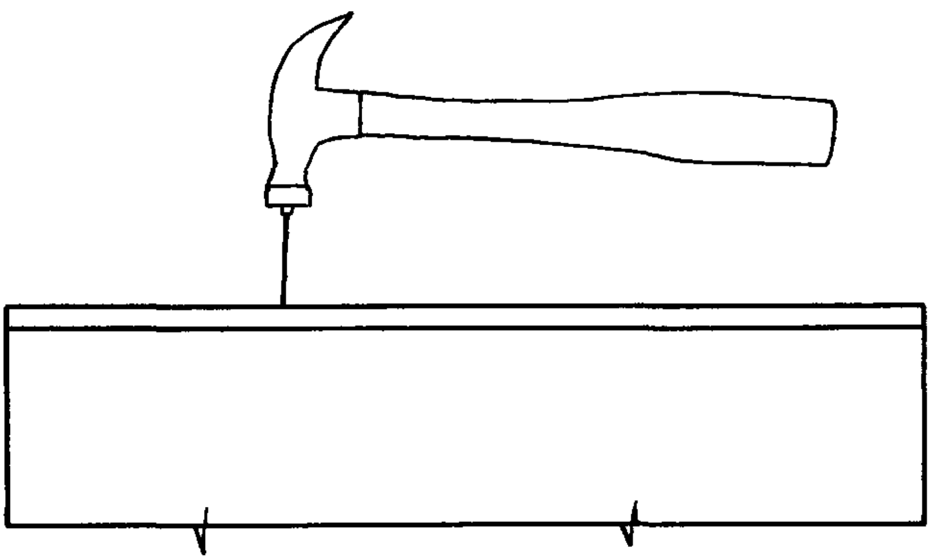
<u>Test Item No. 10</u>. The tenth operation, counterboring, is done as follows: the student is told, "Make a mark about one inch below the first hole you made on the board. Now counter-bore a one half inch hole to the proper depth."



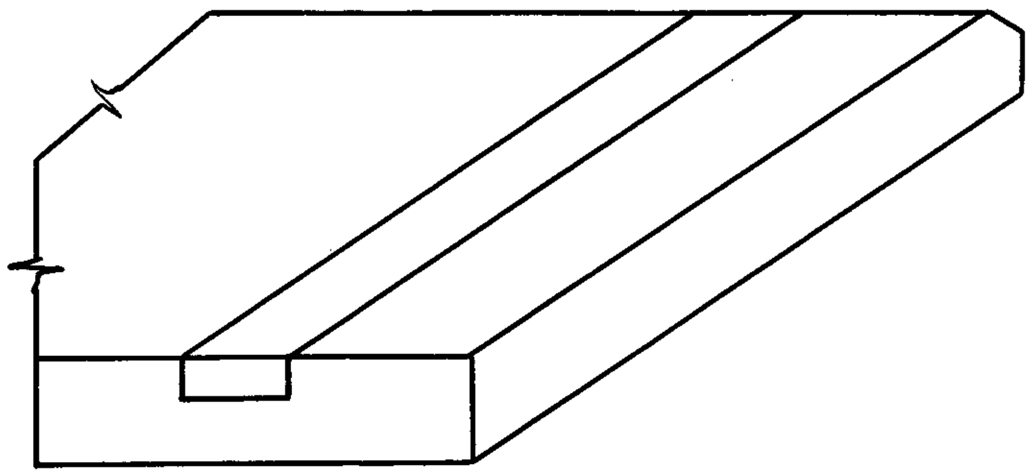
<u>Test Item No. 11</u>. Boring a hole with a brace and bit is the eleventh operation. The student is told, "Place a mark one inch below the last hole you made. Select the proper bit for a one half inch hole and bore a hole through the board."



<u>Test Item No. 12</u>. This operation, driving and setting a brad, may be done anywhere on the jointed edge of the board. A one and one half inch Number 16 brad, or larger, is recommended for this operation. The student is told, "Select a one and one half inch Number 16 brad, and correctly drive and set it anywhere on the jointed edge of your board."



Test Item No. 13. This operation consists of marking out and sawing a dado three quarters of an inch wide and one quarter of an inch deep. The student is told, "One inch in from the right edge of your board mark out a dado three quarters of an inch wide and one quarter of an inch deep. When you have the dado marked out, use a saw to correctly cut this dado."



Test Item No. 14. For this operation the student is told, "Select the proper chisel and chisel out the dado you have just sawed."

A drawing of the total test block, indicating the location of each test item, is illustrated in Figure 2 below.

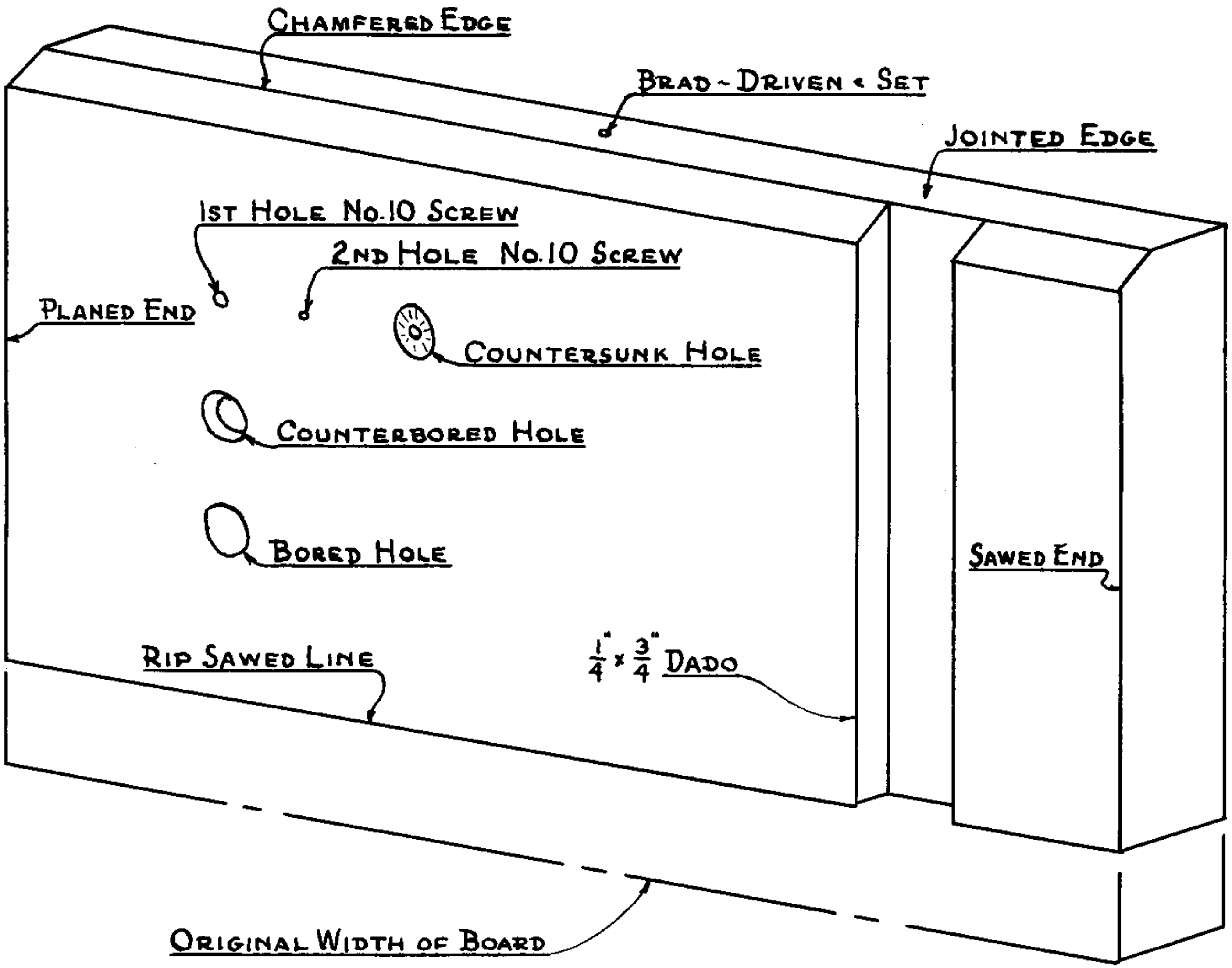

CHAMFERED EDGE
BRAD - DRIVEN & SET
JOINTED EDGE
1ST HOLE NO. 10 SCREW
2ND HOLE NO. 10 SCREW
PLANED END
COUNTERSUNK HOLE
COUNTERBORED HOLE
BORED HOLE
SAWED END
RIP SAWED LINE
$\frac{1}{4}$" x $\frac{3}{4}$" DADO
ORIGINAL WIDTH OF BOARD

FIGURE 2

SCORING THE TEST

The scoring values for the test items 1 through 14 are as follows:

(1) Cut to a line with a crosscut saw.

Scoring:	Accurately cut	4
	Cut veering from line less than 1/8"	3
	Cut veering from line more than 1/8"	2
	Cut going into line	1

(2) Joint a board straight and square.

Scoring:	Accurately jointed	4
	Jointed on a slight bevel	3
	Jointed concavely	3
	Jointed convexly	3
	Jointed with more than one slight bevel	2
	Combination of bevels and dips	1

(3) Plane the end grain of a board.

Scoring:	Accurately planed	4
	Slightly out of square	3
	Grossly out of square	2
	Grossly out of square, ends chipped	1

(4) Rip to a line with rip saw.

Scoring:	Accurately sawed	4
	Cut veering from line 1/8" or less	3
	Cut veering from line 1/8" or more	2
	Cut going into line	1

(5) Use a marking gauge.

Scoring:	Accurately gauged	3
	Gauge mark slightly out of line	2
	Gauge mark erratic	1

(6) Plane a 1/4" chamfer.

Scoring:	Accurately planed	4
	Not planed to line	3
	Planed below line	2
	Planed at several angles	1

(7) Select and drill the first hole for a No. 10 screw.

Scoring:	Accurately drilled	3
	Hole too large	2
	Hole too small	1

(8) Select and drill the second hole for a No. 10 screw.

Scoring:	Accurately drilled	3
	Hole too small	2
	Hole too large	1

(9) Countersink for a No. 10 flat head screw.

Scoring:	Accurately countersunk	3
	Too shallow	2
	Too deep	1

(10) Counterbore for a 1/2" plug in 3/4" stock.

Scoring:	Accurately counterbored	3
	Too shallow	2
	Too deep	1

(11) Bore a 1/2" hole with a bit and brace.

Scoring:	Accurately bored	5
	Hole bored at slight angle	4
	Hole bored at gross angle	3
	Back of hole split out	2
	Gross angle and split wood	1

(12) Drive and set a brad.

Scoring:	Accurately driven and set	4
	Brad set too shallow	3
	Nail set slipped and dug into wood	2
	Hammer head made dent in wood	1

(13) Cut a 1/4" by 3/4" dado with a back saw.

Scoring:	Accurately cut	5
	Cut made away from line	4
	Cut on line	3
	Undercut line	2
	Cut on line and undercut	1

(14) Chisel out dado.

Scoring:	Accurately cut	5
	Too shallow	4
	Cut not at same depth over full length of dado	3
	Cut too deep	2
	Edges of dado chipped	1

The scoring values for each item depended largely on the item itself. In items 12, 13, and 14 the highest score is 5; in items 1, 2, 3, 4, 6, and 11 the highest score is 4; and in items 5, 7, 8, 9, and 10 the highest score is 3. These differences occur because of the number of common errors that are usually made in these operations, or because of the degree of complexity in the individual items. For example, in item 7, selecting and drilling the first hole for the designated size screw, there are only two errors that can be made in drilling that hole, either too large or too small a hole. Therefore, when the correct answer is added, there are only three scoring values that can be given to that item.

Item 12 has five values attached to it. In examining these values it can be observed that each value is significantly different from the others, and that each is also a common error made by pupils in Woodworking classes. If these errors are common, then they must be anticipated and allowed for in the scoring values. Thus there are four errors, plus the correct answer, making a top score of 5. The same approach was used for the items having a high score of four.

In item 2 the same value is given to three errors because it was felt that these three were of equal value.

These scoring values have been applied by a group of advanced students at the State Teachers College, Fitchburg, Massachusetts, to a test run on ten pupils in the writer's school. The results of this part of the study will be discussed in a later chapter.

CHAPTER IV

INTERPRETATION OF DATA

Administering the Test

Upon completion of the construction of the test, the co-operation of the Industrial Arts Department of the State Teachers College at Fitchburg, Massachusetts, was secured to validate further the scoring values of the test. The test was administered to ten upper class pupils from the writer's Woodworking classes. These test results, together with the scoring values, were sent to Fitchburg where eleven Advanced Woodworking students (seniors) and the head of the Woodworking Department evaluated the test results using the writer's scoring values. Their scores, together with the writer's, are shown diagramatically in Table 2 below. The scorers are indicated by letter across the top of the page, and the pupils are listed by number down the left side of the page.

Interpretation of Trial Scores

There are some interesting points brought out by this particular scoring problem. The most noticeable fact is the spread in scores, the smallest being thirteen points on the scoring of pupils eight and ten, and the greatest being twenty points on the scoring of pupil six.

Table 2. Results of the Manipulative Woodworking Test Administered in the Writer's Shop and Scored by a Group of Senior Woodworking Students at the State Teachers College, Fitchburg, Massachusetts.

Scorers

Pupil	A	B	C	D	E	F	G	H	I	J	K	L	M
1	34	28	42	40	31	38	33	42	34	32	32	35	39
2	32	26	44	36	32	36	31	41	29	37	33	33	36
3	23	22	38	38	27	30	35	34	32	32	36	34	34
4	45	32	46	41	38	37	39	43	42	38	38	35	48
5	30	27	37	37	26	31	34	35	37	32	34	35	41
6	31	20	40	35	24	35	38	34	40	33	37	34	40
7	34	30	44	40	38	34	38	40	38	42	38	36	35
8	38	36	49	40	41	38	36	41	46	42	40	41	46
9	40	29	41	34	35	37	35	41	38	43	38	39	46
10	32	27	38	38	32	31	40	40	30	34	34	28	32

Scorer L - Head of Woodworking Dept., State Teachers College, Fitchburg, Mass.

Scorer M - The writer

This spread of scores seems to be the stumbling block that stands in the way of the development of evaluation tests in the manipulative fields of Industrial Arts. Experience seems to indicate that any single project graded by several Industrial Arts teachers will be scored from failing to excellent depending on the standards of each teacher.[1] Whatever can be done to reduce this spread in scores will certainly be to the advantage of Industrial Arts.

The second noticeable point is that of the consistently low scoring by Scorer B. In nine out of the ten cases he recorded the lowest scores. It is also noted that Scorer C recorded the highest scores in six of the ten cases. Perhaps in this consistency of scoring, both high and low, lies the answer as to whether or not this test is of any value to the classroom teacher. For the usefulness of this test lies not in the comparing of one pupil against another, or against a group, but rather indicates the growth and/or weaknesses of the individual pupil. Therefore, while one teacher's marks may not agree with another teacher's, the individual teacher's marks will be consistent within his own group and will be valid for his own use.

The degree of consistency between the different scorers is good, especially those scores by the Department Head at Fitchburg and the writer. These men have been teaching for

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[1] Wilber, <u>loc</u>. <u>cit</u>.

about the same number of years. This consistency of scoring does seem to indicate that the test does have reliability.

The following results were obtained when the writer administered the test to his own Woodworking classes. There are sixty-six pupils in the four grades, divided as follows:

	8th Grade 29 pupils	9th Grade 21 pupils	10th Grade 10 pupils	11th Grade 6 pupils
Mean	21.4	24.9	36	46
S.D.	3.4	4.1	3.7	2.8

The standard deviation at the eleventh grade level is small because of the small number, six, and because they are a fairly select group. The standard deviation at the other grade levels is fairly constant, indicating that the test does have some discriminatory value.

CHAPTER V

CONCLUSION

As the work on this project has progressed, the writer has been impressed by the fact that the number, the kind, and the complexity of the operations or items included in an ability test are not as important as the scoring definitions attached to the test. These definitions must be written as clearly and as objectively as possible in order that there be no doubt as to their meaning and application. The more specific the definition of these scoring values, the more accurate and reliable will be the scoring of these tests.

As indicated in Chapter IV this variation of scores is the stumbling block which apparently stands in the way of the development of ability tests in the field of Industrial Arts. It is doubtful whether there will ever be full accord in the scoring of ability tests, but certainly all effort should point toward that end.

Recommendations for Further Research

If further research is to be done on this project, it is recommended that the test be administered in many schools with the following points in mind:

1. To get suggestions for revisions of scoring values, working toward further objectivity.

2. To establish norms for each grade or class level.

3. To refine further this instrument and to suggest further applications, additional item types, and possible potential in other manipulative fields.

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