INDIVIDUAL MACHINE WORKSTATIONS FOR MACHINE WOODWORK

by

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Chapter I

THE STUDY

General Background

This study of machine workstations followed the equipping of the woodworking area of a general shop in April 1954 with six multipurpose machines as basic machine tools. During the last two months of the school year 1953-54 the instructor observed changes in student attitudes toward their shop work, apparently brought about by the change in shop equipment. But to attribute that change to the change in equipment could only be conjecture on the part of the instructor. There was no proof of a change in the first place and certainly none that any alleged change of attitude was due alone to the type of equipment used. The idea of and the procedures for an experimental study were developed during the following summer (1954), in an attempt to discover the truth of the matter. The experiment, however, was not begun until the 1955-56 school year because of certain extenuating circumstances not directly related to shop work.

The idea of the machine workstation is provocative. The instructor's thinking resulted in many interesting discussions with teachers of academic and industrial-arts subject matter, and with school administrators. These discussions strengthened the instructor's desire to chart an experiment centered on the machine workstations. Apparently the use of multipurpose machines in such a manner was a different and radical approach to the industrial-arts equipment problem. Other shop teachers were at first appalled, and then incredulous, that industrial-arts woodworking was to be taught in a shop thus equipped. Most, however, expressed a desire to know how a program centered around the machine workstation would work out. It seemed there was a need for facts not available from any known source. In an attempt to satisfy that apparent need and the curiosity of the instructor this experiment was set up.

Out of many discussions and some sleepless nights of the instructor came the following plan for the experiment. The primary questions were: In comparison with the conventional shop, is there any possible advantage in using multipurpose machines as basic machines in machine woodworking? Is there any advantage to having individual machine workstations?

From these two questions the following was developed:

	Possible advantage	Estimated degree of advantage	Records necessary
1.	Increased production	Maybe	a) Attendance b) Machine changes c) Machine change time
2.	Increased learning about woodworking machines	Some	a) Machine changes b) Machine change time c) Pre-test and follow-up d) Accident record
3.	Increased learning about machine woodworking	Maybe	a) Pre-test and follow-up
4.	Increased interest	Some	a) Attendance b) Pre-test and follow-up c) Time check d) Student questionnaire
5.	Increased work time	Some	a) Attendance b) Time check
6.	Better quality of work	Maybe	a) Teacher evaluation b) MWVIAA Fair c) Local exhibits
7.	Increased learning about planning	Some	a) Machine changes b) Machine change time c) Pre-test and follow-up d) Time check
8.	Increased learning about safety	Maybe	a) Attendance b) Pre-test and follow-up c) Accident record
9.	Less ambulation of students	Maybe	a) Time check b) Anecdotal record

Points Of Inquiry

Increased production. From one point of view it would seem that if a student be assigned to a machine workstation where he could do a very large portion of his project work without competing with others for the use of a machine he might well be able to do more work; that his work hours would result in greater accomplishment than a like number of work hours in a conventional shop. However, there could be a loss if the student were to spend more time at his machine workstation changing the multipurpose machine from one basic tool to another than the time he would spend waiting for a much-used machine in the conventional shop.

In the attempt to find the answer, data were gathered showing the machine changes made in the experimental group (Machine Change Card, page 57) and a sampling was taken of the time spent in making each of the various changes (Time Lost By Student's Machine Changes: Experimental Group, page 25). Computations that show the number of class periods lost by a boy in the experimental group for machine changes are shown on page 26. This time loss was compared to the "waiting time" of the control group. The waiting time of the control group was derived from the time check (Time Check Card, page 58) and the time sampling of students waiting for a machine (Waiting Time, page 30).

Ostensibly these two computations compare the time loss of the experimental and control groups, which has been translated to show class periods lost to a student assigned a machine workstation and class periods lost to a student in a conventionally equipped shop.

<u>Increased learning about woodworking machines</u>. It would seem that the student who had to set up a circular saw, let us say, on the basic multipurpose machine enough times should learn more about the circular saw than the student who merely used a circular saw.

To make this comparison the data gained from the "Machine Change Card" and the table "Time Lost By Students' Machine Changes: Experimental Group," were used to show how much time an "experimental" student spent on an operation which was not done by students in the control group. To find if this time resulted in learning, identical tests (page 62) were given students in both groups. The results are shown in the comparisons, page 38.

<u>Increased learning about machine woodworking</u>. It would seem possible that the student who must make machine changes as well as normal operational setups on woodworking machines might gain an insight into the techniques of machine woodworking not normally gained by the student in the conventional shop. On the other hand, it is just as possible that the exact reverse be true. For this comparison the Comprehensive Test was used exclusively. Comparative scores are shown on page 38.

Increased interest. It would seem quite likely that if the machine workstation were to show a favorable comparison over the conventional shop on any point, it would be on this one. Apparently the teenage boy has an insatiable interest in machinery. If this be true then surely he will have a greater interest in his work when that work is done at a machine workstation where he may call the machine his own, for his time in the shop, more than in a conventional shop where he shares the machines with others.

In the attempt to make this comparison the attendance record was charted on the theory that the boy with the greater interest will be less likely to miss his shop class and schoolwork than the boy with a lesser interest. Interest leval should also be reflected in more learning, which is purportedly measured by the Comprehensive Test. The Time Check Record, too, should reflect interest level to an indeterminate degree. The Student Questionnaire (page 59) should, however, be a more reliable device for indicating student interest level. The results of the Student Questionnaire are shown on pages 34 and 35.

Increased work time. It seems likely that a student using the individual machine workstation will spend more time working than will the student in a conventional shop who finds it necessary to wait for a turn on a machine. To make this comparison between students in the experimental and control groups the Time Check Record was used to show if a student spent all his time working or some in talking, waiting, watching or other non-working pursuit. The attendance record also should give some indication as to the work time of a student. If he had little interest or for some other reason was habitually absent without excuse, his available work time suffered. If, on the other hand, his attendance record showed no unexcused absences he did not stay away from school and his shop class unnecessarily, and he made use of all the time available to him. A comparison of these data is shown on page 24.

Better quality of work. It is conceivable that a student using the machine workstation would use his time unhurriedly and thus do more accurate work than the student in the conventional shop who, when using machinery in constant demand, hurries his work so that others clamoring for the machine might get their turns with minimum delay. It is, on the other hand, conceivable that the multipurpose machines used as individual workstation, being of the home-workshop type, might be more difficult to set for close tolerances or even be devoid of the consistent accuracy normally built into the heavier machines found in the conventional shop.

It is readily conceded that these points would be extremely difficult to compare but the attempt was made through teacher evaluation, subjective at best, and by the showing made by the experimental group's projects in competition with projects made by students of comparable experience in conventional shops of other schools. These data will be found on pages 32 and 33.

Increased learning about planning. This refers to both project planning and operational sequence planning. It would appear logical that a student using the machine workstation would soon learn the value of looking ahead. It is true that in using the multipurpose machine the operator will find himself making more changes than necessary if his procedure is not well planned. This can result in a loss of time, production, and quality of workmanship. This is also true in the use of unit machines but perhaps to a less-pronounced degree. It seems obvious that a high degree of procedure planning is necessary for the economical use of the multipurpose machine. It also seems likely that reasonable procedure planning may result from reasonable project planning.

In an attempt to measure this comparison point, the machine change record is used to show whether excessive changes were made on the multipurpose machine when compared with the machine-use record of the control group. The Comprehensive Test should also indicate whether the student using the machine workstation had learned more or less about planning, compared with students in the control group. This is based on the assumption that intelligent planning is partially the result of knowledge of machine woodworking and woodworking machines. Results are shown on page 38.

Increased learning about safety. On first thought this point would seem to be totally unrelated to this study. However, a close inspection of the multipurpose machine used as machine workstations in this experiment will reveal certain mechanical features inherent in such machines that may require more intense safety education than normally covered in the conventional shop. This intensified safety education should result in learning to be revealed in the safety section of the Comprehensive Test. See data on page 40.

Less ambulation of students. It would appear reasonable that a student assigned a machine workstation, which also consists of bench space and common hand tools, would have scant need to move away from his station. If this be true then it should manifest itself in increases in nearly all the previously mentioned possible advantages. However, it was decided to try for an answer to this point by the use of the time check and anecdotal record.

Physical Experimental Setup

The woodworking area was equipped to provide six machine woodwork stations. Six multipurpose woodworking machines were installed, one on either side of three two-place benches, the work surfaces of which were four by five feet. Each multipurpose machine was convertible into a nine inch table saw, a fourteen inch lathe, a fourteen inch drill press, a twelve inch disc sander, a horizontal drill press or a four inch jointer. In addition to these, accessories were available on a central tool panel to convert the machine into a drum sander, a molding machine, a shaper, a router, a mortising machine or a jig saw. In the bench area provided for each workstation was a hand-tool panel containing the most frequently used layout tools, a jack plane, wood chisel and back saw. See page 85.

Unit machines available for student use in both groups included a twelve inch single surfacer, a ten inch radial arm saw and a fourteen inch band saw. Portable power hand tools included a jig saw, a router-shaper, one-quarter and one-half inch drill motors, a belt sander and an oscillating sander. Also available was the usual compliment of hand tools from a central tool panel.

The Experimental And Control Groups

Since the two advanced woodworking classes were small, one (of not more than six doing work in wood) was selected as the experimental group. The other advanced class then became the control group. On the whole both groups had received identical training in their freshman and sophomore years.

In the experimental group each student was assigned a workstation. The machine at that station was his for the fifty minutes of his shop period. He made all machine changes as necessary. If the student needed a circular saw he set the machine up as a circular saw. If he needed to use a drill press he set the machine up as a drill press. Each student made all the changes and setups for his work. No one else used the machine during that period. For the student's shop period, the machine was his and his alone.

In the control group the machines were set up more on the conventional shop pattern. Certain of the multipurpose machines were designated for use as saw-jointers, drill press, lathe, jig saw and disc sander. For the most part these machines were set up by the students but were not changed during the period. Thus, if a student needed to use a table saw and the two table saws were busy the student had to find something else to do or wait. This procedure was not entirely satisfactory. If a student needed to use a saw while the two designated machines were in use, but a machine that could be made into a table saw was not in use, the student found it difficult to understand the admonishment of the instructor that he should find something else to do, or wait. Such a situation also caused the instructor anxious moments, for after all, the equipment was put there for student use rather than for the convenience of an instructor. But in-so-far as possible the above outlined procedure was followed closely.

Limitations Of The Study

The scope of this experiment has been limited to a study of the possible educational advantages of the machine workstation when compared with the same values gained in a conventional shop.

Though a well-known brand of multipurpose machine was used in this experiment, no attempt has been made to measure the usefulness, versatility or ruggedness of the machine itself. No record was kept of the time loss resulting from the breakdown of a machine.

Control Of The Experiment

No claim is made that the experiment as set up would furnish a set of incontestable data. The results and conclusions are not unassailable. The experiment had to be fitted into a program in such a manner as to cause the least possible interference and objections. The methods devised for carrying on the experiment and collecting data seemed to be the best under the circumstances.

A student of one group could not be equated with a student of the other group. Even if matching I. Q's. and aptitudes could be found, the background and previous training of the students would quite likely differ widely. The school wherein this experiment was carried on is a small one (115 registered students) and because of the limited curriculum there could be no control over which students enrolled in what group. Indeed, the experimental and control groups were not so designated until after registration, when the class with six or fewer students enrolled in advanced machine woodworking automatically became the experimental group. Both groups were made up of juniors and seniors about evenly divided between them. This was not an ideal testing situation but about as good as could be had at the time.

The methods used for collecting the data were about as good as could be devised for the situation, but they certainly left something to be desired. Though the instructor tried at all times to see that the student-kept time checks, machine changes and machine-use cards were properly filled in, it is conceded that the data cards suffered at times as students failed to keep them faithfully or failed to understand the need of them at all.

As stated above, the experiment could not be allowed to interfere unduly with normal class routine. Whenever the two conflicted it was the experiment that suffered as it gave way to class-work demands. Such conflicts were minimized as much as possible, but occasionally there was just no avoiding them. The equipment was put in the shop for student use and the instructor was paid to teach, so neither equipment nor instructor could be diverted unduly to the personal use of the instructor for the purpose of the experiment.

Another limiting factor is the small number participating as members of the experimental and control groups. It might be more nearly correct to call this a sampling instead of an experiment. However, this instructor is inclined to doubt if further collection of data would add anything but numbers. I could be wrong. I have my limitations too, personal and prejudicial as well as training and background. But this study was made in a conscientious effort to find answers to question postulated, not to "prove" anything; and to the best of my ability that is what it is.

Chapter II

RECORDS AND DATA, HOW ACCUMULATED

Attendance

The attendance data were taken directly from the instructor's Class Record Book in which absences are recorded as excused or unexcused by a code marking.

Comprehensive Machine Woodworking Test

A series of multiple-choice questions were designed by the instructor. The test was given to advanced students in three high school industrial-arts classes other than the instructor's own, and to a group of college students. It was thought that the answers marked by students from other schools would furnish a measure of the understandability of the questions. The responses by the college group should furnish a key to the technical aspect of the test questions.

The responses of these groups to the questions were tallied. This tally was then converted into a percentage figure and each response then given a value. For example, question number 18: thirty-three answered the question. Twenty-nine chose the first response and four the second response. 29/33 = .88 and 4/33 = .12. The first response was then given a value of nine and the second response a value of one.

Where none of the possible responses to a question received a value of seven or greater the question was deleted. Fifty of the one hundred twenty-nine questions in the test were thus eliminated. In the accompanying copy of the original test, non-counting questions are marked with an asterisk (page 62).

Each group was given the test after the series of demonstrations on procedure and safety were completed by the instructor. These demonstrations were given one or two a week and generally terminated about the end of the first semester. The test was administered again at the close of the school year as a final examination.

If a student had taken the test the previous year his score on the previous year's final was used as his pre-test score of the following year. Such scores are marked with asterisks. The reason for following this practice is, I think, valid. Because of the comprehensive testing program used in the elementary and high school years to measure a student's standing and achievement, a student often becomes aware of the advantage of making a low score on the pre-test and then doing his best on the second test. When this happens results do not reflect the truth. It was to avoid this situation that the procedure outlined above was followed.

Machine Change And Machine Use Cards

Each student was issued a "Time Card" which he kept with him during his class period. The card was designed with space for data collected for one week. The experimental group recorded all changes made on the multipurpose machine by circling the proper abbreviations on the card. This specified the machine setup involved in each change.

The control group recorded the use of specific machines on their cards by a mark through a number under the name of each machine. Continuous use of a machine was recorded as one use. However, if the use of one machine was interrupted by the use of another machine it was recorded as three uses, two on the first machine and one on the second machine.

Time Check Card

On the reverse side of the Machine Change Card and the Machine Use Card, space was provided for the entry by the student of what he was doing at specific times during the period. Entry in this record was made when a pre-set bell was rung. The instructor fell heir to an old IBM time clock and this was put to use to ring a bell three times each period. Whenever the bell sounded the student stopped whatever he was doing and recorded in two or three words exactly what he had been doing at the moment. (This tended to make clock-watchers of some of the students, a factor which was scotched when the instructor installed a hidden switch at his desk and operated the bell without the aid of the clock for a period or two.)

The purpose of this record was to get at the waiting time of students in both groups, and to get an indication of the time spent by students in unrelated pursuits such as talking. This sampling record formed the basis for data on the number of weeks spent in milling.

Student Questionnaire

A short series of multiple-choice questions designed to give an indication of how the students felt about the machine workstation setup. Students in both groups (1956-1957) were asked to complete the questionnaire.

Parent Questionnaire

Another short series of multiple-choice questions designed in the attempt to find how parents felt about the machine workstation setup. At the 1956-57 open house, parents and friends visiting the industrial-arts shop were asked to complete the questionnaire. Returns amounted to about twenty per cent.

Quality Of Projects

The annual Industrial Arts Fair sponsored by the Mid-Willamette Valley Industrial Arts Teachers Association was used as a means of comparing projects made by both of the groups involved in this experiment with the work of other students in conventional shops. A record was kept of the projects entered and places, if any, awarded. Not all students entered projects, for the fair is selective. Only the better ones were allowed entry.

Another yardstick for the measuring of comparative quality, though prejudiced, is the opinion of the instructor.

Waiting Time

Each student in the control group was checked twice with a stop watch to find the amount of time spent waiting for a machine he needed. These checks were made on a predetermined day, one shortly after all students were in the milling process and the other five to six weeks later. These data are used to compare the time lost by this group with the machine change time of the experimental group.

Process Distribution

In most industrial-arts courses students spend time in planning, building, assembling and finishing of projects. This study is limited to the time spent in building (or milling) the project. To find the milling time, the Time Check Cards were used to determine what process the student was engaged in chiefly each week. The results are given in weeks spent in each process (or phase) of project construction.

These data are used in conjunction with the waiting time to determine the time lost by a student of the control group in waiting his turn on the various machines.

Chapter III

TABULAR PRESENTATION OF DATA

California Mental Maturity Test Scores

Experimental Group		Control Group	
Student	I. Q. Score	Student	I. Q. Score
1955-56			
1	96	1	86
2	89	2	96
3	94	3	106
4	80	4	99
5	99	5	91
6	99	6	108
*7	108	7	77
*8	99		
*9	105		
1956-57			
10	97	8	76
11	126	9	108
12	99	10	108
13	96	11	77
14	99		
15	82		
*16	105		
Totals	1573		1032

* See note on the following page.

Computations

Sum of the I. Q. scores	÷	Number in group	=	I. Q. average
1573	÷	16	=	98.3
1032	÷	11	=	93.0
Difference in I. Q. average in favor of the experimental group				5.3

Note: Students 7 and 8 were student shop-assistants in each of the two beginning shop classes and did their work during this time in accordance with the provisions for the experimental group.

Students 9 and 16 were advanced boys taking shop during the Shop II period (Carpentry) and did their work in accordance with the provisions for the experimental group.

Attendance Record

Experimental Group

Student 1955-56	Excused Days Absent	Unexcused Days Absent	Days Present
1	4	1	175
2	2	0	178
3	5	0	175
4	16	1	163
5	3	0	177
6	5	0	175
7	0	0	180
8	1	0	179
9	6	0	174
1956-57			
10	10	0	170
11	10	1	169
12	2	2	176
13	4	0	176
14	10	1	169
15	4	0	176
16	5	1	174
Totals	87	7	2786

Control Group

Student 1955-56	Excused Days Absent	Unexcused Days Absent	Days Present
1	3	1	176
2	4	0	176
3	14	0	166
4	5	0	175
5	6	1	173
6	8	0	172
7	7	0	173
1956-57			
8	6	0	174
9	1	0	179
10	7	1	172
11	6	0	174
Totals	67	3	1910

Computations

Days present	÷	Number of students	=	Average days attendance for each student
Experimental Group				
2786	÷	16	=	174.1
Control Group				
1910	÷	11	=	173.6

Unexcused days absent	÷	Number of students	=	Average unexcused days absent for each student
Experimental Group				
7	÷	16	=	.44
Control Group				
3	÷	11	=	.27

Time Lost By Students' Machine Changes

Experimental Group

Operation	Number made by group	x	Time in seconds	=	Time lost in seconds
Saw to:					
Jointer	69		46.0		3174.0
Saw-Jointer	157		18.0		2826.0
Sander	28		60.0		1680.0
Drill Press	86		96.0		8256.0
Lathe	119		76.5		9103.5
Jig Saw	18		85.0		1530.0
Saw-Jointer to:					
Saw	11		10.5		115.5
Horizontal Drill	12		69.2		830.4
Sander	15		60.1		901.5
Drill Press	16		80.0		1280.0
Lathe	5		92.0		460.0
Jig Saw	3		72.7		218.1
Jointer to:					
Saw	23		54.0		1242.0
Saw-Jointer	9		41.2		370.8
Sander	3		48.4		145.2
Drill Press	4		45.0		180.0
Lathe	7		45.2		316.4
Horizontal Drill to:					
Saw	5		61.0		305.0
Sander to:					
Saw	14		55.0		770.0
Saw-Jointer	2		68.5		137.0
Jointer	2		27.0		54.0
Drill Press	4		63.8		255.2
Lathe	5		76.2		381.0
Jig Saw	2		53.0		106.0
Drill Press to:					
Saw	36		68.8		2476.8
Jointer	3		33.2		99.6
Sander	10		59.8		598.0
Lathe	2		97.5		195.0

Lathe to:			
Saw	11	87.0	951.0
Jointer	5	33.1	165.5
Sander	3	78.6	235.8
Jig Saw	2	76.8	153.6
Jig Saw to:			
Saw	15	50.8	762.0
Lathe	1	63.0	63.0
Totals	707		40,343.9

Computations

Time lost for machine changes entire group (col. 4, page 26)	÷	Number of seconds in one minute	=	Minutes lost for machine changes, entire group
40,343.9	÷	60	=	672.4
Minutes lost for machine changes, entire group	÷	Number of minutes in one period	=	Number of periods lost for machine changes, entire group
672.4	÷	50	=	13.45
Number of periods lost for machine changes, entire group	÷	Number of students in group (col. 1, page 23)	=	Class periods lost by each student during year
13.45	÷	16	=	.84

Total time lost for machine changes (col. 4, page 26)	÷	Total number of machine changes (col. 2, page 26)	=	Average time lost for each machine change
40,343.9 seconds	÷	707	=	57.06 seconds

Total number of machine changes (col. 2, page 26)	÷	Number of students in group (col. 1, page 23)	=	Average number of machine changes per student per year
707	÷	16	=	44.2

Minutes lost for machine changes, entire group	÷	Number of students in group (col. 1, page 23)	=	Time lost per student per year in minutes
672.4	÷	16	=	42.03

Process-time Distribution: Control Group

Time In Weeks

Student	Planning	Milling	Assembling	Finishing	Total Weeks
1955-56					
1	5	18	1	12	36
2	7	14	8	6	36
3	9	15	1	11	36
4	6	19	4	7	36
5	6	12	2	9	29
6	7	12	5	11	35
7	8	13	4	11	36
1956-57					
8	9	14	13		36
9	7	13	16		36
10	7	21	8		36
11	5	19	12		36
Totals	76	170	141		387

Computation

Total weeks	÷	Number of students	=	Average weeks milling per student
170	÷	11	=	15.4^{+}

Waiting Time: Control Group

Time in minutes for one class period

Student	First Check	Second Check
1955-56		
1	0:00	0:00
2	9:00	12:00
3	0:00	6:00
4	0:00	0:00
5	0:00	0:00
6	0:00	0:00
7	0:00	4:00
1956-57		
8	2:00	0:00
9	0:00	0:00
10	0:00	0:00
11	0:00	0:00
Totals	11:00	22:00

Computations

Total minutes	÷	Number of Checks	=	Average daily Waiting time for group
33:00	÷	2	=	16.5 minutes

Average daily waiting time for group	÷	Number in group	=	Average daily waiting time per student
16.5 minutes	÷	11	=	1.5 minutes

Average daily waiting time per student	x	Class periods per week	=	Average weekly waiting time per student
1.5 minutes	x	5	=	7.5 minutes

Average weekly waiting time per student	x	Average weeks in milling (page 28)	=	Total waiting time per student per year
7.5 minutes	x	15.4	=	115.5 minutes

Total waiting time per student per year	÷	Length of class periods	=	Periods of waiting time per student per year
115.5 minutes	÷	50 minutes	=	2.31 periods

Machine use record: Control Group

All Students

Machine Used	1955-56	1956-57	Totals
Saw-Jointer	134	105	239
Jointer	7	0	7
Sander	33	61	94
Drill Press	16	71	87
Lathe	2	76	78
Jig Saw	31	15	46
Band Saw	36	51	87
Totals	259	379	638

Computation

Total times machines	÷	Number of students	=	Average number of times each student made use of a machine for one year
638	÷	11	=	58.0

Mid-Willamette Valley Industrial Arts Fair Results

Experimental Group

Student		Project	Place
1	Senior	Serving cart	First
2	Senior	No project entered	
3	Senior	Television table	Second
4	Senior	No project entered	
5	Junior	No project entered	
6	Senior	Sewing caddy	Certificate of merit
7	Sophomore	No project entered	
8	Junior	Coffee table	First
9	Junior	Corner table	Second
10	Senior	No project entered	
11	Senior	Step table	Certificate of merit
12	Senior	No project entered	
13	Senior	No project entered	
14	Junior	No project entered	
15	Junior	No project entered	
16	Junior	Gun rack Tid-bit tray	Second First

Mid-Willamette Valley Industrial Arts Fair Results

Control Group

Student		Project	Place
1	Senior	Small desk	Third
2	Senior	Coffee table	First
3	Senior	Coffee table	Second
4	Senior	No project entered	
5	Senior	Occasional table	First
6	Junior	No project entered	
7	Junior	No project entered	
8	Junior	No project entered	
9	Junior	Table lamps	Rosette
10	Senior	Television table	First
11	Senior	No project entered	

Order Of Awards Given At The Mid-Willamette Valley Industrial Arts Fair

		Experimental	Control
Rosette	Best of division	0	1
Certificate of merit	Outstanding workmanship	2	0
First	Excellent workmanship	3	3
Second	Very good workmanship	3	1
Third	Good workmanship	0	1

Student Questionnaire Results Tabulated

	Machine workstation setup	Flexible shop setup	Unit machines
1. If you had a choice would you prefer in your shop period	7	6	0
2. Do you think you could get more accomplished in a	6	7	1
3. Do you think you could learn more about woodworking machines in a	10	3	0
4. Which do you think would provide the more interesting work situation, a	9	5	1
5. Do you think you could learn more about the safe operation of woodworking machines in the	9	4	0

6. Is there anything you particularly like about the physical setup of our woodwork area?

4	I like to use a machine all by myself
6	I don't have to wait to use a machine
4	I can get more work done
6	I can learn more about machines

7. Is there anything you particularly dislike about the physical setup of our woodwork area?

4 I waste too much time changing from machine to machine

(No other responses)

8. Comments about shop, equipment, instructor and or the shop program

1 Need more project storage room

1 Not enough room

3 Dislike "time cards"

Parent Questionnaire Results Tabulated

	Machine Workstation Shop	Conventional Shop
1. Would you prefer that your boy have in his shop period	5	4
2. Do you think he might accomplish more in a	7	2
3. Do you think he might learn more about woodworking machines in a	5	4
4. Which do you think would provide for your boy the more interesting work situation?	6	3
5. Do you think he might learn more about the safe operation of woodworking machines in the	4	5

Comprehensive Test Results

Experimental Group			Control Group		
Student	Pre-test	Follow-up	Student	Pre-test	Follow-up
1955-56					
1	83.7	88.0	1	75.0	---
2	77.4	80.6	2	84.2	82.9
3	75.8	78.0	3	69.8	59.5
4	61.0	61.2	4	83.9	87.4
5	75.9	73.5	5	77.2	76.7
6	83.9	87.4	6	75.6	74.4
7	80.4	86.3	7	52.6	43.0
8	78.4	77.0			
9	74.5	65.3			
1956-57					
10	27.0	76.9	8	66.1	46.4
11	85.4	70.0	9	* 86.3	77.4
12	* 77.0	80.6	10	* 75.4	77.6
13	* 82.9	81.0	11	* 43.0	50.7
14	71.0	73.0			
15	75.5	73.2			
16	* 65.3	71.1			
Totals	1175.1	1223.1		789.1	677.0

* These grades are from the final test of the previous year for students who took the tests at that time. See

explanation page 16.

Computations

Total group scores	÷	Number in group	=	Average for each student
Experimental Group				
1175.1	÷	16	=	73.44
1223.1	÷	16	=	76.44
Control Group				
789.1	÷	11	=	71.73
677.0	÷	10	=	67.70

Gain (+) or loss (-) in knowledge:

Experimental Group	76.44 - 73.44	=	+3.00
Control Group	67.70 - 71.73	=	-4.03
Difference in favor of Experimental Group			7.03

Safety Test Results

Experimental Group			Control Group		
Student	Pre-test	Follow-up	Student	Pre-test	Follow-up
1955-56					
1	84	100	1	80	--
2	70	100	2	72	86
3	86	80	3	100	100
4	82	86	4	66	66
5	86	72	5	86	100
6	66	66	6	80	100
7	86	100	7	36	68
8	54	80			
9	100	100			
1956-57					
10	86	100	8	56	58
11	100	100	9	* 100	100
12	* 80	80	10	* 100	100
13	* 86	100	11	* 68	72
14	84	100			
15	86	100			
16	*100	100			
Totals	1246	1464		842	850

* These grades are from the final test of the previous year for students who took the tests at that time. See

explanation on page 16.

Computations

Total group scores	÷	Number in group	=	Average for each student
Experimental Group				
1246	÷	16	=	77.87
1464	÷	16	=	91.50
Control Group				
842	÷	11	=	76.54
850	÷	10	=	85.00

Gain (+) or loss (-) in knowledge:

Experimental Group	91.5 - 77.87 =	+13.63
Control Group	85.0 - 76.54 =	+8.46
Difference in favor of Experimental Group		+5.17

Chapter IV

INTERPRETATION OF RESULTS

Increased Production

Comparison of Time Lost By Student's Machine Changes: Experimental Group (pages 25, 26 and 27) with the Waiting Time: Control Group (pages 29 and 30) shows the following:

Time lost for machine changes:	0.84 class periods per student per year
Waiting time:	2.31 class periods per student per year

The difference in these results should give an indication of the advantages of the machine workstation setup. The figures show such a small difference, however, that one wonders if they are significant. May it be pointed out that the data from which these figures were derived present certain vagaries. In the experimental group it is possible that not all machine changes were recorded by the students despite the insistence by the instructor of their importance. The same can be said of the machine use data recorded by the control group. Comparison of the total number of machine changes with the total number of machine uses will reveal, however, that these totals are relatively consistent.

Analysis of the waiting time data will, likewise, present certain discrepancies not at first apparent. To instructors of machine woodwork these figures may, after consideration and reflection, seem unduly low. This instructor believes they are low because students of the control group soon became aware that their un-busy moments were being clocked and would exercise their ingenuity beyond normal limits to avoid just plain waiting. Consequently the figures for waiting time may be less than normal.

This may well be true in this instance, for one of the cardinal rules of this instructor's shop is that a student must be busy and working at all times. A student's failure to do so may result in his loss of shop privileges. Knowing this, it is quite understandable that students should want at least to appear hard at work when the instructor is near, expecially if he has a stop watch in his pocket.

Also, the aggressiveness of the student has much to do with his waiting time. This instructor has observed a particularly shy boy waste more than four continuous periods in busy work because he did not want to intrude on other students' machine use nor yet attract the attention of the instructor. Such situations are a part of teaching and are taken care of as they arise. The instructor regulates in one fashion or another the time spent by each student on the machines so that each may have sufficient time to do his work.

It is, then, the opinion of this instructor that, while the difference is loss of time of the two groups may be minimized, there is practically no time when a boy using the machine workstation is not busy, working at his project, while in the conventional shop there are times when a boy may waste full periods waiting to use a machine that is in much demand.

Of course the latter loss of time can be, and often is, minimized by an alert instructor by apt suggestions to a waiting student of other things he could be doing on his project. This type of situation, however, does not arise in the machine workstation type of shop. The instructor is relieved of this one big complaint because there is no need for a student to do nothing while waiting; for he need not wait at all.

As far as increased production is concerned it is possible for a student to accomplish more because he has more time available to him. This instructor has found this to be the case though he can present no proof to substantiate the claim.

The amount accomplished by students depends so much upon the individual that any claim of increased production resulting from the use of individual machine workstations is likely not valid. But the lesser waste of time by students who use the machine workstation is apparently valid.

Increased Learning About Woodworking Machines And Increased Learning About Machine Woodwork

The students in the experimental group spent a little less than an hour (42.03 minutes, page 27) in changing the multipurpose machine from one unit to another. It is conceivable that time thus spent should result in learning not available to students in the control group.

The figures on gain or loss in knowledge (page 38) show the student in the experimental group to have gained three percentage points in knowledge while working with the machine workstation. The student in the control group lost four percentage points in the same period.

In-so-far as possible the same instruction was given both groups. The one was not slighted in favor of the other. The retention and gain of knowledge apparently can be attributed to one or both of the following reasons:

1. Higher intelligence level of the student in the experimental group.
2. The fact that the experimental group made machine changes while the control group did not.

A study of I. Q. scores on pages 21 and 22 reveals the average of the experimental students to be 98.3 as compared to the control students' average of 93.0. This shows a difference between the students of the two groups of 5.3. The difference in gain of knowledge about machine woodwork and woodworking machines as measured by the comprehensive test of students of the two groups was 7.03 in favor of the experimental student.

These two difference figures appear to be close enough to account for the superiority in learning of the experimental student. However, if this superiority is to be attributed entirely to the higher I. Q. of the group, one may logically expect the difference figures to approach identity even more closely. If such be the case then at least part of the increased learning of the experimental student may be attributed to time spent in making machine changes, which the control student did not make.

Increased Interest

The attendance record (pages 23 and 24) shows a student of the experimental group to have a greater "unexcused days absent" average (0.44 days per year) than a student of the control group (0.27 days per year). If our original premise that student interest would be reflected in the attendance record is true, we must conclude that the machine workstation student has less interest than the unit machine student. Let us see if this conclusion is substantiated by other checks used to help answer the original question.

From the scores of the comprehensive tests (page 38) we find the experimental group to have learned more than the control group. This may in part be a result of a greater interest in shop work created in the experimental student, or a lesser interest created in the control student. It is quite likely that a student who always has a machine available for his every use will maintain a higher interest level than the student who must share the machine with his fellows and sometimes wait for its use. It seems common knowledge that participation results in increased interest while non-participation may well result in lessened interest. It appears likely that the difference in scores of the two groups is, in part, due to a difference in interest level.

Question four of the Student Questionnaire (page 34) deals directly with student interest. Almost twice as many (nine to five) consider the machine workstation to present a more interesting work situation than the flexible shop, and only one of the fifteen returning questionnaires thought the conventional shop offered a more interesting work situation. These questionnaire results may not be conclusive but they do speak well, from the students' point of view, for the individual machine workstation as a means of raising the student interest level.

In talking with other shop teachers about the experimental setup under study, most readily subscribed to the possibility of increased student interest.

That student interest is increased by using a machine workstation situation rather than a conventional shop situation seems to be a tenable conclusion

Increased Work Time

A comparison of the time lost for machine changes (42.03 minutes per student per year) with the waiting time of the control group (115.5 minutes per student per year) reveals that the student in a machine workstation shop has more available work time than the student in the conventional shop. Just how much is not fully discernible from the figures which are subject to certain vagaries discussed on pages 41 and 42. That it is probable seems tenable at this time.

Better Quality Of Work

This seems to be an extremely nebulous point to measure. So many more important factors than type of machines used are involved that no valid conclusion can be reached at this time as to whether individual machine workstations foster better workmanship than single-purpose machines.

However, a study of the projects made and entered in the Industrial Arts Fair, and the places won (pages 32 and 33) by the machine workstation students, will reveal a presence of good quality. That alleged quality seems primarily to be the result of a student's desire for, and a teacher's insistence on high performance of workmanship.

For certain reasons this instructor doubts if better quality work definitely will result from the use of the individual machine workstation; but at the same time it is believed that a lesser quality of work need not necessarily result.

Increased Learning About Planning

The machine change record results (page 27), when compared with the machine use record results (page 31), show that the experimental student made 44.2 changes from one machine to another, while the control student was making use of some machine for a total of 58 times. This would tend to show that the experimental student planned his work to avoid excessive machine changes, while the control student had not seen the need for such planning.

The comprehensive machine woodworking test results (page 38) show the experimental student to have a slight edge on increase in knowledge, which may be attributed, in small part, to the need for better planning of milling procedure when using a multipurpose machine.

The possibility that a student using the multipurpose machine may well learn more about procedure planning can be better appreciated if one thinks of the consternation of a student who discovers that he has forgotten one of several pieces in his previous setup and must now tear down his present intricate setup, change his machine back to another basic unit, set it up to run the forgotten piece, and then re-set the entire machine to make the final milling operation. One occurrence of this is usually sufficient to encourage the student to plan his work carefully and to continually check to see that no piece has been left undone.

Increased Learning About Safety

Although the scores of the safety test (pages 39 and 40) are included in the total scores for the comprehensive test (pages 37 and 38), the safety scores were computed separately for the purposes of this section. The data show a knowledge gain for the experimental student of 13.63 percentage points while the knowledge gain for the control student was only 8.46 percentage points.

These figures show a difference in favor of the experimental student of 5.17 percentage points. The I. Q. score difference (page 22) was 5.3 in favor of the experimental student. These differences are close enough that we may apparently attribute the greater knowledge of safety exhibited by the experimental student to his apparently superior mental capacity. This seems to rule out the machine workstation as a better means of teaching safety.

May it be said that the instructor insists, as do many of his contemporaries, that safety education is a primary teaching objective of industrial arts. Shop safety rules and the reasons for each must be known by the students and safe procedures must be used at all times. Each student must pass a written safety test with a perfect score before he is allowed the use of any machine. Infraction of shop safety rules is good and sufficient reason for loss of shop privileges.

Less Ambulation Of Students

No interpretation can be made on this point for no data collected seem apropos. May it be brought to the reader's attention, however, that interest level of the student, perhaps more than any other one factor (instructor made and enforced rules excepted), will precipitate ambulation or the lack of it. The two will normally be in indirect ratio. Since it seems that the machine workstation student has a higher level of interest in his work (pages 45, 46 and 47) than the flexible shop or conventional shop student, less ambulation of the experimental student should result.

Perhaps data on this point could be gotten if each student were issued a pedometer and a record kept of the readings. An answer to this point would be interesting, if attainable.

Chapter V

CONCLUSIONS

It appears that the results of this study show a degree of substantiation of original premises, when comparing the individual machine workstation shop with the unit-machine (conventional) shop, ranging from none to some as charted below.

	Premise	Relative degree of substantiation				
		None	.	.	.	. Some
1.	Increased production	x				
2.	Increased learning about woodworking machines		x			
3.	Increased learning about machine woodworking		x			
4.	Increased interest					x
5.	Increased worktime				x	
6.	Better quality of work	x				
7.	Increased learning about planning			x		
8.	Increased learning about safety	x				
9.	Less ambulation of students	x				

If we can accept the foregoing conclusions as valid, it follows that we accept the possibility that there is some educational advantage to be had from the use of the individual machine workstation that utilizes a combination machine.

APPENDIXES

DEFINITIONS

Attendance record - Teacher-kept record of student attendance, in a conventional grade book, with excused and unexcused absences so marked.

Class period - The time a class is in session, normally fifty-five minutes. Shop periods are cut short five minutes for clean up.

Class time - Same as class period.

Comprehensive machine woodworking test - An extensive set of questions about machine woodworking, devised by the instructor.

Combination machine - A woodworking machine designed to be operated as any of a variety of woodworking machines by modifying the machine and/or changing accessories. This term is used interchangeably with "Multipurpose machine."

Control student - A student member of the control group. In the control group the multipurpose machines were used as unit (single purpose) machines, each set up for one specific service.

Conventional shop - An industrial arts woodworking shop with a number of unit machines each of which are single purpose--a saw for sawing, a drill press for drilling, etc.

Excused absence - A forced absence of a student, such as by illness.

Flexible shop - A flexible shop has been described as one equipped with multipurpose machines which are changed as needed by the instructor and used as unit machines.

Individual machine workstation - A designated place for a student to work at a multipurpose machine, on which he can do most common woodworking operations. The student assigned such a workstation has the machine to himself for his class period. No one else uses it.

Machine change - A student-kept record of changes made on the multipurpose machine, such as changing its setup from table saw to drill press. Used in the experimental group only.

Machine change time - A stop-watch sampling by the instructor of actual time involved in machine changes made by the students. Used in the experimental group only.

Machine use - A student-kept record of the times a specific machine has been used. Used in the control group only.

Machine workstation - This term is used interchangeably with "Individual machine workstation."

Milling - That portion of project construction that requires the shaping of wood members of a project and involves the use of woodworking machines.

Multipurpose machine - A woodworking machine designed to be operated as any of a variety of woodworking machines, by modifying the machine and/or changing accessories.

MWVIAA Fair - Mid-Willamette Valley Industrial Arts Association Fair. An industrial arts fair patterned after the national Ford-sponsored Industrial Arts Fair. Sponsored by the Industrial Arts teachers of the mid-Willamette Valley each spring, for the purpose of pre-selecting projects to be sent to the national fair.

Period - Class period.

Student questionnaire - A questionnaire devised by the instructor and answered by the students.

Teacher evaluation - The teacher's estimate of work quality done by students.

Unexcused absence - An absence of the student for his own personal reason, such as a hunting trip.

Unit machine - A woodworking machine designed and used for a single purpose; not convertible into a machine that will do a totally different operation.

TIME CHECK RECORD

	Monday	Tuesday
1st		
2nd		
3rd		
4th		
5th		

	Wednesday	Thursday
1st		
2nd		
3rd		
4th		
5th		

	Friday
1st	
2nd	
3rd	
4th	
5th	

Purpose of this record: to find the amount of idle time and the time spent in milling.

MACHINE CHANGE CARD

S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi

Name

S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi

Project

S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi	S S J J D D SrSr P P L L JiJi

S S J J D D SrSr P P L L JiJi	S S J J	S S J J	S S J J	S S J J	S S J J D Sr P L Ji

Purpose of this record: to find the number of machine changes.

Student-kept Records: Experimental Groups

TIME CHECK RECORD

	Monday	Tuesday
1st		
2nd		
3rd		
4th		
5th		

	Wednesday	Thursday
1st		
2nd		
3rd		
4th		
5th		

	Friday
1st	
2nd	
3rd	
4th	
5th	

Purpose of this record:
to find time spent waiting
for machines and the time
spent in milling.

MACHINE USE CARD

NAME______________ WORKSTATION_____

PROJECT____________________________

Saw-Jointer

123456789	10
123456789	20
123456789	30
123456789	40

Drill Press

123456789	10
123456789	20
123456789	30
123456789	40

Band Saw

123456789	10
123456789	20
123456789	30

Jig Saw

123456789	10
123456789	20
123456789	30

Sanders

123456789	10
123456789	20
123456789	30

Planer

123456789	10
123456789	20
123456789	30

Lathe

123456789	10
123456789	20
123456789	30

Power Hand Tools

123456789	10
123456789	20
123456789	30

Purpose of this record:
to find the number of
times each machine used.

Student-kept Records: Control Groups

STUDENT QUESTIONNAIRE

1. If you had a choice would you prefer to have in your shop period:

   O A combination machine for your own exclusive use. (Machine workstation shop)
   O The instructor set up basic machines as needed by the class. (Flexible shop)
   O A conventional shop. (Table saw, lathe, jointer, etc.)

2. Do you think you could get more accomplished in a

   O Machine workstation shop
   O Flexible shop
   O Conventional shop

3. Do you think you could learn more about woodworking machines in a

   O Machine workstation shop
   O Flexible shop
   O Conventional shop

4. Which do you think would provide the more interesting work situation, a

   O Machine workstation shop
   O Flexible shop
   O Conventional shop

5. Do you think you could learn more about safe operation of woodworking machines in the

   O Machine workstation shop
   O Flexible shop
   O Conventional shop

6. Is there anything you particularly like about the physical setup of our woodwork area?

   O I like to use a machine all by myself.
   O I don't have to wait to use a machine.
   O I can get more work done.
   O I can learn more about machines.
   O Other (specify)________________________________

7. Is there anything you particularly dislike about the physical setup of our woodwork area?

    O I waste too much time changing from machine to machine.
    O I would rather use unit machines because they do better work.
    O I can't get around to see what others are doing as much as I would like.
    O The machines are too complicated.
    O Other (specify)________________________________

8. Write below any comments you wish to make about the shop, the equipment, the instructor, the shop program, or any other item directly related to shop work.

PARENT QUESTIONNAIRE

Place a check mark in the circle before the answer you choose.

(A MACHINE WORKSTATION shop is one in which each boy is assigned a certain combination machine which is his exclusively during his shop time--no one else touches it.)

(A CONVENTIONAL shop is one which is equipped with individual machines; saw, lathe, jointer, etc.; which can not normally be converted into another machine in the manner of a combination machine such as we have.

1. Would you prefer that your boy have in his shop period

   O The MACHINE WORKSTATION kind of setup.

   O The CONVENTIONAL shop kind of setup.

2. Do you think he might accomplish more in a

   O Machine workstation shop

   O Conventional shop

3. Do you think he might learn more about woodworking machines in a

   O Machine workstation shop

   O Conventional shop

4. Which do you think would provide for your boy the more interesting work situation, a

   O Machine workstation shop

   O Conventional shop

5. Do you think he might learn more about the safe operation of woodworking machines in the

   O Machine workstation shop

   O Conventional shop

MACHINE WOODWORKING

NAME ____________________
DATE ____________________

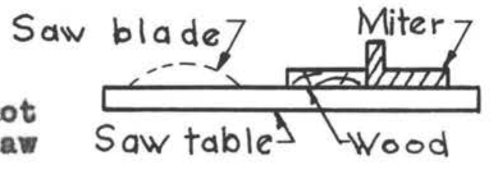
Study the following sketches and decide whether the procedure used in each is right or wrong. Indicate your choice by blocking in the space provided (O).

Also indicate the reason or reasons for your answer by checking the proper responses.

Problem 1 is completed as an example.

1. ● Right
   O Wrong

   O Saw blade too high
   O Miter not used
   O Fence not used
   O This wood shape should not be cut on the circular saw
   ● None of these



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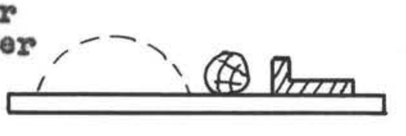
2. O Right
   O Wrong

   O Wood is properly against miter
   O Wood not properly against miter
   O Wood in poor position
   O This wood shape should not be cut on the circular saw
   O None of these



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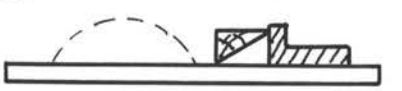
3. O Right
   O Wrong

   O Wood is properly against miter
   O Wood not properly against miter
   O Wood in poor position
   O This wood shape should not be cut on the circular saw
   O None of these



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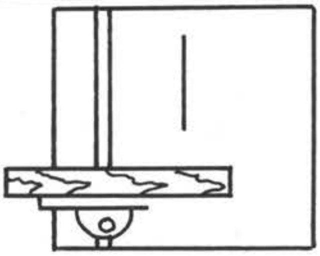
4. O Right
   O Wrong

   O Wood is properly against miter
   O Wood is not properly against miter
   O Wood in poor position
   O This wood shape should not be cut on the circular saw
   O None of these

In problems 5, 6, 7, 8 and 9 consider the wood as being <u>ONE INCH THICK</u>.

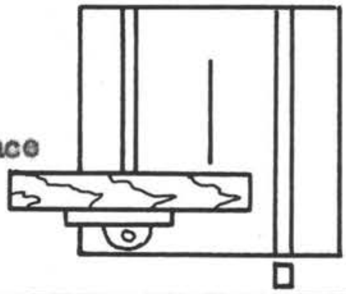
5. O Right
O Wrong

O Wood is properly against miter
O Wood not properly against miter
O Wood in poor position
O This wood shape should not be cut on the circular saw
O None of these



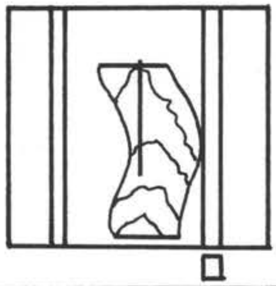
6.* O Right
O Wrong

O Wood is properly against fence
O Wood is not properly against fence
O Wood in poor position
O This wood shape should not be cut in the circular saw
O None of these



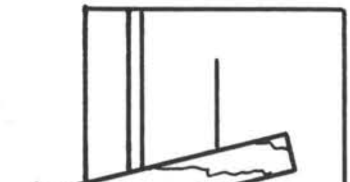
7. O Right
O Wrong

O Wood is properly against miter
O Wood not properly against miter
O Wood in poor position
O This wood shape should not be cut on the circular saw
O None of these



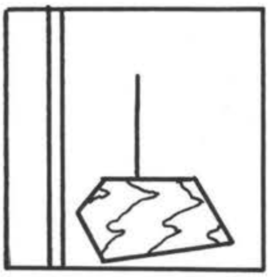
8. O Right
O Wrong

O Wood is properly against miter
O Wood is properly against fence
O Wood in poor position
O This wood shape should not be cut on the circular saw
O None of these



9.* O Right
O Wrong

O Wood is properly against miter
O Wood is properly against fence
O Wood in poor position
O This wood shape should not be cut on the circular saw
O None of these



10. On the circular saw, if the fence is not parallel with the blade, what is the first thing to check?

O The fence with a groove on the table
O The offset screw on the fence
O The table lock
O That the blade is tight on the arbor
O None of these

---

11. When cutting a groove parallel to an edge, which of the following circular saw accessories is used as a guide for the work?

O Miter
O Fence
O Clearance block
O Feather board
O None of these

12.* When the fence is used as a stop gauge to cut several small pieces to the same length on the circular saw, which of the following is used?

O Feather board
O Clamp
O Miter
O Clearance block
O None of these

13.* Two common devices used on the circular saw to cut grooves wider than a saw kerf are

O Dado head
O Hollow ground blade
O Grooving blade
O Wobble saw
O None of these

14.* Kickbacks may occur on the circular saw for the following reasons

O A dull blade
O Saw blade too high
O Saw speed too great
O Splitter guard not used
O None of these

15.* Which of the following describes a safe method of ripping very narrow stock?

O Push the stock through with a push stick
O Push the stock through far enough for a hand-hold beyond the blade, then pull the remainder through
O Rip part way, remove, reverse stick, complete cut
O None of these

16.* Kickbacks may occur on the circular saw for the following reasons

O Push stick not used when necessary
O Not enough set in the saw blade
O Stock being sawed is warped
O Ripping stock with unstraight edge against fence
O None of these

---

17. Comparing the disc sander to the circular saw, the sander revolves at a speed that is

O Greater
O Lesser
O The same

---

18. The saw blade (crosscut, rip or combination) should project about how far above the stock?

O 1/8 inch
O 1/4 inch
O 1/2 inch
O As much as possible
O None of these

---

19. To RIP a board means to cut it

O With the grain
O Across the grain
O At an angle
O On a bevel
O None of these

20.* A combination circular saw blade is used for

O Ripping
O Crosscutting
O Both crosscutting and ripping
O Bevels and angles
O None of these

21.* Which of the following changes is (are) made on the circular saw to adjust for the thickness of grooving and dadoing devices?

O Change throat plate
O Raise saw table (lower saw arbor)
O Remove table insert
O Speed up the machine
O None of these

---

22. How far should the hollow ground circular saw blade project above the stock being cut?

O 1/8 inch
O 1/4 inch
O 1/2 inch
O As much as possible
O None of these

23.* The teeth of a hollow ground circular saw blade have

O No set
O Some set
O Much set

---

24. When ripping a bevel on the circular saw, a tilting table saw has how much advantage over a tilting arbor saw?

O None
O Some
O Much

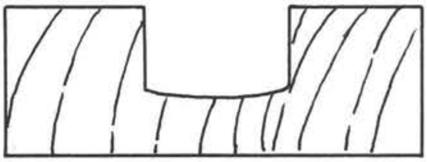
---

25. On the circular saw, does a tilting saw blade have any advantages not found on a tilting table machine?

O Yes
O No

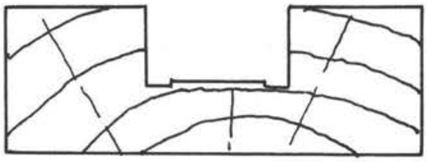
26.* This sketch shows a typical cut made by a

O Dado head
O Wobble saw
O Molding head
O Grooving saw
O None of these

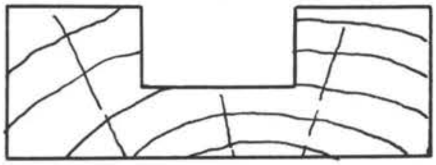


27.* This sketch shows a typical cut made by a

O Dado head
O Wobble saw
O Molding head
O Grooving saw
O None of these



28.* This sketch shows a typical cut made by a



O Dado head
O Wobble saw
O Molding head
O Grooving saw
O None of these

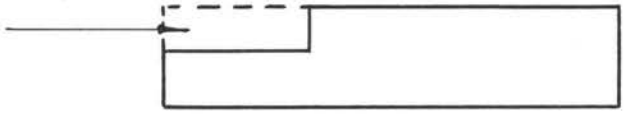
---

29. The cut indicated in the sketch is called a

O Rabbet
O Chamfer
O Bevel
O Dado
O None of these

---

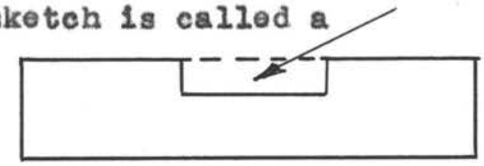
30. The cut indicated in the sketch is called a



O Rabbet
O Chamfer
O Bevel
O Dado
O None of these

---

31. The cut indicated in the sketch is called a



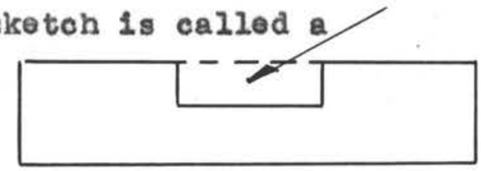
O Rabbet
O Chamfer
O Bevel
O Dado
O None of these

32.* The cut indicated in the sketch is called a

O Rabbet
O Chamfer
O Bevel
O Dado
O None of these

---

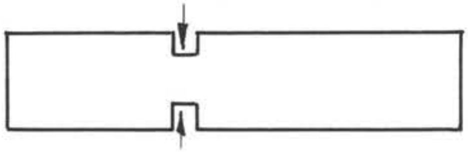
33. The cut indicated in the sketch is called a



O Rabbet
O Chamfer
O Bevel
O Dado
O None of these

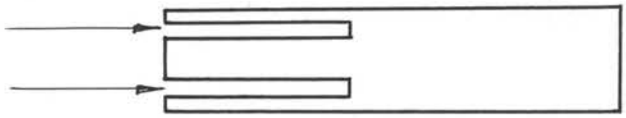
34.* The cut illustrated in the sketch is called a

O Tenon
O Cheek
O Knee
O Shoulder
O None of these



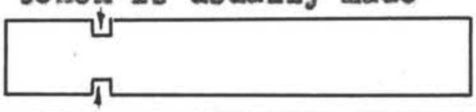
35.* The cut illustrated in the sketch is called a

O Tenon
O Cheek
O Knee
O Shoulder
O None of these



36.* The illustrated cut for a tenon is usually made

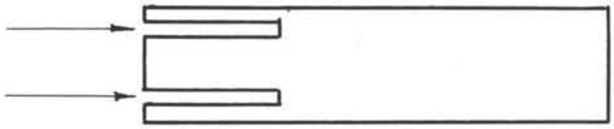
O First
O Last



---

37. The illustrated cut for a tenon is usually made with the aid of the

O Miter
O Jointer
O Tenoner
O Fence
O None of these



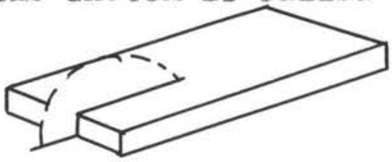
38.* The operation illustrated in the sketch is called

O Resawing
O Ripping
O Crosscutting
O Grooving
O None of these

---

39. The operation illustrated in the sketch is called

O Resawing
O Ripping
O Crosscutting
O Grooving
O None of these



40.* A machine used generally for drilling is called a

O Drill master
O Boring bar
O Jig saw
O Lathe
O None of these

41.* A machine used generally for drilling can also be used to

O Mortise
O Shape
O Cut circles
O Rout
O None of these

42.* Boring tools used to make holes in wood are called

O Drill bits
O Auger bits
O Router bits
O Wood bits
O None of these

43.* The enlargement of a hole in wood with an auger is seldom entirely satisfactory, seldom perfect, but it can be done. Which of the following describes one way you can use?

O Use a planetor bit
O Use a circle cutter
O Start bit easily
O Plug the hole and redrill
O None of these

44.* To prevent wood from splintering around a hole when boring one can

O Dampen wood before drilling
O Drill part way through then reverse piece
O Use a scrap piece under the work
O Run drill at high speed
O None of these

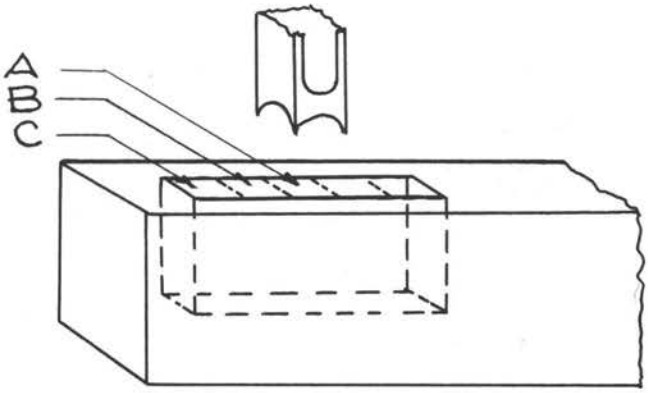
45.* Clearance between mortising bit and chisel should be

O The thickness of paper
O 1/64 inch
O 1/32 inch
O 1/16 inch
O None of these

46.* In what sequence would you cut the rectangular hole indicated in the sketch?

FIRST CUT

O Cut A
O Cut B
O Cut C
O None of these



47.* LAST CUT

O Cut A
O Cut B
O Cut C
O None of these

48.* It is necessary to choose a correct sequence of cuts when making a mortise

O To prevent the wood from splitting
O To prevent the chisel from splitting
O To prevent ends of mortise from slanting
O To prevent the chisel from overheating
O None of these

49.* There should be a clearance between the mortising hold-down and the work of

O A paper thickness
O 1/64 inch
O 1/32 inch
O 1/16 inch
O None of these

50. To keep the mortising bit from sticking use

O Oil
O Grease
O Water
O Wax
O None of these

51. If the mortising chisel clogs it may be because the bit speed is

O Too slow
O Too fast

52.* An auger bit should be operated at a certain speed. Should a mortising bit of the same size be operated at

O Less speed
O Same speed
O Greater speed
O Speed doesn't matter

---

53. The mortising bit is used in making

O Clean round holes
O Holes completely through a board
O Square holes
O Grooves
O None of these

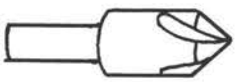
---

54. This tool is called a

O Drill bit
O Center reamer
O Plug cutter
O Auger bit
O None of these

---

55. This tool is called a



O Drill bit
O Center reamer
O Plug cutter
O Auger bit
O None of these

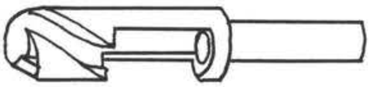
---

56. This tool is called a

O Drill bit
O Center reamer
O Plug cutter
O Auger bit
O None of these

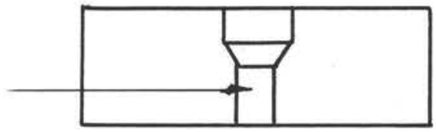
---

57. This tool is called a



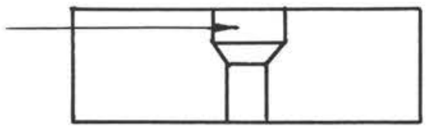
O Drill bit
O Center reamer
O Plug cutter
O Auger bit
O None of these

58.* The tool used to make this part of a screw hole is a



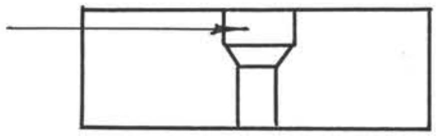
O Drill bit
O Center reamer
O Plug cutter
O Auger bit
O None of these

59.* The tool used to make a piece of wood to fit this part of a screw hole is called a



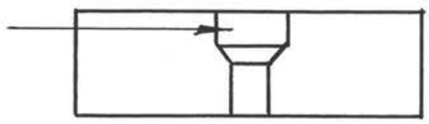
O Drill bit
O Center reamer
O Plug cutter
O Auger bit
O None of these

60.* The tool usually used to make this part of a screw hole is a



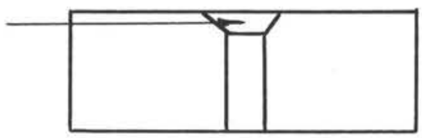
O Drill bit
O Center reamer
O Plug cutter
O Auger bit
O None of these

61.* This part of a screw hole should be made

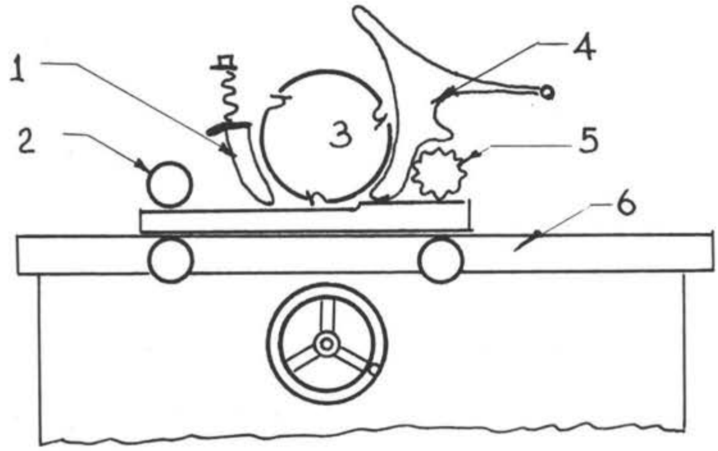


O First
O Last
O Doesn't matter

62.* The tool used to make this part of a screw hole is a



O Drill bit
O Center reamer
O Plug cutter
O Auger bit
O None of these



63. The name of the machine sketched above is

O Jointer
O Planer
O Band saw
O Drum sander
O None of these

64.* The name of the part numbered "1" in the sketch is

O Infeed rolls
O Chip breaker
O Pressure bar
O Drum
O None of these

---

65. The name of the part numbered "2" in the sketch is

O Pressure bar
O Outfeed rolls
O Bed
O Cutter head
O None of these

---

66. The name of the part numbered "3" in the sketch is

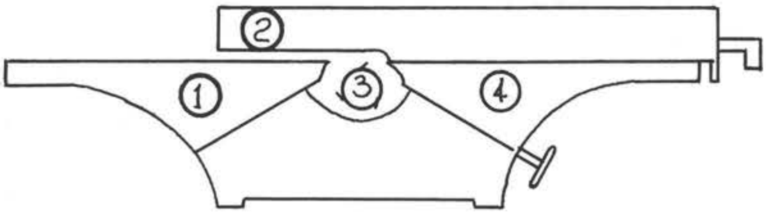
O Outfeed rolls
O Chip breaker
O Cutter head
O Bed
O None of these

67.* The name of the part numbered "4" in the sketch is

O Infeed rolls
O Pressure bar
O Cutter head
O Outfeed rolls
O None of these

68. The shortest piece that can safely be run through the machine sketched on the previous page is never less than the distance between the

- O Chip breaker and infeed rolls
- O Infeed rolls and outfeed rolls
- O Pressure bar and chip breaker
- O Pressure bar and infeed rolls
- O None of these



The following questions refer to the above machine

69. This machine is called a

- O Circular saw
- O Planer
- O Drum sander
- O Shavings machine
- O None of these

70.* Which of these is a push stick for this machine?

- O 
- O 
- O
- O None of these

71.* This machine will

- O Cut one side of a board parallel to the other
- O Never cut one side of a board parallel to the other
- O Leave saw marks on the board
- O Sand the board smooth
- O Do none of these things

72.* This machine will

- O Make a very smooth cut that needs no sanding
- O Leave ripples in the cut surface
- O Not remove saw marks
- O Not cut a rabbet
- O Do none of these

---

73. The name of the part numbered "1" in the sketch is

- O Outfeed table
- O Cutter head
- O Fence
- O Miter
- O None of these

---

74. The name of the part numbered "2" is

- O Outfeed table
- O Fence
- O Infeed table
- O Bed
- O None of these

---

75. The name of the part numbered "3" is

- O Fence
- O Infeed table
- O Cutter head
- O Knives
- O None of these

---

76. The name of the part numbered "4" is

- O Fence
- O Infeed table
- O Cutter head
- O Frame
- O None of these

77.* The fence of this machine will

- O Not tilt
- O Tilt right or left
- O Tilt right only
- O Tilt left only

78.* The cutter head of this machine revolves at a speed that is

- O The same as the circular saw
- O About twice as fast as the circular saw
- O About one-half as fast as the circular saw
- O None of these

79. The guard for this machine is removed for what one operation?

O Rabbeting
O Chamfering
O Beveling
O Sanding edges
O None of these

80.* In cutting a taper on this machine the starting point of the taper is placed on the leading edge of the

O Outfeed table
O Infeed table
O Fence
O Bed
O None of these

81.* The width of a rabbet that can be cut on this machine is determined by

O The length of the cutter head
O The adjustment of the table
O The width of the fence
O The length of the knives
O None of these

---

82. A bevel can be cut on this machine by

O Lowering the table
O Moving the fence to the left
O Raising the table
O Tilting the fence
O None of these

83.* The depth of cut on this machine is determined by setting the

O Position of the depth stop
O Position of the back table
O Position of the front table
O Position of the fence
O None of these

------The following questions refer to the band saw-------

---

84. The band saw blade that clicks when it is being used warns of an impending danger of breaking.

O True
O False

85. The helper should help the band saw operator to guide the work into the saw.

O True
O False

---

86. A helper should be summoned when the work is too large for the band saw operator to handle by himself.

O True
O False

---

87. The principal use of the band saw is to

O Make narrow cuts
O Sand irregular surfaces
O Make curved cuts
O Resaw
O None of these

---

88. To prevent possible injury when a blade breaks the operator should do which ONE of the following:

O Stop the machine immediately
O Open the guard
O Not pull broken blade out of machine

---

89. The band saw should not be backed out of a

O Narrow cut
O Curved cut
O Straight cut

---

90. The blade of the band saw is a

O Continuous blade
O Round blade
O Short, straight blade
O None of these

---

91. The guide post of the band saw is usually placed above the work about

O 1/4 inch
O 1/2 inch
O 3/4 inch
O One inch
O None of these

92. The band saw is operated at a speed that, compared with the circular saw, is

O Less
O The same
O Greater

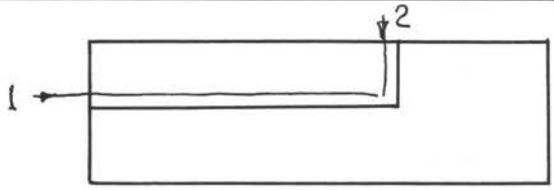
93.* The size of a conventional band saw is determined by

O The size of the throat opening
O The width of the blade
O The height of the machine
O The diameter of the wheels
O None of these

---

94. Of the band saw cuts listed for this piece, which is made first?

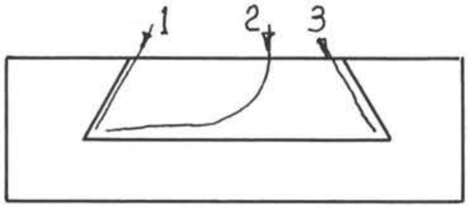
O 1
O 2



---

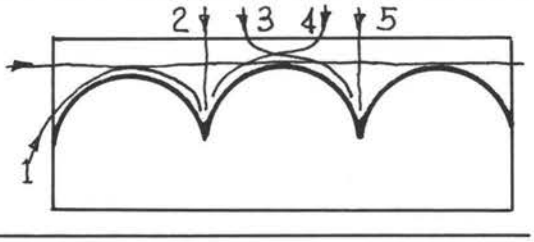
95. Of the band saw cuts listed for this piece, which is made first?

O 1
O 2
O 3



96.* Of the band saw cuts listed for this piece, which is made first?

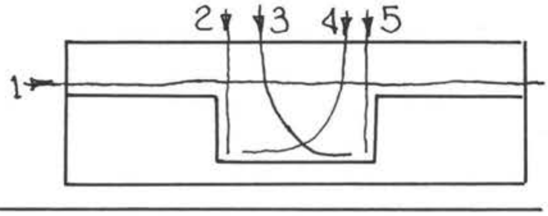
O 1
O 3
O 5



---

97. Of the band saw cuts listed for this piece, which is made first?

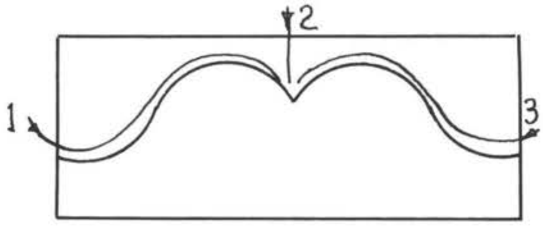
O 2
O 3
O 4



---

98. Of the band saw cuts listed for this piece, which is made first?

O 1
O 2
O 3



99.* The band saw blade usually has

O No set
O Little set
O Lots of set

---

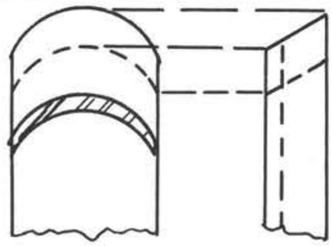
100. The band saw table has a slot so that

O Both halves of the table may be adjusted
O The table will tilt
O The miter may be used on the machine
O The saw may be changed
O None of these

The following questions refer to the lathe and its accessories.

---

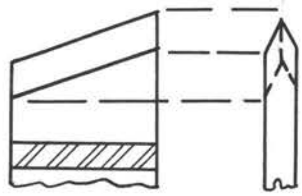
101. This tool is called a



O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

---

102. This tool is called a



O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

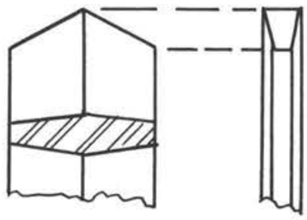
---

103. This tool is called a

O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

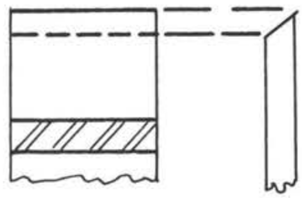
---

104. This tool is called a



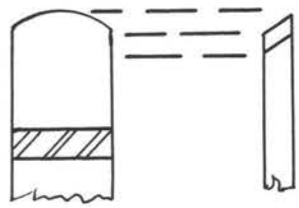
O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

105. This tool is called a



O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

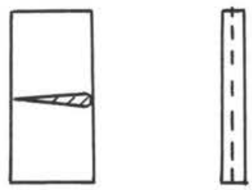
106.* This tool is called a



O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

---

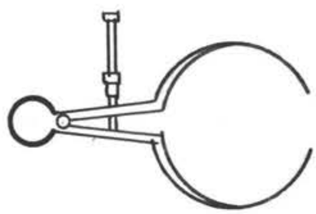
107. This tool is called a



O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

---

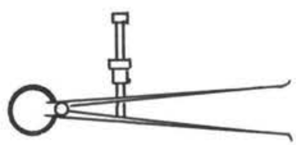
108. This tool is called a



O Divider
O Inside caliper
O Micrometer
O Outside caliper
O None of these

---

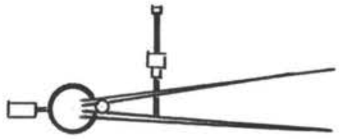
109. This tool is called a



O Divider
O Inside caliper
O Micrometer
O Outside caliper
O None of these

---

110. This tool is called a



O Divider
O Inside caliper
O Micrometer
O Outside caliper
O None of these

111. Which of the following turning tools would you use for roughing off spindle stock?

O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

---

112. Which of the following turning tools would you use to make sizing cuts to a given depth or diameter in spindle stock?

O Skew
O Gouge
O Parting tool
O Diamond point
O None of these

113.* With the possible exception of the skew, lathe tools are sharpened by the use of

O An oil stone
O A file
O Sand paper
O A slip stone
O None of these

114.* Which of the following is (are) shear-cutting tools?

O Diamond point
O Tool rest
O Gouge
O Round nose
O None of these

---

115. Which of the following is (are) scraping tools?

O Caliper
O Skew
O Slip stone
O Round nose
O None of these

---

116. Spindle turning is driven by the

O Live center
O Dead center
O Tool rest
O Tail stock
O None of these

117. The dead center is held by the

O Head stock
O Tool post
O Tail stock
O Cross slide
O None of these

---

118. The live center is attached to the

O Head stock
O Tool post
O Tail stock
O Cross slide
O None of these

---

119. Face plate work is usually turned between centers.

O True
O False

In the following problems select from the listed statements that ONE which will make the BEST completed statement from the standpoint of SAFETY.

1.* If you should need to talk to, or ask a question of, a machine operator you should

O Wait until he is finished
O Yell at him until he stops
O Do something else until he has finished
O Turn the machine off
O Do none of these

---

2. Dull knives on the jointer are not safe because

O They cut too slowly
O They do a poor job of cutting
O More feed pressure is required
O They may cause serious kickbacks
O None of these

---

3. When operating machines it is wise to

O Give the machine some attention
O Be sure the lights are turned on
O Give the machine your undivided attention
O Do your work accurately

---

4. It is good safe practice to avoid pushing the stock across the jointer

O With the thumb on the end of the stock
O With one hand on top of the stock
O With the aid of a helper
O With the back blades in motion
O None of these

---

5. The device used on the jointer and circular saw to prevent injury to the hands is called

O A clearance block
O A C clamp
O A mandrel
O A push stick
O None of these

6. The fence of the jointer

- O May be adjusted while the machine is running
- O May not be adjusted while the machine is running
- O Will tilt either right or left
- O May be adjusted for width of cut
- O None of these

7.* The guard on the jointer is to be

- O In place at all times
- O Removed for rabbeting
- O Placed to cover the back blades
- O In place whenever possible
- O None of these

8.* Stock to be jointed should be

- O Examined carefully
- O Free of knots and splits
- O Run with the grain
- O Run very slowly
- O None of these

---

9. Push sticks (or blocks) are useful to

- O Hold stock down against the table
- O Keep the hand away from danger points
- O Keep the fingers clean
- O Keep the operator farther away from the machine

10.* One must saw carefully with a hollow ground blade because

- O It burns easily
- O It will not cut fast
- O It makes a rough cut
- O It has no set
- O None of these