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A Comparison of Results Obtained by Changing the Amount of Emphasis Placed on Different Aspects of a Seventh Grade Mechanical Drawing Course

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A COMPARISON OF RESULTS OBTAINED BY CHANGING THE AMOUNT OF EMPHASIS PLACED ON DIFFERENT ASPECTS OF A SEVENTH GRADE MECHANICAL DRAWING COURSE

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by

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THIS PAPER IS APPROVED AS MEETING
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George L. Sogge
FOR THE GRADUATE FACULTY

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CHAPTER I

INTRODUCTION

Industrial Arts as a subject area in our public schools has been rediscovered in an era referred to by many as the "Nuclear Age." Advancements in technology now present electronic, atomic, jet, rocket, nuclear, and space considerations.

Never before have the young people in our schools looked ahead to such a vast, new, and unexplored future. Never before have education and industry presented more incentives, opportunities, and rewards for boys and girls with talent and imagination.

In a rapidly changing industrial society, industrial arts helps to orient students to the pertinent aspects of production, consumption, and recreation. These students should be stimulated as never before to cope with the implications of this highly technological age.

No longer can we afford the luxury of having students of mechanical drawing spend a semester or a whole year drawing block forms in order to perfect that one technique. The young junior high school student should be introduced to as many techniques and problem solving activities as he can absorb, with only a minimum time spent on any one facet of the drawing program.

I. THE PURPOSE

It was the purpose of this paper to show that enrichment of the seventh grade mechanical drawing course content results in greater general knowledge of the subject without loss of detail technique.

II. DEFINITION OF TERMS

Mechanical drawing. Mechanical drawing is the graphical representation of objects made with the aid of mechanical devices as contrasted with purely freehand methods. It is often thought of as engineering drawing because it finds its widest use among architects and engineers.

Industrial arts. Industrial arts is the broad study of the materials, organization, tools, processes, products, jobs, and human problems of industry. It has also been defined as a study of the changes made by man in the forms of materials to increase their values and of the problems of life related to these changes.

Industrial design. Industrial design, a graphic art form allied with and stemming from mass production, seeks to integrate industry with our culture. The industrial designer's main contribution is the expression of contemporary art in everyday objects.

Industrial education. This is a generic term including all educational activities concerned with modern industry and crafts, their raw materials, products, machines, personnel, and problems.

Junior high school. This term refers to the unit in public school systems containing seventh, eighth, and ninth grades only and departmentalizing the subject matter areas.

III. OBJECTIVES OF MECHANICAL DRAWING

The greatest use of mechanical drawing is to give graphic instruction to others, generally for the purpose of enabling one person to make what another has designed. What is initially only a picture in the mind of the designer is transmitted to the mind of the worker via the drawing. Mechanically-drawn drawings have been found most efficient for this purpose. The transmission of such knowledge usually calls for a three-dimensional portrayal of the object with detailed information as to precise size and location of component parts. On two-dimensional paper the artist creates a three-dimensional representation with an illusion of depth by observing certain basic rules. His picture must convey all the information. The mechanical draftsman uses his mechanical devices and observes more rigidly formal rules to create a partial picture of the object, but

one supplemented with detailed information in the form of dimensions and notes (11:314).

It is common for all versions of mechanical drawing to depict the object in such a way as to show its front, top, and right sides. The use of additional views permits showing other sides and the interior. In keeping with the usual concept of foreground and background, the draftsman thinks of the near portion as the front and the far portion as the back.

The draftsman creates his drawing on a "picture plane" conceived to lie between him and the object being drawn in the same way that the artist paints his picture on a canvas immediately in front of himself and between himself and the object being pictured. Whereas the artist paints what he "sees," the draftsman places on his drawing an outline without benefit of shades or shadows. These outlines may be considered as the pattern traced on his picture plane by lines of sight (called projectors) from the object to the draftsman's eye (11:315).

IV. LIMITATIONS

This study was principally concerned with the increased amount of general knowledge of the subject resulting from enrichment of the mechanical drawing course content in two comparable seventh grade classes in one junior high school.

No attempt was made to correlate the results with those from other schools or with any national norms.

CHAPTER II

PROCEDURE

In order to compare the relative merits of two different courses of study, it was necessary to give the courses to two quite similar student groups. Accordingly, two seventh grade classes in beginning mechanical drawing at Prosser Junior High School, Prosser, Washington, were selected for this experiment. There were 24 students in each class, both groups heterogeneously composed of "country" boys and "city" boys of comparable chronological age and mental maturity. The control class, given the same course content as in previous years, was designated Group A and the experimental class, given the enriched course content, was designated Group B. Each class was conducted for one hour a day, five days per week, for a total of eighteen weeks. Only the course content was changed; the methods of instruction were kept as nearly identical as possible.

Both groups were taught with identical materials and techniques for the first twenty-six class periods. During this time general drawing and certain basic techniques such as the use of drawing tools, the laying out of a drawing sheet, alphabet of lines, lettering and numbering, and dimensional straight line drawing were introduced. At the end of this period both groups were given a comprehensive test

covering all the basic techniques of drawing, including many advanced skills. This test may be seen in Appendix A. Both groups of students were told of the experiment and urged to put forth their best efforts.

From this point on, Group A was given the traditional course content as outlined in Appendix B, and Group B was given the enriched course as shown in Appendix C.

At the end of eighteen weeks both groups were again given the same test they took at the end of the first twenty-six days. The total scores of Group A students in the pre-test was deducted from Group A's total score in the final test. The same procedure was followed with Group B's scores. The results were the total amounts of gain for each group. Each total was then divided by the number of students in the class to give the average gain per pupil. The difference in average gain between Group A and Group B became the basis for comparing the merits of the two courses in this experiment.

CHAPTER III

PRESENTATION AND ANALYSIS OF THE DATA

As already stated, in order to make an accurate comparison of results obtained from teaching mechanical drawing in two different ways, it was necessary to use two classes that were very similar in chronological age, mental maturity, and social background. It was fortunate that this investigator's seventh grade mechanical drawing classes for the year 1960-1961 at Prosser Junior High School, Prosser, Washington, each with twenty-four students, so admirably met the above requirements.

At the beginning of this experiment Control Group A had an average chronological age of 12.571 years, which compared favorably with the experimental Group B's 12.622 years, a difference of only .051. Group B included slightly larger extremes of 12.07 to 13.36 years as compared to the 12.10 to 13.22 years of Group A, but it is improbable that this difference is significant.

To arrive at a true mental age the results of two recent tests were averaged for each student. These were the Detroit General Intelligence Test and the California Test for Mental Maturity. The totals for all students were combined and the mean for Group A, 107.281, was only .683 less than the 107.964 of Group B. In mental age

Group A had the greater extremes, 70 to 137, as compared to the 86 to 121 of Group B. Again, the small difference of .683 in the means of the two groups was probably not significant. A comparison of chronological and mental maturity ages may be seen in Table I.

Both groups were given identical introductions to mechanical drawing for the first 26 days of the course, the time being fairly evenly divided among the following units of instruction:

1. Class orientation and organization
2. Introduction to drawing
3. Issue and introduction of drawing tools
4. Use of drawing tools
5. Laying out a drawing sheet
6. Locating views and drawing first plate
7. Alphabet of lines
8. Lettering and numbering
9. Dimensional straight line drawing
10. Draw second plate

This introductory section may be seen in Appendix B.

By this time it was felt that the students had sufficient knowledge of the subject to understand the terminology and drawings so that they could intelligently take a general test, the complete text of which may be seen in Appendix A. They were not expected to know all the answers,

TABLE I

A COMPARISON OF THE CHRONOLOGICAL AND THE MENTAL MATURITY AGES

Group	Extremes	Average	Difference
	CHRONOLOGICAL AGE		
A	12.10-13.22	12.571	
B	12.07-13.37	12.622	.051
	MENTAL AGE		
A	70-137	107.281	
B	86-121	107.964	.683

nor were they prepared especially for this particular test. Both groups were tested with certain objectives in mind. These concern the "ability to understand a drawing."

A. Relationship of top, front, and end views.
   1. Knowledge of the shape of the top, front, and end views of an object, given a pictorial view of the object.
   2. Knowledge of the correct placement of the front, top, and end views of a three-view drawing.
   3. Knowledge of which direction is length, width, or thickness in a three-view drawing or pictorial drawing.
   4. Ability to make interpretations about size description, given any combination of views such as pictorial, top, front, and end views.

B. Measurement.
   1. Ability to read a scale or ruler.
   2. Ability to estimate length, sizes, or distances.

C. Line symbols.
   1. Ability to recognize the alphabet of lines.
   2. Show the special use of each line.

The scores made by the students in both classes averaged about the same, Group A having a mean of 56.958 and

Group B 57.25, a very insignificant .292 difference. The high and low extreme scores, as might be expected, followed closely the pattern of the extremes of mental maturity, Group A's wide 24 to 77 raw scores corresponding to the more conservative 35 to 76 of Group B. That the test was not too difficult or unusual was shown by the fact that the average score for both groups was 67 per cent correct out of a possible total of 85 points.

From this point on, the two classes were given different materials, Group A following the testbook Beginning Mechanical Drawing by William E. Roberts. After ten days of free hand sketching on plates 3, 4, 5, and 6, Group A spent most of the remaining part of the semester drawing plates 7 through 26 from the textbook.

Group B drew plates 3 through 10 from the text for 25 days, then turned to sketching for about two weeks. The remainder of the semester was spent mainly with reading and working from the blueprints for woodworkers, metalworkers, and electricians.

During the final week for the semester the same test (see Appendix A) given at the end of 26 class periods was given in exactly the same manner.

Table II shows that Group B made a significantly greater average gain in general mechanical drawing knowledge and ability. Group B made a total average gain of 13.208

TABLE II

A COMPARISON OF THE RESULTS OF THE PRE-TEST WITH THE RESULTS OF THE FINAL TEST GIVEN TO GROUP A AND GROUP B

	Group A	Group B	Difference
Pre-Test			
Extreme High	77	76	1
Extreme Low	24	35	11
Average	56.958	57.25	.292
Mean Percentage	67	67.355	.355
Final Test			
Extreme High	80	85	5
Extreme Low	33	40	7
Average	67.708	70.458	5.75
Mean Percentage	76.11	82.89	6.78
Total Points Gained	7.75	13.208	5.458

grade points or 15.535 percentage points, while Group A improved only 7.75 grade points or 9.11 percentage points, a difference of 5.458 average grade points. In Group A only four students gained more than 10 grade points, the highest being 15, while in Group B 10 students made a gain of more that 10 points, one gaining 24 points between the two tests. On the final test one boy in Group B had a perfect paper of 85 points. Even if Group B's original slight advantage of .292 is deducted from the final test totals, it still leaves a difference of 5.166 grade points or 6.077 percentage points.

CHAPTER IV

SUMMARY AND CONCLUSIONS

I. SUMMARY

This research was carried out to compare the effectiveness of two courses of study in seventh grade mechanical drawing. One course of study, labeled the traditional type and consisting mainly of instrument drawing, was taught to the control class, Group A. The other course of study, labeled experimental, included blueprint reading and freehand sketching with a small amount of instrument drawing was given to Group B.

The two classes each contained twenty-four boys of comparable social background and very evenly matched chronological and mental maturity ages. Both groups were given a comprehensive test after twenty-six days of basic instruction. At the end of the eighteen week's training period the same test was given again in order to show the amount of gain in mean raw score for each group.

Both the control and experimental groups made large enough gains in mean raw score between the initial and final testing so that one can be quite sure the gains were not due to chance happening. Experimental Group B had an average gain of 5.458 points greater per student than did Control Group A.

II. CONCLUSIONS

The very small difference between the mean raw score of the control group and experimental group at the initial testing showed that the two groups were not significantly divergent at that time. In other words, the difference between the means of the raw scores of the two groups on the pre-test could easily have occurred by chance alone.

The mean raw gain score (final testing minus initial testing) for Experimental Group B was significantly greater than the corresponding gain for Control Group A. This difference was large enough to conclude that the gain was influenced by the pupil learning factor. Thus, it is probably safe to conclude that the enrichment of the seventh grade mechanical drawing course by the addition of large amounts of freehand sketching and blueprint reading (with correspondingly less instrument drawing) results in greater general knowledge of the subject. On the basis of this one small experiment, however, it would not be safe to assume that all classes would benefit equally or that the enriched course should be recommended to all teachers. More experimental evidence is needed before such a general conclusion can be drawn.

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APPENDIXES

APPENDIX A

MECHANICAL DRAWING TEST

DIRECTIONS: Each of the following statements has suggested answers, only one of which is correct. Place the letter of the correct answer on the line to the left of the question. (The first question has been answered correctly as an example.)

B 1. Part of a circle is called an (A) object (B) arc (C) isometric.

___ 2. Half of a complete circle contains (A) 360 (B) 75 (C) 180 .

___ 3. The left and right edge of this paper are said to be (A) horizontal (B) parallel.

___ 4. Guide lines are used to keep lettering (A) uniform height (B) connected (C) extended.

___ 5. Circular objects require (A) three views (B) one view (C) two views.

___ 6. The top and end views of an object show the (A) length (B) width (C) thickness.

___ 7. The front view of an object is directly below the (A) top view (B) end view.

___ 8. A right angle contains (A) 180 (B) 45 (C) 90 .

___ 9. Arcs are dimensioned by giving their (A) diameter (B) circumference (C) radii.

___10. The T-square head should be placed on the edge of the drawing board (A) at the top (B) at the bottom (C) at the left edge.

___11. Dimensions that are placed nearest the object are the (A) shortest (B) longest.

___12. Arcs are drawn with a (A) divider (B) compass (C) 6-H pencil.

___13. The scale used in mechanical drawing for measuring is the (A) architect (B) ruler (C) equilateral triangle.

___14. Triangles are so named for their shape which has (A) one angle (B) three angles (C) two angles.

___ 15. A 6-H pencil has lead that is (A) medium (B) soft (C) hard.

___ 16. Vertical lines are drawn from (A) top to bottom (B) bottom to top.

DIRECTIONS: Here are some conventional lines that are generally accepted for use in mechanical drawing. They are the alphabet of lines. In the left column below you find descriptions of lines. Read the descriptions and place the number from the right column which correctly matches these descriptions. (The first is correctly answered as an example.)

b	1. Invisible or hidden lines	a.	_____ _ _____	light
___	2. Construction lines	b.	- - - - - - - -	medium
___	3. Center lines	c.	_____ _ _ _____	heavy
___	4. Border lines	d.	_____	heavy
___	5. Dimension lines	e.	⟵ 5 1/4 ⟶	light
___	6. Cutting plane lines	f.	_____	very light
___	7. Break line	g.	~~~~~	heavy

DIRECTIONS: Below are some statements about the lines described above. Fill the blank with the names of the line which makes the statement correct. The first problem has been correctly answered.

1. A border line is used to enclose or frame a drawing where required.

2. A _____ line is used to show where a section is taken.

3. A _____ line is used as an axis line where circular or symmetrical objects are drawn.

4. _____ lines show where parts are broken away.

5. _____ lines represent edges of the object which are hidden by other parts.

6. _____ lines are used as blocking-in lines in laying out a drawing.

7. _____ lines indicate the direction and limits of measurement.

DIRECTIONS: On the following pages you will find three blueprints. The name of each appears below with the special information and directions for answering the questions listed under each. Be sure to read all directions carefully.

BLOCK

Directions: On this blueprint an isometric view is shown in the upper right hand corner. Below it the top, front, and end views are shown. Using the dimensions on the isometric view, answer the following questions on the blank to the left of the question. (Block blueprint is on page 24.)

_____ 1. What is distance "G"?

_____ 2. What is distance "B"?

_____ 3. What is distance "C"?

_____ 4. What is distance "H"?

_____ 5. What is distance "D"?

_____ 6. How high is this block?

_____ 7. How long is this block?

_____ 8. What is the thickness of this block?

FACEPLATE

Directions: On this blueprint you are shown a picture drawing of the faceplate with no dimensions on it. The other two views are a top view and a font view in full section. Answer the following questions on the blank to the left of the question by comparing the two views. Faceplate drawing is on page 25.

_____ 1. What is the diameter of "A"?

_____ 2. What is distance "B"?

_____ 3. What is the diameter of "C"?

_____ 4. What is the thickness of the base?

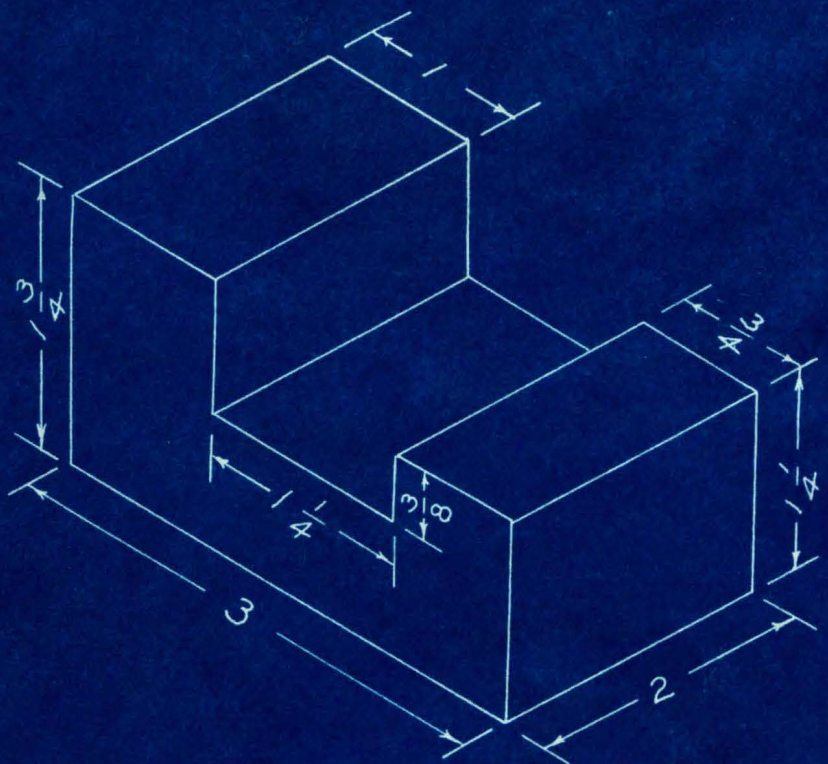
_____ 5. What is the radius of the fillets?

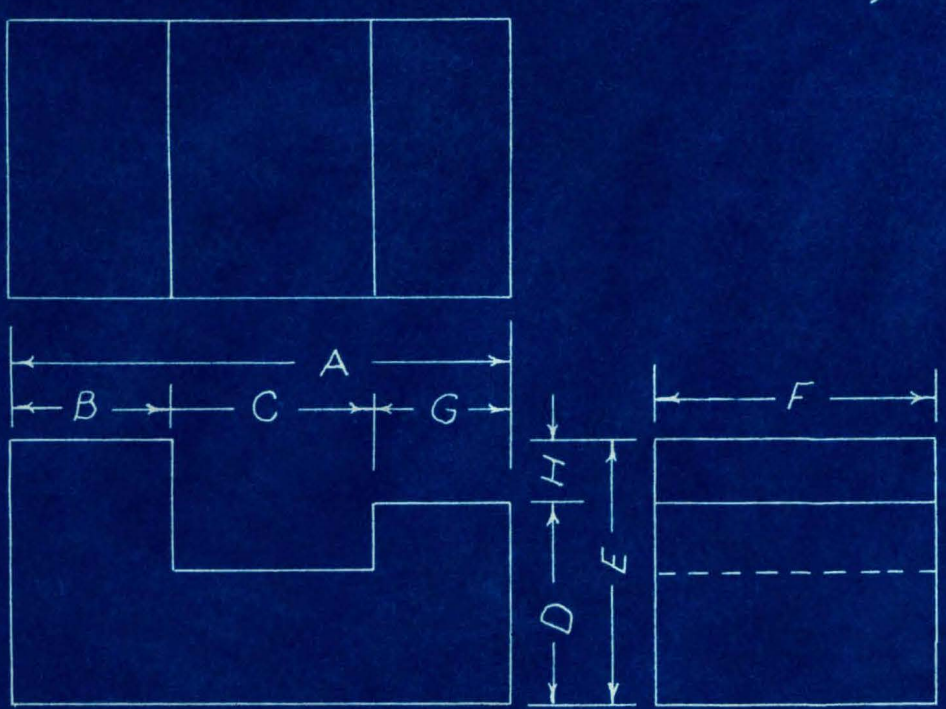
_____ 6. What is the total height of the faceplate?

_____ 7. What is the largest diameter?

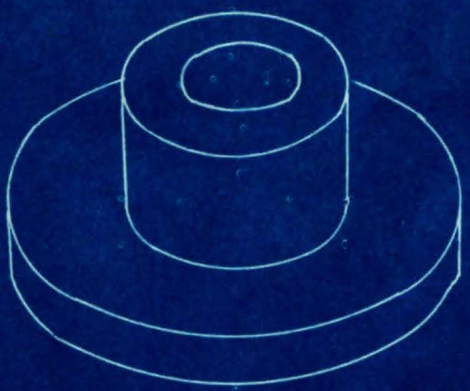
_____ 8. What is the distance from "a" to "b"?

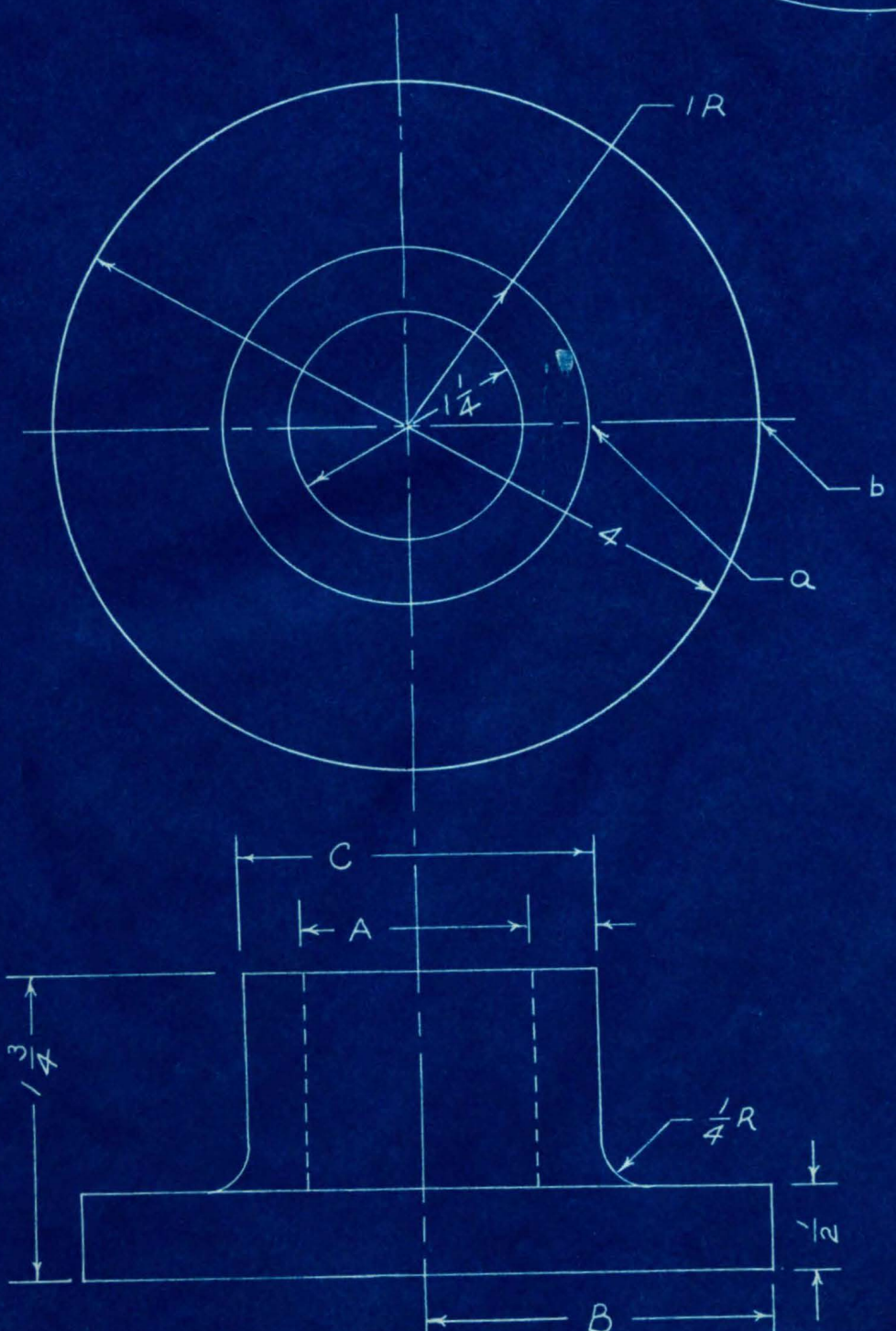
BLOCK





FACEPLATE





LEVER ARM

Directions: The picture view as well as the top and front views are dimensioned for you. Using all three views as a guide, you should be able to answer the questions. You may have to add dimensions in order to answer some of the questions. (Lever arm drawing is on page 27.)

1. Give the following distances.

   A _____ E _____

   B _____ F _____

   C _____ G _____

   D _____

_____ 2. What is the distance from "A" to "B"?

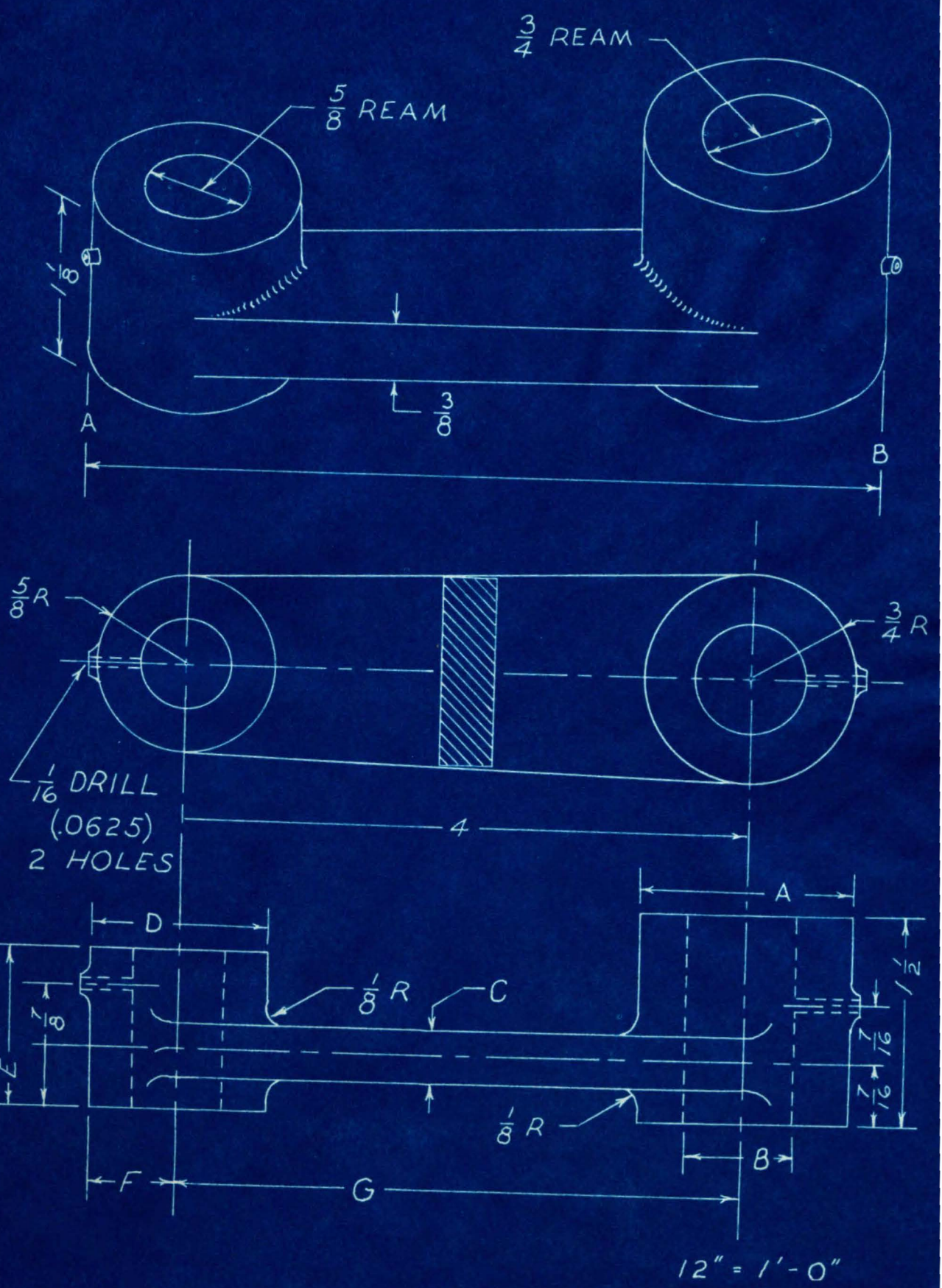
_____ 3. What is the radius of "D"?

_____ 4. What is the radius of "A"?

_____ 5. What is the diameter of the oil holes?

_____ 6. What is the diameter of the largest reamed hole?

LEVER ARM


3/4 REAM
5/8 REAM
1 1/8
3/8
A
B
5/8 R
3/4 R
1/16 DRILL
(.0625)
2 HOLES
4
A
D
1/8 R
C
1/8 R
1 1/2
7/16
7/16
1/8
E
F
G
B
12" = 1'-0"

DIRECTIONS: Below is a drawing of a scale used in mechanical drawing. It is marked in the usual way, divided into 1/16 inch, as a United States Standard Rule. On the blanks to the right of the letters A, B, C, etc. place the dimension which that point shows on the scale. For example: X below points to 1/16 inch, therefore, 1/16 is placed on the blank to the right of X as: X 1/16 .

A _____ H _____ O _____

B _____ I _____ P _____

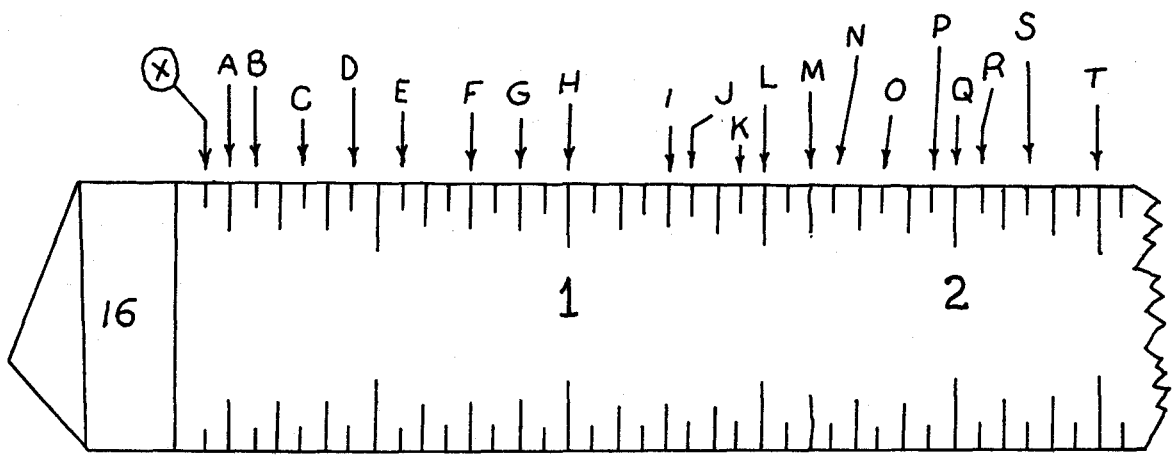
C _____ J _____ Q _____

D _____ K _____ R _____

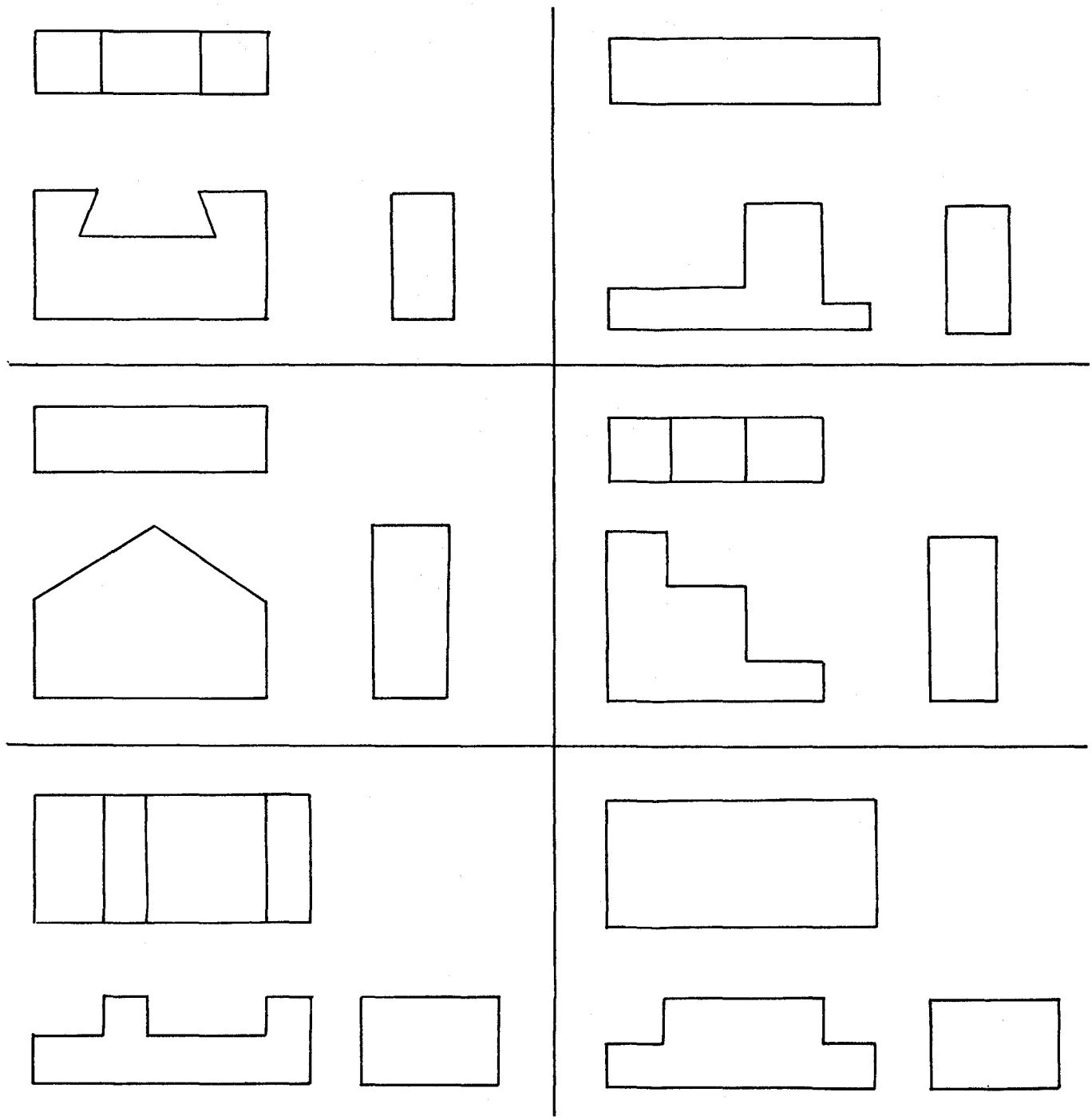
E _____ L _____ S _____

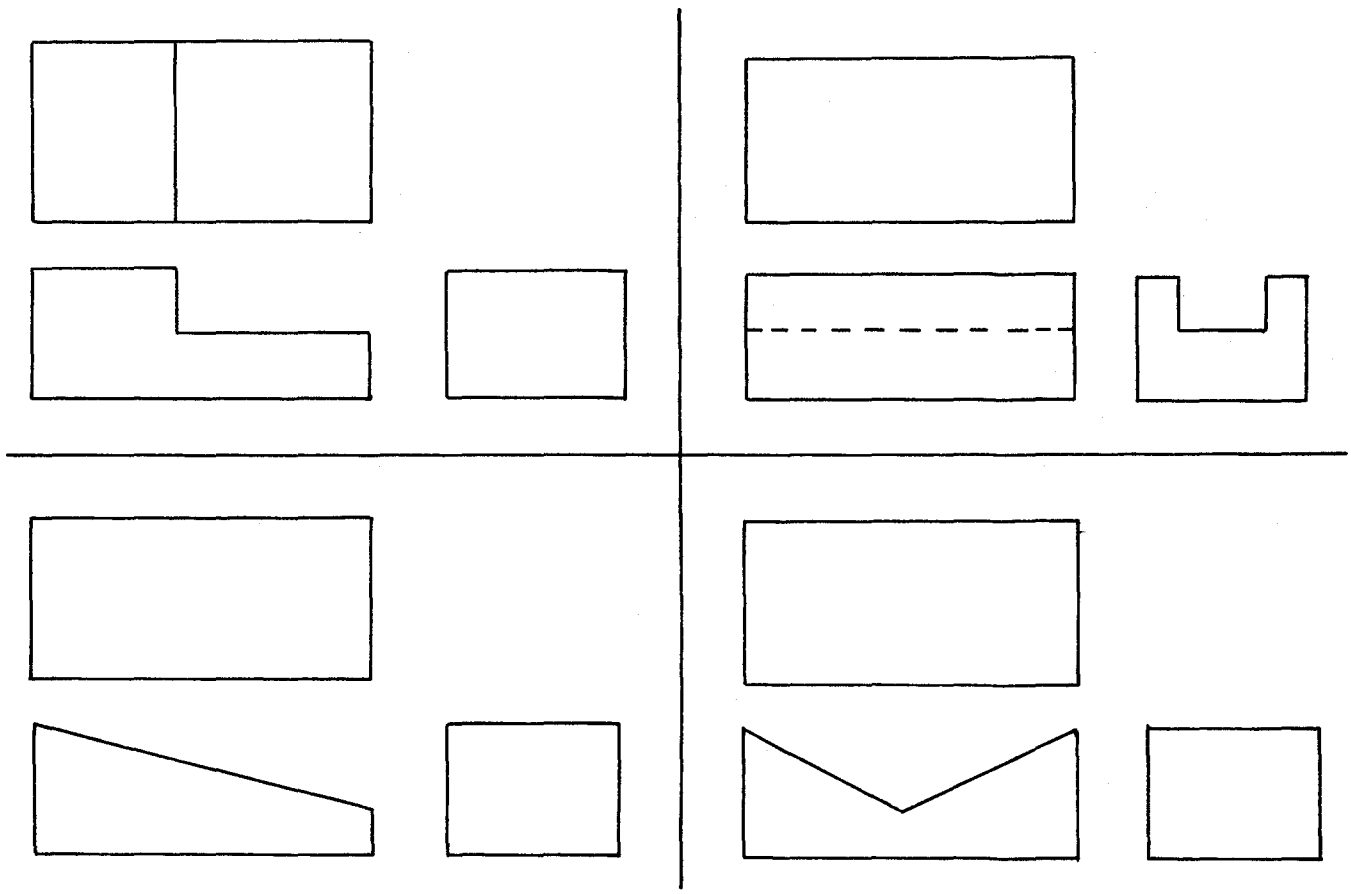
F _____ M _____ T _____

G _____ N _____



Directions: In each of the following ten drawings you are given three views. Some of the views are incomplete. You are to complete either of the incomplete views with an object or hidden line.





APPENDIX B

TRADITIONAL COURSE OF STUDY

TIME	UNITS OF INSTRUCTION	INFORMATION TECHNICAL AND RELATED	COORDINATED ACTIVITIES
2 days	Class orientation and organization	Education, Industrial Arts, and Mechanical Drawing objectives. Class organization Classroom safety and conduct	List objectives--mimeo of all objectives Discuss objectives Select class officers, time-keepers, etc.
2 days	Introduction to drawing	Means of expressing ideas Language of industry Layman understanding History	Show drawings and blueprints of bridges, houses, tools, and shop projects.
2 days	Drawing tools	T-square, triangles, drawing board, pencils (2H-6H), architect's scale, compass, erasers, drawing paper.	Issue tools, check out text-books.
3 days	Use of drawing tools	Fasten drawing paper to drawing board Use of T-square Use of triangles and T-squares Measure and mark distances Draw horizontal and vertical lines	Demonstrate on drawing board the use of each drawing tool and have students do same operation.

APPENDIX B (continued)

TIME	UNITS OF INSTRUCTION	INFORMATION TECHNICAL AND RELATED	COORDINATED ACTIVITIES
2 days	Lay out a drawing sheet	Limits of drawing plate Record strip	Distribute mimeo sheet on lay-out of drawing plate
4 days	Choose and locate views Draw first plate	Top, front and end views Theory of orthographic projection Sandpaper block	Distribute mimeo on centering views Demonstrate: blocking in a working drawing
3 days	Alphabet of lines	Border line, dimension arrow heads, construction, center lines, object lines, cutting plane, hidden lines, break	
3 days	Lettering and numbering	Gothic capitals	Demonstrate freehand lettering on chalkboard
2 days	Dimension straight line drawing	General accepted usages Judgment	Demonstrate: shape and spacing

APPENDIX B (continued)

TIME	UNITS OF INSTRUCTION	INFORMATION TECHNICAL AND RELATED	COORDINATED ACTIVITIES
3 days	Draw second plate	Planer block--3 views	Demonstrate: placement of views placement of dimensions
10 days	Freehand sketching Plates 3, 4, 5 and 6	Techniques of sketching Pictorial views Orthographic sketching Dimensions	Plan views Obliques Isometrics Orthographics
3 days	Plate 7	Rectangular frame--3 views	
3 days	Isometric plate 8	Box--3 views and isometric	Demonstrate isometric centering
3 weeks	Plates 9 to 13	Work at own speed	Check individual progress Demonstrate sections
4 days	Plate 14	Draw to scale "Octagonal Taboret"	

APPENDIX B (continued)

TIME	UNITS OF INSTRUCTION	INFORMATION TECHNICAL AND RELATED	COORDINATED ACTIVITIES
3 days	Compass Dimension circles and arcs Plate 15	Adjust and use a compass	Demonstrate use of a compass and dimensions, arcs, and circles
3 days	Plate 16	Washer 2 views	Review dimensioning
24 days	Plates 17 to 24	Work at own speed Plates include procedures covered in all phases of instruction completed	Check individual work Review as necessary
7 days	Stretch out problems Plates 25-26	Scoop Funnel	Discuss methods of sheet metal work
4 days	Last days of course	Finish plates Check in equipment Test	

APPENDIX C

EXPERIMENTAL COURSE OF STUDY

TIME	UNITS OF INSTRUCTION	INFORMATION TECHNICAL AND RELATED	COORDINATED ACTIVITIES
26 days	First 26 days are the same as the Traditional Course of Study.		
3 days	Plate 3 Isometric	Rectangular frame; 3 views isometric	Demonstrate isometric centering
8 days	Plates 4-6	Plates with 3 views and isometric	Check individual progress
3 days	Plate 7	Adjust and use of a compass; arcs	Demonstrate use of compass
5 days	Plate 8	Bisect lines; arcs; angles Transfer an angle Construct an equilateral triangle; regular hexagon; octagon Draw a circle through 3 points Tangent arcs Use French curves	Demonstrate on chalk board Have students do sample of each geometric figure

APPENDIX C (continued)

TIME	UNITS OF INSTRUCTION	INFORMATION TECHNICAL AND RELATED	COORDINATED ACTIVITIES
3 days	Plate 9	Adjustable shaft support	Go through problem with class
3 days	Plate 10	Link	Check individual work
3 days	Sketching Plate 11	History Techniques of sketching Sketch--square, rectangle, right angle, fillets	Demonstrate construction of alphabet of lines for sketching
1 day	Sections	Solid round, wood Tubular Rectangular Full half and half section	Sketch on chalk board
1 day	Sketch Plate 12	Tool Post Wrench	Go through plate with students
3 days	Sketch Plate 13	Motor pulley Abbreviations AC-Alternating current	Check individual progress
5 days	Blueprint reading	Elements of blueprint reading Symbols: steel shapes; woodwork; electricity Blueprint reader's dictionary	

APPENDIX C (continued)

TIME	UNITS OF INSTRUCTION	INFORMATION TECHNICAL AND RELATED	COORDINATED ACTIVITIES
2 days	Blueprint	Read blueprints and sketch	Have students read and interpret blueprints
6 days	Blueprint Reading for woodworkers Plate 14	Dimensions; joints; fasteners Board measure Foundry rammer	Short quiz
8 days	Blueprint reading for metal workers Plate 15	Fastening Wire size Pattern development Sugar scoop	Short quiz
5 days	Blueprint reading for electricians	Circuits Wire burglar alarm circuit	Test
5 days	Ink tracing Graphs Charts Diagrams and maps	Ink tracing of any completed plate	Demonstrate inking Discuss material on graphs, maps, etc.