5-1959

# A Study for the Purpose of Ascertaining the Basic Units of Instruction for a Unified Drafting Program in Utah High Schools

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# A STUDY FOR THE PURPOSE OF ASCERTAINING THE BASIC UNITS OF INSTRUCTION FOR A UNIFIED DRAFTING PROGRAM IN UTAH HIGH SCHOOLS

by

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A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Industrial Education

UTAH STATE UNIVERSITY
Logan, Utah

1959

ACKNOWLEDGMENTS

Gratefully, I wish to express my appreciation to Dr. William E. Mortimer for the counsel and leadership necessary to complete this study. My committee members, Dr. D. R. Stone, Professor Charles W. Hailes, and Professor Carl R. Wallis, have enthusiastically contributed to the progress of my Master's program.

For my wife, Joyce, I am especially grateful. Encouragement and assistance were always given when needed.

ElMont L. Bingham

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# CHAPTER I

## INTRODUCTION

In recent years industrial arts programs have experienced a rapid increase in student enrollment. This is especially true of the drafting area. The extraordinary rate of industrial development within our state is largely responsible for demands for improved training in high school drafting programs.

The apparent inconsistency of course content being taught in Utah high schools indicates a strong need for a unified drafting program that will meet the challenge of our industrial society.

Recently, in a few of our Utah high schools, drafting courses that seem to be effected by industrial influence have been added to the industrial arts programs. These courses, along with others of a technical nature, have been added to apparently fill a gap that exists between the schools' training and industries' needs. The question is asked: Are industrial arts drafting programs in Utah high schools unified in their efforts to meet the needs of our local industries?

### Purpose

This study proposed to accomplish the following:

1. To determine the value placed upon each unit of instruction in the mechanical drawing program by individual high school instructors and industrial draftsmen in Utah.

2. To determine if any unit sequence was being followed by high school drafting teachers of Utah.

3. To determine what units of drawing were being taught, and how many class periods were being spent on each unit.

4. To obtain suggestions from industrial draftsmen as to what mechanical drawing units should be taught, and how many class periods should be spent on each.

5. To recommend a high school mechanical drawing program that should meet the needs of students in an industrial society.

## Delimitations

The data for this study have been confined to the following: The programs of industrial arts teachers of mechanical drawing in the high schools of Utah who teach at least one period a day, five periods a week, for the entire school year. This study was not concerned with advanced courses of high school mechanical drawing, but only with the first-year programs.

## Method of Procedure

In an effort to make this study as valid as possible, a personal interview was conducted by the author with all Utah industrial arts instructors that qualified for this study. Using the 1958-59 list of "Utah Industrial Arts Instructors," Leonard W. Glismann, Utah State Industrial Arts Director, selected the names of instructors who were probably teaching high school mechanical drawing in the state of Utah.

A self-addressed postal card was then sent to these instructors, asking for their present status. A few follow-up letters completed the final list of qualifying instructors. (Forms used are reproduced in the appendix.)

Twenty-four drafting instructors, whom it was felt could contribute to this study, were then contacted in personal interviews. These interviews were conducted on weekends, during school time, or at any other time an effective discussion could be arranged. Discussion time ranged from thirty minutes to two hours, averaging around fifty minutes.

A standard questionnaire was used in all interviews. The questionnaire contained an explanation of the study, along with three check lists. A copy of this questionnaire is found in the appendix. The textbook, Mechanical Drawing, by French and Svensen (5), was used during the interviews to establish the scope of the units under discussion.

Personal contacts were also made with six leaders of industry in Utah and interviews were arranged with personnel representing their respective drafting departments. In interviewing these men, the procedure was kept as close as possible to that used with the drafting instructors in high schools.

In addition to the data gathered from interviews with the high school instructors and with the personnel of six industries in Utah, the results of a conference organized by the Utah State Industrial Arts Director with nine drafting representatives of Utah industries were also presented to furnish additional information. These results were also used in formulating the conclusions of this study.

## Definitions of Terms

A few terms used within this study have been defined to encourage better understanding between reader and author:

### Industrial arts

Industrial arts refers to a field of study within a general educational curriculum that is concerned primarily with technical arts that are typical of industry. Some of the areas included are: drafting, wood, metal, crafts, leather, electricity, welding, automobile, and others.

### Mechanical drawing (drafting)

This is a basic language used in all of the sciences, engineering professions, homemaking, and most trades and technical fields. In our highly developed industrial society, it is an essential form of communication whereby ideas can be presented to others quickly and vividly. It is a tool through which ideas may be developed and expanded by graphic methods.

### One year's drafting program

This program refers only to the programs of drafting teachers that teach at least one class of mechanical drawing a day, five periods a week, for the full school year.

### Units of instruction

These units are the smaller areas within a mechanical drawing program. In most cases they may be taught as separate areas, such as sketching, shape description, architectural drawing, lettering, sectioning, and others.

# CHAPTER II

## REVIEW OF LITERATURE

Very little has been written pertaining to a unified drafting program for Utah high schools. However, a few excellent studies of a similar nature have been compiled for high school drafting programs in various school systems in the nation. These studies and other written material that seemed applicable to this study are here reviewed.

### Related Studies of High School Drafting Programs

Joseph S. Chick's study of "Drafting for the Pueblo, Colorado, Schools" included the following units of instruction: (2, p. 63)

1. Standards of the department.
2. Definition and use of mechanical drawing.
3. Use and care of instruments.
4. Geometric construction.
5. Angles obtained by combination of triangles.
6. Alphabet of lines.
7. Orthographic projection.
8. Lettering.
9. Dimensioning.
10. Working drawing.
11. Layout of drawing on paper.
12. Detail and assembly drawings.
13. Projection aids.
14. Completion of drawing.
15. Sections.
16. Auxiliary views.
17. Design and original problems.
18. Map reading.
19. Map drawing.
20. Reading charts and graphs.

21. Making charts and graphs.
22. Inking.
23. Tracing.
24. Reproduction.
25. Blue print reading.
26. Drawing from models.
27. Architecture.
28. Architectural drawings.
29. House planning.
30. Pictorial drawings.
31. Machine drawing.

Some of the areas just listed could be combined into fewer units by allowing one unit to represent several related units. For example, architecture, architectural drawing, and house planning might be organized into one unit.

Carl N. Jones, in his study of "Mechanical Drawing for Second Year High School," (9) reviewed sixteen standard texts on mechanical drawing for high schools and found that the content of the books could be grouped under twenty typical subject matter areas. The textbooks were further studied to determine the relative importance the authors attached to the various subject matter areas. The amount of space in all the books was totaled and the per cent of the total devoted to each topic was computed: (9, p. 8)

| Typical Topics | Percent |
|---|---|
| Machine Drawing | 15 |
| Orthographic Projections | 15 |
| Equipment (use and care of) | 9 |
| Architectural Drawings | 7 |
| Developments and Intersections | 7 |
| Applied Geometry | 6 |
| Charts, Diagrams and Graphs | 5 |
| Dimensions and Notes | 5 |
| Lettering | 5 |
| Pictorial Drawing | 4 |
| Sketching | 4 |
| Auxiliary Projection | 3 |
| Duplication, Reproduction | 3 |

| | |
|---|---|
| Sections, Conventions | 3 |
| Electrical Drawings | 2 |
| Perspective | 2 |
| Welding Drawings | 2 |
| Aircraft Drawings | 1 |
| Piping Drawings | 1 |
| Structural Drawings | 1 |

Kenneth A. King's "A Study of Needs in Mechanical Drawing by Employers in Grand Haven, Michigan," (11) sought to determine those units which employers of the community most desired their prospective employees to learn in a high school drawing class. Sixty-six employers were interviewed. He used a check list showing one point as very desirable and five points as undesirable. In the final tally, units were totaled and listed in order from most important to least important: (11, p. 3)

1. Drawing course
2. Freehand sketching
3. Sections
4. Draw from objects
5. Draw details
6. Use of scale
7. Completion drawings
8. Class organization
9. Sheet metal layout
10. Screw threads
11. Moulding foundry
12. Draw assemblies
13. Shop trips
14. Fastenings
15. Moving pictures
16. Pictorial-isometric
17. Pictorial-oblique and cabinet
18. Pictorial-perspective
19. Copy drawings
20. Gears
21. Cams
22. Lettering
23. Symbols-welding
24. Pencil tracing
25. Symbols-electric
26. Symbols-plumbing

27. Ink tracing
28. Inking
29. Making blue prints
30. Sign lettering

Although Floyd C. Allison's study, "Machine Drafting Inventories for Day Trade and Industrial, Evening Trade, Extension, and Defense Training Classes," (1) did not deal directly with secondary education, it was felt that his conclusions had implications of value for this study. He listed the following sixteen units as being desirable in a beginning course of trade drafting: (1, p. 4)

1. Sketching
2. Projections
3. Line Symbols
4. Dimensioning
5. Drafting Pencils
6. Lettering
7. Sections
8. Screw Threads
9. Conventional Breaks
10. Notes and Specifications
11. Standard Materials
12. Tapers
13. Drawing Material
14. Instruments
15. Inking and Tracing
16. Machine Terms and Operations

In 1955 Lyle MacKellar, at Wayne University, conducted a study concerned with courses of study for mechanical drafting in high schools. He quoted summaries from the previously mentioned studies, and formulated both a beginning and an advanced program for the high school level: (12, pp. 42-43)

| Beginning Drafting | Advanced Drafting |
|---|---|
| 1. Introduction | 1. Introduction |
| 2. Use and Care of Instruments | 2. Dimensioning |
| 3. Lettering | 3. Working Drawings |
| 4. Sketching | 4. Auxiliaries |
| 5. Geometric Constructions | 5. Welding Drawings |
| 6. Orthographic Projections | 6. Linkage and Cams |
| 7. Sections and Conventions | 7. Gears and Gearing |
| 8. Dimensioning | 8. Pipe Drawings |
| 9. Inking and Tracings | 9. Shop Practices |
| 10. Pictorial Drawings | 10. Illustration Drawings |
| 11. Blue Print and Other Duplications | 11. Architectural Drawing |
| 12. Fasteners | |
| 13. Sheet Metal Development | |

Henry F. Gerdom conducted a study of drafting methods and practices within Indiana industries and school systems (7, p. 3):

> The purpose of this report is to aid in the determination of certain problems and practices relevant to drafting both within industry and the school system. From the data obtained, we hope to draw certain conclusions which will aid in the formulation of a series of more effective training principles--principles which will aid in formal drafting course instruction within the schools.
>
> The ultimate goal of such a list of training principles is to improve formal drafting instruction so as to provide industry with more adequately and suitably trained products, draftsmen that industry can utilize without adding expense for immense retraining.
>
> Therefore, this study is concerned with five questions:
>
> 1. What drafting training is being done within industry?
> 2. What drafting training is not being done in the schools that should be done in order to make it more effective?
> 3. Are the high schools providing an adequately trained product?
> 4. What does industry desire to have the schools do in the line of training?
> 5. What type of coordination can be set up between the high schools and industry to obtain more effective instruction, and provide industry with draftsmen who are capable and qualified to do the job?

He listed the following methods suggested by industry for the establishment of coordination between the school and industry:

1. Drafting instructors should establish personal contacts with heads of engineering in various plants.
2. Afford drafting students practical shop experience in specific industries followed by experience in the drafting divisions of the various industries.
3. Employ drafting instructors on a part-time basis.
4. Have industrial draftsmen and drafting personnel visit the classroom to explain the functioning of the drafting division and its relation to industry as a whole.
5. Set up a cooperative program to determine industrial drafting needs rather than just teaching the old drafting practices. Drafting instructors should have at least two years' experience in industry. Such experience might be obtained in the summer through part-time employment. It is felt that many high school instructors cannot convey drafting principles to their students because they lack practical experience in the fundamentals of drafting, and hence, their experience is textbook centered as is their course of study.
6. Visitation between school officials and industry to understand industrial requirements and practices.
7. Shop experience on a part-time basis while the student is taking high school drafting course work.
8. A cooperative education program or plan whereby some high school credit can be given for work done in industry under industrial supervision.
9. Drafting instructors should hold interviews with drafting supervisors and heads of drafting divisions of local industry which employs. Through such interviews, instructors will obtain information regarding the weak points of training both their graduates, and in the program.
10. Lengthen the training period of high school drafting programs so that basic fundamentals can be applied to complex industrial drafting problems, hence, providing draftsmen who can do a job without too much retraining.
11. Industry feels that it would be wise to submit progress reports to the schools pointing out the shortcomings of high school graduates or part-time employees.

Logan Guffey's "A Course of Study in General Drawing on the High School Level" listed units of drafting that he felt had value for the schools of Kansas (8). He included:

1. Pictorial sketching
2. Lettering

3. Use and care of equipment
4. Alphabet of lines
5. Geometrical constructions
6. Pictorial drawing and shading
7. Multiview drawing
8. Dimensioning
9. Working drawings
10. Sectional views
11. Auxiliary views
12. Pattern development
13. Home planning
14. Inking
15. Graphs and charts
16. Furniture construction and design

Clifton James Manock, in his study, "Implications for the Secondary School Curriculum Revealed by a Survey of Draftsmen in Industry," (13) sought to ascertain the influence which local industries exert on the objectives of a mechanical drawing course. Data were collected by questionnaires from 175 chief draftsmen of California industries. The results confirmed the value of the common techniques usually taught in high school drafting courses. In addition, the following units were indicated as necessary in certain jobs:

1. Pictorial sketching
2. Shading
3. Analytical geometry

4. Perspective
5. Oblique projection
6. Surface development
7. Proportions
8. Pantographs
9. Photostat

## Periodical Literature Concerned with Education and Industrial Drafting

Arthur H. Rau, of the General Electric Company, Schenectady, New York, wrote on the subject "Industrial Drafting Looks at Industrial Education." Some of his remarks were as follows: (14, p. 43)

> Drafting education has always been primarily concerned with the theory of drawing. The student is impressed with the importance of painstaking exactness in measurement and delineation, and with the necessity for time-consuming elaboration of details. As a result, he emerges an artist, skilled in the theoretical niceties of drafting as an art, but with little knowledge of the practical requirements of industrial drafting.

Further on in his article, Rau listed some specific areas of drawing that he felt should be considered for a more effective drawing program that may represent the needs of industry. These suggestions were as follows: (14, p. 45)

1. Avoid drawing more views than are necessary.
2. Stress orthographic drawing.
3. Simplify drawing whenever possible.
4. Freehand drawing should be used in drafting.
5. Pencil in most cases is used instead of ink.
6. Cut all corners for speed.

J. Gerardi, of the University of Detroit, pointed out a few facts that were aimed at simplified drawing. He challenged the

industry's point of view—that of adopting a simplified drafting program into the schools—and gave as his defense the following reasons: (6, p. 62)

> Industry must assume the responsibility of training its own competent draftsmen. For its own sake, it must give its draftsman training which can be used regardless of his place of employment. If industry really believes in standardization, and if industry wants to reduce its training cost, then the cheapest, best, and most efficient training which can be given to develop competent draftsmen is to teach and advocate the practices which have been acknowledged, debated, reconciled, approved, and standardized by such agencies as the A.S.A., S.A.E., A.S.M.E., A.S.E.E., and others.

> The conclusions are evident. Simplified drafting techniques may be profitable if used locally, but cannot be tolerated where communications involves a large number of people or inconvenient locations.

As another approach to this drafting problem as it fits into a school curriculum, O. A. Embretson, drafting instructor at a vocational and adult school in Racine, Wisconsin, commented on industry and education as follows: (4, p. 16)

> It would seem reasonably urgent that the drafting instructor evaluate his program and course outlines in the light of present-day practices within industry today.

> Of all the students who plan to go on to college or enter fields of employment, only 5% plan to enter a trade but 70% eventually enter a trade. In order to promote a greatly stepped-up program which can be done, management and labor, technical school and high school administrations must sit down together and select proper personnel to organize a much needed training program that will satisfy industry as a whole. Then, too, industry must be sincere in their endeavors by creating vacancies, incentives in pay, and occupational merit which will support the program.

> <u>The gap between industry and schools is much too large.</u>

> The start of a greatly accelerated program in cooperation with industry and school for youth graduating from high school, and those dropping out prior to graduation, must originate in the high schools first with a pre-apprenticeship training program working hand in hand with the technical school.

For the greater share it seems as though the high schools adhere to the objectives to train for higher education with the majority going into various occupations and only less than 5% entering the trades.

Administration should take time out from their desk duties which bog them down and meet this virtually untapped resource for training and accept the challenge with utmost sincerity, and in that way help close the long existing gap between school and industry.

Lawrence S. Wright listed a few conclusions that he felt would help in obtaining a basic understanding about drawing, problem-solving, and industry: (16, p. 35)

1. The methods of thinking through a problem in industry are real day-to-day experiences which follow closely the method of scientific thinking.

2. Drawings and reproductions of drawings used for production by industry are generally the direct outgrowth of problems that have been identified and solved.

3. It appears that if our source of teaching content is from industry, that a part of the work in drawing must be done on a problem solving basis rather than by simply copying line work exercises from the nearest book on engineering drawing.

4. Because the reproductions of shop drawings are the means of communication between the engineer and the industrial worker, and because the reproduction of shop drawings is a basic industrial process, at least one unit of instruction on this topic should be included in the work of the students in drawing.

Robert Jones, of Chicago, Illinois, discussed some interesting ideas in an article he called, "The Lag in Industrial Education and Industrial Application." (10, pp. 34-37)

The emphasis in industrial drafting rooms today is on "time." Time saved in the drafting department reflects on the over-all productivity of the entire organization. That is why simplification in drafting practices is being encouraged by industry.

With today's compact reproduction equipment, there is no reason why a basic understanding of the end use of a drawing cannot be an integral part of the industrial education curriculum.

> Drafting educators should familiarize themselves with the various techniques involved in modern drafting practice. Many methods, changes, deletions, and additions to original drawings can be made without ever touching the original.

Reeves, in his article "Homework for--Ahem--Drafting Students," (15) brought out a few refreshing suggestions for additional units that could supplement a drafting program by outside assignments. He felt that the following units could be handled very effectively by students outside of class:

1. Related information
2. Sketching
3. Preliminary design
4. Occupational information
5. Reading assignments
6. Sketching and designing
7. General information

Mr. Coughlin, in his article "Labor Looks at Drafting Education," expressed in the following paragraph a very real method of bringing the thoughts of industry to the students of high school drawing classes: (3, p. 20)

> One method of cooperation between instructors and industry is arranging periodic visits by students to various areas of industry so they might learn what lies ahead in their chosen careers. Also, lectures by industry representation in schools is a very enlightening adjunct to instruction.

## Summary

In reviewing the literature pertinent to this study, information was gained from the writings of researchers in various schools and

writers in industry. All of these authors were from outside the state of Utah. The following findings and suggestions seemed significant to this study:

1. All the studies concerned with curriculum agreed that certain specific units of instruction were essential in a high school drafting program.

2. There is a need for coordination between drafting in industry and high school drafting training.

3. The industrial writers suggested that if high schools would simplify some of their areas of drafting, the needs of industry would be met more effectively.

4. The increasing demand for drafting personnel in industry necessitates better planning between school administrators and industry.

5. Longer class periods should be assigned to drafting courses in high schools.

6. Students and teachers should visit with drafting departments in industry, and industrial representatives should be invited to visit with school drafting classes to promote better understanding between education and industry.

# CHAPTER III

## BACKGROUND OF THE STUDY

In recent years science and technology have made rapid gains due, in part, to competition in technology between nations of the world. These rapid changes have demanded a re-evaluation of high school curriculums. Within the high school curriculums, industrial arts assumes the responsibility of offering course work that will provide experiences typical of industry.

Industry has expressed the need for more effective training of high school students in various technical areas. One area in which a revision of curriculum seems necessary is drafting. The problems involved in determining what revisions were necessary in drafting programs to meet the needs of an industrial society prompted this study. This study endeavored to establish what units of instruction should be offered in the high school drafting programs of Utah.

After reading various theses, periodicals, texts, and other sources that were related to this study, a plan for collecting data was formulated. The drafting text approved by the state Course of Study Committee, Mechanical Drawing, by French and Svensen, which was used by and was familiar to most of the high school drafting instructors in Utah, was referred to in organizing a check list. This check list and the personal interviews were the main sources of data, and therefore

a clear understanding of what should be included in each unit of instruction was essential to the validity of the study.

Following is a description of these units as used in the interviews and based on the above-mentioned text: (5)

Aircraft drafting in general consists of assembly and detail drawings, but these vary in some respects from the usual machine drawings. For example, assembly drawings may or may not contain some or all dimensions and information. They may show the whole plane, groups of parts, or just one or two parts.

Architectural drafting is concerned with the representation and specification of buildings and structures of various kinds. Although the general principles are the same as for other technical drawings, certain methods of representations, conventional symbols, and practices are necessary because of the relatively small scale used for architectural plans.

Auxiliary views are projections on an auxiliary plane parallel to a slanted surface. They are views looking directly at the slanted surface in a direction perpendicular to it.

Blue print reproduction is a method used to reproduce a penciled or inked tracing onto paper used as the final print, commonly referred to as a blue print.

Cams and gears are machine parts that frequently occur on working drawings. The theory and specifications of cams and gears are important divisions of the study of mechanism, to which the student is referred. The student should, therefore, know how to represent them on drawings.

Charts and graphs are the application of drafting techniques to represent graphically values, tables, ideas, and trends, such as are found in instructional aids.

Electrical drafting is used in making symbols and schematic or line diagrams for showing wiring, circuits, and arrangements of electrical equipment.

Geometric construction is the use of basic fundamentals found in geometry that can be applied to mechanical drawing practices; such as angles, arcs, circles, ellipses, hexagons, involutes, bisecting lines, perpendiculars, ogee curves, tangents, and various other geometric shapes.

Map drafting is essentially one-view drawings of part of the earth's surface.

Mechanical drafting covers areas such as working drawings, detail drawings, and assembly drawings.

Pictorial drawing can be a perspective, isometric, or oblique kind of drawing. It is a one-view drawing that shows two or more sides to an object from one of many possible angles.

Principles of size description are methods of giving information about the size, in addition to the shape description, to give complete information on the working drawing. They are concerned with finished or machined surfaces, systems of dimensioning, lines, figures, arrowheads, use of dimensioning, location dimensioning, use of decimals, standard details, curves, angles, tapers, and notes.

Production illustrations vary from single sketches to elaborate shaded drawings, and they may be based upon any of the

pictorial methods: perspective, oblique, or isometric. Exploded views, space diagrams, rendering, line shading, shading surfaces, and airbrush rendering are some of the techniques used.

Reading and making a drawing consists of studying the views of an object to see what each line means, and from this study deciding how the surfaces that enclose the parts of the object are shaped and exactly where they are located.

Revolutions have a practical purpose, for when working drawings are being made, objects often can be described better by drawing one of the views, or part of a view, in revolved position.

Screws, bolts, and other fasteners which are standardized fastenings call for the use of drafting in designing and building machines. Other engineering projects require a knowledge of certain parts that are often used in their construction.

Sections show hidden detail in views called sections, and may be drawn to show the object as if it were cut apart.

Shape description is based on the principles of orthographic projection by representing solid objects on a sheet of paper in such a manner as to tell the exact shape. This is done by drawing views of the object as seen from different positions, and by arranging these views in a systematic manner.

Sheet metal drafting consists of the representation of the finished object for sheet metal work, and the drawing of the shape of the shape of the flat sheet, which, when rolled or folded and fastened, will form the object.

Sketching is a free-hand approach to drawing that can be used to convey an idea or object without the use of the usual drawing instruments.

Structural drafting is concerned with the drawings made for the framework and supporting members of structures, such as columns, floor members, and roof and bridge trusses.

Techniques of finished drawings apply to the finished appearance of a drawing, by the proper application of the alphabet of lines, symbols, and arrangement of information.

Use and care of instruments refers to the proper respect and use of drafting instruments and of the related equipment, with emphasis on the correct drafting procedures.

Welding drawings make use of ideographic symbols to give the necessary information needed in the welding industry.

# CHAPTER IV

## PRESENTATION OF THE DATA

In organizing this study, it was felt that three areas of data could be collected and measured with good results: (1) data to ascertain what degree of importance (value) teachers of high school drafting and men in industrial drafting assigned to each of the units of instruction found in the Utah high school drafting programs, (2) data to ascertain whether a sequential order of teaching these units had significance, and (3) data to establish how many class periods should be spent on each unit of learning.

In presenting the data, information received from the drafting teachers will be presented first; information collected from industrial draftsmen next; and, finally, the data from these two sources will be compared.

### Response from Teachers

This study was concerned with collecting data from only the high school mechanical drawing instructors of Utah that taught at least one drafting class per day, five periods a week, for the full school year. Twenty-four teachers were interviewed and each completed the three check lists used in the questionnaire. Those participating in the study were from the high schools listed in Table 1.

TABLE 1

HIGH SCHOOLS PARTICIPATING IN STUDY

| High School | Number of Drafting Instructors | Number Interviewed |
|---|---|---|
| Bear River High | 1 | 1 |
| Ben Lomond High | 2 | 2 |
| Bingham High | 1 | 1 |
| Bountiful High | 1 | 1 |
| Box Elder High | 1 | 1 |
| Cedar City High | 1 | 1 |
| Cyprus High | 1 | 1 |
| Davis High | 1 | 1 |
| Dixie High | 1 | 1 |
| East High | 1 | 1 |
| Highland High | 1 | 1 |
| Jordon High | 1 | 1 |
| Logan High | 1 | 1 |
| Murray High | 1 | 1 |
| North Cache High | 1 | 1 |
| Ogden High | 1 | 1 |
| Parowan High | 1 | 1 |
| Payson High | 1 | 1 |
| South High | 1 | 1 |
| Spanish Fork High | 1 | 1 |
| Uintah High | 1 | 1 |

TABLE 1--Continued

| High School | Number of Drafting Instructors | Number Interviewed |
|---|---|---|
| Weber High | 1 | 1 |
| West High | 1 | 1 |
| Total | 24 | 24 |

Teachers' response to unit value

A check list was compiled to ascertain the degree of importance drafting teachers of Utah placed on the various units of instruction within their own mechanical drawing programs. (See Appendix C.) The teachers were requested to circle a number to represent the value assigned to each unit. The values ranged from "very essential unit" (5 points) to "unit of no value (1 point).

Lettering was rated most important by the teachers, closely followed by shape description, sections, and principles of size description. Aircraft and map drafting, welding drawing, and charts and graphs were considered of least importance. (See Table 2.)

Teachers' response to sequential order

To determine if there was any value in teaching these units of instruction in sequential order, the teachers were asked to list the units in the order in which they felt they should be taught.

TABLE 2

VALUE ASSIGNED TO EACH UNIT BY TEACHERS

| Units of Instruction | Mean Value |
|---|---|
| Lettering | 4.83 |
| Shape description | 4.75 |
| Sections | 4.63 |
| Principles of size description | 4.54 |
| Techniques of finish drawing | 4.50 |
| Pictorial drawing | 4.38 |
| Use and care of instruments | 4.29 |
| Auxiliary views | 4.13 |
| Mechanical drafting | 4.00 |
| Geometric constructions | 3.92 |
| Reading and making a drawing | 3.83 |
| Sketching | 3.67 |
| Screws and bolts, etc. | 3.33 |
| Revolutions | 3.00 |
| Architectural drafting | 2.88 |
| Sheet metal drafting | 2.71 |
| Blue print reproduction | 2.58 |
| Cams and gears | 2.21 |
| Productions illustration | 2.21 |
| Electrical drafting | 2.00 |
| Structural drafting | 1.75 |
| Charts and graphs | 1.58 |
| Welding drawing | 1.50 |
| Map drafting | 1.46 |
| Aircraft drafting | 1.21 |

(See Appendix C.) Table 3 lists the units that they felt should be taught in sequential order. Sequential order did not seem to be necessary for any but the 12 units listed in the table.

Values listed in the column to the right of the 12 units were the result of tabulations used to establish the sequential order.

TABLE 3

SEQUENTIAL ORDER OF TEACHING UNITS ACCORDING TO TEACHERS

| Numerical Order | Unit of Learning | Assigned Value |
|---|---|---|
| 1 | Lettering | 439 |
| 2 | Use and care of instruments | 408 |
| 3 | Shape description | 397 |
| 4 | Geometric constructions | 351 |
| 5 | Principles of size description | 333 |
| 6 | Sketching | 323 |
| 7 | Techniques of finish drawing | 300 |
| 8 | Sections | 268 |
| 9 | Auxiliary views | 266 |
| 10 | Pictorial drawing | 253 |
| 11 | Mechanical drafting | 223 |
| 12 | Reading and making drawings | 222 |

Teachers' response to time emphasis

To obtain data regarding the amount of time Utah high school drafting students spent on each unit of learning, a check list was devised to show the number of classroom periods each teacher used in covering the various units. (See Appendix C.) The responses were tabulated and averaged, and the results are shown in Table 4.

The time used by the instructors in teaching the various units ranged from less than one class period to 28 class periods. The greatest amount of time was spent on shape description. Sections, pictorial drawing, and mechanical drafting followed, in order of time spent. The least amount of time was required for welding drawing and map and structural drafting—each of which averaged less than one full class period in the high school curriculums.

Comments from teachers

During the personal interviews with the drafting instructors, important information was obtained that could not be given on the check lists. These remarks are summarized as follows:

Generally, the high school drafting teachers were unified in their mechanical drawing programs. One reason for small differences that did exist was the wide range of total enrollments within our Utah high schools. In large high schools with enrollments of 1,000 students or more, drafting was usually offered for two years. This allowed for an advanced class to be taught the second year. The drafting teachers of smaller schools had less opportunity to offer

TABLE 4

AVERAGE NUMBER OF CLASS PERIODS TEACHERS SPENT ON EACH UNIT

| Unit of Instruction | Average Class Periods |
|---|---|
| Shape description | 28 |
| Sections | 16 |
| Pictorial drawing | 15 |
| Mechanical drafting | 13 |
| Architectural drawing | 11 |
| Lettering | 10 |
| Auxiliary views | 9 |
| Principles of size description | 9 |
| Geometric drawing | 9 |
| Techniques of finished drawing | 8 |
| Sketching | 8 |
| Reading and making drawings | 7 |
| Use and care of instruments | 6 |
| Screws, bolts, and other fastenings | 6 |
| Sheet metal drafting | 6 |
| Revolutions | 5 |
| Blue print reproduction | 3 |
| Electrical drafting | 2 |
| Cams and gears | 2 |
| Production illustration | 1 |
| Charts and graphs | 1 |
| Structural drafting | 1 |
| Welding drawing | 1 |
| Aircraft drafting | - |
| Map drafting | - |

advanced courses in drafting, especially if the drafting teacher had other teaching responsibilities that would allow them to teach only one or two drawing classes. Therefore, in the larger school districts, the first year was usually spent on the fundamentals of mechanical drawing, with the feeling that students wishing to specialize in such areas as architectural drawing could do so during their second year. In the smaller school district, however, the instructors felt that they should cover most of the fundamental units of mechanical drawing as quickly as possible and then include some of the advanced areas, such as architectural drawing, toward the end of the school year.

Drafting teachers of school districts that were not close to large industrial centers felt that their community needs were different in some respects from the needs of communities close to large industries.

## Response from Industry

Data were collected from six industries which employ a large share of the drafting personnel of Utah. The information was gathered, whenever possible, in a manner similar to that used in obtaining data from the Utah high school drafting instructors. In every contact, the people of industry responded, no matter how busy their schedule. In three cases the individuals contacted were not qualified as drafting experts, and security measures prevented contact with the drafting department. In these cases, however, the persons being interviewed consulted with their drafting departments while filling out the check lists.

In some cases, these representatives from industry completed only those check lists covering areas in which they felt qualified. Of the three check lists, they felt least qualified to fill out the one referring to sequential order of teaching the units.

Industry's response to unit values

For those industries that responded to the check list concerned with unit values, the degree of importance was represented by one of five numbers, as was used in rating units of learning by the teachers. (See Appendix C and Table 2, page 25.)

Table 5 lists the units of instruction in order of importance, according to the data gathered from industry. Lettering was felt to be the most important, closely followed by architectural drafting, auxiliary views, and sections. Aircraft drafting and blue print reproduction were felt to be least important.

Industry's response to sequential order

As with the drafting teachers, the people of industry were given a check list to ascertain their thinking on sequential order of teaching the units of instruction. (See Appendix C and Table 3, page 26.)

Industrial personnel expressed little interest in sequential order; they seemed more interested in the material taught. All of the industries did not participate in filling out the check list. One abstained because of lack of available time, and one felt he was not qualified to list the sequential order most effective on a high school

TABLE V

VALUE ASSIGNED TO EACH UNIT BY INDUSTRY

| Unit of Instruction | Mean Values |
|---|---|
| Lettering | 5.00 |
| Architectural drafting<br>Auxiliary views<br>Sections | 4.75 |
| Geometric constructions | 4.50 |
| Sketching<br>Techniques of finish drawing<br>Welding drawing | 4.25 |
| Electrical drafting<br>Mechanical drafting<br>Pictorial drawing<br>Principles of size description<br>Revolutions<br>Shape description<br>Structural drafting | 4.00 |
| Sheet metal drafting<br>Use and care of instruments | 3.75 |
| Cams and gears<br>Charts and graphs<br>Map drafting<br>Reading and making drawings<br>Screws, bolts, and other fasteners | 3.50 |
| Production illustration | 3.25 |
| Blue print reproduction | 2.50 |
| Aircraft drafting | 2.25 |

level. No significant pattern was shown in the tabulation of the information that was given by those who did complete the check list.

## Industry's response to time emphasis

Industrial draftsmen were asked to complete the same check list as was completed by high school drafting teachers in regard to amount of time that should be spent on each unit of instruction. (See Appendix C and Table 4, page 28.)

Table 6 shows the average number of class periods assigned to each unit of instruction by industry. The suggested time to be spent varied from three to sixteen periods for each unit. The greatest amount of time was shown in the tabulation for mechanical drafting. Lettering, shape description, and auxiliary views followed closely. It was recommended that the least amount of time be spent on charts and graphs, map drafting, production illustration, and use and care of instruments.

## Results of nine-industry conference

In addition to the information gained from the foregoing interviews with industrial representatives, the results obtained from a conference involving nine industries of Utah employing draftsmen, conducted by Leonard W. Glismann, Utah State Industrial Arts Director, on June 24, 1959, are herewith presented.

The purpose of this conference was to formulate objectives and to suggest units of instruction that should be offered in Utah high school drafting programs.

TABLE 6

CLASS PERIODS TO BE SPENT ON EACH UNIT AS RECOMMENDED BY INDUSTRY

| Unit of Instruction | Average Class Periods |
|---|---|
| Mechanical drafting | 16 |
| Lettering | 15 |
| Shape description<br>Auxiliary views | 13 |
| Sections | 12 |
| Technique of finish drawing | 10 |
| Geometric constructions<br>Pictorial drawing | 9 |
| Architectural drafting<br>Principles of size description<br>Sheet metal drafting<br>Sketching | 8 |
| Reading and making drawings | 6 |
| Blue print reproduction<br>Electrical drafting<br>Revolutions<br>Screws, bolts, and other fasteners<br>Structural drafting<br>Welding drawing<br>Cams and gears | 5 |
| Aircraft drafting<br>Charts and graphs<br>Map drafting | 4 |
| Production illustration<br>Use and care of instruments | 3 |

The following objectives were agreed upon by members of the conference:

a. Teach students the techniques and abilities which will aid them to obtain and hold a job.

b. Aid students in analyzing their vocational interests.

c. Teach students basic techniques in design and drafting for industry.

d. To acquaint high school students with job opportunities in industry.

e. Give students an understanding and an appreciation of employer-employee problems.

f. Develop in students desirable habits and attitudes for successful employment.

To meet these objectives, this industrial council felt that the following units of instruction should be included in high school drafting programs:

| Unit of Instruction | Hours |
|---|---|
| 1. Introduction | 2 |
| 2. Line Techniques | 6 |
| 3. Lettering | 10 |
| 4. Shape Description Theory | 20 |
| 5. Size Description Theory | 10 |
| 6. Shop Processes | 4 |
| 7. Freehand Sketching | 10 |
| 8. Sections | 20 |
| 9. Auxiliary Views and Revolutions | 20 |
| 10. Machine Detail Drawings | 40 |
| 11. Machine Assembly Drawings | 40 |
| 12. Pictorial Drawings and Rendering | 20 |
| 13. Threads and Fasteners | 10 |
| 14. Developments and Intersections | 20 |
| 15. Cams and Gears | 10 |
| 16. Performance Tests of Skills and Abilities | 10 |
| 17. Industrial Changes: Employment Opportunities and Labor Laws | 4 |
| 18. Employer-Employee Relationships: Applying for and Getting Ahead on the Job | 4 |

| Unit of Instruction (cont.) | Hours |
|---|---|
| 19. Math Problems from Industry . . . . . | 20 |
| 20. Science Problems from Industry . . . | 10 |
| 21. Field Trips . . . . . | 10 |
| 22. Industrial Talks . . . . . | 10 |
| 23. Mapping and Topographic Drawing . . . | 10 |
| 24. Electrical Drafting . . . . . | 10 |
| 25. Architectural Drawing . . . . . | 10 |
| Total | 340* |

*Two periods per day for 34 weeks. This provides a two-week leeway in the school year for extra time needed for opening and closing of school, school extra-curricular activities, etc.

The units of instruction recommended by this council agreed for the most part with the recommendations of teachers and men interviewed in industry. They suggested related information be given, however, which ordinarily cannot be found in approved textbooks; such as, shop processes, performance tests or skills and abilities, industrial changes, employer-employee relationships, math problems from industry, science problems from industry, field trips and industrial talks.

These additional units suggested by the conference are significant to this study and will be used in formulating the conclusions.

Comments from industry

During the personal interviews with men in industry, ideas were expressed that could not be recorded in a check list. These remarks are summarized as follows:

Those contacted in industry were eager to correlate the needs of industry with the curriculum of drafting programs in Utah high schools. Industry was mainly concerned that the basic courses be taught first. Their second suggestion was that greater emphasis be placed upon speed of drawing, rather than on "pretty," time-consuming drawing.

These men in industry felt that more time should be spent in teaching blue print reading than in teaching the students to draw through copy work. The idea of working with actual objects should be stressed more, and reference to textbooks should be used less. There was a feeling that students should be allowed to visit industry in action, to feel the atmosphere and to see the end product.

Another big concern of industry was that more class time should be allowed for the teaching of drafting. They suggested that two periods a day, five days a week, be allowed for the full school year.

The industries working with missile programs are expanding faster than drafting personnel is being trained. In many areas of industry the technicians are constantly in need of a drafting background in order to read the blue prints that are required in the completion of their individual assignments.

In summary, there is a general feeling of urgency in industry for the schools to meet the needs of our industrial society. Industry does not choose to tell how, or what methods should be used to effect this end, but only to suggest what areas should be taught to meet their needs.

The following letter, received from an executive of an important industry in Utah, typifies the feeling found among the men contacted in industry:

> We are pleased to return herewith your Survey on a Unified Drafting Program for Utah High Schools.
>
> You will note from Page 1 that I consider almost every subject to be very essential or essential. The text-book "Mechanical Drawing," by French, covers what I consider to be a minimum basic drafting course for high school programs. Almost every subject in the book is important and should be covered.
>
> I have been unable to fill in Page 5 of your Check List because of the basic limitations you have established for a high school drafting course limited to a total of approximately 130 hours. I do not believe that this amount of time is sufficient for an adequate course to meet the demands of our State, and I feel that a drafting course should cover a minimum of two periods because very little can be accomplished in a 45-minute period. Most of this time is lost in getting started so that actual drafting experience would be negligible. I believe that a minimum high school drafting course should consist of a first year introductory course and a second year advanced course, each consisting of two periods a day, five days a week for the full year.
>
> Drafting is a basic language used in all of the sciences, engineering professions, homemaking and most trades and crafts. In our highly developed industrial society it is an essential form of communication throughout all our activities.

## Comparison of Data from Teachers and Industry

It seemed that a comparison of the data found by interviewing the high school drafting teachers and industrial draftsmen of Utah would be of value. The results of the check lists filled out by these two groups regarding unit value and time emphasis will be compared. No comparison could be made between teachers and industry concerning sequential order, because some of the men in industry interviewed felt unqualified to respond in this area and no pattern was found in the

data. To give some criteria for evaluating the sequential order found in the data obtained from the teachers, this sequence will be compared with that found in the textbook approved for use in Utah high schools, Mechanical Drawing, by French and Svensen (5).

## Comparison of teachers' and industry's responses to unit value

In comparing the data received from teachers and industry, the values assigned to the units were similar in most cases. Lettering was rated the highest in value, with shape description, sections, principles of size description, and techniques of finished drawing also rating high. Some of the units rated as having little value were aircraft drawing, charts and graphs, map drafting, production illustration, and structural drafting. Architectural drawing was rated very high by industry, but was rated relatively low by teachers. See Table 7 for further comparisons.

## Comparison of teachers' response to sequential order with that given in approved text

No valid sequential order was obtained from industry; therefore as a criteria for comparison the first 12 units (exclusive of the introduction) of the approved high school drafting textbook, Mechanical Drawing, by French and Svensen (sixth edition), were compared with the 12 units obtained from the teachers' data.

The findings showed that the first four units were the same, but were listed in a different order. Following these four, the

TABLE 7

COMPARISON OF VALUES ASSIGNED TO EACH UNIT BY TEACHERS AND INDUSTRY

| Unit of Instruction | Teachers' Mean Value | Industry's Mean Value |
|---|---|---|
| Lettering | 4.83 | 5.00 |
| Shape description | 4.75 | 4.00 |
| Sections | 4.63 | 4.75 |
| Principles of size description | 4.54 | 4.00 |
| Techniques of finished drawing | 4.50 | 4.25 |
| Pictorial drawing | 4.38 | 4.00 |
| Use and care of instruments | 4.29 | 3.75 |
| Auxiliary views | 4.13 | 4.75 |
| Mechanical drafting | 4.00 | 4.00 |
| Geometric constructions | 3.92 | 4.50 |
| Reading and making a drawing | 3.83 | 3.50 |
| Sketching | 3.67 | 4.25 |
| Screws and bolts, etc. | 3.33 | 3.50 |
| Revolutions | 3.00 | 4.00 |
| Architectural drafting | 2.88 | 4.75 |
| Sheet metal drafting | 2.71 | 3.75 |
| Blue print reproduction | 2.58 | 2.50 |
| Cams and gears | 2.21 | 3.50 |
| Production illustration | 2.21 | 3.25 |
| Electrical drafting | 2.00 | 4.00 |
| Structural drafting | 1.75 | 4.00 |
| Charts and graphs | 1.58 | 3.50 |
| Welding drawing | 1.50 | 4.25 |
| Map drafting | 1.46 | 3.50 |
| Aircraft drafting | 1.21 | 2.25 |

sequential orders were not in agreement. These results indicated that the state approved text does not follow a sequence favored by the majority of the high school instructors. (See Table 8.)

TABLE 8

SEQUENTIAL ORDER LISTED BY TEACHERS COMPARED WITH APPROVED TEXT

| Teachers' Sequence | Textbook Sequence |
|---|---|
| 1. Lettering | 1. Use and care of instruments |
| 2. Use and care of instruments | 2. Lettering |
| 3. Shape description | 3. Geometric constructions |
| 4. Geometric constructions | 4. Shape description |
| 5. Principles of size description | 5. Sketching |
| 6. Sketching | 6. Reading and making drawings |
| 7. Techniques of finished drawing | 7. Sections |
| 8. Sections | 8. Auxiliary views and revolutions |
| 9. Auxiliary views | 9. Principles of size description |
| 10. Pictorial drawings | 10. Techniques of finished drawing |
| 11. Mechanical drafting | 11. Screws, bolts, and other fastenings |
| 12. Reading and making drawings | 12. Mechanical drafting |

## Comparison of teachers' and industry's responses to time emphasis

In comparing the data collected from teachers and industry, there was significant agreement on most units of instruction in regard to time emphasis. Both groups suggested that more time be spent on shape description, sections, mechanical drafting, pictorial drawing, and lettering; and both groups agreed that little time should be spent on aircraft drafting, map drafting, charts and graphs, structural drafting, and production illustration.

One of the most significant comparisons was that industry suggested that from three to sixteen periods be spent on each unit, while teachers spent from less than one period to 28 periods on the various units.

See Table 9 for further comparisons.

TABLE 9

CLASS PERIODS TO BE SPENT ON EACH UNIT AS RECOMMENDED BY TEACHERS AND INDUSTRY

| Unit of Instruction | Average Class Periods (Teachers) | Average Class Periods (Industry) |
|---|---|---|
| Shape description | 28 | 13 |
| Sections | 16 | 12 |
| Pictorial drawing | 15 | 9 |
| Mechanical drafting | 13 | 16 |
| Architectural drawing | 11 | 8 |
| Lettering | 10 | 15 |
| Auxiliary views | 9 | 13 |
| Principles of size description | 9 | 8 |
| Geometric drawing | 9 | 9 |
| Techniques of finished drawing | 8 | 10 |
| Sketching | 8 | 8 |
| Reading and making drawings | 7 | 6 |
| Use and care of instruments | 6 | 3 |
| Screws, bolts, and other fastenings | 6 | 5 |
| Sheet metal drafting | 6 | 8 |
| Revolutions | 5 | 5 |
| Blue print reproduction | 3 | 5 |
| Electrical drafting | 2 | 5 |
| Cams and gears | 2 | 5 |
| Production illustration | 1 | 3 |
| Charts and graphs | 1 | 4 |
| Structural drafting | 1 | 5 |
| Welding drawing | 1 | 5 |
| Aircraft drafting | - | 4 |
| Map drafting | - | 4 |

# CHAPTER V

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine the units of instruction necessary in drafting programs of Utah high schools to meet the needs of a rapidly growing industrial society.

The data for this study were collected during personal interviews with 24 high school drafting instructors and representatives of six industries which hire industrial draftsmen. All industrial arts drafting teachers of Utah high schools who were teaching at least one mechanical drawing course for a full school year participated in the study. The results of a conference of nine industries interested in training requirements for industrial drafting on a high school level were also used in the study.

A questionnaire was used in all of the interviews, which contained an explanation of the study and three check lists. The check lists were formulated to gain information in three areas: value of each unit of instruction, sequential order of teaching the units, and number of class periods to be devoted to each unit.

### Summary

Following is a summary of the data gathered from the teachers and from the representatives of industry:

Unit value

From the check lists completed by teachers and industry, various units of instruction were rated with values ranging from "very essential unit" (5 points) to "unit of no value" (1 point). Lettering was rated highest by both industry and teachers, and aircraft drawing was rated lowest. In general, both groups agreed in the values placed on the various units of instruction. One exception was architectural drawing, which was rated very high by industry, but rated relatively low with teachers. The list of the units of instruction with the mean value assigned by each group follows:

| Unit of Instruction | Teachers' Mean Value | Industry's Mean Value |
|---|---|---|
| Lettering | 4.83 | 5.00 |
| Shape description | 4.75 | 4.00 |
| Sections | 4.63 | 4.75 |
| Principles of size description | 4.54 | 4.00 |
| Techniques of finished drawing | 4.50 | 4.25 |
| Pictorial drawing | 4.38 | 4.00 |
| Use and care of instruments | 4.29 | 3.75 |
| Auxiliary views | 4.13 | 4.75 |
| Mechanical drafting | 4.00 | 4.00 |
| Geometric constructions | 3.92 | 4.50 |
| Reading and making a drawing | 3.83 | 3.50 |
| Sketching | 3.67 | 4.25 |
| Screws and bolts, etc. | 3.33 | 3.50 |
| Revolutions | 3.00 | 4.00 |

| | | |
|---|---|---|
| Architectural drafting | 2.88 | 4.75 |
| Sheet metal drafting | 2.71 | 3.75 |
| Blue print reproduction | 2.58 | 2.50 |
| Cams and gears | 2.21 | 3.50 |
| Production illustration | 2.21 | 3.25 |
| Electrical drafting | 2.00 | 4.00 |
| Structural drafting | 1.75 | 4.00 |
| Charts and graphs | 1.58 | 3.50 |
| Welding drawing | 1.50 | 4.25 |
| Map drafting | 1.46 | 3.50 |
| Aircraft drafting | 1.21 | 2.25 |

Sequential order

Data received from the teachers indicated 12 units that had sequential value. No pattern of sequential order was found in the data from industry; therefore as a criteria for comparison, the first 12 units (exclusive of the introduction) of the approved high school drafting textbook, Mechanical Drawing, by French and Svensen (sixth edition), were compared with the 12 units obtained from the teachers' data.

The findings showed that the first four units were the same, but were listed in a different order. Following these four, the sequential orders were not in agreement. These results indicated that the state approved text does not follow a sequence favored by the majority of the high school teachers. The sequential orders that were compared were as follows:

| Teachers' Sequence | Textbook Sequence |
|---|---|
| 1. Lettering | 1. Use and care of instruments |
| 2. Use and care of instruments | 2. Lettering |
| 3. Shape description | 3. Geometric constructions |
| 4. Geometric constructions | 4. Shape description |
| 5. Principles of size description | 5. Sketching |
| 6. Sketching | 6. Reading and making drawings |
| 7. Techniques of finished drawing | 7. Sections |
| 8. Sections | 8. Auxiliary views and revolutions |
| 9. Auxiliary views | 9. Principles of size description |
| 10. Pictorial drawings | 10. Techniques of finished drawing |
| 11. Mechanical drafting | 11. Screws, bolts, and other fastenings |
| 12. Reading and making drawings | 12. Mechanical drafting |

Time emphasis

The data indicated that there was general agreement between teachers and industry on the number of class periods that should be spent on each unit of instruction. Teachers felt that the most time should be spent on shape description, however, allotting 28 class periods to this area. Industry felt that the most time should be spent on mechanical drawing, but allotted only 16 class periods to this area. Less than one full class period was given to aircraft drafting and map drafting by teachers. Industry agreed, allowing 4 class periods for

these units. Industry's lowest rating, 3 class periods, was given to production illustration and use and care of instruments. A complete comparison follows:

| Unit of Instruction | Average Class Periods (Teachers) | Average Class Periods (Industry) |
|---|---|---|
| Shape description | 28 | 13 |
| Sections | 16 | 12 |
| Pictorial drawing | 15 | 9 |
| Mechanical drafting | 13 | 16 |
| Architectural drawing | 11 | 8 |
| Lettering | 10 | 15 |
| Auxiliary views | 9 | 13 |
| Principles of size description | 9 | 8 |
| Geometric drawing | 9 | 9 |
| Techniques of finished drawing | 8 | 10 |
| Sketching | 8 | 8 |
| Reading and making drawings | 7 | 6 |
| Use and care of instruments | 6 | 3 |
| Screws, bolts, and other fastenings | 6 | 5 |
| Sheet metal drafting | 6 | 8 |
| Revolutions | 5 | 5 |
| Blue print reproduction | 3 | 5 |
| Electrical drafting | 2 | 5 |
| Cams and gears | 2 | 5 |
| Production illustration | 1 | 3 |
| Charts and graphs | 1 | 4 |

| | | |
|---|---|---|
| Structural drafting | 1 | 5 |
| Welding drawing | 1 | 5 |
| Aircraft drafting | - | 4 |
| Map drafting | - | 4 |

Results of nine-industry conference

The units of instruction recommended by this council agreed for the most part with the recommendations of teachers and men interviewed in industry. They suggested that related information be given, however, which ordinarily cannot be found in approved textbooks; such as, shop processes, performance tests of skills and abilities, industrial changes, employer-employee relationships, math problems from industry, science problems from industry, field trips, and industrial talks.

Comments from teachers and industry

The following comments made by teachers during the interviews seemed pertinent to the study:

1. Drafting programs vary with school enrollment; as large schools can offer advanced drafting classes, while some small schools can offer only a beginning course.

2. Course content will vary between schools offering a one-year course and those offering a two-year course.

3. Drafting instructors carrying teaching assignments other than drafting usually have fewer facilities to work with.

4. Drafting programs will vary depending on local industries and geographical location.

Industrial representatives made the following suggestions for improvement of high school drafting programs during the interviews:

1. Greater emphasis should be placed upon speed of drawing, rather than on "pretty," time-consuming drawing.

2. More time should be spent on blue print reading.

3. More drafting assignments should utilize actual objects, rather than pictures of them.

4. Students should visit various industries to see drafting practices as applied in industry.

5. More class time should be allowed for drafting classes.

## Conclusions

On the basis of the findings of this study, the following conclusions were indicated:

1. Most of the high school drafting teachers of Utah and the representatives of industry were unified in their opinions on value of the units of instruction.

2. Most representatives of industry did not feel qualified to suggest a sequential order for teaching the units, and the state approved text does not follow a sequence favored by the majority of the high school instructors.

3. In general, industry agreed with the teachers on the number of class periods that should be spent on each unit.

4. Some differences existed among teachers regarding time to be spent on each unit, for schools of smaller enrollment usually

offered only one year of drafting, while larger schools could offer a two-year course.

On the basis of the findings of this study, the following drafting program would meet the needs of high school students in an industrial society:

| Units of Instruction | Number of Class Periods | Number of Homework Assignments |
|---|---|---|
| Lettering | 1 | 10 |
| Use and Care of Instruments | 2 | |
| Shape Description | 28 | |
| Geometric Constructions | 9 | |
| Principles of Size Description | 9 | |
| Sketching | 1 | 7 |
| Sections | 16 | |
| Auxiliary Views | 9 | |
| Pictorial Drawing and Rendering | 10 | 5 |
| Mechanical Drafting | 13 | |
| Reading and Making Drawings | 8 | 10 |
| Revolutions | 5 | |
| Threads and Fasteners | 6 | |
| Sheet Metal Drafting | 6 | |
| Electrical Drafting | 2 | |
| Cams and Gears | 2 | |
| Blue Print Reproduction | 3 | |
| Architectural Drawing | 11 | |

| | |
|---|---|
| Charts, Maps, and Graphs | 3 |
| Field Trips | 3 |
| Industrial Talks | 3 |
| Related Math and Science Problems | 5 |
| Employment and Related Problems | 3 |
| Total Class Periods | 175 |

## Recommendations

On the basis of the findings of this study, the following recommendations are made for the improvement of drafting programs in Utah High Schools:

1. Units that can be completed outside of class should be covered in homework assignments, so that more class time would be available for the other units.

2. More emphasis should be placed on blue print reading.

3. After the basic principles of drafting have been taught, more emphasis should be placed on speed of drawing.

4. Students should spend more time on drawing assignments concerned with real objects, rather than pictures.

5. Teachers and students should visit various industries to see how drafting is applied in industry.

6. More related information should be incorporated into drafting programs.

Further studies

Further studies that might prove of value, suggested by the data of this study, were:

1. A study to ascertain the basic units of instruction for a unified drafting program for the advanced or second-year students in high schools of Utah.

2. A study to ascertain the values and problems of adopting a two-period drafting program into the high schools of Utah.

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## LITERATURE CITED


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# A P P E N D I X

APPENDIX A

Ogden, Utah
October 31, 1958

Dear (name of industrial arts teacher):

You were recommended to me by Leonard Glismann as a person teaching a good drafting program at the high school level.

In an effort to complete a study concerned with secondary school drafting programs in the state of Utah, I am looking forward to visiting with you for any helpful contributions you might offer.

By your filling in and mailing the enclosed postal card, I will then be informed of your present teaching program.

Thanks again,

ElMont L. Bingham
Ben Lomond High School
800 Jackson Avenue
Ogden, Utah

ELB/j

Encl.

APPENDIX B

(Self-addressed postal card enclosed with letter)

(Please check proper statement.)

_____ I teach a high school drafting program that is planned for one period a day, 5 days a week, for a full school year.

_____ I teach a drafting program that is planned for a fractional part of a school year.

_____ I teach a drafting program to students of junior high level only.

_____ I do not teach a drafting program.

(Please list below your home address and phone number.)

_____

## APPENDIX C

## QUESTIONNAIRE USED FOR COLLECTING DATA

Value check list

In an effort to ascertain the importance of various units within a secondary drafting course, the following suggested list has been compiled. Any additions or deletions to this list will be gratefully accepted.

Encircle the number to the left of each unit which designates the degree of importance you consider it has in a secondary drafting program.

Very essential unit---5 points

Essential unit-------4 points

Unit of some value---3 points

Unit of little value--2 points

Unit of no value-----1 point

1 2 3 4 5 Aircraft Drafting

1 2 3 4 5 Architectural Drafting

1 2 3 4 5 Auxiliary Views

1 2 3 4 5 Blue Print Reproductions

1 2 3 4 5 Cams and Gears

1 2 3 4 5 Charts and Graphs

1 2 3 4 5 Electrical Drafting

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | Geometric Construction |
| 1 | 2 | 3 | 4 | 5 | Lettering |
| 1 | 2 | 3 | 4 | 5 | Map Drafting |
| 1 | 2 | 3 | 4 | 5 | Mechanical Drafting |
| 1 | 2 | 3 | 4 | 5 | Pictorial Drawing |
| 1 | 2 | 3 | 4 | 5 | Principles of Size Description |
| 1 | 2 | 3 | 4 | 5 | Production Illustration |
| 1 | 2 | 3 | 4 | 5 | Reading and Making Drawings |
| 1 | 2 | 3 | 4 | 5 | Revolutions |
| 1 | 2 | 3 | 4 | 5 | Screws, Bolts, and Other Fastenings |
| 1 | 2 | 3 | 4 | 5 | Sections |
| 1 | 2 | 3 | 4 | 5 | Shape Description |
| 1 | 2 | 3 | 4 | 5 | Sheet Metal Drafting |
| 1 | 2 | 3 | 4 | 5 | Sketching |
| 1 | 2 | 3 | 4 | 5 | Structural Drafting |
| 1 | 2 | 3 | 4 | 5 | Technique of Finished Drawing |
| 1 | 2 | 3 | 4 | 5 | Use and Care of Instruments |
| 1 | 2 | 3 | 4 | 5 | Welding Drawings |

Sequential order check list

To ascertain the value of teaching certain units of secondary drafting in a sequential order, the following suggested check list has been compiled. Any improvements which you can suggest, either by way of additional units or by eliminating some from the list, will be appreciated.

From the alphabetical list on the right, arrange the units in a row on the left hand side of the sheet in the sequential order in which you believe they should be taught.

| Sequential Order | Check List |
|---|---|
| 1._____ | a. Aircraft Drafting |
| 2._____ | b. Architectural Drafting |
| 3._____ | c. Auxiliary Views |
| 4._____ | d. Blue Print Reproduction |
| 5._____ | e. Cams and Gears |
| 6._____ | f. Charts and Graphs |
| 7._____ | g. Electrical Drafting |
| 8._____ | h. Geometric Construction |
| 9._____ | i. Lettering |
| 10._____ | j. Map Drafting |
| 11._____ | k. Mechanical Drafting |
| 12._____ | l. Pictorial Drawing |
| 13._____ | m. Principles of Size Description |

| | |
|---|---|
| 14._____ | n. Production Illustration |
| 15._____ | o. Reading and Making Drawings |
| 16._____ | p. Revolutions |
| 17._____ | q. Screws, Bolts, and Other Fastenings |
| 18._____ | r. Sections |
| 19._____ | s. Shape Description |
| 20._____ | t. Sheet Metal Drafting |
| 21._____ | u. Sketching |
| 22._____ | v. Structural Drafting |
| 23._____ | w. Technique of Finished Drawing |
| 24._____ | x. Use and Care of Instruments |
| 25._____ | y. Welding Drawings |

Time emphasis check list

In an effort to evaluate the time emphasis to be placed on different units within a high school mechanical drawing course, the following suggested list may be checked. You are strongly encouraged to write in any unit which you think should be added to this list and to delete any unit you think should be dropped from this list.

In planning a high school drafting course, it is assumed that each period will be 45 minutes in length, 5 days a week, for at least 35 weeks.

Opposite the units of the following list, place the number of days you believe should be spent on each unit. Upon completion of the list, make certain the total equals 35 weeks (175 days).

| Check List | Number of Days |
|---|---|
| Aircraft Drafting | _____ |
| Architectural Drafting | _____ |
| Auxiliary Views | _____ |
| Blue Print Reproduction | _____ |
| Cams and Gears | _____ |
| Charts and Graphs | _____ |
| Electrical Drafting | _____ |
| Geometric Construction | _____ |
| Lettering | _____ |
| Map Drafting | _____ |
| Mechanical Drafting | _____ |

| | |
|---|---|
| Pictorial Drawing | _____ |
| Principles of Size Description | _____ |
| Production Illustration | _____ |
| Reading and Making Drawings | _____ |
| Revolutions | _____ |
| Screws, Bolts, and Other Fastenings | _____ |
| Sections | _____ |
| Shape Description | _____ |
| Sheet Metal Drafting | _____ |
| Sketching | _____ |
| Structural Drafting | _____ |
| Technique of Finished Drawing | _____ |
| Use and Care of Instruments | _____ |
| Welding Drawings | _____ |