THE VALUES OF MECHANICAL DRAWING IN AN INDUSTRIAL ARTS PROGRAM

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CHAPTER I

INTRODUCTION

In this technical age of advancement, shops in large industries are backed by strong drafting departments. The drafting department sets the pace for the operations of the shop, the morale of the employees, and discipline.

Drafting is a graphic language, according to Spencer, who asserted:

> Drawing, entirely apart from its uses in industry has great value to nontechnical people, simply as a means of expressing ideas effectively. Usually this is done by means of a freehand sketch on the back of an envelope or on a piece of scratch paper. How many times have you heard someone say, when words have failed, "Oh, I guess we'll have to draw him a picture". If a person has good ideas, but no effective way of expressing them to other people, the ideas are apt to get nowhere.[1]

By virtue of its being a graphic language and thus being adaptable to any country, French and Svensen have pointed to it as a form of universal language:

> A projection drawing gives a precise picture of the article to be made, it means the same thing to everyone. Drawings that are made correctly can be used not only in this country, but also with a few changes in countries where people speak different languages.
>
> In this country many different workmen read and use the same drawing. The best way to learn to read them is to learn to make them.[2]

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[1] Spencer, Henry Cecil, Basic Technical Drawing, p. 5.

[2] French, Thomas E., and Svensen, Carl, Mechanical Drawing, p. 11.

Some students entering into high school have had a difficult time when confronted with making the decision whether to take mechanical drawing or to by-pass the course. Some insight into the function of mechanical drawing may be obtained from the following statements by Spencer:

> To help you "find yourself," many schools offer a wide variety of shop or technical courses, such as woodwork, machine shop, electrical work, drafting, and so on. Drafting is considered basic to all of these. It is the principal means of expression of ideas in a technical world - a graphic language which has its own alphabet, grammar, and penmanship. It has been truthfully said that the industrial history of the United States has been written in terms of the graphic language. If you do not understand this language, you will be in a real sense illiterate.
>
> Even if you find yourself in a field only indirectly associated with industry a knowledge of the graphic is essential in order for you to read blue-prints. Regardless of your future vocation, you will have many uses for your knowledge of drafting. Drawing is the oldest type of written expression and is understood the world over. A word is an abstract symbol representing a thing or an idea, but a picture represents an object as it is. "One picture is worth a thousand words," said Confucious. To understand the truth of this, try to tell in words how to build a footstool, a house, or a six-jet bomber! You will find that you cannot accurately and completely describe in words how to make even a simple screw or gear. But no object is so complicated that it cannot be drawn. In fact, if it cannot be drawn first, it cannot be built.[3]

Statement of The Problem

The purpose of this study was to find the values of mechanical drawing and the benefits gained from a course in mechanical drawing in high school, with the endview of determining the advisability of requiring it as a prerequisite for any other shop course.

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[3] Op. cit., p. 1.

The values of mechanical drawing were thought to be best shown in the answers to three questions: What are the motivational effects of mechanical drawing? What are the disciplinary values of mechanical drawing? What is the role of mechanical drawing in developing the ability to visualize?

Procedures

To obtain information from authorities, materials were reviewed in Montana State College library and in the drafting department of Montana State College.

To determine the reactions of industrial arts instructors, questionnaires constructed by the writer were sent to 75 instructors in the high schools of Oregon. The letters and questionnaires were sent to all sections of the state of Oregon, so that a cross section of the entire state was covered in this survey. In addition, a survey was made of some leading industries which used drafting technology in their operations. These were located in California, Oregon, and Washington.

Limitations

Authors of literature were reviewed in Montana State College library and the drafting department.

Industrial arts instructors in the state of Oregon were contacted to find their opinion on mechanical drawing in the shop program. The survey of high school instructors was limited to the state of

Oregon due to time and finances.

To determine the attitude industry had toward mechanical drawing, management was contacted.

Chapter 3 deals with findings on the role of mechanical drawing as viewed by the authorities in literature.

CHAPTER II

REVIEW OF LITERATURE

Man did not evolve from the cave age until he began to adapt his thinking into expressions in sketches and pictures. Historians and authors have given some interesting enlightment on man's graphic communication from ancient to the present time.

Literature in the drafting field was reviewed to determine opinions on the three basic questions regarding mechanical drawing posed in the problem. The findings on the questions are discussed in the sections that follow.

Motivational Effects of Mechanical Drawing

Man's first step in expressing his thinking creatively was by crude sketches and pictures. As man progressed these sketches evolved in an expressive language which is today called mechanical drawing.

Thinking creatively. Although it may be said that creativity is a cause and not an effect of drawing techniques, it may be more the case that the two are so inter-dependent on each other that the role of one is not separate from the other.

Creativity can be expressed in mechanical drawing, and the drawing can open the door to additional expressions of a creative nature.

Historically, Americans have held that creative thinking played an important role in the development of this country.

French and Svensen gave some light on the early Americans in the following statements:

> Americans can take pride in the wide use they make of this pictorial language and in the advances they contributed to the art.
>
> George Washington and his officers used drawing instruments, Thomas Jefferson made plans for Monticello, his beautiful home in Virginia.
>
> At the United States Military Academy where every cadet learns to express his ideas of roads, bridges, machines, buildings, military operations, and so on in a pictorial way, another French Scholar, Claudes Crozet, taught Monge's projections methods of drawing for the first time in this country. American teachers and engineers added to Crozet's work and further developed this pictorial language. West Point graduates, among whom were the first trained engineers of our country, have often contributed to our technical progress. They have drawn pictures and plans for some of our railroads, bridges, public buildings, lighthouses, canals, and atomic energy plants.
>
> We usually find it difficult, and in most cases impossible, to describe in words the appearance of the things we want to make or build. Since we use pictorial sketches, drawings, diagrams, and photographs, today there is hardly a newspaper, magazine, catalogue, or book without them.[3]

Mechanical Drawing as a Language. Mechanical drawing is held by authorities to be a universal language. In support of the idea Svensen gave an interesting account of the importance of drawing:

> From the earliest time to the present, drawings have held an important place in the industries and in all engineering work. Drawings are necessary in planning and describing work to be done, in estimating costs and in explaining methods of procedure to be followed in the making of individual parts as well as in the assembling and erecting of machines and structures.

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[3] French and Svensen, op. cit., p. 2.

> Drawings are made by draftsmen and engineers, but they must be read and understood by all who are associated in any way with the industries. Since this is an engineering age it is necessary for practically everyone to have some knowledge of, and some ability to read drawings, plans sketches, and diagrams. Those who are directly engaged in constructive mechanical work, whether in the engineering office or manufacturing plant, must have working knowledge of the principles involved in the making of drawings.
>
> Drawing is the oldest of all languages, a universal written language, and the only really definite language for use in certain fields of expression.[4]

Disciplinary Values of Mechanical Drawing

In the drafting room the student receives precise disciplined training comparable to that experienced in a foreign language. This was effectively brought out by French and Vierck in the following statement:

> The importance of this graphic language can be seen by comparing it with word languages. All who attend elementary and high school study the language of their country and learn to read, write, and speak it with some degree of skill. In high school and college most students study a foreign language. These word languages are highly developed systems of communication. Nevertheless, any word language is inadequate for describing the size, shape, and relationship of physical objects.[5]

The Drafting Room. The organization of the drafting department is as important to the students as power tools and equipment are to the shop.

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[4]Svensen, Carl Lars, Drafting for Engineers, p. 1-2.

[5]French, Thomas E., and Vierck, Charles J., Fundamentals of Engineering Drawing, p. 3.

Coyle made some recommendations in the following statements:

> It is surprising to find the number of drafting rooms where parts are being drawn with no samples of the part or concept as to the use of the part. Every good drafting room has a "bone yard" where all kinds of parts are accumulated. These should be used by students to help them understand assembly and detailing, and the use of auxiliary views. They should be used for the design of parts that fit and function with these parts. They should be used as examples of manufacturing methods and pieces for which jigs, fixtures, and dies may be designed.
>
> All of the supplies, the instruments, the scales, and the paper should meet industrial standards. Where possible, the procedures should be those used in industry. Reproducing equipment should be large and modern. Drawings should remain on the boards and not be removed each period. The checking should be carried out as is in industry.[6]

Blueprinting and Blueprint Reading. Industries in their manufacturing processes have depended on drawings and blueprints to supply needed information to their workers.

Coyle pointed out that the total atmosphere of the drafting room should be a feeling of orderliness and controlled discipline.[7] This has a basic training concept rather than a concept of reforming which has been given to discipline in recent years.

In the past, people have thought that the reading of blueprints was difficult. This theory has been examined by authorities, as illustrated in the following statements:

> Blueprint reading in the minds of some people is a mysterious and difficult subject, and yet, strange as it may seem, no man engaged in mechanical work is willing to admit that he doesn't know how to read a blueprint.

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[6]Coyle, Frank J., Looking at The Shop Program, The Shop, April, 1961, p.11.

[7]Ibid. p. 11.

> Thus blueprint reading may be likened to the sign language used on the plains. The old trapper may have been able to speak English or French, and Indian only Choctaw or Cherokee, but by means of a sign language they could and did communicate with each other. Their signs were in some cases motions of fingers, in others marks, and each mark had a meaning. To know this sign language of blueprints or mechanical drawing, is very valuable and necessary in many cases. It is a universal language; for the reader may be American and the draftsman French, but the Frenchman can make the drawing so the American can read it. There are two parts to this sign language, the making of the signs (the drawings) and the translation of the signs (blueprint reading).
>
> It is obvious that no matter how good an operator may be he will be much better if he can read blueprints, for he will be able to read from the print just what is to be built and see the part as it will be. Also he has a record or instruction sheet to which he can refer from time to time as the job progresses without having to ask the supervisor question after question.[8]

Development of the Ability to Visualize

Space relations "are particularly important in dealing with things, rather than with people or words".[9]

Familiarity with spatial relations is needed in many areas. Bennett, Seashore, and Wesman pointed this out in the following statement:

> This ability to manipulate things mentally, to create a structure in one's mind from a plan,....It is an ability needed in such fields as drafting, dress designing, architecture, art, die making, and decoration, or wherever there is need to visualize objects in three dimensions.[10]

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[8] Simple Blueprint Reading, The Lincoln Electric Company, p. 3.

[9] Bennett, George K; Seashore, Harold G.; Wesman, Alexander G., Differential Aptitudes Test Manual, p. 5.

[10] Bennett, Seashore, and Wesman, op. cit., p. 7.

One of the most important and underlying objectives in a course of mechanical drawing is the development of student's ability to visualize. Recent research has given some indication of doubt on the effectiveness of mechanical drawing programs in the development of the ability to visualize, but the ineffectiveness may be laid at the feet of uninspired instructors, rather than inappropriate materials.

In the drafting room a student is exposed to new concepts of expression by means of lines, circles, hidden lines, etc., which are called orthographic drawings. Orthographic drawings (some times referred to as working drawings) show the exact sizes and shapes of the parts of an object by means of "views", each of which shows how the object appears from a different direction. The views are systematically arranged on the drawing sheet so the student may mentally connect them together to obtain an imaginary picture of the entire object. The process of forming the mental picture is called "visualization."

From the orthographic drawings the student is then prepared for expressions in isometric or pictorial projections, which can improve his mental ability to see shapes and objects in their true perspective in his mind. An alert instructor can weld these together in the student's mind and improve the ability of the student to "visualize".

After noting what literature had to say about these three questions, the survey of instructors in industrial arts in the state of Oregon was made to determine their attitudes.

The findings of the survey are discussed in Chapter 3.

CHAPTER III

ATTITUDES OF INDUSTRIAL ARTS INSTRUCTORS ON ROLE OF MECHANICAL DRAWING IN HIGH SCHOOLS

To determine the attitudes of industrial arts instructors the writer constructed a questionnaire which was sent to 75 instructors in the state of Oregon.[11] A total of 47 responded to this survey.

The attitudes of industrial arts instructors were reviewed to discover their views on the three questions posed in the problem. The questions are discussed in the following sections.

Motivational Effects of Mechanical Drawing

The survey revealed that 90 percent of the instructors responding agreed that students with drafting experience gained before shop entrance showed more ability in planning projects of their own than those with no previous drafting experience. Of the 47 questionnaires received, 36 indicated a positive difference in shop work with students that had pre-shop training in mechanical drawing compared with those that had none.

Although the instructors surveyed did not make any specific statements regarding the role of mechanical drawing in promoting the ability to think creatively, their feelings can be induced by interpreting the tenor of their responses. In general it can be said of the industrial arts instructors in Oregon that there is much to be gained by all students who take mechanical drawing. In fact, more

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[11] A copy of the questionnaire sent to instructors is included in Appendix B.

than three-fourths of them felt that mechanical drawing would be helpful to any student in school regardless of his educational or vocational plans.

Disciplinary Values of Mechanical Drawing

In the drafting room the student receives precise training in the placement and handling of drawing equipment, cleanliness, neatness of work, and individual work, all of which are disciplinary values that become more effective with proper operation in the drafting room. A wide majority of the instructors (76 percent) felt that some of the skills learned in handling technical instruments were carried in the shop later.

Thirty-five percent of the instructors did not have proper equipment or physical area in which to conduct a successful drafting program and develop disciplinary values. There were 38 instructors who indicated that they were not satisfied with the drafting program in their school, but were hoping to improve their departments. Sixty-eight percent of the instructors held blueprinting and blueprint reading to be important. Footnotes on the questionnaires, written in by the instructors, placed very little value on ink drawings.

Development of the Ability to Visualize

The language of drafting is entirely graphic and written. It cannot be read aloud, but must be interpreted by acquiring a visual

knowledge of the object represented; and the student's success in it will be indicated not alone by his skill in execution, but also by his ability to interpret his impressions and to visualize clearly in space.

The instructors supported this premise, with 90 percent of the responses indicating that students who had mechanical drawing had less trouble in planning their own projects in the shop.

The last area of survey was to determine the attitudes on mechanical drawing of management of some large industries located in California, Oregon, and Washington. The views and opinions gleaned from the questionnaires received from industry are discussed in Chapter 4.

CHAPTER IV

ATTITUDES OF INDUSTRIAL MANAGEMENT IN THE ROLE OF MECHANICAL DRAWING IN HIGH SCHOOLS

To determine attitudes of industrial management on the three basic questions posed in the problem, questionnaires were sent to 12 organizations.[12] The writer constructed a questionnaire which was sent to management of industry. Ten responded in this survey.

The representatives of industry were very much interested in mechanical drawing on the high school level with nine of the ten suggesting that a closer relationship between industry and mechanical drawing departments be established. A closer relationship between the two would certainly enrich the drafting department of any school.

Motivational Effects of Mechanical Drawing

Of the 10 representatives of industry, five felt that there should be more interest aroused in the mechanical drawing throughout the high school. It was also pointed out definitely by the representatives that mechanical drawing was important for their employees, because the employees that had mechanical drawing experience were able to advance more rapidly than the ones who had no drafting.

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[12] A copy of the questionnaire sent to industry is included in Appendix D.

Disciplinary Values of Mechanical Drawing

Industrial managers indicated that they were not in a position to know very much about the organization of procedures in the high school drafting departments in the State of Oregon. However, 60 percent of the representatives stated that ink drawing was not necessary, and a few footnotes indicated that it was a waste of time. This corresponded with the general report of industrial arts instructors.

The importance of blueprinting and blueprint reading was of great concern to the industries, 60 percent indicated that they had to train their employees in the basic principles of blueprint reading.

Development of Ability to Visualize

Even though the language of mechanical drawing is a graphical or written one which industries use all of the time, there was no information as to the development of visualization. Perhaps this type of question may have received more enlightening answers if sent to shop foremen instead of the management.

The opinions of authors as reviewed in literature, surveys of industrial arts instructors, and management of industry will be discussed in Chapter 5.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was made to find the values of mechanical drawing in the high schools of the State of Oregon.

An answer was sought in order to justify mechanical drawing as a prerequisite to shop entrance in the industrial arts departments of the high schools in Oregon.

Summary

To secure the answer to the question, literature was reviewed, industrial arts instructors were contacted by letters of introduction and questionnaires to find their position on mechanical drawing, and representatives of industries who used mechanical drawing and blueprints for their general operations were contacted by letters of introduction and questionnaires to find their views on values of mechanical drawing.

The literature revealed that mechanical drawing has great value for technical and non-technical people because it is a means of expressing ideas effectively. When words fail to express an idea a small sketch on paper may clarify the problem.

Many of the authorities referred to mechanical drawing as a universal or graphic language, recorded by historians as the oldest written form of expressing ideas.

Ninety percent of the industrial arts instructors agreed that students with drafting experience gained before shop entrance were

better prepared and showed more ability in planning projects of their own than those with no previous drafting experience. Industrial management indicated that employees with mechanical drawing experience were able to advance more rapidly.

The disciplinary values of mechanical drawing was held by the authorities to be precise training, comparable to a foreign language. The instructors felt that this precise training in the placement and handling of drawing equipment, cleanliness, neatness of work, and individual work, were all disciplinary values. While industry places heavy emphasis on mechanical drawing, because employees with drafting experience were able to advance more rapidly.

Visualization was held by the authors to be the underlying factor in drafting. Authors brought out how man began from ancient times to draw what he visualized, and has been developing this technique down through the ages. The industrial arts instructors supported the question of visualization with 90 percent stating that students who had drafting had less trouble in planning their own projects in the shop.

Forty-six percent of the industrial arts instructors recommended one full semester of mechanical drawing as the minimum amount of time to be given to each student before entering the shop program. All of the instructors held that students who have mechanical drawing before going into shop were better prepared to plan their own projects more effectively.

One whole year for mechanical drawing was recommended by 80 percent of the representatives of industry, while the other 20 percent

suggested two years as the minimum for high schools.

Industry and industrial arts instructors agreed that ink drawing was a waste of time due to the recent developments in reproduction.

Representatives of industry were most anxious to cooperate with high schools in developing the mechanical drawing departments.

Conclusions

As a result of this study the writer has come to these conclusions:

1. The present mechanical drawing programs should not only be maintained, but there should be a definite move in expanding this course. If industry wants people who have had as much as two years of training, then this may be used as an indication that the programs which the schools are supporting in general are falling short of a desirable goal.

2. Mechanical drawing should be a prerequisite to shop entrance, as the instructors surveyed indicated that those students who have had mechanical drawing are better prepared and better able to carry out individual projects.

3. Ink drawings should not be a part of the curriculum. Modern reproducing techniques have eliminated the need for such time-consuming processing in the training of students.

4. Industry is more than willing and ready to cooperate with the schools in improving the curriculum. It should be noted

that this is on the school's terms. Industry has shown that it is willing to lead out in this respect, and the tremendous resource material can be available to the schools, if the schools go after it.

Recommendations

The writer recommends that some study be made in the smaller schools with small budgets and those that have crowded conditions in the shop areas, to find out how mechanical drawing may be integrated into the total shop program.

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APPENDIX

APPENDIX A

Letter Sent to Instructors

Halfway, Oregon
Jan. 1, 1960

Fellow Instructors,

This letter is to introduce a questionnaire concerning the values of mechanical drawing in an industrial arts program.

This study is to be used as partial fulfillment of requirements for a Master of Education degree. I have selected this field in an attempt to further the work already done in the state of Oregon in mechanical drawing.

If this happens to be outside of your present teaching field, this is your opportunity to express an opinion as to how the course should be set up and its value in the shop area.

All returns will be strictly confidential. Feel free to take as much liberty as you wish in making comments and criticism on any or all items. Use the back of the form for additional suggestions.

Please fill in the questionnaire and return at your earliest convenience.

Thank you in advance for your cooperation.

Sincerely yours,

George Savchenko

APPENDIX B

Questionnaire Answered By Instructors

Answer all questions with yes or no, except number 2.

1. Do you have mechanical drawing in your school? _____

2. If yes to above question, do you favor nine weeks or one semester? _____

3. Do you have proper drawing desks and equipment for mechanical drawing? _____

4. Do you consider drafting as a course in which the student learns a skill in handling technical instruments? _____

5. Would you consider the skills learned in handling technical instruments are carried into shop operations? _____

6. In your experience did you notice any difference in shop work from students who had mechanical drawing and those who did not? _____

7. Do you place any value in ink drawings and blueprint reading? _____

8. At present technical advancement in industry do you favor more emphasis on mechanical drawing in high school? _____

9. Should there be a closer correlation between industry and mechanical drawing in high school? _____

10. Do students in your school take keen interest in mechanical drawing? _____

11. Would you suggest mechanical drawing only for those students who plan to go into some phase of engineering? _____

12. Would you consider mechanical drawing helpful to the student regardless what his present plans may be? _____

13. Should there be more interest aroused in this field in the high schools of Oregon? _____

14. Does your community (as a whole) favor mechanical drawing in your high school? _____

15. Are you satisfied with the drafting department in your school? _____

16. Do you require mechanical drawing as a prerequisite to shop entrance? _____

17. If your answer is yes in question 16, were students required to draw some project which they made in the shop? _____

18. Do students that have drafting experience before shop entrance show advanced ability in planning projects of their own over those that had no drafting experience? _____

APPENDIX C

Letter Sent to Industry

Halfway, Oregon
Jan. 1, 1960

Dear Sirs:

This letter is to introduce a questionnaire concerning the values of mechanical drawing in an industrial arts program.

This study is to be used as partial fulfillment of requirements for a Master of Education degree. I have selected this field in an attempt to further the work already done in the State of Oregon in mechanical drawing. I am also interested in what industry may have to say about mechanical drawing in the high schools.

If you are not directly connected with drafting in your company this will give you an opportunity to express an opinion on mechanical drawing in the high schools.

All returns will be strictly confidential. Feel free to take as much liberty as you wish in making comments and criticisms on any or all questions. Use the back of the form for additional suggestions.

Please fill in the questionnaire and return at your earliest convenience.

Thank you in advance for your cooperation.

Sincerely yours,

George Savchenko

APPENDIX D

Questionnaire Answered by Industry

Answer all questions with yes or no, except number 8.

1. In your opinion should there be a closer relationship between industry and mechanical drawing in high school? _____

2. Does your company employ many workers who are not on highly technical jobs, but still must have training in reading blueprints? _____

3. Should there be more interest aroused in this field throughout the high schools? _____

4. Do you train many of your employees the basic principles in blueprint reading? _____

5. Is your company interested that all employees learn the basic rules of blueprint reading? _____

6. Does an employee who has had mechanical drawing in high school advance more rapidly than the one who had none? _____

7. Although the secondary schools are not directly connected with the industrial world, would you suggest that more training in mechanical drawing would bring more rapid advancement to the employee and render more efficient service to the employer? _____

8. What would be your suggested length of time in mechanical drawing for a student in high school (circle one) six weeks, nine weeks, one semester, one whole year, or two years?

9. In our age of technical advancement would you be in favor of all boys in high school having some mechanical drawing before graduation? _____

10. In your judgement would you say that the present mechanical drawing programs offered in our schools are efficient enough for the current industrial expansion? _____

11. Should blueprinting be taught along with mechanical drawing? _____

12. Do you place any value on ink drawing? _____