FREEHAND DRAWING AS AN APPROACH TO DRAFTING THEORY AT THE SECONDARY SCHOOL LEVEL

by

FRANKLIN B SHESLER

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APPROVED: [redacted]

Head of Department of Industrial Education

In Charge of Major

[redacted]

Chairman of School Graduate Committee

[redacted]

Dean, Graduate School

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CHAPTER I

INTRODUCTION

Drafting, the nucleus of industrial activity and advancement, has been expressed widely as the "language of industry" in order to accent its extreme importance in this technological age. The evolution of present industrial production methods has placed heavy demands on careful planning for the attainment of peak efficiency. Mass production has depended on drafting, not only in scheduling and directing individual efforts toward a common end, but in minimizing trial and error procedure; thus a high degree of efficiency has been achieved. Technological advancement has resulted by amalgamating the visions of the industrial scientist, the inventor, and the designer through this medium of concise, graphic expression. From the inception of an idea through its incubation period and finally to the realization of its intended purpose, drafting, in varied form, has been instrumental in the modifications effecting its refinement.

All who have taken part in the industrial achievement of this country have been cognizant of this "language."

Drafting has been rightly considered a technical language differing from most languages only in that it cannot be spoken. Like all languages it has been grounded on an alphabet; however, lines instead of characters have been used. It further parallels any cultural language in that its conventional and idiomatic representations, comparable to grammatical construction and idioms peculiar to a given language, have been established through popular usage. These conventions and idioms have formulated the principles which must be understood and observed when the "language" is to be written or read. The high school, early to recognize the importance of literacy in the "language", annexed it to its curriculum in an effort to administer these drafting principles to those preparing themselves for industrial life.

The machine age has given impetus to the importance of drafting in all walks of life, and as an adjustive measure, some high schools have extended their offering of drafting in an effort to include all who have desired it in light of general education. This adjustment developed from the intention of the high school to nurture the nation's youth in the broad aim of citizenship, not

in specific vocations. From a study of the general educational values and social habits contributed by high school drafting, Cox (12:239)* concluded:

> High school drafting is a valuable subject in the curriculum. The values derived from it will prove beneficial to any pupil in or out of school. Pupils studying this subject learn appreciation of good work. They learn how to be alert and look for the worthwhile, which is a good educational aid in any vocation or high school subject. The pupil will receive as many educational values and social habits from this subject as can be obtained from almost any other high school subject.

Drafting must be generalized in order to benefit the greatest number of pupils, for a universal, vocational treatment of drafting in the high school would be unwarranted as census statistics will disclose. According to the 1940 census, there were 52,789,000 persons over 14 years of age gainfully employed in the United States with only 111,805 of these individuals listed as either designers or draftsmen; of the latter group, there were 88,191. These figures do not imply that drafting is not important; rather they connote the relatively small number who serve as the scribes for industry. Those individuals in industry who are required to have a knowledge of the "language" far outnumber

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*First number refers to the corresponding numbered item in the bibliography. The second number refers to the page of the reference.

the actual draftsmen. Svensen (40:1) has written concerning the status of drafting, "Since this is an engineering age, it is necessary for practically everyone to have some knowledge of, and some ability to read drawings, sketches, and diagrams."

In generalizing drafting to keep abreast of the trend in education, the scope and methods employed in teaching it had to be modified. The content of the introductory course was broadened to offer the maximum number of experiences in the time alloted. The broadened content would assist in the guidance of the pupil's choice of vocation, emphasize the practical application of drafting, and influence the individual's daily life. Where the masses were to be enlightened (not just those with a definite purpose) teaching methods, beginning with course planning and carrying through the method of presentation, took on a new flavor. The high degree of manipulative skill, required of the former vocational emphasis, gave ground to the inclusion of more and varied information topics for the development of an informed individual. The project method, individual interest grouping, etc., have been advanced as possible over-all approaches in the enlightenment of pupils in drafting practices; however, other methods of less

magnitude have evolved to encompass specific techniques and understanding of drafting theory. The many worthwhile methods of teaching drafting in current use have stemmed from the aim of instructional efficiency exalted by industrial arts teachers cognizant of the ever-changing industrial practices.

Definitions of Terminology

In order to avoid any confusion in the reader's mind, the following terms, so widely and sometimes carelessly used, are defined to facilitate the comprehension of their application in this study, as the writer interpreted them.

Drafting. The linear description of any value or object, executed either freehand or mechanically.

Drafting Theory. Includes the principles and conventional standards peculiar to drafting.

Freehand Drawing. Synonymous with freehand drafting or technical sketching where drafting theory is executed without the aid of mechanical devices. By analogy, it may be considered the shorthand form of drafting.

Mechanical Drafting. Also referred to as mechanical drawing where drafting is formally executed with the aid of instruments.

Industrial Arts. The term implies generality as characteristic of the subject it modifies; a broad pupil experience is the aim.

Area. Denotes a specific unit or integral part of any organized whole.

General Education. All those experiences of the curriculum contributing toward the cultural background of the pupil.

Statement of the Problem

Those concerned with the presentation of drafting theory to the high school pupil maintain two major schools of thought regarding the treatment of the subject; the divergence of practices in treatment has been influenced by the two general divisions of drafting, mechanical and freehand. Through the conventional reference to drafting in the high school as "mechanical drawing", the conservative teacher, representing one faction, has limited his offering to only the mechanical aspects of drafting. Whereas, the more liberal teacher with a broader interpretation of the subject, representing the other faction, has included the freehand drawing method as a supplement to his instrumental program for introducing theory as well as annexing another form of pupil activity.

The study was instituted on this variation of practices which evidenced a clearly defined need for such a study. Since industry employs both methods, it has served as the moderator upon whose composite recommendations the values of freehand drawing as an approach to drafting theory at the secondary school level have been judged.

Purpose of the Study

The purpose of the study was to establish tangible evidence in corroboration of the freehand drawing method in presenting drafting theory to the beginner at the secondary school level; the study was broken down as follows:

1. To determine the extent to which freehand drawing is used in the first year drafting course in the more progressive schools and in industry.
2. To determine at what point in the learner's experience the freehand drawing method should be introduced.
3. To compare the opinion of teachers and industrial draftsmen in their justification of the freehand drawing method in the course for beginners.
4. To determine those areas in the beginner's course of study which lend themselves to the freehand drawing methods in order to insure a well rounded knowledge of drafting theory.

5. To present criteria which may serve as a basis for further development of a more extensive and intensive use of the freehand drawing method in a beginning drafting course.

Location of the Study

In order to obtain responses indicative of progressive teaching methods, the city high schools of Los Angeles were selected for this study, with the assumption that they would reflect the desired qualities. The Los Angeles metropolitan area also supports considerable and diversified industry, thus its industries offered a favorable standard of comparison in evaluating the methods practiced in the classroom.

Subjects Employed in the Study

The study included three major groups for consideration which were as follows: the high school drafting teachers, the industrial draftsmen of selected industries, and the employers of the latter group.

The teacher group was comprised of 44 industrial arts drafting teachers which were distributed throughout the 35 high schools offering drafting in the Los Angeles City System.*

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*See Appendix C

Selected industries supplied the other two groups studied in order to get a sampling of the various phases of drafting.* In establishing a sampling from the various industries represented in the area of the study, the Los Angeles Chamber of Commerce was consulted in order to ascertain the principal industries. Aircraft, motion pictures, and oil well equipment manufacturers represented the three largest industries; therefore, they were selected for this study, since they utilized drafting to a high degree. Ten of the best draftsmen as designated by the employer, and one employer represented each of the principal industries. The balance of the industrial responses represented some of the more specialized phases of drafting which included the following: 11 architectural, 7 machine, 5 structural and sheet metal, 5 electrical, and 4 map drafting. In all cases, the employer's viewpoint was furnished by either the personnel director, the chief engineer, or the art director who was cognizant of the existing policies within the industry.

The evidence produced as a result of this study was derived from the whole hearted cooperation of 44 teachers,

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* See Appendix D

55 draftsmen, and 10 employers which gave a total of 109 individual viewpoints.

Sources of Material for the Study

The material for this study was gathered from the following sources:

1. Textbooks devoted to the field of drafting.
2. Historical references.
3. Recent writings in periodicals concerning the developments of drafting in the schools and in industry.
4. Los Angeles City Schools curriculum.
5. "Directory of the Personnel, 1946-1947" of the Los Angeles City Schools.
6. A bulletin compiled by the Los Angeles Chamber of Commerce entitled, "Industrial Firms Employing 50 or More Persons in the Los Angeles District."
7. Interviews with teachers, draftsmen, and the employers of the latter.

The Method Employed in the Study

In approaching the problem for obtaining the fullest possible meaning commensurate with the resources available to the writer, the normative-survey technique was selected for conducting the study, using the interview method as the medium for securing the desired data. This method afforded an opportunity for the writer to

observe the actual conditions as they existed.

In order to keep the interviews within meaningful limits and systematically record the datumas it was presented, a questionnaire form was devised for each group represented in the study.* These were designated as forms T, D, and E, representing the teacher's, draftsmen's, and employer's, respectively. Direction in the preparation of these instruments came through an exhaustive review of available literature, in order to ascertain the trends and innovations in drafting practices both in light of the school and industry. The factor of time was realized in their construction which necessitated a concentration of pertinent inquiries in order to minimize the imposition placed upon the individual being interviewed. This generous concession to be granted by the subjects of the study represented valuable instructional time on the teacher's part and money in the case of industry.

A summation of like data has allowed averages to be assigned in representing each factor for comparison in the final treatment. To assist in the comparisons, tabular and graphic forms have been employed.

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* See Appendix B.

Limitations of the Study

The scope of this study does not include the construction of a program of study in the use of the free-hand drawing method; rather, it was directed toward the collection of evidence which might serve in any future reform of the present method of teaching drafting.

All investigation was concentrated on the first-year industrial arts drafting course at the senior high school level, which is normally presented in the tenth year in the Los Angeles city high schools. All of the responses gained from industry were directed toward this end.

The criteria advanced have been formulated on the relatively few cases in the study through the following assumptions:

1. That the Los Angeles city high schools were as representative as any school system would be in the use of progressive teaching methods.
2. That the draftsmen and their employers of the selected industries in the Los Angeles metropolitan area would reflect the current practices in drafting, nation-wide, as well as offer competent opinions in matters concerning the instruction of the subject.

The validity of this study will be only as great as the validity of the assumptions upon which it was established.

Review of Literature

Authoritative Excerpts. By applying the general quotations of authorities to a specific instance, free-hand drawing might well serve as the vehicle for pupil attainment of drafting skills.

Since drafting is essentially a subject demanding skill, Selvidge (37:44) has been quoted as saying, "To know how to do a thing is the first step in the development of skill; to be able to do it efficiently is skill."

From another quarter, Bonser (8:142) sheds light on the subject of skill from the functional standpoint by saying:

> . . .an emphasis upon learning to do and to do well the things that make up the desirable activities of life instead of merely memorizing assigned materials of learning techniques and skills that are but remotely related to daily life activities.

Specifically, the attributes in sketch making have been described by Anthony (2:98), who said, "Skill in making readable sketches is not so much dependent on the clever handling of a pencil as in well directed thought and observation." Anthony (2:93) continues by saying, ". . .sketches are of the greatest value in that they may be made quickly, and by adding the necessary measurements may be made to serve the purpose of a more finished and expensive drawing."

Other Studies. These allied efforts have been shown on the freehand method both with a direct and indirect treatment for the justification of its presence in the high school drafting course.

Hale (23:231) made a study supporting the importance of freehand sketching through observing the frequency of the various forms of graphics appearing before the public in textbooks, periodicals, and handbills. All of the perused material netted 15,794 drawings covering an area of 88,434 square inches of literature. The two most important forms of drawings before the public's scrutiny were found to be pictorial forms with a frequency of 4,662 while the freehand sketches ran a very close second with 4,602. The balance of the drawings were distributed over several other forms of graphics; however, none approached the magnitude of the preceeding forms. These figures revealed his obvious conclusions.

Freehand drawing was discovered to be of paramount importance by a study conducted by Dart (13). Through a representative sampling of all occupations in the Eugene (Oregon) metropolitan area, a combined lay opinion ranked sketching and freehand drawing in light of usefulness, as first of the ten possible areas presented for their consideration. The composite rank designated for

sketching and freehand drawing by the three groups of the study which were the lay public, the jury of educators, and the drafting pupils of the Eugene High School, remain first. This side light was revealed in his effort to ascertain the necessary qualities of the emerging secondary school drafting course.

Textbooks. Through the complete omission of reference to the freehand drawing method or because of only a brief mention of it, many author-authorities of existing textbooks have indicated it as having a low degree of importance to a drafting course. This influence may be responsible for the comparatively undeveloped capacity of the freehand drawing method in present classroom instruction. The foregoing may be indicated more fully in Table I.

Table I

Freehand Drawing Instruction in 25 Selected Drafting Textbooks

Author		Date Published	No. Pages	Pages devoted to Freehand Drawing	Per Cent
Anthony, Gardner C.	(2)*	1922	152	8	5.20
Badger, O.B., Others	(3)	1938	55	12	21.80
Bailey, Charles H.	(4)	1920	90	2	2.20
Bartlett, Frank W.	(5)	1914	159	11	6.90
Blessing, G.,Others	(7)	1912	174	27	15.50
Brodie, Harold J.	(9)	1924	237	3	1.30
Carter, Isaac N.	(10)	1939	255	11	4.30
Ellis, George	(15)	1913	193	13	6.70
Ermeling, W., Others	(16)	1924	80	5	5.30
French Thomas	(17)	1941	611	9	1.50
French T., Others	(18)	1940	259	8	3.10
Fryklund, V., Others	(19)	1938	156	4	2.50
Gieseck, F., Others	(20)	1936	530	10	1.80
Jones, Franklin D.,	(25)	1920	337	18	5.30
Jordan, H., Others	(26)	1923	298	6	2.00
Mattlingly,E.,Others	(30)	1940	217	6	2.80
McGee, Richard A.,	(31)	1930	192	4	2.10
Orth, H., Others	(32)	1934	284	12	4.22
Paull, James H.	(34)	1936	195	1	0.50
Roberts, William	(35)	1936	142	0	0.00
Sahag, Leon M.	(36)	1942	380	6	1.50
Smith, William G.	(38)	1934	223	0	0.00
Svensen, Carl	(40)	1935	539	21	3.80
Woellner, R.,Others	(45)	1932	114	4	3.50
Zipprich, Anthony	(47)	1924	128	128	100.00

Although some authorities devote few pages to actual sketching instruction as shown by Table I, they do profess its

*Number refers to the bibliographic entry.

inestimable value to the technical professions. For the most part, such values have been included in the preface as instructions to the teachers. The extreme case is represented by Zipprich (47) whose text is designed to instruct the pupil in drafting theory exclusively, through the freehand medium.

Industrial Literature. An indication that the labors of industrial draftsmen were far too exacting and time-consuming for all practical purposes, came to light in a recent article by Drago (14:524) who stated:

> Clearness and legibility are all that is required of any finished drawing. If a draftsman can be trusted to use his judgement in designing a machine or choosing the information required by the shop man for making it, he ought to be able to judge when he must use stiff precision methods or when a free-hand sketch would be good enough.

Abundant literature may be had concerning the so-called "production illustration" which George Tharratt introduced at Douglas Aircraft Corporation in 1939. This development has dominated the recent drafting literature in regard to the freehand aspects of drafting. Since experiments have proven beyond doubt its favorable effect on the speed of assembly, many other aircraft concerns have adopted its use. This form of drafting impinges on commercial art, and it demands a more talented individual for its execution. The

production illustrator must be versed in both forms of drawing, that of the artist as well as the mechanic.

A brief history of freehand drawing as it is related to drafting will be traced in Chapter II revealing incidents and exponents in its use. The review is treated in both a general and specifically educational nature.

CHAPTER II

A HISTORICAL REVIEW

Drafting Through the Ages

The Inception. The definite origin of drawing has been obscured in the wake of time; however, in the prehistoric era delineation as an aid to human expression in the events of life is manifest in the picture writing on the walls of caves. Probably before utterances were coherently systematized, man communicated with his fellows using lines in representing his mental image with some degree of likeness. Since primitive drawings of the human figure and animals exist, made by the cave men at a time long before the innovation of writing, drawing can be considered the outcome of a desire to imitate and a natural aptitude possessed by man. The graphic records of these early concepts and their subsequent development stand as witnesses today to impress us with the vast way in which graphics have contributed to our heritage.

Ancient. With uncertainty, early Egyptian civilization, dating back some seventy centuries, has been accredited with the first use of graphics as an aid in

architectural planning. Evidences of the ancient's crude draftsmanship have been discovered in the form of rough sketches depicting a stepped pyramid on the base stones of what is assumed to be the first pyramid proper. Other graphic solutions of design used by early Egyptian builders were recorded on trestle boards, elevated stone tablets, on which the working drawings were engraved. They were strategically placed about the construction area in order to facilitate the workers by furnishing them with the needed information.

Unlike the other ancient civilizations for which we have no tangible record of architectural graphics, the Egyptians have revealed their early method of planning through the permanence of the material on which they were inscribed. This definite lack of tangible graphics for the many ancient civilizations leads Waffle (43: 332) to say, "Though there is a wealth of available information relative to the early structural accomplishments, there seems to be a missing link between the design and execution of the ancient works."

The monumental achievements of ancient civilizations such as the pyramids and temples built during the Egyptian Dynasties, the temples of Mesopotamia of approximately the same era, and later, the great edifices and engineering feats of the Greeks and Romans bear

witness for the doubtless necessity of careful and extensive planning preceding their construction. There is a possibility that the planning was kept in a fluid state with the architect constantly at the scene of construction directing the workers and altering the plans to meet the problems as they arose.

With further evidence that drawing must have served the ancient architects, Waffle, (43:332) relates:

> For landscape and architecture, there was adopted an ingenious combination of drawing, both in ground plan and in the elevation, to express the idea in the simplest and clearest manner possible. Probably the most concrete of these indications is among the Chaldean statues. On the knees of one image lies a tablet intended to receive an inscription or design. Another similar statue, of smaller proportions, holds on its knees the same kind of tablet on which the plan of a fortress, with its bastions and posterns, is engraved in outline just as an architect of the present day would draw it. A graduated rule, subdivided into fractions of unequal but proportional length is carved in relief beside the plan for which it serves as a scale. Finally, at the side lies the stylus with which the architect engraved his design.

Aristotle, during the third century B.C., professed the interdependence of design and architecture and the subordination of fine arts to architecture which inferred the necessity of architects in the unified planning and construction of the refined Grecian works of art. His philosophy concerning the natural

tendencies of the pupil in drawing further substantiates the belief that graphics were commonplace during that period.

In 30 B.C. the Roman architect Vitruvius wrote ten volumes on architecture which discussed projection drawings as they were applied to structures; however, the theory of projection was not well developed and professed until the period of the Renaissance.

Medieval. After the fall of the Roman Empire, a lull in architectural advancement prevailed. The Middle Ages brought forth a new architectural order under the auspices of the church which gave birth to the cathedrals of Europe.

According to Longfellow (28:165) Benedictine Monks with a knowledge of building methods, made the plans necessary for the construction of churches and convents. In explanation of a plan preserved by the Benedictine Order, Longfellow (28:169) wrote:

> The famous monastic plan preserved in the Benedictine abbey of St. Gall is not only the oldest architectural working drawing left to us, but a precise and authentic record of the manner of building in the ninth century, and in some ways more valuable than if it depicted a particular set of existing buildings, for it shows the ideal at which the enlightened builders of that day were aiming. It is a drawing on parchment, two and half feet by three and a half,

dated 820, and sent to Gozper, abbot of St. Gall at that time, by some friend who is not identified, for guidance or suggestion in the rebuilding of his monastery which was then to be undertaken.

Technical drawings of a much later origin, about 1300 A.D., used in designing the cathedrals of Siena, Cologne, and Orvito were discovered to have been executed in a crude form of perspective. The theory of perspective, utilized by the architects in making the drawings, was not a product of that period, for the ancient Greek mathematicians understood and applied, to some degree, the basic principles of perspective. A well developed theory of perspective to be applied extensively in graphics was not realized until the fifteenth century.

Modern. Drafting became significant during the Renaissance in expressing the innovations in architecture and engineering, for creativeness was exalted during this period.

Leonardo da Vinci (1452-1518), the celebrated engineer, scientist, and artist, contributed much in the advancement of graphics. His treatise on painting which included a complete and vivid description of the theory of perspective was accepted by the other masters of the time with enthusiasm, for they successfully adapted his principles to their works.

Leonardo's prolific genius was recorded in a personal notebook by his own hand through the use of freehand sketches and accompanying notations. He employed the principles of both perspective and projection in his sketches; however, he favored perspective as a medium of expression as observation of his drawings will testify. This fact may be attributed to his ability as an artist, in which case, pictorial representation would be the natural tendency. For the most part, the sketches were done with pen and ink with little regard for scale or proportion which would suggest that they were made rapidly as the ideas occurred to him; nevertheless, his sketches of natural life express meticulous execution.

A good portion of Leonardo's notes have survived him to be published in a volume known as the "Codice Atlantico" which has served as a source for present reproductions of his works in many books. Parsons (33: 19) describes the volume as containing four hundred and two sheets and more than seventeen hundred drawings.

The theory of projection was elevated to the status of a science through the investigations conducted by the famous Italian architects, Brunelleschi (1379-1446), and Alberti (1404-1472). Gaspard Monge

(1746-1818), the French mathematician, gave further refinement to the newly founded science in a treatise on orthographic projection published in 1795. Monge, through introducing orthographic projection, not only laid the foundation for descriptive geometry which claims him as its father, but he also furnished a completely descriptive, concise mode of expressing mechanical intricacies which began to develop with the outset of the Machine Age.

The invention of the steam engine by James Watt in 1774 launched the Machine Age. Until this time, the demand for graphics came principally through architecture, and they were executed freehand. Mechanisms of war and engineering were of such a simple character that usually a pictorial sketch would suffice in the event they could not be described in writing; however, the designer of a machine was usually the builder. The Machine Age reversed this condition by placing greater emphasis on the art of engineering which gave rise to a wide-spread understanding of orthographic projection in order to minimize confusion and unify productive efforts.

Drafting was practiced as an art during the first half of the nineteenth century, and it began to assume its significance as a technical language. The drawings

rendered were quite elaborate, a carry-over from the architectural influence; yet accuracy was not sacrificed for ornamentation. Since that time, the trend has been to omit superfluous details and color renderings in order to produce, in the shortest possible time, a severely simple but complete drawing for ease in interpretation.

Modern drafting is considered to have started with the introduction of the blueprint process in 1880 which facilitated immeasurably the circulation of drawings. Specialization in drawing arrived during this period as a result of the high degree of specialization in industry, but the conventions and standards established through the years have been generally applicable in all cases. Some variations have been observed in the form of idiomatic usage of the "language" peculiar to the industry concerned.

A recent trend in graphics has made the power of expression through freehand drawing significant. Some would view "Productive Illustration" as a regression from the scientific advancement of orthographic projection; however, it served its purpose by increasing assembly efficiency in the aircraft industry during the recent emergency and remains with a promising future. A clear insight into the assembly of mechanisms was

furnished the masses of workers untrained in the theory of projection through this medium of "exploded" three dimensional views. Commercial artists were called upon to make perspective sketches of the parts of an assembly in their correct relationship. Although, today, the finished drafts of technical drawings are generally rendered with the aid of instruments, freehand drawing still serves designers, engineers, and mechanics as a spontaneous and rapid means of recording ideas and pertinent information.

Drawing in the School

Developments in Europe. Drawing was taught in some of the earliest schools for its cultural aspects, but its import as a fundamental study, subordinate only to reading and writing, was first proposed by Mulcaster (1531-1611), the noted English educator, in his curriculum for the elementary school. In relating Mulcaster's declaration in support of his proposition, Bennett (6:33) quoted, "the hand, the ear, the eye be the greatest instruments whereby the receiving and delivery of our learning is chiefly executed." In further argument for the position of drawing, Mulcaster refers to the viewpoints contained in Aristotle's "Politikes" as quoted

by Bennett (6:34):

> There he sayeth, that as writing and reading do minister much helpe to trafficque, to housholdrie, to learning, and all publicke dealinges: so drawing by penne or pencil is verie requisite to make a man able to judge, what that is which he byeth of artificers and craftes men, for substannce, forme, and fashion, durable and handsome or no: and such other necessarie seruices, besides the delitefull and pleasant.

A treatise on educational reform by Sir William Petty, published in London in 1647 included the following statement in corroboration of Mulcater's views concerning the merits of drawing as a general education study according to Bennett (6:45):

> That in no case the art of drawing and designing be omitted to what course of life soever those children are to be applied, since the use thereof for expressing the conceptions of the mind, seems (at least to us) to be little inferior to that of writing, and in many cases performeth what by words is impossible.

Pestalozzi (1746-1827) placed great emphasis on drawing for teaching children to be conscious observers of things about them and to relate their ideas for others to interpret. An alphabet for form description was devised so all things observed could be translated into graphic form with reasonable likeness. The alphabet included straight lines, angles, circles, and arcs which he believed to be the basis of all graphic representation. Through exercises involving these

rudiments, first singly and later combined to describe natural objects, the pupil gained the perception of eye measurement for evaluating objects in their true proportions.

In describing the status of drawing in the German schools in 1893, Bennett (6: 241) quotes a statement, concerning a two-year drawing course for pupils twelve to fourteen years of age, reported by Stowe after a study of elementary public instruction in Europe:

> Elements of Drawing /Italics in original quotation/
> For this the pupils have already been prepared by the exercises in ornamental writing in the previous part of the course. They have already acquired that accuracy of sight and steadiness of hand which are among the most essential requisites in drawing well. The first exercises are in drawing lines, and the most simple mathematical figures, such as the square, the cube, the triangle, the parallelogram; generally from wooden models, placed at some little distance on a shelf, before the class. From this they proceed to architectural figures such as doors windows, columns, facades. . .All learn enough of drawing to use it in the common business of life, such as plotting a field, laying out a canal, or drawing the plan of a building; and many attain to a high degree of excellence.

Technical drawing, as we know it today, originated in France, and by 1865 it evidenced a high degree of refinement both in instructional methods and widespread usage. Early in the dissemination of orthographic drawing, Bonaparte, after a personal survey of industry, is quoted by Bennett (6:276) to have said:

> I have found everywhere workmen distinguished in their craft, have great dexterity in execution, but hardly one who can make a drawing of the simplest type of a machine or could express his ideas by a sketch or by a memorandum. It is a gap in French industry; I will fill it up. No more Latin (that will be taught in the lycees which are going to be organized), but trades with the theory necessary for their progress. Here excellent foremen for our manufactories will be trained.

With this impetus, the art of drafting flourished. The fact remains that France maintained progressive measures in the field of drawing as it was felt to be the indispensable basis for all good construction, and she influenced the balance of the world with her methods.

The characteristics of the French methods of instructing drawing, prevalent in 1865, are significant in that they manifest a tendency to coincide with current methods; Bennett (6:284)* outlines them as follows:

(1) Early emphasis on geometrical drawing, followed by
(2) Projection drawing leading up to dimensioned sketches, at the same time giving special attention to training the memory for form and developing the constructive imagination.
(3) Drawing to scale.
(4) Machine drawing taught through the making of sections and details from assembly drawings and assembly drawings from detail drawings.

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*A quotation by Bennett (6:285) from a report of the French Commission on Technical Instruction fully describing the method of instruction may be found in Appendix A.

(5) Designing parts of machines, applying knowledge of strength of materials.
(6) Visiting factories to make dimensioned sketches of machines from which finished drawings were to be made.

Attention is directed to the use of sketching in the program outlined; it was introduced in the beginning as an expedient in delineating the pupil's mental image of the problem and recording pertinent information which is quite in keeping with present practices in industry and the more progressive instructional situations.

Drawing in the United States. The European advancement in the art of drawing had its influence on American education. Writings were translated and observations were made of the methods professed abroad which caused American educators to sense a need for its presence in the school. John Rubens Smith, a teacher of drawing in 1822 wrote and published "The Juvenile Drawing Book", which paralleled Pestalozzi's philosophy of "alphabet of form" in teaching drawing. A further literary offering known as "The Eye and Hand" came from William Bentley Fowle who translated a French drawing book by Louis Benjamin Francoeur in 1827. The book by Francoeur had satisfied an order given by Bonaparte to prepare a text for the national schools of France. Through observation of European schools in 1843, Horace Mann recognized and advocated the value of drawing in

the school. Mann's report during the same year to the Massachusetts State Board of Education on "The Value of Instruction in Drawing" lead the board in 1848 to place drawing on the list of subjects to be taught in the elementary school. Bennett (6:440) quotes from Mann's report as he emphasized the import of drawing both to the pupil and the teacher:

> Drawing, of itself, is an expressive and beautiful language. A few strokes of the pen or pencil will often represent to the eye what no amount of words, however, well chosen, can communicate. For the master architect, for the engraver, the engineer, the pattern designer, the draughtsman, moulder, machine builder, or head mechanic of any kind, all acknowledge that this art is essential and indispensable. But there is no department of business or condition in life, where the accomplishment would not be of utility. Every man should be able to plot a field, to sketch a road or a river, to draw the outlines of a simple machine, a piece of household furniture, or a farming utensil, and to delineate the internal arrangement or construction of a house.
>
> .....
>
> . . .every teacher, even of the humblest school, ought to be acquainted with the art of linear drawing, and be able to form all the necessary figures and diagrams not only with correctness but with rapidity. But in teaching naviagation, surveying, trigonometry, geometry, etc.; in describing the mechanical powers, in optics, in astronomy, in the various branches of natural philosophy, and especially in physiology, the teacher who has a command of this art, will teach incomparably better, and incomparably faster than if he were ignorant of it. I never saw a teacher in a German school make use of a ruler or any other mechanical aid, in drawing the most nice or complicated figures. I recollect

> no instance in which he was obliged to efface a part of a line because it was too long, or to extend it because it was too short. If squares or triangles were to be formed, they came out squares or triangles without any overlapping or deficiency.

In 1840, Rembrant Peale introduced drawing in the Philadelphia high school. According to Clark (11:16) Peale had his pupils sketch first from copies and later from nature. His system also presented freehand drawing to the pupil before mechanical drawing, for it was his belief that training of the eye and hand was a requisite for entry into any mechanical vocation.

From 1870, which marked the beginning of the industrial arts movement, to the present, drawing has gained ever-increasing importance in the school. In 1870, the legislature of Massachusetts, through the demands of industrialists for the inclusion of technical education in the public schools, passed the act which established drawing in the public school curriculum; it also provided free instruction in the subject in either day or night school for persons over fifteen years of age in cities of more than 10,000 population. The drawing taught in the public schools emphasized its industrial utility rather than its cultural values.

Under the able guidance of such exponents as Professor Walter Smith and Mr. John D. Philbrick, Massachu-

setts, led the nation in educational developments in drawing. Many of their developments were borrowed from the highly refined methods abroad. Because of their background in art, they stood solidly against the pure mechanical drawing which later dominated industrial arts drawing.

The need for drawing and design by industry was disclosed at the centennial exhibition at Philadelphia in 1876. In response to the rising industrial need for technical training, Professor Calvin M. Woodward established his manual training school in St. Louis which gave instruction in technical drawing. Moreover, Professor Woodward's school, illuminating his tireless effort and philosophy, served as probably the most outstanding single influence in the promotion of the industrial arts movement.

The industry of man will remain the pacemaker for the school. As Mann once wrote according to Bennett (6:441) ". . .whatever is important to men to know, as men, should be learned by children in school."

CHAPTER III

THE STUDY

Although drafting in the classroom is generally maintained in an air of abstraction, its basic concepts are borrowed from the industrial field in order to fortify the characteristics of its name. If this were not so, there would be little purpose for its inclusion in the curriculum of the modern high school in its present capacity. With this in mind, the study was focused on three principal groups, namely: the high school drafting teachers, the industrial draftsmen, and the employers of the latter group.

The teachers represent one of the greatest influences on the lives of youth, the nation's potential labor force. It is upon their guidance and instruction that many pupils will later rely in seeking employment. This group was canvassed to obtain data, both objective and subjective, which would connote the conditions, methods, and scope of experiences prevalent in the instruction of drafting.

Since the employers of the draftsmen designated them as the best in their employ, the responses gained

from this source were believed to be indicative of competent judgement in matters concerning the scope and methods employed in teaching high school drafting.

Industrial concerns represent a good proportion of the future employers of high school pupils not intending to continue their formal education after high school graduation; therefore, the employer group voiced the facts and opinions regarding desired as well as necessary qualifications of prospective employees and the use of technical sketching.

These data secured from educational and industrial sources as a result of this study will first be treated by groups, separately, in order to build for each a sufficient background setting. Later, a composite treatment of these findings will be presented to facilitate the making of comparisons.

Teachers' Ratings

In order to furnish an insight into the conditions under which the drafting teachers of Los Angeles labor, a brief background is presented to reveal their situation. Although various curriculum committees have contributed toward the present suggested general course of study in drafting for the city schools, only those serving on the committees were observed to practice the recommendations.

By and large each teacher displayed a program of his own design.

For the most part, the teachers devoted their full time to the subject, since drafting was administered in all cases as a unit shop subject. Of the 44 teachers in all, 33 (75%) stated that they taught drafting exclusively; the remaining 11 (25%) taught in addition, such subjects as mathematics, stagecraft, art-craft, photography, and coaching. One teacher was also principal of an evening high school. The undivided interest in the majority of cases exemplified the desires of the teachers to instruct in drafting. By way of interest, 3 of the 33 teachers instructing full time held Doctorates in the field of education.

Classes: Size and Number per Teacher.

For the number of classes assigned each of the 44 teachers in beginning drafting, the range was found to be from 1 to 5 classes, with a median of 2 classes. The average class size for the foregoing cases indicated a median of 30 pupils with a range of from 9-40 pupils. See Table II.

Table II

Classes: Size and Number per Teacher

	Frequency	Range	Median
Beginning classes per teacher	44	1-5	2
Class size	44	9-40	30

These figures suggest the crowded conditions experienced in some portions of the city as a result of the recent sharp influx of population in the Los Angeles metropolitan area. In no instances were the classrooms designed to facilitate the extreme case represented; the usual original capacity was approximately 25 pupils.

Drafting Instruction: Maximum Offering and Estimated Percentage of Pupil Completion.

In contrast with the beginning classes, the teachers were also responsible for as many as 13 other semester units of work in drafting which represented the vocational provisions in the school to assist the specializing few. The maximum number of semester units offered in drafting, and the estimated percentage of pupils completing the maximum offering are shown in Table III.

Table III

Drafting Instruction: Maximum Offering and Estimated Percentage of Pupil Completion

	Number of cases	Range	Mode
Maximum offering in semester units	35	4-15	6
Estimated percentage of pupils completing maximum offering.	34*	3-25	10

*The one omission is contributed to Jacob Riis High School, a corrective school, where pupils seldom complete the program.

The relationship between the maximum offering in semester units and the percentage of pupils completing the maximum offering was observed to be inversely proportional; that is, the extreme of 25% completion represented the maximum offering of only 4 units whereas the 3% completion corresponded to the 15 units. The mode signifies rather clearly the common offering of the schools as well as the relatively small percentage of pupils who avail themselves of the vocational phases of the high school program.

Drafting was a universal requirement for the pupils majoring in industrial arts; however, in some cases where facilities did not permit, only one semester was required instead of two. The percentage of industrial arts majors was generally small; therefore, the

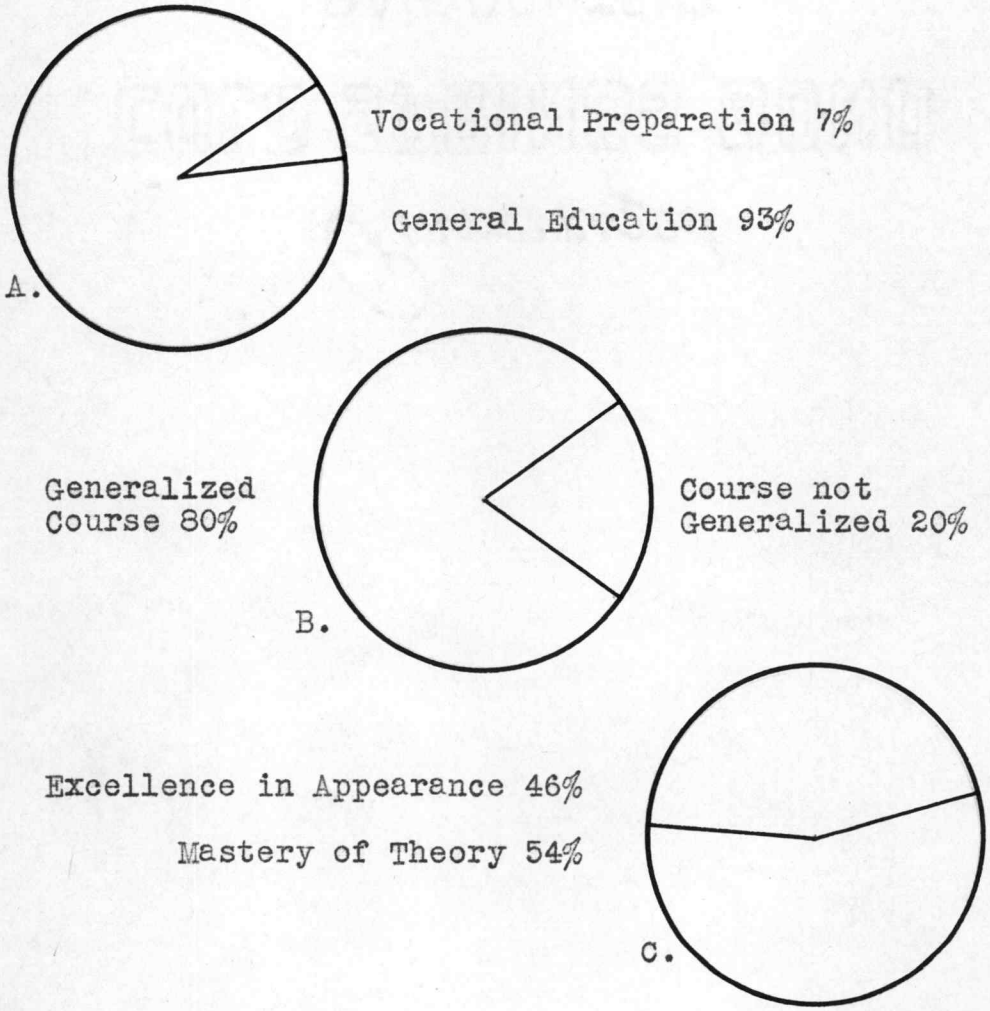
balance of the pupils enrolled were taking drafting as an elective subject.

Course Aims and Application in First Year Drafting.

The predominant aim in the first year course of study was unanimous (93% of the cases) expressed as substantiating general education. Only 3 of the 44 cases (7%) directed their efforts with vocational emphasis; this condition was fostered through laying the ground work for advanced courses during the first year. However, in the degree of generalization concerning their first year of drafting, only 35 of the 44 responses (80%) replied that it could be considered a terminal course with the remaining 9 cases (20%) presenting a negative response. In keeping with the thought of general education, an average of approximate percentages on the distribution of emphasis revealed a 54% to 46% relationship between the mastern of theory and the excellence of appearance in pupil work, respectively. Representations of these data may be seen in Graph 1, parts A, B, and C, respectively.

Graph 1

Course Aims and Application in First Year Drafting



This apparent state of incompatability regarding parts A and B of Graph 1 may be due to a loose usage of terminology; in any case, part B showing 80% of the cases generalized, is probably the more accurate accounting of the proper interpretation of general education and its application. Part C shows how the appearance of the pupil's

work is subordinated to the mastery of theory which is in agreement with the attributes of general education.

Distribution in the Use of Visual Aids.

The visual aids most commonly used among the 44 teachers in supplement to demonstrations, aside from the textbook are best denoted in Table IV.

Table IV

Distribution in the Use of Visual Aids

Visual Aid	Frequence of Use	Percent
Blackboard	44	100.00
Flash-card	2	9.09
Mimeograph	31	70.45
Model	40	90.91
Clay Model	8	18.18
"Glass" Projection Box	20	45.45
Cardboard Developments	31	70.45
Slides	3	6.84
Motion Pictures	16	36.36

The circumstance rendered by all of the teachers through admission that the blackboard was used extensively is significant; sketching is indispensable in the conveyance of thought.

In response to the inquiry whether or not "production illustration" was included in the program of studies, 14 (32%) replied in the affirmative while the remaining 30 (68%) acknowledged the question in the negative. The intention of this inquiry was to discern the degree of interest maintained by the teachers in pertinent industrial developments; in only a few instances did it prove embarrassing. All of those professing the use of "production illustration" offered it as a specialization feature during the advanced work.

The foregoing has served as a cursory survey of conditions relevant to the subject of drafting in general. Attention will now be focused on the matters pertaining to the specific problem.

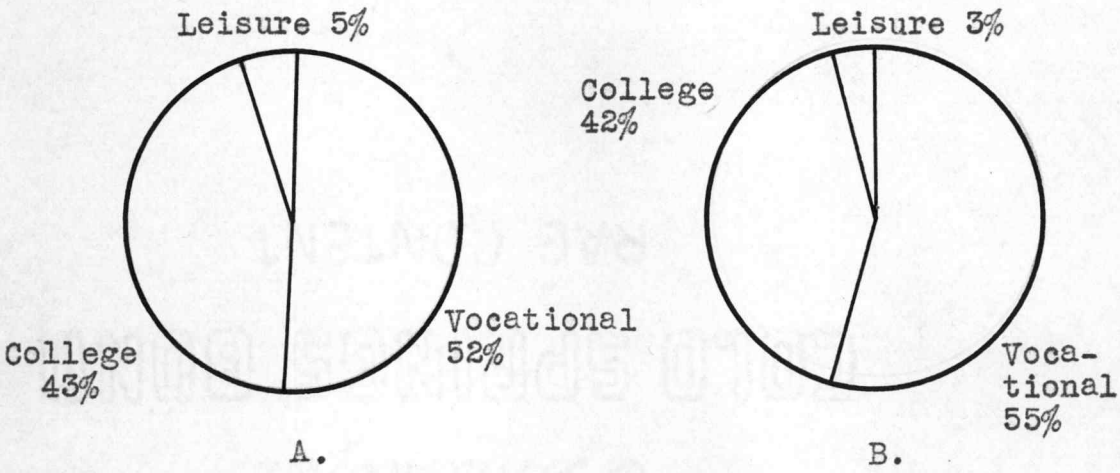
Teachers' Background In and Use of Freehand Drawing.

A search into the teacher's freehand drawing background disclosed the origin of his apparent interest in its use as a vehicle of learning. Of the total 44 responses, 23 (52%) stated that their first sketching came by way of an industrial experience, 19 (43%) associated its inception with collegiate training, and 2 (5%) found the experience in a leisure time activity. This would indicate that they all had a knowledge of sketching. An

indelible impression must have been formed by the industrial contact for it was through this group that the freehand drawing method found its greatest outlet. They numbered 21 out of 38 or 55% of the total number who professed the use of this method, leaving 16 persons (42%) with the college inception and 1 (3%) with the leisure time experience. For these relationships see Graph 2, parts A and B. The six teachers omitted in part B represented that group which did not believe freehand drawing should be included in the first year drafting course. Little appreciable difference resulted from the six ommissions.

Graph 2

Teachers' Background In and Use of Freehand Drawing

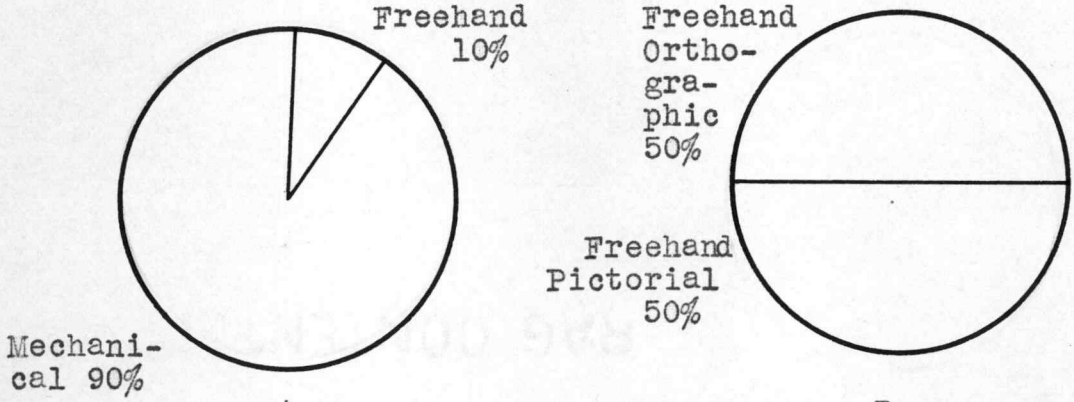


Distribution of Time in Freehand Drawing.

For the 38 teachers using the freehand drawing method, the median of the approximate percentage of time devoted to its use was established at 10% with the extremes of 2% and 55%. The median for the approximate percentage relationship of time applied to freehand orthographic and pictorial drawing was found to be one of 50% to 50%. See Graph 3, parts A and B. In other words, the 10% of the total time devoted to freehand drawing would be divided equally between freehand orthographic and freehand pictorial.

Graph 3

Distribution of Time in Freehand Drawing



Average Number of Plates, Freehand and Mechanical.

The averages of the estimated average number of plates completed during the first semester drafting class of each type, freehand and mechanical, are shown in Table V.

Table V

Average Number of Plates, Freehand and Mechanical

	Frequency Response	Percentage Response	Range in No.Plates	Median
Freehand	22	50	1-30	4
Mechanical	44	100	12-38	20

The differential of 16 cases between the 22 exhibited in Table V as using freehand plates and the 38 formerly

mentioned as using the freehand method, resulted from the teacher's informal presentation of sketching; thus the term "plate" was not warranted. These informal sketches preceded each instrumental drawing.

A ratio between averages was established at 1:5 in the use of freehand and mechanical plates by those professing the use of both media.

Pupils were encouraged by 38 of the 44 teachers or 86% to use pictorial sketches as an aid to visualizing a working drawing; the remaining 6 (14%) did not believe it was of any value.

Introduction of Freehand Drawing by the Teacher.

Freehand drawing was believed to be used most advantegously, preceding each instrumental drawing, by 16 (42%) of the 38 teachers using the freehand method in order to insure understanding of the immediate problem. Those believing it should end off the course as an additional learning area numbered 12 (32%) of the responses; in this way, the freehand drawing method was believed to provide masterful expression through applying the theory already obtained. The remaining 10 (26%) of the cases believed that sketching should precede all else in order to establish a quick, over-all understanding of the

selected drafting theory. Refer to Table VI for comparisons.

Table VI

Introduction of Freehand Drawing by the Teacher

Point of Introduction	Frequency	Percentage	Rank
In the beginning, as a means of establishing an over-all understanding of the selected drafting principles to be presented	10	26	3
Preceding each instrumental drawing, in order to insure understanding of the immediate problem.	16	42	1
At the end of the course, as an additional learning area to provide masterful expression through applying the theory already obtained	12	32	2

Justification by the Teachers of Freehand Drawing in the Course for Beginners.

The 38 teachers using the freehand drawing method justified its presence in their beginning course in the order of rank, obtained from the mean scores of their weighted opinion, indicated in Table VII. Numerical values were automatically assigned to each statement in Table VII when the individual ranked them in the order of

their importance; numeral 1 signified the most important. A summation of these assigned values levied by the individual rendered the raw score. Responses were gained only on those statements which coincided with the individual's viewpoint; this explains the apparent omissions existing in the column marked "frequency."

Table VII

Justification by the Teachers of Freehand Drawing in the Course for Beginners

	Frequency	Mean Score	Rank
It is logical, since the pupil exercises past experience in acquiring a new experience	37	2.67	3
Basic drafting theory can be advantageously divorced from instrumental techniques for more extensive and more rapidly executed pupil activity.	34	2.32	2
It serves to impress the pupil with its possibilities as an effective means of expression in daily life.	38	2.68	4
It is used extensively in industrial activities.	38	2.26	1
The cost of required materials is held to a minimum.	32	4.84	5
It should not be included in the drafting course	6	----	--

Percentage of Time Devoted to the Areas of Learning--Teacher Ratings.

Those areas of learning offered by the teachers in the first year course and the percentage of time devoted to each may be seen in Table VIII. The rank, based on the median percentage, was assigned in order to designate the importance attached by the teachers to the eleven areas of learning with the greatest frequency of response. Each teacher described the relationship of the time spent in the various areas on a percentage basis. All of the 18 suggested areas received at least one response which would indicate an effort by some teachers to offer a very broad experience to the pupil. Sketching was incidental and supplementary to the areas of learning in most cases; however, some formal plates were accomplished freehand as previously related in Table V.

Table VIII

Percentage of Time Devoted to the Areas of Learning---Teacher Ratings

	Frequency of Response	Range of Percentage	Median	Rank
Orthographic	44	10-50	20	2
Working Drawing	43	5-55	25	1
Lettering	42	2-30	5	6
Dimensioning	37	1-15	5	7
Sectioning	41	2-15	10	3
Auxiliary Projection	33	2-15	7	5
Isometric	41	3-25	10	3
Fasteners	23	1-20	5	8
Developments	33	2-30	8	4
Oblique	33	1-10	3	9
Perspective	10	1-15	5	
Architectural	6	3-38	5	
Structural	4	1-12	4	
Map	1	--	1	
Pipe Drawing	4	1- 3	2	
Electrical	2	1- 5	3	
Charts and Diagrams	4	2- 5	4	
Reproductions	20	1- 5	2	10

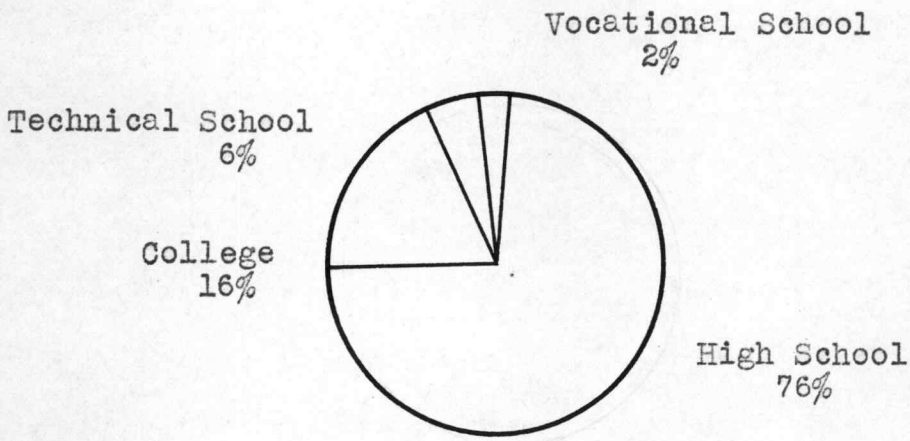
Draftsmen's Ratings

Institutions Furnishing Draftsmen with Initial Drafting Theory.

A glance at the educational background of the 55 industrial draftsmen is revealing. Their first knowledge of drafting theory was obtained as expressed by 42 (76%) of the group in high school, 9 (16%) in college, 3 (6%) in technical school, and 1 (2%) in vocational school. Of the 42 obtaining their first knowledge in high school, 13 (31%) of them did so in one of the Los Angeles high schools. A successful comparison of the opinions of these draftsmen and those of their former teachers was impossible, since the turnover has been too great in recent years. For the relationships concerning initial theory see Graph 4.

Graph 4

Institutions Furnishing Draftsmen
With Initial Drafting Theory



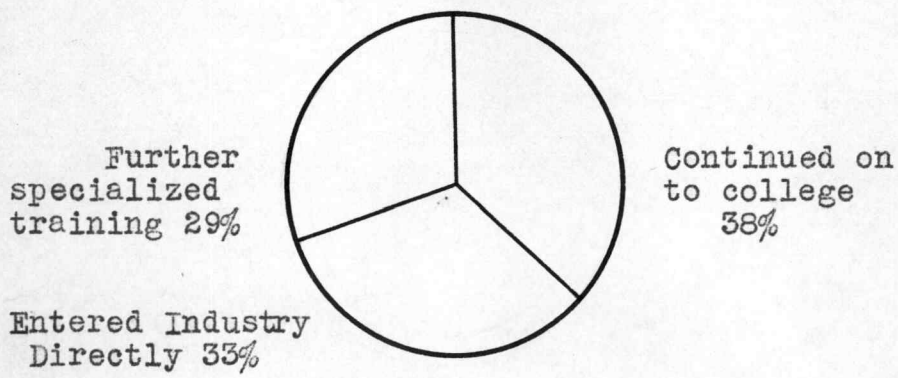
Educational Characteristics of High-School-Trained Draftsmen.

The amount of prevocational preparation varied greatly as would be expected of a group this size. A range of from one and one half years of high school, or its equivalent, to five years of architectural training in college was encountered in these 55 cases. Of the 42 who had high school training in drafting, 16 (38%) continued on to college, 12 (29%) sought further training in technical, vocational, or night school, and 14 (33%) entered industry directly with no further training. The average experience in industrial arts drafting for the

group entering industry directly from high school was 3 years. This latter condition exemplifies industry's recognition of the high school drafting program. See Graph 5.

Graph 5

Educational Characteristics of High-School-Trained Draftsmen

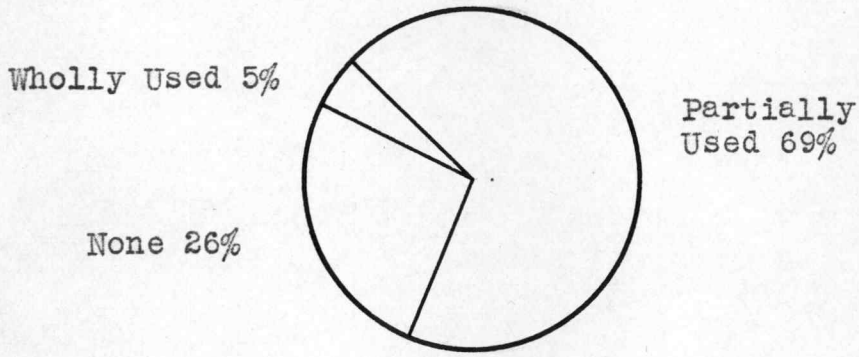


Use of Freehand Method in Learning Drafting Theory.

The 55 draftsmen learned the theory of their art through the freehand drawing method to the degree shown in Graph 6.

Graph 6

Use of Freehand Method in Learning Drafting Theory



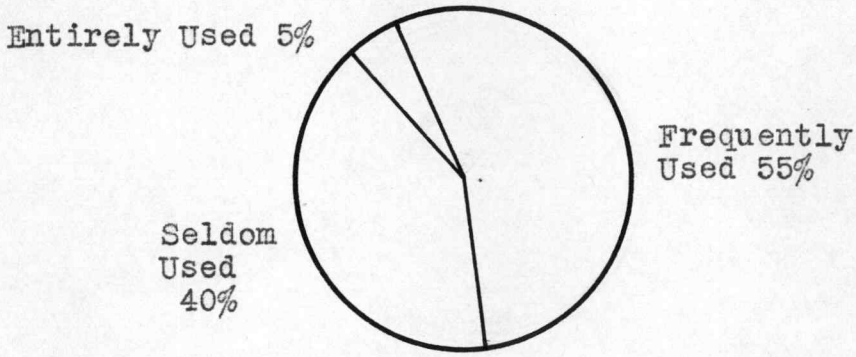
Those expressing their training as wholly freehand were former commercial artists serving now as illustrators in the motion picture industry and in architecture.

Extent Draftsmen Use Sketches.

Indicative of the import of sketching, 30 of the 55 draftsmen or 55% disclosed that it was frequently used in the description of a single product of maintenance or design; 22 responses or 40% indicated that it was seldom used while again the 3 illustrators representing 5% expressed its use entirely. None stated that it was never used. These data are represented in Graph 7.

Graph 7

Extent Draftsmen Use Sketches

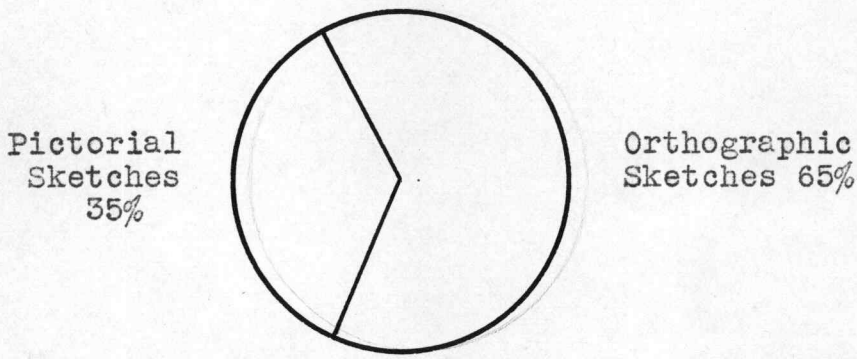


Sketches Most Frequently Used by Draftsmen.

Orthographic sketches were conceded the more frequent usage by industrial draftsmen; 36 (65%) of the draftsmen signified a greater use of orthographic sketches while the remaining 19 (35%) utilized the pictorial sketch to a better advantage. Graph 8 will bear this out.

Graph 8

Sketches Most Frequently Used by Draftsmen



Importance of Sketching to the Draftsmen.

Sketches were ranked by draftsmen first in importance as expedients in conveying thoughts and information. Ranking was accomplished through a mean score arrived at by totaling the values automatically assigned the statement when the individual ranked them in their order of importance; numeral 1 signified the most important. For the ranks furnished the other uses of sketching see Table IX.

Table IX

Importance of Sketching to the Draftsmen

	Frequency of response	Mean Score	Rank
Conveying thoughts and information to others rapidly	55	1.42	1
As a means of recording data	49	3.26	4
In the solution of design problems	54	2.29	2
Pictorial sketches as an aid in interpreting an intricate working drawing.	46	2.85	3

Recommended Introduction of Freehand Drawing by the Draftsmen.

Freehand drawing was believed to be used most advantageously at the beginning of the course as a means of establishing a quick, over-all understanding of the selected drafting theory by 30 (55%) of the 55 draftsmen. Those believing that sketching should precede each instrumental drawing in order to insure understanding of the immediate problem numbered 21 (38%) of the responses while the remaining 4 (7%) of the cases would have it at the end of the course as an additional learning area to provide

masterful expression through applying the theory already obtained. Refer to Table X for comparisons.

Table X

Recommended Introduction of Freehand Drawing, By the Draftsmen

Point of Introduction	Frequency	Percentage	Rank
In the beginning, as a means of establishing an over-all understanding of the selected drafting principles to be presented.	30	55	1
Preceding each instrumental drawing, in order to insure understanding of the immediate problem.	21	38	2
At the end of the course, as an additional learning area to provide masterful expression through applying the theory already obtained.	4	7	3

Justification by the Draftsmen of Freehand Drawing in the Course for Beginners.

In the case of the draftsmen, not one considered sketching useless in teaching drafting, and their first justification for the use of sketching was that it serves to impress the pupil with its possibilities as an effective means of expression in daily life. The teachers ranked this same vindication as fourth in importance,

which was the only difference displayed through combined opinion. See Table XI. The ranking scores in Table XI were a summation of the automatic values assigned as before where the individual ranked the statements in their order of importance; numeral 1 signified the most important.

Table XI

Justification by the Draftsmen of Freehand Drawing in the Course for Beginners

	Frequency of response	Mean Score	Rank
It is logical, since the pupil exercises past experience in acquiring a new experience.	53	2.55	3
Basic drafting theory can be advantageously divorced from instrumental techniques for more extensive and more rapidly executed pupil activity.	54	2.33	2
It serves to impress the pupil with its possibilities as an effective means of expression in daily life.	54	1.70	1
It is used extensively in industrial activities.	48	3.22	4
The cost of required materials is held to a minimum.	31	4.81	5
It should not be included in the drafting course.	--	--	--

Areas of Learning Recommended by the Draftsmen for Freehand Treatment.

The selection of the necessary areas of learning, adaptable to freehand treatment, yet insuring the well rounded understanding of the subject during the first year course, may be seen in Table XII as the draftsmen viewed the problem. The selected areas of learning were ranked in their order of importance by each draftsman which automatically assigned values of rank; numeral 1 was again considered most important. Since there was no prescribed number of responses, none were considered for comparison beyond the fewest areas ranked, which was eight. This measure was taken in order to include the opinions of all of the draftsmen. Only the first eleven areas receiving the greatest frequency of responses were given a combined rank, for the others lacked significance.

Table XII

Areas of Learning Recommended by the Draftsmen for Freehand Treatment

	Frequency of Response	Mean Score	Rank
Orthographic	41	2.07	1
Working drawings	49	4.06	4
Lettering	53	2.81	2
Dimensioning	48	5.04	6
Sectioning	48	5.77	8
Auxiliary Projection	19	5.94	10
Isometric	54	5.64	7
Fasteners	1	8.00	
Developments	14	6.50	11
Oblique	23	5.78	9
Perspective	42	3.76	3
Architectural	20	4.10	5
Structural	11	6.54	
Map Drawing	7	4.57	
Pipe Drawing	1	8.00	
Electrical	1	6.00	
Charts and Diagrams	4	6.00	
Reproductions	2	4.50	

Employers' Ratings

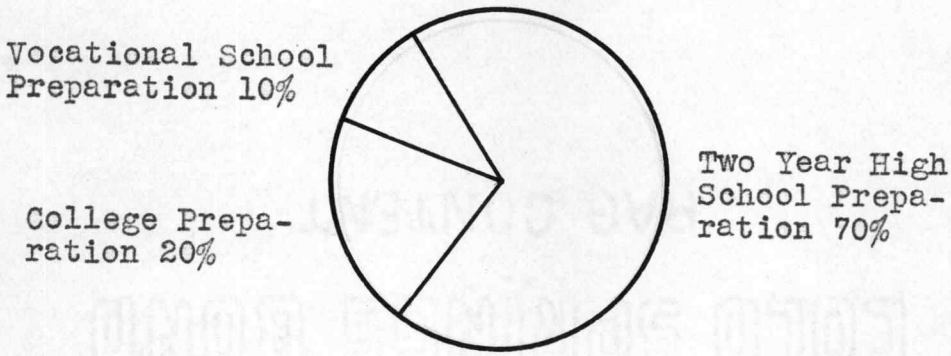
Although vocational education is not the aim of the high school, it is interesting to study the employer's opinions, concerning draftsmen's qualifications, for their general implications. Many of the pupils who do not avail themselves of further formal education will be confronted, quite suddenly upon graduation, with the policies determined by employers.

Minimum Qualifications for the Drafting Room.

A minimum qualification for entry into the drafting room was found to be in 7 (70%) of the 10 cases, a two year high school preparation; 2 (20%) required a college preparation while only 1 (10%) required a vocational school background. The first mentioned qualification implies the reliance placed by industry upon the high school industrial arts drafting program. For comparisons see Graph 9.

Graph 9

Minimum Qualifications for the Drafting Room

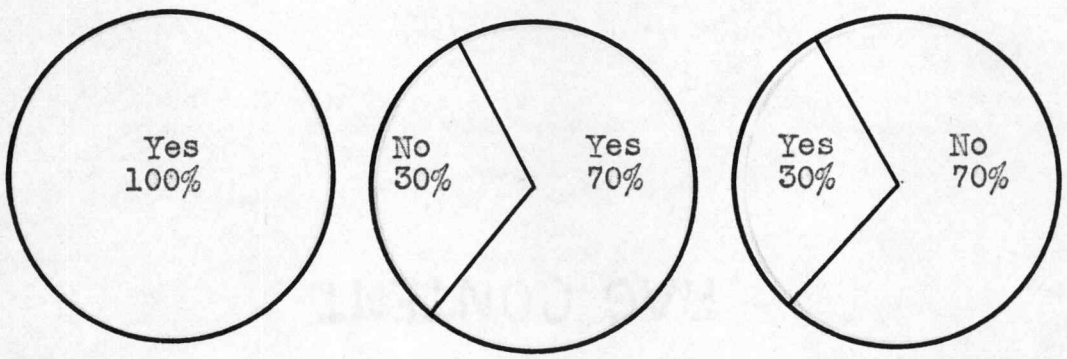


Appraisal of an Employee's Sketching Ability.

The consideration granted a prospective employee with a working knowledge of technical sketching, other things being equal, is shown in Graph 10, parts A, B, and C, representing positions in the drafting room, the administration, and the production force, respectively. "Yes" or "No", indicates for each group whether or not the prospective employee would be given greater consideration.

Graph 10

Appraisal of an Employee's Sketching Ability



A. Drafting Room

B. Administration

C. Production Force

Positions Demanding Technical Sketching.

Those positions inferring leadership in personnel or ideas find sketching a required asset. The positions listed in Table XIII were the ones volunteered by the employer group as demanding a working knowledge of technical sketching.

Table XIII

Positions Demanding Technical Sketching

Positions	Frequency Mentioned
Draftsmen	10
Engineer	6
Superintendent	4
Foreman	5
Machinist	2
Designer	4
Illustrator	3
Architects	3
Electricians	1
Sheet Metal Layout	1

Importance Attached to Sketching by Employers.

The employers considered sketching most important as a time saving method of conveying thoughts and information; this was similar to the combined draftsmen responses shown in Table IX. Of course, this merely confirms the response one would expect from an industrial concern where time and money are synonymous. Scoring for subsequent ranking was accomplished as before where the automatic evaluation of each statement resulted from

the individual ranking them in the order of their importance; numeral 1 was most important. This, along with the ratings of other functions of sketching, are shown in Table XIV.

Table XIV

Importance Attached to Sketching by Employers

	Frequency of response	Mean Score	Rank
Conveying thoughts and information to others rapidly.	10	1.4	1
As a means of recording data.	10	2.7	3
In the solution of design problems	10	2.4	2
Pictorial sketches as an aid in interpreting an intricate working drawing	9	3.4	4

Areas of Learning Desired by Employers of Draftsmen.

The areas of learning desired of those entering their employment as draftsmen were ranked in order of importance by each of the 10 employers. These automatic values determined the rank of each of the eleven areas receiving the greatest frequency of response. Since there were no prescribed number of responses, none were considered for comparison beyond the fewest number given

which was seven; this was done in order to include the responses of all the employers. See Table XV.

Table XV

Areas of Learning Desired by Employers, of Draftsmen

	Frequency of response	Mean Score	Rank
Orthographic	5	1.8	1
Working Drawing	9	2.1	2
Lettering	10	2.8	3
Dimensioning	9	4.1	6
Sectioning	9	5.6	8
Auxiliary Projection	3	5.7	9
Isometric	3	6.7	10
Fasteners	1	7.0	
Developments	2	7.0	11
Oblique	--	--	
Perspective	4	5.3	7
Architectural	4	3.3	4
Structural	2	4.0	5
Map Drawing	1	2.0	
Pipe Drawing	1	1.0	
Electrical	1	3.0	
Charts and Diagrams	1	4.0	
Reproductions	--	--	

Composite Treatment for Comparisons

Each group has furnished data which will be paralleled to assist in the making of comparisons. Some modifications in the extent of the former treatment of data were found necessary in order to direct attention wholly on the salient characteristics of this study.

Of the 44 teachers contacted, 38 (86%) professed the use, to some degree, of the freehand drawing method in their course for beginners. The remaining 6 teachers (14%) saw no purpose for its inclusion in the beginning course. A median of 10% expressed the approximate instructional time devoted to the freehand drawing method by the 38 teachers using it. The time spent on freehand drawing was divided between orthographic and pictorial forms on a median percentage relationship of 50% to 50%.

On the other hand, the 55 draftsmen revealed that sketching was used by all of them. The extent of its use was shown to be "frequent" by 30 (55%) of the draftsmen, "seldom used" by 22 (40%), and "entirely used" by 3 (5%). Orthographic sketches were used more frequently than the pictorial form by 36 (65%) of the draftsmen while 19 (35%) expressed the reverse condition. Comparisons of these data are shown in Graph 11, parts A, B, and C.

Graph 11

Comparisons in Extent of Freehand Drawing Usage in Schools and in Industry

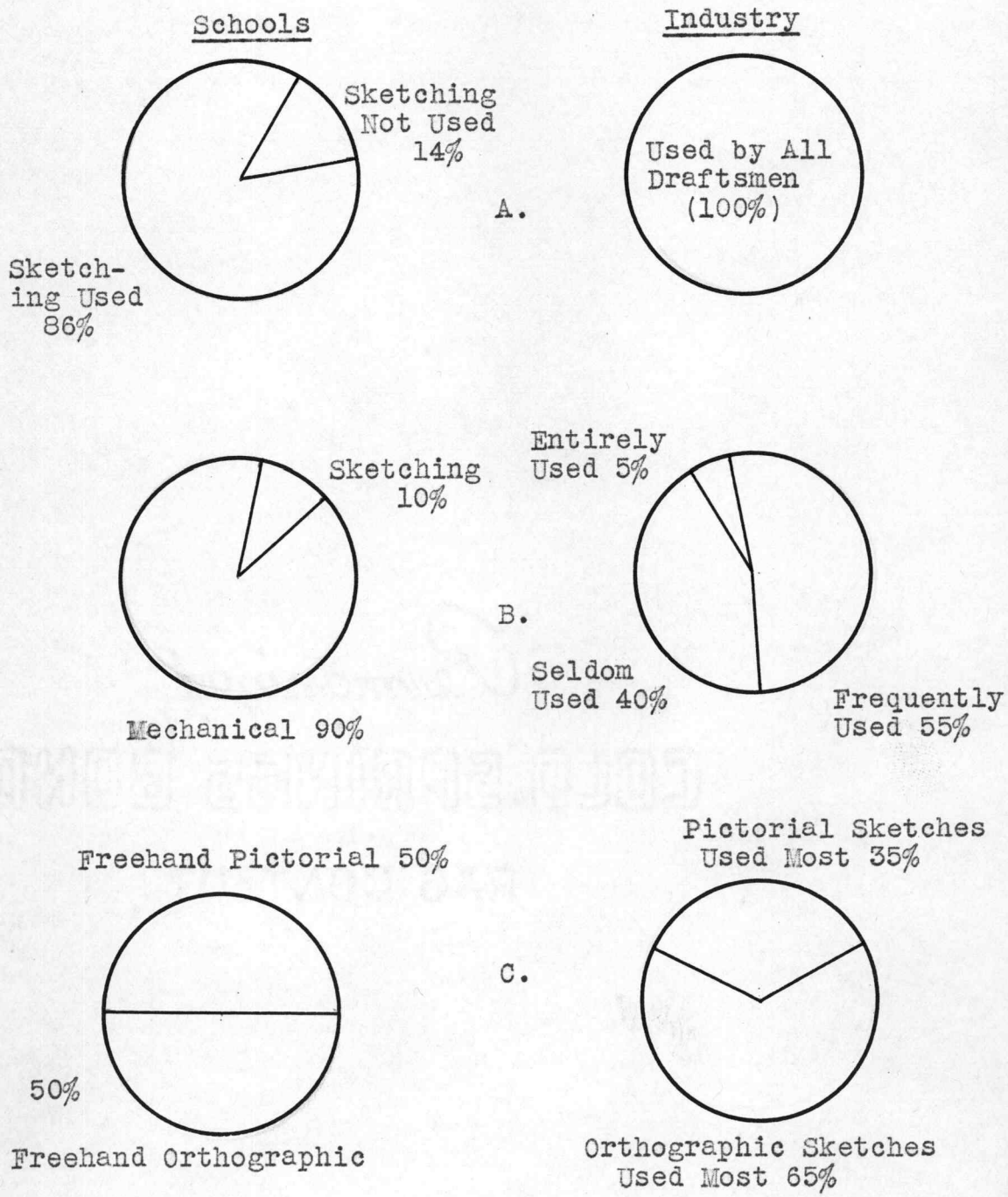


Table XVI shows a comparison of the importance of sketching indicated by the draftsmen and their employers. The "Rank" indicates the position of importance assigned by each group through combined opinion.

Table XVI

Comparison of Opinion on the Importance of Sketching by Draftsmen and Their Employers

	Rank by Draftsmen	Rank by Employers
Conveying thoughts & information	1	1
As a means of recording data	4	3
In the solution of design problems	2	2
Pictorial sketches as an aid in interpreting an intricate working drawing	3	4

The inclusion of freehand drawing in the drafting course creates the problem of when it should be introduced in the learner's experience. Table XVII indicates the opinions on this matter maintained by the teachers and the draftsmen with ranks denoting the greatest frequency concurred on each.

Table XVII

Comparison of Opinion on the Point of Introduction of Sketching by Teachers and Draftsmen

	Rank by Teachers	Rank by Draftsmen
In the beginning, as a means of establishing an over-all understanding of the selected drafting principles to be presented.	3	1
Preceding each instrumental drawing, in order to insure understanding of the immediate problem.	1	2
At the end of the course, as an additional learning area to provide masterful expression through applying the theory already obtained.	2	3

Table XVIII, presents the opinion of the teachers and draftsmen on the justification of the freehand drawing method in the drafting course for beginners. The rank denotes the importance levied on the statements by the group.

Table XVIII

Comparison of Opinion Justifying Freehand Drawing by the Teachers and the Draftsmen

	Ranked by Teachers	Ranked by Draftsmen
It is logical, since the pupil exercises past experience in acquiring a new experience	3	3
Basic drafting theory can be advantageously divorced from instrumental techniques for more extensive and more rapidly executed pupil activity	2	2
It serves to impress the pupil with its possibilities as an effective means of expression in daily life	4	1
It is used extensively in industrial activities.	1	4
The cost of required materials is held to a minimum.	5	5

A comparison of the necessary areas of learning in drafting as viewed by the teachers, the draftsmen, and the employers of the latter is shown in Table XIX. Although the employer group expressed the knowledge of the areas of learning as those desired of a prospective employee, it is interesting to include these data in the comparison. The ranks assigned the areas of learning

specify their relative importance. For the teachers, the rank was determined through the median percentage of time devoted to each area; whereas the mean score of the draftsmen and the employers was the determinant in each case. Not all of the possible areas were ranked; only the first eleven with the greatest frequency of response were considered from each group, for the remaining areas lacked significance due to the few cases they represented.

Table XIX

Comparison of the Importance Assigned the Learning Areas by Teachers, Draftsmen, and Employers

	Rank by Teachers	Rank by Draftsmen	Rank by Employers
Orthographic	2	1	1
Working Drawing	1	4	2
Lettering	6	2	3
Dimensioning	7	6	6
Sectioning	3	8	8
Auxiliary Projection	5	10	9
Isometric	3	7	10
Fasteners	8		
Developments	4	11	11
Oblique	9	9	
Perspective		3	7
Architectural		5	4
Structural			5
Reproductions	10		

CHAPTER IV

SUMMARY AND RECOMMENDATIONS

Summary

Throughout the history of mankind, drafting in sketch form has assisted in the expression of ideas. Earliest man probably used it as his sole language while civilizations of later ages used it chiefly in planning their monumental works of art. Sketching has had its advocates; Leonardo da Vinci exemplified its worth through usage while Pestalozzi professed its value in developing children to become conscious observers of things about them.

Drafting is of paramount importance in this engineering age, for technological advancement has evolved into reality through this medium of graphic expression. As never before, a conscious need has been maintained in the minds of those illiterate in this "language", since their environment will not let them rest in ignorance. Through the recognition of this need, the high school has included drafting in its curriculum as an industrial arts subject in order to give the masses an insight into the rudiments of draft-

ing theory.

Two schools of thought exist in the manner of presenting drafting theory. There are those who contend that the pupil activity should be wholly mechanical, while others insist upon the use of freehand drawing as an approach to drafting theory, and as a supplement to the mechanical techniques. It was upon these different views that this study was founded. The purpose of the study, in general, was to determine if there is tangible evidence in support of the freehand drawing method of teaching drafting theory at the secondary school level.

In approaching the problem, three principal groups were studied; they were the high school industrial arts drafting teachers of Los Angeles, industrial draftsmen of that area, and the employers of the latter group. The coverage of these groups was accomplished by interview, which afforded an opportunity for the writer to see conditions as they existed. This effort encompassed 44 drafting teachers, 55 draftsmen, and 10 employers.

The study of the teachers disclosed that 38 out of the 44 responding or 86% used freehand drawing in supplementing the instrumental drawing. On the basis of the median of their responses, these 38 teachers de-

voted 10% of their instructional time to freehand drawing. As between orthographic and pictorial freehand drawing, the median percentage relationship was found to be 50% each. The use of pictorial sketches was encouraged in interpreting intricate working drawings by the 38 teachers professing the freehand drawing method, whereas the remaining 6 teachers did not believe it was of any value. The greatest percentage of teachers using sketching introduced it preceding each instrumental drawing; 16 of the 38 (42%) represented this group. The other two alternatives were designated in this order: at the end of the course 21 (32%) and at the beginning of the course 10 (26%).

In justifying the presence of freehand drawing in their courses, the 38 teachers indicated as their first defense, through combined response, that: 1) it was used extensively in industrial activities. Following in close second was the justification that: 2) more extensive and more rapidly executed pupil activity could be effected through divorcing theory and instrumental execution. The remaining justifications were ranked in the following order: 3) logical approach, using a past experience in acquiring a new one; 4) effective means of expression in daily life; and 5) low cost of instructional

materials required.

The eleven areas of learning most frequently offered the beginning pupil were found to be, in their order of importance: working drawings, orthographic projection, sectioning, isometric, developments, auxiliary projection, lettering, dimensioning, fasteners, oblique, and reproductions.

A polling of the activities and opinions of the 55 draftsmen revealed that 30 of that number 55% used sketches "frequently" in describing a single product of maintenance or design; 22 (40%) indicated "seldom used", while 3 (5%) expressed its use "entirely used".

Draftsmen favor the use of orthographic sketches to the pictorial form as 36 (65%) confirmed this practice, while only 19 (35%) were of the reverse opinion. In ranking the importance of sketching, considering usage, the draftsmen believed it most important as a means of rapidly conveying thoughts and information to others. Other uses by order of rank were in design solution, interpretation of working drawings, and recording data. Of the 55 draftsmen, 30 (55%) voiced the thought that sketching should be used in the beginning of the course for establishing over-all understanding of selected theory; 21 (38%) would have it used before

each instrumental drawing, while the remaining 4 (7%) recommended its use as an additional learning area at the end of the course. In justifying the use of freehand drawing in the beginners course, through combined opinion, the 55 draftsmen believed it was best defended as an effective means of expression in daily life. The other vindications in their order of importance were more extensive and more rapidly executed pupil activity effected by divorcing theory and instrumental execution, logical approach using a past experience in acquiring a new one, used extensively in industry, and low material cost. The eleven areas of learning most frequently suggested for freehand treatment in the course for beginners were ranked by the draftsmen in the following order of importance: orthographic projection, lettering, perspective, working drawings, architectural, dimensioning, isometric, sectioning, oblique, auxiliary projection, and developments.

Employers of the draftsmen contributed information on current minimum requirements for drafting room positions and opinions concerning the use of technical sketching. Their combined opinion has shown the general acceptance of high school training in this particular field for direct application in industry; 7 (70%) of the

10 employers stated that two years of high school preparation was a minimum requirement while the remaining 3 (30%) considered only a more specialized training. In general, the draftsman and the administrator are required to use the power of expression gained through sketching, as indicated by the employers, while members of the production force need not be so equipped. This group considered sketching most important as an expedient in conveying thought and information which was identical to the draftsmen's response. The other uses of sketching were cast in the following order of importance: for design solutions, for recording data, and for interpreting working drawings.

The eleven areas of learning most frequently desired of a prospective employee for the drafting room, were ranked in the following order of importance: orthographic projection, working drawings, lettering, architectural, structural, dimensioning perspective, sectioning, auxiliary projection, isometric, and developments.

Recommendations

After careful consideration of the findings of this study, the following recommendations have been offered:

General.

1. That all first year courses in drafting be generalized to include the greatest number of experiences possible within the limited time in order to develop understanding and appreciations in the pupil.

2. That greater emphasis be placed on mastery of theory than on excellence of appearance in pupil effort.

3. That teachers of drafting be well grounded in the use of sketches during their college preparation, not only in knowledge and appreciation of its value but in proficiency of manipulative techniques as well.

4. That teachers be cognizant of all pertinent industrial developments in order to insure a vital offering to their pupils.

Specific.

1. That sketching be used more extensively and more intensively in presenting drafting theory to the beginner.

2. That greater emphasis be placed on orthographic than pictorial sketches; the use of the latter being encouraged as an aid to the interpretation of an intricate working drawing.

3. That the freehand drawing presentation include the following areas of learning in order to insure a well rounded knowledge of theory during the first year drafting course: orthographic projection, lettering, working drawings, perspective,

architectural, dimensioning, sectioning, isometric, oblique, and auxiliary projection.

4. That the freehand drawing method be introduced in the beginning as a means of establishing an expeditious, over-all understanding of the selected theory to be presented during the first year course in drafting; to be followed with the mechanical execution of similar problems.

For Further Study.

1. An experimental study in order to determine the relative effectiveness of the two methods, freehand and mechanical, in presenting drafting theory.

2. An experimental study in order to compare the degrees of efficiency obtained by the two methods of presenting drafting theory by freehand sketching; as a whole in the beginning, and preceding each instrumental drawing.

3. A comparative study between the over-all freehand presentation of drafting theory at the beginning of the course and Gestalt Psychology.

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HISTORICAL QUOTATION BEARING UPON THIS STUDY

APPENDIX A

From Bennett (6: 285)

At the Central School as at La Martinere, the pupil from his first entrance begins to draw in perspective from models; then he passes quickly to projection, which is more closely connected with the labour of the workshop. As soon as he has acquired sufficient skill, the following plan is pursued: a model is placed before 12 or 14 pupils; the teacher takes it to pieces before them, explains the principal arrangements, draws attention to the different forms, and after having given all necessary explanations removes the model. The pupil must then execute from memory and without instruments, sketches of the whole, and of the details and sections required by the teacher. When the time fixed for the execution of this drawing from memory has elapsed, the model is replaced before the pupils, the teacher points out the corrections to be made, and a pupil placed close to the model takes all the measurements and dictates the dimensions. The model is once more removed, and from the sketch the pupil must now make a drawing to scale. This kind of work, and a little drawing of ornament and practice in tinting, constitute the study of the first year. During the second and third years, the pupils while continuing from time to time the drawing from memory, pass on to another kind of study. Drawings of machines are given to them, but not to be servilely copied; they are required to draw a section on a line marked on the drawing. In this way the pupil can never copy a drawing without understanding it; he must analyze it in all its particulars for himself. To others, again, is given a drawing, as for example, of a steam-engine, taken from some work on machinery, together with the text which accompanies it. The teacher explains to the pupil a certain portion of the machine - the cylinder for instance, with the arrangement of its parts; the latter must then draw every piece of it (as if it were taken completely to pieces) to a certain fixed scale. When this work is finished the copy is removed, and the pupil must proceed to draw

the whole from the drawings which he has already made of the parts. In these two divisions the young men are also practiced in making designs of parts of machines according to the principles of the strength of materials which they have learned in school; designs for boilers according to the principles of physics; designs of machines or of buildings of all kinds as applications of the sciences which they have studied at school. As a supplement to the study of drawing, the pupils of the second and third years visit every Thursday certain manufactories which are fixed upon, and must bring back figured sketches of some of the machines; these they must afterwards reproduce as finished drawings to scale. Afterwards from all these drawings a selection is made of those which possess most interest, or are of the greatest utility, and these being lithographed, an album is made intended specially for the use of the pupils of the school.

APPENDIX B

QUESTIONNAIRE

Form T

1. How many beginning classes do you usually have each semester?_____

2. What is the average number of pupils in a beginning class?_____

3. Which aim is predominant in your first year course of study?

   _____Vocational preparation
   _____General education

4. Is the first year's work generalized to such a degree that it could be considered a terminal course?
   Yes_____ No_____

5. On which do you place greater emphasis? (Please indicate relationship on a percentage basis).

   _____Mastery of theory
   _____Excellence of appearance through the development of motor skills.

6. What is the maximum offering in drafting at your school, in semesters? _____.

7. Approximately what percentage of the pupils enrolled for first year drafting complete the maximum offering?_____

8. Approximately what percentage of instructional time is devoted to freehand representation?_____

9. How is the time on freehand drawing divided? (Please indicate relationship on a percentage basis). Orthographic_____ Pictorial_____

10. At what point in the learner's experience is freehand drawing introduced? (Please indicate with a check).

    _____In the beginning, as a means of establishing an over-all understanding of the selected drafting principles to be presented.

_____Preceding each instrumental drawing, in order to insure understanding of the immediate problem.
_____At the end of the course, as an additional learning area to provide masterful expression through applying the theory already obtained.

(Please state any other method not listed).

11. Do you encourage the use of pictorial sketching as an aid to visualizing a working drawing? Yes_____ No_____

12. When did you first introduce freehand drawing in your course of study for beginners? (Please indicate the year)._____

13. What is the average number of plates completed by a class in first semester drafting? Freehand_____ Mechanical_____

14. What areas of learning do you offer the beginner during the first year's work? (Please indicate those areas offered by the approximate percentage of time devoted to each).

____Orthographic
____Working drawings
____Lettering
____Dimensioning
____Sectioning
____Auxiliary projection
____Isometric
____Fasteners
____Developments
____Oblique
____Perspective
____Architectural
____Structural
____Map drawing
____Pipe drawing
____Electrical
____Charts and Diagrams
____Reproductions

15. Do you offer instruction in production illustration? Yes____No____. At what point in the learners's experience is it introduced?
____During the first year's work
____As a specialization feature in advance work.

16. Which of the following visual aids are employed in presenting the initial problems and demonstrations?

_____Blackboard sketches
_____Flash cards
_____Mimeographed job plans
_____Models
_____Clay Modeling
_____"Glass" projection box
_____Cardboard developments
_____Slides
_____Motion pictures
(Please list any others)

17. Do you teach drafting exclusively? Yes___ No____.
(If no, please list other subjects taught.)

18. Was your freehand drawing background gained principally through:
_____participation in class study during college training?
_____vocational necessity from industrial experience?
_____pursuit of a leisure time activity?

19. How would you justify the presence of freehand drawing in your course of study for beginners? (Please indicate numerically in the order of importance; numeral 1 being most important.)
_____It is logical, since the pupil exercises past experience in acquiring a new experience.
_____Basic drafting theory can be advantageously divorced from instrumental techniques for more extensive and more rapidly executed pupil activity.
_____It serves to impress the pupil with its possibilities as an effective means of expression in daily life.
_____It is used extensively in industrial activities.
_____The cost of required materials is held to a minimum.
_____It should not be included in the drafting course.
(Please list any other support not mentioned.)

QUESTIONNAIRE

Form D

1. Where did you obtain your first knowledge of drafting principles?
(Please indicate with a check.)

_____In high school (If you attended a Los Angeles city high school please state which one and years attended.)

_____

_____In college
_____On-the-job-training
_____Night school (high school adult training program)
_____Technical school
_____Vocational school

2. How many years of drafting preparation did you undergo before seeking employment?

_____High school
_____College
_____Night school
_____Technical school
_____Vocational school

3. To what degree did you learn drafting principles through the use of freehand drawing technique?

_____None _____In part ____Wholly

4. To what extent are freehand working sketches employed in describing a single product for maintenance or design?

_____Never used
_____Seldom used
_____Frequently used
_____Entirely used

5. How do you employ freehand sketching? (Please indicate numerically in the order of importance to your work; numeral 1 being most important.)

_____Conveying your thoughts and information to others rapidly
____As a means of recording data
_____

_____In the solution of design problems
_____Pictorial sketches as an aid in interpreting an intricate working drawing.

6. Which form of sketching do you perform more frequently? (Please indicate with a check.)
Orthographic____ Pictorial____.

7. In view of revision of the present traditional courses in high school drafting, how could the inclusion of freehand drawing be justified as a service to the beginning pupil in the mastery of drafting theory? (Please indicate numerically in the order of importance; numeral 1 being most important.)

_____It is logical, since the pupil exercises past experience in acquiring a new experience.
_____Basic drafting theory can be advantageously divorced from instrumental techniques for more extensive and more rapidly executed pupil activity.
_____It serves to impress the pupil with its possibilities as an effective means of expression in daily life.
_____It is used extensively in industrial activities.
_____The cost of required materials is held to a minimum.
_____It should not be included in the drafting course.

(Please list any other support not mentioned.)

8. At what point in the learner's experience would you recommend the introduction of the freehand drawing technique? (Please indicate by a check.)

_____In the beginning, as a means of establishing an over-all understanding of the selected drafting principles to be presented during the course.
_____Preceding each instrumental drawing to insure understanding of the immediate problem.
_____At the end of the course as an additional learning area to provide masterful expression through applying the theory already obtained.

9. What areas of learning should be offered the beginner through freehand drawing to insure a well rounded knowledge of the subject during the first year's work? (Please indicate those areas selected from the following list numerically in the order of importance; numeral 1 being most important.)

_____Orthographic	_____Oblique
_____Working drawings	_____Perspective
_____Lettering	_____Architectural
_____Dimensioning	_____Structural
_____Sectioning	_____Map drawing
_____Auxiliary projection	_____Pipe drawing
	_____Electrical
_____Isometric	_____Charts and diagrams
_____Fasteners	
_____Developments	_____Reproductions

QUESTIONNAIRE

Form E

1. What minimum background qualifications must one possess in order to enter your employment in the drafting department?
   ___High school preparation in drafting (two years or more).
   ___Vocational school preparation in drafting.
   ___College preparation in drafting received as incidental to engineering studies.
   ___Graduate architect or equivalent.
   (Please list any other necessary qualifications).

2. Would a prospective employee be considered more valuable if he possessed the ability to make technical sketches freehand; other things being equal? (Please indicate by yes or no).
   ____for a drafting room position
   ____for an administrative position
   ____for a place in the production force.

3. What positions in your organization demand a working knowledge of technical sketching?

4. Why do you consider the use of sketches important? (Please indicate numerically in the order of importance; numeral 1 being most important).
   ____Time saving method of conveying thoughts
   ____As a means of recording data
   ____Used effectively in the solution of design problems.
   ____Aids in interpreting working drawings by using pictorial sketches.

5. Which of the following areas of drafting knowledge would be desirable of those seeking your employment as draftsmen? (Please indicate those areas selected from the following list numerically in the order of importance; numeral 1 being most important).

____Orthographic	____Oblique
____Working drawings	____Perspective
____Lettering	____Architectural

_____Dimensioning	_____Structural
_____Sectioning	_____Map drawing
_____Auxiliary pro-jection	_____Pipe drawing
_____Isometric	_____Electrical
_____Fasteners	_____Charts and diagrams
_____Developments	_____Reproductions

APPENDIX C

Schools and Teachers Contacted in the Survey

Phineas Banning High School	Winn, Herman Pitt
Bell High School	Herold, Henry Danelle
Belmont High School	Weir, David
Canoga Park High School	Squire, Loyd Parker
Dorsey, Susan Miller High School	Jepson, William August
Eagle Rock High School	Brauer, Easton Buryl
Fairfax High School	Riggs, G.D.
Francis, John H., Polytechnic High	Linton, John Albert
Benjamin Franklin High School	Sherinyan, William K.
John C. Fremont High School	Brown, Harry Preston Hall, Walter
Gardena High School	Spicer, Claude Earle
James A. Garfield High School	Dobric, Fred Robert
Alexander Hamilton High School	Lowe, R.I.
Hollywood High School	Blake, G.J.
Huntington Park High School	Merrill, W.R.
Thomas Jefferson High School	Reilly, W.F.
Jordan, David Starr, High School	Welty, Carl D.
Abraham Lincoln High School	Badger, Alex J.
Los Angeles High School	Becker, Franklin R.

Manual Arts High School	Richards, John A. Woods, Walter Allen
John Marshall High School	Flam, August Hiel, Frank L.
Nathaniel Narbonne High School	Hunt, Ellis A.
North Hollywood High School	Gullord, William Earl
Jacob Riis High School	Pieri, Ernest Eligio
Theodore Roosevelt High School	Shearer, L.R. Thomas, H.W.
San Fernando High	Knowlton, C.H. Odell, T.D.
San Pedro High	Amann, E.G. Defever, Edmond
South Gate High	Reynolds, Frank R.
Torrance High	Burchett, James H.
University High	Armstrong, John W. McLoughlin, Stuart
Van Nuys High	Ingram, John P.
Venice High	Gyllenswan, Gunnar E. Lord, Earl M.
Verdugo Hills High	Sours, Archie L.
George Washington High	Cundiff, Stanley M. Quistorff, Otto W.
Woodrow Wilson High	Currin, Clarence R.

APPENDIX D

Organizations Contacted In the Survey

Axelson Manufacturing Company, 6160 Boyle Avenue, Los Angeles, California.

Bash Ross Tool Company, 5856 Boyle Avenue, Los Angeles, California.

California Cornice Steel and Supply Corporation, 1620 North Spring Street, Los Angeles, California.

Eagle-Lion Studios, Hollywood, California.

Lockheed Aircraft Corporation, Burbank, California.

Mid-West Piping and Supply Company, 520 South Anderson Street, Los Angeles, California.

Survey Division--Los Angeles County, Los Angeles, California.

Williams, Paul R., Architect, 3757 Wilshire Blvd., Los Angeles, California.

Western Electric-Research Division, 7501 Romaine St., Hollywood, California.

Wurdeman and Becket, Architects, 3757 Wilshire Blvd., Los Angeles, California.