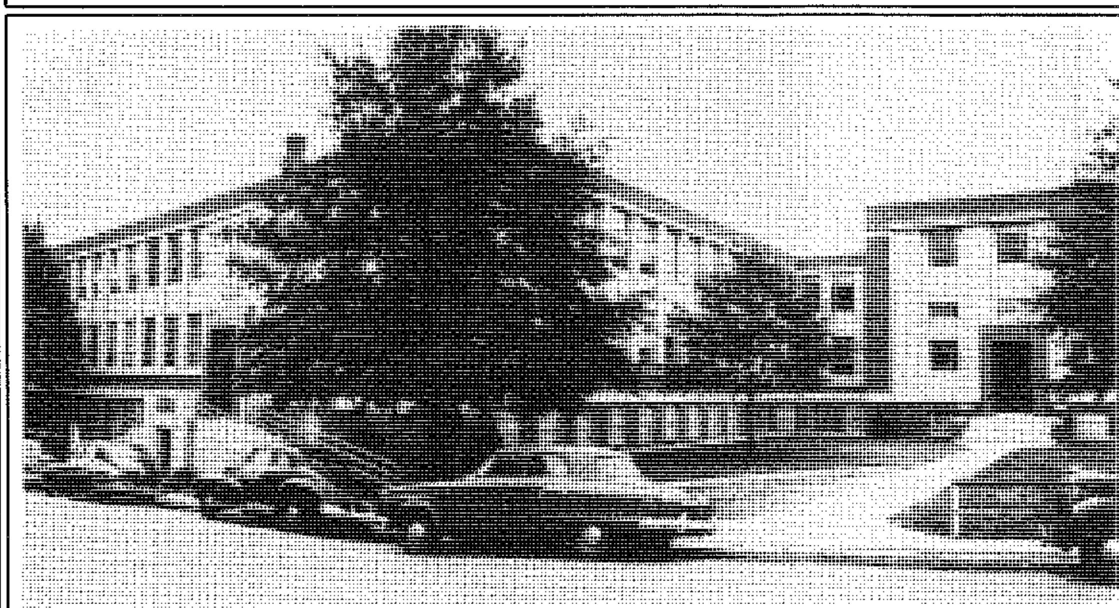
JOURNAL OF ENGINEERING DRAWING

VOL. 14, NO. 3 NOVEMBER, 1950 SERIES NO. 42



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A S E E

JOURNAL OF ENGINEERING DRAWING

PUBLISHED IN THE INTEREST OF TEACHERS OF ENGINEERING DRAWING AND RELATED SUBJECTS

VOL. 14, NO. 3 NOVEMBER, 1950 SERIES NO. 42

CONTENTS

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THE DIVISION OF ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY OF THE
AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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ASEE

RESOLVED

That, with the presentation of this Scroll, the Drawing Division of the American Society for Engineering Education hereby acknowledges the many distinguished services rendered through the years from 1906 to 1950 by

FREDERIC G. HIGBEE

The Society expresses its deep appreciation for those services and the great personal pleasure of the individual members in having his friendship. Presented this twenty-first day of June in the year of our Lord nineteen hundred and fifty.

O.W. Potter

CHAIRMAN OF THE DIVISION

PRO. F. G. HIGBEE

It is fitting that Professor Higbee should be the first person from the Engineering Drawing Division to receive the award for distinguished service. He has contributed extensively to our endeavors. Two instances of his action are:

(1) In 1928 he introduced the resolution for the creation of the Engineering Drawing Division.

(2) In 1936 he introduced the resolution in our Division creating the Journal of Engineering Drawing.

PRO. F. G. HIGBEE, University of Iowa

DIVISION ACTIVITIES

by

Professor Ralph S. Paffenbarger, Chairman
Division of Engineering Drawing

One of the most outstanding events of our annual meeting at Seattle in June was the awarding of the first scroll of recognition for distinguished service to the Drawing Division of the American Society for Engineering Education. This idea was originated by our immediate past Chairman Orrin W. Potter, and establishes a fine tradition which shall be continued. The committee making the award consisted of John T. Rule, Chairman; Frank A. Heacock, and Henry C. Spencer. It was indeed an excellent selection that Professor Frederic G. Higbee should be the recipient of the first award. The presentation was made by Professor Rule at our annual dinner at the University of Washington on June 21, 1950. A copy of the scroll is shown on the frontispiece of this issue of the Journal.

Professor Higbee has given many years of outstanding service to the society having been a member since 1906. He served as its vice president in 1922-23, a member of the council from 1916 to 1919, and 1946 to 1948.

He was born in Fremont, Ohio, on November 29, 1881, received the degree of Bachelor of Science in Mechanical Engineering from Case Institute of Technology in 1903, and his M.E. degree in 1908 from the same institution. After a year as an assistant engineer with the Osborn Engineering Company and the J.B. Davis and Sons, he returned to his Alma Mater as an instructor. From 1905 to 1908 he was an assistant professor of drawing at the State University of Iowa, and in 1908 he was promoted to professor and Head of the Department of Engineering Drawing at that school, which position he has held since that time. He has been an outstanding figure in the field of engineering drawing throughout his years of service. He was instrumental in establishing our own Division of Engineering Drawing in the Society, the first one to be established, and soon we can celebrate our 25th anniversary of this event. Professor Higbee also established the T-square Page in our Journal of Engineering Education, and served as its editor from 1930 to 1936. He likewise was a pioneer in sponsoring this Journal of Engineering Drawing and served as its editor in 1936 and 1937.

Professor Higbee, in addition to his many top assignments on his own campus such as Director of Convocations, etc., served as secretary to the Alumni Association of the University of Iowa from 1929 to 1936. He also served as Chairman of the Iowa City Zoning Commission, and was a member of the Board of Adjustments of Iowa City. He was instrumental in helping establish our first drawing and drafting standards having served for many years on the Z-14 Committee its executive group and was secretary of both groups. On the last revision of the American Standard Drawings and Drafting Room Practice 1946, he served as Chairman of the Subcommittee on Revision and did the editorial work on this volume.

As an author Professor Higbee has an outstanding list of books to his credit such as: Essentials of Descriptive Geometry 1915 - (several since); Descriptive Geometry Problems 1921; Engineering Drawing Problems (with Henry C. Thompson, Jr.) 1927; Drawing Board Geometry 1937; 101 Problems in Drawing Board Geometry 1938; Engineering Drawing Problems with John M. Russ 1941, in addition to these texts, he has contributed to many educational and technical journals.

Professor Higbee, in addition to the A.S.E.E., is a member of Sigma Xi, Tau Beta Pi, Pi Tau Sigma, Iowa Academy of Science, Zeta Psi, Triangle Fraternity, and Iowa City Engineers Club.

One of Professor Higbee's two sons, Jay Alvin, was present at the dinner and witnessed the presentation. Professor Higbee's response was very well given, and he was indeed appreciative of the honor.

ENGINEERING DRAWING JOURNAL

I would like to ask your cooperation in extending the circulation of this publication "The Journal of Engineering Drawing." Will you not assist the Circulation Manager, Professor Warren J. Luzadder, by asking each of your colleagues who are not subscribers to join the vast group now supporting our professional publication. I have every copy of the Journal since it was printed, and have them bound in two booklets with a third one about ready for binding. I consider this as much a part of my library as any text on engineering drawing or descriptive geometry. Without this publication, it is very difficult to know what is going on or being produced around the country. All the outstanding papers from our meetings are reproduced in this Journal. Send in the subscriptions. Let's swamp the circulation manager.

MID-WINTER MEETING - JANUARY 18, 19, 20, 1951

The mid-winter meeting announced in this issue, will be a fine occasion. Texas A & M College is celebrating its diamond jubilee, and will have a lot of things special to entertain us. What college can celebrate its 75th anniversary without raising a little whoopee! Take a look at the program and plan to join in the celebration at College Station, Texas. Mark your date book, old calendar, new calendar, and start recruiting an automobile load for January 18, 19, 20, 1951.

SUMMER SCHOOL FOR ENGINEERING DRAWING TEACHERS - ANNUAL A.S.E.E. MEETING MICHIGAN STATE COLLEGE EAST LANSING, MICHIGAN JUNE 21-29, 1951

A short summer school for engineering drawing teachers is being planned in connection with our annual meeting at Michigan State College, East Lansing, Michigan. This will start four days previous to our annual meeting and conclude with our regular sessions alloted during the meeting of the Society. The general theme of this project will be "Improving Our Status as Teachers of Engineering Drawing" treated on the basis of

(a) Meeting curriculum requirements
(b) Teaching methods by lecture demonstrations
  1. Basic drawing
  2. Descriptive Geometry
  3. Advanced drawing
  4. Elementary and advanced graphics
(c) Industrial applications

The program will be worked out approximately as follows:

Thursday, June 21, 1951

A.M.
8:00 - 9:00 Registration.
9:00 - 12:00 Papers and discussions dealing with courses, administration, reproduction, tests, credits, etc.

P.M.
2:00 - 4:30 Papers and discussions continuing with morning topics - Teacher Training, etc.
6:00 - Dinner. Social gathering.
7:30 - Tour of displays with discussion by exhibitors. Directed by Committee on Exhibits.

Friday, June 22, 1951

A.M.
9:00 - 12:00 Teaching Methods. Lecture demonstrations with discussion on Basic Drawing.

P.M.
2:00 - 4:30 Teaching Methods. Lecture demonstrations with discussion on Descriptive Geometry.
7:30 - Teaching Aids. Exhibits and discussion directed by Committee on Teaching Aids.

Saturday, June 23, 1951

A.M.
9:00 - 12:00 Teaching Methods. Lecture demonstrations with discussion on Advanced Drawing.
12:00 - Group picture.

P.M.
2:00 - 4:30 Teaching Methods. Lecture demonstrations with discussion on Elementary and Advanced Graphics.
6:00 - Dinner; Executive Committee dinner.

Sunday, June 24, 1951

Open for visits to Detroit; Ann Arbor, and Dearborn; University of Detroit, Wayne University, University of Michigan, Greenfield Village, etc.

Monday, June 25, 1951

A.M.
9:00 - Inspection trips.

P.M.
2:00 - Conference. Industrial application, papers and discussions.

Tuesday, June 26, 1951

A.M.
8:30 - Inspection trips.
10:00 - Conference.
12:00 - Luncheon. Business meeting and Committee reports.

P.M.
2:00 - Conference. Industrial application, discussion.

Wednesday, June 27, 1951

A.M.
9:00 - General sessions of the Society.

P.M.
2:00 - General sessions of the Society.
6:00 - Annual Engineering Drawing Division dinner with program including awards, entertainment and an address by a member of Michigan State Faculty.

Thursday, June 28, 1951

General sessions and Annual Dinner of the Society.

Friday, June 29, 1951

Closing sessions of the Society.

YOUR COOPERATION APPRECIATED

The above program is just a suggested outline. This was made up on August 1, and will be changed.

Justing Rising sent me the tabulation from questionnaire answers received after our last summer school in St. Louis, five years ago. These will be used to advantage by your Executive Committee in working out a program that the majority are interested in having. I have received many names of persons for faculty and participants in our program. I would like to see a wide distribution of participants throughout the country, not more than two, say, from any one school with many of the capable young staff members on the program and top industrial selections. Upon reading this article, or before December 20, will you please write me giving the following information and answer the suggested questions:

1. Your name.
2. Your school.
3. Your address.
4. Whether you will (or will not) attend the mid-winter meeting at Texas A & M.
5. Whether you will (or will not) attend the summer school for engineering drawing teachers.
6. I offer the following suggested changes on your program outline.
7. I would like to see the following persons on the program (name and give suggested title of their paper or project).
8. I would like to see the following type of exhibits.
9. I suggest inspection trips to the following plants in the Lansing area.

(Continued on page 34)

MID-WINTER DRAWING DIVISION PROGRAM

TEXAS A & M COLLEGE

COLLEGE STATION, TEXAS
January 18, 19, and 20, 1951

The Agricultural and Mechanical College of Texas (Texas A & M) is celebrating its 75th Anniversary during 1950-51. The Drawing Division was invited to hold its Mid-Winter Meeting at College Station during the annual meeting in Seattle. The Executive Committee accepted the offer and fixed the dates of January 18, 19, and 20, 1951. The tentative program includes:

THURSDAY, JANUARY 18, 1951
(All Meetings in Memorial Student Center)

7:00 A.M.-6:00 P.M.	Inspection trip to the Humble Oil and Refining Company; San Jacinto Monument; Battleship Texas; New $100,000,000 Houston Medical Center; etc. Meet in lobby 6:45 a.m.
7:30-10:00 P.M.	Dinner Meeting of the Executive Committee. Meet in lobby 7:20 p.m.

FRIDAY, JANUARY 19, 1951

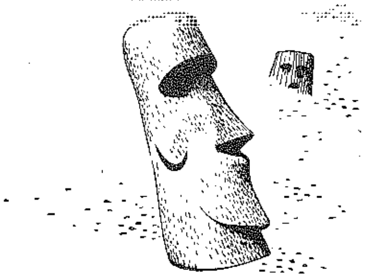
8:00-9:45 A.M.	Open House - Engineering Drawing Department, Anchor Hall
10:00 A.M.-12:00 Noon	Registration and conducted tours of A & M
12:00 Noon-1:15 P.M.	Drawing Division Luncheon: Welcome - President M.T. Harrington of Texas A & M. Response - Professor Ralph S. Paffenbarger, Chairman Drawing Division of ASEE
1:45 P.M.	DIVISION PROGRAM "The Design and Development of the Agricultural Airplane" - Fred E. Weick, Research Engineer and Distinguished Professor of Aeronautical Engineering, Texas A & M.
To be supplied later	
To be supplied later	
6:30 P.M.	Dinner Meeting - Memorial Student Center Music - Bryan High School Acapella Choir Humorous - The Future We're Headed for It - Cayce Moore, The Nation's Most Famous Barber Speaker - "The Future of Plastics" - Elgin B. Robertson, Texas Professional Engineer

SATURDAY, JANUARY 20, 1951

8:00-11:30 A.M.	Descriptive Geometry Film-Committee to Evaluate:
Names to be supplied later	1. 2. 3. 4. 5. 6.
	"Technical Drawing Curriculum Leading to a Bachelor of Science Degree" - Professor H. C. Spencer, Director Technical Drawing Department, Illinois Institute of Technology. Discussion:
	"A Re-Examination of the Methods of Teaching Basic Drawing" - Professor H. L. Henry, Associate Professor of Mechanical Engineering, Louisiana Polytechnic Institute. Discussion: 1. Professor R. M. Coleman, Department of Engineering, Texas Western College.
To be supplied later	2. 3.

This is the program as of September 28, 1950, when copy was submitted to the Journal of Engineering Drawing. The final program with blanks for hotel accommodations and advanced registration will be mailed members of the Drawing Division in December, 1950. Reservations are to be returned to Professor B. F. K. Mullins, Engineering Drawing Department, Texas A & M College, College Station, Texas.

Photo credit: American Museum of Natural History, New York



THE MYSTERY OF MAN

On the shores of Easter Island, in the far-off South Pacific, there stand a number of mysterious heads, forty, fifty, sixty feet high, carved from stone, with shadowed eyes that have gazed for centuries across the sea toward Polynesia. Who carved these bleak and brooding figures, whence their sculptors came, what the stricken shapes may be trying to say . . . perhaps no one will ever know. Perhaps again the only message is the wonder that aboriginal men possessed the talent and ability to cut these shapes.

But here again is testimony to the claim that talent and ability are possessed, not by one man, not by one race, not by one age, but by all men of all times . . . requiring just the right spark to ignite the flame . . . requiring just the right opportunity and environment to raise the level of performance among all men to heights now reached by only a few.

Certainly if an educator is to be dynamic, hopeful, optimistic, such is the position he must take with respect to the youngsters in his charge. Such must be his creed, his curriculum, his norm.

And when he takes this first *big* step, then all other steps must be taken in conformity. There can be no statement that the whole is important and that the parts are not. No saying that a youngster's future is unlimited if his present contradicts it. Ideals cannot be clean if the approach to them is shoddy. No instructor in mechanical drafting, for example, can expect much if the supplies and instruments his students use are cheap, carelessly chosen . . . proof of a vast indifference . . . contradicting all for which true education *really* stands.

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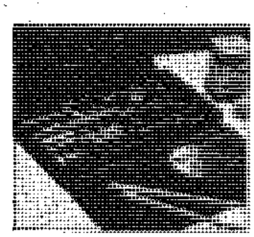

DIETZGEN

EVERYTHING FOR DRAFTING AND SURVEYING

(Printed in U.S.A.)

RESPONSE—A SPEECH

by

Prof. F. G. Higbee
University of Iowa

Mr. Chairman, Ladies and Gentlemen:

I find it difficult indeed to express my deep appreciation. Words are, as we teachers of graphics so well know, such impotent tools; and when used by a teacher of graphics to convey sentiments so near the heart they become indeed of uncertain worth. So allow me to say simply and sincerely thank you, and to amplify this brief but genuine acknowledgement with a few ideas.

I trust you will permit me to accept this award as an expression of professional approval of accomplishment you consider worthy of recognition. I hope you will grant me the right to assume this honor as an expression of personal regard from colleagues with whom I have long been privileged to associate. I would like as well to accept this recognition as an indication that you and I believe that we have more to do than meet our classes, that you and I owe it to our students, to ourselves, and to our profession to devote our talents also to the great purpose of advancing knowledge in our chosen field.

Because I am the first recipient of this award I deem this occasion merits more than a formal expression of thanks. Since I have known for some weeks that I was to be thus honored, I have written what I have to say both because I wish to be brief and because I wish you thus to appreciate that I have given consideration to these remarks.

The mantle of distinction is seldom a single-handed achievement. There are others in this division as deserving as I. I would tonight remind you that in this chosen field of ours there are many whose influence, whose accomplishments, and whose contributions we shall always remember. Some of these are no longer with us. Some have retired from active service. Some of these you know. Some are here tonight. To these and to this division I owe much. In receiving this award I would like you to consider that he who stands here and speaks is but the representative of all of these and of this great division which has inspired and stimulated its membership to greater accomplishment.

Even from a person who has been singled out as I have tonight a discourse on the factors which win promotions and influence deans might seem presumptious. But permit me to remind you that I am a charter member of this division, that I am probably its oldest member in age and in years of service, and that less than half a dozen members of the A.S.E.E. have been members of the parent body longer than I. From such a background I have arrived at certain conclusions. Like auxiliary views which clarify oblique situations on a drawing, perhaps these comments may be helpful in the personal assessment which every teacher should periodically undertake.

By all means take yourself seriously. The teaching of engineering drawing is an important job. Your teaching, your thinking, your personality will have a lasting influence on the development of some raw material into a finished product. The courses you handle are admirable tools for the processing of uniformed and undeveloped young minds into efficient and competent thinking devices. The high standards you set and demand from your students inevitably become gages in future work and in future character. What you have chosen to do challenges you in countless ways to give the best you have and to accept nothing less than the best from your pupils.

Earlier in these comments I said you and I believe we have more to do than meet our classes. If there is one oblique area in the whole picture I am endeavoring to draw for you tonight where supplementary and auxiliary reenforcement is needed, this one I would consider our best example. This is the area where teaching ends, and general usefulness begins. Usefulness to your colleagues, usefulness to your department, usefulness to your faculty, usefulness to your college soon establish you as a valuable man whose services extending beyond the classroom make the overall management and conduct of the institution smoother. Of course, I recognize the endless hours of so-called extra-curricular chores, the tiresome and dreary committee meetings, and the uninspiring routine of much of such labor. But such labor is part of the institutional program, it has to be done by some one. As engineers you are prepared to do it well.

On the entrance door to our engineering building there is lettered this golden statement: "The best asset the engineering profession has is its reputation for honesty." That is a general belief and widely accepted. Within colleges and without, people have come to trust engineers, have come to consider them men of unshakeable integrity. What a priceless trait to own! What an invaluable contribution to education, to industry, to government. It behooves us to more than teach. Education certainly can use qualities which are characteristic of engineering minds.

Especially is this true in deliberations and discussions and decisions where weariness, inertia, lack of stamina, sheer boredom, timidity, or lack of conviction may cause men to say yes with lips while believing no with mind. Courageous and constructive opposition is, to my observation, the most valuable and hardest-to-get quality in educational discussions. In

(Continued on page 34)

APPRECIATION OF ENGINEERING DRAWING AS A BASIC ACADEMIC STUDY

by

Stanley S. Radford, Assistant Professor of Engineering Drawing
Michigan State College, East Lansing, Michigan

Introduction

It appears that there is a need for engineering drawing teachers to teach their students not only how to draw, but to instill an appreciation of engineering drawing and to emphasize its significance as a basic academic study in the training of an engineer.

Many students enter college directly on graduation from high school with varying degrees of preparation in technical drawing -- ranging from no previous training to 1, 2, or 3 years of work with varying time allotments in the high schools from whence they come. The quality of their previous training varies considerably. Most beginning college students have had very little opportunity to work in industry so they do not have an adequate basis for judgment as to the significance and value of engineering drawing and descriptive geometry courses for success in engineering work.

The writer, after spending 14 years as a teacher of technical drawing and machine shop work in public high schools and trade schools and 14 years as teacher of engineering drawing and descriptive geometry at Michigan State College -- was privileged to serve as a part-time engineering placement counselor during the college year of 1948-49 to some 440 engineering seniors and graduate students. Many personal interviews with senior students about to graduate are confused by the complexity and varied special phases of modern industry as indicated by the question frequently asked -- "Just where do I fit into the industrial picture?" Or, "which job am I best prepared to excell in?" Graduating seniors frequently accept what appears to be the best job available and often find very little use for some of the special option courses taken in college. During their initial industrial experience, they are required to apply their knowledge of basic engineering studies such as mathematics, english, engineering drawing, advanced design, and related shop, field, or construction courses. After graduation, many young engineers realize a need for more work in engineering drawing and design to meet industrial training program requirements.

Field representatives from both large and small industries coming on campus to interview graduating seniors for employment frequently ask the question, "Why is it that many engineering students are adverse to working as draftsmen during their initial industrial training experience?" Or, "why do some students regard work in industrial drafting rooms as 'dead-end jobs'?"

Questions such as these indicates that counseling and guidance of prospective engineering students in high schools and of engineering students in colleges and universities is not what it should be or is still inadequate in some respects.

The purpose of this article is to stimulate thought and discussion relative to the value and place of engineering students to meet industrial requirement for success in the many and varied phases of engineering work.

The discussion which follows in the form of key questions and answers serves to define engineering drawing, trace its historical significance and development as a basic academic study, its practical and cultural value to the students, its contribution to the technological and scientific progress of our country, its place in industrial training programs, and to summarize current industrial trends of thought relative to engineering drawing in it, and finally to arrive at a few basic conclusions which may be helpful to engineering curricula study committees, school administrators, teachers, counselors, and students, locally and elsewhere.

Discussion

Question #1. How is engineering or technical drawing defined?

In general, engineering or technical drawing may be defined as a "universal graphic language" utilized by engineers, designers, and technicians to convey their ideas of mechanical design and construction to skilled artisans, mechanics, and tradesmen employed in creative and useful engineering work. It is the language used by engineers and architects to develop, record, and transmit their ideas to those who are to execute their designs.

Specifically, engineering or technical drawing may be defined as the graphic art and science of shape description of any object with clarity and accuracy as to its form or contour, size, finish, color, and details of construction.[1]

Question #2. What can be said of the significance of engineering drawing in ancient times?

In ancient times, architects and construction engineers made use of technical drawings, both free-hand and mechanical, to portray graphically their ideas of design and construction as applied to various types of public structures such as temples, coliseums, bridges, roads, and military fortifications. Hand tools and utensils, weapons and boats, utility and artistic structures, were also objects of study by all the early civilizations. The Egyptians, Hebrews, Greeks, and Romans made successive contributions as evidenced by graphical sketches and drawings recorded on the walls of caves, those unearthed by archeologists from the tombs of ancient kings, and the recorded evidence in the Bible. Men in ancient times were forced by necessity to develop their mechanical ingenuity and creative ability to meet the dangers from wild beasts, floods, fire, famine, disease, and other warlike tribes or peoples threatening their very existence. The civilizations that grew strong and survived were those that developed capable leaders, thinkers, and master-craftsmen to plan, organize, and supervise the work of fellow-craftsmen, who in turn guided the work of many slave laborers in the erection of beautiful and ornate temples, irrigation systems, and military weapons and fortifications. Intricate and ornate hand carvings found in oriental temples in India and China, and those found in the ruins of ancient civilizations in Central and South America, indicates the existance of a highly developed apprentice system of education in which the knowledge and skill of the father, or master-craftsman was passed on to his sons or to other youths who were apprenticed to him.

The master-craftsman was the design engineer of ancient times. He acquired his training in the school of practical experience. It was he who traced the designs on the trestle board and guided the activities of fellow craftsmen and workers. Design engineers were held in high esteem and regard by their king or ruler. These men were "the brains" behind the ruler or leader and even though they often received little credit and their names were not recorded in ancient history -- who can belittle the magnitude of their achievements when one considers the feats of building construction with the limited power facilities available in their time. One can only marvel at the beauty and symmetry as well as the strength and grandeur of ancient structures. Even today, the ruins of many ancient structures evidence the careful planning, constructive imagination, skill and mechanical ingenuity of the designers and craftsmen of ancient civilizations.

[1]Technical Drawing - Giesecke - Mitchell - Spencer, p. 1; The Macmillan Co., New York, N.Y., Publishers.

The chief point of historical significance in the work of ancient designers, construction engineers, and craftsmen lies in the fact that many of the most beautiful temples were built as an expression of their worship, love, and loyalty to their Gods or rulers. This fact is evidenced in the question once asked of a stone mason, who was busily engaged in fitting building stones in the temple wall with meticulous care -- "Why do you spend so much time at such menial labor?" The answer came quickly -- "Sir, I am building a cathedral!"

Are we as industrial arts and engineering educators developing this kind of spirit and pride in workmanship in our students who become the craftsmen, designers and process engineers of today? Are we developing an appreciation of the value of technical drawing and design as a fundamental tool of expression?

Question #3. How did engineering or technical drawing develop as a basic academic study?

Engineering drawing had its earliest beginnings as an academic study in a Roman treatise on architecture by Vitruvius, in 30 B.C., in which he referred to projection drawings for structures, but it was not until the early part of the fifteenth century that the theory of projections was well developed by the Italian architects -- Brunelleschi, Alberti, and others.

The theory of projection drawing was advanced to an academic study by the French mathematician, Gasper Mongè, near the end of the eighteenth century. This development of the theory of orthographic projection provided the basis of descriptive geometry, the science which treats of the graphical description of objects of three dimensions and provides exercises designed to train the mind to visualize and to solve space problems.[2]

In the subsequent development of engineering drawing and descriptive geometry texts, both European and American authors utilize the same basic principles of projection with some variations in the practical applications or usage of them. The continuity of effort by many capable authors and teachers in developing better methods of presentation, with a liberal use of visual aids of all kinds, the application of technical sketching and drawing to practical engineering problems and projects to stimulate student interest and ability to visualize graphical solutions, the utilization of objective type tests, and systematic methods of checking and grading drawings -- has contributed much to the ultimate success of engineering graduates in not only the many special phases of engineering work but also in such major fields as education, business, law, and others.

The contribution of technical display drawings, unused materials, tools and fixtures, illustrative brochures of mechanical devices by industrial employers to engineering drawing departments has aided in the development of engineering drawing on a practical basis.

The establishment of policies favorable to the employment of engineering drawing teachers for summer work or for longer periods of time by industrial employers has contributed to more efficient teaching in line with actual industrial practice.

The development of engineering drawing to its present status as a basic academic study in the engineering curricula is the result of sound basic teaching by mature and experienced engineering drawing teachers and their supervision of younger teachers to enable them to do efficient and inspirational teaching.

Question #4. Why is engineering drawing considered a basic academic study in the engineering school curricula?

Engineering drawing is quite generally recognized as one of the basic studies in the training of engineering students because of its practical and cultural value.

From the practical standpoint, the beginning engineering student finds a need for immediate use of engineering drawing in other related academic and shop subjects. The ability to read and make technical sketches and drawings and to apply layout methods learned in drawing courses is a necessity in beginning courses in pattern-making, machine shop, foundry, sheet-metal and forge shops. Engineering drawing problems require the practical application of arithmetic and some usage of algebraic formula and trigonometric functions to arrive at accurate solutions. Some related shop knowledge is taught in engineering drawing courses relative to good mechanical construction, shop terminology, and the usage of machine tools and processing methods.

Descriptive geometry develops the ability of the student to visualize and apply the principles of orthographic projection to the solution of space problems. It is useful in the solution of intersection and development problems frequently encountered in building construction and mechanical equipment such as pipes, sheet-metal ducts, eave-troughing, cornice detail, and roof intersections. It is also used extensively in auto and airplane body "lofting" which involves full size layout of sheet-metal intersections and developments of curved and warped surfaces. Descriptive geometry is frequently used to make graphical solutions of mining, geology, and other mathematical problems of a geometrical nature.

Engineering drawing and descriptive geometry courses are taught to provide a foundation in fundamental principles during the first year of college work. At M.S.C., two terms of engineering drawing and one term of descriptive geometry with approximately 10 weeks per term of actual classroom instruction is provided, after taking out the time allotted for registration, holidays, and final examinations. The engineering student applies the basic knowledge and techniques learned in these courses to the various design and special option courses given during the third and fourth years such as machine design, kinematics, tool drawing and design, time and motion study, processing of materials, thesis studies, and special research projects.

Free-hand sketching and technical drawing is used by the engineering student to some extent in physics, chemistry, and engineering laboratory experimental reports to illustrate the mechanical set-up of laboratory equipment and its functioning. It is also used to illustrate sales, production, safety, and business statistics in the form of charts, graphs, and posters. The various forms of pictorial drawing and production illustration utilized in textbooks and industrial service publications are indicative of the many and varied uses of engineering drawing and its practical value.

From the cultural viewpoint, the engineering student develops qualities of mind such as the power to visualize and creative imagination, and to apply the basic principles of projection and dimensioning -- along with basic skills in mensuration and mathematics, free-hand sketching and graphical analysis, utilization of drafting instruments and equipment, and free-hand placement of dimension numerals and lettering of general and specific explanatory notes.

Engineering drawing perhaps more than any other academic study requires a high degree of physical and mental coordination of hand, eye, and brain. Practice is necessary to become skillful in the rendering of quality drawings. In beginning courses, students are apt to make many mistakes in computation and layout. Where there is more student inaccuracy, the greater the necessity for a class period long enough to make allowances for errors and correction of them. More time is necessary for thorough teaching of beginning students than is usually the case with advanced students.

The exacting nature of engineering drawing and descriptive geometry courses contributes directly to the formation of such desirable work habits as -- accuracy, neatness, thoroughness, self-reliance, patience, and perseverance in self-improvement in technical work. Technical sketching and drawing develops the students sense of proportion and practical judgment in design. A good designer is essentially a technical artist with an appreciation for beauty and proportion as well as strength and utility in design.

(Continued on page 27)

[2]Technical Drawing, Giesecke, Mitchell, Spencer, p. 1, The Macmillan Company, New York, N.Y. Publishers.

PROJECTED TRIMETRICS

by

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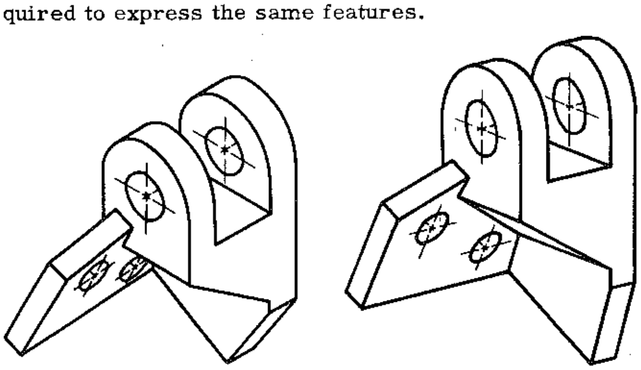
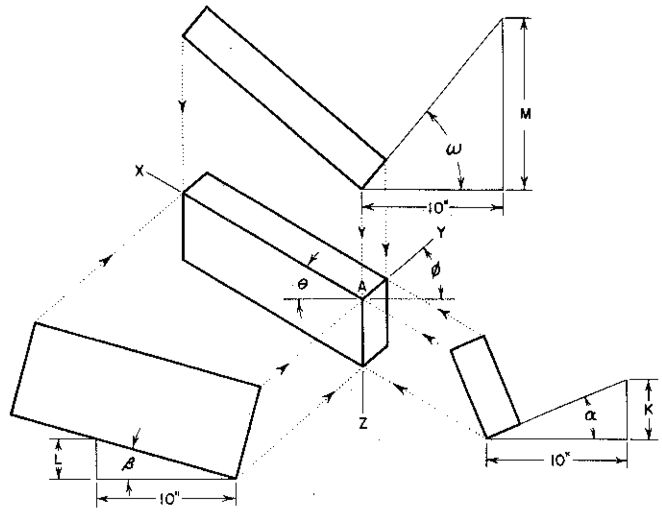
Pictorial representation, of one form or other, has become increasingly popular in the engineering field. Isometric drawing was one of the first pictorial methods to be widely used and probably is still used more than any other form. It is simple and generally gives a fair to entirely adequate picture of a large percentage of objects. There is no scalar difficulty, the three scales being equal (0.81 of normal length); actually in practice, the scale values are neglected and the dimensions laid out to full length, thus resulting in an over-size, but correctly proportioned drawing. However, too frequently, the angle of inclination required by the 30° isometric axes does not show the object to best advantage and may give a mis-leading representation. Thus it then becomes necessary to use another projection or accept an inferior pictorial. The Dimetric projection is more flexible than the Isometric, but most flexible of all is the Trimetric and, inasmuch as it offers no more difficulty than does the Dimetric, the advantage of this method becomes obvious. Figure 1 is an example of the advantage of the Trimetric projection over the Isometric type. The Trimetric allows the inclined portion of the bracket to be shown at the same time as giving a very good view of the bracket. While an Isometric drawing of this object could show the under portion, the major surfaces could not be shown in the same view. Two Isometric drawings would thus be required to express the same features.



ISOMETRIC PROJECTION TRIMETRIC PROJECTION

Fig. 1

Trimetric projection allows an unlimited choice of angles for its principal axes; therefore, the object can be tilted as necessary to bring "its best face forward." In this manner the desired details of the part can be properly emphasized. With a little experience and forethought, a wise choice of angles can be made to obtain the best effect. Figure 2 illustrates the angles θ and ϕ which are the apparent angles of inclination of two of the three axes of the Trimetric. For the purposes of this discussion, it will be considered that one of the axes

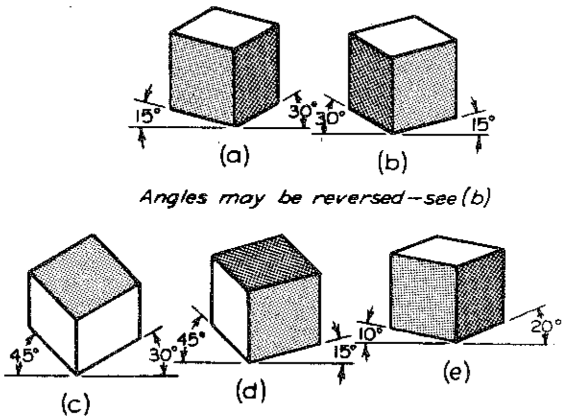


ORIENTATION OF ORTHOGRAPHIC VIEWS
FOR
PROJECTING TRIMETRICS.

Fig. 2

will be aligned with the "vertical" (90° to the T-square) direction on the drawing. This will be done for simplification though this axis may, of course, be chosen at any desired angle; however, to use the table to be later discussed, we will consider the "horizontal" direction to be perpendicular (on the drawing) to this "vertical" axis no matter what the latter's inclination. In Isometrics, the angles of θ and ϕ are each equal to 30° and the draftsman's only choice is which three planes will be shown; there is no choice of emphasizing the important surface and diminishing the less important ones as they are all equally represented. In Trimetrics, by properly choosing the angles of the axes, the most important face can be made predominant, the next most important emphasized to a lesser or equal degree and the least surface minimized. The only limitation of the angles θ and ϕ is that their sum must be less than 90°; if their sum is 90°, then the resultant view will merely be an orthographic one showing one plane true size, and not a pictorial at all.

Figure 3 illustrates five different choices of angles and shows how the major surfaces of a cube can be shown to varying degrees depending only upon choice of axes. In Figure 3a the front view shows best and the top and right side views are approximately equal in proportions. In 3b the right side view is largest and top and front approximately equal. In 3c the top is shown best, with right side and then front following in that order; similarly then, on to 3d and 3e and to whatever variations required.



COMMONLY CHOSEN ANGLES

Fig. 3

By these same figures, it is readily seen that the scales along the three axes are not equal values as they were in Isometric drawings. Because of the variable tilt, the angle between the line of sight and the planes of the object is different for each of the principal planes. The foreshortening of the object along the three axes is then a variable quantity and a properly determined scale is necessary for each axis. Here then, is the principal reason for the slow growth of the use of this type of projection. Time had to be consumed constructing the three scales necessary for each set of angles that might be chosen. As long as only a few standard sets of axial directions were used (such as is represented by Figure 3) these scales could be made up in advance and used repeatedly thereafter. However, this resulted in considerably reducing the flexibility of the method and limited its value. There are on the market several such sets of trimetric scales available for two or three standard choices of θ and ϕ. But to use Trimetrics to its full capabilities, one must not put a strait-jacket on the method. Even when the scales are available, there is still a bit of time lost in having to pick out the proper scale for each measurement; however, considering the advantages, this small factor is negligible. In spite of the above-mentioned handicaps, much use has already been made of Trimetrics in Engineering Drawings, for it admittedly does give the best end result. The aircraft industries have in particular made much use of this method; Glen L. Martin Company and McDonnell Aircraft Corporation being outstanding examples. Pictorial forms came into their own during the last war when it was necessary to use unskilled labor to make intricate machine parts. These people had only a minimum training in blueprint reading and thus pictorials were vitally necessary. Pictorials in service manuals made field servicing much easier because of the clarity of the drawings. Thus the field for pictorials, and for Trimetrics in particular, is very large and very important.

This article will discuss a simplified method of making Trimetrics that was originally developed by Professors T. H. Schmid and L. Eckhart of Vienna, Austria and which has been further facilitated by the compilation of the table discussed below. This latter development was made by Professor H. E. Grant of Washington University, St. Louis, Missouri. In this method, the need for specialized scales is eliminated and the pictorial is made by simple projection from two orthographic views. The two orthographic views are properly oriented on the drawing and corresponding points are projected to the pictorial thus quickly completing it. Very seldom are pictorials drawn when the orthographic drawing of the part is unavailable, and therefore, no extra work is required by this method as the necessary views can be cut from a print, properly oriented, fastened to the paper by scotch tape and the resultant pictorial made. In some cases, three orthographic views may be required, but generally two are sufficient. Figure 2 will illustrate the method of procedure to be followed.

Now, having a general outline of the process, we will consider a step by step progression to turn out a completed Trimetric projection. The first step is to decide which surfaces of the object are to be stressed in order to present the best possible representation of it. Having decided the way the object is to be shown, then the angles of θ and ϕ must be considered so that the object will appear as wanted. Here again one might refer to Figure 3 until past experience would dictate the necessary choice. The only caution that should be interposed here is the reminder that the angle sum must be less than 90°. A general summary of results would show that if θ and ϕ are small, the top is minimized while front and side views become large. If they are large, the top view takes predominance and the front and side views are smaller. A small angle for θ or ϕ will mean that the adjacent (to the angle involved) face will become large, while a large angle means the reverse.

Now having chosen θ and ϕ and having two or three orthographic views of the subject piece, we then enter into the table to find the angles of inclination α , β , and ω (See Figure 4). In the table, the values of θ are along the left edge while the values of ϕ are along the bottom. These values are for every five degrees from zero to forty-five degrees. If, perchance, an angle larger than forty-five degrees might be desired, it is necessary to reconsider the choice of the "vertical" axis and assign this name to one of the other axes and then set off values from a new "horizontal" line perpendicular to this axis and the angles then will be reduced to tabular values. Having proceeded into the table to the intersection of the row for θ with the column for ϕ, we find six different values. If we wish to use angular values, then the values for α , β , and ω may be used. If greater accuracy is desired, then the tangent offset values, k, l, m, may be used. For the purposes of the initial discussion, let's consider that we will use the angular values. These angles of α , β , and ω will then give us the inclination of the orthographic views with respect to our horizontal line. We must keep in mind that the projection lines to the pictorial from the orthographic views will be parallel to the respective trimetric axes, AX, AY, and AZ, where AZ is the axis we have considered vertical. The projections from the top orthographic view to the Trimetric are parallel to the AZ axis; from the front orthographic view to the Trimetric are parallel to the AY axis; and from the right side view to the Trimetric

VALUES OF Θ (ANGLE OF AXIS UPWARDS TO LEFT)

45°	α	2°30'	K	.438	α	5° 4'	K	.888	α	7°46'	K	1.364	α	10°40'	K	1.884	α	13°53'	K	2.471	α	17°37'	K	3.178	α	22°13'	K	4.085	α	28°31'	K	5.434				
	β	12°53'	L	2.289	β	16°38'	L	2.989	β	19°15'	L	3.494	β	21°27'	L	3.931	β	23°32'	L	4.356	β	25°44'	L	4.820	β	28°21'	L	5.396	β	32° 6'	L	6.274				
	ω	16°28'	M	2.957	ω	22°46'	M	4.199	ω	27°22'	M	5.176	ω	31° 6'	M	6.033	ω	34°19'	M	6.828	ω	37°13'	M	7.598	ω	39°55'	M	8.367	ω	42°29'	M	9.160				
40°	α	2°29'	K	.435	α	5°	K	.874	α	7°35'	K	1.332	α	10°19'	K	1.821	α	13°17'	K	2.363	α	16°37'	K	2.986	α	20°31'	K	3.744	α	25°22'	K	4.742	α	32° 6'	K	6.274
	β	11°28'	L	2.030	β	14°37'	L	2.609	β	16°44'	L	3.008	β	18°26'	L	3.336	β	20°	L	3.639	β	21°31'	L	3.942	β	23°15'	L	4.298	β	25°22'	L	4.742	β	28°31'	L	5.434
	ω	17°53'	M	3.229	ω	24°37'	M	4.584	ω	29°28'	M	5.650	ω	33°22'	M	6.586	ω	36°42'	M	7.454	ω	39°40'	M	8.294	ω	42°24'	M	9.134	ω	45°	M	10.000	ω	47°30'	M	10.916
35°	α	2°28'	K	.431	α	4°55'	K	.861	α	7°24'	K	1.300	α	10°	K	1.763	α	12°45'	K	2.264	α	15°47'	K	2.826	α	19°12'	K	3.484	α	23°15'	K	4.298	α	28°21'	K	5.396
	β	10° 9'	L	1.792	β	12°46'	L	2.267	β	14°28'	L	2.580	β	15°47'	L	2.828	β	16°56'	L	3.047	β	18° 3'	L	3.258	β	19°12'	L	3.484	β	20°31'	L	3.744	β	22°13'	L	4.085
	ω	19°28'	M	3.534	ω	26°38'	M	5.017	ω	31°44'	M	6.186	ω	35°47'	M	7.210	ω	39°13'	M	8.160	ω	42°14'	M	9.080	ω	45°	M	10.000	ω	47°35'	M	10.974	ω	50° 4'	M	11.951
30°	α	2°26'	K	.427	α	4°50'	K	.846	α	7°13'	K	1.268	α	9°40'	K	1.704	α	12°14'	K	2.169	α	15°	K	2.679	α	18° 3'	K	3.258	α	21°31'	K	3.942	α	25°44'	K	4.820
	β	8°54'	L	1.565	β	11° 2'	L	1.950	β	12°22'	L	2.192	β	13°22'	L	2.376	β	14°13'	L	2.533	β	15°	L	2.679	β	15°47'	L	2.826	β	16°37'	L	2.986	β	17°37'	L	3.178
	ω	21°16'	M	3.892	ω	28°55'	M	5.526	ω	34°15'	M	6.812	ω	38°26'	M	7.939	ω	41°56'	M	8.987	ω	45°	M	10.000	ω	47°45'	M	11.011	ω	50°19'	M	12.055	ω	52°46'	M	13.161
25°	α	2°25'	K	.423	α	4°44'	K	.828	α	7° 1'	K	1.232	α	9°19'	K	1.642	α	11°42'	K	2.071	α	14°13'	K	2.533	α	16°56'	K	3.047	α	20°	K	3.639	α	23°32'	K	4.356
	β	7°40'	L	1.346	β	9°21'	L	1.648	β	10°22'	L	1.829	β	11° 6'	L	1.962	β	11°42'	L	2.071	β	12°14'	L	2.169	β	12°45'	L	2.264	β	13°17'	L	2.363	β	13°53'	L	2.471
	ω	23°25'	M	4.331	ω	31°35'	M	6.149	ω	37° 9'	M	7.580	ω	41°27'	M	8.835	ω	45°	M	10.000	ω	48° 3'	M	11.126	ω	50°47'	M	12.253	ω	53°17'	M	13.414	ω	55°40'	M	14.644
20°	α	2°23'	K	.417	α	4°37'	K	.809	α	6°47'	K	1.189	α	8°55'	K	1.571	α	11° 6'	K	1.962	α	13°22'	K	2.376	α	15°47'	K	2.828	α	18°26'	K	3.336	α	21°27'	K	3.931
	β	6°25'	L	1.125	β	7°41'	L	1.351	β	8°25'	L	1.480	β	8°55'	L	1.571	β	9°19'	L	1.642	β	9°40'	L	1.704	β	10°	L	1.763	β	10°19'	L	1.821	β	10°40'	L	1.884
	ω	26° 7'	M	4.902	ω	34°50'	M	6.960	ω	40°37'	M	8.580	ω	45°	M	10.000	ω	48°32'	M	11.318	ω	51°33'	M	12.595	ω	54°12'	M	13.869	ω	56°37'	M	15.183	ω	58°53'	M	16.575
15°	α	2°20'	K	.409	α	4°28'	K	.781	α	6°28'	K	1.134	α	8°25'	K	1.480	α	10°22'	K	1.829	α	12°22'	K	2.192	α	14°28'	K	2.580	α	16°44'	K	3.008	α	19°15'	K	3.494
	β	5° 7'	L	.895	β	6°	L	1.051	β	6°28'	L	1.134	β	6°47'	L	1.189	β	7° 1'	L	1.232	β	7°13'	L	1.268	β	7°24'	L	1.300	β	7°35'	L	1.332	β	7°46'	L	1.364
	ω	29°44'	M	5.714	ω	39° 2'	M	8.112	ω	45°	M	10.000	ω	49°22'	M	11.654	ω	52°50'	M	13.191	ω	55°44'	M	14.679	ω	58°15'	M	16.165	ω	60°31'	M	17.697	ω	62°37'	M	19.319
10°	α	2°15'	K	.395	α	4°12'	K	.737	α	6°	K	1.051	α	7°41'	K	1.351	α	9°21'	K	1.648	α	11° 2'	K	1.950	α	12°46'	K	2.267	α	14°37'	K	2.609	α	16°38'	K	2.989
	β	3°42'	L	.647	β	4°12'	L	.737	β	4°28'	L	.781	β	4°37'	L	.809	β	4°44'	L	.828	β	4°50'	L	.846	β	4°55'	L	.861	β	5°	L	.874	β	5° 4'	L	.888
	ω	35° 9'	M	7.044	ω	45°	M	10.000	ω	50°57'	M	12.327	ω	55° 9'	M	14.367	ω	58°24'	M	16.261	ω	61° 4'	M	18.094	ω	63°21'	M	19.926	ω	65°22'	M	21.813	ω	67°13'	M	23.814
5°	α	2° 4'	K	.363	α	3°42'	K	.647	α	5° 7'	K	.895	α	6°25'	K	1.125	α	7°40'	K	1.346	α	8°54'	K	1.565	α	10° 9'	K	1.792	α	11°28'	K	2.030	α	12°53'	K	2.289
	β	2° 4'	L	.363	β	2°15'	L	.395	β	2°20'	L	.409	β	2°23'	L	.417	β	2°25'	L	.423	β	2°26'	L	.427	β	2°28'	L	.431	β	2°29'	L	.435	β	2°30'	L	.438
	ω	45°	M	10.000	ω	54°50'	M	14.196	ω	60°15'	M	17.500	ω	63°52'	M	20.397	ω	66°34'	M	23.087	ω	68°43'	M	25.689	ω	70°31'	M	28.291	ω	72° 6'	M	30.970	ω	73°31'	M	33.075
	5°				10°				15°				20°				25°				30°				35°				40°				45°			

VALUES OF ϕ (ANGLE OF AXIS UPWARDS TO RIGHT)

Fig. 4

are parallel to the AX axis. The orientation can be adapted to any of the other principal views or to any views whose lines of sight are mutually perpendicular. The base of the right side view is inclined angle α to the horizontal, the base of the front view is inclined at angle β to the horizontal, and the right edge of the top view is inclined at angle ω to the horizontal. If desired, the tangent offset values k, l, m, may be used noting that the tangent of angle "X" is side opposite over the side adjacent and that the tabular values assume that the length of the adjacent side is ten inches. To take an example, if θ is 15° and ϕ is 30°, then α is 12°22', β is 7°13', and ω is 55°44'. These angles are given to the closest minute though for normal use they may be used to the closest degree or half degree. Similarly the corresponding values for k, l, and m are 2.192, 1.268, and 14.679 respectively. The orthographic views to be used are then placed on the drawing at a convenient distance from the area to be occupied by the pictorial such that the projections are parallel to their corresponding axes and becomes doubly irksome if the drawing is to be inked. However, for most purposes, an approximate ellipse is completely satisfactory and the four center method, which follows, will be accurate within a few percent of the actual values. If the ellipse is extremely flat, the error will increase and may not be satisfactory. In order to use this "four center" method, it is necessary to obtain the major and minor diameters of the ellipse. These can be determined by projection as is illustrated in Figure 6. The major diameter is always the true value of the diameter of the circle. It is obtained by projecting the contour elements of the circle such as points R and S of Figure 6. In the Trimetric, points R and S lie along the diameter passing through the center of the ellipse and perpendicular to the projections from the circular view of the circle. In the figure, these were obtained from the right side view. The minor diameter will be perpendicular (on the drawing) to the major diameter both in the pictorial and in the orthographic view where the circle

(Continued on page 33)

SOME COMMENTS ON OBTAINING A QUALITY SET OF DRAWING INSTRUMENTS

by

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During the period of the last war manufacturers were frustrated in supplying the home market with quality drawing instruments. Various factors that need not be expressed here were responsible. Sets of lesser quality were substituted and served our needs as well as some other products manufactured then. It is reasonable to suppose, regardless of our thinking then, and reflections now, that their use served for a common good. They provided a visual aid in focusing our critical attention upon the desirable and undesirable features of drawing instruments.

After the war improvements were looked for, improvements in keeping with modern "streamlined" and functional design. But as the reconversion period progressed it became apparent that practically no change was forthcoming; sets lacked the features for making penciled tracings used today for reproduction purposes; sets had more pieces than needed and still were attracting the inexperienced and unsuspecting student. Inquiry through several sources seemed to indicate a reason for this failure: the teaching profession, among others, was still requiring the so-called standard set. But be that as it may, the question arose as to what could be done to improve the quality of workmanship, design, and materials, and to help in making a better selection of instruments for our students?

The answer appeared to be the preparation of a set of specifications which could be used by the manufacturers as a guide for designing and making the instruments, and by teachers, retailers, students, and others for judging and selecting them. How this idea appeared to others prompted the solicitation of opinions from drawing teachers, engineers, draftsmen, and manufacturers who favorably, and in some quarters enthusiastically, subscribed to it. With this encouragement Purdue's drawing staff indicated a willingness to lend itself to the development of specifications for instruments needed by its students only. This limitation was quite logical as the staff could not reflect the wishes of everybody. Yet it did recognize that the needs of other schools are similar to those of Purdue. And finally with the manufacturers giving their voices of approval, the groundwork was laid for the preparation of the specifications.

The following is a brief resume of the procedure. The members of the design departments of the various schools of engineering at Purdue were asked to indicate their needs relative to kind and number of pieces, and the spread of compasses and dividers. Later at a meeting of our drawing staff the number and kinds of pieces to be included in a basic set were decided upon, using as factors for consideration: 1) The minimal pieces needed for drawing and design courses at Purdue and probable later use in industry, and 2) Present day functional needs. The pieces selected were a beam compass, large bow compass, friction divider, pen to be used interchangeably in both compasses and a slip handle, and a pocket carrying case.

A questionnaire then was developed listing for each piece: 1) All known types, such as ringhead or wishbone type compasses with center or side wheel adjusting screw; 2) All known construction features, such as collet or split leg clamping screws; threaded or smooth centerpoints; 3) Materials: aluminum alloys, steel, nickel silver; and 4) Sizes: radius ranges of compasses; lengths of dividers and ruling pens.

The questionnaires were circulated to more than fifty drafting teachers, engineers, and draftsmen, and the data collected were turned over to a committee composed of Professor Elrod, Mr. Bolds, Mr. Hammond, and the writer for preparation of the preliminary specifications.

The Committee at the outset deliberated on the scope and wording of the recommendations. Two alternatives were before it - either to write them in rigid and detailed form thereby requiring the manufacturer to design and produce all new pieces, or to be flexible and general permitting the use of existing satisfactory pieces, and/or the partial redesign of nearly satisfactory pieces. The latter was chosen as the guide. The preliminary draft was prepared, circulated to the same people for criticism, discussed at another meeting of the staff and then returned to the Committee for revising. The final draft was approved by our staff at its meeting on 23 March, 1949. Copies were sent immediately to the various manufacturers and dealers.

To obtain the reactions and comments from an entirely different source, the recommendations and a note of explanation were sent to a number of chief engineers and chief draftsmen. The Committee was gratified to hear that these men not only endorsed the movement but gave enthusiastic approval to the specifications.

The specifications as finally approved appear at the end of this paper. In submitting them it is not intended to convey that they are exhaustive, or perfect. Such compilations seldom are. So far, however, they have served their purpose well.

It might be of interest at this point to list the reasons for including certain items and restrictions in the original, and suggestions for additions and modifications that now might be made after having used them several months. These will be grouped under the same headings as found in the recommendations.

On the BASIC SET

The beam compass is used extensively in design courses at Purdue; and while not of major necessity in our drawing courses, it is a convenient tool to have.

The bow compass capable of drawing both large and small circles was selected rather than the large friction head and small bow compasses. This type compass, within its radius limits, is capable of producing the dense black lines needed for pencil tracings.

Inking practice is gradually being eliminated from the drafting rooms, but occasionally the need for it still arises. We think a small amount of time devoted to it is desirable in our teaching program. In view of these factors the number of pens - ruling pens, bow pens - should be reduced to a minimum. One pen is sufficient and in addition to being less expensive than three, there is a further advantage in having one pen serve in all compasses and as a ruling pen. The pen can be changed quickly from one unit to another without having to be reset, refilled or recleaned as would be the case if three different pens were used.

On the GENERAL REQUIREMENTS

If these were to be revised, the following might be added:

Thumbscrews shall have a minimum diameter of 5/16 inch.

Clamping and adjusting screws shall be of the cap screw rather than of the bolt and nut principle.

Lead holders shall not have blind holes.

Lead holders shall be capable of receiving leads the diameters of which are commonly in use either in the wooden or mechanical pencils.

On the BEAM COMPASS

3/16 inch standard key stock and a coupler were specified so that the beam capacity could be rather easily increased and at a minimum of expense. Longer lengths of bars are usually readily available in company stock rooms or supply houses. In colleges extra lengths can be set aside to serve departments' particular needs.

On the BOW COMPASS

The threaded centerpoint facilitates adjusting when the compass is in the nearly-closed positions.

The friction head type with center screw was overlooked when the original draft was prepared and should be included.

Another item to be added suggests that a knee joint should be provided either in the pen leg or in the pen itself to permit inking large and small circles.

On the SLIP HANDLE RULING PEN

The graduated thumbscrew was included as a particular aid to the inexperienced and infrequent user of the pen.

Two additional comments might have been added: One would have reference to the knee-joint required either in the pen itself or in the pen leg of the bow compass; the other to the fact that the nibs should have curvature in opposite directions to permit using the pen against straight or curved guides.

On the POCKET CARRYING CASE

In writing the recommendations for this unit, the Committee, at this stage, had become apprehensive of the cost of the complete set. To effect some economy the Committee recommended an inexpensive case. There is no serious objection, however, to a better case if the total cost of the set and the quality of the instruments are in keeping with each other.

A recommendation specifying finger lifts for all "flat" pieces should have been added to this unit.

A feature not prescribed in the recommendations is a formed recess to accommodate small bow dividers as needed only by our Mechanical Engineering students in a later year. The recess should be filled with a dummy block to be removed when the divider replaces it.

The progress to date should be of material interest. Of the many companies receiving the recommendations, four have submitted hand-machined prototypes representing their interpretations of these recommendations, and others have indicated they were working on their patterns. Some sets have been resubmitted twice, and each modification showed a noticeable improvement over the one preceding. The staff examined each critically and prepared detailed lists of suggested improvements that were passed on to the manufacturer.

New design and clever little construction features have been introduced. How well these will stand the test of continued usage remains to be seen, but all appear at this writing to be sound. One set is completely new in both design and shapes of sections; another is nearly so with modified design to one part; while the remaining sets are combinations of new and partially new designs, and stock parts.

The Gramercy Import Company has submitted its third version and sets are now in production. The Eugene Dietzgen Company likewise has submitted its third modification. The Keuffel and Esser Company and the Frederick Post Company have just submitted their first interpretations. All are striving to put forth A-1 sets which conform to the recommendations given them. Their goal is to have them in production in time for delivery in September 1950.

Perhaps few realize the time, effort, and money being spent by these companies in their attempt to develop further the general qualities and functional designs of instruments. It is a tremendous undertaking for which we are grateful. We as teachers should be critical of the instruments and materials recommended to our students, since what we require is a reflection upon our judgment. And if we are careful, then we are in effect helping these and other companies to produce the kinds of instruments we desire, and all should be mutually benefitted.

Appreciation and thanks are likewise extended to the engineers, draftsmen, and others who contributed to the enhancement of these recommendations.

REQUIREMENTS FOR A BASIC SET OF DRAWING INSTRUMENTS FOR STUDENTS IN THE ENGINEERING DRAWING COURSES AT PURDUE UNIVERSITY

RECOMMENDED BY THE ENGINEERING DRAWING STAFF

The purpose of these specifications is not to set up any one design or type of instrument as a standard, nor to recommend any certain assortment of instruments as the ideal set, but to prescribe a "basic" set of instruments such that when built according to the intent of the requirements herein enumerated and described, will be adequate for all Engineering Drawing courses and satisfactory for professional use. Additional pieces may be added for specialized courses or industrial applications.

BASIC SET

The basic set shall include:

1. Beam compass
2. Bow compass
3. Friction divider
4. Slip handle ruling pen.
   Pen to be used interchangeably with both compasses.
5. Pocket carrying case

GENERAL REQUIREMENTS

All instruments shall be made of corrosion resistant materials such as hard nickel silver, corrosion-resistant steel, or hard aluminum alloys. Parts of the instruments such as screws, springs, fulcrums, trunnions and centerpoints shall be of high grade steel, properly heat treated and finished to provide long wear and smooth operation. The design and manufacture of all parts shall be consistent with good workmanship.

Holder for leads and/or centerpoints shall be of the conventional split clamp type with a clamping screw (not a bolt) of ample proportions, or a three jaw chuck or collet. Either type shall be freely adjustable to grip securely standard pencil leads of normal range.

All centerpoints shall be of the shouldered type and of such diameter that they may be used interchangeably with leads in lead holders. (Exception: threaded centerpoints. See Bow Compass.)

Sufficient needlepoints of the same diameters shall be furnished to be used interchangeably with leads in lead holders.

All thumb screws, clamping screws, etc., shall have heads of ample size. Heads shall be of corrosion resistant material, or well plated, and shall have knurled edges.

BEAM COMPASS

Beam compass shall have a capacity of not less than 16" radius.

Beam bar shall be of standard bar stock size, other than round, not machined. This will allow the use of stock sizes for longer bars.

Bars shall be not less than 3/16" square; other angular sections of equal or greater area are acceptable.

Maximum length bar to be 10", with rigid setscrew type coupler.

Bar and coupler may be of mild steel properly plated to prevent rust.

Holes in beam legs and coupler shall be broached to fit bar snugly, keeping angular play between legs to a minimum.

Both legs shall receive leads, centerpoints, or needlepoints interchangeably. In addition to this, one leg shall have thumbscrew clamping device to receive either pencil or pen attachment. The other leg shall have micrometer, cam, or eccentric adjusting device.

Separate pen and pencil legs may be furnished if desired. Legs shall be as short as practicable to provide a well balanced instrument.

Beam locking device shall be spring type with large knurled thumbscrew or nut. (Continued on page 31)

OUTSTANDING AIDS *for Engineering Drawing Stude*
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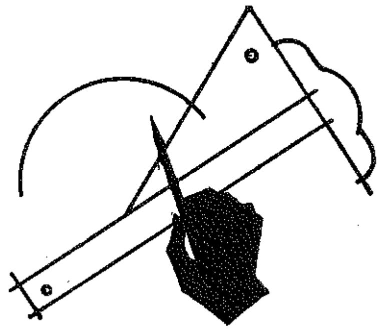

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By Thomas E. French, The Ohio State University. Revised by Charles J. Vierck and associates of the Department of Engineering, The Ohio State University. 694 pages........$4.25

The value of a course in drawing lies in the selection, methods of presentation, and correlation of the problems with assigned study of the text. In this revision many of the favorite problems of the previous edition have been retained and many new ones representing current design have been added. The chapter on illustration and the complete rewriting of the chapter on perspective plus the expansion of the chapter on dimensioning into two chapters will be of tremendous value to the user of this text.

Engineering Drawing Problems

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Practical, direct and thorough, this book presents a series of problems in the most logical and usable order for the first-year classes in engineering drawing. In accordance with a recent survey made by the drawing division of the American Society for Engineering Education, the book includes exercises in all of the subjects usually covered in schools throughout the country.

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This revision retains all the well-liked features of earlier editions but offers many improvements and much new material. New chapters have been added on aircraft drawing, production illustration, and welding drawing.

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CONSTRUCTION OF ISOMETRIC BLOCK DIAGRAMS IN CARTOGRAPHIC WORK

by

Richard G. Huzarski

Probably none of the so-called "Earth Sciences" depends as strongly on graphics and draftsmanship as cartography, the art and science of representing the terrestial globe or a part of it in two dimensions. And of all the various phases of cartography few adapt themselves to purely graphic solutions as well as the construction of block diagrams, which represent pictorially the earth's surface relief and subsurface formations.

Such diagrams are a valuable adjunct to many works on physical geography, geology, geomorphology, natural resources, and related subjects. For this reason a thorough understanding of their construction is a useful tool for an author, cartographer and draftsman; yet a complete analysis of the problems and procedures involved in such a construction is difficult to find in any standard textbook.

The oblique, cabinet, and perspective projections have all been employed in producing such block diagrams. Isometric projection, however, with its ease and speed of construction, measurability in three directions, and reasonably pleasing appearance, is probably the most appropriate for a beginner, and to it the present discussion is limited. For the sake of clarity each step of the problem is illustrated by a separate figure. In actual practice, with careful draftsmanship, the entire problem can be solved on one or, at most, two diagrams.

If the finished block diagram is to show only the topography and surface features, then all one needs to produce it is a contour map of the terrain and a sheet of drafting paper. At the outset of the work the map should be carefully examined, and turned so that the north-south and east-west borders lie at 45° to the horizontal. The question of which corner of the map should point in what direction is determined by noting which parts of the map show the highest elevations, and placing them farthest away from the draftsman. In this position the map should then be affixed near the top of the drafting paper.

It is true that in the process of turning the map the usual north-up orientation will be often destroyed, as it is on the map shown in Figure 1, but this is of no consequence to the resulting block diagram. On the other hand, if the promontories of the area are left on the nearer side of the map, then in the pictorial representation they will conceal all the low land lying beyond them. In the case of an area with the elevations rising toward the center, it is advisable to cut the map across the center, and to construct two separate diagrams, each with the elevations rising toward the far edges.

Upon the contour map a grid of squares is next drawn. The direction of the lines forming this grid is of no consequence, though they are usually made parallel to the borders of the map. In order to make the future work more accurate the squares should not be larger than 1/2" x 1/2".

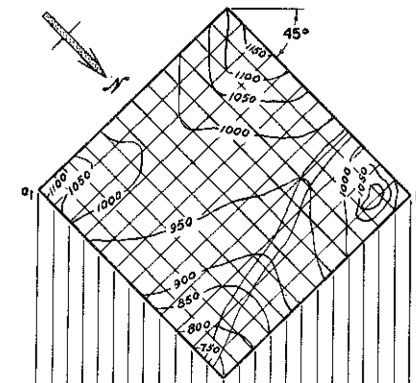


Fig. 1.

Contour map of the area with superimposed grid.

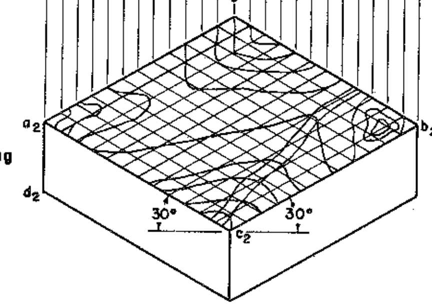


Fig. 2.

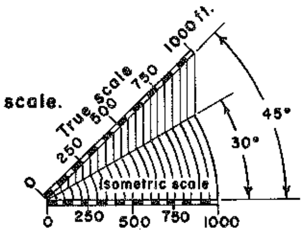
Base of the block showing isometric projection of the contour map.

The next step consists of projecting the map isometrically onto the drafting paper. This is done by repeating the horizontal line $a_1 - b_1$ (not necessarily the diagonal of the map) in the position $a_2 - b_2$, Figure 2, and drawing the borders of the map, such as $a_2 - c_2$ and $b_2 - c_2$, at 30° to the horizontal. Upon the parallelogram so formed the grid is next produced and used as the base onto which sufficient number of points from the contour lines and river banks are projected to enable one to sketch in the contours and the river isometrically.

For a strictly topographic block diagram the height $a_2 - d_2$ of the base is dictated solely by good taste; in geological work it is determined by the amount of subsurface material to be shown. Let us assume that in the case considered the height of 500 feet is appropriate, and that the scale of the original map is shown on the 'True Scale' bar of Figure 3.

Fig. 3.

Construction of the isometric scale.



At this point it is well to realize that line $a_2 - d_2$ and all the other ortho-T-square edges of the block, though they appear vertical, are in reality rotated in the profile planes, and must consequently be foreshortened. Their apparent length can be determined mathematically or by the method of rotation. Since the process, however, will have to be repeated in several following steps of the problem, it is far more expedient to construct an isometric scale as shown in Figure 3. Once the method of its construction is understood, and where no necessity exists for showing the entire construction, the isometric distances may be read directly from the 30^o line of Figure 3. The 500 foot distance measured on the isometric scale can then be plotted as the length of the line $a_2 - d_2$ and all similar edges.

With the base of the block diagram completed, the surface features should now be given their proper height. Assume that the top surface of the base is at the same elevations as the lowest contour line, or in this case at 750 feet above sea level. Since the contour interval is 50 feet, set the dividers to this distance on the isometric scale. Now, using the dividers so set, transpose the 800 foot contour line one contour interval above its original position on Figure 2. To avoid confusion of too many similar lines on the same figure, sketch this new 800 foot line with a pencil considerably softer than the one originally used. Next set the dividers to read twice the contour interval, and transpose the contour line of 850 feet that distance above its original position. Continue this procedure until the highest contour line is transposed. By way of example point e_4 of contour 1050 feet on Figure 4 will be raised to the position e_4t which is found to be (1050 - 750) : 50 = 6 contour intervals above e_4.

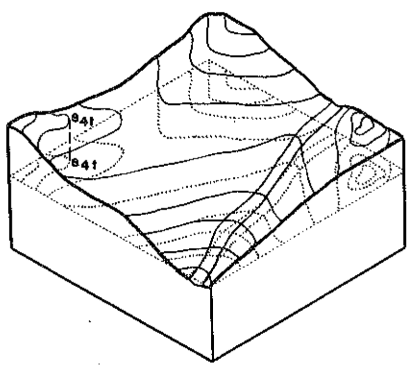


Fig. 4.

Isometric block diagram completely expanded.

It is advisable to mark the points where the river shores cross the new set of contours while transposing the latter. In this way the sketching of the river upon the vertically developed diagram will be greatly facilitated. The completely expanded block diagram is shown by solid lines in Figure 4.

When the use of a transparent drafting medium, such as vellum paper or tracing cloth, is permissible, a considerable gain in time and accuracy may be accomplished in the following manner. Place the medium over Figure 2, and trace the base of the block and the lowest contour line. Slide the medium a distance of one contour interval, measured isometrically, toward yourself, and trace the next higher contour line. Repeat this process for each successive contour line until the work is completed.

There are several graphic means of imparting plasticity to the block diagram. Probably the simplest of these is the method of hachuring. By using it even an amateur can produce a fairly pleasing result with little practice if he remembers that each hachure should curve, so as to remain perpendicular to both contour lines between which it is drawn, and that the closer together the two adjacent contour lines approach each other, the denser and heavier the hachures must be drawn. Figure 5 shows how the surface of the area appears when hachured in this way.

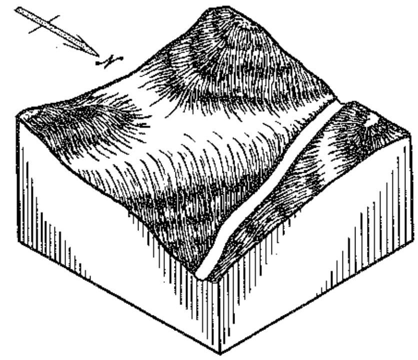


Fig. 5.

Isometric block diagram showing topography by hachures.

With this phase of the work completed all that remains to be done is to shade the eastern and southern vertical walls to complete the topographic block diagram.

Some additional information is necessary before the geology of the area can be properly represented. Let us say that six consecutive sedimentary formations are known to exist in the district, and that these formations are conformal, which is to say that they lie parallel to each other.

The thickness of the topmost formation, hereafter designated as Stratum I, is impossible to determine, due to the extensive and uneven surface erosion. At point f_6, Figure 6, the contact of this formation and Stratum II which underlies it is found, and there drilling operations determine the following sequence and thickness of formations:

Stratum II.	145 feet.
Stratum III	80 feet.
Stratum IV.	150 feet.
Stratum V	135 feet.
Stratum VI.	depth unknown.

It is further ascertained that the strike of the formations is N 73^o E and the dip is 11^o SE. Let it be required to find where on the given map the strata come to the surface of the ground.

The first step in this part of the problem is to construct an auxiliary view of the terrain taken in the direction of the strike of the strata. On this view, shown in Figure 7, the strata will appear in their true thickness and the dip in its true size. Furthermore, the consequent contour lines can be shown here as straight, parallel lines.

From each point where a contact plane between the two adjacent strata intersects a contour line in Figure 7, we erect a projection line to the same contour line on Figure 6. In this way point g_7, lying on the intersection of the contact plane of Stratum I and II and contour

(Continued on page 26)

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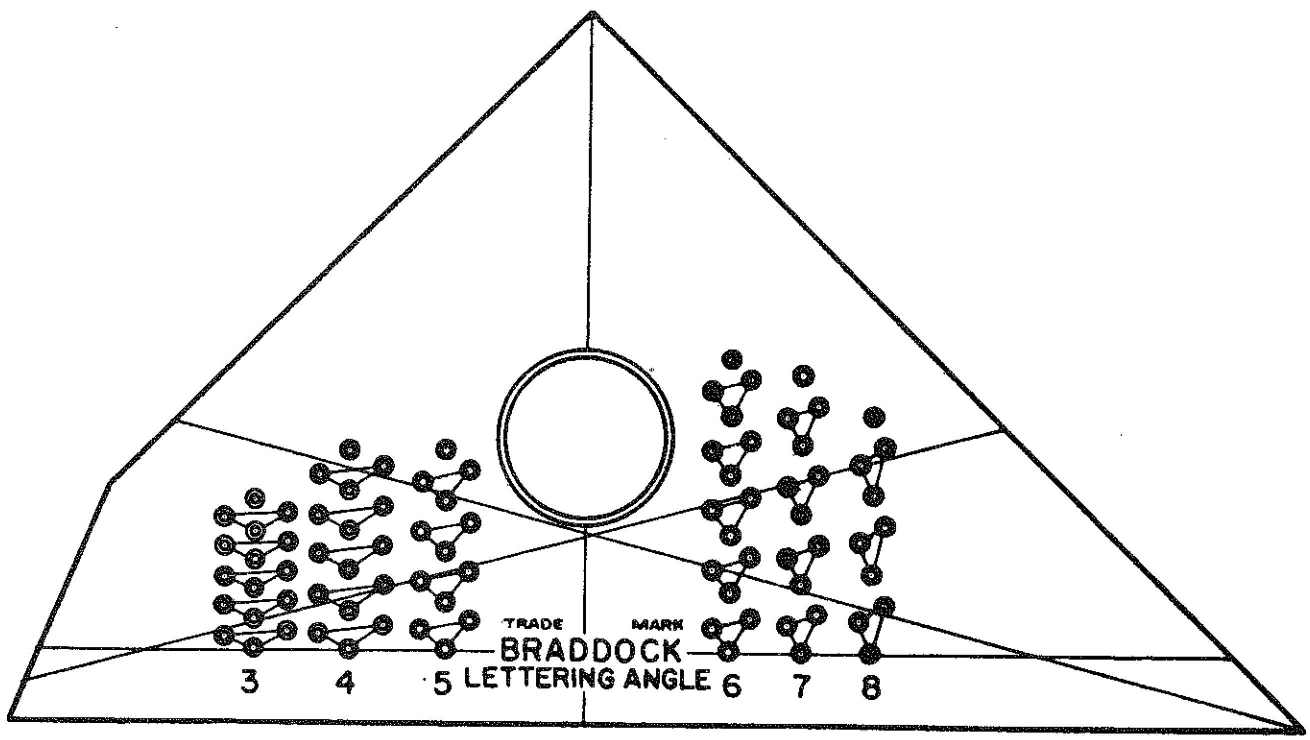

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ENGINEERING DRAWING AS SEEN BY A CONSULTING ENGINEER

by

Marvin C. Nichols
Annual Engineering Drawing Competition Award
A & M College
May 12, 1950

It is a pleasure for me to be present on this occasion and to have the opportunity to speak to the Freshman Class in Engineering Drawing. Particularly do I enjoy being on the A & M campus. Both my sons are engineering graduates of this institution. My father-in-law graduated here in the Class of 1889. Recently I presented him on his 80th birthday a Senior Ring. The authorities tell me they know of no Senior ring for an earlier class. I consider it an honor to be invited here today.

The preparation of these remarks has been a difficult assignment. It has been over thirty five years since my own course in Freshman Engineering Drawing under Professor C. E. Rowe at the University of Texas. I do recall that I literally sweated blood over the problems and plates. But you can see that I survived with no visible ill effects. Professor Rowe was a perfectionist. The drawings had to be just right. They were either good or bad; acceptable or unacceptable. There was no middle ground. To visualize the object or the problem was relatively easy for me, but the actual translation to an acceptable finished drawing was indeed difficult. I marveled at the seeming ease with which some of my classmates prepared their drawings.

Engineering Drawing has been defined as a graphic language. It is a language of contemplation, of vision, of exactness, of accuracy of neatness, of truthfulness, of character, of honesty. In this language you cannot have several meanings for your thoughts as is possible or even likely in the written or spoken languages. You can say exactly what you intend without misunderstanding on the part of your readers. But if you do not make a good drawing it may be meaningless or distressingly confusing.

In the past years I have had occasion to employ a number of recent graduates from A and M and other colleges and universities. It is our policy to employ for our regular payroll only engineering graduates when circumstances will permit. How to use these young engineers to our mutual best advantage is a challenge. Frankly in our business we have not solved this problem to our own satisfaction. The young engineer is in reality an apprentice learning the way we wish things done. So in effect in speaking to you today I am analyzing and taking stock of a problem that falls to me every year.

Within certain limits when we employ a young graduate engineer he can be placed in one of the following positions:

1. Draftsman
2. Instrumentman
3. Inspector or Assistant Resident Engineer
4. Junior Designer

It would seem obvious that a good instrumentman should be proficient not only in surveying but also in Engineering Drawing. His notes must be neat, legible and accurately portray in a graphic language what he sees and finds on the ground. The notes are turned over to the draftsman and designer. They must be able to visualize from the notes what exists in the field on the ground. In turn they must enlarge, design, and further portray in graphic language the proposed structures. The resident engineer or inspector must be able to interpret the drawings in order to determine whether or not the structures are being built in conformity with the plans and the intentions of the designer. It is essential that an engineer be able to prepare and interpret Engineering Drawings. In none of the above positions can the young engineer really fit unless he has a knowledge of Engineering Drawings and is reasonably proficient in their preparation and interpretation.

Students often wonder "what good will this course of study be to me when I am out making a living". The same question in different forms presents itself to the practicing engineer every day. Basically three groups are involved in such a question: the individual, the employer and the public. To be specific in this instance - "How will proficiency in Engineering Drawing aid me as an individual in my relations with my employer and how will that in turn affect the public interest".

To explore this question, let us analyze the development of a set of plans and specifications for a surface water supply or other engineering project. The steps to be taken are as follows:

1. The need for the project becomes apparent.
2. An engineer is employed.
3. One or more solutions are developed through an engineering report.
4. The client approves one of the recommended solutions.
5. Detail field surveys are made.
6. Preliminary sketches and designs are prepared.
7. Tentative selection of equipment is made to determine approximate dimensions.
8. Detail plans are prepared.
9. Specifications are written.
10. Contract for construction is awarded.
11. Working drawings are prepared.
12. Construction contract is completed.
13. "As-Built" drawings are completed.

Engineering Drawings are a part of and essential to most of the above steps. If you are proficient in Engineering Drawing you will fit readily into the staff of the Consulting Engineer who may be in charge of the work. Field surveys, preliminary sketches and designs, selection of equipment, detail plans and specifications, working drawings, supervision of construction and

(Continued on page 25)

(Continued from page 23)

"as-built" drawings all require a direct application of Engineering Drawing. The specification writer must be trained in Engineering Drawing in order that he can translate the graphic language of the designer into the written specifications. The young engineer must be well grounded in Engineering Drawing if he expects to progress very far in the office of a Consulting Engineer.

A Consulting Engineer is dependent upon his staff to an astonishing extent. He becomes known by the quality of the work turned out by his office. Of course he is directly responsible for the soundness of the basic plan, but the impressions made by the appearance and thoroughness of the drawings are of the utmost importance. A client when presented with a sloppily and carelessly prepared set of drawings begins to wonder if the thinking behind the whole scheme and plan may not also be sloppy. Frequently he would be correct in so believing.

A contractor when bidding on a job is influenced by the quality of the drawings. He is in a sense gambling his money on an interpretation of the drawings. If they are systematic, orderly, neat, clear, accurate in detail, he will understand what is required to be built. If the contractor understands the plans and believes them to be subject to only one interpretation he will bid lower than otherwise. If the Consulting Engineer's resident engineer or inspector has a good set of drawings handed him after the award of the construction contract, he can impartially and effectively supervise the work of the contractor. All of these relationships are bottomed on good Engineering Drawings, faithfully prepared and interpreted all down the line. A Consulting Engineer to succeed, or even stay in business, must through his office turn out good Engineering Drawings.

The client and the public profit from good Engineering Drawings. As previously pointed out good drawings result in lower bids from contractors. This is a very real and evident benefit from good drawings. In the process required to prepare good drawings a better plan of the work will evolve and develop. The bugs, so to speak, are worked out. Field changes are kept to a minimum. The structure will better serve the purpose for which it was designed. The utility and usefulness of the works are improved. These are all benefits which the client and the public receive. As the client receives added benefits from good drawings the reputation and prestige of the Consulting Engineer and his staff is enhanced. Good drawings pay dividends: better service to the client; adequate and fair profit to the contractor; better fees to the Consulting Engineer; better salaries for young engineers.

You also receive other intangible benefits from Engineering Drawing. A college education does not guarantee that you will be a successful engineer. It does provide the tools and mental equipment with which you are to work. Engineering Drawing has a definite place in this training. It stimulates your imagination. You have to contemplate, study and concentrate in order to visualize the problem at hand. The portrayal by Engineering Drawing is accurate, neat and honest; when you grasp the ideas you put them down graphically and the graphic language is a truthful language. The engineer needs to have all of these attributes.

In preparing these remarks I asked Mr. O. C. Allen, one of our engineering designers, what impressions he had received of the value of Engineering Drawing as he had observed it after some six years on our staff. Mr. Allen was employed by us in 1944 as Engineer in Charge of Progress Reports and Control during the construction of Pantex Ordnance Plant for Ordnance Department and Corps of Engineers. Mr. Allen is a college graduate, a proficient draftsman and an experienced and capable Senior Designing Engineer. His personal progress has been excellent. The following are his impressions in his own words:

"A young engineer upon accepting employment is most likely to be placed under a person of broader experience in the actual design of engineering works. In the usual case this means the new man is assigned to drafting, for here he can become familiar with the nature of the work done by the organization and with the details.

Since drafting in some form is most likely in store for young students, it is to their advantage to develop while in school some proficiency along these lines, or at the most to avoid being a poor draftsman. A good engineer who is dexterous and can ably assist in the production of good Engineering Drawings is more likely 'to catch on' in an engineering office than the one who is lacking in this ability. All engineering works are worthy of good clear drawings, complete in detail, good composition, legible lettering and neat in appearance. Engineering plans are often judged by their appearance and poor drafting should be avoided for this reason if no other."

A competition such as this is very worthwhile. Recognition of a job well done is stimulating to the participants. It encourages everyone to do his assignment better. The professors, teachers, judges and your speaker have benefited from this program of awards. I have derived value from the preparation of these remarks. Contemplation of my experiences thirty five years ago, together with a review of how Engineering Drawing affects my own business, has crystalized my concepts of Engineering Drawing. Based upon my observations as an employer you will do well to place a high value upon Engineering Drawing. It is an essential factor in your later engineering career.

I assume most of you are preparing yourselves as potential Professional Engineers. Let me urge you to become affiliated with the Student Chapter of the National Society of your particular branch of engineering. The civils, electrical, mining, mechanical, chemical, petroleum, geology and other branches have societies concerned with the technical aspects of particular branches of the profession. I suggest that you participate in their activities.

As an officer of the Texas Society of Professional Engineers, I can assure you that Society is interested in your professional welfare. This organization is a component part of the National Society of Professional Engineers. All of its members are Registered Professional Engineers. It represents, through its members, all branches of the engineering profession. You will be interested in knowing that Mr. Carl Svenson, an authority on Engineering Drawing, is Secretary of the Texas State Board of Engineering Registration. Mr. Svenson, a former professor of Engineering Drawing, is the author of several widely used text books on that subject.

You should at the proper time affiliate yourself with (1) your technical society and (2) the Society of Professional Engineers.

It has been a most pleasant day for me. Some years ago Professor Mullins was a valued member of our staff. He and the other members of the faculty are to be commended for the fine competitive spirit which exists in their classes. You young gentlemen have a wonderful opportunity. It is an honor and a privilege to be a student at A and M. Do your job well and in due time you will be joining the ranks of professional engineers. You need not look forward to years of slaving over the drafting board, but it is essential that you attain a reasonable proficiency in Engineering Drawing.

Thank you very much.

(Continued from page 21)

line of 1000 feet is projected to point g_6 on contour line of 1000 feet on Figure 6. A sufficient number of points so found will determine the contacts of the strata where they lie at or near the surface. These contacts are shown by

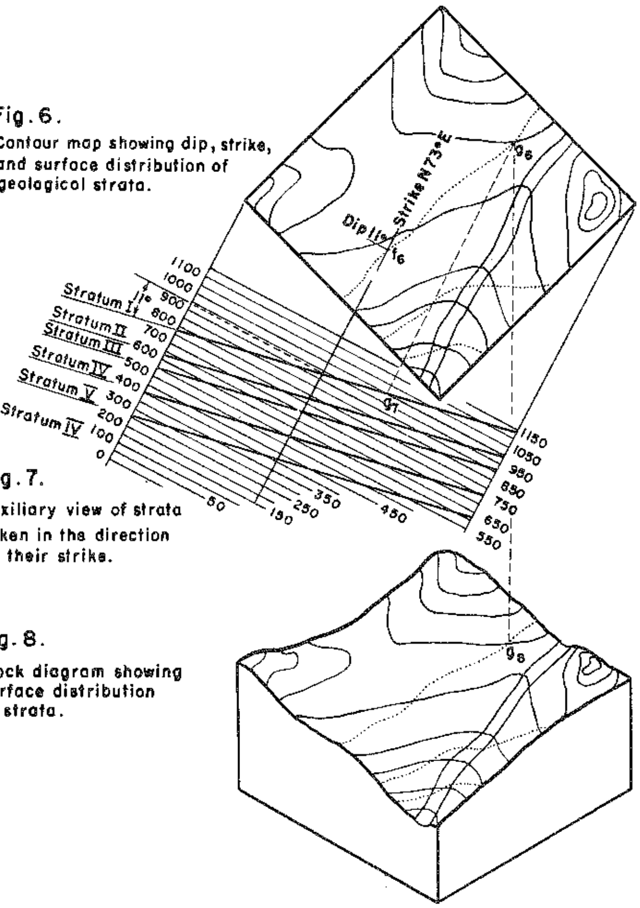


Fig. 6. Contour map showing dip, strike, and surface distribution of geological strata.

Fig. 7. Auxiliary view of strata taken in the direction of their strike.

Fig. 8. Block diagram showing surface distribution of strata.

the dotted lines on Figure 6. From here they can be easily projected to the vertically developed surface of the block, as point g_6 is projected to point g_8 on Figure 8.

The last step of the problem consists of determining how the subsurface strata will appear on the vertical eastern and southern walls of the block.

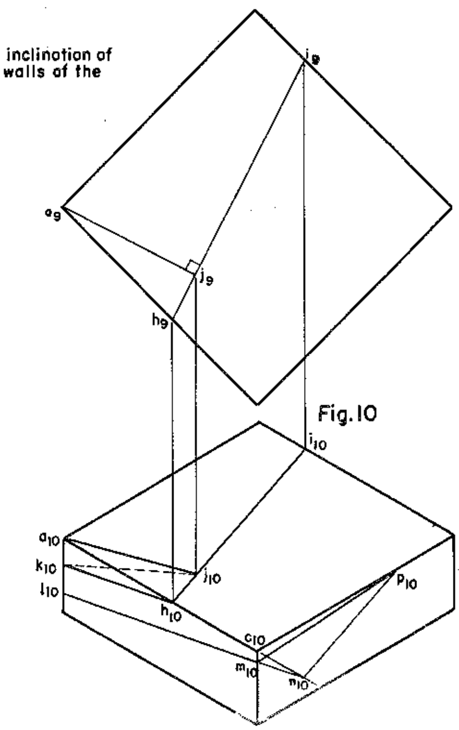
At any convenient place on the map draw the line $h_9 - i_9$, parallel to the strike of the beds. From point a_9 construct line $a_9 - j_9$ perpendicular to $h_9 - i_9$. Project both of these lines to the top surface of the base of the block, where they will show as $h_{10} - i_{10}$ and $a_{10} - j_{10}$.

It can be determined graphically from Figure 7 that in the horizontal distance equal to the length of the line $a_9 - j_9$ (280 feet) the vertical drop is 165 feet. This length, measured isometrically, is now laid off from a_{10} to locate point k_{10}. The line $h_{10} - k_{10}$ shows the inclination of contact planes on the eastern vertical wall.

On the same wall construct line $l_{10} - m_{10}$ parallel to $h_{10} - k_{10}$ and so located that point m_{10} is below point c_{10}. Prolong this line till it intersects the extended top surface at point n_{10}. The line connecting points m_{10} and p_{10} shows the inclination of contact planes on the northern vertical wall.

Fig's. 9 & 10

Method of determining inclination of strata on the vertical walls of the block diagram.

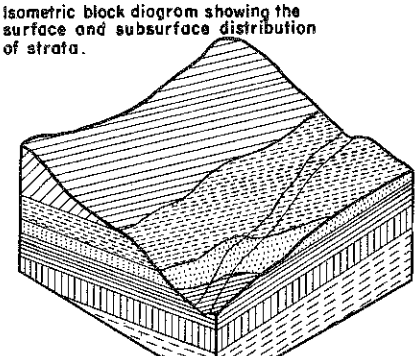


The entire subsurface disposition of strata can now be shown on the block diagram. This is done by drawing straight lines across the vertical walls from the points where the surface expressions of the contact plane intersect the upper edges of these walls. These lines should be parallel to $h_{10} - k_{10}$ on the eastern wall, and to $m_{10} - p_{10}$ on the northern wall.

Since the process of reproduction used here limits the figures to a black on white rendition, the strata are differentiated by a variety of stippling symbols as shown on Figure 11. However, when at all permissible, a scheme of colors should be employed in this phase of the problem. In this way, using transparent coloring pigments, both the surface geology and the hachured surface topography can be shown on the finished diagram, without producing any conflict of stipplings and hachures.

Fig. 11.

Isometric block diagram showing the surface and subsurface distribution of strata.



With the above work completed, all that remains to be done in the problem is to add such necessary elements of cartographic drawing as the north point, the scales, the legend of symbols, the title block, and the border. These will finish an accurate and attractive isometric block diagram of the area.

(Continued from page 11)

Engineering drawing and descriptive geometry courses contribute to both the practical and cultural development of all types of students by providing the mental disciplines and basic abilities necessary for individual success in engineering work. Engineering drawing is one of the basic tools of expression utilized by all engineers. Without adequate and thorough training in engineering drawing -- any engineer will be greatly handicapped in modern competitive and cooperative industrial enterprize. For these reasons, most engineering educators and practicing engineers recognize that it is a basic study and as such is entitled to a place of primary importance in the engineering curricula.

Question #5. In what ways has engineering drawing contributed to the technological and scientific progress of our country?

The present technological and scientific progress made in this country is the result of the exercise of individual initiative and cooperative effort or team work of scientists and highly skilled design and experimental engineers and technicians.

The part which engineering drawing has played in the development of our country is indicated by its wide-spread utilization by scientists, engineers, teachers, designers, inventors, artisans, mechanics, and tradesman during the past fifty years. While there have been many individual contributions by men gifted with inventive genius such as Robert Fulton, Thomas A. Edison, Henry Ford, and others -- the rapid industrial development and expansion has been due to organized and coordinated effort on the part of many engineers, teachers, scientists, and technicians in scientific research and experimental engineering in its many and varied phases.

Study of the work of many inventors reveals that both free-hand sketches and technical drawings were utilized to grasp and record ideas of mechanical construction on paper. Continual revision and changes were often made as a result of failures, discovery of new scientific truth or facts, study of the work of others, and by experimentation and model building. Many of the major contributions in the past have come by the way of the laboratory and experimental research method and not by purely theoretical design and mathematical hypothesis. Many of our most valuable inventions came as a result of keen observation and reflective thinking on the part of the inventor as to the reasons for experimental failure. Continued persistent effort by the trial and error method to eventually achieve success -- came sometimes by chance or accidental discovery.

Likewise, there are many great scientists and engineers today who are especially talented in the development of scientific theory and the use of higher mathematics to formulate scientific truths. Even greater contributions and discoveries are apt to come in a shorter period of time by intensified cooperative effort on the part of trained physicists, chemists, and mathematicians -- working in harmony with design and process engineers as a team to make scientific theory and formula become a reality in terms of mass production.

Mass production has been made possible by the cooperative work of designers, inventors, and mechanics, at all levels of achievement. Engineering drawings on file in any industry furnish a record of changes and improvement in design of products from year to year. The rapid expansion of modern industry has been due in a large measure to the development of new alloy metals, plastics, synthetic rubber and fibrous materials, oil and petroleum products, and to the continuous improvement of machine tools and processing methods. The development of water, steam, gas, and electrical power facilities has kept pace with industrial demands. The possibilities of atomic energy, radar, and electrical control devices indicate the dawn of a new age or a Kingdom of Heaven on earth, provided men everywhere can learn to live in peace with one another.

Engineering students should be taught the importance of engineering drawing and design as a medium of expression to promote "good works" in all countries desirous of aid in solving their problems of development of natural resources and power facilities, disease and sanitation, and the mass production of consumer goods and conveniences by the application of modern engineering methods. Young design engineers should realize the opportunity that exists for them to become able humanitarian leaders in service to men everywhere. The success of any engineer depends on his ability to solve difficult problems of a human and spiritual nature. Who is better fitted today to lead the peoples of the world to a peaceful solution of their human problems than the scientists and engineers who have both the knowledge and skills to interpret the necessity for wise usage of modern scientific discoveries?

The evidence all points to the fact that engineering drawing is playing a major role in the development of design, experimental, process, and technical sales engineers, who are and will continue to make major contributions to the scientific, technological, and cultural progress of this country and to that of other countries desirous of our help.

Question #6. What can be said of the place of engineering drawing in industrial "on-the-job training" or in the "corporation training school programs" for engineering graduates?

Engineering drawing and descriptive geometry courses are regarded as basic preparation for the further development of engineering graduates during their initial industrial experience.

Work in industrial drafting rooms is usually encouraged or required as a part of the basic preparation of young engineers for later success in any phase of supervisory work in accordance with individual abilities, interests, and the company or corporation needs from year to year.

Work as a detailer and layout man thoroughly familiarizes the engineering trainee with the company products, their design, and the processing methods used in their manufacture. This experience is an essential part of the training of engineering graduates to further develop their judgment and capacity to supervise the work of others. Any engineering graduate should welcome the opportunity to gain this practical experience under the supervision of experienced design engineers and industrial training supervisors.

Students who have a special interest and ability for design work are encouraged to continue in it and often these men become excellent experimental and development or process engineers. The value of design and process engineers with inventive and creative imagination to improve present methods and products or to develop new ones is being recognized today more than ever before.

Since it takes about six or seven years to develop an excellent design or process engineer, it is apparent that engineering educators should encourage engineering students, who are motivated by a real desire and liking for design work, to take all the technical drawing and design courses offered in the engineering curricula. The better the preparation in college, the more apt the young engineering graduate is to excell in industrial training programs.

The place of engineering drawing and design in industrial training programs is one of major importance as evidenced by the time allotted to it, and the fact that many industrial employers require it and regard it as basic in the training of an engineer.

Question #7. What are the industrial trends of thought relative to the engineering school curricula and the place of engineering drawing in it?

In answering this question, the following summary of industrial thought should be given careful consideration by engineering curricula study committees.

1. There is a definite trend of thought that the four-year engineering school curricula provides sufficient time for basic preparation during the first two years and for considerable specialization by all types of students in the third and fourth years in line with their major field of engineering work. The present curricula as it exists in most accredited

(Continued on page 29)

(Continued from page 27)

engineering schools and the time allotted to basic engineering drawing courses is not sufficient to prepare engineering graduates for positions as design or process engineers or to supervise the work of skilled technicians and tradesmen.

Four years is enough time to require of the majority of engineering students in college preparation for further development as engineers by industrial employers. The five year curricula should not be made mandatory by engineering colleges for all types of students. Many students do not have the interest or desire to spend more time and money for further training in college.

2. It is of the utmost importance to provide thorough training in basic engineering studies such as mathematics, english, engineering drawing, physics, chemistry, and related shop studies such as pattern-making, foundry, machine shop, forge-shop, and others such as surveying, strength of materials, and mechanics during the first two or three years of college work, with the balance of the time left devoted to special option or design courses offered in the major fields of student interest.

There are a few courses which should be required of all senior engineering students such as -- engineering law and ethics, industrial organization and plant management, engineering materials and processing methods, advanced design and special laboratory courses in each major field, and placement procedures and interviewing techniques. A wide range of elective studies should be permitted in accordance with individual student interest after required work is completed. The elective studies should be of a humanistic, business, or technological nature to permit more choice at the senior level to broaden their training and increase their versatility.

3. The place of engineering drawing is one of primary importance in the engineering curricula not only because of its practical and cultural value, but also due to the part it plays in integrating other basic academic and related shop studies in preparation for advanced courses in college and eventual success in industry. Practically all engineering students utilize technical sketching and drawing, therefore, the time allotted to it should be sufficient to teach basic units of subject matter as outlined in any of the more recent engineering drawing textbooks. Advanced design courses in jigs and fixtures, tool and die design, power plant construction and design, and descriptive geometry applied to auto and airplane body design, etc. should be made elective for all students interested in becoming design engineers, regardless of their major field of specialization. Practical problems in design such as encountered in industrial practice should be utilized in such courses.

A concerted effort should be made to do an efficient job of teaching basic subjects by utilization of mature teachers having industrial experience as well as educational qualifications -- to insure practical as well as theoretical teaching with beginning students. Well qualified teachers are needed to inspire and motivate students with an interest and desire to master basic academic and related shop subjects. Sound basic teaching of beginning students in engineering drawing is just as important as specialized teaching of advanced students.

4. There should be an adequate time allotment for basic engineering drawing and descriptive geometry courses. Some engineering educators desire to add more special option courses within the four year curricula by reducing the present 3 hour class period in engineering drawing, meeting 3 times per week, to 2-4 hour class periods per week, or possibly 3-2 hour periods, the present allottment for teaching descriptive geometry. This would result in reduced per pupil-cost, might increase the pupil-teaching load, and might seriously impair the efficiency of student preparation.

The trend of industrial thought relative to this proposal is expressed in a resolution written by the Detroit Engineering Society to the President of the Engineering Drawing Division of the American Society for Engineering Education -- that their officers "give vigorous support to the retention of adequate training in Engineering Drawing in all engineering curricula".[3] Basic training in engineering drawing should not be reduced to a dangerous minimum for the sake of effecting a minor reduction in the cost of student preparation. The time allotted should be increased instead of decreased at a time when the demand for design and process engineers is apt to be greater.

5. If it is desirable to add more advanced technology courses to the present engineering curricula, it would seem feasible to do so at the graduate level in a fifth year where such training would be more effective because of the maturity and special interests and abilities of the students. Students having special talent for design and experimental engineering work should be encouraged to continue in the graduate school. This procedure would result in the up-building of the graduate school by providing a corps of students with capacity for further development at less expense than would be possible in the undergraduate school. There is a definite need for graduate students to work on a cooperative basis with industry in the solution of special research or experimental problems in design and development.

This procedure would appear desirable in solving the need for more specialized technology courses and would permit the retention of an adequate time allotment for the teaching of basic engineering drawing courses.

6. Engineering students should remember that opportunity exists for specialized training in the school of practical experience in industry -- provided they do not have the inclination, the time, or money to spend in continuing a fifth year in college. Engineering graduates should not be adverse to working in industrial drafting rooms as a part of their initial training for supervisory positions in industrial organizations. Drafting should not be considered as a "dead-end job" with no future. The working conditions and financial remuneration of designers and chief draftsmen compare favorably with supervisory jobs in other special phases of engineering work. This is true because of the scarcity of experienced designers and an increasing need and realization of the value of such men by industrial employers.

Engineering educators should not lose sight of the fact that industry provides the opportunity for further specialization by engineering graduates in solving technological problems. Many industries are better equipped with special facilities and have more financial support for conducting experimental or research projects than most engineering schools.

Engineering schools can best participate on a cooperative basis with industrial employers by sending capable undergraduate students to them to acquire practical experience during vacation work periods or possibly for eight to ten week intervals for special projects or thesis studies with school credit given for such work in industry. Industrial research or special problems requiring more time for study and experimental development should be assigned to graduate students as a part of their work toward an advanced degree.

Many industrial field representatives say -- "Give us engineering graduates thoroughly trained in engineering fundamentals in any major field of engineering and industrial employers will provide the specialized training needed to meet specific job requirements".

Summary

Finally, there are a few basic conclusions which may be summarized as follows:

1. It appears that the place of engineering drawing in the engineering school curricula is a problem for further study by a curricula committee composed of representatives from industry and the engineering faculty in any particular college with the results of their work submitted to the A.S.E.E. national accrediting agency for final approval. The work of such a committee will involve careful evaluation of the present offerings, instructional facilities, time available,

(Continued on page 31)

[3]A.S.E.E. Journal of Engineering Education; Nov. 1949; p. 211.

(Continued from page 17)

BOW COMPASS:

The bow compass shall have a capacity from 1/16" radius (1/8" dia.) to $3\frac{1}{2}$" radius (7" dia.), either of Steelspring or Ringhead type with center wheel adjustment.

The instrument must be sufficiently rigid so that when pressure is applied in drawing small circle arcs, in either direction, the pencil leg shall not lag so as to produce a variation in radius; likewise at maximum radius the instrument must be sufficiently rigid to maintain a constant radius under reasonable pressure.

One leg of the compass shall have a thumbscrew clamping device to receive either pencil or pen attachment.

A threaded, shouldered type centerpoint, similar to those found on some pre-war instruments, is highly recommended.

Center wheel screw shall be of ample diameter, with very fine, multiple threads. Screw of .10 - .12 dia. with 56-64 threads per inch recommended. Corrosion resistant properties of this screw are important.

The hardened steel trunnions which receive this screw shall be secured to the compass legs by snug fitting dog point setscrews; or shall be cylindrical, snugly fitted to the legs and completely encircled by the legs. In either design the trunnions shall be replaceable.

The handle on any ringhead type compass shall be securely anchored to the fulcrum.

The lead and centerpoint shall be at such an angle with the legs that their axes will be parallel when the compass is set at 1/3 to 1/2 its maximum capacity.

The split leg friction clamp which allows angle to be changed between centerpoint and leg is not acceptable.

FRICTION DIVIDER:

6" friction divider may be of conventional design and shall have replaceable points. The legs shall be shaped to provide easy operation. Hair spring adjustment is not necessary.

SLIP HANDLE RULING PEN:

Pen shall be of a properly hardened high grade steel, with graduated thumbscrew adjustment. Shank of pen shall be made to fit both the bow compass and the beam compass.

A friction slip handle shall be furnished not less than 1/4" dia. and of a length to make a pen 5" - 6" long when assembled.

The pen shall be properly sharpened and be capable of producing lines from 1/200' inch to 1/20 inch in width when used as a ruling pen.

POCKET CARRYING CASE:

An inexpensive pocket case of fiber, plastic, good quality heavy cardboard, or similar materials shall be provided.

Case shall accommodate the beam compass, assembled and extended to nearly maximum length of longest bar, with a partition (or compartment) between the legs of the beam to accommodate the other instruments.

Overall dimensions of case must be kept to a minimum so that case may be carried in the inside coat pocket. Suggested maximum outside size 4" x 3/4" x 11".

Form fitting, plush lined compartments, leatherette, etc., cases are not desirable.

APPROVAL:

Approval for use by students in Engineering Drawing and Descriptive Geometry at Purdue University may be granted only after the submission of sample pieces and a written description and brief specifications (materials, etc.).

VARIATION:

Sets varying to a minor degree from the requirements outlined herein will be considered for provisional approval.

(Continued from page 29)

and the cost involved -- measured in terms of the value received by the engineering student and to the engineering profession and society in general.

2. It also appears that there is need for agreement on the part of engineering educators, counselors, and practicing engineers -- to emphasize the importance of student mastery of basic academic studies such as -- mathematics, english, technical drawing, and as many related shop studies as possible in both the high schools and engineering schools. Carefully organized guidance literature, published by the Engineering Council for Professional Development Committee on Selection and Guidance, should be made available to high school students for study before selection of engineering as a career. A prospectus of special option and advanced design courses, giving a clear explanation of the nature of each course and how it contributes to preparation of the student for industrial work should be made available for use by faculty advisors and counselors as an aid to students in selection of such courses in college.

3. It seems desirable that teachers of basic engineering studies should take a more active part in discovery of students having "special interests and talents" and be in position to recommend and advise students in making elections of advanced special option or design courses. The value of basic engineering drawing and related shop teachers as counselors should not be overlooked by college administrators in setting up engineering school faculty-student advisory systems. Experienced industrial and shop teachers of beginning engineering students can do much to make counseling and guidance work of advanced special option teachers and major professors more effective in any field of student interest in the engineering school.

4. The cooperation of technical drawing and related shop teachers, vocational counselors, and administrative officers in high schools is needed to guide students with a definite interest and ability for engineering work. This article should be helpful in focusing their attention on the value of technical drawing as either a required or an elective study for prospective engineering students in the high schools. Technical drawing and related shop teachers can do much to instill in students at an early age an appreciation of the value of engineering or technical drawing as a part of their background of training for success in the engineering school and, ultimately, in engineering as a profession.

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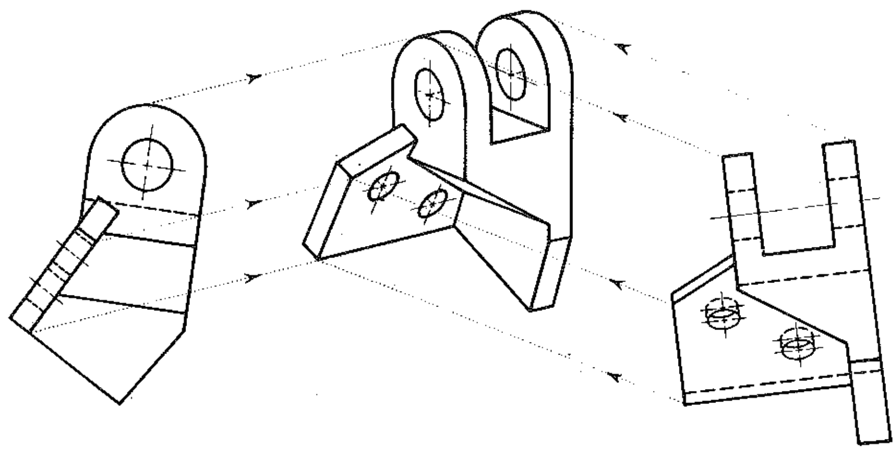

TRIMETRIC PROJECTION

Fig. 5

so that the views have the proper inclination to the horizontal. Figure 5 then illustrates how the various points in the orthographic views are projected until they intersect in the Trimetric thus locating those points in the pictorial. Figure 5 shows how the Trimetric projection of Figure 1 was obtained. Usually, any two adjacent orthographic views (which give three sets of mutually perpendicular dimensions) of the object are sufficient. Obviously, top and bottom views would not suffice as the height dimension is missing from both of those views. Visibility can generally be determined by simple visualization and hidden edges and surfaces are most frequently omitted.

Thus far, we have overcome the objections of varying scales, but there still remains the difficulty that circles become ellipses in the pictorial. They can, of course, be drawn by point by point plotting and then faired in with an irregular curve. This is a most tedious process and appears as such. Thus the points K and J were obtained in the side view and the height measurements Y were transferred to the edge view of the circle (in the front view) and thus points K and J obtained in the front view. These points were then projected to the minor diameter in the Trimetric and thus K and J determined there. Having the major and minor diameters, then the four

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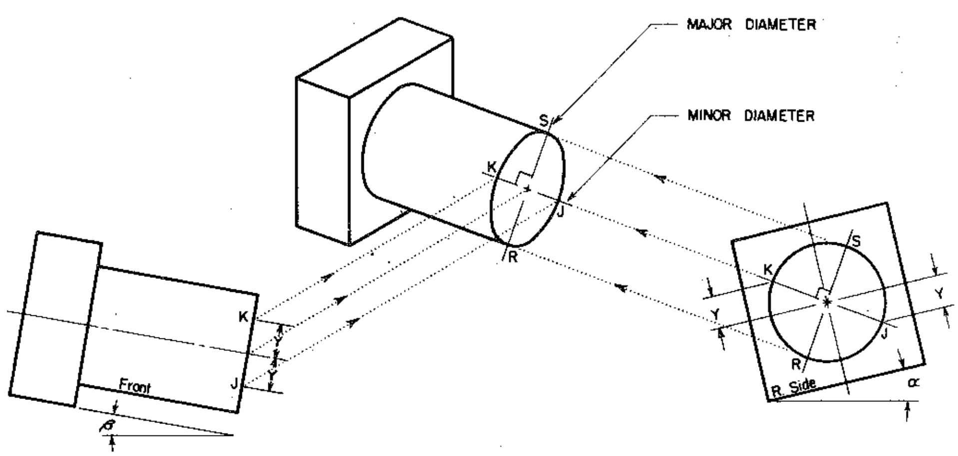

LOCATION OF DIAMETERS OF ELLIPSES

Fig. 6

(Continued from page 6)

10. I suggest the following project to be added to the program.

11. On the teaching demonstration programs, I should like to suggest the following topics be covered (name suggested demonstrator if you have one).

12. State your own willingness to participate either on program or committees if you are going to be there.

Thanks for your kind cooperation, you will receive a reply if you send these to

Ralph S. Paffenbarger
Department of Engineering Drawing
218 Brown Hall, The Ohio State University
Columbus 10, Ohio

Our summer school program will be presented to the Executive Committee on Thursday, January 19, at its meeting in College Station, Texas, and must be completed before February to go to the A.S.E.E. headquarters.

Let's get together first at College Station.

(Continued from page 9)

educational administration yes men are plentiful. Men who can analyze and oppose and come up with alternate or better solutions to matters under discussion are persons who in the long run will have influence and prestige.

You may well ask where does one learn to be serious, to be useful, to be constructively analytical of issues. Could there be better training than engineering education? Could there be better experience than active participation in the Division of Engineering Drawing? I think you will agree with me that before this group neither of these queries needs an answer or discussion. I raise these questions largely because they give me opportunity to bear testimony. I have long believed and consistently preached that there is no better education than engineering. As for my association with this division I can but say here that it has been a help, an inspiration, professionally fruitful and personally delightful.

Perhaps, as I have rambled on, you have been able to discern among the several views I have sketched here the great personal pride I feel in this honor you have awarded me, and the professional satisfaction I have in work you have thus deemed worthy of recognition. Whatever else of these remarks you may later recall, I want you to remember that I ask you personally and the Division of Engineering Drawing as an organization to share with me in pride and in satisfaction. For you and the Division have been an inspiration. I am proud indeed to be counted among its members.

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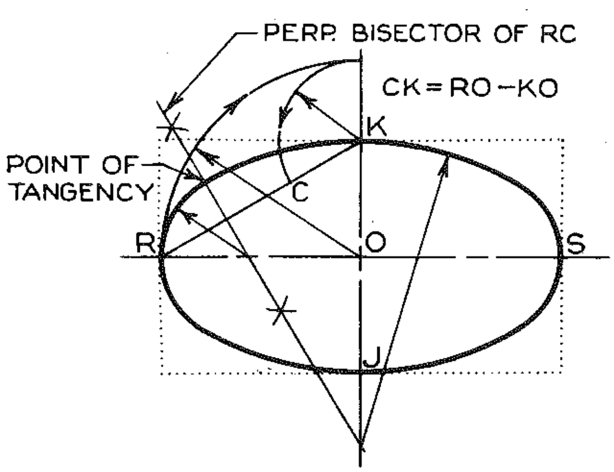

4-CENTER APPROXIMATE ELLIPSE

Fig. 7

center method of constructing the ellipse can be used. This is illustrated in Figure 7.

If ellipse guides are available, they may be to further reduce the work of drawing the ellipses and and the four center method abandoned. The proper ellipse may be determined by trial and error using the plotted major and minor diameters, or by computing trigonometrically or graphically, the angle between the line of sight and the plane involved. A table of values for proper choice of ellipse guide is at present being computed for sets of values corresponding to the angles of the table of Figure 4. Six sets of properly fore-shortened scales for the usually chosen sets of angles have been prepared by J. E. Senne of Washington University, St. Louis, Missouri. These have been printed and are available for sale. They can be cut out and used on the edge of a piece of cardboard or celluloid and will thus eliminate the need for making up the scales. The Trimetric layout then proceeds in the usual order for any trimetric problem.

This paper has been a brief discussion of a simplified manner of making accurate pictorials in Trimetric form. In order to properly teach the theory of pictorials, the students at Washington University go through the process of laying out scales and then using them to construct the pictorial. Later they are shown the projection method, and so have a short cut to use while still having a firm foundation in the overall process involved. With this simple method of construction, the industrial use of Trimetric Projection will undoubtedly be greatly increased in the future.

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