The Journal of Engineering Drawing

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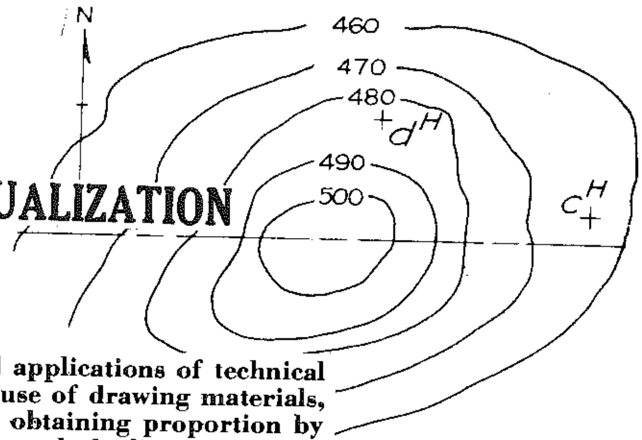

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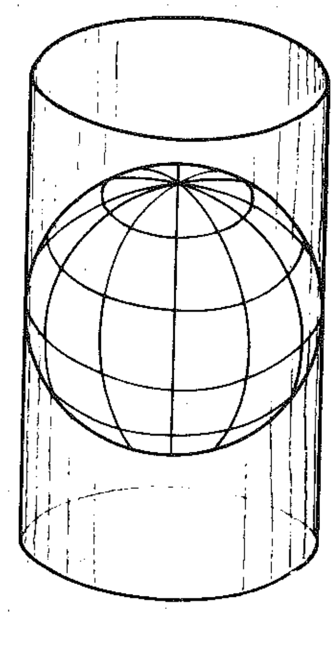

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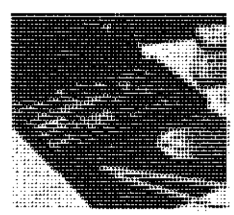

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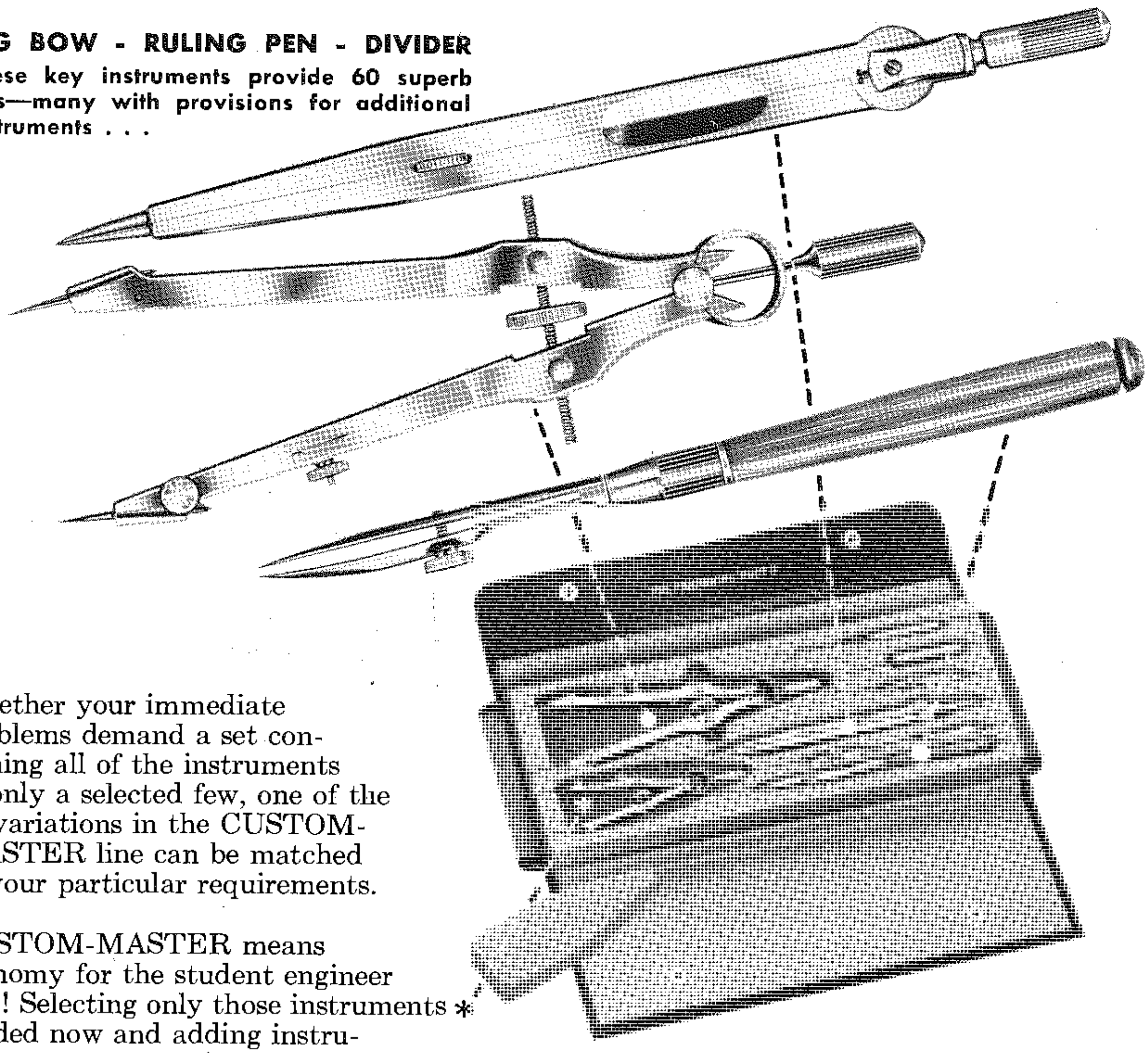

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CARTOGRAPHY
A GRADUATE COURSE IN GRAPHICS

by
Professor J.G. McGuire
The Agricultural and Mechanical College of Texas

In the State of Texas there are approximately forty junior colleges and about a dozen senior colleges that teach the usual engineering drawing courses. Also, there are eight teachers colleges that offer drawing. Many of the drawing teachers in these institutions have started their teaching career with a B.S. degree in industrial education, engineering, or mathematics. Quite a number of these individuals have returned to Texas A.& M. seeking additional training for their chosen profession - the teaching of graphics.

To satisfy this demand the Engineering Drawing Department of Texas A.& M. has developed several courses at the graduate level that may be used as credit toward the Master of Science degree. At this time, sufficient courses are offered for the student to take a Minor in Graphics with a Major in Industrial Education. Also, with special permission, courses may be used as credit toward the Master of Science degree in Engineering.

Cartography is one of these courses that is now offered at the graduate level in the Engineering Drawing Department at Texas A.& M. One may ask the question - can a course in cartography be a graduate course with the usual high academic standards required by the graduate school. I quote from one graduate school catalogue as follows: "The principal function and objective of the Graduate School is to inspire and educate at an advanced level of instruction those men who are to be the intellectual leaders in the various professions and fields of research." Recently, one of our top mathematics professors made the statement that calculus could be taught at the graduate level. As a matter of fact, a course is now offered in advanced calculus at our institution for seniors and graduate students. Also, I would like to quote one more individual who is the vice-president of one of our better-known land grant universities. While speaking before our graduate faculty recently, he made a statement somewhat as follows: Rather than have numbers to denote the level of instruction in a particular course it would be much more appropriate to number the professors." In other words, it would seem that the teacher is the major factor in bringing any course to the level normally expected of graduate instruction.

I think it may be safely said that a graduate course should raise the educational level beyond that which the student has attained in his undergraduate study. Furthermore, such a course should require an attitude of critical analysis or of research on the part of the instructor and of the student. Certainly, the student should be expected to develop the "research habit" and to express, particularly in writing, sensible ideas in a sensible manner.

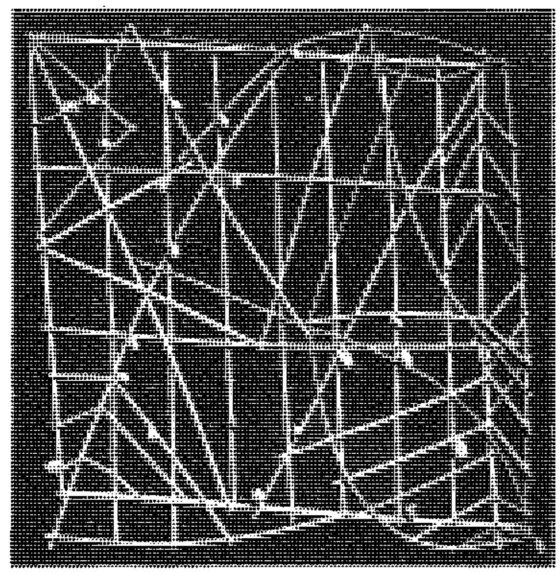


Fig. 1. Chart of Marshall Islanders

Courtesy McGraw-Hill Book Co.

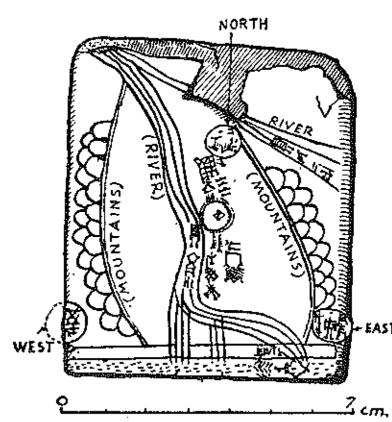


Fig. 2. The Oldest Map

Courtesy McGraw-Hill Book Co.

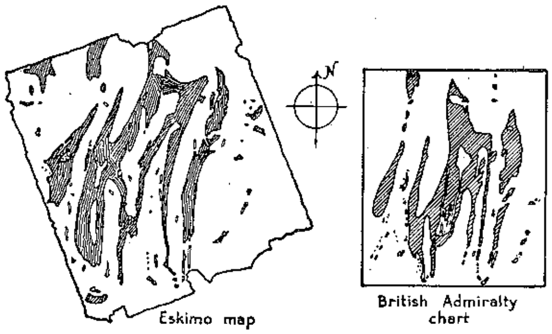


Fig. 3. Hudson Bay Charts
Courtesy McGraw-Hill Book Co.

All of the foregoing objectives have been kept in mind in developing our course in Cartography. The objectives of any course should be sufficiently fluid to permit shifting of emphasis depending on the type and interest of the student to receive the instruction. So far, most of our graduate students are or expect to be teachers of drawing. Therefore, the subject of Cartography has been taught with the idea of broadening the student's interest and knowledge of the field of graphics rather than as a vocational subject.

As an introduction to this course some time is spent on the history of Cartography. Our students, being mainly mature individuals, take a great interest in the maps and charts of primitive people such as the Marshall Islanders, the Babylonians, and the Eskimos. Fig. 1 shows one of the interesting primitive works of the Marshall Islanders. The chart consists of shells attached to a framework made of the midribs of palm leaves. It is said that Anthropologists were puzzled by these curious structures before they finally found them to be charts used for navigation purposes. The shells represent islands, the straight lines the open sea and the curved lines represent the wave fronts approaching the islands.

Fig. 2 shows the world's oldest map. It is a small clay tablet and it is preserved in the Semitic Museum of Harvard University. This clay tablet was found in the ruined city of Ga Sur about 200 miles north of Babylon and it is supposed to be about 4,500 years old.

Fig. 3 shows a comparison of a chart made by a Hudson Bay Eskimo of a particular area with a British Admirality chart of the same region. The Eskimo chart was made without the aid of such modern devices as surveying instruments and it compares quite well with the British map.

In studying the historical background to Cartography tbe student becomes familiar with the philosophy and accomplishments of some of the great men that had profound influence on the development of maps through the ages. In particular, the accomplishment of two eminent gentlemen of history, Ptolemy and Mercator, are studied in quite some detail. This study of the history of Cartography is carried on through the development of the American system.

The main section of our course takes up common terms of the Cartographer such as longitude, latitude, parallels, and meridians. Furthermore, the more common types of projections are studied in some detail.

Fig. 4 is a page from a students notebook showing the usual methods of map projections. Since the earth is approximately in the shape of a sphere, the problem is to project the grid (made up of parallels and meridians on a sphere) onto a surface that can be developed. Fig. 4 (A) shows the use of a tangent cone with the light source at the center of the sphere. Fig. 4 (B) and Fig. 4 (C) show two methods of projecting the grid upon a cylindrical surface with the light source at the center of the sphere. Figures 4 (D), 4 (E) and 4 (F) show methods of projecting the grid upon a plane surface. The light source should be noted for each case.

Actually, most systems of map projections are modifications of the foregoing methods. The term "Projection" has come to mean any orderly system of parallels and meridians on which a map can be drawn. In most cases these systems are not projections at all in the sense that the term is used in engineering drawing. There are hundreds of ways that a grid of parallels and meridians may be constructed - some good for one purpose and some for another. Some are equal - area (the same area on the map as on a globe of equal scale) while others are conformal (any small area on the map has the same shape as on the globe). The equal-area map cannot be accomplished without considerable distortion and with directions quite twisted. Furthermore, the conformal map, while showing direction correctly, its scale must vary considerably. Since there is no perfect map projection for all purposes, it is necessary for the Cartographer to make an intelligent selection of the system to use for a particular purpose.

A typical problem to introduce some of the grid systems is as follows: Draw the parallels 10°, 0°, and 10°, and the meridians 40°, 50°, and 60°, corresponding to a globe of 72-inch circumference, in equirectangular projection with 50° as the standard parallel.

This is one of the simplest of projections since the parallels and meridians are made up of a network of evenly spaced horizontal and vertical lines (Fig. 5). First we lay out the parallels spaced at true distances. This is calculated as follows:

On Globe, $1^\circ = 72/360 = 0.2''$

and, $10^\circ = 2''$

Therefore, we space the parallels 2" apart.

Next, we take the standard parallel (50° in this case) and divide it by the following formula:
1° long $= 1^\circ$ lat. $\cos\theta$, where θ is the degree of latitude.

$$\text{Therefore, } 1^\circ \text{ long.} = 0.2 \cos 50^\circ = (0.2)\ (0.6428) = 0.12856$$

$$\text{and } 10^\circ \text{ long.} = 1.2856''$$

This projection is neither equal-area nor conformal; however, the exaggeration is small for small areas. Its chief use is for maps of towns, counties and states.

Fig. 6 (a) and (b) show the Mercator projection. It is well known for its use in navigation. It is the only system in which all compass directions show as straight lines.

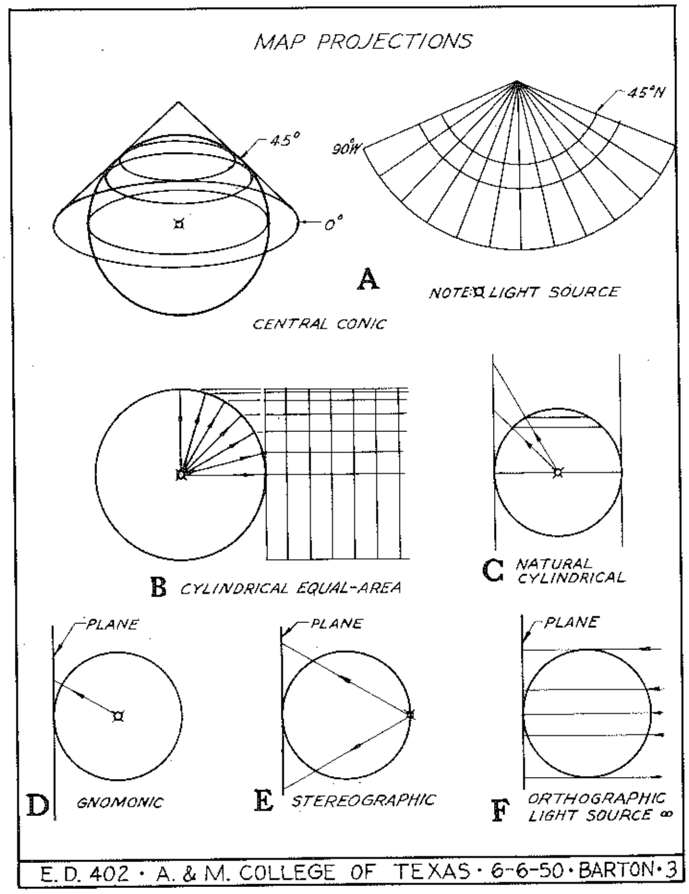
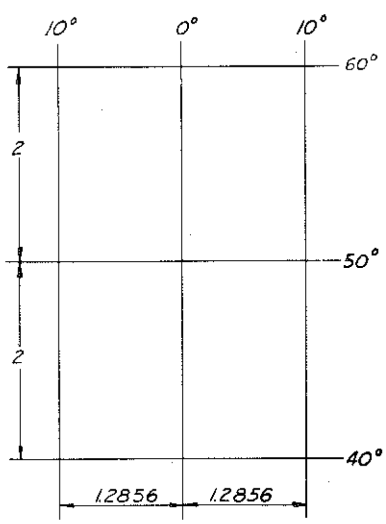
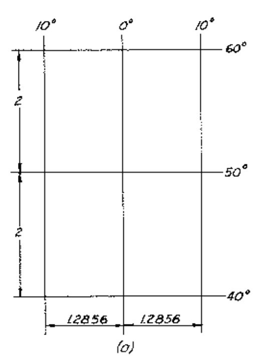
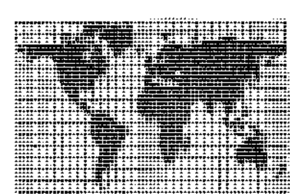


Fig. 4. Map Projections



(a)





(b)

Fig. 5. Equirectangular Projection

Courtesy McGraw-Hill Book Co.

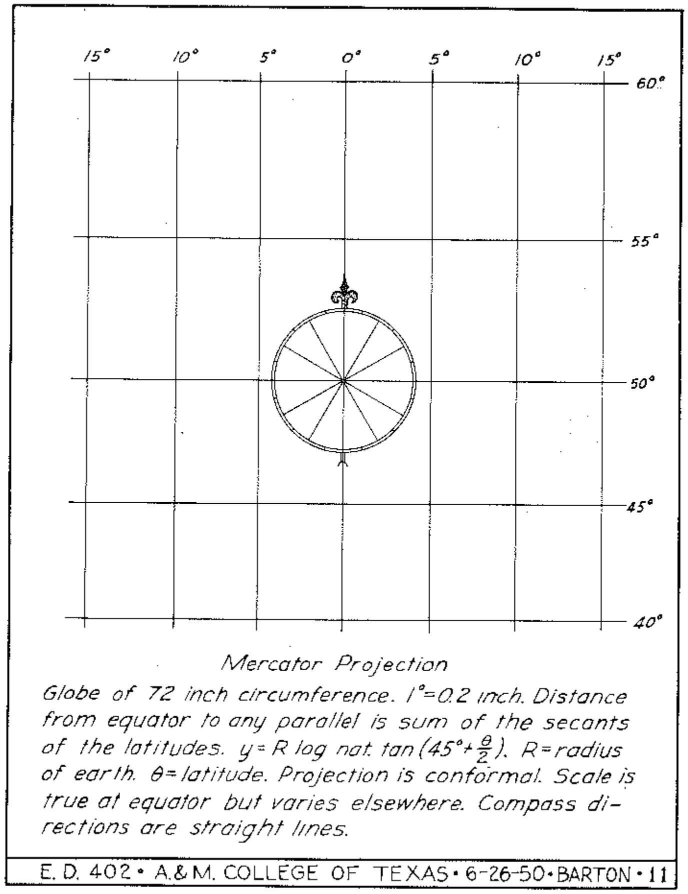


Fig. 6 (a). Construction of Grids for Mercator Projection

Fig. 7 shows a page from a student's notebook illustrating the polyconic projection. It is used principally for topographic maps.

In addition to taking up the more common map projections, the three illustrations just shown being typical examples, relief methods and map reading are included in our course. Also, a brief survey is given of some of the Cartographic specialities such as statistical maps, two dimensional and three dimensional diagrams, and models.

Fig. 8 is a typical problem type that is sometimes used in undergraduate courses in descriptive geometry; however, problems of this nature fit in quite well in our course to strengthen the young teacher's knowledge of the fundamentals of projections. The problem in this case is to determine the shortest distance along the earth's surface between two points of known latitude and longitude. Also, the problem requires the initial and final bearings of the great circle course between these two points. Fig. 9 shows one student's solution to this problem. It has been found that this type of problem challenges the average student that registers for our graduate courses.

In summary, an attempt has been made to show the philosophy used in setting up a graduate course in graphics at our institution. Also, a brief survey of the content of a course in Cartography has been given.

In conclusion, it is my opinion that the engineering college drawing departments should be directly concerned with what is offered in drawing at the high school and junior college level. The engineering colleges can and should, I believe, offer leadership and assistance in setting up the proper role for these institutions in the field of graphics.

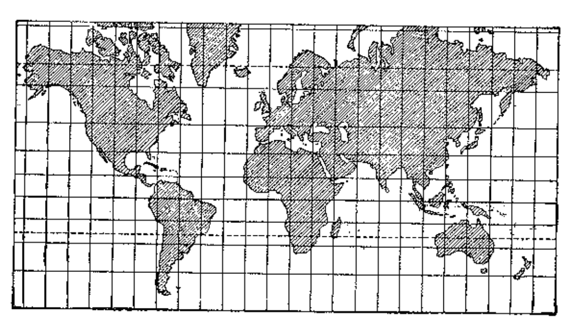


Fig. 6(b). Mercator Projection
Courtesy McGraw-Hill Book Co.

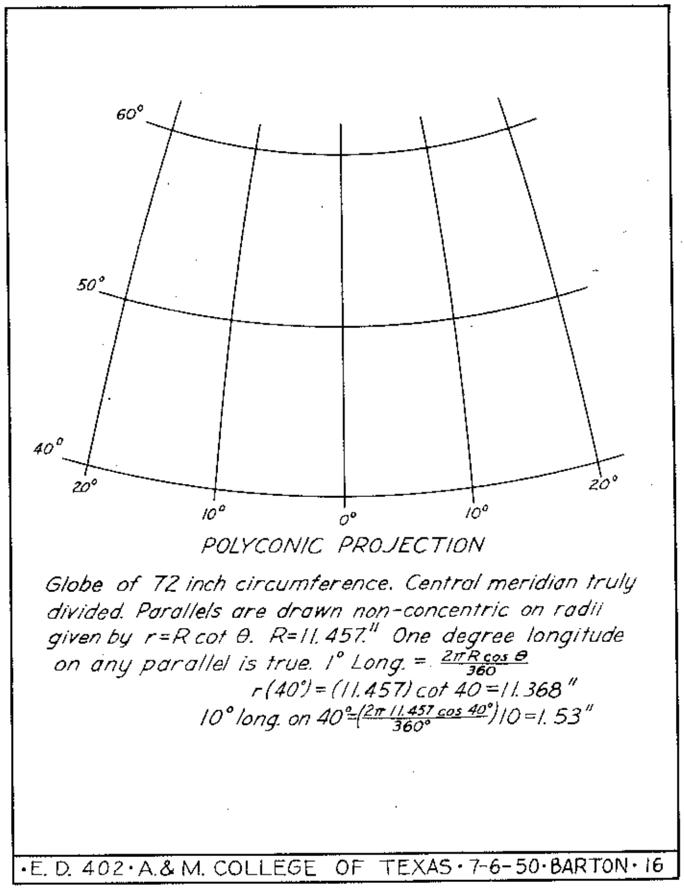


Fig. 7. Polyconic Projection

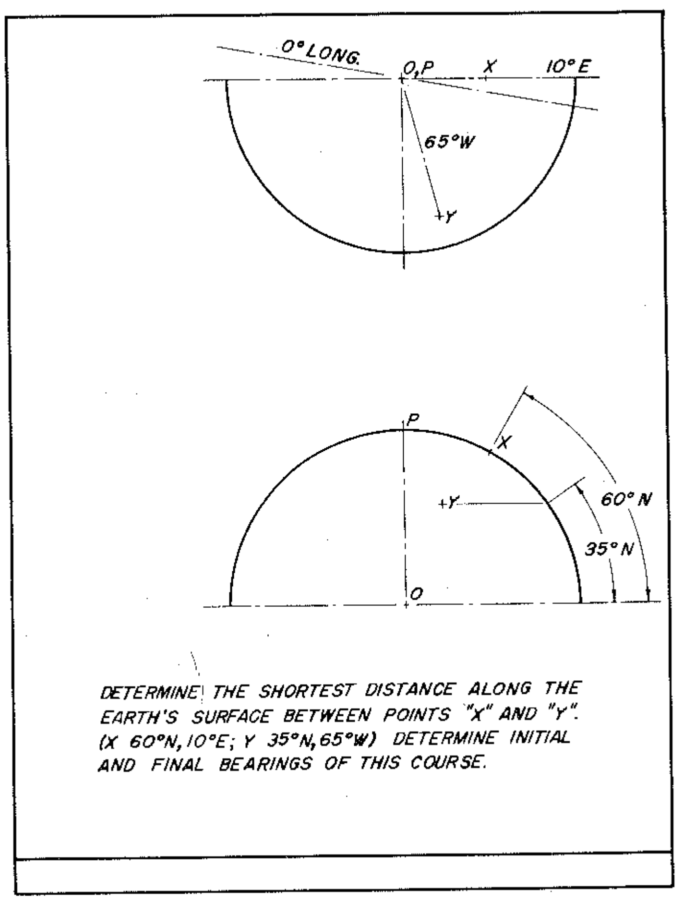


Fig. 8. Spherical Triangle Problem

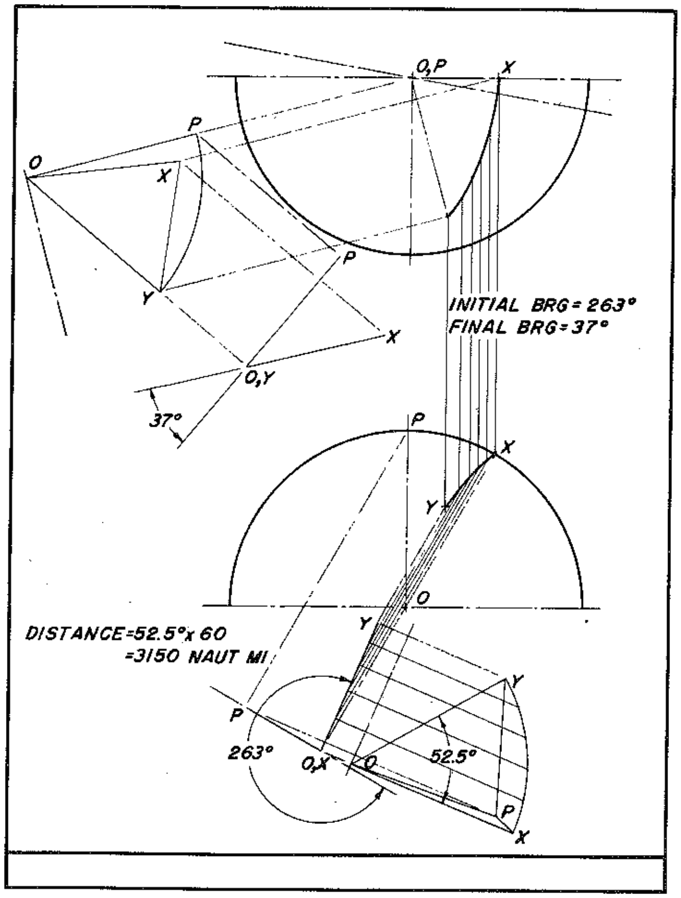


Fig. 9. Problem Solution

A FEW WORDS CONCERNING OUR INDEX

A Communication from Professor Irwin Wladaver
New York University
University Heights, New York 53, N.Y.

January 8, 1953

Dear Warren:

If any readers, particularly authors of the various articles, find that I've made errors of any kind in the Index, or that I've omitted from the Index any items that should rightfully have been included, I'll be glad to make up a list or errata and a list of addenda and send it with the next possible Journal. It could be in the form of a separate sheet that could be inserted in the Index itself or perhaps printed on a page of that Journal. I think this would be an important duty to perform . . .
The Index is now at the printer's.

Vlad

NEWS ITEM

Iowa State College
Department of Engineering

The Iowa State College Department of Engineering Drawing was host at a breakfast in the Memorial Union on the Iowa State Campus, Saturday morning, October 4, 1952.

The guests were members of the Drawing Division of the American Society of Engineering Education who were at Iowa State for the North Midwest Section meeting of the Society. Approximately 35 members were in attendance.

A program followed the breakfast with Professor J.S. Rising, Head of the Engineering Drawing Department of Iowa State, serving as chairman. Two principal speakers were on the program. Mr. Elmer Sherrill, Head of Material Engineering, John Deere Waterloo Tractor Works, spoke on the topic "Selection and Use of Industrial Standards". Mr. Albert Dattels, Sales Manager for the Keuffel & Esser Company, Chicago, Illinois, had as his topic "Recent Developments in Reproduction Materials".

APPLYING GRAPHIC SKILLS TO THE SOLUTION OF DIFFERENTIAL EQUATIONS

by

Gerald W. Walsh, Jr., Assistant Professor
Department of Engineering Drawing

Syracuse University

The primary purpose of this article is that of demonstrating how graphics can be used to stimulate student interest toward the solution of certain types of problems appearing in many engineering senior and graduate courses. This main theme will be supplemented by discussing some of the practical results obtained through this application of graphics.

The problem encountered concerns the solution of the partial differential equation

$$\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = f(x,y)\,,\ C,\ 0. \qquad (1)$$

This equation represents many types of engineering problems such as plane stress, potential in electrostatic fields, steady state heat flow, torsional stress and slider bearing lubrication.

For example, a typical problem of this nature is a study of the pressure distribution on a slider bearing. The boundary values; that is, the oil pressure at the edges of the slider, are known. Pressures on the slider at interior points are unknown and must be determined. In equation (1), ϕ represents the pressure at any interior point. However, the determination of these interior values by application of the formula is extremely difficult, even in the hands of an expert mathematician, and the complicated boundary shapes encountered in practice frequently render the problem virtually unsolvable.

This general type of problem occurs in almost any advanced course in applied mechanics. To obtain a solution the student must be very well versed in mathematics, and must spend unusually long time intervals to obtain solutions. But most students do not have the mathematical training required, and even if they did, there is little desire on their part to spend the necessary time. Because of these factors, many courses include only the theoretical and omit the practical applications, and lowering of both student interest and course enrollment frequently results. The objective is to provide incentive and motivation to encourage the study and analysis of such problems. In order to do this, applied mechanics and graphics joined forces.

One procedure developed transforms the original equation (1), into the following iteration equation:

$$\phi_0 = \frac{\phi_1 + \phi_2 + \phi_3 + \phi_4}{4} + \frac{h^2 C}{4} \qquad (2)$$

To use this equation a uniform rectangular grid is drawn within the boundary of the problem. ϕ_0 represents the value at any point where two grid lines cross, and is the average of the four adjacent points, ϕ_1, ϕ_2, ϕ_3, ϕ_4. In the second term of the equation, h equals the spacing between points and C is the right side of equation 1. When C equals a constant, it is called Poisson's equation and when C equals zero, it is known as Laplace's equation.

In the solution of equation (2), boundary values must be known and one assumes initial values for the interior points. Then taking one interior point at a time, each is corrected by application of the formula. Thus, an averaging procedure is introduced and the process is repeated until sufficient accuracy is obtained. This accuracy is reached when the old and new values for all points remain the same within the number of decimal points accuracy required. Sometimes as many as twenty to thirty trials over the entire grid will be required. Although the procedure makes the problem solvable from a mathematical standpoint, it requires a minimum of twenty hours to arrive at a satisfactory solution for simple problems. For more involved problems, considerably more time is required. Accordingly, the incentive toward solution is still very low.

It was decided to study the problem from a graphics viewpoint to see if the time element could be sufficiently reduced through the use of an alignment chart. The resulting chart is shown in Fig. 1. This is a graphic means for the averaging of the four numbers, and incorporates certain special features characteristic of this type of problem.

The general application of the chart is shown on the chart itself. Frequently in these problems, two values will be identical. Therefore, the X_3 and X_4 scales are combined. When the chart is used the identical values are averaged last, and since they coincide, this eliminates one step. Also, while normally the two axes are used only as pivot points, they have been calibrated. Thus, if one point being averaged equals zero, then the answer can be read on the axis II scale without setting the zero value on X_4. If two values are zero then axis I is calibrated so that the answer can be read directly after aligning the two values other than zero on scales X_1 and X_2.

The use of this chart seems to create interest among the students. Human errors are greatly reduced and solution time is considerably shortened. Use of this chart, along with other graphical aids has resulted in solutions by students of many problems not previously adopted to class room analysis.

An additional method for the solution of Laplace's equation only, was originally developed by Christian E. Grosser, formerly of the applied mechanics staff at Syracuse University. Here again an approximate formula for the solution of the differential equation was derived. This equation is as follows:

$$\phi_0 = \frac{\frac{\phi_1}{r_1} + \frac{\phi_2}{r_2} + \frac{\phi_3}{r_3} + \frac{\phi_4}{r_4} \ \cdots + \frac{\phi_n}{r_n}}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \frac{1}{r_4} \ \cdots + \frac{1}{r_n}} \qquad (3)$$

To use this equation radial lines at equal angles are drawn from the interior point in question to the outer boundary. The formula states that the value of the interior point ϕ_0 is equal to the sum of the boundary

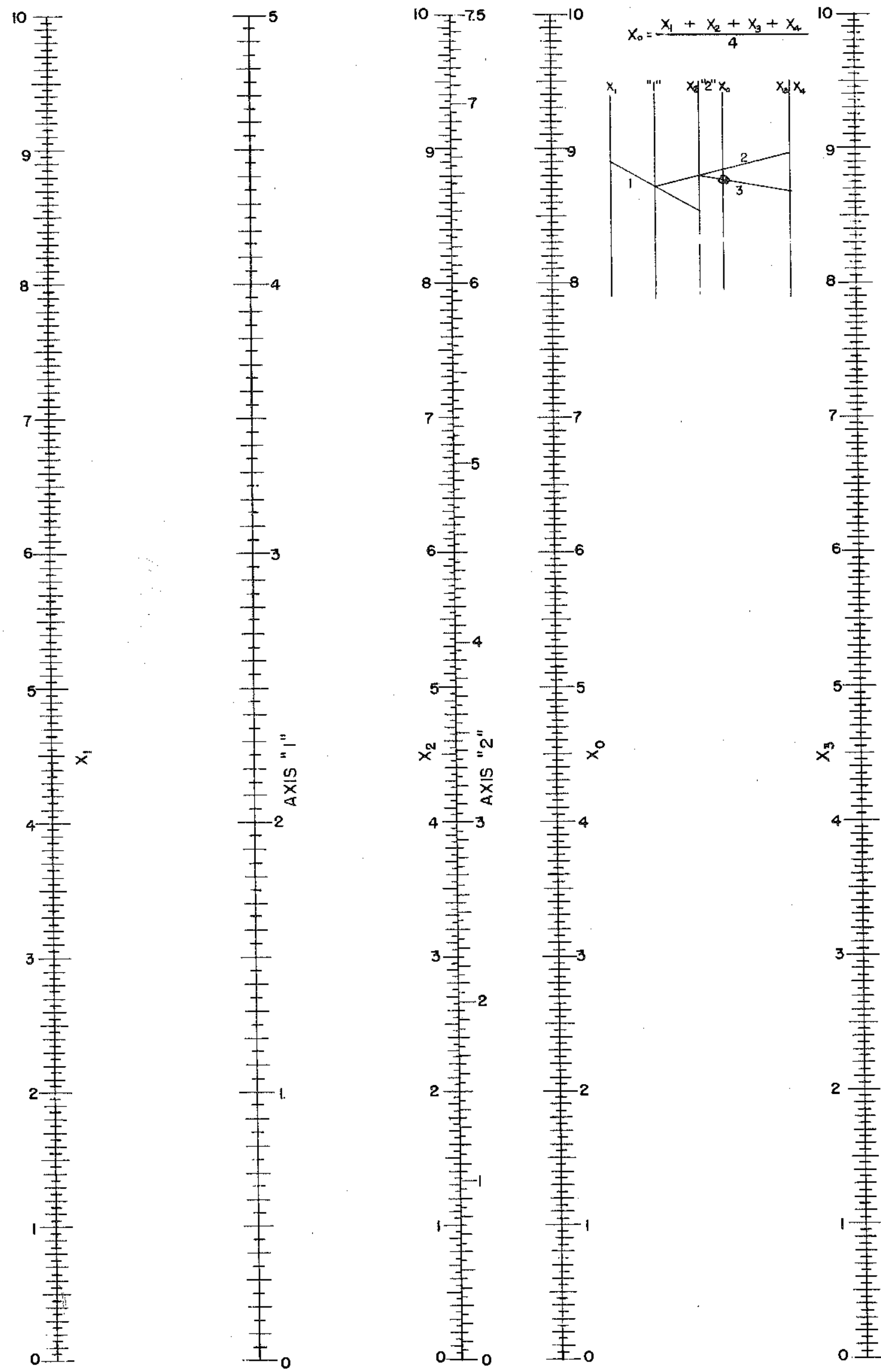


Fig. 1

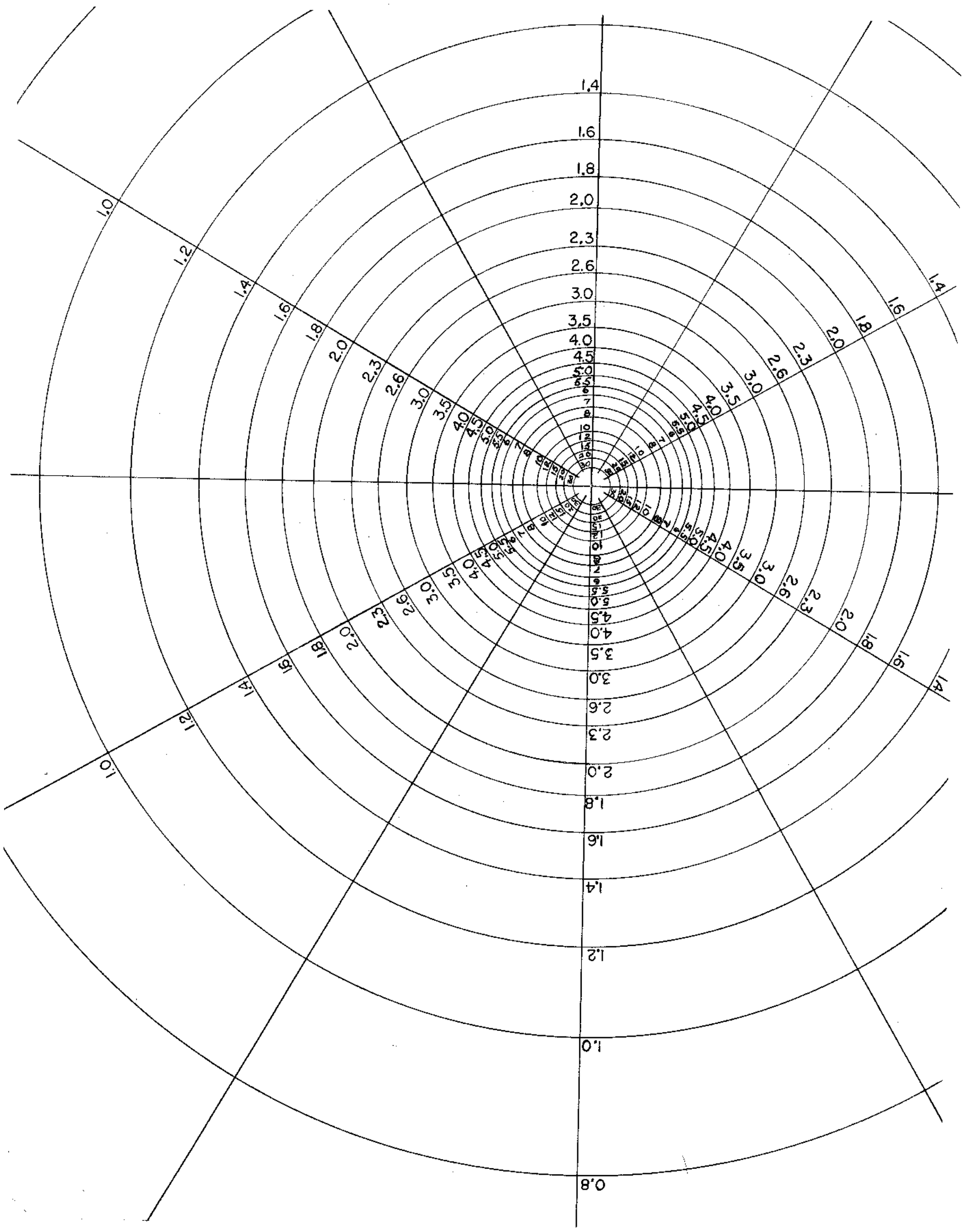


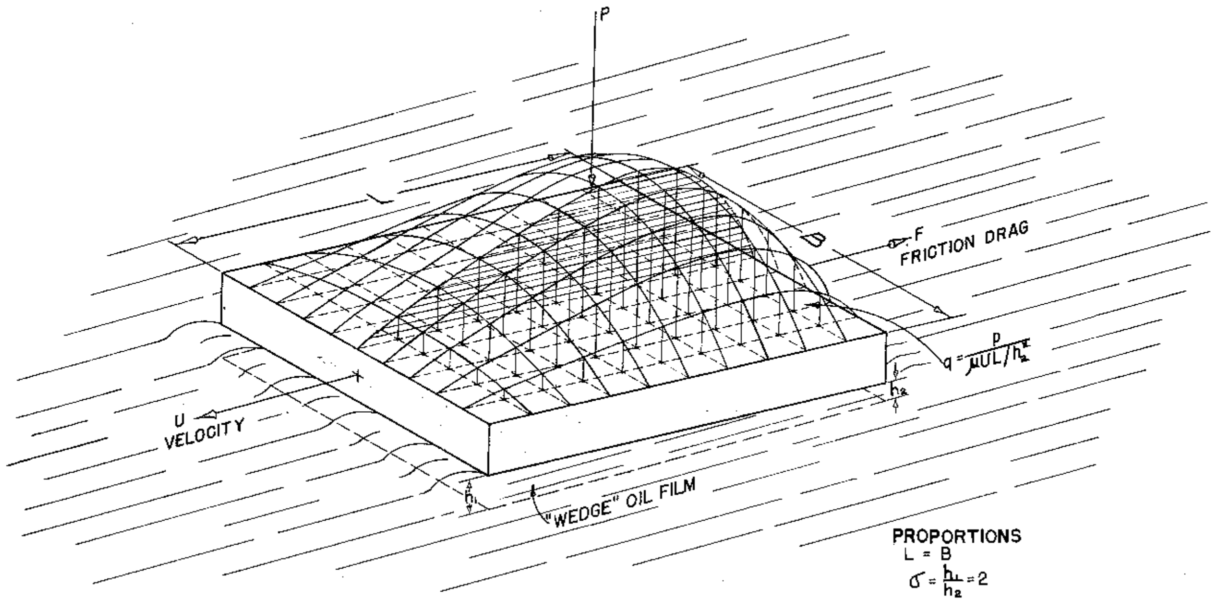
Fig. 2

SOLUTION OF LUBRICATION PROBLEMS BY DIFFERENTIAL ANALYSIS

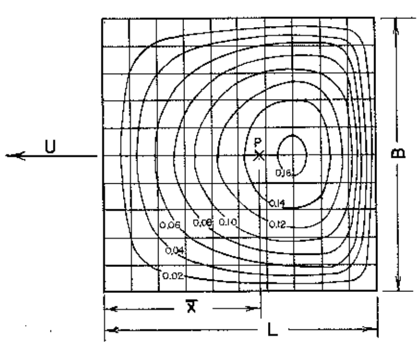
GENERAL DIFFERENTIAL EQUATION FOR SLIDER BEARING:

$$\frac{\partial^2 q}{\partial\left(\frac{x}{L}\right)^2}+\frac{\partial^2 q}{\partial\left(\frac{y}{B}\right)^2}=\frac{3(\sigma-1)}{\sigma+(1-\sigma)\frac{x}{L}}\,\frac{\partial q}{\partial\left(\frac{x}{L}\right)}-\frac{6(\sigma-1)}{\left[\sigma+(1-\frac{x}{L})\right]^3}$$

SLIDER BEARING



LINES OF CONSTANT PRESSURE



FORMULAS

LUBRICANT PRESSURE INTENSITY FACTOR = q

OIL VISCOSITY = μ

LOAD FACTOR:

$C_P = 0.069$

LOAD:

$$P=\frac{\mu UL^2 B}{h_2^2}C_P$$

SUPPORT FACTOR:

$C_G = 0.58$

LOCATION OF CENTER OF PRESSURE:

$\overline{x} = L\,C_G$

FRICTION FACTOR:

$C_F = 0.72$

FRICTION DRAG:

$$F=\frac{\mu ULB}{h_2}C_F$$

G. W. WALSH

Fig. 3

(Continued on page 20)

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Announcing the 8th Editio

French's ENGINEERING DRAWING

By THOMAS E. FRENCH

as revised by

CHARLES J. VIERCK
Department of Engineering Drawing
Ohio State University

Ready in March

IN 1911 the McGRAW-HILL BOOK COMPANY announced publication of the first edition of French's *Engineering Drawing*. Since that time this outstanding text has appeared in eight editions and sold over 1,000,000 copies—startling evidence of its exceptional popularity in engineering drawing courses.

Now in its eighth edition, as revised by Professor Vierck, the book still maintains the innovations introduced by the author over 41 years ago. While the advantages of Professor French's presentation are preserved, revisions of the text throughout eight editions have served to strengthen

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n of an Unchallenged Leader

its approach and shape it to the changing needs of teachers throughout the world. As such, it stands unchallenged in the field.

In the eighth edition, text and problems have been brought up to date by the elimination of obsolete material, and new subject matter is consistent with current standards and practice. Almost every chapter has been altered or rewritten, and figures have been changed to increase their over-all usefulness.

Teachers will discover that this revision follows a more logical pattern in its presentation. The material on projection has been expanded for greater coverage. The division of chapters into shorter units will simplify reading assignments. All of the chapters on projection have been grouped in the front portion of the book. Dimensioning follows next. Then the basic machine elements, such as screw threads, fasteners, pipe, gears, etc. are discussed. The chapter on Working Drawings follows. The latter chapters of the book deal with the specialties—architectural, structural, topographic drawing, etc.

Favorite problems of previous editions have been retained, and many new ones representing current design, have been added. Some new problems have been arranged in "exploded" form and many of the older ones rearranged to make for greater flexibility in their choice.

Thus, with the incorporation of many new changes to improve the book's teachability, *Engineering Drawing* remains the ideal text for students.

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(Continued from page 17)

values divided by their respective radii, all divided by the sum of the reciprocals of the radii.

To facilitate the use of equation (3) the graphics department developed a transparent overlay of the form shown in Fig. 2. For actual use this diagram was inked on tracing cloth and then reproduced by the dry-ammonia vapor process on sensitized transparent film.

The center of the overlay is placed over the particular interior point in question. Where each radial line crosses the boundary, the boundary value is recorded, and at the same time the value of the circle through the boundary point is recorded. These circle values are reciprocals of the radius. Now the boundary values and the reciprocals of the corresponding radii can be quickly listed. Each boundary value ϕ_i is multiplied by the circle value $\frac{1}{r_i}$ and these products summed up to obtain $\sum_{i=1}^{n} \frac{\phi_i}{r_i}$ The circle values may be also summed up to give $\sum_{i=1}^{n} \frac{1}{r_i}$ Then the former divided by the latter will result in the value of the interior point.

Results obtained by the foregoing method are quite accurate for engineering work if n equals 20 in equation (3). The method when applied to problems of Laplacian nature rapidly reduces the time spent in solution. This is not an averaging procedure, but gives a direct answer. However, it must be repeated for each interior point whose value is desired.

These are but two of several steps developed to speed up the solution of this type of problem. All methods together have made possible rapid solutions whicb never before could be presented in regular classes.

It might be of interest to discuss a few of the results obtained by the opening of this new field. These results were obtained to both check the accuracy of this grapbical method and to bring forth some of its potentialities. In one investigation torsion in beams of standard structural shapes was analyzed. It was found that the emperical formulae already developed for beams of square and rectangular cross-sections agreed within three percent with those solutions obtained by the graphical approach. However, the graphical analysis, when applied to I-Beams, Channels and Angles, seemed to indicate that the approximate formulae now in use are in error by as much as thirty percent. Certainly such an apparent discrepancy points to the need for further study.

In another study the distribution of stresses in a beam were determined from the photoelastic stress pattern. In this case a simply supported Bakelite beam was loaded by means of a concentrated force at its center, and the photoelastic fringe values at the beam's edges were obtained. Using these data the internal stress distribution was rapidly determined through the use of the graphical aids.

Finally, the pressure distribution on a square slider bearing was analyzed. Fig. 3 illustrates the results obtained. Actually the drawing itself is a new graphical approach designed to better illustrate these results. In the illustration you will note that the pressure is represented as a pillow-shaped surface rising above the bearing. Height of the pillow at any point is a measure of the pressure. This pictorial representation portrays the solution to the average reader with considerably more meaning than the conventional approach as shown in the lower left corner.

The preceding solutions are but a few of the many made possible by this new approach. The field for investigation at present appears to be almost unlimited. Now that a simpler graphical approach has been provided, perhaps the solution to many problems hitherto considered to be unsolvable by analytical methods will lend themselves to class room analysis and solution.

I hope that in writing this article, I have shown that graphics can hold an important place in the advanced training of students. With some small effort, an instructor may definitely illustrate to his classes that graphical methods often present ways and means of reducing the time element. If we, as teachers, only try, we shall find that there are many opportunities for demonstrating how graphics can aid the engineer beyond just reading a blueprint. Graphics can serve as both an essential tool and a motivating force in interesting students in the solution of advanced engineering problems.

PERSONALITY SKETCH OF PROFESSOR RANDOLPH P. HOELSCHER

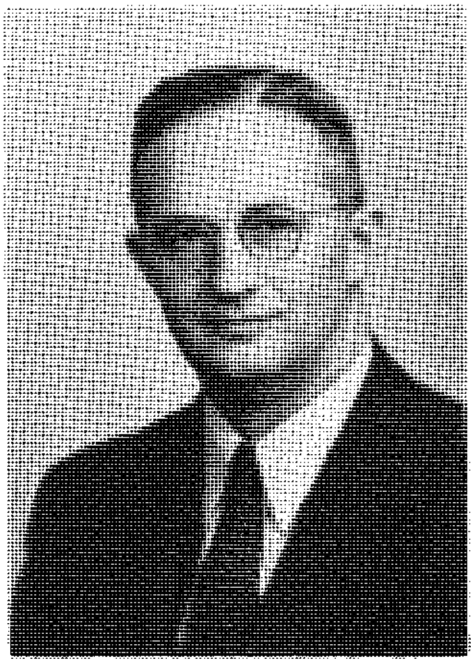
by

Professor C.H. Springer
University of Illinois

Professor Randolph P. Hoelscher, Head of the Department of General Engineering Drawing at the University of Illinois is a charter member of the Division of Engineering Drawing. Ever since the founding of the division, he has been a very active and valuable member. He is recognized as one of the most energetic and efficient members of the group and his name is usually suggested when a particularly difficult job of organization is encountered.

Professor Hoelscher was born December 12, 1890 in Evansville, Indiana and received his primary and secondary education in that city, graduating from Central High School in 1908. He received the degree of B.S.C.E. in 1912 from Purdue University, the M.S. degree from the University of Illinois in 1927 and the Professional C.E. degree from Purdue University in 1929.

After graduating from Purdue he was employed as a Structural Engineer by George L. Mesher and Company of Evansville, Indiana until 1916. He began his career as a teacher at Baldwin Wallace College in Berea, Ohio where he was an Instructur in Physics from 1916 to 1918. In 1918 he came to the University of Illinois as Instructor of General Engineering Drawing where he advanced rapidly to the rank of Professor. In 1946 when large enrollment in the University of Illinois made it necessary to open a branch at Navy Pier in Chicago, Professor Hoelscher was chosen to organize the engineering courses and become



Associate Dean of Engineering. He remained at Navy Pier in that capacity until 1949 when he returned to Urbana to become Head of the Department of General Engineering Drawing.

Professor Hoelscher is a Licensed Structural Engineer in the State of Illinois and has always maintained his interest in professional work. He is a member of A.S.C.E., A.S.M.E. and has been very active in the work on Standards for A.S.A. He was chairman of the subcommittee on Revision of A.S.A. Z-14 - 1946. He is Chairman and Member of the Executive Committee of Sectional Committee Y-14 of A.S.A. He was also Chairman of the American, British, Canadian Conference of Unification of Drafting Standards in New York June, 1952.

He has been a very valuable member of the Drawing Division of A.S.E.E. and his worth has been recognized by his colleagues who have elected him to many offices. At the organizational meeting in Chapel Hill he was elected secretary. He was chairman of the Division for the years 1940-42, Chairman of the Drawing Division Summer School at St. Louis in 1946, Chairman of the Policy Committee of tbe Drawing Division from 1951 to date and served as a member of A.S.E.E. Council for two terms from 1941 to 1944 and from 1948 to 1950. At present he is a member of the Executive Committee of the Drawing Division.

In University work at Illinois he has been equally active, having served as Secretary of the Senate for six years, Chairman of the Committee on Admissions from Secondary Schools for 4 years, Chairman of the Committee on Commencement for 18 years, and Chairman of the Committee on Civil Defense from 1951 to date.

As a teacher, Professor Hoelscher is always interested in helping the students develop their abilities and in providing opportunities for individual and original thinking. In the class room, his thoroughness and meticulous attentions to details inspires the students to do their best work.

As an author, Professor Hoelscher bas contributed some of his most valuable work. His publications include the following:

1. Report of National Survey of Engineering Drawing. Journal of Engineering Drawing.
2. Report of Survey and Syllabus for High School Drawing. University of Illinois.
3. Engineering Drawing with H. H. Jordan. John Wiley and Sons.
4. Essentials of Engineering Drawing with C. H. Springer. Swift and Company.
5. Basic Units in Mechanical Drawing. 2 Volumes with A. B. Mays. John Wiley and Sons.
6. Industrial Production Illustration with Springer and Pohle. McGraw-Hill.
7. Graphic Aids in Engineering Computation with Arnold and Pierce. McGraw-Hill.
8. Teaching of Mechanical Drawing. John Wiley and Sons.
9. Proceedings of Drawing Division Summer School - 1946 with Justus Rising. McGraw-Hill.

His activities in social circles are also quite diverse, being a member of Triangle Fraternity, Tau Beta Pi, the Presbyterian Church, Kiwanis, Masonic Lodge and Scottish Rite.

His wife, who was Hazel Heeger before their marriage, was also a native of Evansville, Indiana. They have two cbildren, Betty, who is married to a very promising civil engineer and, William, who is at present serving with the armed forces in Germany. Hazel and Rand are seen at their best when entertaining their two grandchildren, Randy and Martha.

CONIC CONSTRUCTIONS FROM THE PROJECTIVE VIEWPOINT

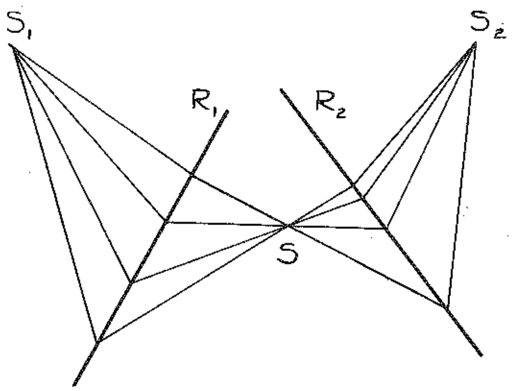
by

Steven A. Coons

Section of Graphics

Massachusetts Institute of Technology

I. If a sheaf of rays through a point intersects a straight line in a point row, the sheaf is said to be in projective relation to the row. If two sheaves are in projective relation to the same point row, they are in projective relation to each other.



$S_1 \overline{\wedge} R_1 \overline{\wedge} S \overline{\wedge} R_2 \overline{\wedge} S_2$

Fig. 1

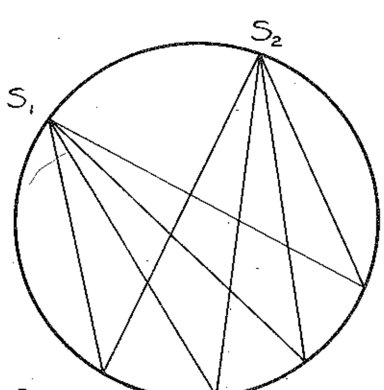
Thus in Figure 1 the sheaf S_1 is projectively related to row R_1 and thus to sheaf S and row R_2 and sheaf S_2. This is written

$$S_1 \overline{\wedge} R_1 \overline{\wedge} S \overline{\wedge} R_2 \overline{\wedge} S_2.$$

This "chain" may be abbreviated to read:

$S_1 \overline{\wedge} S_2$, or S_1 is projectively related to S_2.

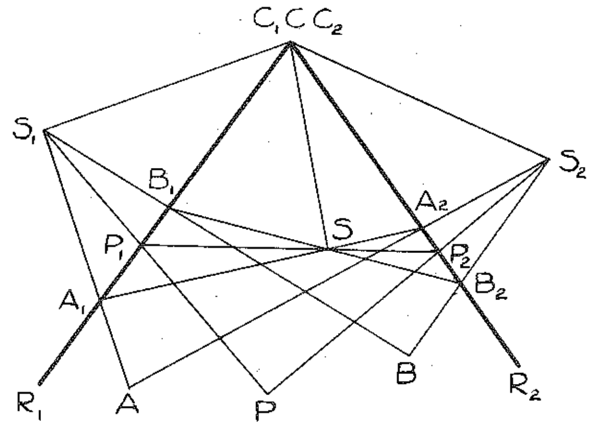
II. If two sheaves of rays are projectively related, corresponding rays will intersect in a conic (Figure 2). The conic will contain the points of support S_1 and S_2 of the sheaves. This is a standard proposition of projective geometry.



$S_1 \overline{\wedge} S_2$

Fig. 2

Thus in Figure 1 corresponding rays of S_1 and S_2 will intersect in a conic. This is shown in Figure 3. For clarity only two of the original pairs of rays are shown. Thus ray s_1A_1 corresponds to ray S_2A_2 and they intersect in A, which is a point on the conic.



$S_1 \overline{\wedge} R_1 \overline{\wedge} S \overline{\wedge} R_2 \overline{\wedge} S_2$

Fig. 3

If any new ray from S_1 is drawn to intersect R_1 in P_1 we may draw P_1S to intersect R_2 in P_2. S_2P_2 will then be the corresponding ray to S_1P_1 and will intersect it in a point P on the conic.

Now if we draw S_1C_1 to R_1 at its point of intersection with R_2, then C_1S will intersect R_2 in C_2 coincident with C_1 and the corresponding rays S_1C_1 and S_2C_2 will establish C also at the intersection of R_1 and R_2. Thus this point of intersection C itself lies on the conic. Hence R_1 and R_2 must be chosen through a given point on the conic.

III. Now suppose we are given 5 points S_1, C, S_2, B, A through which to draw a conic (Figure 4). We may choose S_1 and S_2 as sheave centers and draw two random lines through C to contain the point rows R_1 and R_2.

Now if we can establish a projective relation between sheaves of rays through S_1 and S_2, they will intersect in a conic. In particular, if we make corresponding pairs of rays intersect at A and B, the conic will be the conic through the 5 given points.

To do this we draw AS_1 intersecting R_1 in A_1 (Figure 3) and AS_2 intersecting R_2 in A_2. Similarly, we draw BS_1 and BS_2 establishing B_1 and B_2. Now, for the sheaf at S_1 to be projectively related to the sheaf at S_2, they must be tied together through a third center S. Furthermore, S must lie on A_1A_2 and on B_1B_2 and thus at their intersection. This establishes S and consequently the chain $S_1 \overline{\wedge} R_1 \overline{\wedge} S \overline{\wedge} R_2 \overline{\wedge} S_2$. Then to find any other

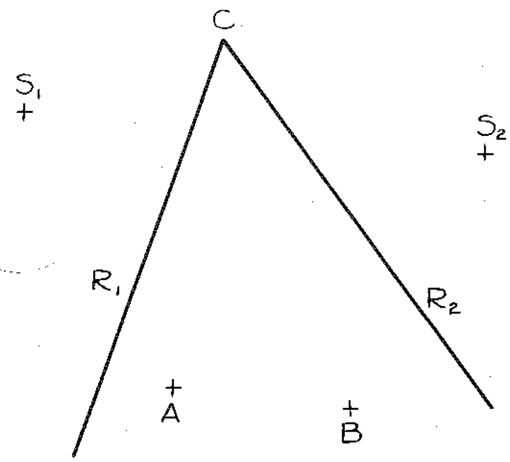


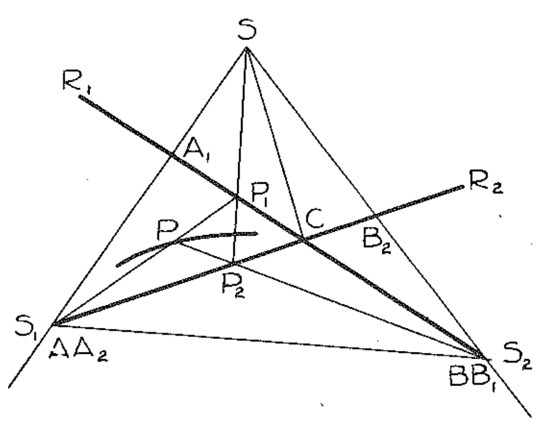
Fig. 4

point on the conic we draw a random ray from S_1 intersecting R_1 in P_1. We then draw P_1S intersecting R_2 in P_2. This establishes S_1P_1 and S_2P_2 as corresponding rays which will intersect in a point P on the conic.

IV. The only restriction on drawing R_1 and R_2 is that they must intersect in a point on the conic. We may, therefore, draw R_1 through C and S_2 and R_2 through C and S_1. The determination of S and any 6th point on the conic would be as before.

Then if we let A approach S_1 along the conic until they coincide, the line AS_1 becomes the tangent to the curve at S_1. Similarly, if we let B approach S_2, the line BS_2 becomes the tangent at S_2. We then have two point tangents and a point to establish the conic (Figure 5).

To draw the curve we proceed as before to establish our projectively related chain. To determine S we draw AS_1 (the tangent) intersecting R_1 at A_1, then AS_2 intersecting R_2 at A_2 or coincident with A. Thus A_1A_2 coincides with the tangent AS_1 and thus S lies on it. Similarly S lies on the tangent BS_2 and consequently at the intersection of the two tangents. Any 6th point P on the conic is determined as before: draw a random ray through S_1 intersecting R_1 at P_1. Draw P_1S intersecting R_2 at P_2. Then S_1P_1 and S_2P_2 intersect at P on the conic.



$S_1 \;\overline{\overline{\wedge}}\; R_1 \;\overline{\overline{\wedge}}\; S \;\overline{\overline{\wedge}}\; R_2 \;\overline{\overline{\wedge}}\; S_2$

Fig. 5

V. With this we have established a basic procedure for constructing conics from points and tangents. It should be noted that in every case the construction can be carried through by the use of a straight edge only.

Keeping the simplified pattern of Figure 5 in mind, let us consider some standard problems.

1. Given the major axis of an ellipse and a point C on the ellipse (Figure 6).

Since we may draw the tangents at the ends of the major axis, we have the same two point-tangents and a point as found in Figure 5. In this instance S, lying at the intersection of the two tangents, is at infinity.

To find any new point on the conic we proceed as before, drawing S_1P_1, then P_1S to find P_2, then P_2S_2 to establish P where it intersects S_1P_1.

2. Given the major and minor axes of an ellipse. This is a special case of the preceding problem with C lying at the end of the minor axis.

3. Given the transverse axis and a point on an hyperbola (Figure 7). Since the tangents at the ends of the axis can be drawn, the problem is the same as problem 1, except that the point C lies outside the tangents. The construction is the same.

4. Given the axis, the vertex and a point C on a parabola (Figure 8). Since a tangent may be drawn through the vertex, we may take the vertex as S_1. Since the parabola may be considered as an ellipse with one end of the major axis at infinity, S_2 lies at infinity along the axis, and the tangent through it will be parallel to that through S_1. S lies at the intersection of the tangents or at infinity perpendicular to the axis. The construction is the same as before. Note that this is the standard parallelogram method for constructing a parabola!

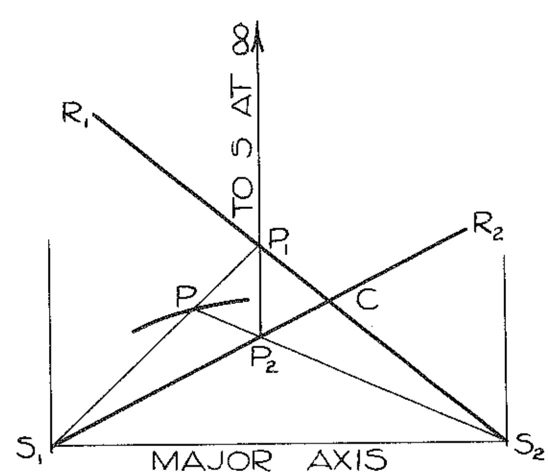


Fig. 6

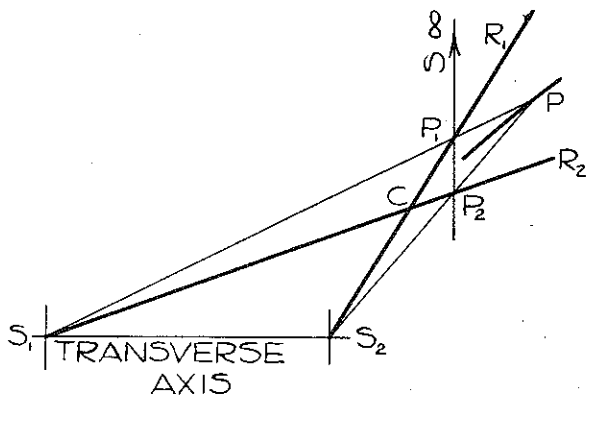


Fig. 7

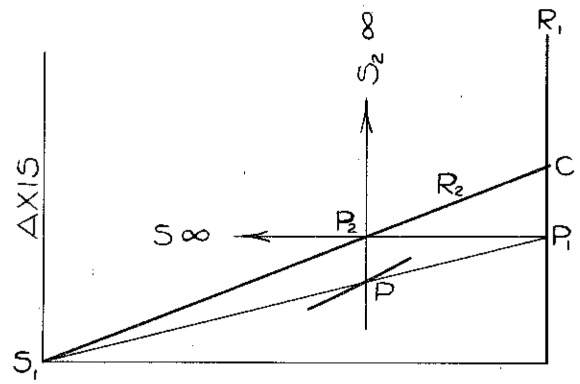


Fig. 8

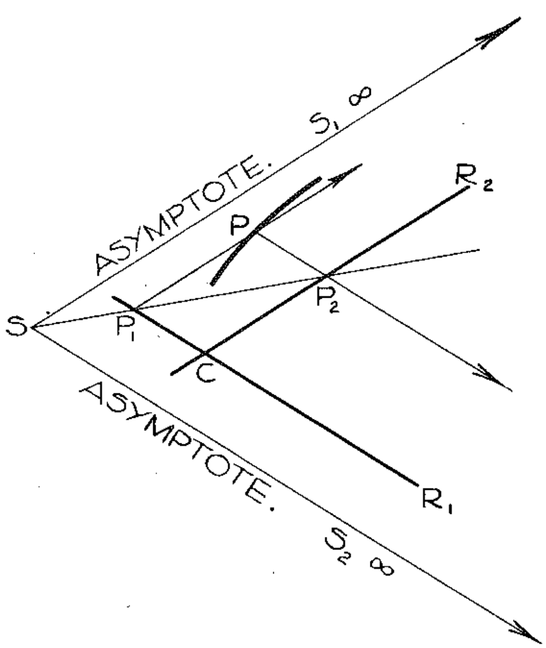


Fig. 9

5. Given the asymptotes and a point C on an hyperbola (Figure 9). Since the asymptotes are tangents at infinity, S_1 and S_2 are at infinity and S lies at their intersection. The construction for additional points is the same as before.

Note that the construction of a rectangular hyperbola having the X and Y axes as asymptotes is a special case of this problem.

6. Given a pair of conjugate axes of an ellipse (Figure 10). We may use the two tangents at the ends S_1 and S_2 of one axis and the point C at one end of the other. We might proceed as before by drawing R_1 and R_2 through S_2 and S_1 respectively. However, to make the construction conform to the standard parallelogram construction, we will abandon our exact analogy to Figure 5 and draw R_1 and R_2 parallel to the conjugate axes. We must then determine the location of S.

Since AS_1 intersects R_1 at ∞ and AS_2 intersects R_2 at ∞ both A_1 and A_2 lie on infinity. Thus S lies on the line at infinity. BS_1 intersects R_1 at B_1. BS_2 intersects R_2 at B_2. Since B_1B_2 is the diagonal of the parallelogram, S lies on this diagonal at ∞. To determine any

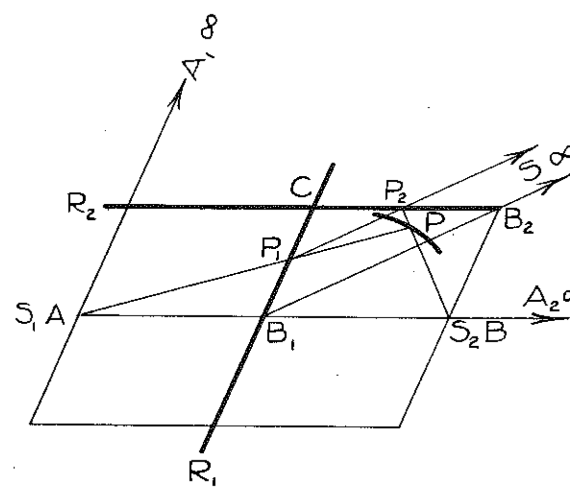


Fig. 10

further point on the conic we proceed as before. Note that this is the standard parallelogram method. The location of S at ∞ along the diagonal serves to divide R_2 similarly to R_1 by proportional division.

The foregoing examples serve to indicate the generality of the method. By means of it we have tied together as one construction many of the standard but apparently unrelated conic constructions. Furthermore the construction having a projective base requires the use of only a straight edge since it is completely non-metric in nature.

Only one point has been obtained in the figures. However, in every instance the entire curve can be obtained. We have in general taken R_1 and R_2 through S_1 and S_2 but this need not be done. It is interesting for instance to construct an ellipse from the major and minor axis by drawing any two random lines through the end of the minor and calling them R_1 and R_2. This gives some notion of the wide range of the construction. The entire theory is an excellent example of the power of projective notions.

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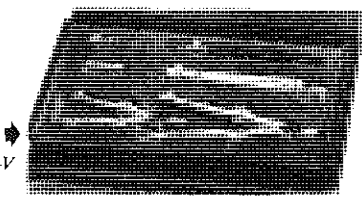

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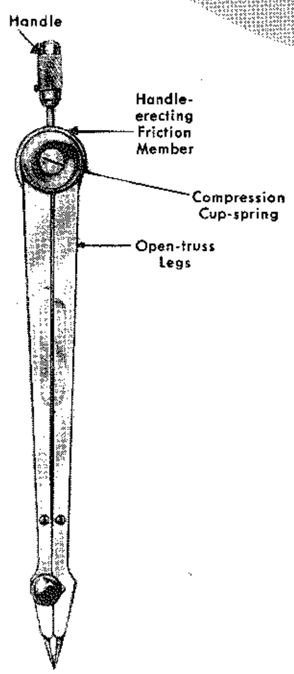

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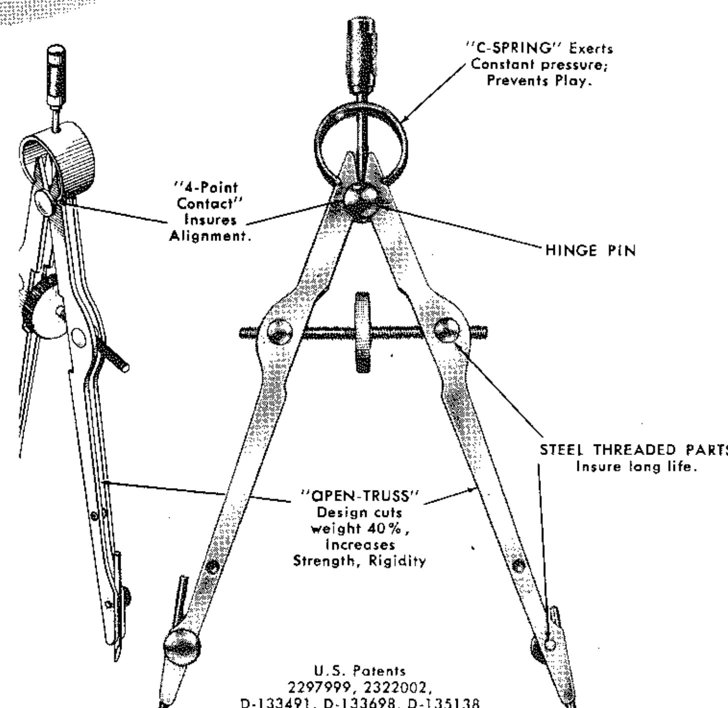

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COURSE DEVELOPMENT IN ENGINEERING DRAWING TO MEET THE NEEDS OF PRESENT DAY ENGINEERING EDUCATION

by

Professor Ralph S. Paffenbarger
Ohio State University

Nothing is static in our world. Fortunes fluctuate; riches take wings; those who are up today may be down tomorrow. Speaking as individuals, someone has said that by the time you are rich enough to sleep late, you're so old you wake up early every morning. Another has put it; by the time you are important enough to take two hours off for lunch, the doctor limits you to a glass of milk. Very few of the engineering drawing departments in the colleges and universities throughout this country have been static. Our courses have been continually changed to meet the progressive needs in engineering.

The Engineering Drawing Division of A.S.E.E. was the first group to recognize the need for specialized effort in keeping abreast of the progressive development in our field and meeting the training requirements for this work. This year we are celebrating the twenty-fifth anniversary of our establishment. There has never been any question of our sincerity of purpose and our concentrated efforts in better preparing ourselves to do a more finished job in educating engineers to supply the needs of industry. Certainly, we must have been on the right track, for today there are twenty-one such divisions in our parent society. We, likewise, were among the first to hold a Summer School for further broadening the members of our division, and last summer we held our fourth such school at Michigan State College in East Lansing, with over 200 attending. Here again, the importance of this endeavor is being recognized by other divisions, and an average of three divisional summer sessions a year are now being held at the time of the annual meeting of the Society.

In 1900, Ira O. Baker, President of the Society for the Promotion of Engineering Education, in his presidential address, "Engineering Education in the United States at the End of the Century," was concerned with the introducing of the humanistic courses into the engineering curricula.

It is gratifying to know that today through years of concentrated effort we have eventually accomplished this early suggestion, and the outstanding technical schools of the country have added from 20% to 25% additional training in the humanistic-social studies. The manner, however, in which these curricula changes have been made as well as their lack of uniformity throughout the country is alarming. To me it is obvious that you can't cut 1/5 to 1/4 of the technical content of any curricula in order to include these non-technical electives and still improve the professional training of our students without lengthening the period of study. The 5-year program is the only adequate solution, and I feel that those schools which have adopted this program need no longer apologize for such improvement. Unquestionably a good 5-year program is better than any good 4-year program. If we look at the training in other professional colleges, we find few 4-year programs. It takes five or more years in Pharmacy, Law, Veterinary Medicine, Dentistry, or Medicine to acquire the professional degree. These fields have constantly upgraded their professional standards since they have found it necessary to develop additional training skills by the interjection of more work rather than decreasing the time of basic courses. Schools of architecture and landscape architecture were the first of our close associates to adopt almost universally the 5-year program.

Being curious by nature and extremely interested in the engineering teaching profession, I have, in the past few years, talked with many members of our Society, from all parts of the United States regarding the curricula changes which I have just been discussing. Some of these educators have expressed the feeling that their schools have not changed to a 5-year program because of a fear that X University, fifteen miles across the city, or Y University, seventy-eight miles to the south, would attract their potential students. What an amazing conclusion! What a selfish motive! How can we expect to strengthen our engineering educational program with such thinking?

Actually, according to Engineering Enrollments[1] there has been no greater loss of students in the 5-year program than there has been in the 4-year. Of course the high school graduate will consider the advantages and disadvantages of the 5 and 4-year programs in his selection of a university.

STUDENT BACKGROUND

We are all aware of the faulty background of our beginning students, particularly in mathematics and physics, not to mention drawing, which is much more limited and comparatively weaker than the math and science group. I have checked admissions in the College of Engineering at my school for the past five years and find the following deficiencies in credits for admissions: 15% lacked advanced algebra; 5%, lacked plane geometry; 28% lacked solid geometry. This means that these students are delayed a quarter or more before they can take a full schedule in engineering. In other words, they are handicapped at the start.

Observations have shown that the majority of entering freshmen who have had high school drawing have found it of little help to them in their first quarter of college engineering drawing. There are exceptions where students have come from technical high schools and large city high schools where better instruction is offered, and where the student has had better instruction and equipment.

In gathering material for this paper, I had some very interesting discussions with my friend and neighbor, Dr. Clyde Hissong, former Dean of Education at Bowling Green State University, and now State Director of Education for the State of Ohio. Among other things which I have discussed with Dr. Hissong is the matter of cooperation between Engineering Colleges and Secondary Schools,

[1] Journal of Engineering Education, February, 1952.

a subject which was proposed for consideration by Dean Hollister to the Executive Board and General Council of A.S.E.E. Our endeavor for cooperation is not new to our own state department. Almost every pressure group that has a current manpower shortage is competing with each other to acquire a share of the graduating high school seniors. These groups are attempting to alleviate such shortages as teachers, nurses dentists, aviation trainees, and others.

Most of us are familiar with the type of courses that our high schools offer. We know that certain pressure groups influence these high school curricula, demanding large doses of Civics and American History, etc. We have attempted to help the teaching of mechanical drawing by trying to interest the high school teachers. We have always invited these high school teachers to our summer school and have had limited response. A small number of high school teachers subscribe to our Engineering Drawing Journal. What the A.S.E.E. should do, according to Dr. Hissong, is to go to the secondary teachers' meetings with our vocational folders. Innumerable groups do this and establish vocational organizations within the high schools, such as F.T.A. (Future Teachers of America), F.F.A. (Future Farmers of America), etc. Neither the teachers nor the schools will come to us; we have to go to them. In addition to giving this information, we should also prepare a brochure for prospective engineers and send it to Vocational Guidance Directors for distribution to all high schools. This should be a folder with information written in a clear and forceful manner on the prerequisites necessary for engineers, and on the advantages of a career in engineering. Let's put specific material into the hands of the students.

With the current shortage of students we are in competition with the other colleges (Arts, Education, Commerce, etc.) for the college-bound high school graduate. It should not be our desire to attract those with little or no engineering potential, and yet, we want the student whose interests and capabilities indicate an engineer in the making. However, just as we desire to attract such a select group, so too must the student, and his parents, be attracted by what we have to offer. What do we have to offer--an engineering degree which will provide the student graduate with a broad humanistic and technical base upon which to build his future.

Now, as engineers, we know what a firm foundation is necessary if we are to build successfully. Certainly one of the fundation stones, no matter in what nation we teach, is an academic knowledge of the common language of the people. Engineers, however, have in addition to the peoples' mother tongue, the international language of graphics. Here is a foundation stone of great significance, a form of communication which is universally understood.

OUR GRAPHIC LANGUAGE

It is needless to recount the development of the graphic language because of our familiarity with this interesting history. The ancient Egyptians developed their hieroglyphics so that the workmen of the era could fashion stone, metal, wood and cloth into goods and structures. And we have followed their lead with our methods of expression, advancement in design, and general utilization of the forces and materials of nature for the production of world goods which have resulted in constant improvement in the machines, structures, and complex productions of the day. As we have progressed in the past, so are we to progress in the future.

As has been frequently mentioned, the engineer's graphical expression has been the very means of our advancement from a simple existence to a cultured outlook. All that the past has yielded has first been recorded graphically. All that the future holds in recording our scientific development will be first produced on the drawing board. No short cuts for complete recording of ideas have been devised. It has never been possible to transfer such communication skill to the machine. True, we have instruments and equipment to aid and speed us in our work, and are constantly trying to improve our methods in accomplishing our recorded expression.

ADEQUACY OF TIME

Frequently, misunderstanding arises from people following the wrong suggestions. Too many articles incorrectly presented have had a powerful tendency to misdirec. some of our colleagues. I am reminded of the two headlines that appeared in a certain issue of a western paper. These headlines, in bold face type, referred to articles in the right and left columns. On the first line appeared the following: "3000 Chickens Stolen", and on the second line, "Democrats Hold Big Chicken Dinner."

Engineering Drawing and Descriptive Geometry today are just as important to an engineer as they ever have been. A reduction in time and credit has come about in many schools through some of the following causes:

1. Squeeze-out due to lengthened program without increasing the time of instruction. It has previously been mentioned that time should be extended from four to five years in order to properly cover the basic material so essential to an engineer's professional development.

2. Insufficient understanding by those in charge of curricula of the usefulness of the graphic courses. This can be remedied by educating the persons involved on how the engineering drawing courses have been progressively changed in order to keep abreast of the demands of industry.

3. Lack of progressiveness in a particular department of engineering drawing to keep abreast of the times with their courses and methods of instruction which should be remedied by adopting corrective measures rather than eliminating the program.

Basic drawing and descriptive geometry courses should constantly be improved to meet the needs of present day industrial practices. These should be designed so as to intelligently interpret the existing standards and latest fabrication and assembly methods in all fields of engineering.

NEED AND VALUE OF ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY

I could fill several pages with testimonials on the value of engineering drawing and descriptive geometry, obtained from the many industrial chief engineers, chief draftsmen, and engineering executive with whom I am associated in the American Standards Drawing and Drafting groups. Likewise, I could extract from my files many letters of appreciation from former students, but rather than draw on these I would like to quote from an article written by the late Dean Charles E. MacQuigg, former Dean of Engineering at Ohio State University and past President of the American Society for Engineering Education in 1948.

Dean MacQuigg was one of the foremost authorities on Engineering Education, a metallurgical engineer of great vision and high accomplishments in the research field.

His article appeared on the T-square Page in the September issue, 1949, of the Journal of Engineering Education, and is as follows:

"I think that engineering drawing is one of the most important subjects of the curriculum in the education of the engineer, for several good reasons. Among them are:

"a. It is an indispensable tool for the engineer throughout his life, even if he never practices engineering. How many times has one been delighted with an accurate, easily understood sketch of a wholly non-engineering subject and quite removed from all technical atmosphere? It can be made to supplant many lines of written description--may even be read and understood by one with no medium of spoken words.

"b. It is incomprehensible how one can gain any knowledge of science and engineering without the use of proper diagrams, drawings, sketches, etc., to say nothing of mapping. We can imagine commerce getting along without shorthand, but not engineering work without drawing!

"c. Coming early in the various curricula, drawing serves to bring the new student close to a realization of his objective in trying to fit himself for his career. Possibly many teachers of engineering drawing do not realize the special opportunity they have in beginning to nurture this idea of "career" in the beginning student. Particularly is this true if the teacher can draw from his own experience as an engineer and point up his dicta by apt references to the usefulness of the work as it unfolds.

"d. One of the most helpful attributes of a properly taught course in engineering drawing is that of discipline. If I may be pardoned a personal reference, engineering drawing was one of the most difficult subjects I had in my college work; not because I did not understand it (with reasonable diligence, even descriptive geometry made good sense to me) but it was the necessity of being neat and accurate! My own clumsiness was more difficult than the ideas of "upness and downness, frontness and backness, rightness and leftness." But I was compelled (and I mean with a capital C) to learn to start and stop at the right place! Since we must all agree that discipline is a watchword in the education of the engineer, I don't know of a better place to include it than in the drawing room."

OBJECTIVES

In this quotation, Dean MacQuigg expressed some of our engineering drawing objectives. All of these objectives lead each student toward an adult lifetime of service to himself and his fellow man. Perhaps one of the more important items is that phase of our work which assists the student in developing his "power to visualize" through logical conclusions, based upon accurate observations and orderly thinking.

Another objective, from a generation ago, but certainly keeping pace with our times, is the broadening experiences of the association of all engineering students with specialists in fields other than their own. This applies to faculty as well as students. Broadening is only partially done within the engineering college. Added to this type of broadening is the increasing philosophy of engineering educators to concern themselves with the broadening courses outside their field.

The fundamentals of our courses have not changed. Orthographic projection remains the standard for shape description, and problems of space geometry are solved through its use. The details, however, must be altered as the storehouse of engineering knowledge becomes better stocked. The development of our engineering drawing courses, therefore, parallels the advances made in the engineering industries. Together with industrial executives, members of this division have constantly worked for the improvement of the American Standards. As these improvements are presented, they are included with the reasons for such changes in our courses of instruction. Surely here is a procedure that allows the student to acquire some appreciation of today's engineering problems.

Engineering drawing is too often thought of primarily as a course in learning how to draw, i.e., manipulating a T-square, triangles, and drawing instruments. These instruments are merely the tools for expressing the ideas to be recorded but the subject is, in fact, a means of acquiring the power and habit of exact thinking, that most difficult of all habits to fix. It develops the constructive imagination and the perceptive ability which enables one to think in three dimensions. It enables one to visualize quickly and to build a clear mental image accurately. The ability to perceive mentally, the skill to record the visualized impression accurately, and the talent to progressively increase in speed and lettering proficiency are the essential requisites for exact expression. Following adequate training in shape description and size description, useful drawings are then produced in the form of working drawings.

Once the student has mastered the fundamentals of orthographic projection, our objective is to employ these principles in the solution of space problems--a preliminary step to three dimensional design. In descriptive geometry, we further develop the student's power to analyze, ability to reason clearly, and logic of simplification; thereby, allowing him to solve a problem with the greatest graphical reliability.

Just as descriptive geometry may be considered the graphical counterpart of solid geometry, so too, the other mathematics courses have their graphical parallels. Our objectives here require us to acquaint the students with corresponding drawing board solutions; for graphics and mathematics are as two eyes, each capable in itself, but immeasureably better when paired.

Most engineering measurements are recorded on graphical devices, and their conversion to numerical data is limited by the accuracy of the measurement scale.

Graphic solutions are recognized as correct only to the degree of exactitude of the drawing. In comparison to algebraic methods, they may be refined to limits well within the physical-strength-factor variation of most materials, and in many instances are closer to being exact than the theory on which the design formula depends. The graphical method is oftentimes the preferable method, is a checking medium, requires less time, is more easily interpreted, and often reveals some hidden relationships.

If the aircraft industry can solve graphically the contours of a fuselage to tolerances of one thousandth of an inch, there can be little doubt as to the practical application of graphics. Similarly, in all branches of engineering there are many applications of advanced graphics and nomographic charts which should receive more emphasis.

CONCLUSIONS

With our educational objectives changed to meet the current needs of industry, we cannot adequately train engineers with less instruction. We have greater opportunities than ever before to improve our instruction. We have improved textbooks and workbooks, devised effective teaching aids, have consistently developed better course content through industrial cooperation, and have worked with industry in the preparation of American Standards reports. Research papers and reports on teaching methods, course content, etc., have been made available through our Journal of Engineering Drawing. Excellent material is now available on Graphic Methods. Better tests and test information to more accurately classify students have been prepared.

With these educational facilities for developing the constructive imagination; space visualization; systematic and logical thinking; accurate observation and habits of accuracy; neatness and skill, the cultural side of the work of a department of engineering drawing becomes a highly important factor in the training of the future engineer. When we add to these the practical aims included in the science of drawing, the knowledge and skill required in making engineering drawings, the ability to think on paper and solve problems graphically; the potentialities of our courses it would seem that Engineering Drawing cannot be equaled by any other fundamental subject in the curriculum of engineering education.

EDITOR'S CORNER

The EDITOR'S CORNER was initiated in our last issue with the idea in mind of presenting short items of general interest to our subscribers. It was started with the hope that most of the material for future issues would be furnished by you, our readers. Acceptable news items might consist of announcements of professional conferences or they might be just "chit-chat" covering professional achievements or interesting events in the lives of our associates. Humorous items related to our field of graphics will be welcomed. Between now and the time our next issue is sent to the printer sometime early in April your editor will expect to receive a goodly numher of news items. PLEASE GIVE.

If it is true that confession is good for the soul, the editor will feel better after an honest admission that this column was in truth created to fill a vacant corner on page 32 of our last issue.

It has now become apparent that almost anything can happen and usually does before an issue of our magazine is printed and in the hands of our circulation manager. Please bear with us and we will endeavor to give you a constantly improving magazine. We will try to get copies in the mail on schedule in spite of the exasperating things that can happen.

For Volume 17 we have selected a yellow cover. We hope that you will like our face-lifting job which is about completed. From now on we will devote our time to securing top rated material for our articles. If you have an urge to write please contact the editor.

On behalf of our readers your editor wishes to thank our colleague Professor Irwin Wladaver for preparing the index which was enclosed with your Journal. As you look it over, remember that it represents considerable work on the part of a truly active member of our division. The editor would also like to express your appreciation to Dean Saville for arranging for the publication of this much needed index by the New York University Press at only a token cost to the Journal. Because of this aid being given, the reader is receiving the index without extra charge.

The reader may be interested in knowing that industrial concerns are placing our Journal in the hands of many of their technical and scientific personal. For instance, the General Electric Company purchased forty extra copies of the November issue. These extra copies were purcbased in spite of the fact that the company pays for a number of subscriptions at each of their main plants. Our articles on graphical solutions are useful to them. It is our hope that we can continue to be of service to people in industry. We welcome their subscriptions.

The University of Maine, Iowa State College, and Ohio State University have joined Clemson College on the list of colleges having a one-hundred percent subscription record. Congratulations.


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MOTIVATION AS A TEACHING TOOL

by
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Seldom has the engineering drawing teacher a greater opportunity for accomplishment as when he is confronted with the problem of dealing with the "slow" student. This feeling of accomplishment - of a tough job well done - can be the most satisfying reward in the teaching profession. All too often the course material, in the form of lectures, demonstrations, and homework assignments, is carefully given out, but the student is left to sink or swim. If we do not give extra teaching effort to these few who sink we miss an opportunity of being not only of great service to this group, but also of great service to ourselves in achieving this self-victory in teaching.

Motivation is often the basic cause for a turning point. The poor student has no driving reason for applying himself, no will to learn, no determination. Many students have not been sufficiently encouraged to try their best. Others have never experienced the inner satisfaction of understanding; they have never tasted that sweet self-prestige. Some have acquired atrocious study habits - more do not really study at all. In every case talents can be brought to light that surprise tbe student and instructor alike.

All of us have had at one time or another a few such "slow" students in the class; in fact they can be recognized within a few class periods. In this respect we have one great advantage over our fellow teachers. The teacher of engineering drawing need not wait for the first examination to discover if he has left any students behind. Indeed, the first simple drawing executed by the student will expose his weaknesses. Immediately that extra effort should be put forth. The better-than-average student does not need your help at this time, but the below-average student quickly falls hopelessly behind. If patient, but firm, corrections and explanations fall on seemingly deaf ears, further attemps must be made. This is the time for an instructor and student to sit down together to painstakingly iron out the difficulty. Sometimes only one or a few such meetings may be necessary to reveal the principle missed. All too often the student himself must suggest that he see the instructor after class for further explanation.

Many students can be motivated by demands on their original and creative thinking. It is difficult to teach original thinking, but not impossible. Material can often be presented in a less conventional, more inspired fashion by touching on topics related to the subject at hand. Originality and imagination can be encouraged by a certain amount of flexibility in the problem layout and attack. Above all, a student should never be reprimanded for work that is not definitely incorrect.

Occasionally a student appears just not to be made of college material by our standards. If we can keep a true perspective, realizing that a student failing one course, can excel in another, then we can deny any suggestion of inherent inferior intelligence. Every instructor has witnessed that elusive "spark" that will suddenly change a dull plodder into a bright, eager student. We can all remember a repeater who does excellent work the second time around, when he really has the will to succeed, and we have all had experience with foreign students who must tediously overcome their language difficulties.

Unfortunate is the student who has the motivation to learn the subject matter, but has formed such poor study and note-taking habits that easy assimilation of the study material is impossible. For this category, a frank discussion of the pitfalls along the road to learning can be an invaluable aid. Many students do not realize how readily a subject can be mastered when the mind <u>and</u> body have favorable environments. Noisy surrounding - distractions of any kind - must be avoided. The ideal study condition is a not too comfortable, straight-back chair, together with a desk or table, proper illumination - not too glaring and not too low, and of course no radio. Study should be alone; review, with others. If the study foundations have been well laid, the review can be the most important and gratifying part of the learning process.

The memory can be trained by stopping at intervals during study, and recalling even the fine points. Difficult statements often become obvious when read aloud. Important words and sentences can be underlined; notes put in the margin. Although some material must be memorized, the majority will fall into such a natural sequence that it can be made a permanent possession by the application of the mind with some determination. Lord Halifax is reported to have said, "Education is what you remember after you have forgotten all that you have been taught". Emphasize that understanding is the requisite to memory.

A subject must be enjoyed to be mastered. Difficult indeed is the problem that is disliked, and a course that is distasteful soon becomes unbearable. It is the instructor's responsibility to transfer his enthusiasm for his subject to the student. Impress upon him the important part each subject plays in his engineering career, showing that every course has been chosen above hundreds of kindred subjects as being the one which will be the most meaningful to him in his chosen profession.

The helpful engineering drawing teacher must have a close relationship with the student if he is to serve the student's needs to the best advantage. Questions in the lecture should be encouraged, laboratory problems discussed thoroughly as they arise, and the instructor's free hours made available. A thorough answer to any question is mandatory. The instructor must take the greatest care that he does not, by word or deed, make himself unapproachable to the student. The day of the arbitrarily stern pedagogue is gone. In bis place has risen a more human counselor. Everyone in the business world, and especially the future engineer, must learn the proper relationship between employer and employee: kind, helpful guidance. The new engineering student has had virtually no industrial experience. Where else, but at the hands of a friendly teacher, can he find direction and motivation for himself? We, as teacher, are in the responsible position of starting every student on the right track toward his goal early, directly, and effectively.


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