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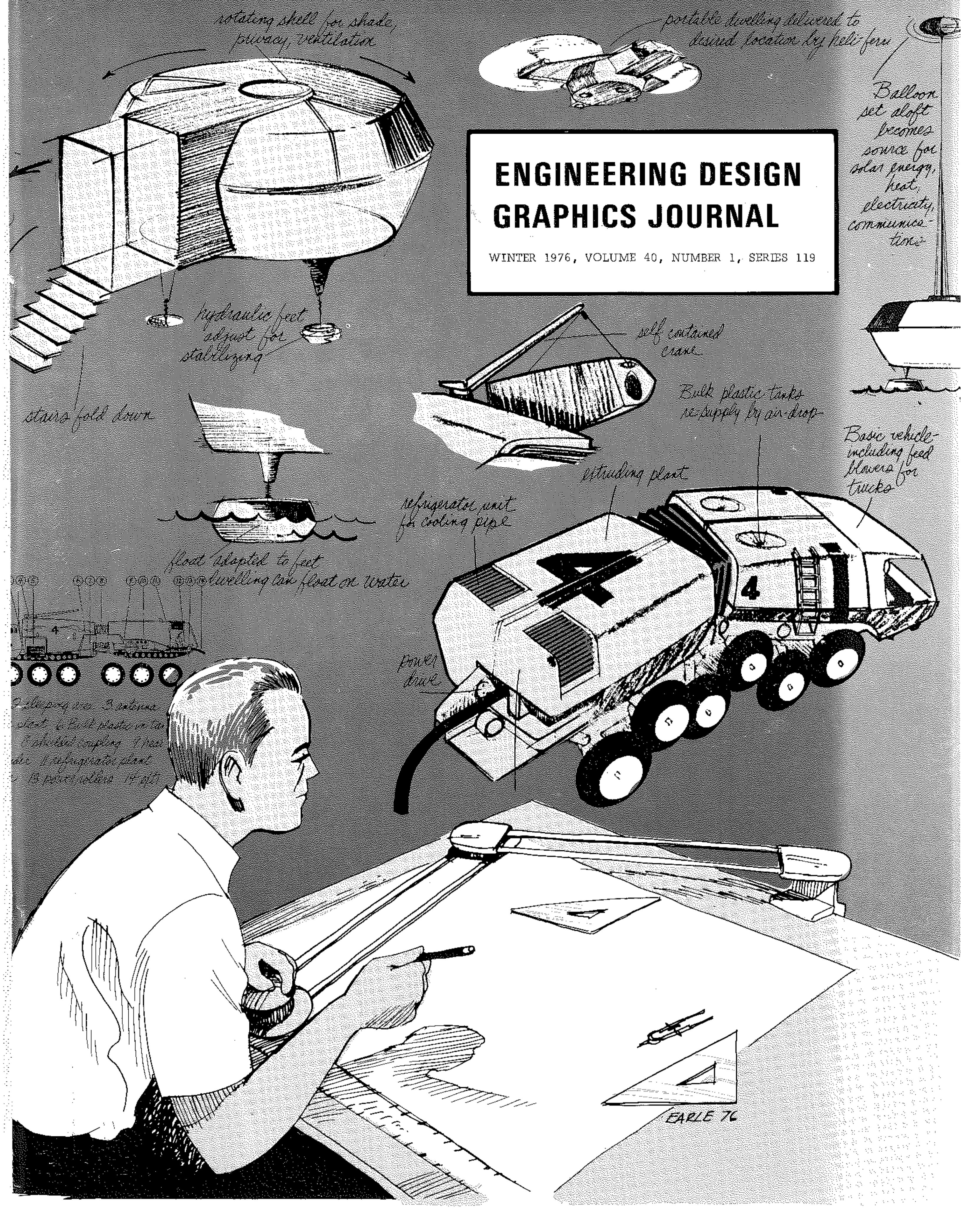
ENGINEERING DESIGN GRAPHICS JOURNAL

WINTER 1976, VOLUME 40, NUMBER 1, SERIES 119



JUNIOR COLLEGE GRAPHICS TEACHERS INVITED TO JOIN A.S.E.E. AND AFFILIATE WITH ENGINEERING DESIGN GRAPHICS DIVISION

The Engineering Design Graphics Division was organized in 1928 to promote a higher level of professionalism in engineering education. Now, almost a half century later, we find there is a need to redouble our efforts in this behalf. With greater emphasis being placed upon the significance of graphics in the educational program for engineers and technicians, we find there is a likewise need to upgrade our level of teaching. Today there is a shortage of teachers in the areas of design graphics and descriptive geometry. How well are you able to keep pace with the demands made upon you to more effectively teach design graphics in the presently allotted time?

The leadership within the Engineering Design Graphics Division is aware of the rapid changes occurring in the discipline of design graphics, and is taking steps to keep the teacher's effectiveness abreast of these changes.

Not only are we inviting you to join the Division, wherein you may work with the rest of us in these efforts, but also you are being invited to join with us in sharing your abilities to maintain a high level of professionalism in the instructional arena.

Membership in the A.S.E.E. is open to all individuals who are or have been actively engaged in any phase of educating engineers and technicians. If you wish to join our group, please fill out the application on page 47 and mail it to the A.S.E.E. office whose address is at the top of the form.

The Engineering Design Graphics Division is planning a three day World Congress for design graphics and descriptive geometry to be held in connection with the annual A.S.E.E. meeting either in 1977 or 1978. It is tentatively planned to invite a number of graphics professors from several foreign nations to participate in this meeting. We would certainly welcome your attendance. In fact, we would appreciate an immediate response from you if you are interested in such a meeting, and if there is a remote or definite possibility of your attending this meeting. Your response, in effect, will add your name to our mailing list and give us an idea of the interest existing among graphics teachers throughout the nation for such a program.

Respectfully,

Clarence Hall, Vice Chairman
of EDG Division
142 Atkinson Hall
Louisiana State University
Baton Rouge, La. 70803

WORLD CONGRESS

AMOGENE DEVANEY OF AMARILLO COLLEGE TO CHAIR PLANNING COMMITTEE FOR WORLD CONGRESS DEVOTED TO ENGINEERING GRAPHICS & DESCRIPTIVE GEOMETRY

The Engineering Design Graphics Division of ASEE is planning a World Congress devoted to the historical review of engineering graphics and descriptive geometry. A number of papers pertaining to the historical role of descriptive geometry in various engineering curricula of different nations will be presented. A special effort will be made to emphasize the significant role that descriptive geometry has had in the process of developing one's ability to visualize in three dimensions. This facility on the part of the engineer is essential for creative design work.

During the latter half of the 18th century France assigned her most scholarly men of mathematics, science and engineering the task of improving the development and applications of descriptive geometry. As one considers the rigor of this discipline he realizes that it offers a great intellectual challenge equal to that of other areas of mathematics. Despite the fact that much of the mathematical rigor has been deleted from the descriptive geometry classes taught by engineers, it remains the basic science of engineering graphics.

The Engineering Design Graphics Division welcomes the many graphics teachers of our junior colleges and other two-year institutions to participate in the World Congress. Not only do we invite you teachers as participants, but also, we welcome those who would like to present papers or serve as members of panel groups that are being organized.

The date of the World Congress has not been finalized as of this time, but further information may be obtained by writing the Committee Chairman whose address is:

Professor Amogene Devaney
Amarillo College
P.O. Box 447
Amarillo, Texas 79105

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

ENGINEERING DESIGN GRAPHICS JOURNAL

WINTER 1976 VOLUME 40 NUMBER 1 SERIES 119

TABLE OF CONTENTS

Engineering Design Graphics Journal

ENGINEERING DESIGN GRAPHICS JOURNAL is published - one volume per year, three numbers per volume, in Winter, Spring, and Fall - by the Engineering Design Graphics Division of the American Society for Engineering Education - for teachers of Engineering Graphics, Computer Graphics and Design Graphics.

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NOTE
The views and opinions expressed by the individual authors do not necessarily reflect the editorial policy of the ENGINEERING DESIGN GRAPHICS JOURNAL or of the Engineering Design Graphics Division of ASEE. The editors make a reasonable effort to verify the technical content of the material published; however, final responsibility for the opinions and the technical accuracy of each article rests entirely upon the author.

ENGINEERING DESIGN GRAPHICS JOURNAL OBJECTIVES:

The objectives of the JOURNAL are:

1. To publish articles of interest to teachers of Engineering Graphics, Computer Graphics and allied subjects.
2. To stimulate the preparation of articles and papers on the following topics (but not limited to them):
3. To encourage teachers of Graphics to innovate on, experiment with, and test appropriate techniques and topics to further improve quality of and modernize instruction and courses.

REVIEW OF ARTICLES

All articles that are submitted will be reviewed by several authorities in the field associated with the content of each paper before acceptance. Current, newsworthy items will not be reviewed in this manner, but will be accepted on the basis of the judgement of the editors.

DEADLINES FOR AUTHORS AND ADVERTISERS

The following are deadlines for the submission of articles, announcements, or advertising for the three issues of the JOURNAL:

Fall--October 1
Winter--December 1
Spring--February 1

STYLE GUIDE FOR JOURNAL AUTHORS

The Editor welcomes articles submitted for publication in the JOURNAL. The following is an author style guide for the benefit of anyone wishing to contribute material to Engineering Design Graphics Journal. In order to save time, expedite the mechanics of publication, and avoid confusion, please adhere to these guidelines.

1. All copy is to be typed, double-spaced, on one side only, on white paper, using a black ribbon.
2. Each page of the manuscript is to be consecutively numbered.
3. Two copies of each manuscript are required.
4. Refer to all graphs, diagrams, photographs, or illustrations in your text as Figure 1, Figure 2, etc. Be sure to identify all such material accordingly, either on the front or back of each. Illustrations cannot be redrawn; they are reproduced directly from submitted material and will be reduced to fit the columnar page. Accordingly, be sure all lines are sharply drawn, all notations are legible, reproduction black is used throughout...and that everything is clean and unfolded. Do not submit illustrations larger than 8-1/2 x 11. If necessary, make 8-1/2 x 11 or smaller photo copies for submission.
5. Submit a recent photograph (head to chest) showing your natural pose. Make sure your name and address is on the reverse side.
6. Please make all changes in your manuscript prior to submitting it. Check carefully to avoid ambiguity, to achieve maximum clarity of expression, and to verify correct spelling throughout. Proofreading will be done by the editorial staff. Galley proofs cannot be submitted to authors for review.
7. Enclose all material unfolded in large size envelope. Use heavy cardboard to prevent bending.
8. Send all material, in one mailing, to:

   James H. Earle, Editor
   Engineering Design Graphics
   Texas A&M University
   College Station, Texas 77843

CALENDAR OF ASEE ANNUAL MEETING
1976--University of Tennesee, June 14-17, 1976
1977-Fresno State College

CALENDAR OF MID-YEAR MEETING
1975-76--Arizona State University, Jan. 7-8, 1976
1976-77--Montreal, Canada

EDITOR'S PAGE

VOTE

A slate of candidates for the various offices of our Division is included in this issue. Each of these candidates is well deserving of the office for which he is running, having worked for the Division in many capacities in the years past.

Whichever of the candidates elected for these offices will serve well, insuring an active and healthy Division under their administration. However, the strength of our Division lies in active participation of its members in the voting for and supporting its officers. We highly recommend that you give thought to the candidates presented by your nominating committee, and vote for those of your choice.

Division elections in the past have not resulted in the voter turnout comparable to the size of our membership. Perhaps this means that our membership would be satisfied with any of the candidates who are placed on the slate. If this is the case, it is commendable that our Division has such equally talented candidates competing for each office.

On the other hand, it is more likely that our members are somewhat indifferent to each election. Please consider the work that must be performed by your Division's officers once they have been elected in comparison to the small effort involved in voting as an active member of the Division.

THANKS

During the last decade, the William C. Brown Company of DeBuque, Iowa, has been instrumental in saving our Division thousands of dollars by printing the Journal at the lowest cost possible. They have been providing this support since 1964 and charging the Division no more than their printing costs in return for one or two pages of advertising in each issue. During these past twelve years, they have printed approximately thirty-six issues of the Journal. The savings on this printing would be approximately $18,000 if the Journal was printed at the usual commercial rate.

Mr. Ed O'Neil, the production manager of the William C. Brown Company, has been very helpful in working with the past editors of the Journal. Even though there was no profit incentive, the Brown Company has given very prompt service in printing, labeling, and mailing the Journal.

We of the Division owe a debt of gratitude to them for the fine service that they have provided throughout these past years.

Jim Earle

Tools perspective

TECHNICAL DRAWING
Sixth Edition

The late *Frederick E. Giesecke*, the late *Alva Mitchell*, the late *Henry Cecil Spencer*, and *Ivan Leroy Hill*, Illinois Institute of Technology

Since its initial publication, ***Technical Drawing*** has been used by more than two and a half million students. The *Sixth Edition* retains the features that have made previous editions so successful while incorporating changes necessary to bring it completely up-to-date with the latest trends in engineering education and the newest developments in industry.

Drawing on their long experience, the authors have included all the fundamentals needed by scientists and engineers alike. The book gives your students detailed, step-by-step instruction in the principles of design and technical drawing. It emphasizes freehand technical sketching as an important means of communication. After an introduction to drawing fundamentals, essential lettering and layout techniques, material is arranged topically so that each chapter is a logical extension of information given in preceding chapters.

Several other significant changes have been made:

- A new layout using a two-column design allows easier reading and comprehension.
- A second color increases the text's visual attractiveness and vitalizes presentation of the material.
- The most recent American National Standards (ANSI 14) are followed in this edition.
- Several chapters have been extensively revised, including those on "Alignment Charts," "Empirical Equations," and "Graphical Mathematics."
- A number of drawings have been converted to the decimal-inch system now that it has come into extensive use in industry; many problems present an opportunity for the student to convert dimensions to the metric system; metric equivalent tables are included for this purpose.
- Because illustrations are so important in a book like this, the quality of the drafting and precision of the drawings in this edition are even more outstanding than in past editions. The new, large-page format has made possible improved and larger illustration placement.
- Many problems and illustrations have been revised to make them more contemporary.

1974

And, to help your students get the most out of *Technical Drawing:*

TECHNICAL DRAWING PROBLEMS, Series 1, Fifth Edition 1976

TECHNICAL DRAWING PROBLEMS, Series 2, Third Edition 1974

TECHNICAL DRAWING PROBLEMS, Series 3, Second Edition 1974

Keys to each series are provided *gratis.*

FUNDAMENTALS OF ENGINEERING GRAPHICS

***Joseph B. Dent, W. George Devens, Edward A. Bender, Frank F. Marvin,* and *Harold F. Trent,* all, Virginia Polytechnic Institute and State University**

Here is clear, concise and well-illustrated treatment of essential concepts of engineering graphics. Suitable for one- or two-term introductory courses, this textbook-workbook leads the beginning student from lettering, sketching, and pictorial drawing through use of instruments, scales (including metric) and geometric construction. Building on this foundation, the authors present orthographic projection and auxiliary views in a straight-forward, integrated manner. The progression from points to lines, then planes and solids provides the student with a "building block" approach to descriptive geometry or applied spatial relationships.

Vectors, intersections, developments, technical practices, working drawings, graphs, and graphical calculus complete the text portion.

Practical application of principles is emphasized in the 109 printed problems following the text. Problem sheets are arranged sequentially with the text material to permit variety in scheduling laboratory and homework assignments.

The *Instructor's Manual* is designed to assist the instructor in preparing complete course and lesson material adapted

for the professional

to his particular requirements. The manual contains a complete course outline and lesson plans (ninety one-hour periods) keyed to the text material. Complete solutions to problems are included.
1974

INTRODUCTION TO ENGINEERING GRAPHICS

George C. Beakley,
Arizona State University

Designed to meet the needs of today's condensed courses, ***Introduction to Engineering Graphics*** provides a concise yet comprehensive introduction to all aspects of engineering graphics.

The material has been carefully organized to allow the instructor maximum freedom in course planning. Coverage of drawing and graphics is complete in this timely book which contains over 600 line illustrations. Included are lettering techniques, sketching, measurement, dimensioning, graphics, graphical methods of analysis, principle and auxiliary views, geometric figures, intersections, descriptive geometry, and nomography. Valuable reference material on graphical constructions, symbols, measurements and units (including S.I. metric information), and parts specifications is included in the appendix.

A *Teacher's Manual* is available, *gratis.*
1975

DESIGN: SERVING THE NEEDS OF MAN

George C. Beakley,
Arizona State University, and
***Ernest G. Chilton,* Stanford University**

This exciting, unconventional new book will inspire and delight students as it introduces them to creative, functional design and its importance to man's well-being. A stunning, well-designed format complements and exemplifies textual content as this book explores man's unique capacity to solve problems through the design process.

Challenges facing the designer, new horizons in creative thinking, ingenious designs in nature, achieving pleasing aesthetic designs—these are some of the motivational topics that are discussed before the text explores design methodology.

The comprehensive content gives a complete and realistic view of the many fascinating possibilities of creative design and its practical applications.
1974

INTRODUCTION TO ENGINEERING DESIGN AND GRAPHICS

***George C. Beakley,* and *Michael J. Nielsen,* both, Arizona State University; and *Ernest G. Chilton,* Stanford University**

This exciting introductory text combines design and graphics in a modern, meaningful way, reflecting the current approach to teaching graphic skills. The use of models, materials and processes of design, decision processes, economic considerations, and design parameters for human satisfaction are explored in depth. Each chapter forms a separate "mini-text" complete with instructional material, bibliography, and problems, giving students in-depth coverage. Eight appendices offer a wealth of useful tables, graphs, and data. This is the only book that gives students an opportunity to learn the fundamentals of engineering design. A complete *Instructor's Manual* is available on adoption.
1973

Two excellent workbooks particularly coordinated with **INTRODUCTION TO ENGINEERING GRAPHICS and INTRODUCTION TO ENGINEERING DESIGN AND GRAPHICS are:**

GRAPHICS FOR DESIGN AND VISUALIZATION, PROBLEMS, SERIES A,
***George C. Beakley, Donald D. Autore,* and *John B. Hawley,* all, Arizona State University**
1973

and

GRAPHICS FOR DESIGN AND VISUALIZATION, PROBLEMS, SERIES B,
***George C. Beakley* and *Donald D. Autore,* both, Arizona State University**
1975

Macmillan

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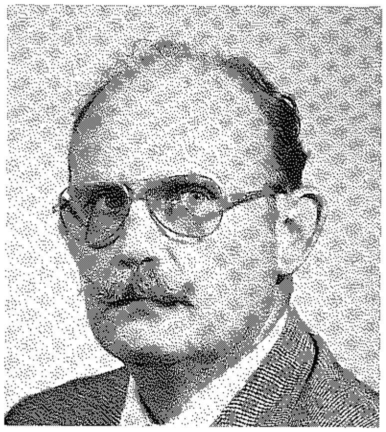


by Dr. Charles Cozzens
Memphis State University
Memphis, Tennessee

Graphic Integration of the Sine Curve

Those of us who are associated with Engineering Design Graphics and appreciate the value of graphic display are aware of the fact that mathematic functions may be, indeed long have been, portrayed graphically. We are equally aware that some are quick to point out that such graphic displays are, at best, imprecise representations of ideas. But regardless of how precise or imprecise a presentation may be, a graphic display remains a very useful tool for communicating mathematic concepts.

As an example of how a mathematic concept may be portrayed graphically consider the drawing shown in Figure 1. Here a circle of unit radius is shown along with any angle θ. Sin θ is shown as a portion of a chord of the circle and the cosine as a portion of a radius. By casually viewing this drawing anyone familiar with the trigonometry of a right triangle can understand the basis for certain trigonometric identities. As an example it is immediately understandable why

$$\frac{SIN\theta}{COS\theta}=TAN\theta$$

and why

$$SIN^2\theta+COS^2\theta=1.$$

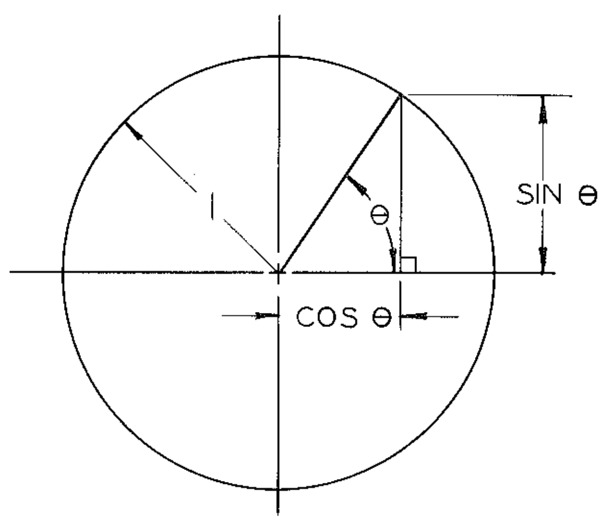


Figure 1: A circular path of motion that defines the relationship between the sine and cosine functions of θ.

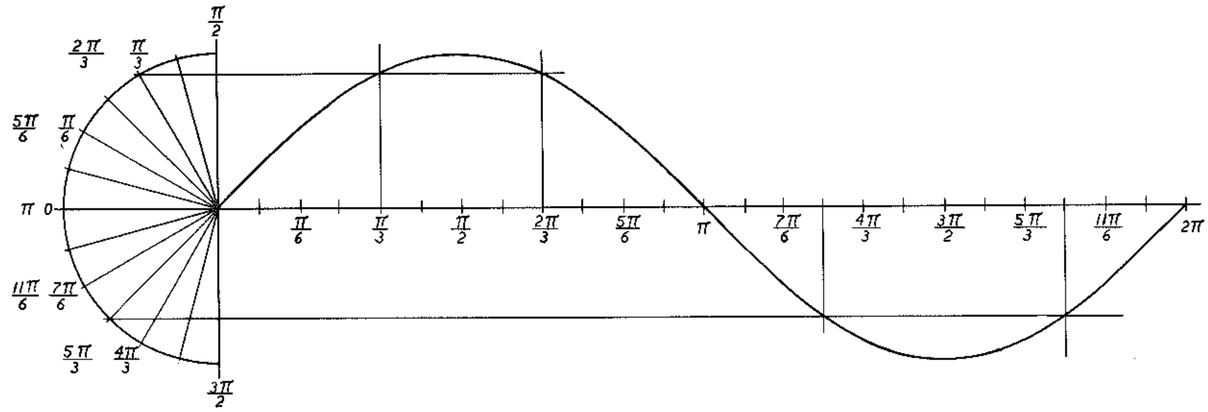


Figure 2: The generation of the sine curve.

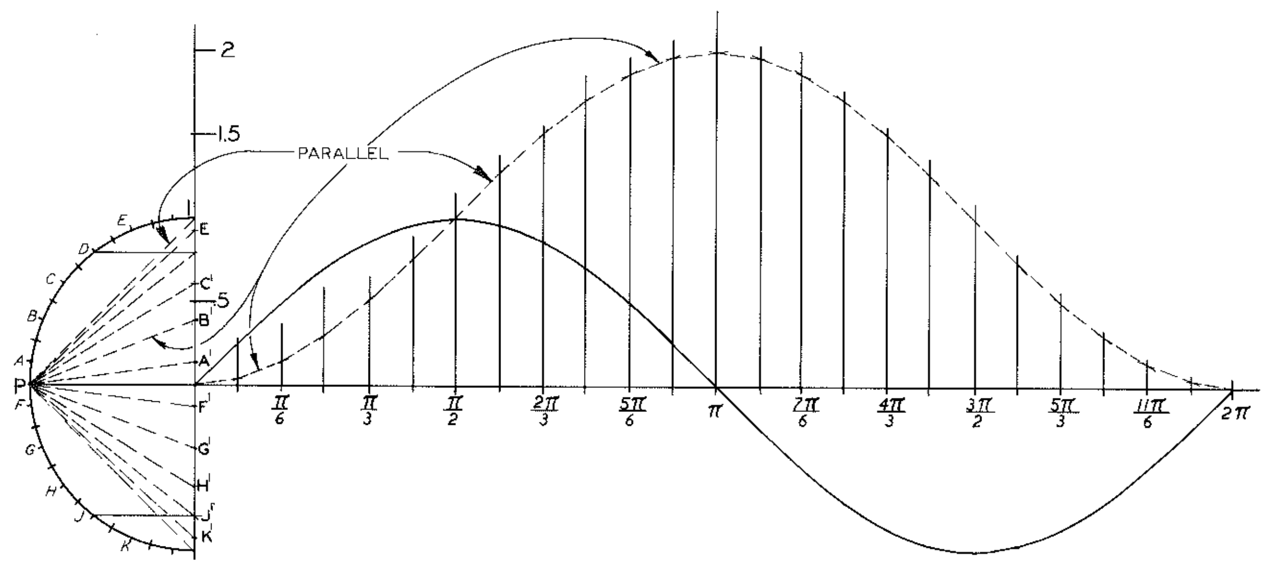


Figure 3: The integration of the sine curve.

Other relationships can be shown but such demonstrations are outside the purpose of this paper. This paper is intended to show how the unit circle can be used to generate a sine curve and then how graphical methods may be employed to integrate this function i.e. how the area under a sine curve may be found graphically.

First, to generate the sine curve consider the drawing shown in Figure 2. Recall that the circle is to be considered as having unit radius. Additionally, it should be pointed out that the divisions along the absissa π/12, π/6, etc. should be considered as accurate circumferential representations of the unit circle. Note that the projection from π/3 on the unit circle provides the value for the sine at that angle and also for 2π/3. Similarly, values for 15π/12 and 21π/12 are found from a common projection.

Figure 3 shows the basic approach to the graphic integration of the curve. Almost any comprehensive textbook on graphics offers discussion on this process. But while attempting this process for the first time the writer experienced some difficulty in locating pole point P. By self-imposed specification the writer elected to have the value of the integral curve to be read on the same scale as the value of the Sinθ. This decision made the location of P very critical inasmuch as this location affects the scale of the ordinate on which the integral is to be read. Let it simply be stated that after some ex-

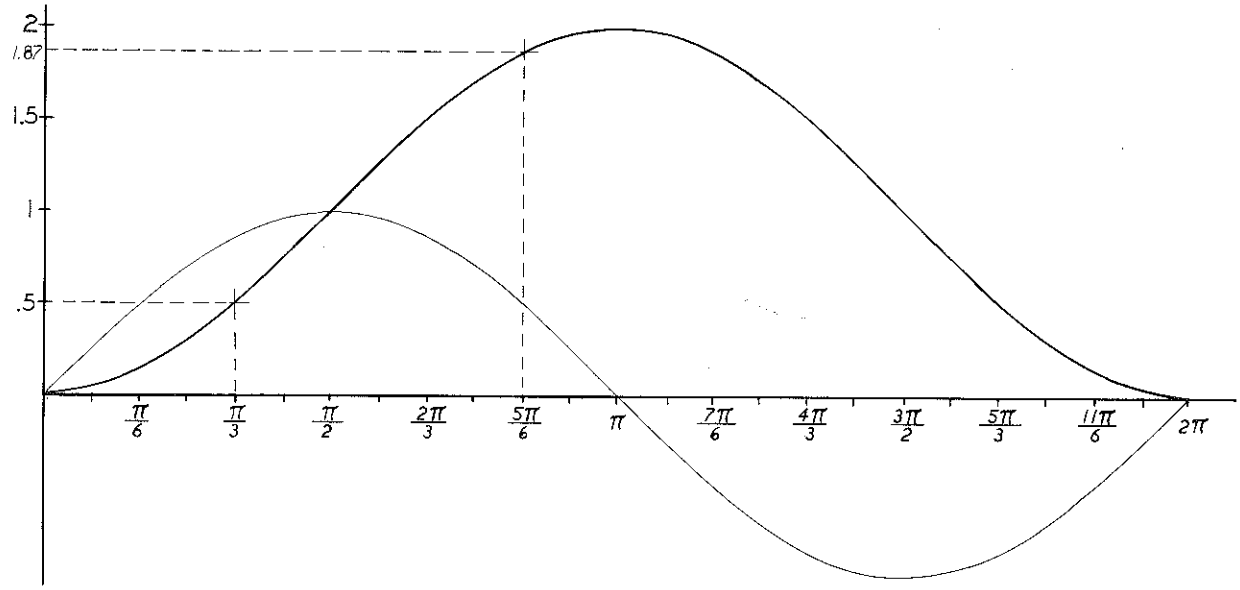


Figure 4: The integral curve and the original curve.

perimentation it was found that P could be located one radius away from the origin of the sin curve or at the intersection of the unit and the absissa. This is at -1 on the absissa.

After locating P, points A, B, C, etc. are located at midpoints between 0 and $\pi/12$, $\pi/12$ and $\pi/6$, $\pi/6$ and $\pi/4$ and so on. These points are projected orthogonally to the ordinate to locate A', B', C' etc. and the rays or strings P-A', P-B', P-C', etc. are drawn.

Next, a string is drawn parallel to P-A' from the origin of the sine curve and terminated on an ordinate drawn from $\pi/12$. From this point a string is drawn parallel to P-B' to intersect the ordinate drawn from $\pi/6$. Figure 3 shows the parallelism of P-B' and the strings between $\pi/12$ and $\pi/6$ and between $5\pi/6$ and $11\pi/12$. It should be noted that the string P-1 spans two spaces on the integral curve; i.e. from $5\pi/12$ to $7\pi/12$. After the complete set of strings has been established a uniform curve is drawn so as to pass through the various points located by the intersections of the strings and the ordinates. Figure 4 shows the completed integral curve and the original sine curve. But it is yet to be shown that this curve can be used to determine the integral between two limits.

To consider this problem let it be required that the integral curve be used to determine

$$\int_{\frac{\pi}{3}}^{\frac{5\pi}{6}} \text{SIN}\theta\alpha\theta$$

From Figure 4 it may be shown that the integral value for $5\pi/6$ is approximately 1.87 and for $\pi/3$ it is approximately .5. Subtracting the latter from the former it is found that area under the sine curve between the stated limits is approximately 1.37 units. This answer compares rather favorably with the mathematic solution if the reader cares to check.

Integrals of the sine curve which start at zero may be read directly from the integral curve without subtraction. As an example

$$\int_0^{\frac{\pi}{3}} \text{SIN}\theta\ \alpha\theta = .5$$

may be determined from Figure 4 by reading a value of .5 on the absissa corresponding to $\pi/3$. No subtraction is necessary in this case since the integration starts at 0.

Another example of this graphic technique is offered in Figure 5. There the fundamental steps for the

$$\int_0^{\frac{5\pi}{12}} \text{TAN}\theta\ \alpha\theta$$

are illustrated. The limit of $5\pi/12$ was arbitrarily selected because the tangent of an angle larger than this is inconvenient to deal with graphically and indeed finally becomes infinitely large.

This example may be used in the same manner as the graphic integration shown in Figure 4. The reader may choose to test the integral curve bearing in mind the limits of graphic accuracy.

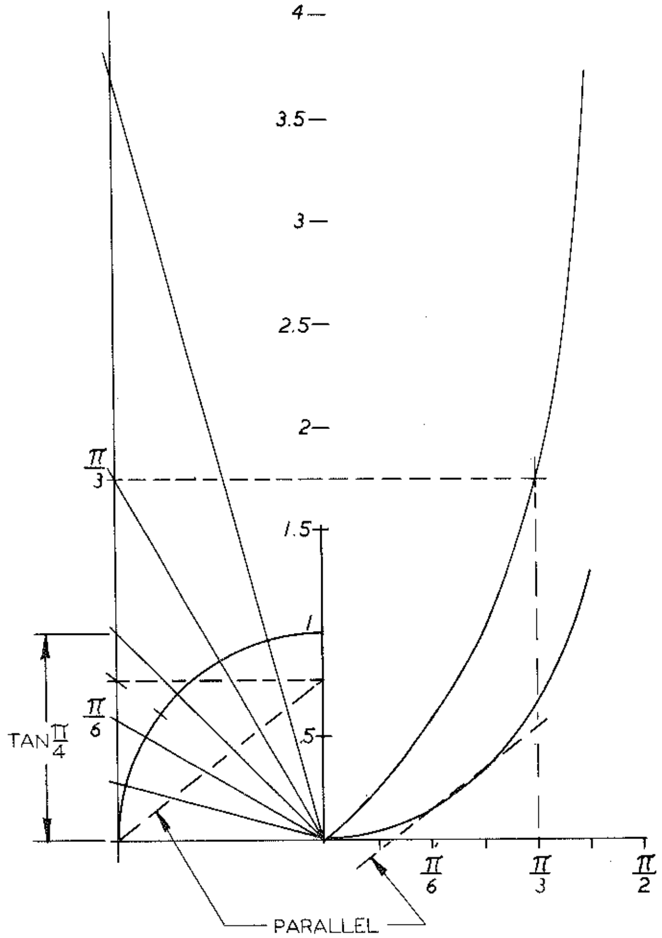
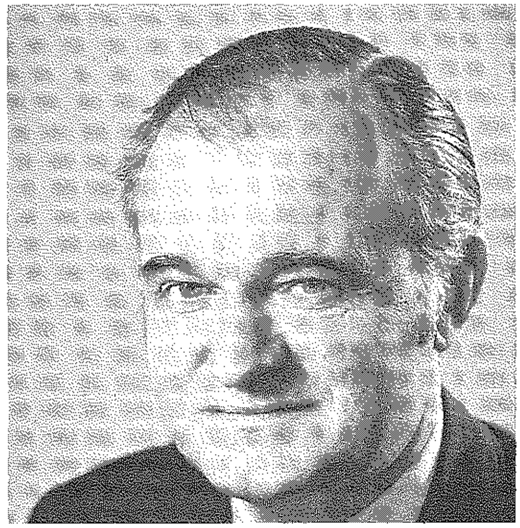


Figure 5: The method of determining the integrals of the sine curve.

No claim is made that the graphic technique described here can be used to supplant more traditional and exacting methods of integration. On the contrary, those methods probably cannot be replaced by any graphic process. The main suggestion made here is that graphic presentations may be used to aid students to "see" how functions can vary and in so doing aid them to a deeper appreciation of graphics and certain areas of mathematics.



Steve Slaby

by Abram Rotenberg
and Steve Slaby
Princeton University

Computer Aided Design of Master Templates

INTRODUCTION

Optical light projection techniques are commonly used for the inspection of a wide variety of engineering products such as gauges, small gears, screw threads, etc. The method used is to place the object to be inspected in the path of a collimated beam of light (See Fig. 1) with its shadow being projected on a flat screen or surface. The contour of the object's shadow is then compared to or overlaid on an accurate master drawing or template (usually referred to as "the master") to assess the degree of accuracy of the object's shape. The master usually represents a flat face or plane section of the object in its desired degree of accuracy.

The contour of the object's shadow (See Fig. 2) may be regarded as an enlarged or magnified parallel projection of the line of contact between the projecting cylinder of parallel light rays and the surface of the object being inspected. (In the analysis presented in this paper an idealized optical system is assumed having no inherent distortions). The contour of the shadow is an accurate magnified reproduction of the line of contact of the intercepted light rays if the line of contact is itself a plane figure located parallel to the flat screen onto which it is projected. However, the optical light projection method as indicated above, is also used for the inspection of objects producing three-dimensional lines of contacts. The inspection of screw threads is an example of such objects in which case the specific master is a drawing (or template) of an axial full section of the required thread while the line of contact (established by the intercepted light rays) is always some three-dimensional curve which normally is assumed to be flat thereby introducing an error because of this assumption. This error normally has been ignored since for most standard threads it has been considered insignificant. However, for other engineering products bounded by helical surfaces (such as worms, multi-start threads, certain types of cutting tools, etc.) the error is significant and optical light projection inspection techniques can be used in these cases providing the master drawings or inspection templates are properly designed.

The presentation that follows will show that, through the joint application of the theory of descriptive geometry and computer graphics, master drawings (templates) can be properly designed and executed to satisfy the inspection requirements to a high level of accuracy.

BASIC RELATIONSHIPS*

Figure 3a represents the plan and elevation (First angle projection used in this paper) of a helical surface S generated by a straight line AB rotating around the z-axis and at the same time moving along it so that the velocity ratio of the two motions remains constant. EF is the direction of a collimated light ray and the view in the P direction (perpendicular to the screen) shows the contour of the shadow of the surface on a flat screen parallel to the z-axis, Figure 3b. Also shown in Figure 3c is the axial section of a perfect triangular (or trapezoidal) thread with its profile plane parallel to the yz plane.

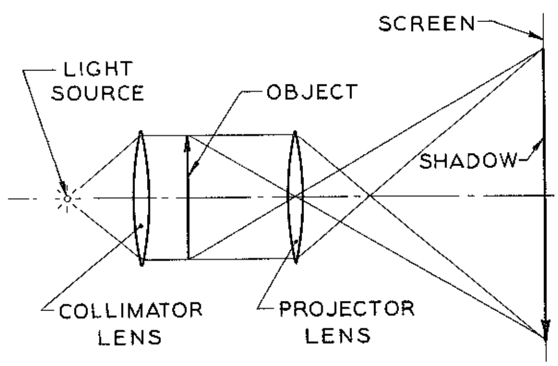


Figure 1: The optical system for projecting the object onto a screen.

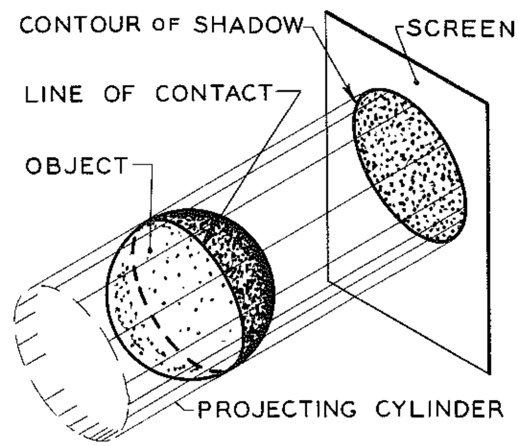


Figure 2: A collimated beam of light projects the contour of the object onto a screen.

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* Notation used in this presentation is as follows:

A,B,C,D,....etc. represents points in space

a_1,b_1,c_1,d_1....etc. represent horizontal projections (plan views) of points A,B,C,D,....etc.

a_2,b_2,c_2,d_2....etc. represent frontal projections (elevations) of points A,B,C,D,....etc.

a_3,b_3,c_3,d_3....etc. represent shadows of points A,B,C,D,....etc.

EF represents the direction of collimated light rays

μ = is the angle between the direction of the collimated light rays and a normal to the flat screen upon which the shadow is projected.

θ = is one half of the thread angle

D = is the major diameter of the thread

d = is the minor diameter of the thread

t = is the lead of the thread

Referring to Fig. 3a:

$$\frac{z_B - z_A}{z - z_A} = \frac{D - d}{D - 2r}$$

Solving (1) for z and using

$$z_B - z_A = \frac{D-d}{2} \tan \theta$$

and $z_A = \frac{t\phi}{2\pi}$,

we have:

$$z = \frac{D-2r}{2} \tan \theta + \frac{t\,\phi}{2\,\pi}$$

which is the equation of the helical surface in cylindrical coordinates. Any point m_3 on the contour of the shadow may be regarded as a point of intersection of a line MM' parallel to EF and tangent to the helical surface A at point M. Since in the selected system of coordinates EF is parallel to the xz-plane,

$$\tan \mu = \frac{-\partial z}{\partial x}$$

and, differentiating equation (2) we get:

$$\tan \mu = \tan \theta \cos \phi + \frac{t}{2\pi r} \sin \phi$$

or solving (3) for r:

$$r = \frac{t \sin \phi}{2\pi \ (\tan \mu - \tan \theta \cos\phi)}$$

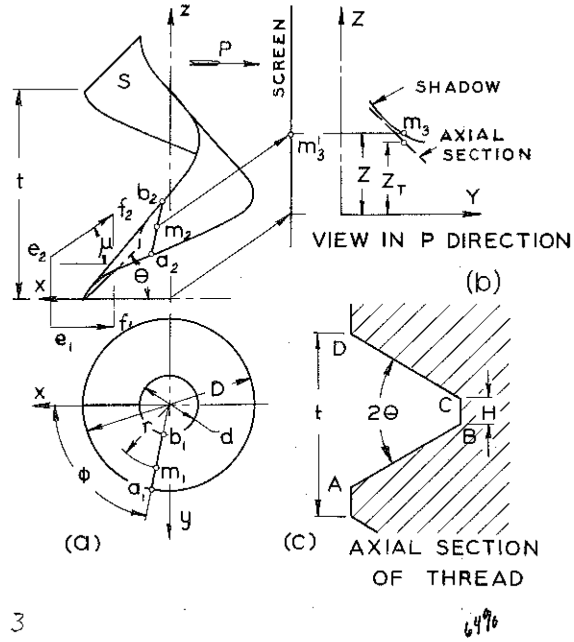

Figure 3: The plan and elevation views of helical surface S generated by straight line AB rotating around the z-axis.

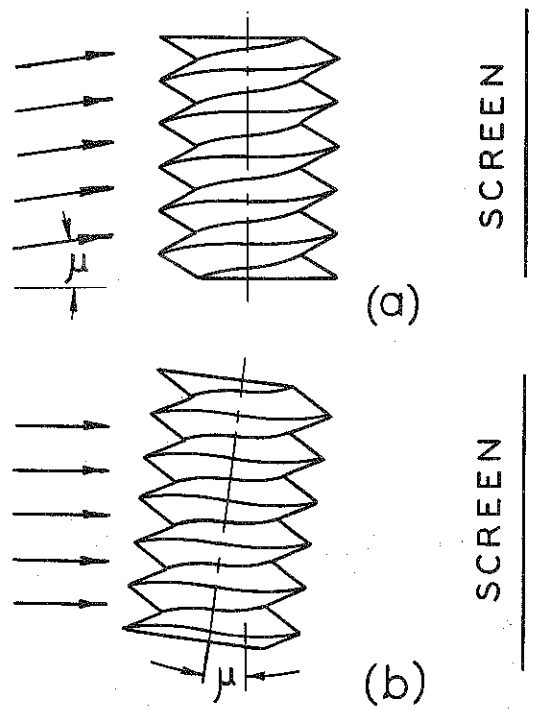

Figure 4: In some cases, the collimated light is normal to the screen and the axis of the thread is placed at an angle to the screen.

For a triangular (or trapezoidal) thread, the coordiantes of a point on the contour of the shadow ("view in the P direction") are

$$Z = z + r \tan \mu \cos \phi$$

$$Y = r \sin \phi$$

for a point on the flank AB of the thread, and

$$Z = z + r \tan \mu \cos \phi + H + \frac{D-d}{2} \tan \theta$$

$$Y = r \sin \phi$$

for a point on the flank CD (Fig. 3c)

If the three-dimensionality of the line of contact is ignored, the resulting form error, measured along the axis of the thread, may be calculated as

$$E_a = Z - Z_T,$$

where $Z_T = \frac{t}{4} + (\frac{D}{2} - d + r \sin \phi) \tan \theta$

for a point on CD.

In some commercially available models of optical light projectors, the direction of the collimated light is fixed normal to the screen and the axis of the thread under inspection is placed at an angle μ to the screen (Fig. 4b). In this case, the coordinates of a point on the contour of the shadow may be obtained by multiplying the value of Z in equations (5a) and (5b) by cos μ:

$$Z' = Z \cos \mu$$

COMPUTER-GENERATED MASTER DRAWINGS

A computer program "HEL", written in APL, uses equations (2), (4), (5a), (5b) to calculate the Y and Z coordinates for any value of φ and plots the theoretical contour of the shadow ("master") for a given axial section of a triangular (or trapezoidal) thread. The contour may be plotted to any desired scale and with an accuracy limited only by the computer-graphics equipment available. The program also calculates the maximum axial form error as defined by equations (6), (7a) and (7b). The contour of the shadows may be plotted for either of the two commonly used systems:

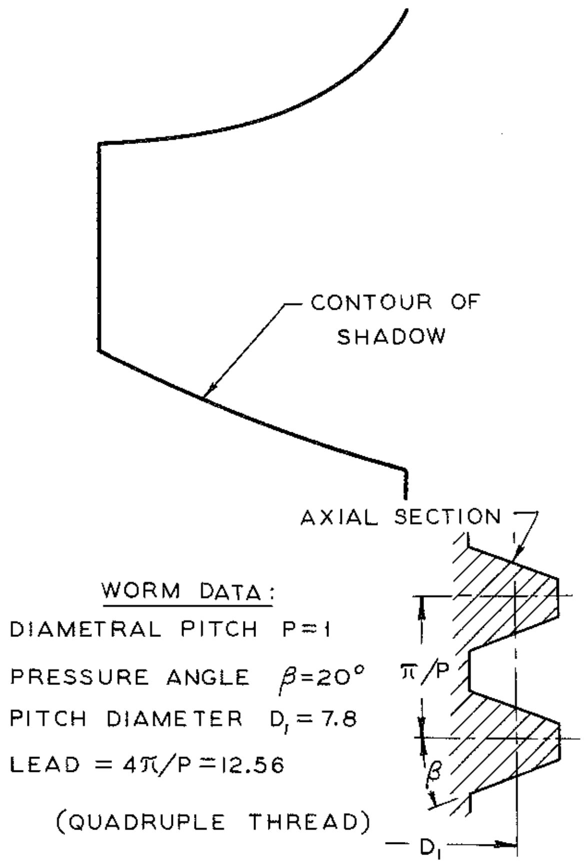

Figure 5: An example of a master drawing generated by "HEL".

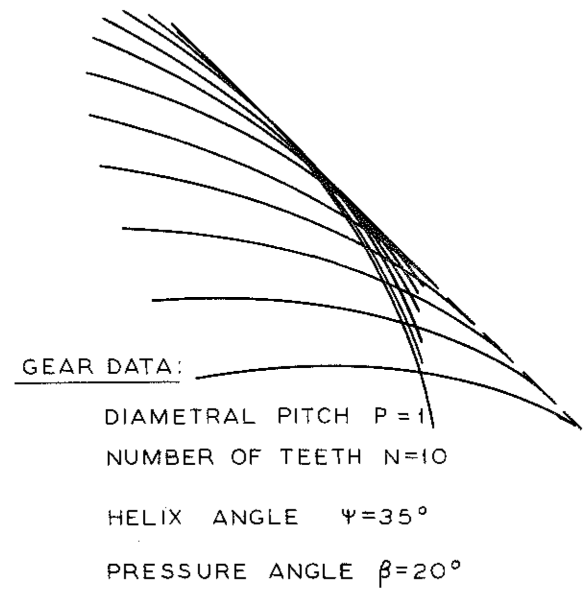

Figure 6: An example of a "HELGEAR" drawing to test the accuracy and profile of an involute helical gear tooth.

(i) axis of the thread is parallel to the screen and the direction of the light rays forms an angle μ (usually $\mu = \text{artan}\ \frac{2t}{\pi(D+d)}$) with the screen

(ii) axis of the thread forms an angle μ with the screen and the direction of the light rays is normal to the screen (Fig. 4b).

An example of a master drawing generated by "HEL" is shown in Figure 5.

Another computer program "HELGEAR", also written in APL, is an example of how to obtain plots of shadows of helical surfaces generated by the generatrix line of any shape. This program draws consecutive positions of the generatrix (in the example used, an involute of a circle) of the helical surface and rotates them through any desired angle about an axis parallel to the screen and normal to the axis of the helical surface. The envelope of the projections of the rotated consecutive positions of the generatrix may be used as a master drawing for determining the accuracy of the form of the helical surface. Figure 6 shows an example of a master drawing obtained with "HELGEAR" and designed to test the accuracy of the profile of an involute helical gear tooth.

RECOMMENDATIONS AND CONCLUSIONS

It is proposed that, whenever the 3-dimensionality of the line of contact cannot be ignored, computer programs like "HEL" and "HELGEAR" be used to obtain theoretical contours of the shadows of the surfaces to be inspected. These contours may then be used as masters to detect any imperfections in the geometry of the manufactured surface. A difficulty that is likely to arise in implementing this recommendation, is "blurring" of the projected contours due to the fact that a three-dimensional curved-line cannot be placed in one focal plane of a lens. The method may, therefore, be successfully used only if the particular optical light projector is capable of coping with the maximum out-of-focus distance of the points on the line of contact.

By Bill Stinson
Department of Engineering Drawing
Queen's University
Kingston, Canada

The Stereographic Net as a Graphical Aids

A stereographic projection of a sphere is a conical or perspective projection of a sphere in which the plane of projection contains the center of the sphere and the point of concurrence of the projectors is the pole of this plane, i.e. the zenithal point of the sphere when this plane is horizontal. The projections of all points of the lower hemisphere will fall within the great circle intersection of the plane of projection with the sphere, and projections of all points of the upper hemisphere will fall outside this same great circle. Obviously those points on the upper hemisphere near the zenithal point will have projections at very great distances outside the limiting circle separating the two hemispheres. For this reason, normally the projection is restricted to that of the hemisphere falling inside the limiting circle.

Usually in applying stereographic projection of a sphere to problems in structural geology we use the lower half of a sphere having its N-S axis and E-W line lying in the horizontal plane of projection. The projection of this hemisphere is represented by its great circle intersection with the plane of projection, by the projections of the lower half of a family of meridian circles established every two degrees, and by the projections of the lower half of small circles located every two degrees and lying in planes perpendicular to the N-S axis (like parallels of latitude). The orthographic projections of a hemisphere in Figure 1 show one sample circle of each type. The resulting stereographic projection is a diagram bounded by the circular rim of the hemisphere and consisting of a network of the projections of these small and great circles, Figure 2.

It should be noted that the stereographic projections of circles or circular arcs are themselves circular arcs. (See appendices A & B).

REPRESENTATION OF PLANES

In looking at such a net, Figure 2, we should visualize a series of meridian planes all containing the N-S axis and dipping at various angles into the hemispherical bowl and intersecting its surface along the great circles represented by the arcs containing the north and south poles.

By using an overlay of tracing paper the lines of the net can be used to draw the projection of a plane of any strike and dip. This is done by first marking a North reference-point and the direction of the given strike and then revolving the overlay about the center, or vertical axis, until the given strike direction coincides with the N-S axis of the fixed stereonet. With the overlay in this position, then the great circle corresponding to the dip of the given plane is traced on the overlay. In this way all planes are represented as planes through the center of the sphere and having the appropriate strike and dip.

REPRESENTATION OF LINES

Each line to be represented by the stereonet is represented by a line from the center of the hemisphere to the point where it intersects the spherical surface. In other words, each line is represented by the stereographic projection of the radius of the sphere having the same bearing and plunge as the given line. From this it should be obvious that the stereographic projection of every line lying in a specific plane will

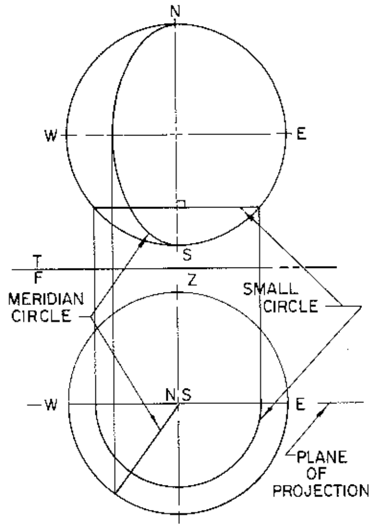

Figure 1: Two views of the types of circles on a sphere.

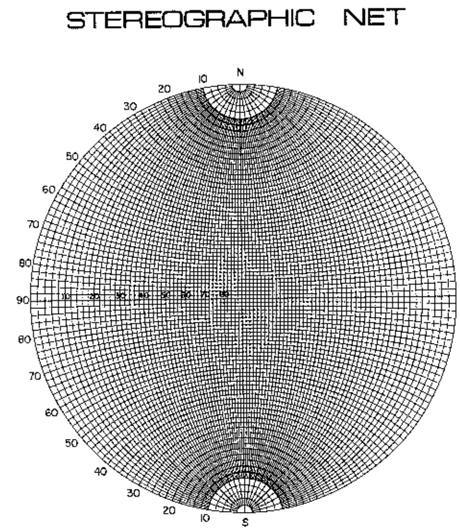

Figure 2: A stereographic net.

extend from the center of the stereogram to an appropriate point on the projection of the great-circle intersection of that plane and the hemisphere.

Horizontal lines as represented using the stereonet terminate on the limiting circle which represents the rim of the hemisphere. As the plunge or downward slope of a line increases from zero, the end point of the line moves farther and farther from the rim of the hemisphere; and when the plunge equals 90° the line projects as a point at the center of the stereonet.

MEASUREMENT OF ANGULAR RELATIONSHIPS

Since all lines are represented as lines through the center of the hemisphere and all planes are represented as planes containing the center of the hemisphere, the stereonet can only be used to deal with angular relationships of lines and planes, and in no way can be used to deal directly with linear quantities and relationships.

Obviously the angle between two lines must be measured in the plane of the two lines. For example if the bearing of a given line (or strike of a plane) is to be measured, it must be measured in the horizontal plane containing the North line and the horizontal projection of the given line (or strike line); and therefore, using the stereonet must be measured using the angular divisions around the limiting circle of the stereonet, the rim of the hemisphere.

If the angle between any two non-horizontal lines is to be measured, then it must be measured in the plane of those two lines and may be measured using the divisions already available along the plane's great circle as though the plane were a self-contained protractor. This is possible since the stereographic distortion of the various parts of the semi-circular intersection of the plane and the hemisphere is the same as the distortion of any corresponding angle segment to be measured.

If the pitch of a line in a plane is to be measured, this merely entails counting out, along the plane's great circle, the number of degrees between the plane's strike line and the given line.

Since the plunge or slope angle of a line and the dip of a plane are defined as angles in vertical planes, they must be measured using the equivalent of a protractor in a vertical position. Since the vertical E-W semi-circle of the hemisphere is subdivided every two degrees by meridian circles of the hemisphere, it may be used for this purpose. On the stereonet it projects as a straight-line perpendicular to the N-S axis, but with appropriate graduations every two degrees permitting the measurement of angles from 0-90° from the horizontal.

Example 1: Establish the stereographic projection of a line bearing N50°E, coincides with the plane of the E-W great circle. Then, using the graduations already available along its straight-line projection, count down into the hemisphere from its rim through 34° and mark the end of the given line. Join this point to the center of the sphere and rotate the overlay back until its north-point matches that of the stereonet, Figure 3.

Similarly, if the projection of a line is arrived at by other construction, its plunge or slope angle may be measured sim-

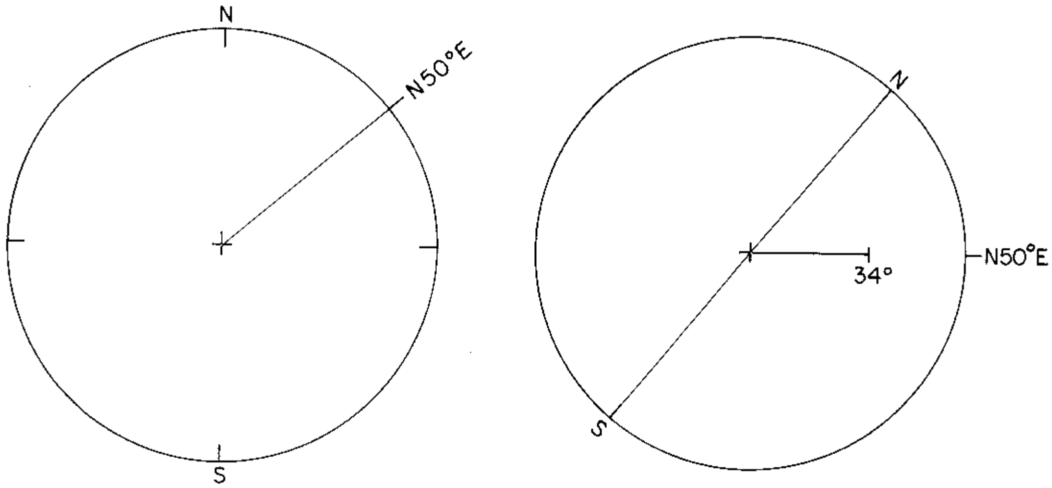

Figure 3: The construction of a line bearing N 50°E using a stereographic net.

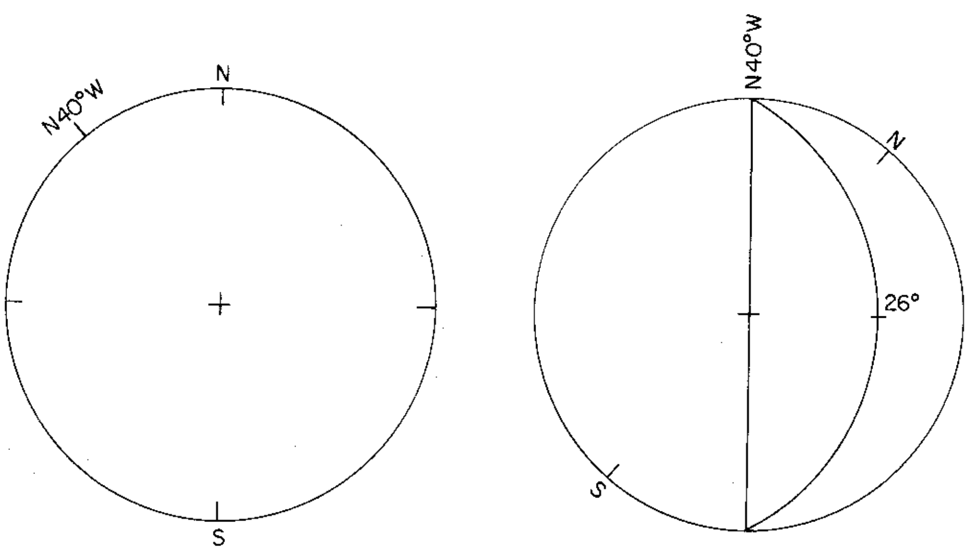

Figure 4: The construction of a plane having a strike of N 40°W and a dip of 26° NE.

ply by rotating the overlay until the projection of the line coincides with the projection of the E-W great circle, and reading off the position of the end of the line as an angle below the rim of the hemisphere.

Example 2: Establish the stereographic projection of a plane having a strike of N40°W and a dip of 26°NE.

Since the dip or slope angle of a plane is the dihedral angle between it and any horizontal plane, it is equal to and is measured as the slope angle of a line of the plane having a pitch of 90° or a line down-on-the-dip. First, a north-point and the strike of the plane, N40°W, are marked on the overlay and the overlay is then rotated until the strike line of the plane coincides with the N-S axis of the stereonet; this places a line in the given plane having a pitch of 90° in the plane of the vertical E-W great circle. The dip angle can now be measured (or established) by counting down into the hemisphere from the north-easterly part of its rim through 26° to the location of the great circle intersection of the plane and the hemisphere. This great circle

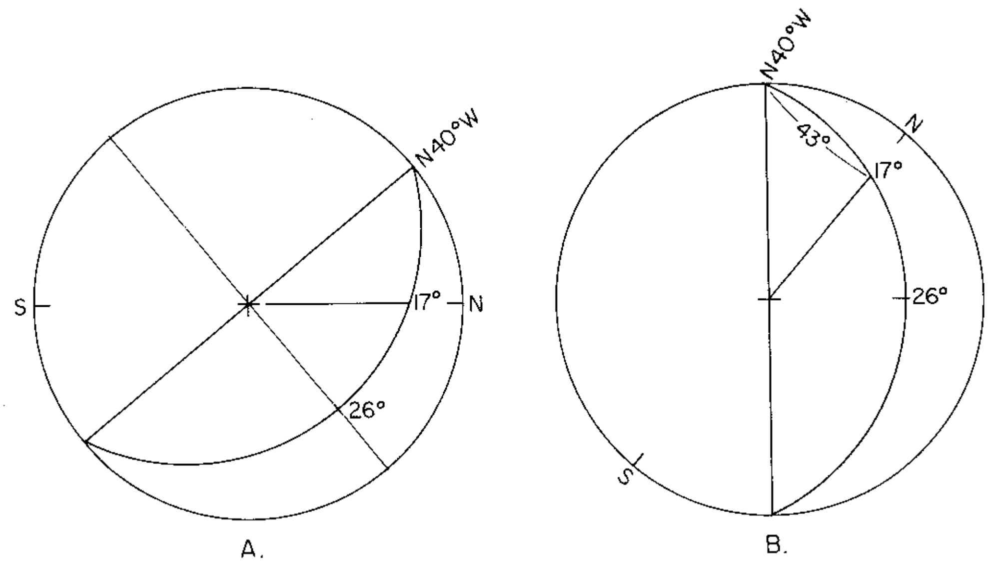

FIGURE 5.

Figure 5: The determination of the apparent dip of the plane with a vertical cliff that bears due north.

may be drawn on the overlay by tracing the appropriate circular arc of the stereonet, Figure 4.

SOLUTIONS to 7 BASIC PROBLEMS (No rotation)

The following problems may be solved using the stereonet and by merely revolving the overlay about the center of the stereonet, i.e. about the vertical axis of the hemisphere. Later it will become necessary in solving certain problems to rotate the problem components about other axes.

Problem 1:

A plane having a strike of N40°W and a dip of 26°NE is exposed on a vertical cliff bearing due North. What is the apparent dip of the plane as seen on the cliff? What is the pitch of its line of intersection with the cliff?

Solution: Draw the strike line and great circle projection of the given plane on the overlay as shown in Figure 4B. Establish the line in this plane having a bearing due North. Note that its end point must be on the great circle intersection of the plane and the hemisphere. Rotate the overlay until the projection of this line coincides with the projection of the E-W great circle, Figure 5A. Measure its plunge or slope (17°) by counting down from the rim of the hemisphere in the E-W great circle.

Rotate the overlay until the strike line coincides with the N-S axis of the stereonet, Figure 5B, and measure the pitch of the line by counting out the number of degrees along the plane's great circle between its strike line and the line bearing due North (43°).

Problem 2:

In a plane with a strike of N20°E and a dip of 46° easterly, those lines having a plunge of 46° having a bearing of S70°E and a pitch of 90°. What are the bearing and pitch of those lines in this same plane having a plunge of 25°?

Solution: Draw the strike line and great circle of the given plane on the overlay. Note that the lines of this plane all terminate on its great circle and that they vary in slope from 0°, the strike line, to 46° for a line perpendicular to the strike line. Each line may be selected on the basis of its slope or plunge by noting the point where the given plane's great circle (on the overlay) intersects the projection of the E-W circle of the stereonet as the overlay is revolved. When the required plunge or slope angle is less than the dip of the plane there will be two solutions, or two points where the plane's great circle intersects the vertical E-W circle at the 25° plunge position. The positions of the overlay to locate each of these are shown in parts A and B of Figure 6. The bearing and pitch of these two solutions may then be read off in the usual way.

Problem 3:

Determine the strike and dip of the plane containing two given lines, such as lines plunging 17° N40°W and 20° N60°S.

Solution: The two lines are first represented on an overlay by establishing their bearings and the points where they intersect the hemisphere. Then the overlay is merely rotated until the end-points of the two lines lie

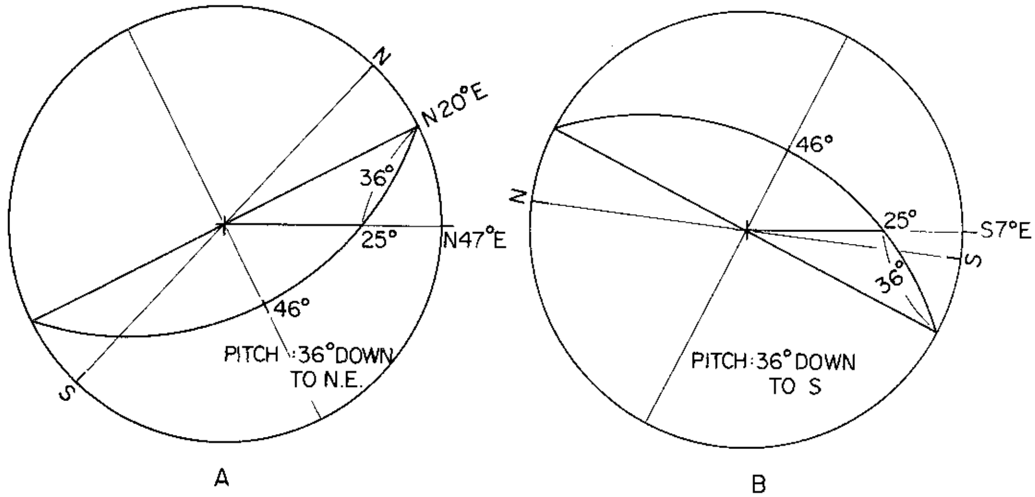

Figure 6: The solution to problem 2.

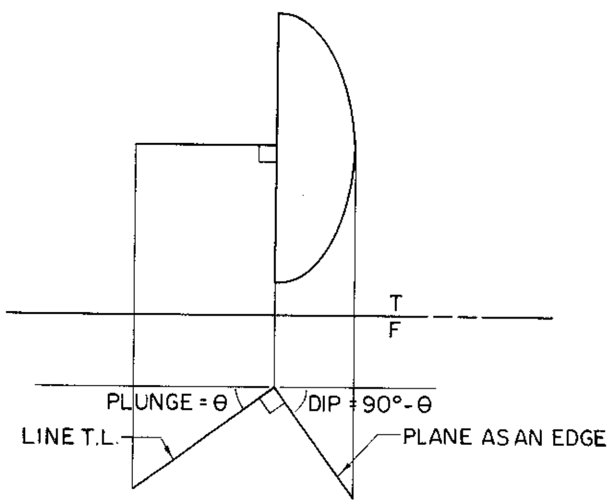

Figure 7: The determination of the angle between two planes.

on the same meridian circle. This meridian circle is traced on the overlay and the strike and the dip of the plane containing it are read from the stereonet.

The reader may use the stereonet in Figure 2 and a sheet of vellum as an overlay to check through the method of the solution to this and subsequent problems discussed, even though the size of Figure 2 may result in inadequate accuracy.

Problem 4:

Determine the angle between any two given lines such as those in (3).

Solution: Once the plane of the two lines is established as in Problem 3 then the plane and its meridian circle are used as a protractor and the angle between the two lines is counted out along the great circle or meridian circle of the plane.

Problem 5:

Determine the bearing and plunge of the line of intersection of 2 planes.

Solution: On an overlay establish a north point and draw the stereographic projections of the two planes, i.e. of the strike lines and the great circle intersection of each of the planes with the hemisphere. The two strike lines intersect at the center of the sphere and thus locate one point common to the two planes. Each of the two great circles is the locus of those points common to the corresponding plane and the hemispherical surface and therefore the point where the two circles intersect is common to the two planes. Therefore, the line joining the center of the hemisphere and the point of intersection of the two circles is the required line of intersection.

Problem 6:

Determine the magnitude of a dihedral angle or the angle between 2 planes.

Solution: On an overlay establish a north point and the projections of the two planes and determine the line of intersection. Since the dihedral angle must be measured in a plane perpendicular to the line of intersection, establish such a plane by giving it a strike perpendicular to the line of intersection and a dip angle complementary to the plunge angle and in the opposite direction, Figure 7.

Establish the lines of intersection of this perpendicular plane with each of the original planes and determine the angle between them.

Problem 7:

Determine the angle between a line and a plane.

Solution: Since the angle between a line and a plane is defined as the angle between the line and its orthographic projection on the plane, it is necessary to draw on the overlay the stereographic projections of both the given line and its projection on the given plane. The projection of the given line on the plane is obtained by determining where the plane containing the line and a line perpendicular to the given plane intersects the plane. (The line perpendicular to the given plane is established by giving it a bearing perpendicular to the strike of the plane and a plunge complementary to the dip angle of the plane, Figure 7). The angle between the given line and its projection is then measured along the great circle of the perpendicular plane.

APPENDIX

If the section of an oblique cone taken perpendicular to the mid-section of the cone and at an angle θ to one principal element is a circle, then any section taken perpendicular to the mid-section and at an angle θ to the other principal element is also a circle.

Shown in Figure 8 is the orthographic projection of an oblique cone on a plane parallel to its mid-section VAB. Section AB, making an angle θ with principal element VB is a circle as shown in Auxiliary View #1. Another section, ab, is taken perpendicular to the mid-section VAB and at an angle θ with the other principal element VA.

A third section, cd, has been taken perpendicular VAB and parallel to the base AB through any point O of ab.

How, in similar triangles bOc and dOa

$$\frac{Oa}{Oc} = \frac{Od}{Ob}$$

$$\therefore \; Oc \times Od = Oa \times Ob$$

Note also that the 2 curves of intersection on the surface of the cone, one appearing as cd have a common chord, rs, which appears as a point at O in the main projection of the cone. Using Auxiliary View #2 that shows the circular section at cd it is clear that:

$$Oc \times Od = (rO)^2$$

$$\therefore \quad Oa \times Ob = \left(\frac{rs}{2}\right)^2$$

∴ Curve of intersection appearing at ab is a circle.

The stereographic projections of circles or circular arcs lying on the surface of the sphere are themselves circles or circular arcs.

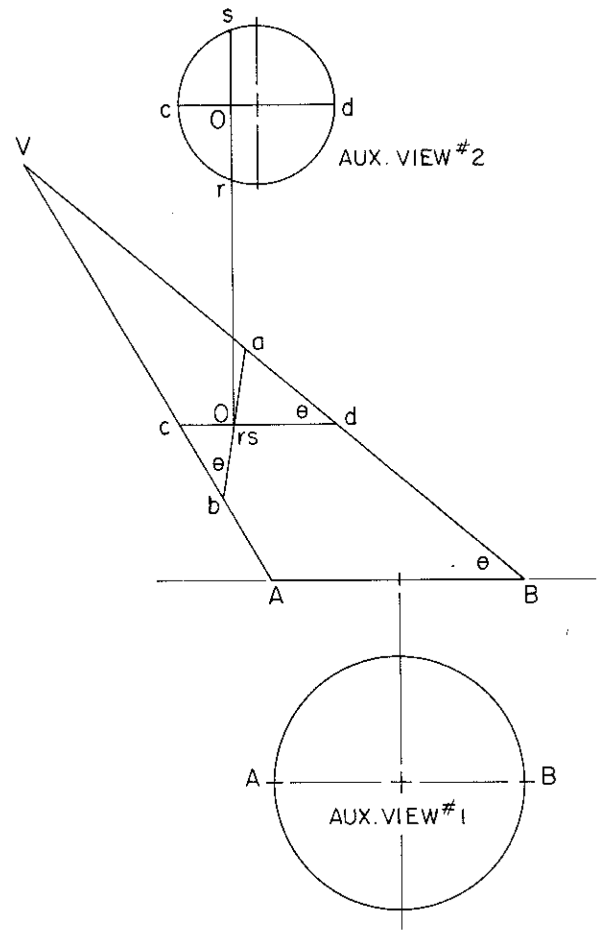

Figure 8: The determination of the angle between a between a line and a plane.

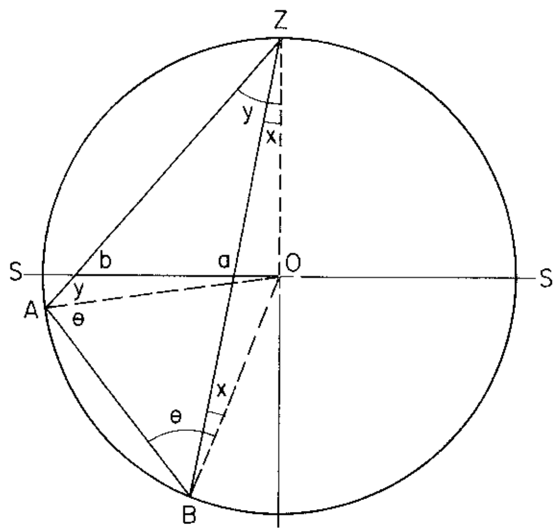

Figure 9: The circle is the orthographic projection of a sphere and AB is a circular section of the sphere appearing as an edge.

In Figure 9, the circle is the orthographic projection of a sphere on a vertical plane, and AB is a circular section of the sphere appearing as an edge.

S-S is the horizontal plane on which the lower half of the sphere is projected stereographically and the zenithal point, Z, is the point of concurrence of the associated projectors. The projectors from all points of AB to Z will form an oblique cone whose section ab will be the stereographic projection of circle AB.

In ΔAOB, AO = BO, and $\angle OAB = \angle OBA = \theta$

$\therefore \theta = \frac{1}{2}(180° - \angle BOA)$, but $\frac{1}{2}\angle BOA = \angle BZA$

$\therefore \theta = 90° \angle BZA = 90° - (Y-X)$

Or $\theta + Y = 90° + X$, i.e. $\angle A = 90° + X$

From equation (1.) $\angle a = 90° + X$, $\therefore \angle A = \angle a$

$\therefore$ On the oblique cone with mid-section ZAB, section ab is a circle.

$\therefore$ The stereographic projection of circle AB is a circle.

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Donn, W.L., and Shimer, J.A., 1958, Graphic Methods in Structural Geology, New York.

JOBS

The Engineering Design Graphics Department of Texas A&M University is seeking applicants for an assistant or associate professorship that must be filled by September 1976. Duties will include the teaching of engineering graphics and descriptive geometry to freshman engineering students. Also, it is desired that applicants are competent to teach specialty courses such as computer graphics, electronic drafting, pipe and vessel drafting, nomography, etc.

It is preferred that applicants have a doctor's degree with at least one degree in a field of engineering. Salary is open based upon the qualifications of the applicant. Texas A&M is an equal opportunity, affirmitive action employer.

Graduate Assistantships and part-time teaching positions will also be available in September 1976 in the Engineering Design Graphics Department.

Contact James H. Earle, Engineering Design Graphics Department, Texas A&M University, College Station, Texas, 77843, Phone 713-845-1633.

by Dr. Edward Holland, Jr.
Federal City College
Washington, D. C.

Testing With Slides in Graphics

A variety of audio-visual techniques have gained widespread acceptance in engineering graphics during the past two decades. Engineering graphics concepts have been successfully taught using such media as transparencies, slides and filmstrips, closed circuit television, and single concept film loops, with varying degrees of success. It appears that these instructional aids provide the instructor with an improved and more efficient mode of presentation than the lecture-chalkboard method, but these instructional aids lack one important ingredient--that of placing the student in a more active learning environment.

During the past five years, the Engineering Design Graphics Department at Texas A&M University has developed and used a series of 35mm slides to supplement classroom lectures. These slide series have been used to cover such topics in engineering graphics courses as: the design process, engineering presentations, use of drafting machines, scales, section views, dimensioning, and threads and fasteners. The slides add much to the classroom presentations, but often students lose interest in the presentations and are frequently unable to recall the significance of the slide series. As an attempt to increase student involvement and interest in the slide presentations, multiple-choice slide quiz questions were added to two of the 35mm slide series. The threads and fasterners and dimensioning slide series were revised gy adding approximately 50 multiple-choice slide quiz questions to each slide series. Examples of these slide quiz items are shown in Figure 1.

The Problem

A study[1] was conducted to determine whether audio-visual presentations, complete with multiple-choice slide quiz questions, were of value in helping students understand concepts related to specific units in engineering graphics.

The problem was to evaluate the effectiveness of two methods of audio-visual instruction in an engineering graphics learning situation. The two methods of instruction were: (1) experimental tape-slide series complete with slide quiz questions inserted at intervals throughout the presentations, and (2) control tape-slide series without slide quiz questions. Information was also gathered to evaluate student preference regarding the two audio-visual methods.

Related Studies

Several researchers have studied the effects of self-paced, individualized, and other instructional techniques that place the student in a more active learning environment. Durney[2], in analyzing the characteristics of effective learning, suggested that educators use the following five principles as a checklist for evaluating effective learning systems:

1. The learner must be active. Telling a student something does not necessarily mean that he has learned it.
2. Feedback and a second try are essential. The learner must be able to find out what he did poorly, try to improve it,

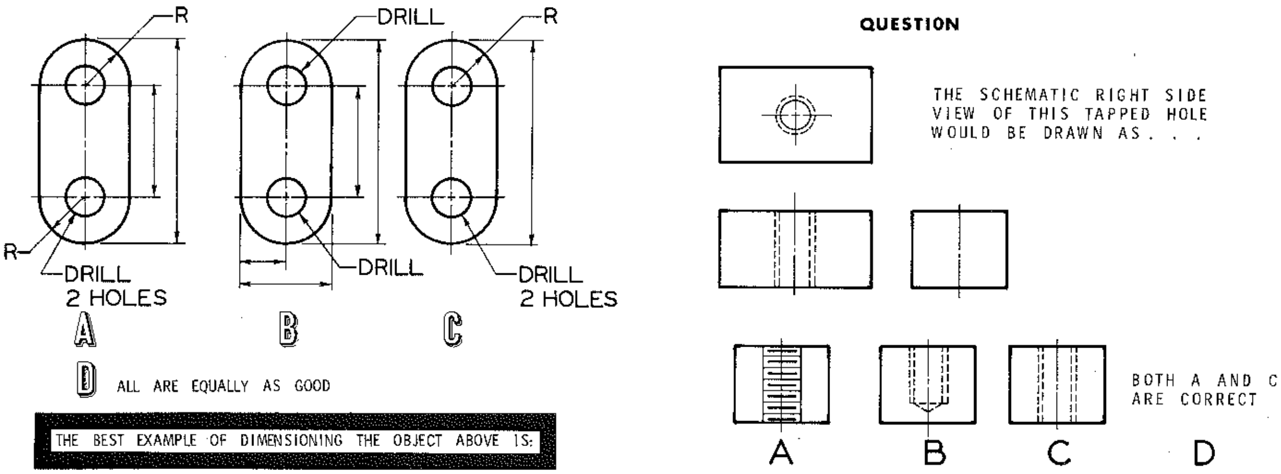


Figure 1: Two sample slides that were prepared to test students on principles of engineering graphics.

and try again. He must also feel rewarded (as opposed to penalized) in some sense for doing well.

3. The learner must know the learning objectives: i.e., just what it is that he is trying to learn. If the learner is confused about just what it is that he is trying to learn (his learning objectives), his learning will proceed very slowly, if at all, and he will be discouraged.
4. The learner must be committed and he must be motivated to learn. If the learner is not committed, he will not put forth the effort required to learn, and, consequently, he will not learn.
5. Each person learns at a different rate and in his own way. No two individuals are exactly alike, and no two learn in exactly the same way, even though there is much that is common to everyone's learning (pp.406-407).

In referring to the checklist for evaluating effective learning systems, one may note that feedback is considered desirable in order for the learner to effectively understand the information presented. Programmed instruction utilizes the breakdown of units of instruction into small steps. Learning these small units of information is structured so that: (1) the learner is presented with a concept, (2) the learner is required to respond to a series of questions about the concept, and (3) the learner is immediately informed as to whether or not he answered the questions correctly. Programmed instruction not only enables the student to participate in a more active learning environment through actively responding, but it also enables the student to gain immediate feedback regarding the degree of correctness or incorrectness of his response.

The value of response and immediate feedback in programmed and individualized instruction has gained widespread acceptance and attention by educational researchers in recent years. Levie and Dickie[3] reviewed 61 studies which have compared the values gained from overt (actively responding by writing answers or selecting from multiple-choice alternatives) versus covert ("thinking" answers or merely reading) schemes of responding. Of the 61 studies investigated, 33 resulted in no significant differences in posttest achievement; 18 showed overt responding to be superior; 4 studies favored covert responding; and 6 studies were found to be invalid because of interactions with other variables.

Conducting The Experiment

Three threads and fasteners and three dimensioning tape-slide presentations were developed and tested on a total of 98 students at three different schools: Texas A&M University, College Station, Texas; San Jacinto College, Pasadena, Texas; and Thomas Nelson Community College, Hampton, Virginia. Two sections (experimental and control) of students at each school were shown the tape-slide

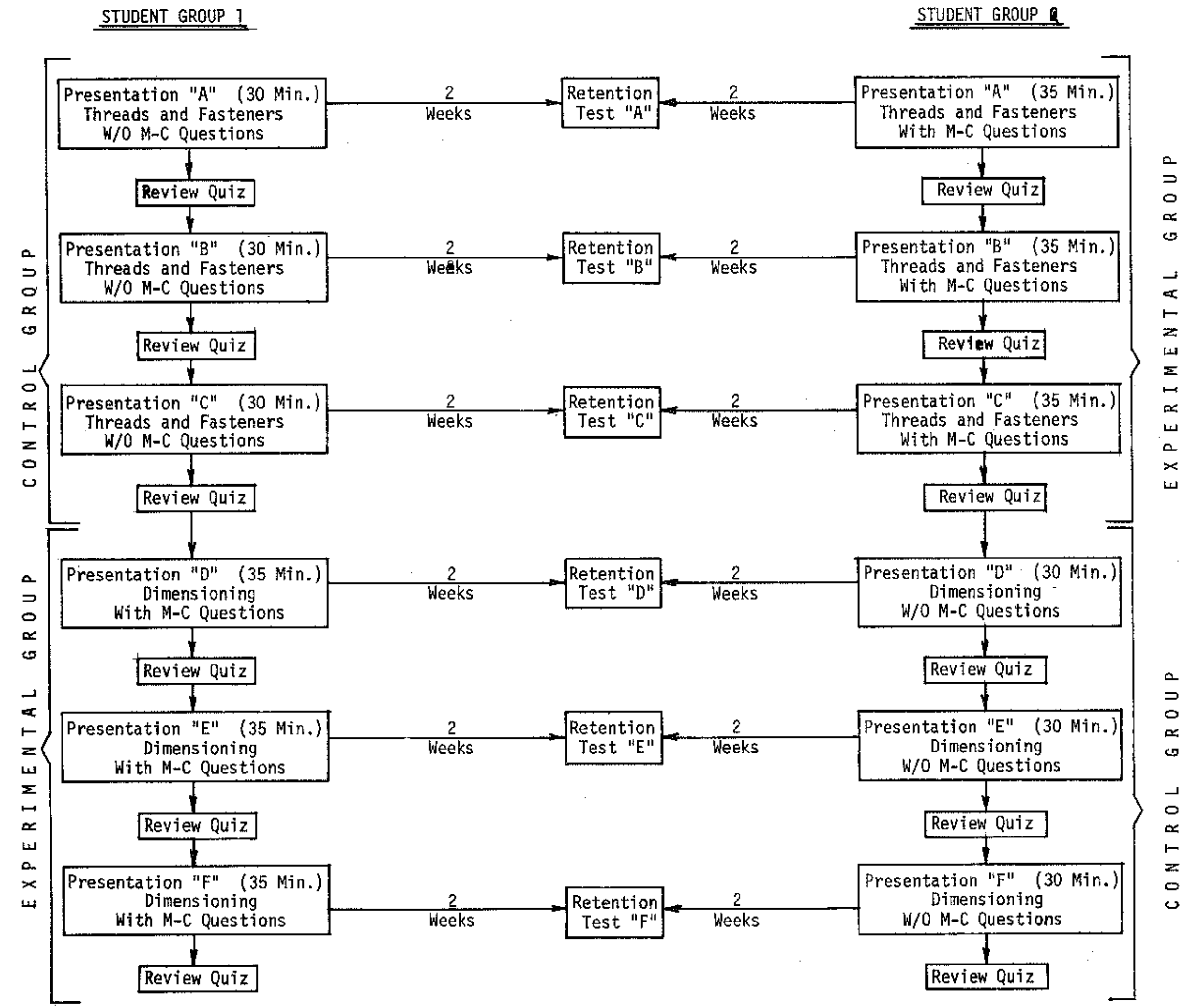


Figure 2

Figure 2: The organization of the experiment.

series. The experimental sections were shown the slides with multiple-choice questions added; the control sections were shown the same slides as the experimental group, but without the multiple-choice questions. In order to eliminate any student effects in the experiment, the two groups of students--Group 1 and Group2--served as an experimental group for one tape-slide series and as a control group in the second series (see Figure 2). Narrations for both the experimental and control presentations were recorded on cassette tapes to eliminate any teacher effects and to maintain uniformity in the presentations.

The students in the experimental sections were required to respond to the multiple-choice questions on a specially designed answer card[4] (see Figure 3) that served to lead the student to the correct response. The answer card consisted of seven prepunched computer cards, a cover card, and a backing card that were stapled together. If a student responded correctly to the slide quiz questions, his pen point would pierce through the cover card into one of the prepunched holes. If a student responded incorrectly, he was required to respond until he made a correct response.

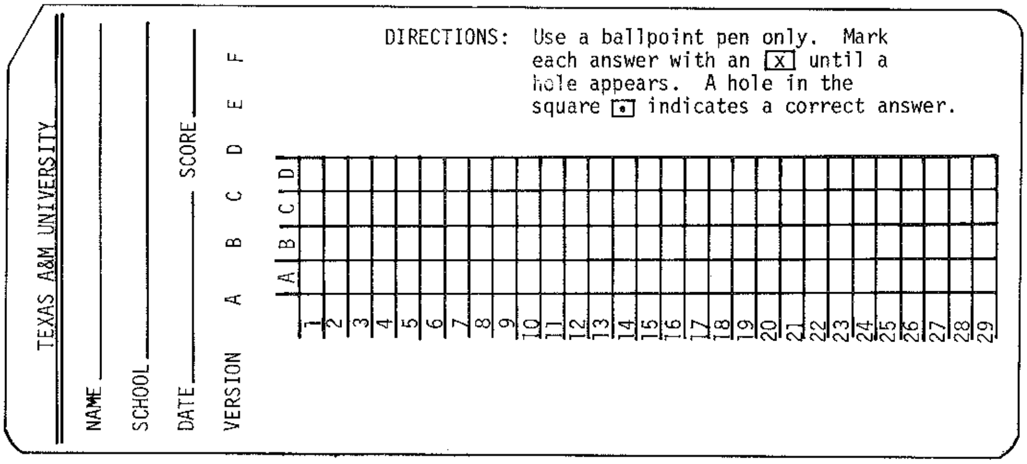


Figure 3: The specially designed response card.

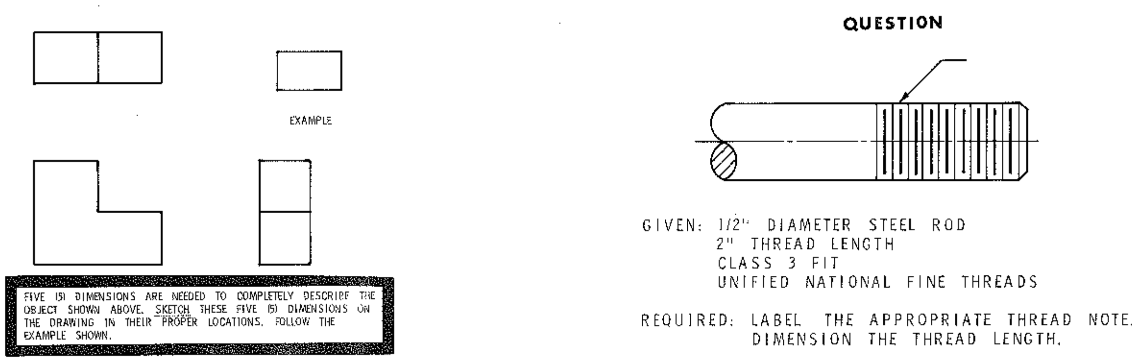


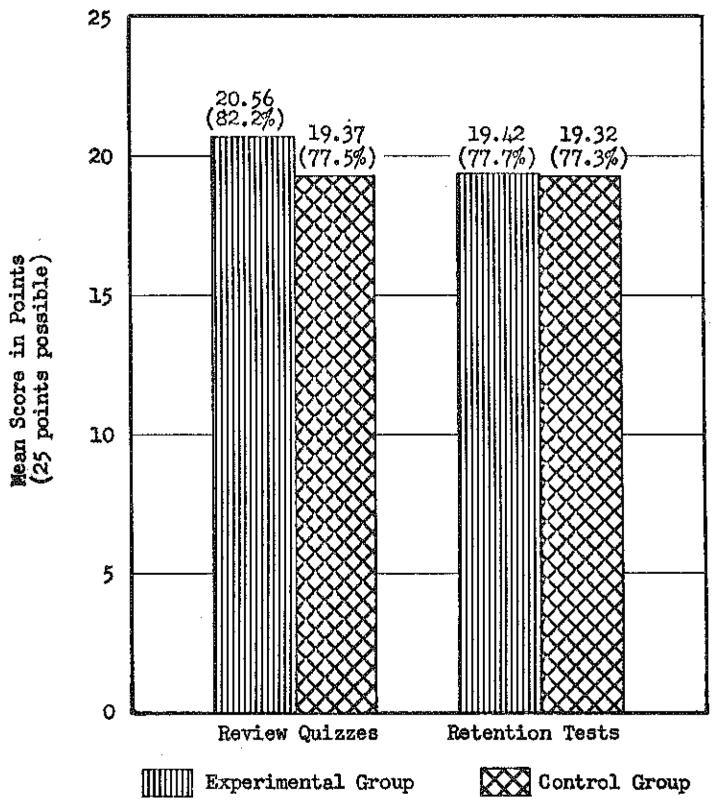
Figure 4: Two sample slides prepared to measure initial achievement.

Review quizzes were administered to both the experimental and control groups immediately after each presentation. The review quizzes consisted of completion and performance-type questions, and were used to measure initial achievement (see Figure 4).

Retention tests were administered to both the control and experimental groups two weeks after the last tape-slide presentation for each unit was shown. The retention tests were used to evaluate student recollection of the concepts presented.

In analyzing the data, it was found that the experimental group of students yielded a mean score of 82.24 percent on the review quizzes as compared to a control group mean of 77.48 percent (Figure 5). This 4.76 percent difference in group means was found to be statistically significant at the .01 level of confidence.

The retention test analysis yielded a mean score of 77.70 percent for the experimental group and a mean of 77.30 percent for the control group. This .40 percent difference in group means was not significant at the .05 level, thus indicating no appreciable



Analysis for Review Quizzes

SOURCE	df	S.S.	M.S.	F
Groups	1	204.27	204.27	12.84** (.01 level)
Error	552	8,780.42	15.91	

Analysis for Retention Tests

SOURCE	df	S.S.	M.S.	F
Groups	1	.39	.39	0.03 (NS)
Error	152	2,164.25	14.24	

Figure 5: Comparison of the experimental and control group review quiz and retention test means.

mean difference between the experimental and control students' ability to recall the concepts presented in the tape-slide series after a two week lapse of time.

Summary

In observing student participation in both the tape-slide series with and without multiple-choice questions, it was apparent that those students who played an active role in the class presentations not only showed a higher degree of initial achievement but also indicated that they enjoyed the addition of multiple-choice questions in the slide series. The addition of multiple-choice questions to the slide presentations seemed to have little, if any, effect on the students' ability to recall the information presented after a two week lapse of time.

[1]Holland, Edward, Jr. "An Experimental Study to Determine the Effectiveness of Slide Quiz Items as a Part of Audio-Visual Presentations in Engineering Design Graphics." Unpublished Ed.D. dissertation, Texas A&M University, 1973.

[2]Durney, Carl H. "Principles of Design and Analysis of Learning Systems." Engineering Education, Vol. 63 (March 1974), 406-9.

[3]Levie, W. H. and Dickie, K. E. "The Analysis and Application of Media," in Robert M. W. Travers (ed.), Second Handbook of Research on Teaching. Chicago: Rand-McNally and Co., 1973.

[4]Pressey, S. L. "Development and Apprasial of Devices Providing Immediate Automatic Scoring of Objective and Concommitant Self-Instruction." Journal of Psychology, Vol. 29, (April 1950), 417-47.

by James H. Earle
Engineering Design Graphics Department
Texas A&M University

A Review of the Visiting Engineer Program

The Engineering Design Graphics Department of Texas A&M University initiated an industrial flavor to their two engineering design graphics courses in 1966. This program was an interface with industry which brought practicing engineers from industry into contact with freshman engineers on a working basis, enabling the students to obtain an introduction to the engineers' approach to problem solving. This program was called the Visiting Engineer Program.

Fifty-seven engineers made two visits each to work with three classes of students during each visit in the program's first year, 1966-67. This began as an experimental program that has been in continuous operation since, growing each year until it has almost doubled in enrollment and in participation from industry.

THE COURSES

The Visiting Engineer Program is organized to serve two courses, EDG 105 and EDG 106, which cover basic graphics, descriptive geometry and design. Approximately one-third of the courses are devoted to the Visiting Engineer Program and the solution of design problems by student teams. The remaining two-thirds of the courses are handled as conventional lecture laboratory classes where students solve graphics problems as daily assignments. The overall objectives of the courses are to introduce the freshman student to engineering design, problem solving, engineering applications of graphics, and engineering communications. Much emphasis is placed on the use of the graphical process to originate and develop ideas as well as to present them in an engineering form.

CLASS ORGANIZATION

The average class size is between thirty-eight to forty students. Each student meets 3 two-hour or 2 three-hour sessions for a total of six hours per week. A class of forty students is divided into five teams of seven or eight students who are assigned to team projects. Class time is set aside during which the student teams work on their projects (Figure 1). Approximately one third of the class time is used for team projects with the remaining two thirds used for the completion of daily graphics problems.

Design problems are selected by student teams from a list of problems suggested by their instructor, or they are allowed to propose their own when a team has a specific project in mind that is comparable to those suggested. Proposed problems must receive the approval of the instructor to insure that they are neither too difficult nor too simple to properly challenge a team.

Design problems are selected to simulate systems design and analysis on an elementary level for the first course, EDG 105. The problems for the second course, EDG 106, involve product development. Examples of problems of this type are shown in Figure 2. The teams of engineers meet with each class--once as a consultant, and once as reviewers of the finished project (Figure 3).

The visiting engineers from industry are scheduled to make two visits per semester to work with three classes, as consultants during the first visit and as evaluators during the second visit (Figure 2). The first visit is scheduled during the eighth week of the

WK	PERIOD 1	PERIOD 2	PERIOD 3
1			
2		ASSIG. PRO.	
3		1 HR	
4		1 HR	
5		1 HR	
6		2 HR	
7		2 HR	
8		VISIT ENG	
9		2 HR	
10		2 HR	
11		2 HR	
12	2 HR	2 HR	2 HR
13			
14	PRACTICE	VISIT ENG	
15			
16	EXAMS		

Figure 1: The shaded areas on the semester schedule represent periods devoted to the team project.

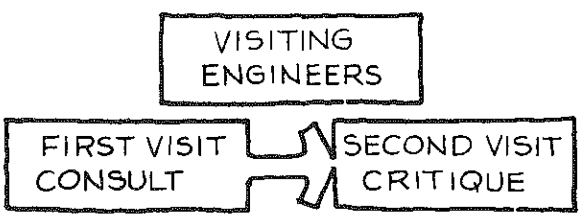


Figure 3: Visiting engineers make two visits to the same classes each semester.

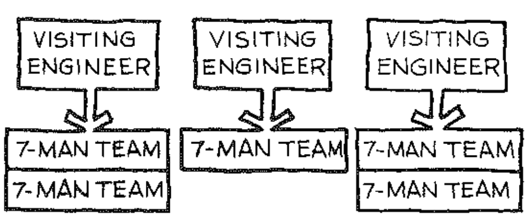


Figure 4: The class is divided into three groups and the visiting engineers rotate to each group at 30-minute intervals.

FEASIBILITY STUDY

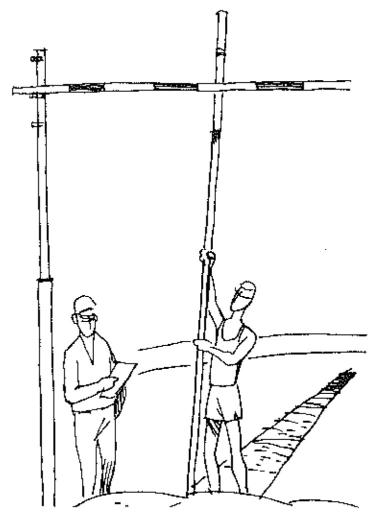
Analogy: A common engineering-management problem is that of plant location in a given area for a particular product. An analysis must be made of company and community requirements and the mutual benefits to be derived by each prior to execution of final plans. Engineering problems must be studied concurrently with management problems. Predictions are based on available information whether from like situations previously undertaken or from entirely unproven criteria. It is possible that a feasibility study will result in a negative conclusion. Study of the overnight campsite outlined below will provide an experience in a problem related to an engineering-management feasibility study.

OVERNIGHT CAMPSITE

Many people travel with campers and trailers on vacations and business trips. Most seek campsites at national and state parks that are usually out of town. There may be a need for in-town campsites for campers who wish to spend the night near or in cities.

Analyze the feasibility of converting a local lot on a major highway or near your campus into a complex of campsites for overnight campers. Determine the facilities that would be desired and the expenditures required for an operation. The method of renting and managing the individual campsites must also be considered. Each campsite needs to be as small and efficient as possible to offer the maximum in economy. Conduct a cost analysis to arrive at the profit margin and the feasibility of such a system.

Pole Vault Pit



The eighteen foot pole vault is an athletic feat that will be a reality in the future. Most pole vault events at the university level have jumps of fifteen feet or better at the present.

The pole vault pit and runway have changed during the last few years, but the standards that support the crossbar and the techniques of positioning the standards and the crossbar have not changed to a great degree. Officials of this event must adjust the position of the crossbar for each vaulter. They have considerable difficulty in replacing the crossbar after unsuccessful vaults at heights in excess of fourteen feet.

A sporting goods manufacturer has recognized this as market for a new design to improve the present vaulting pits. You have been asked to develop a solution to this problem that would be superior to the present equipment and sufficiently economical so as to gain this market. Investigate as many features as possible that could feasibly be incorporated into your design.

Prepare drawings and a model of your design as outlined in the design specifications. Make an estimate of the manufacturing costs, shipping weight, potential customers and other pertinent information.

Figure 2: Examples of system and product problems that were assigned as team projects.

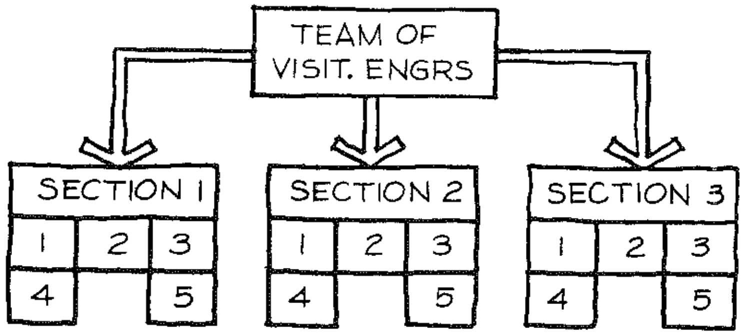


Figure 5: Each team of three engineers visits with three classes during a day.

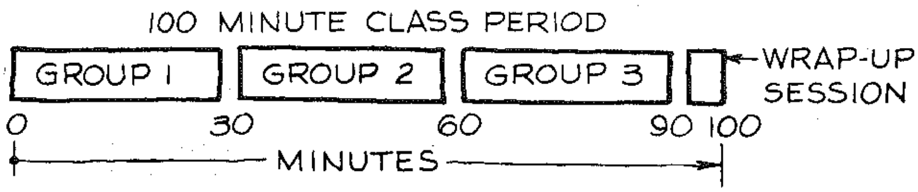


Figure 6: The distribution of the time used for a single class period.

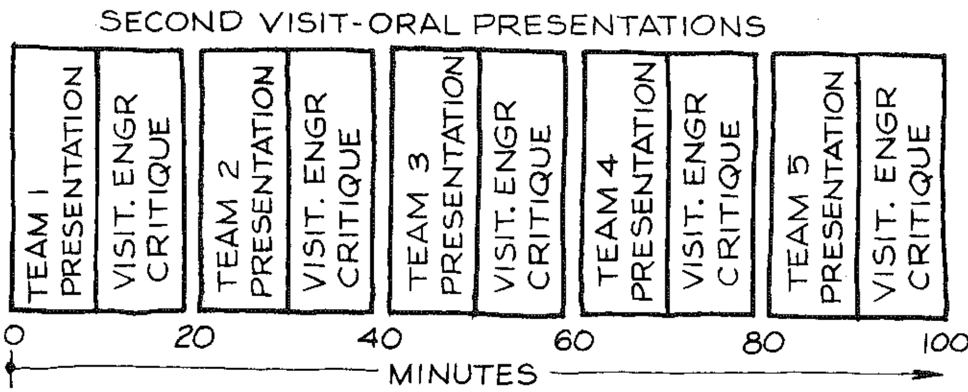


Figure 7: The distribution of the time used for the second visit.

semester. A panel of three engineers is assigned as consultants to work with each class during this visit.

THE FIRST VISIT

Each class is divided into three groups (Figure 4) and a visiting engineer assigned to each group. Each engineer will visit with each group for thirty minutes on a personal level and then he is rotated to the second group for thirty minutes, and then to the third group for thirty minutes. This allows the engineer to participate on three different projects and have direct contact with all students in a class.

During the day each team of visiting engineers will meet with three sections (classes). Each section is managed in the same manner described above (Figure 5).

As consultants, the visiting engineers will be asked general questions about the projects being worked on by student teams with little emphasis placed on specific theoretical questions. The engineers' primary role is to evaluate the preliminary ideas developed by the teams and to provide general guidance to them. He will present ideas for consideration that have been overlooked by the teams. This provides valuable insite into engineering when visiting engineers relate class problems to real problems encountered by the engineers in his professional activities.

During a two hour session, each of the three groups within the class will have contact with each of the three engineers. The remaining ten minutes of the two hour class is used as a general wrap-up session that permits students to ask questions of the three engineers comprising the panel of consultants (Figure 6).

THE SECOND VISIT

The engineers return for the second visit during the fourteenth week of the semester with the same engineers meeting with the same classes with whom they met during the first visit. Each team will give an oral presentation of their design solution to the panel of engineers and their classmates in a ten minute presentation. They are prepared to justify their designs and answer questions posed by the visiting engineers.

After each ten minute presentation by a student team, the visiting engineers give an eight to ten minute critique on the design solution and the student's presentation. This discussion provides the teams with exposure to an engineering evaluation. Each of the three visiting engineers participates in the critique of each team. (Figure 7).

PROGRAM OBJECTIVES

The primary objective of the Visiting Engineer Program is to help engineering students learn (1) the steps that develop an original design; (2) the principles of solving an engineering problem; (3) more of profession of engineering; and (4) the importance of presenting engineering solutions in an oral, graphical, and written form.

The problems assigned are structured to introduce students to situations where there are no single solutions. Ideal problems are those that require an analysis of interrelated systems as encountered in real life situations by practicing engineers. Not only are engineering disciplines involved but also overlapping areas such as law, economics, human factors, politics, and etc. (Figure 8).

The team projects and Visiting Engineer Program place emphasis on the importance of liberal studies and social problems to engineering and involves students in projects requiring creativity and innovations, and stresses the importance of improving the engineer's communication process.

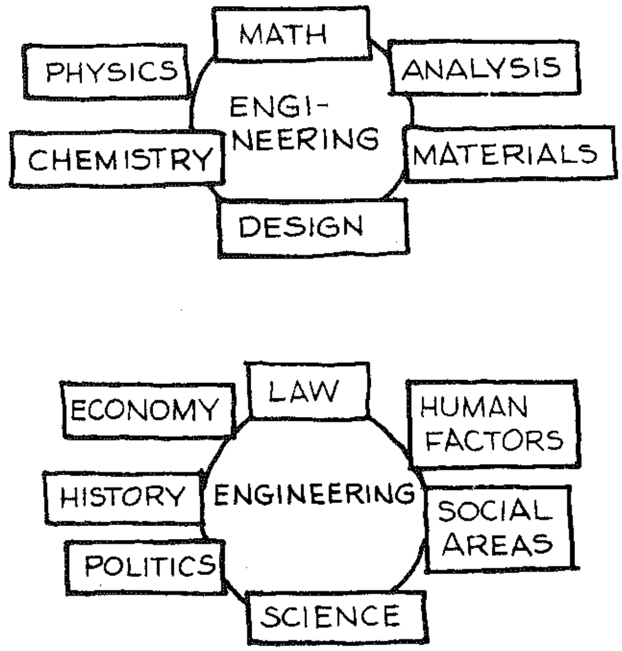


Figure 8: Projects are designed to emphasize the interdiciplinary aspects of engineering beyond the ac ademic disciplines of math, science, and engineering.

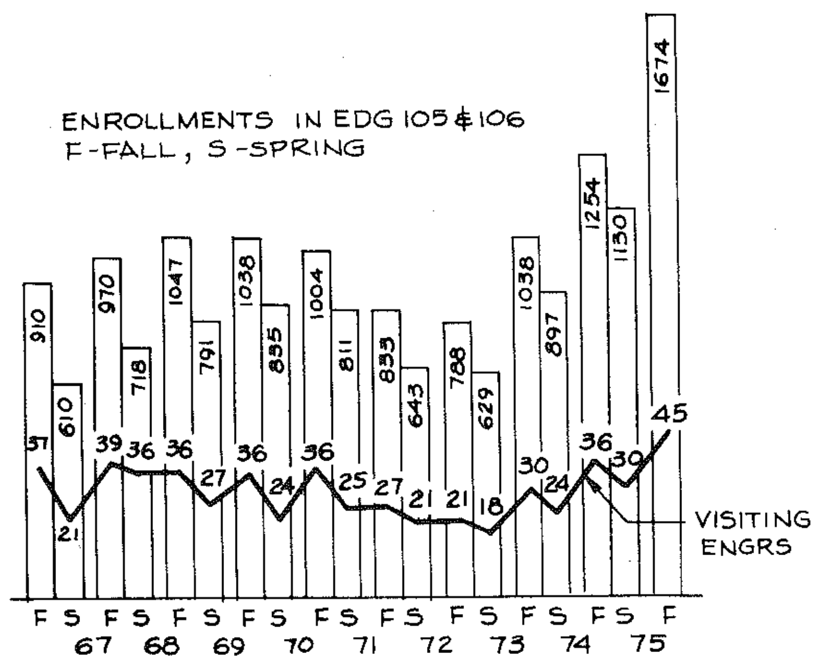


Figure 9: A history of the visiting engineer program since 1966.

REVIEW

The growth of students enrollment and participating visiting engineers is shown in Figure 9 from the beginning of the program in the fall of 1966. During the fall semester of 1975, 1473 students were enrolled in EDG 105 and 201 in EDG 106 for a total of 1647 students. Thirty-three companies furnished 45 practicing engineers for this semester for the Visiting Engineer Program.

This brings the total engineers who have participated in the program to 569 during 19 semesters. This close relationship with the practicing engineers has been a highly valuable experience for the student design teams. There is no better method of introducing students to engineering than bringing them into contact with the members of the profession who are engaged in a variety of engineering activities. The dedication of the participating engineers to their profession has increased our student's appreciation for engineering.

The engineers who participate come mostly from Texas industries within a two hundred mile radius; however some have traveled to Texas A&M from New York, Tulsa, El Paso, and Chicago to serve as consultants.

Visiting engineers serve at their own expense with no funding necessary form the University. The only expense involved is that of a luncheon for each engineer during both his visits. Industry and the profession of engineering has been highly cooperative and enthusiatic with regard to this program, and has shown their enthusiasm through active support of it.

The association of the Engineering Design Graphics faculty with the visiting engineers has permitted a review of course content and relationship to the needs of industry. In a sense, visiting engineers have served as a rotating industrial advisory committee, offering suggestions for improvement. This relationship with industry has been highly valuable for the improvement of professional training and course content development. Visiting engineers are encouraged to offer suggestions for modification of course materials that would improve present offerings.

FOR MORE INFORMATION

We of Texas A&M University are proud of this Visiting Engineer Program. We would be more than happy to share additional details of this program with any of you who are interested in learning more of it. For a brochure of which outlines and describes the current program, please write to: James H. Earle, Engineering Design Graphics Dept., Texas A&M University, College Station, Texas 77843, Phone 713-845-1633.

Limerick Laureates

Competition in the Latter-day Limerick Laureates Laboratory since the last issue has been excellent. There were so many entries of missing last lines to the 3 incomplete limericks submitted by Gordon Sanders that we have decided to print the best last line to each. The Limerick Laureates of the three lines, in turn, will receive a cash award of one dollar (not a big award, but it's fun).

Following are the complete limericks with the last line appearing in italics followed by the author's name and school.

Show Off?

Wound tight at the top of his swing
Great power he intended to bring
But he loosened his grip
When he felt something rip
As a hornet zeroed in for a sting!

Prof. Clair M. Hulley
University of Cincinnati

Design: Form and Function

They admired her form, you could see -
The address and the rest, obviously...
Her waggle - follow through
Was too good to be true
But refused to yell fore from the tee.

Prof. W. G. G. Blackney
Auburn University

Clawed His Way to the Top

An EDG Division Chairman called Claude
With a middle name "Zest" is no fraud -
For the job that he's done
And a year that's been fun -
We give Zest a good rest as rewaud.

Dr. Irwin Wladaver
Miami Beach, Florida

In addition to the winners of the best last line, there was also a Limerick Laureate of 5 lines. We send our congratulations and five dollars to Prof. Clair M. Hulley for the limerick verse printed below.

Computer Graphics '75

A freshman programmer named Jim
Used logic that really was grim
A "GO" for an "IF"
Drove his prof stiff
So the course proved a "closed loop" for him!

Prof. Clair M. Hulley
University of Cincinnati

Send all limericks and/or missing lines to:

Garland K. Hilliard, Associate Editor
239 Riddick Hall
North Carolina State University
Raleigh, North Carolina 27607

by Frances A Mosillo and B. E. Wolf
University of Illinois at Chicago Circle

Motivation Through Computer Graphics

ABSTRACT

As the need for Engineering Graduates to be proficient draftsmen has decreased, although the need of the Engineer to interpret the blueprint has not diminished, more appropriate ways of presenting graphical material have become obligatory. This paper describes the program at the University of Illinois at Chicago Circle which was designed primarily to motivate and teach the basic principles of multiview projections. In addition, there have been several other beneficial effects resulting from introducing the student to the computer facilities and the computer graphics components.

ACKNOWLEDGEMENT

The authors wish to express their gratitude to Dr. Joseph Engel for his counsel and support, to Robert Pancner and Fred Schroeder who spent a great deal of personal time to discuss and make arrangements in the development of this teaching program, and to Edward Jakubas who developed the illustrations and added editorial comments. Computing services used in this research were provided by the Computer Center of the University of Illinois at Chicago Circle. Their assistance is gratefully acknowledged.

BACKGROUND

During a special summer school sponsored by the Engineering Design graphics Division of the ASEE (June, 1972), a computer graphics language called TRIDM was distributed to each of the participants. The adaptation of the computer to Engineering Drawing topics was begun at Chicago Circle following this distribution. The original TRIDM was developed by Byard Houck of North Carolina State University. The Chicago Circle TRIDM utilizes the basic TRIDM program to do all of the graphical calculations and operations, but the language was found to be too complex for a freshman course that was expected to stress engineering graphics and not computer programing. Therefore, two preprocessors were developed to simplify the student's involvement in a computer language (since no previous computer knowledge is needed), and also to emphasize the basic principles of Engineering Drawings. These preprocessors have their own languages that the students find easier to use. The preprocessors generate the more complicated TRIDM code based on the student's instructions.

APPLICATIONS

The first preprocessor the students use is called TRIDM1. The purpose of this program is to introduce the student to:

1. Pictorial interpretation of points and lines in a three dimensional, rectangular coordinate system;
2. Showing the point-by-point relationship in connecting these points in a logical orderly manner;
3. Visualization from the pictorial to the principal orthgraphic projections;
4. Showing the alignment and relationship of the principal multiviews;
5. Reinforcement of the 3-dimensional aspect of each multiviews by using wire frame objects & showing all lines as visible lines;
6. The experience of inputting material to the computer and receiving output.

The second preprocessor the students become involved with is TRIDM2. This version reinforces the principles involved in TRIDM1 and also introduces the students to:

1. Visualization by the manipulation of shapes in three dimensional space:
   a. Spatial visualization in getting three dimensional shapes in the correct location and orientation to define an object;

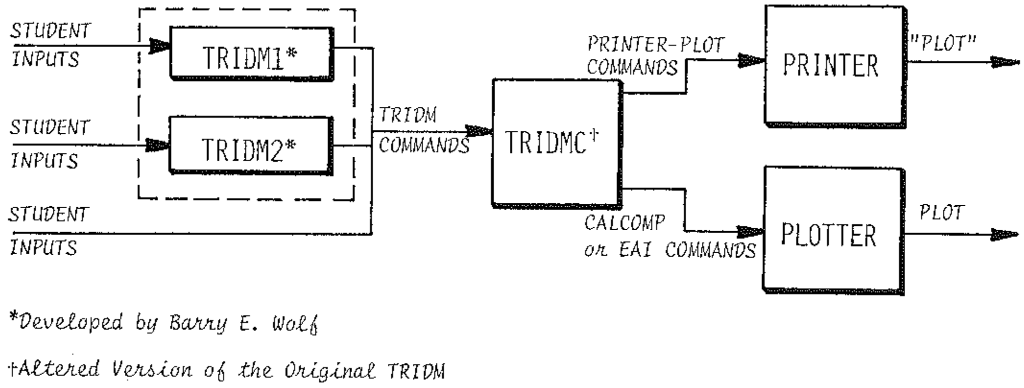


Figure 1: A flow diagram which illustrates the relationship between the students and the TRIDM1 System.

b. Translation and rotation of objects in three dimensional space;

c. Illustration of drawings to different scales;

2. Placement of multiviews in their proper location and location and orientation on a two dimensional sheet of paper. (Visualization and realization as to the location of parts of an object and its ultimate location on the paper. Overlapping views as well as views running off the paper usually result when the student is not aware of this relationship);

3. Computer control through the use of structured command usage.

TRIDM1 - Student input consists of data cards describing the X, Y, and Z coordinates of each point in the order that they are to be drawn. Each card also has a code for a pen control (up or down) to be followed when moving to the specified point. The output will be a plot of all six principal views, a perspective, a border and title box.

TRIDM2 - Student input consists of the X, Y, and Z coordinate points as described above, and further includes newly created commands which combine and simplify the original TRIDM commands for the student.

TRIDM - Student input consists of all standard TRIDM commands. Used only by advanced students, due to complex nature of these commands.

TRIDM1 AND TRIDM2 COMMANDS

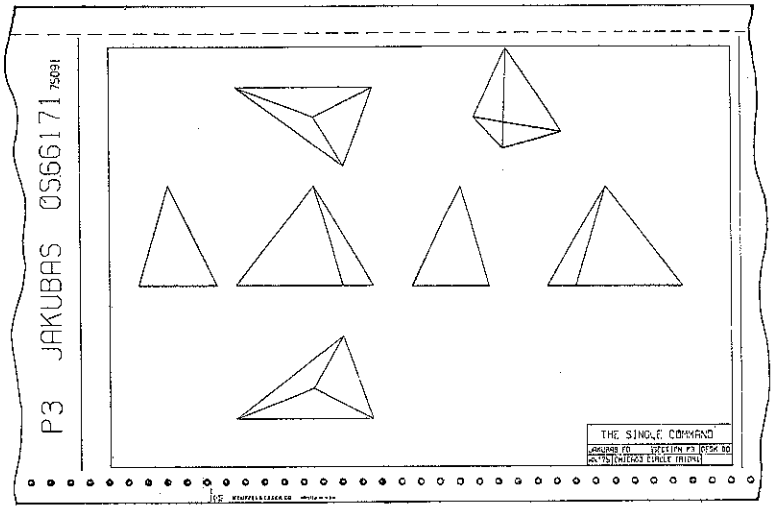
TRIDM1 has one command, (OBJS). This command identifies an object in space and the order in which the lines of this object are connected. From this information it will generate the six principal views and a perspective of the object.

TRIDM2 Is made up of the command in TRIDM1 (OBJS) plus five additional commands. One of these commands (MOVE) gives the learner experience in the translation of points, lines, and geometric shapes in space, while another gives the learner experience in the rotation (REVO) of these elements. A fourth command enables the student to assemble (ASMB) these geometric shapes in space, and a fifth command enables the learner to increase or decrease (MULT) the size of previously established objects. A final command (VIEW) is the one that activates the drawing of the specified views in their respective locations.

The first five commands (OBJS, MOVE, REVO, ASMB, MULT) require the learner to experience spatial relationships as all the manipulations had to be visualized in three dimensions. The last command is the only two dimensional command, used to draw all of the previous information on a two dimensional surface. The students use this command to locate the necessary views to be drawn and to specify which view is required. However, in so doing this, the student must visualize what the individual multiview looks like as well as being aware of the required orientation of orthographic views. This in itself, as all drawing teachers are aware, is no small task. Is there anything more frustrating for an instructor than to have a student complete a multiview out of projection on the final exam?!

PROGRAM DESCRIPTION

TRIDM creates alteration matrices that are stored as they are created. The program maintains a table of objects, alteration matrices and the order of operation. When the user wishes the plot to be drawn, the program then performs the alterations on the objects, and generates simple plot calls.




```
+++++++++++++++++++++++++++
+LISTING OF INPUT TO TRIDM1+
+++++++++++++++++++++++++++

 COLUMNS 1 COLUMNS 2 COLUMNS 3 COLUMNS 4 COLUMNS 5 COLUMNS 6 COLUMNS 7 COLUMNS 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
*'. THE SINGLE COMMAND*
          #N'75     JAKUBAS ED            SECTION P3          DESK 0?
OBJS AA
0.0       0.0       0.0                     11  D100
2.75      0.0       2.0                     10  A110
3.5       0.0       0.0                     10  B120
0.0       0.0       0.0                     10  D130
2.0       2.5       0.75                    10  C140
3.5       0.0       0.0                     10  B150
2.0       2.5       0.75                    11  C160
2.75      0.0       2.0                     10  A170
0.0       0.0       0.0                     11  D180
                                            -1
 COLUMNS 1 COLUMNS 2 COLUMNS 3 COLUMNS 4 COLUMNS 5 COLUMNS 6 COLUMNS 7 COLUMNS 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Figure 2: Six principal views of an object generated by TRIDM1 and the printout of this data.

Changes to the original TRIDM were kept at a minimum in order to keep our TRIDM compatible with other TRIDM versions in use.

TRIDM will accept and process a multitude of student errors, and either correct them, or else clearly explain to the student what the error was. If results will be meaningful, TRIDM1 will produce a plot of the student input. The six principal views, along with a perspective are placed neatly within set borders. These views and placement are automatic, no student intervention is required.

TRIDM2 will generate the majority of the TRIDM commands, regardless of compexity (of use), from simplified TRIDM2 commands. TRIDM2 does extensive error checking, to insure that absolutely no invalid TRIDM commands are passed to TRIDM. This of course duplicates some of the TRIDM error checking routines. The justification of this duplication is that TRIDM2 handles more types of errors, and produces clearer, easier to understand, and most certainly more informative error messages, than does TRIDM. TRIDM is a good and useful language, but one must be intimately familiar with it to get satisfactory results. TRIDM2 allows an absolute novice at computer usage to get very sophisticated computer graphics plots.

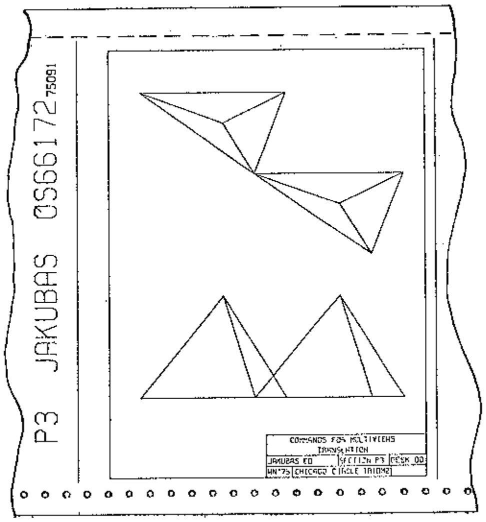
TRIDM2 works basically on a generalized code producing system. Based on given parameters, a multitude of TRIDM commands can be produced from the same routine. Common areas are used for all general parameter passing, and argument lists are used when passing specific parameters. This system makes TRIDM2 run quite fast.

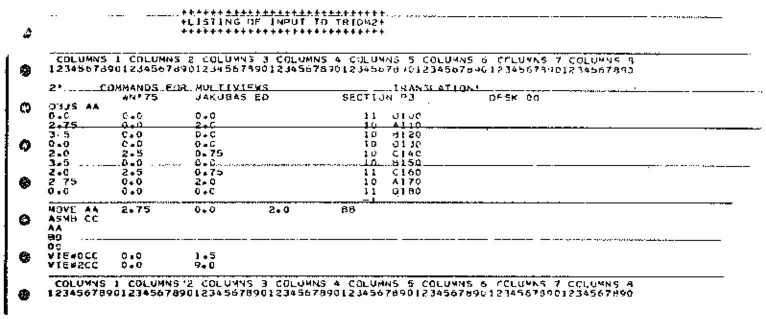
Wherever flexibility is possible, TRIDM2 optimizes the student's commands to produce faster running, more refined, TRIDM code.

SPECIAL INNOVATIONS IN TRIDMC

The original version of TRIDM was geared toward individual use. It did not lend itself easily for use by an entire class of students, using a large computing facility along with many other classes. In addition to developing TRIDM1 and TRIDM2 for the sake of creating an easier command structure, TRIDM itself was altered to work easier within the heavy usage area.

A subroutine was added to TRIDM to draw a title box on the plotting sheet. This title box controls information identifying the plot itself, the student (name, desk #, etc.), and which pre-processor was used (TRIDM1 or TRIDM2).





```
*****************************
*LISTING OF INPUT TO TRIDM2*
*****************************

COLUMNS 1 COLUMNS 2 COLUMNS 3 COLUMNS 4 COLUMNS 5 COLUMNS 6 COLUMNS 7 COLUMNS 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

2*      COMMANDS FOR MULTIVIEWS                    TRANSLATION*
          AN*75     JAKUBAS ED              SECTION P3          DESK 00
O3JS AA
0.0       0.0       0.0                       11  0100
2.75      0.0       2.0                       10  A110
3.5       0.0       0.0                       10  B120
0.0       0.0       0.0                       10  0130
2.0       2.5       0.75                      10  C140
3.5       0.0       0.0                       10  B150
2.0       2.5       0.75                      11  C160
2 75      0.0       2.0                       10  A170
0.0       0.0       0.0                       11  0180
MOVE AA   2.75      0.0       2.0       BB
ASMB CC
AA
BB
00
VIEW0CC   0.0       1.5
VIEW2CC   0.0       9.0

COLUMNS 1 COLUMNS 2 COLUMNS 3 COLUMNS 4 COLUMNS 5 COLUMNS 6 COLUMNS 7 COLUMNS 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Figure 3: A translation in TRIDM2 and the printout of the data.

A plotter, as a rule, is a very slow output device. Even in a computer environment where turnaround could take only 20 minutes, it is usual that plot will not be ready for perhaps a few hours. This extensive waiting period during development of a plot is intolerable to the student. Therefore, a print-plot feature was added to TRIDM. Using this feature the student can produce a reasonable facsimile of his plot on the printer, taking full advantage of the faster turnaround time. When he is satisfied with his print-plot, he can then request the final version on the plotter.

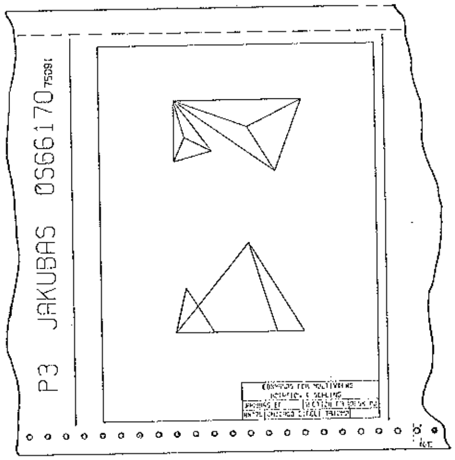
Occasionally a student will have problems with TRIDM that his teacher has to solve for him. Or perhaps the teacher merely wants to test out his own ideas. In either case, the teacher should not be required to wait a few hours for his plot. Therefore, an interactive feature was added to the TRIDM package. Using TSO (Time Sharing Option), an interactive terminal, and an EAI 230 plotter, one can utilize TRIDM on line. Use of TRIDM on line is ordinarily streamlined (as little printing to the terminal as possible), geared more towards simply producing the plot. But if errors are detected, the user can, by request, back up the process and receive all the usual output. By allowing the user to back up instead of restart the process, valuable computing time is saved.

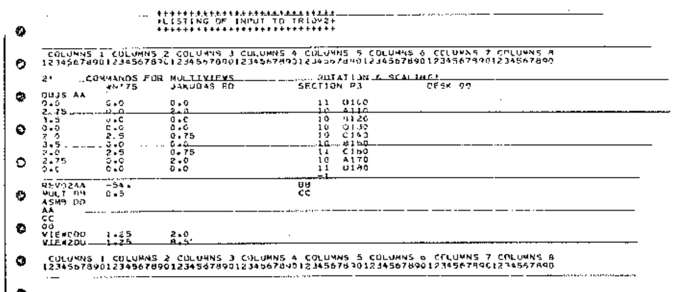
In general, innovations made to TRIDM, in order to develop TRIDMC, were done to make the use of TRIDM by many people as easy and fast as possible.

PHYSICAL FACILITIES

The equipment currently being used at the Circle Campus is an IBM 370/158 (VS) in conjunction with a CalComp 663 plotter. This is a complete "hands off" system where the student reads in his deck through a reader and picks up his output (and plot) at a later time from a numbered bin in another room. In the preliminary stages of the TRIDMC development, an IBM 1800 computer was used in conjunction with a CalComp 1627 plotter. This was a complete "hands on" system where an operator had to feed the decks into the reader in the same room as the computer, punch the appropriate buttons on the computer as well as activate the appropriate controls for the printer and plotter to operate.

The TRIDMC package needs a Fortran compiler, 12K of core, and a printer. If a plotter is available, it can be utilized easily,





```
++++++++++++++++++++++++++++
+LISTING OF INPUT TO TRIDM2+
++++++++++++++++++++++++++++

 COLUMNS 1 COLUMNS 2 COLUMNS 3 COLUMNS 4 COLUMNS 5 COLUMNS 6 COLUMNS 7 COLUMNS 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
2*    COMMANDS FOR MULTIVIEWS             ROTATION & SCALING*
          W'75        JAKUBAS RD              SECTION P3          DESK 99
OBJS AA
0.0        0.0        0.0                       11   D100
2.75       0.0        2.0                       10   A110
3.5        0.0        0.0                       10   B120
0.0        0.0        0.0                       10   D130
2.0        2.5        0.75                      10   C140
3.5        0.0        0.0                       10   B150
2.0        2.5        0.75                      11   C160
2.75       0.0        2.0                       10   A170
0.0        0.0        0.0                       11   D180
                                                -1
RSVO2AA    -54.                              BB
MULT BB    0.5                               CC
ASMB DD
AA
CC
DD
VIEWCDD    1.25       2.0
VIEW2DD    1.25       8.5
 COLUMNS 1 COLUMNS 2 COLUMNS 3 COLUMNS 4 COLUMNS 5 COLUMNS 6 COLUMNS 7 COLUMNS 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

PRINTOUT OF FIGURE 4

Figure 4: The rotation and scaling of a plot in TRIDM2 and a printout of the data.

due to a centralization technique employed by TRIDM. Some intermediate storage space is also needed. This can be on disk or tape.

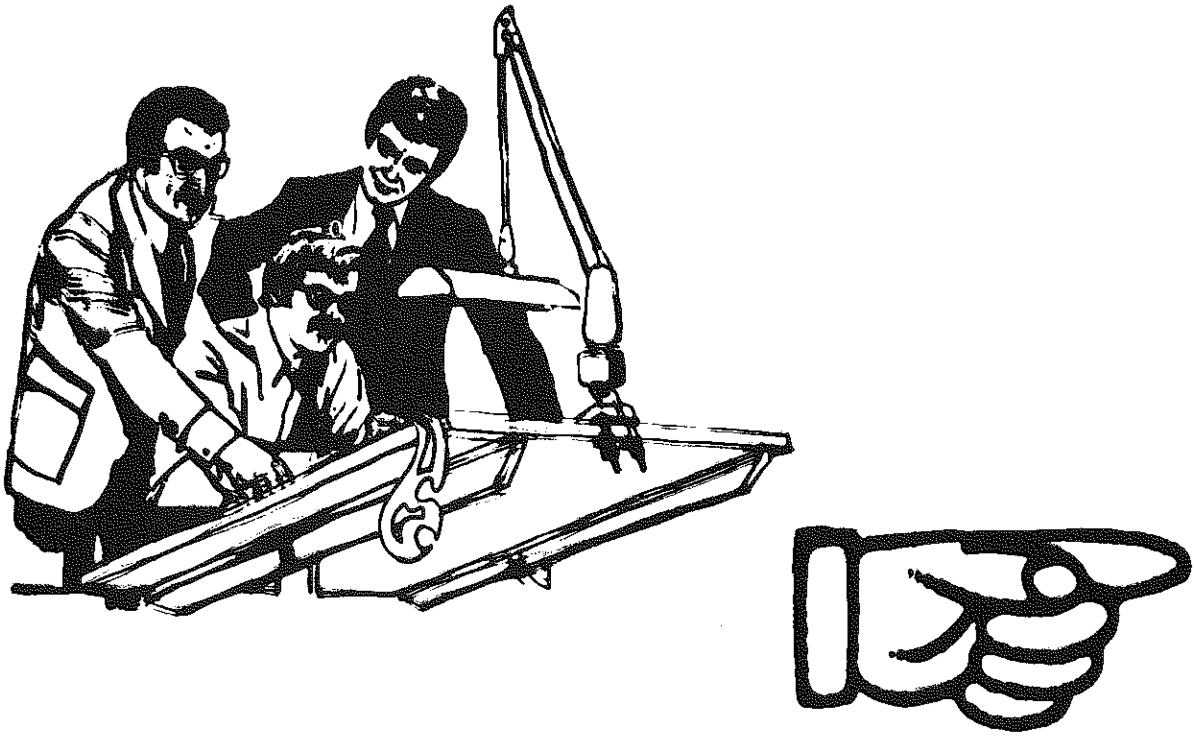
TRIDM lends itself easily to overlaying techniques, which is why it can be squeezed into 12K of core. Some examples of the versatility of the TRIDMC package follows. A community college in one of the northern suburbs of Chicago has an operating version of TRIDMC on an IBM 370/135 DOS System, using the printer-plot feature (they have no plotter). Also, a community college in California is utilizing the Circle version of TRIDM on an IBM 1130 computer with a CalComp 563 plotter.

DISCUSSION OF STUDENTS USING TRIDM

Although the faculty who taught the basic Engineering drawing courses resisted the implementation of Computer Oriented graphics on the basis of it being too time consuming and/or complicated in an already overburdened graphics course, the students overwhelmingly accepted it. Back in the days when the students were learning the harder to use TRIDM language rather than the simplified preprocessor languages, though they complained of the time consumed in the course, they overwhelmingly wanted the computer material to be retained if not increased.

The faculty were concerned that the computer material would completely overshadow the basic objective of the course of Engineering Drawing, that is, reading working drawings. The evolution of TRIDM1 and TRIDM2 however, recognizes this basic charge. Carefully chosen examples to teach and motivate students in the learning of reading multiviews has since reduced the amount of work in the course substantially without reducing student interest or learning. In fact, the Engineering Graphics staff has also embraced the approach because for the first time in a very long period of time, the students are acting positively towards this area, which is quite a switch from merely taking the course as a requirement. Also, for the first time in many years a sufficient number of students are taking elective courses in the Engineering Graphics area to indicate that these courses are being well received.

Additional courses are being developed at this time to utilize the computer as a tool only, rather than to study the computer or computer languages. The Engineering students are being attacked from all sides on the theories and languages of the computer without being given adequate opportunity to learn of the engineering applications of computers. The tack taken in this course and in other planned courses will, we hope, fill this void for more engineering students in the future.



Design Simplification

by Edward Holland, Jr.
Federal City College
Washington, D. C.

Many complex engineering problems can be solved by relatively elementary means. The piece of equipment shown represents the ultimate in a simplified solution to a rather complicated engineering problem.

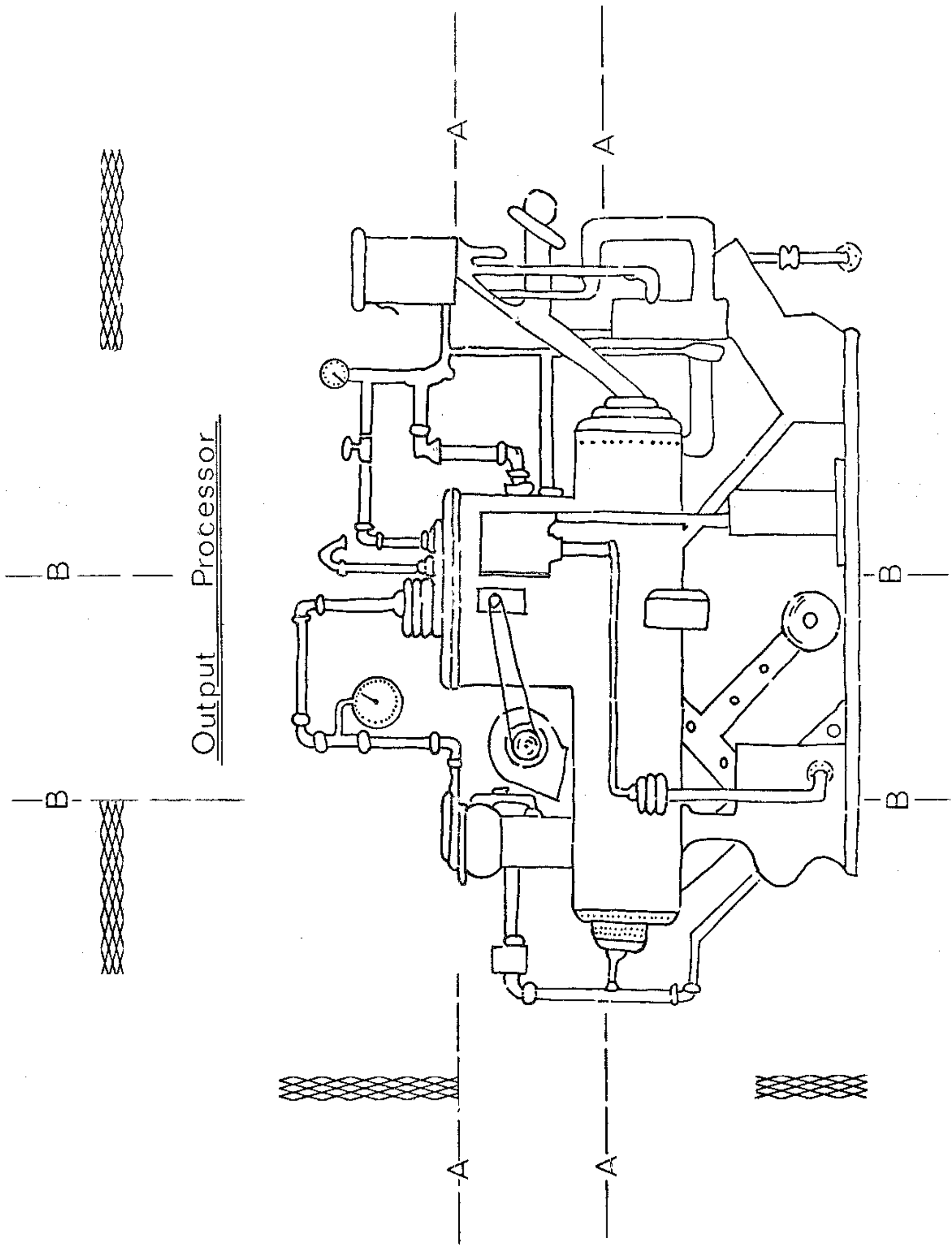
A large industrial firm was confronted with the problem of designing and manufacturing a functional piece of equipment known as an "output processor". The firm's engineering department investigated the function of the output processor, and in three months developed a prototype as shown in the figure. The estimated cost for this processor was $45,900.

Management evaluated the design prototype and concluded that a less costly output processor could be developed. The problem was turned back to engineering, and after another four months of intense investigation and refinement, a simplified version of the output processor was developed (this simplified unit can be viewed by folding the figure along lines "A" until the vertical crosshatched line is continuous). The proposed cost of this simplified unit was reduced from the original $45,900 figure to $25,000. Management again evaluated this simplified design, but concluded that the cost and complexity of the processor were still excessive.

The project was near abandonment when, as a last ditch effort, it was turned over to a group of college engineering students.

This group evaluated the two previous solutions, made an extensive series of modifications, and constructed a mock-up of the proposed solution for $24.95.

Management was informed of this miraculous solution, and immediately sent a group of engineers to the college campus to evaluate the prototype. Much to their surprise, the engineers found that his drastically simplified output processor satisfactorily met all of the design criteria (keep section "A" folded and fold figure along lines "B" until the horizontal crosshatched line is continuous).


Output Processor
A
A
A
A
B
B
B
B

Candidates for Office

The candidates below have been nominated for the office indicated below by your nominating committee. Ballots will be mailed to all members of the Engineering Design Graphics Division this spring.

The results of the election will be announced at the annual ASEE meeting in June. The new officers will take office at the close of this meeting.

Please vote for the candidates of your choice when the ballot is received.

AMOGENE F. DeVANEY

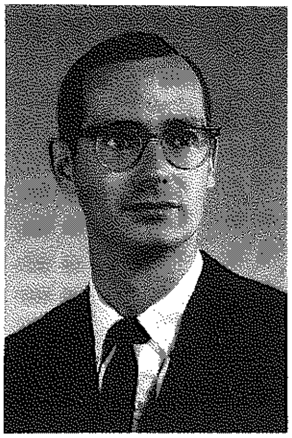
Candidate for Vice Chairman

Professor DeVaney is a graduate of West Texas State University, and holds a doctors degree from New York University. She is a professor of mathematics and engineering graphics at Amarillo College in Texas. As a member of ASEE since 1948, Amogene has served the EDG Division in many capacities: executive committee, the teaching techniques committee, the nominating committee. She is presently chairman of the committee that is planning a world congress for the graphics field that is sponsored by the EDG Division. She has authored a number of publications.

W. GEORGE (BUD) DEVENS

Candidate for Vice Chairman

Professor Bud Devens is a graduate of West Point and the University of Illinois. His broad experience includes twenty years service in combat construction, civil works and command duties in the U. S., Europe, and Asia. He is presently professor and director of the Division of Engineering Fundamentals at Virginia Polytechnic Institute. He has been active as an author in the field of graphics and metrication. Bud has served as vice chairman and chairman of the Southeast Section of the Engineering Design Graphics Division. He was a co-host of the Williamsburg midyear meeting of the Division.



ROBERT J. FOSTER

Candidate for Secretary-Treasurer
1976-79

Professor Foster received his degrees, including his doctor's degree, from Pennsylvania State University. He joined the engineering graphics program of Penn State in 1959; he is presently in charge of that program. His industrial experience includes work with the Bendix Corporation, the Naval Research Laboratory, Erie Technological Products and others. Bob has served during the last three years as Associate Editor of the EDG Journal, and has served actively in the Division. He is the author of a number of publications.

PAUL DeJONG

Candidate for Director of Publications
1976-79

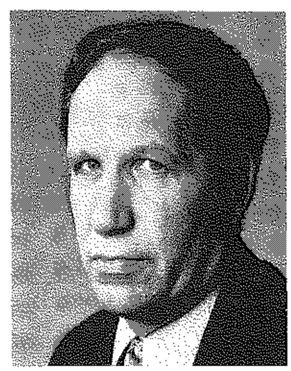
Professor DeJong received his bachelor's degree in mechanical engineering from Iowa State University in 1960. He is a registered professional engineer in Iowa and South Dakota.

His industrial experience includes work as a private consultant, design engineer, draftsman and designer, and cartographic draftsman. Paul has taught engineering graphics at Iowa State University since 1966. He is the author of a number of publications. He is presently ending his term of office as secretary-treasurer of the Division.

FRANK F. MARVIN

Candidate for Secretary-Treasurer
1976-79

Professor Marvin is a West Point graduate with over twenty-four years service in the Air Force as a pilot, research and development engineer, and teacher. He has been a member of ASEE since 1958. He is an associate professor of Engineering Fundamentals at Virginia Polytechnic Institute and is the author of a number of publications. Frank has served as chairman of the Graphics Technology Committee.



EDWARD W. KNOBLOCK

Candidate for Director of Publications
1976-70

Professor Knoblock teaches engineering graphics, design, and manufacturing processes at the University of Wisconsin at Milwaukee. His twenty years of teaching also include an assignment at Oakland Community College. He is presently assistant dean of undergraduate studies at the University of Wisconsin. Ed served as Division secretary in 1966-67. He has also served on the Teaching Methods Committee and the Design Display Study Committee.

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INDIVIDUAL MEMBERSHIP APPLICATION

Date_______________

I, ______________________ (signature), hereby apply for membership in the American Society for Engineering Education, and enclose ______________ as my annual membership dues for the year. $5.50 and $1.50 of this amount are for a year's subscription to ENGINEERING EDUCATION and *Engineering Education News* respectively. The undersigned member of ASEE stands as my sponsor. (If ASEE sponsor is not readily available, application may be submitted to ASEE Headquarters for continuing action.)

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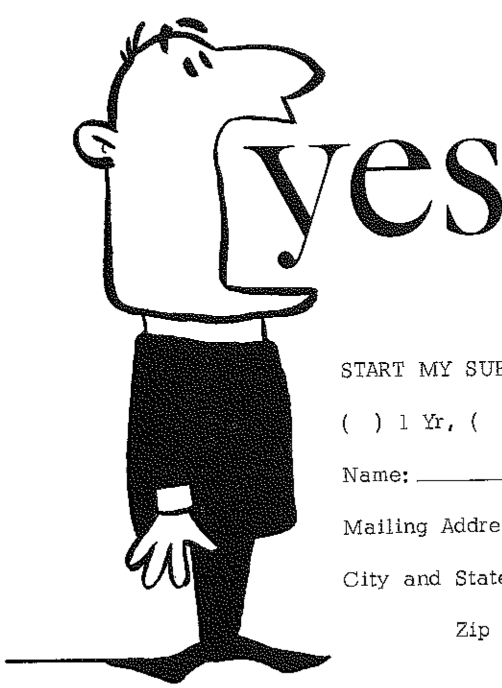

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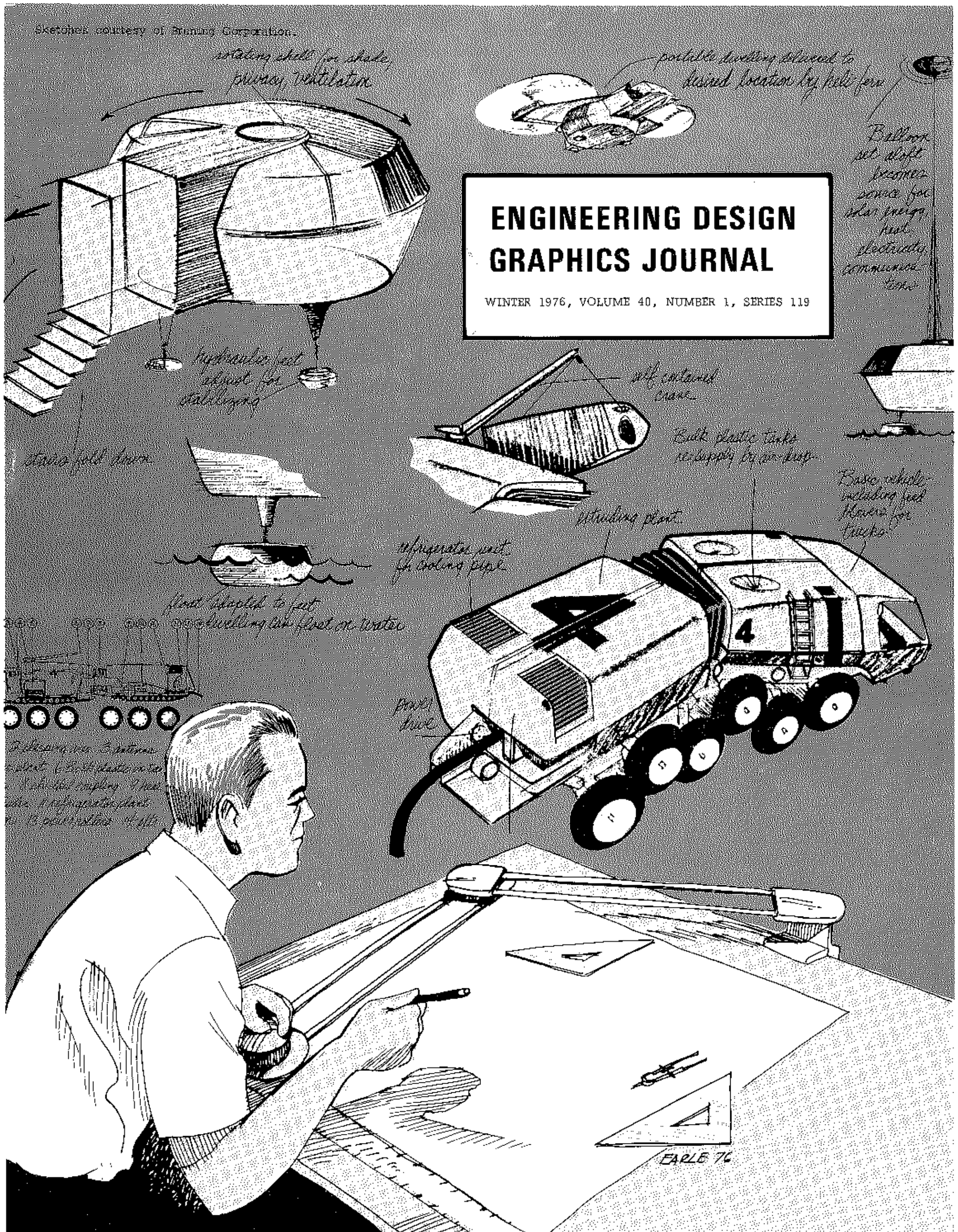

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