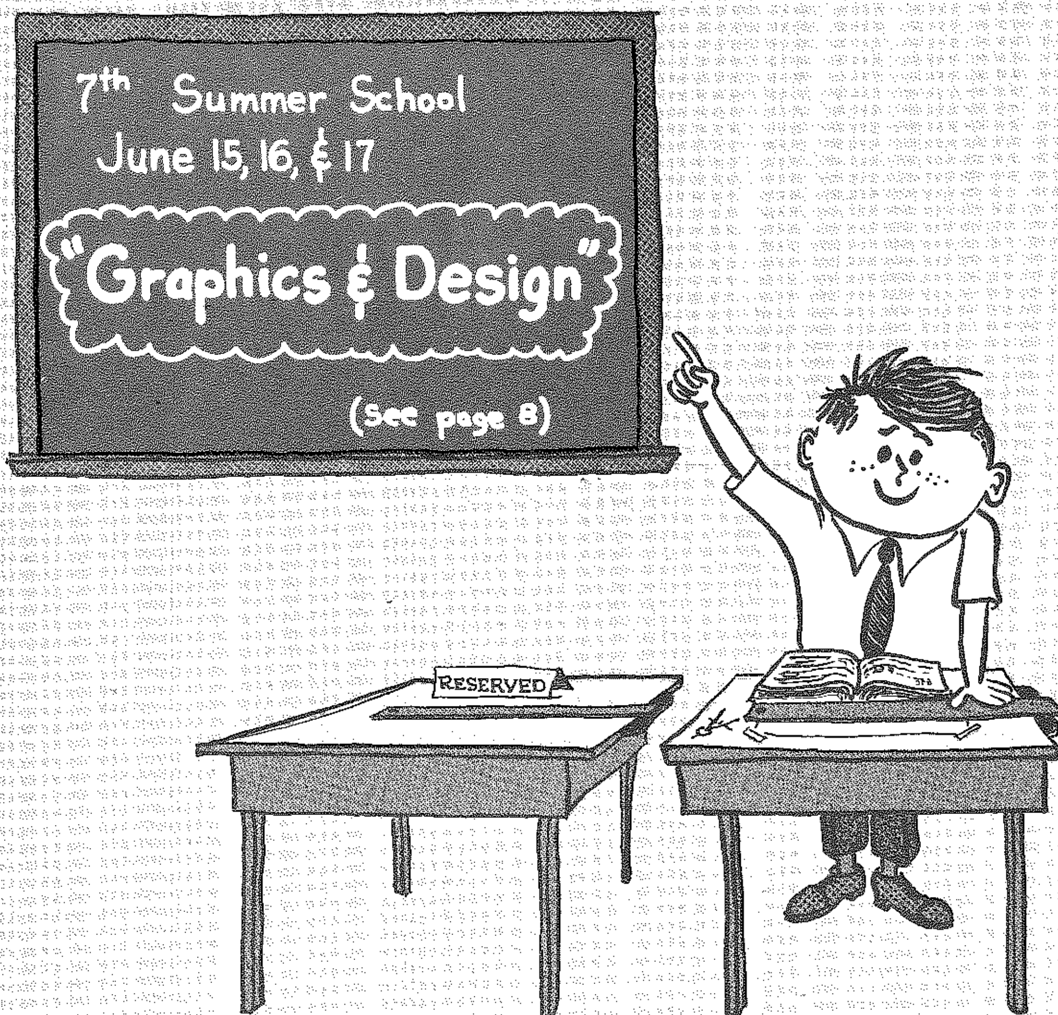
The Journal of Engineering Graphics

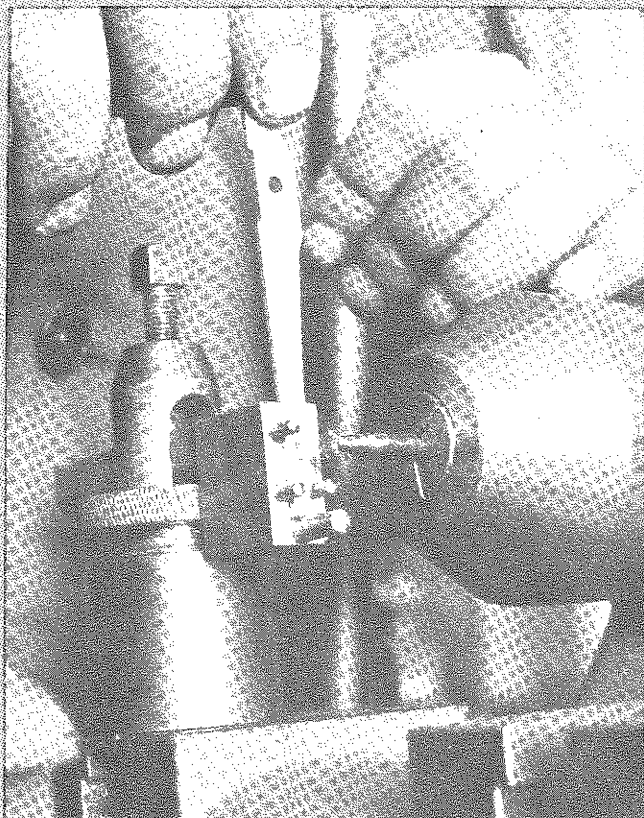


May (Spring) 1967 Volume 31, No. 2, Series 92

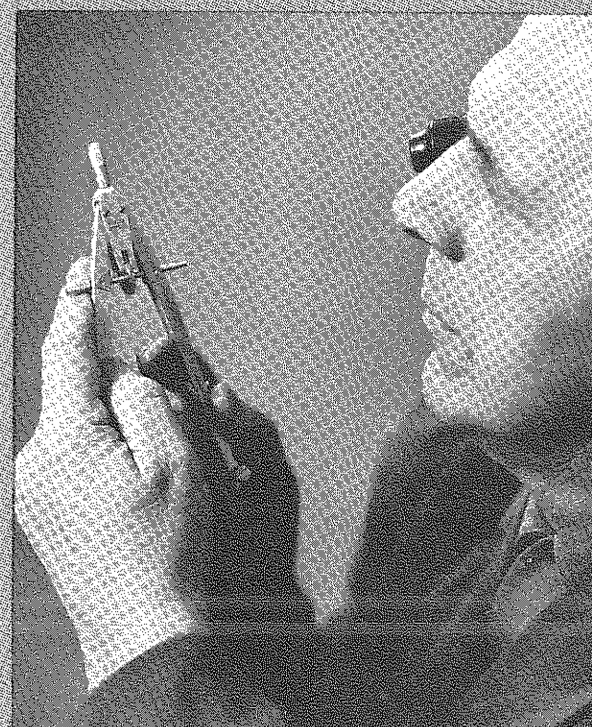
Published by the Division of Engineering Graphics, American Society for Engineering Education.

CRAFTSMANSHIP

OLD WORLD
HANDWORK



+ PRECISION



= QUALITY

ASPEN, COLORADO PHOTO BY: BERKO

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Frank Oppenheimer, President

The Journal of Engineering Graphics

May (Spring) 1967 — Volume 31, No. 2, Series 92

Published for teachers and others interested in Engineering Graphics. It is published three times per year -- Fall (November), Winter (February), and Spring (May).

The subscription rates are: $2.00 per year in the United States (single copies 75 cents). Foreign rates upon request.

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DEPARTMENTS

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ABOUT THE COVER

Expression of appreciation should be made to Robert J. Christenson of the GMI faculty, who designed the original format for the covers of the Journal of Engineering Graphics starting with issue Number 1 of Volume 29; and who prepared the subsequent cover designs including this issue.

Available For Examination Spring 1967

TECHNICAL DRAWING, Fifth Edition

By the late Frederick E. Giesecke, the late Alva Mitchell; revised by Henry Cecil Spencer, on leave, the Illinois Institute of Technology, and Ivan Leroy Hill, the Illinois Institute of Technology

Since the original publication of the First Edition, TECHNICAL DRAWING has been used by more than two and a half million students. In the painstaking process of constant revision, the authors have sought and achieved excellence: excellence in illustration and example; excellence in definition and explanation; and excellence in the production of a book which includes *all* of the basic graphics instruction needed by the engineer, the scientist, or the draftsman.

In this Fifth Edition, the authors have thoroughly revised all material to accord with the current *ASA Y14 American Standard Drafting Manual*, including the latest American Standard on *Dimensioning and Tolerancing for Engineering Drawings*. In addition, modern trends in engineering education have been taken into account. Leading engineers and manufacturers, mindful of the role of TECHNICAL DRAWING in the education of future engineers and scientists, have helped the authors incorporate the most current industrial thinking in this new edition. One example is the emphasis placed upon decimal dimensioning in the illustrations and problems. Technical sketching is also emphasized. Four entirely new chapters have been included: Electronic Diagrams, Alignment Charts, Empirical Equations, and Graphical Mathematics.

A text that has become *the* classic, the Fifth Edition of TECHNICAL DRAWING continues to uphold the standard of excellence set and maintained by the previous editions.

LETTERS TO THE EDITOR

Dear Professor Black:

Enclosed you will find my reply to the controversial article "Descriptive Geometry a Self-dependent Spatial Science" by T. D. Pozniak, Buffalo, published in the November, 1966 issue of the Journal of Engineering Graphics.

I feel that this is exclusively a matter for the Division of Engineering Graphics of ASEE, and the reply should be presented to the members of the Division.

Sincerely yours,
V. P. Borecky
University of Toronto

GLOSSARY AND COMMENT

PECULIAR LINES AND PLANES by V. P. Borecky, J.E.G. - February, 1966.

DESCRIPTIVE GEOMETRY A SELF-DEPENDENT SPATIAL SCIENCE by T. D. Pozniak, J.E.G. - November, 1966.

A technical article dealing with an unusual topic can be extremely beneficial to the subject when the description of an application of rather unfamiliar concepts is expressed in judicious form, and when an accepted designation of notation and terminology is preserved. On the contrary, the contents of an article can prove quite harmful to the subject when it demonstrates a disordered haste in the arrangement and a mixed-up terminology.

How is it possible to eliminate in advance any doubt about the real value of the article?

Before an article is accepted for publication, its contents must be examined by several experts in the field (i.e., members of a specially appointed committee, or independent outside referees) whose suggestions should be carefully weighed prior to the final decision of the editor.

The publication of misleading articles should be avoided as much as possible. Much harm can be done by dubious statements which may not be immediately detected by the average reader. (See Editor's Note.)

Sound response and objective criticism is always appreciated, but unfounded statements can create unnecessary confusion and lead to incorrect conclusions.

For several years I have been taking pains in re-establishing the fading reputation of subjects pertaining to engineering graphics.

In the following, while giving some detailed explanations, I am analyzing point by point, the

Continued on page 23

GRAPHITE DUST

IMPROVEMENT ADDS NEW DIMENSION TO ASCA, ISI'S WEEKLY CURRENT AWARENESS SERVICE

A new important feature has been added to ASCA (Automatic Subject Citation Alert) -- the world's first commercially available large-scale computerized weekly information system designed specifically for individual scientists, it was announced by ISI (Institute for Scientific Information) Philadelphia.

A scientist can now indicate his subject interests by telling the ASCA system what words, word stems and phrases describe his areas of interest. The ASCA system then automatically sends him weekly computer printouts reporting new research of interest to him.

This ability to describe subjects by words augments the ASCA system's existing capability of answering such questions as "what current papers have cited earlier papers," "has this man published any new works recently," "what current works cite a particular author's paper," "What current papers are being published by a given organization, either industrial, academic or governmental."

ASCA examines current journals as fast as they appear, extracts those items related to the scientist's selected interests, and mails him a personal computer printout each week. The report gives complete bibliographic data for the items retrieved. If no findings are made in a given week, the scientist still receives a report confirming the fact that a search was conducted for him.

More than 1600 significant journals in all areas of research are covered in the ASCA system. Even though this new feature has been added and additional journals are now covered, there will be no price increase. The basic rate for ASCA remains at $100 per year.

For additional information, contact Mrs. Joan E. Shook, Institute for Scientific Information, 325 Chestnut Street, Philadelphia, Pennsylvania 19106.

Continued on page 53

Editors' Board

EDUCATION SHOULD BE THE

FOUNDATION TO PROGRESS

Industry and government are now bulldozing their way through many problems because of a lack of knowledge and the inability of engineers to adequately communicate ideas. Engineers must be educated in practical aspects of engineering and not in just the theoretical alone. It is difficult to separate the practical from the theoretical in actual practice.

A sound career in engineering is built step-by-step from experience based on practical knowledge. Engineering graphics, properly taught and having a comprehensive coverage, is basic to the foundation of any engineering career. Engineering graphics may also be a major assist in a scientific career. Even the long-haired engineer must come down to earth at times in order to explain his ideas to others.

A scientific education alone has proved inadequate to gain the respect of the practicing engineer. It does not prepare the engineer for job assignments in numerous fields of industry. As the practicing engineer reaches retirement, the young engineer must take his place of responsibility. Many times the young engineer is promoted to a job of responsibility. He has many new ideas and a progressive spirit, but he lacks the ability to put his ideas across for his fellow workmen. He has not had the training nor experience in graphical communication required for the job. Furthermore, many educators are ignoring this shortcoming inflicted on the young engineer. Nor has company management completely informed educational administrators and curriculum supervisors of changing needs in engineering.

Failure to examine the curriculum and college courses offered in the light of what they will do for the future of the student is almost criminal. Let us reappraise our objectives, plan the best possible use of our potential resources, and chart a reasonable course into the probable developments that lie ahead. Currently the trend is that fewer and fewer entering students in the engineering schools have had instruction in engineering graphics. Furthermore, it is unreasonable to expect high schools to teach college level courses. On the other hand, college courses should be more than repetition of high school work. All work should be as professional as we can make it.

Engineering graphics is the handmaiden of both the sciences and engineering. Fundamentals of the graphic language must be mastered before design courses can be successfully taught. Not knowing the usefulness of graphical computation is a severe handicap to the engineer. The designer uses engineering graphics as a means of communication to himself as well as to his production team. In fact, the science of descriptive geometry is the graphical tool that he uses for solving problems in space relationships of design and engineering fundamentals. Engineering graphics is his way of indicating true meaning.

Engineering graphics courses should serve the two-fold need of providing communication techniques required in the student's future courses as well as his work experience. The engineer must know more than the draftsman who works for him. He should be an idea man. Emphasis on freehand drawing is not a sufficient substitute for instrument-accurate drawings. Nor does the use of freehand drawing give a license for performing sloppy and careless work. Likewise, instrument drawings do not substitute adequately for the proper use of freehand drawings. One supports the other. The engineer must be proficient in both even though his major work in the profession may not be on the board.

Descriptive geometry is the key to engineering graphics. The value of descriptive geometry depends upon its use in attacking spatial problems in all fields of science. The graphic procedure for many problem solutions has saved millions of dollars in many industries through accurate analysis.

Aesthetics, even though it is related to art, expresses an idea that engineers must learn. Art combined with engineering graphics is an improved tool for the designer in recording and communicating ideas. It is used by many specialists to help their business agents secure the confidence of customers by furnishing good intelligent engineering and pictorial drawings.

The habit of thinking in graphical language for representing space concepts is a valuable skill which the engineering student will surely use to advantage. However, every drawing should be justified and the student should be taught how to produce them with the least expensive method at hand. We must be careful that we do not capture the student and lead him into a temporary state of uselessness to his profession because he has not learned how to make practical applications. We cannot be certain of the future, but we can use our past experiences as a guide. Engineering graphics can be taught in relation to the broader interests of our time and as a medium for the acquisition of a liberal education.

E. D. B.

At the moment I have two ideas under consideration for our annual meeting at UCLA in June, 1968.

Since the Junior College is a most significant and expanding element of higher education, especially in the West, I hope that we can make every effort to extend our membership in that area and to encourage attendance from that group at the UCLA meeting by devoting one of our sessions to a panel discussion of their engineering program.

In addition, I feel sure that the time will be ripe for us to display our new look to our colleagues from other departments. With the essential cooperation of a great many, I hope to have available at UCLA an impressive display of selected engineering design orientation projects. I am confident that for our maximum development our overall image must reflect our endeavors to provide student inspiration and motivation by means of those creative design projects appropriate to the young engineering student. I trust that by the preceding statement I do not leave the impression that I am less devoted to the traditions of our specialty. Rather I feel that to maintain the stability of these traditions, our course work must be periodically updated and pruned. Above all, however, our graphic concepts must be attractively packaged, displayed, and advertised in order to bolster our competitive educational posture.

Directly or indirectly our Michigan State summer school should suggest many design projects that will produce student work that can be exhibited and discussed at UCLA. Local publicity can also help our cause. For example, the University of Idaho has just released a fine article on the results of an open-end freshman design project with awards provided by local industry.

Please discuss this design project display with your associates and plan to provide some choice exhibits for our next years' promotional activities that should be of benefit to all.

Cordially yours,

Eugene G. Paré
Vice Chairman
ASEE Engineering
Graphics Division

PAST RECIPIENTS OF DISTINGUISHED SERVICE AWARD

1950	F. G. Higbee
1951	F. E. Giesecke
1952	G. J. Hood
1953	C. L. Svensen
1954	R. P. Hoelscher
1955	Justus Rising
1956	R. S. Paffenbarger
1957	Frank Heacock
1958	H. C. Spencer
1959	C. E. Rowe
1960	C. H. Springer
1961	W. E. Street
1962	Jasper Gerardi
1963	T. T. Aakhus
1964	W. J. Luzadder
1965	R. T. Northrup
1966	J. S. Rising

COMMITTEE REPORTS

WILLIAM S. CHALK GETS FRANK OPPENHEIMER AWARD

Presentation by A. L. Hoag

Washington State University
Pullman, Washington - June 22, 1966

The FRANK OPPENHEIMER AWARD for excellence in presentation has been established through the generosity of a long-time friend of the Division, Frank Oppenheimer of Gramercy Guild Group, Inc. The purpose of the award is to encourage excellence in presentation of papers at meetings of the Division and speakers are judged on familiarity with content, timing, delivery, enthusiasm and effective use of visual aids (if used).

The judges at this meeting unanimously voted the award, consisting of $100 and a certificate, to Professor William S. Chalk of the University of Washington for his presentation of the paper entitled "The Design Process for Freshman Engineers."

DIVISION OF ENGINEERING GRAPHICS OFFICERS 1967-1968

E. G. Pare — Chairman
Washington State University

E. D. Black — Vice Chairman
General Motors Institute

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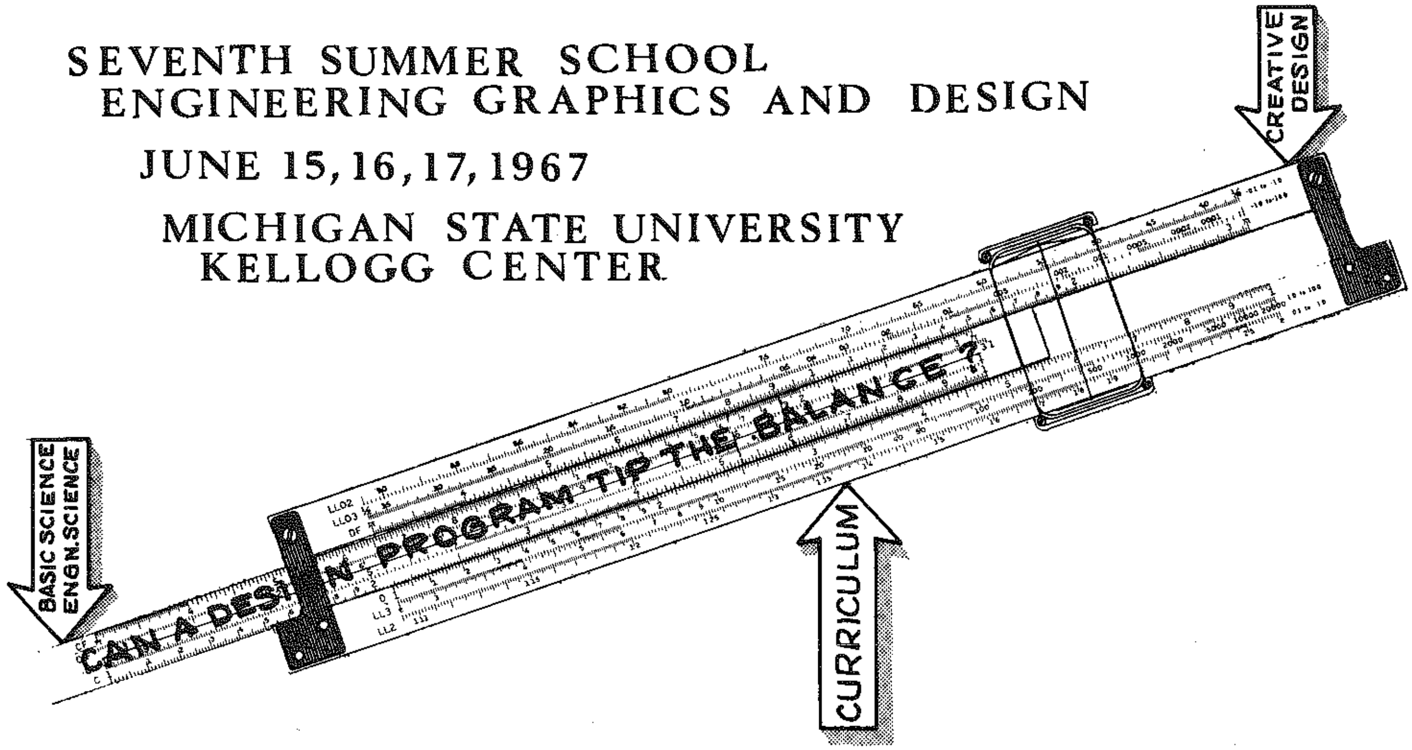
SEVENTH SUMMER SCHOOL
ENGINEERING GRAPHICS AND DESIGN

JUNE 15, 16, 17, 1967

MICHIGAN STATE UNIVERSITY
KELLOGG CENTER



SPONSORED BY THE DIVISION OF ENGINEERING GRAPHICS
OF THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
AND MICHIGAN STATE UNIVERSITY, EAST LANSING, MICH.
(immediately prior to the A. S. E. E. Annual Meeting)

Based on the conviction that engineering design is central to the practice of engineering and therefore central to engineering education, the Division of Engineering Graphics of A. S. E. E. will conduct its seventh summer school devoted to this central theme.

PURPOSE

1. To present engineering graphics as a vehicle for instruction in engineering design.

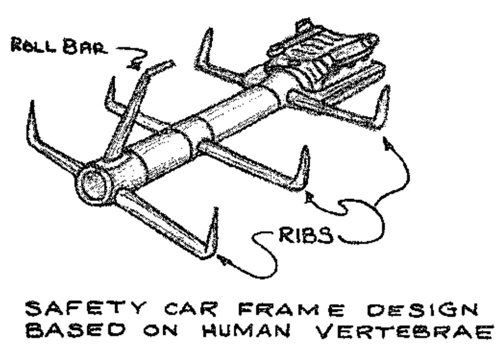
2. To broaden the outlook of engineering graphics educators in the area of design education.

3. To give educators intense coaching in curriculum planning, writing of case studies, selection and writing of design projects, and the role of graphics in design education.

4. To bring recognized authorities in design education in contact with graphics educators.

FORMAT

The summer school will be conducted on a lecture-workshop basis with every effort made to involve attendees in actual problem solving sessions. Lectures will be somewhat formal (entire group in attendance). Workshops will be informal in nature with coaches (limited to about 25 per group).



SAFETY CAR FRAME DESIGN
BASED ON HUMAN VERTEBRAE

The summer school will be held in the modern facilities of the Kellogg Center at Michigan State University, East Lansing, Michigan. East Lansing is served by major airline, bus, and rail transportation systems.

REGISTRATION

Advanced registration is required. All members of A. S. E. E. are eligible to attend. Due to the limited size of the facilities at the Kellogg Center, attendees will be limited to 150 with 25 additional observers. Applications have been mailed out to all Engineering Graphics Division members and selection will be based on a random number process. If an application was not received, please address inquiries to:

Prof. Matthew McNeary
A. S. E. E. Graphics Summer School
Department of General Engineering
University of Maine
Orono, Maine 04473

HOUSING

A number of rooms will be reserved at the Kellogg Center at $9.00 for single, $4.50 for double, with the remainder at local hotels and motels at $10 to $12. All attendees are expected to make their own arrangements.

Registration fee, design kits and materials, lecture notes, and the summary dinner will be paid for through a grant to the division.

MEALS

Meals, on a pay-as-you-eat basis, may be obtained during the summer sessions in the completely air-conditioned facilities of the Kellogg Center. Cafeteria, as well as dining facilities, are available with meals from $1.00 for breakfast, $1.50 for lunch, and $2.00 for dinner.

PROGRAM

WEDNESDAY, JUNE 14

5:00-8:00 PM — Registration and coffee

THURSDAY, JUNE 15

8:00-9:00 AM — Registration
9:00-10:30 AM — Welcome-Introduction Design Process

COFFEE BREAK

10:45-12:30 PM — A Design Case History

LUNCH

2:00-4:30 PM — Workshop-Identification of needs, writing of design projects, writing of case studies.
5:00-6:00 PM — Informal Discussions

FRIDAY, JUNE 16

8:00-9:00 AM — Review of Assignments
9:00-10:30 AM — The Task Specification Phase

COFFEE BREAK

10:45-12:30 PM — The Concept Phase and Graphics

LUNCH

2:00-4:30 PM — Workshop-Writing of Task Specifications and Conceptual Design
5:00-6:00 PM — Informal Discussions

SATURDAY, JUNE 17

8:00-9:00 AM — Review of Assignments
9:00-10:30 AM — Design Solution and Graphics

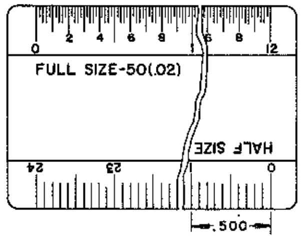
COFFEE BREAK

10:45-12:30 PM — Curriculum Planning and Course Outlines

LUNCH

2:00-4:30 PM — Evaluating a Design Project, Design Solution, and Summary Session
6:00-9:00 PM — Dinner-Speaker on Design Education

THE DECIMAL INCH



by

Russell Hastings*
Clark Equipment Company
Battle Creek, Michigan 49016

Editor's Note: This paper is the summary of a talk given before the Cleveland Engineering Society, December, 1966.

The USA Standard B-87.1-1965, Decimal Inch, was announced in February, 1966. It contains some new recommendations and practices that will probably affect every one of us in the near future.

The purpose of this article is to summarize a few of the principal points, and also to tell you about further work being planned by the B-87 Committee with respect to decimalization of other units of measure, and the preparation of a handbook useful for those whose work involves the converting of metric dimensions to U. S. conventional units of measure or vice versa, and the rounding-off of the resulting dimensions.

Broadly speaking, our objective is to decimalize our measurements as far as practical without upsetting existing standard tools. The purpose is to save money by saving time -- simply because our numerical counting system is also based on ten. If our counting system had been based on eight instead of ten, there would be no merit in decimalizing our units of measure; instead we could stay with fractions because a system of numbers based on the number eight could be divided repetitively by two with no loss of efficiency. There would be no point in writing the dimensions in fractional form. Instead we would use a decimal point plus the numerals 4 or 2 or 1, as follows:

1/2 = .4	1/16 = .04
1/4 = .2	1/32 = .02
1/8 = .1	1/64 = .01

But of course no one is proposing that it would be worthwhile at this late date to revise the basis of our system of numbers from ten to eight. We must simply continue as best we can on the basis of counting by tens.

Let's make a test here today to determine the facts about this claim that it is much more efficient to work with decimals than with fractions.

Test papers were then issued to everyone in the audience with instructions to keep track of their time while adding each of these two columns of equivalent dimensions as rapidly as possible:

1.02	1 - 1/64
0.28	9/32
1.97	1 - 31/32
2.75	2 - 3/4

Analysis of the 135 test papers which were turned in proved the point decisively, as follows:

	Two-place Decimals	Fractions
Median time required	10 sec.	45 sec.
Erroneous answers	13	57

(The correct answers are 6.02 and 6-1/64)

Furthermore, decimalization is now becoming more important because of the increasing frequency with which metric dimensions must be converted into inch dimensions and vice versa. The conversion from a fraction of an inch to millimeters is not too difficult if you use a table, but the reverse process is nerve racking. Try it sometime and you will find out.

*Chairman of the USASI B-87.1 Decimal Inch

About eight years ago, the Industrial Truck Association of the United States prepared a Recommended Practice for the standardization of the mounting dimensions of forks that are used on forklift trucks. The purpose was to facilitate interchanging of different makes and types of forks and attachments on trucks made by different manufacturers -- because truck users often have a need for such interchanging. We presented this standard to the corresponding trade association in Europe; and were successful in getting them to accept the proposed standard for European use.

It then became necessary to express this standard in millimeters as well as inches. However we found that the Europeans at first wanted to express the dimensions in full millimeters. Even after they reluctantly conceded that they could base their dimensions and tolerances on the nearest one-half millimeter equivalent of the American fractional inch dimensions, it was not possible to develop a set of millimeter dimensions that would assure that a fork made to inch dimensions would fit a truck made to metric dimensions and vice versa.

By slightly revising our American fractional inch sizes, and expressing them as two-place decimals, we acquired enough added flexibility in choice of sizes to be able to successfully interchange with millimeter dimensions that involved no subdivision of the millimeter smaller than one-half millimeter. This added flexibility stems from the fact that there are 100 possible increments of dimension in an inch when using two-place decimals, but much fewer than 64 practical increments on a fractional basis because it is so undesirable to work with a lot of odd fractions, such as 45/64. The metric system offers only 25 increments per inch on a full millimeter basis, or 51 on a half-millimeter basis.

Going back now to the B-87 standard for the decimal inch -- the standard had been initiated in 1960 by the Mechanical Standards Board of the ASA as a means to encourage greater use of decimalization in the preparation of standards that were under the purview of that board. The ASA sectional committee was organized in February, 1961, and it has been under the chairmanship of Roy Trowbridge, engineering staff, General Motors Corporation, and vice-chairman of ASA's Standards Council. The standard received its final ASA (now USASI) approval in July, 1965, but the announcement was not made until February, 1966. In December, 1965, Roy Trowbridge retired as chairman due to press of other duties -- and I was then elected chairman. He continues to be active in the committee.

1. There is new terminology, both written and oral. Utilizing as a starting point the prefixes for multiples and submultiples established several years ago on an international basis, and also adopted by the U. S. National Bureau of Standards, we developed new terms for one-thousandth of an inch and one-millionth of an inch. The international prefix for one-thousandth is "milli." The term "milli-inch" could have been comprehended on an international basis -- but it would have had no superiority over our present term "thousandth inch." However, if the term could be shortened, there would be an economy in time and space. Consequently it is now official that the term "mil" -- spelled M I L -- is a U.S.A. Standard for expressing 0.001 inch.

   Several other possibilities were considered. The runner-up was "thou" -- spelled T H O U. This term has acquired considerable use in England, but it was decided that "mill" would be better for the following reasons:

   The term "mil" was being used to some extent in the United States.

   It is a sounder basis to relate it to the internationally accepted prefix "milli."

   The pronunciation of "mil" is obvious and simple, even for people whose native language is not English. In contrast, the TH in "thou" would be difficult for German speaking people.

   Similarly, we decided that the international prefix "micro" -- meaning millionth -- would result in "micro-inch," and could be shortened to one word "mike."

   For phonetic reasons the term is spelled M I K E instead of M I C, and it can be abbreviated as "mk." It is also more convenient, and less likely to cause errors, to write 50 MK on a drawing than to write ".00005."

   Another new convenience is the omission of "S" from the plural form of the terms. This practice is analogous to the omission of "S" from abbreviations, as recognized by leading abbreviation standards. This omission is proper when the term is used in combination with and immediately following a number -- for example, 20 mil or 50 mike.

2. Twenty-mil increments are considered to be preferred dimensions -- but it

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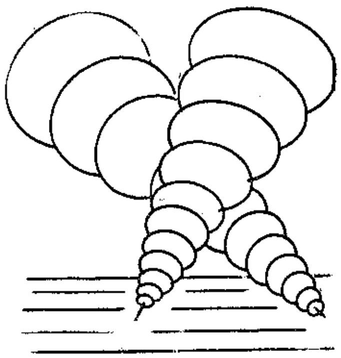
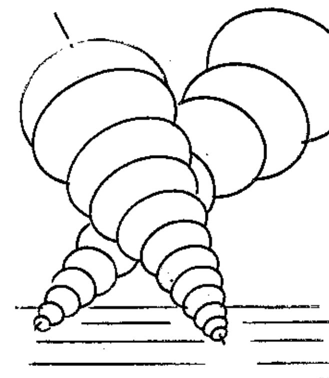
CIRCULAR FEATURES INVOLVING AXONOMETRIC PROJECTION

by

Al Romeo, Assistant Professor
of
Engineering Graphics
The Ohio State University





FOREWORD

In a paper entitled "A Direct Method of Axonometric Projection" published in the Journal of Engineering Graphics, February, 1967 (winter issue), Vol. 31, No. 1, Series 92, a theory and procedure for the direct projection of a pictorial view, using the "method of intersections," was developed and illustrated. The procedure involved identifying a specific line-of-sight (LOS) in the principal orthographic views, from which the axonometric axes could be constructed and the principal views could be oriented and located to directly project into the axonometric view.

The following article is concerned with the application of the above techniques to objects that have circular features in any of the surfaces (planes), whether in the principal planes or not. The method proposed involves simply the identification of the position and length of the major and minor diameter for any projected circle, following which either ellipse templates, if they are available, or any of the geometric ellipse constructions which are based on the major and minor diameter, can be used. The theory behind this method is the determination of the true angular relationships existing between the line-of-sight and the planes or surfaces in which circular features are located.

In the process of developing an axonometric view of an object that contains circular features, there are several alternative methods for constructing the elliptical representations of the circular features. The obvious method is the point by point plotting of the ellipse, such as is necessary in the construction of any irregular curve in pictorial drawing. Although plotting is not difficult to accomplish, it is quite tedious. Another method is to identify, in the axonometric view, either the major and minor diameters or any pair of conjugate diameters of the elliptical representation. With either of these pairs of diameters, there are several geometrical constructions which may be applied to complete the ellipse. However, it is not always possible to readily identify and locate these pairs of diameters in a pictorial view, particularly if the circular feature is on an oblique plane.

Finally, if a set of ellipse templates (for various projection angles) is available in the size range required, they can be utilized effectively as they provide the particular projection angle when it is identified. Since the sets of ellipse templates are identified in terms of the angle (or its supplement) that the line-of-sight of the axonometric view makes with the plane of the particular circular feature, it becomes necessary to determine the viewing angle, for each surface containing a circular feature. A simple method for determining the angle is to determine first the angle between the picture plane of the axonometric view and the plane of the circle. This angle is the complement of the angle desired.[1]

The method described below utilizes the line-of-sight method for the construction of the axonometric view of an object. A simple geometric construction in the principal orthographic views, involving the line-of-sight (LOS), provides a ready identification of the particular ellipse angle required, for any circular feature, in any plane of the object. The theoretical base for this technique utilizes principles of space geometry some of which are reviewed in the following:[2]

1. The axis of a circle (right circular cylinder) is perpen-

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[1]Hoelscher & Springer - Engineering Drawing and Descriptive Geometry, John Wiley & Sons, 2nd Edition, 1961.

dicular to the plane of the circle.

2. At least one true length diameter of a circle will appear in every and any orthographic projection of the circle. That diameter will be perpendicular to the axis and will appear perpendicular in that view.

3. If the particular projection (view) of the circle is an ellipse, the true length of the diameter will be the major diameter of the ellipse. Since this diameter must be perpendicular to the axis, the minor diameter (which is also perpendicular to the axis) will appear coincident with the axis in this view.

4. In an axonometric view of an object, the axes of all circles or circular features that lie in principal planes, will be parallel to the appropriate axonometric axes of this view. (As a matter of fact, if the axis of any circular feature is parallel to any edges of the object, they will obviously be parallel in the axonometric view.)

The application of these principles to the objective of specifying the ellipse, is simply one of determining the angle between the line-of-sight for the axonometric view and each of the various planes containing a circular feature. This is accomplished simply by the rotation of the line-of-sight, since the angle between a line and plane will appear in true size in any view where the line is true length and, simultaneously, the plane appears as a line (an edge view).[2] Therefore, in the original orthographic views, the line is rotated about an axis (of a cone) that is perpendicular to the plane for which the angular relation is desired. In the adjacent view (the view in which the plane appears as an edge and the axis of rotation appears normal), the line (limiting element of the cone of rotation) will appear in true length, and will be one side of the true angle between the line and the plane. This condition is readily demonstrated on the object shown orthographically in Figure 1 for which a pictorial view in the direction "LS" is required. To determine the angle between the upper horizontal surface of the object and the LOS, the LOS (LS) must be rotated about an axis through point "L" (Figure 2) which is perpendicular to that surface. The true angle (18°) is defined by the limiting element of the cone of rotation and the base of the cone (which is, of course,

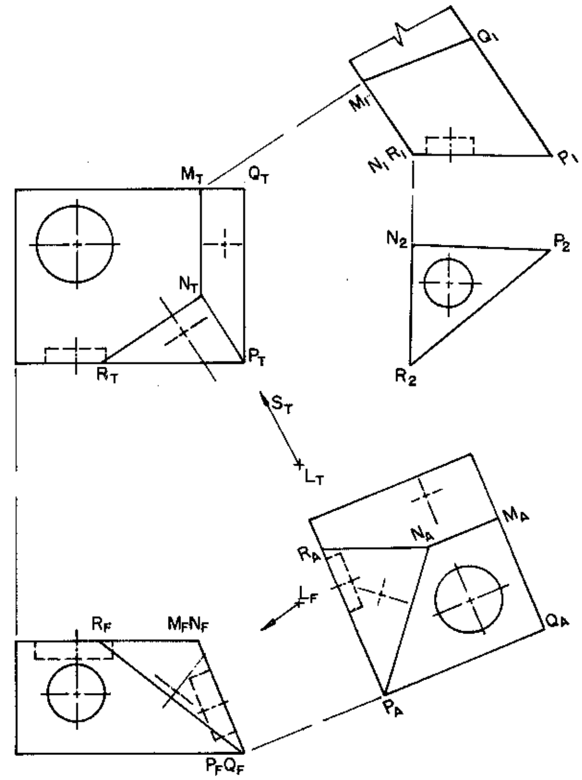


Figure 1

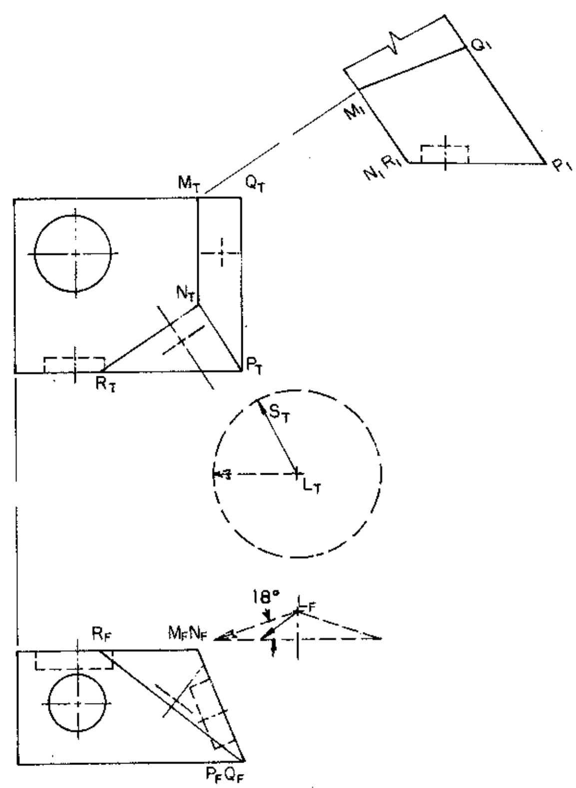
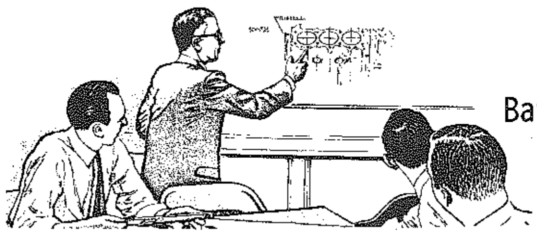


Figure 2

[2] Shupe and Machovina - Engineering Geometry and Graphics, McGraw-Hill Book Co., Inc., 1956.

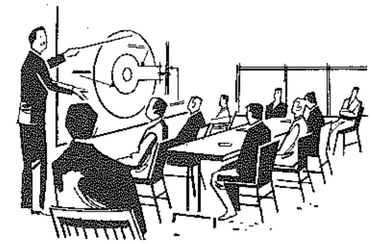
Continued on page 29

ENCODING THE PROTOTYPE: THE ENGINEERING MODEL



By

Alan Krigman
Battelle Memorial Institute
Columbus, Ohio



INTRODUCTION

Engineering models represent a meeting ground for physical systems and human minds. Since it is a model that is "analyzed" rather than an actual system, an accurate model should contain all of the information relevant to a problem situation. Devising the model is the key step in describing and predicting system behavior, because analysis of a complete model is algorithmic.

Frequently, modeling is a two-step process. A primary model, often a diagram, is used to represent and relate significant parameters. A secondary, or working model is then constructed, which is operated upon to obtain a solution. The choice of this computing model is influenced by the prototype system, the available techniques of manipulation, and the questions to be answered.

THE NATURE OF MODELS

Because ability to reason is limited by memory, intellectual capacity is augmented by such memory aids as words, numbers, diagrams and symbols. In one linguistic theory (1)[1], for example, it is hypothesized that grammar developed to minimize the information a speaker stores to organize and communicate thoughts.[2] Graphic storage of ideas provides an expanded temporary memory. One need only attempt to solve a pair of simultaneous algebraic equations without writing them down to see the need for such expanded capacity.[3]

[1]Numbers in parentheses indicate references at the end of paper.

[2]A distinction between long and short term memory is made by Miller (2), who concluded that a human could keep only about seven units of information in his temporary storage.

[3]Peirce, in the Nature of Mathematics (3), states: "Kant, in the Critique of Pure Reason . . . rejects the definition of mathematics as the science of quantity. What really distinguishes mathematics, according to him, is not the subject of which it treats, but its method, which consists in studying constructions or diagrams. That such is its method is unquestionable correct; for, even in algebra, the great purpose which the symbolism subserves is to bring a skeleton representation of the relations concerned in the problem before the mind's eye in a schematic shape, which can be studied much as a geometrical figure is studied."

Models range from iconic to symbolic.[4] Icons, which "look like" prototype objects, often contain a great deal of information, but, even the most detailed icon is not equivalent to the prototype system. A photograph of an automobile is not an automobile, nor does it have the shape of the actual vehicle. It fails to portray such vital automotive characteristics as the suspension and power transmission systems. A representation of the former as masses, springs, and dampers, which looks nothing like a car, would be more appropriate, and with a title "Automotive Suspension" would be understood by anyone with a background in dynamics.

In a photograph, neutral and significant properties of the prototype may be suggested, some of which are present only in the mind of the viewer. The diagram showing the related masses, springs, and dampers, however, includes only properties assumed germane to some aspect of the prototype, and once established, completely specifies the system to be studied.

Symbolic models, such as equations, words, and pure numbers, generally require sets of rules, or algorithms, for manipulation. Calculus, grammar, and arithmetic are typical. Symbols tend to be more precise than icons. The icons are usually more detailed, but the details are not necessarily related to the particular aspects of the prototype of interest. A precise model should not, a priori, be assumed to be an accurate representation of a prototype.

MODELS AND PHYSICAL LAWS

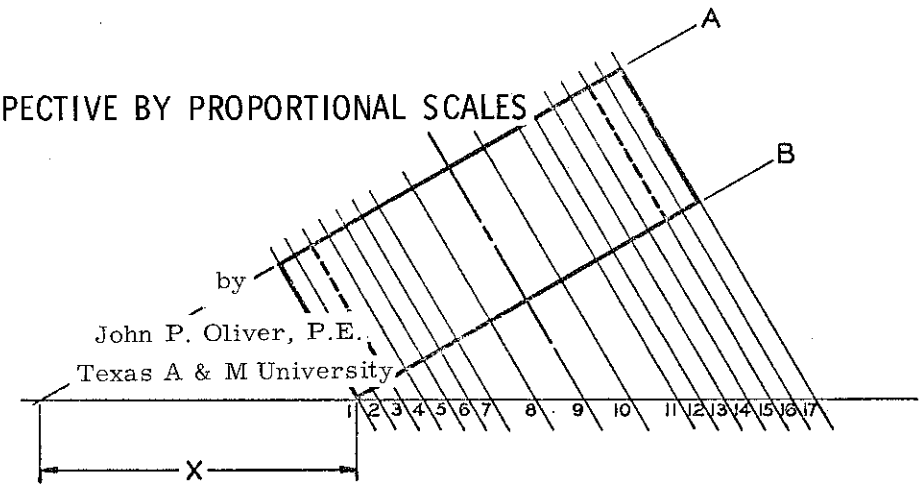
The most common secondary model in engineering analysis is the differential equation. It is difficult to question so vernerable an institution, but, as Philbrick and Paynter (4) have written: "Would you drive a spike with your fists? No? Then why bruise your brain on an armor-plated differential equation? Man is a user of tools, and is helpless without them." Differential equations

[4]Peirce, in Logic as Semiotic: The Theory of Signs (3), divides signs into three trichotomies. In his second trichotomy, concerned with the relation of the sign to its object, he states, "A sign may be termed as Icon, an Index, or a Symbol."

Continued on page 48

PERSPECTIVE BY PROPORTIONAL SCALES

by
John P. Oliver, P.E.
Texas A & M University



One of the most annoying of all problems in perspective is what may be termed the "vanishing point spread." The near vanishing point is not so bothersome, but, frequently, the far vanishing point lies on the next man's desk or some other inaccessible place. In any case, it is hard to utilize. It is especially true when the angle of inclination with the picture plane is small and the distance of the station point to the picture plane is relatively large. Suppose, for example, a 20°-70° inclination is used with SP (Station Point) distance of 200 feet. The far vanishing point will be 2.747 x 200 or 549.4 feet from CV (center vertical). Even at a scale of 1/8" = 1' - 0" which is small, VP (Vanishing Point) will be 68.68 inches from CV. The near VP will be 9.1 inches from CV giving an overall spread of 77.78 inches. If a larger scale is used, the spread will be proportionately greater.

Many methods have been devised to solve the problem. The perspective grid is in common use but it has the disadvantage of a lack of flexibility. Two measuring points are frequently used, but here the solution becomes quite complicated at times. Tangential layouts of calculated angles have been used. Perspective lineads and templates have been in use for many years. There are other methods which lend themselves to the solution of problems.

One method that I have found to be relatively simple is an adaptation of the principle of similar triangles. It may be designated as the "Method of Proportional Scales." In this method, a plane is determined somewhere behind and parallel to the Picture Plane in which horizontal and vertical measurements are respectively proportional to those of the Picture Plane. In this manner, the convergence of the vanishing lines may be easily determined. Figure 1 illustrates a conventional perspective layout. Here it may be noted that for any given inclination of the object to the Picture Plane and for any Station Point distance, D, the distances from the CV to the right and left Vanishing Points may be calculated from trigonometry. In the Picture Plane view, the horizon line has been chosen as being above the object to increase the readability of the illustration. The Vanishing Lines are now drawn in.

Location of a plane in which horizontal and vertical distances are 3/4 of the corresponding distances in the Picture Plane is illustrated in Figure 2. Measure to the right of CV a distance equal to R/4 and to the left of CV a distance equal to L/4. From these points drop lines vertically downward to intersect the lower vanishing lines. A horizontal line through these points of intersection is H/4 above the ground. Thus the 3/4 scale plane has been established. To illustrate the method, let us set up a problem. Draw a full-scale two-point perspective of the steel ring shown in Figure 3. Position the object at a 30° - 60° inclination to the Picture Plane with H equal to eight inches and D equal to 14 inches. Use a 3/4 scale plane.

Then:

H/4 = 2 inches
R = 14 x 1.732 = 24.248 inches
R/4 = 6.062 inches
L = 14 x .577 = 8.078 inches
L/4 = 2.018 inches

In Figure 4, the ring is inclined 30° - 60° to the Picture Plane and the front and rear face planes are projected to the Picture Plane determining the distance x. The ring is sliced by vertical planes parallel to its axis and these planes projected to the Picture Plane.

Figure 5 shows the layout. The horizontal 3/4 scale line is two inches above the ground. The left vertical 3/4 scale line is 2.019 inches to the left of the full-scale vertical line, and the right vertical 3/4 scale line is 6.062 inches to the right of the vertical full-scale line. Join the base of the vertical full-scale line to the base of the right vertical 3/4 scale line, thus determining the horizontal trace of the face Plane B.

Lay off along the ground line, to the left of the full-scale line, the distance x. Lay off along the horizontal 3/4 scale line, to the left of the right 3/4 scale line, the distance 3x/4. Join

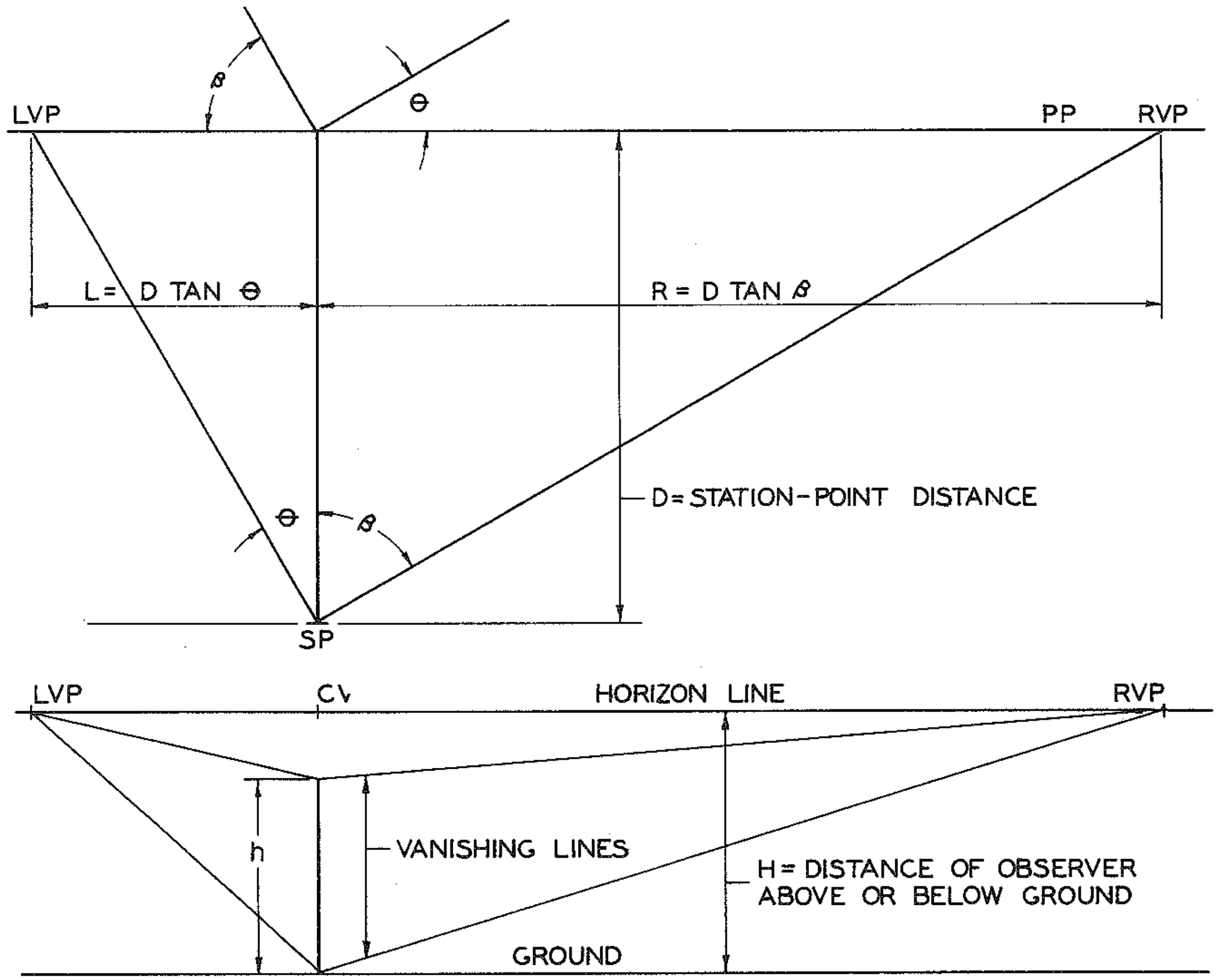


Figure 1

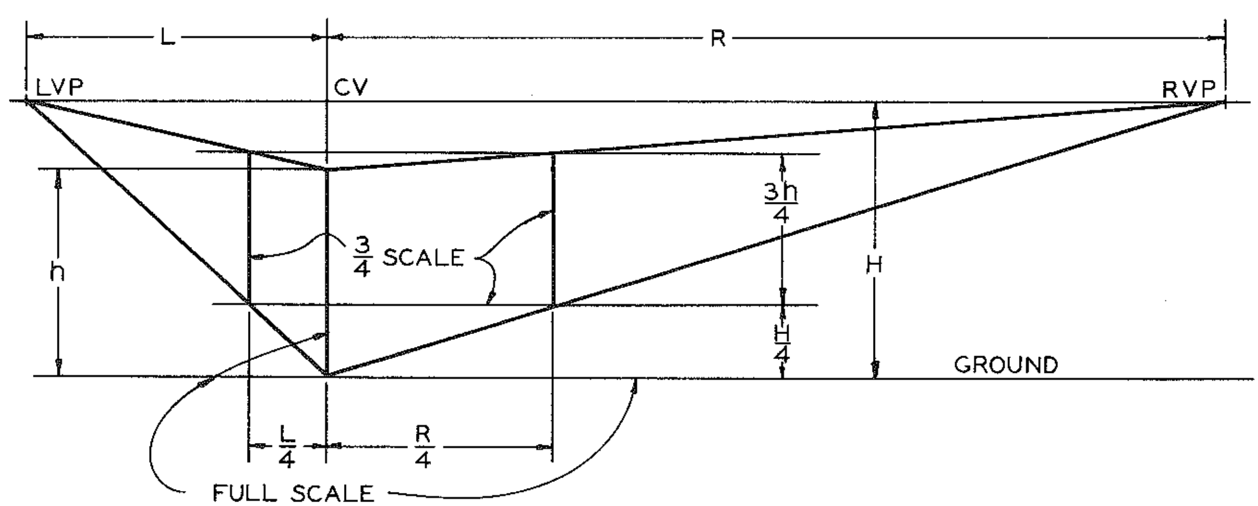
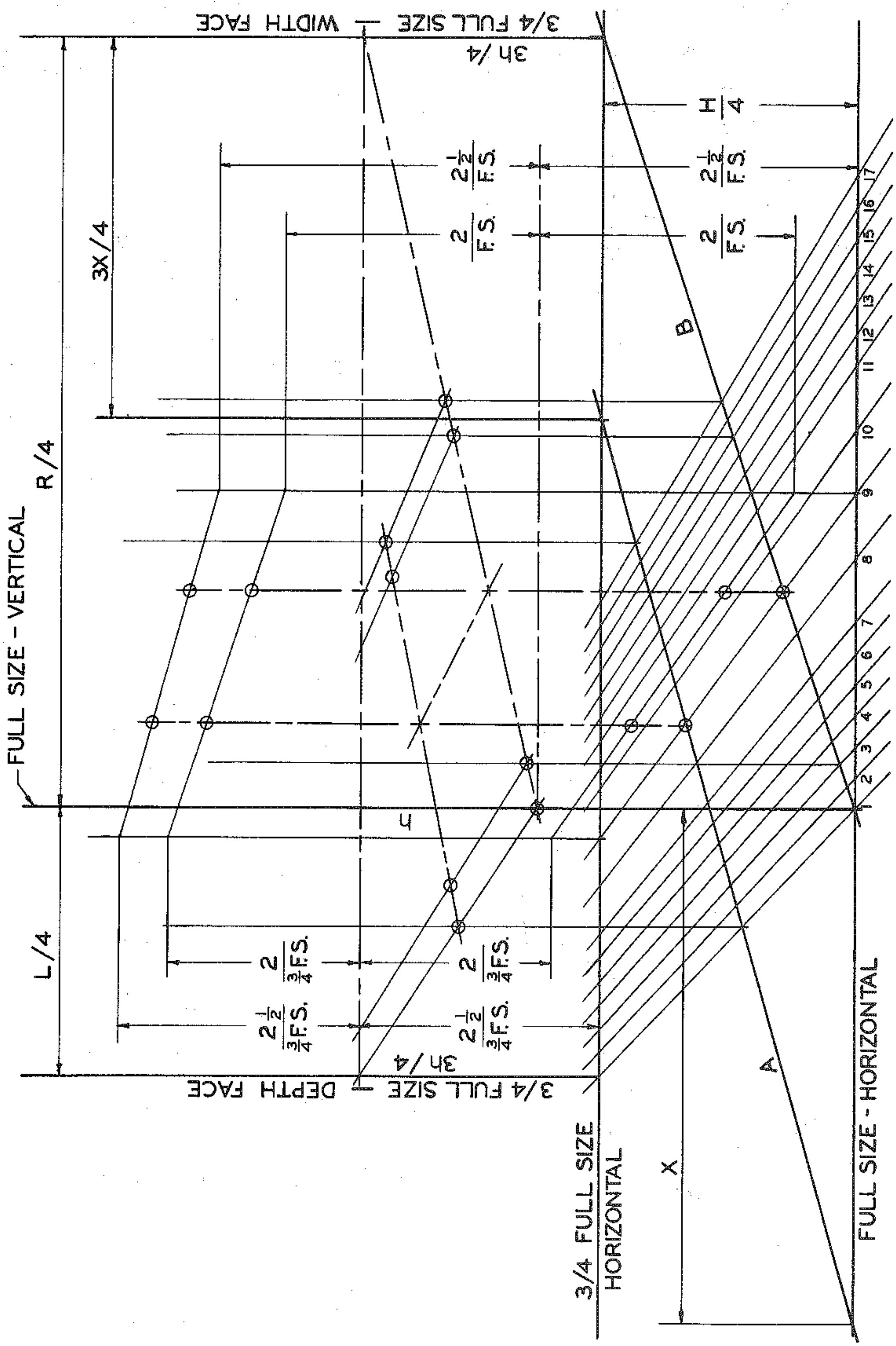


Figure 2


FULL SIZE - VERTICAL
R/4
L/4
3X/4
3/4 FULL SIZE — WIDTH FACE
3/4 FULL SIZE — DEPTH FACE
3h/4
3h/4
h
H/4
2½/F.S.
2/F.S.
2½/(¾F.S.)
2/(¾F.S.)
B
A
X
3/4 FULL SIZE HORIZONTAL
FULL SIZE - HORIZONTAL
2
3
4
5
6
7
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9
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Figure 5

these two points and the horizontal trace of the face Plane A is determined.

Lay off along the ground line, to the right of the vertical full-scale line, the distance between the vertical sliding planes as projected on the Picture Plane (see Figure 4). Along the horizontal 3/4 scale line to the right of the vertical 3/4 scale line; lay off these same distances at 3/4 scale. Joining the corresponding points, we determine the horizontal traces of the slicing planes. Where these traces cross A and B, erect vertical lines. Points on the four perspective circles lie on these lines.

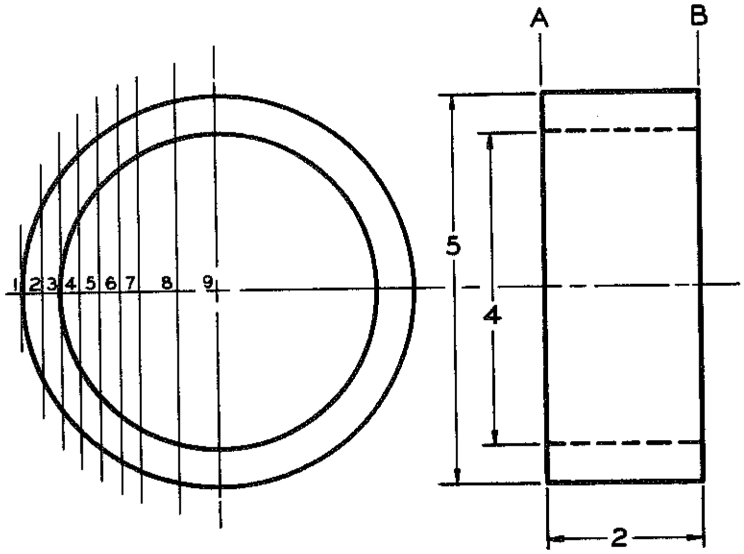


Figure 3

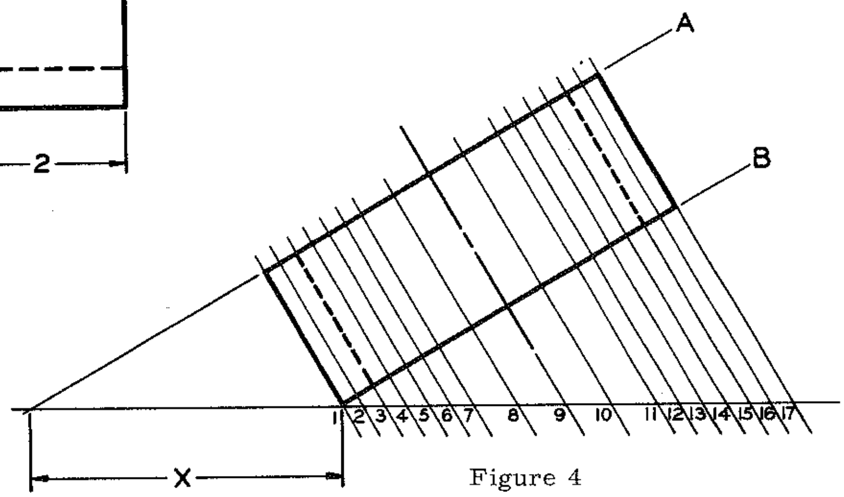


Figure 4

To facilitate the location of these points, locate the horizontal center plane of the ring. Distances are measured above and below this plane at full-size in the Picture Plane and to 3/4 scale in the 3/4 full-size plane. Distances above and below this horizontal plane are obtained from Figure 3. In order to avoid confusion, only a few points are located in Figure 5. Figure 6 shows the completed drawing.

This method is quite simple to execute when use is made of proportional dividers, thus lending itself to quick studies of large objects at comparatively large scale. Arches, church doors, small architectural bridges and many other structures may be treated quickly and accurately by this method.

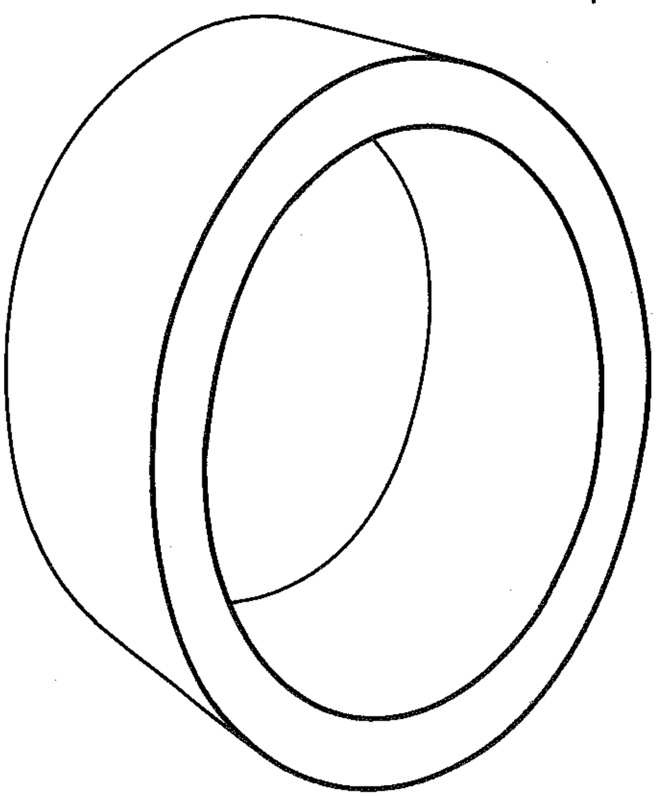
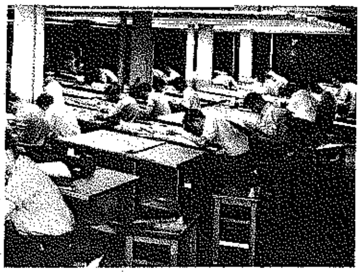


Figure 6

We are all partners in growth and freedom.

Why buy a pile driver to push a thumb tack.

If tomorrow's jobs require more education and training, the only security is a marketable knowledge combined with skill.



ON TRANSPOSING NOMOGRAMS TO SLIDE RULES

by

L. M. Weiner

Illinois Teachers College Chicago-North

Editor's Note:

This article by Professor Weiner is reprinted to correct the previous publication in the November (Fall), 1966, issue of the JEG. One whole page of the manuscript was somehow omitted. The Editor asks the forgiveness of both the reader and Professor Weiner.

A nomogram is a graphical computational aid for evaluating one of the variables in an expression of the form F (x, y, z, ---, w) = o given the values of the others. Nomograms have long been used by engineers and physicists to facilitate their computations.

Another device in common use as an aid in performing various computations is the slide rule. In examining the relative merits of these two devices, one finds that the slide rule has several advantages over the nomogram; namely,

1. The slide rule generally gives more accurate readings.
2. The slide rule is easier and quicker to use in that no straight edge is required.
3. There is no need to mark up a slide rule as is usually done in the case of a nomogram so that it may be used over and over again indefinitely.

In view of these advantages it would seem desirable to have available methods for constructing slide rules which would do the same computations as certain nomograms, and the present paper provides several such constructions.

In a three-parallel scale chart such as illustrated in Figure 1, three variables x, y, and z are laid off at distances f(x), g(y), h(z) along each of three vertical scales starting at the bottom and the collinearity of the three points x, y, and z means that F(x, y, z) = 0 or as is seen by Figure 1 that:

$$\frac{g(y) - f(x)}{h(z) - f(x)} = \frac{a}{b} \qquad (1)$$

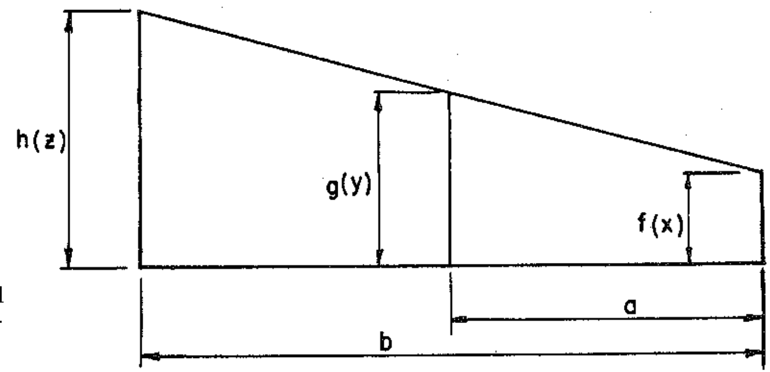


Figure 1

where F(x, y, z) = b g (y) - a h (z) + (a - b) f(x), Equation (1) is reducible to:

$$h(z) + (\frac{b}{a} - 1)\ f(x) = \frac{b}{a}\ g(y) \qquad (2)$$

This may be transposed to a slide rule as is shown in Figure 2. When the top scales are shifted a distance h(z) to the right so that the index is opposite z, the value x moves to the point directly above y as is shown in Figure 3.

It is seen from Figure 3 that Equation (2) is satisfied by the values x, y, and z.

In setting up these scales, one must either be careful to see that the initial points of the scales correspond to three points which were on a horizontal line in the original nomogram or else one may put the initial points anywhere, and then position the index properly by lining up an x and y and putting the index directly over the corresponding z.

The method described above may easily be adapted to the case of a five-equally-spaced, parallel-line nomogram with an index line, as illustrated in Figure 4, by proceeding in two stages, and it will result in a slide rule of the form shown in Figure 5.

A Z Chart is a nomogram in the form of Figure 6. Three collinear points x, y, and z satisfy the functional relationship F(x, y, z) = 0. It is seen from the figure that:

Continued on page 54

A GRAPHICAL METHOD FOR CONSTRUCTING A TIME-DISPLACEMENT CURVE FROM A PHASE-SPACE TRAJECTORY

by

Warren G. Lambert

The Pennsylvania State University

Fayette Campus

A qualitative description of the response of a dynamic system is obtained by a plot of the velocity (x) versus the displacement (x). The space defined by these two coordinates is called the phase space, and the resulting curve is called the phase trajectory. A typical phase space plot is shown in Figure 1.

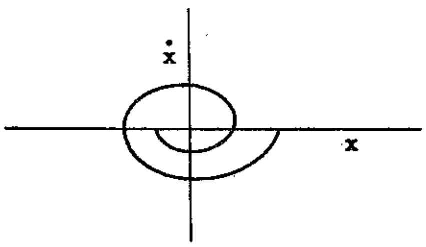


Figure 1. Phase Space Plot

The goal of the engineering analyst in the area of system dynamics is an analytical expression which expresses the displacement as a function of time and, as in most cases, if an analytical expression is not obtainable, then a graphic plot of displacement versus time would be extremely valuable. The analytical expression

$$t = \int_0^x \frac{d\varepsilon}{\dot{\varepsilon}} \qquad \text{I}$$

is in most cases either too difficult or impossible to integrate, and the phase space trajectory does not indicate analytically any relationship between displacement and time. The author has found, however, that the phase space trajectory may be utilized to obtain a time-displacement plot as follows:

Step I

Plot the phase space trajectory and divide the x axis into n equal increments. Locate the points a, b, etc., such that $\dot{x}_a$, $\dot{x}_b$, etc., represent the mean velocities during the incremental displacement. See Figure 2.

Note that

$$x_{n+1} - x_n = \dot{x}_b dt, \text{ etc.} \qquad \text{II}$$

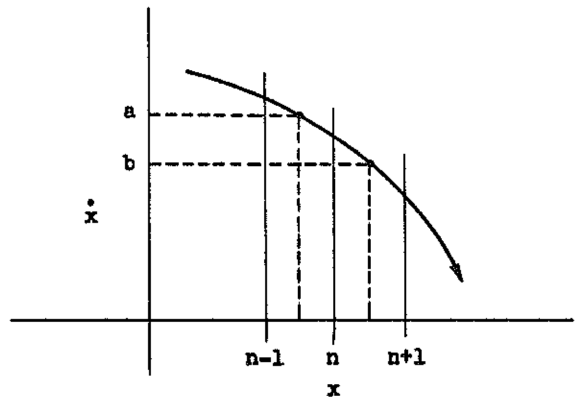


Figure 2. Phase Space Plot

$$\left(\frac{d\dot{x}}{dx}\right)_{x=x_b} = \tan\theta_b, \text{ etc.} \qquad \text{III}$$

and in general

$$\int_0^x \tan\theta \, dx = \dot{x} - \dot{x}_0 \qquad \text{IV}$$

Step II

Plot the tan θ versus x

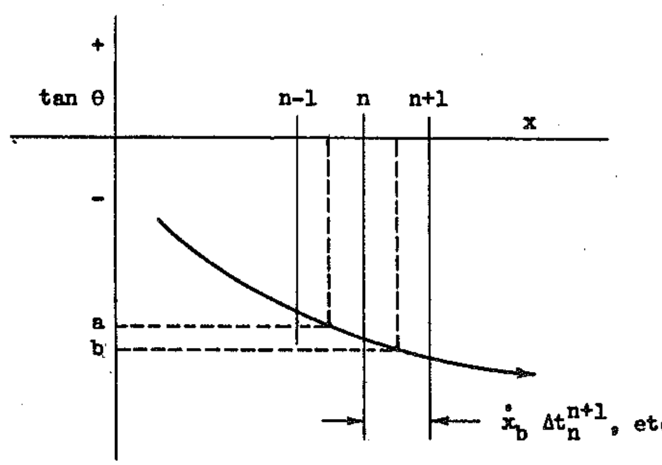


Figure 3. Tan θ versus x

Note that Equation IV implies that

$$(\tan \theta_b)\, \dot{x}_b \, \Delta t_n^{n+1} = \dot{x}_n^{n+1} \qquad \text{V}$$

or in general

$$(\tan \theta_j)\, \dot{x}_j \, \Delta t_k^{k+1} = \dot{x}_k^{k+1} \qquad \text{VI}$$

Step III

Since $(\tan \theta_j)$, x_j, and $\dot{x}_k^{k+1}$ for a, b, etc., are known, the following plot is constructed.

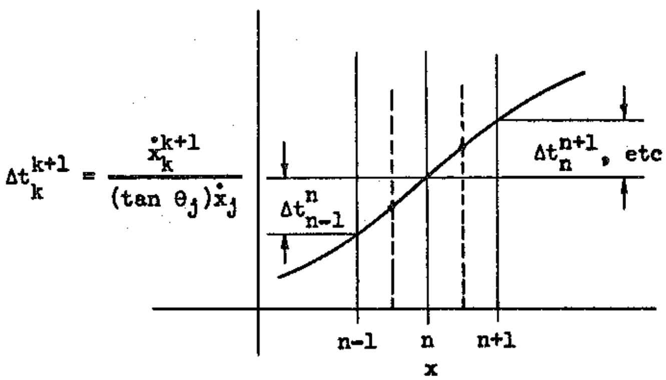


Figure 4. Time versus x

Note that

$$\dot{x}_k^{k+1} = \dot{x}_{k+1} - \dot{x}_k \qquad \text{VII}$$

$$\tan \theta_j = \frac{\dot{x}_{k+1} - \dot{x}_k}{\Delta x} \qquad \text{VIII}$$

$$\dot{x}_j = \frac{\dot{x}_{k+1} + \dot{x}_k}{2} \qquad \text{IX}$$

so that Equation VI reduces to

$$\Delta t_k^{k+1} = \left| \frac{\Delta x}{\dot{x}_j} \right| \qquad \text{X}$$

Equations VI or X permit one to quickly and easily construct a time-displacement plot from a given phase space trajectory. The units chosen for the phase space coordinates must be such that the proper unit results for the time increment given by Equation X. If the phase space trajectory is plotted on a square grid, then the time increment given by Equation X reduces to the ratio of the number of squares counted horizontally divided by the number of squares counted vertically up to the mean velocity ($\dot{x}_j$) corresponding to the number of horizontal squares counted.

A number of examples follow.

Example 1:

Consider the spring-mass linear oscillator, the phase space plot results in a phase trajectory whose equation is

$$\frac{x^2}{\frac{2E}{k}} + \frac{\dot{x}^2}{\frac{2E}{m}} = 1$$

which plots as

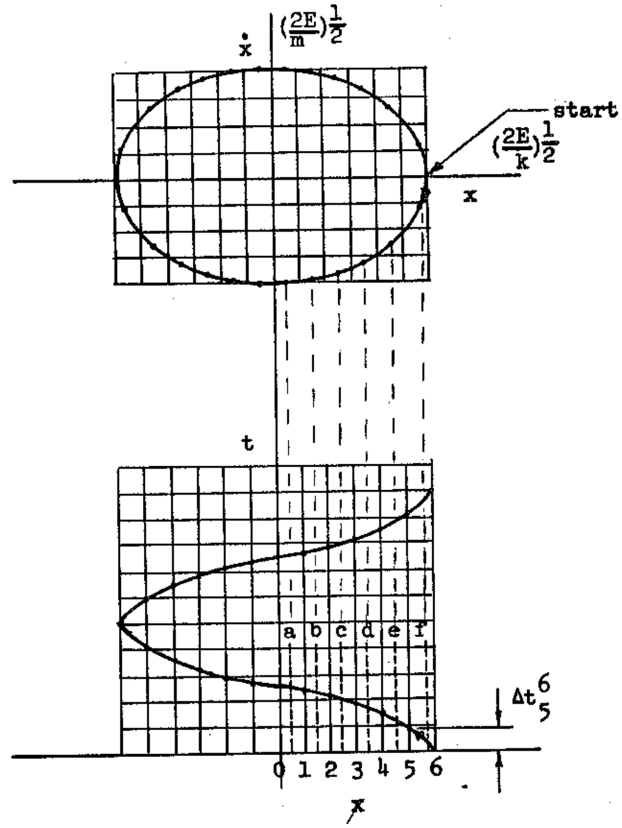


Figure 5. Plot of spring-mass linear oscillator

The scale for Δx is $\frac{1}{6}\,\frac{2E}{k}$ and the scale for $\dot{x}$ is $\frac{1}{4}\,\frac{2E}{m}$, hence for the time scale, say 6 - 5,

$$\Delta t_5^6 = \frac{2}{3 w_n n}$$

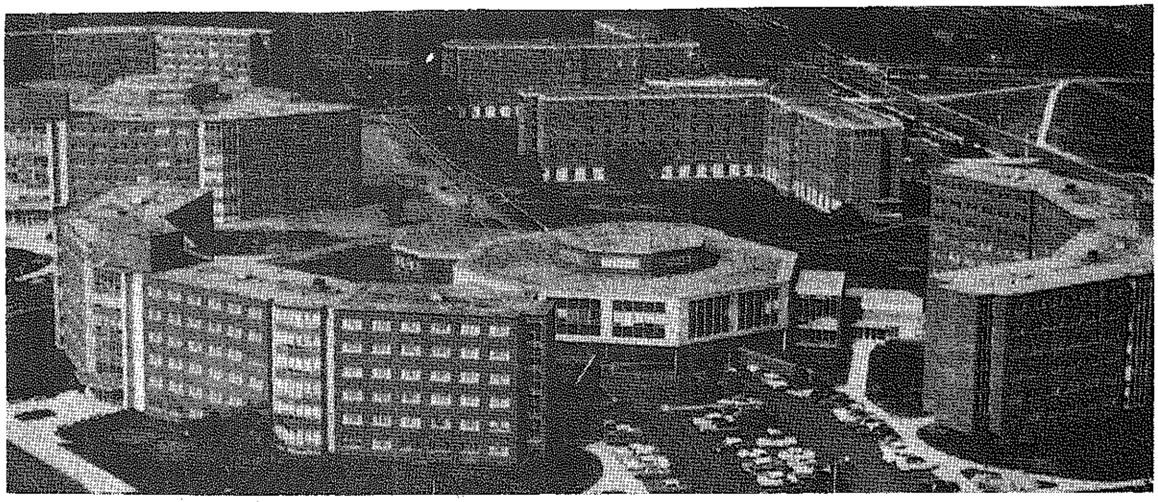
where w_n is the natural frequency $\frac{k}{m}$ and n is the number of squares from the x axis down to point f on the phase trajectory.

Example 2

This example and those which follow represent an application of the technique as applied in Example 1. The figure at the top of each page represents the phase plot while the lower figure represents the time-displacement curve as plotted from the phase plot.

Continued on page 56

MICHIGAN STATE IS SET FOR 1967 ANNUAL MEETING AND ENGINEERING GRAPHICS SUMMER SCHOOL



HOST SITE IN 1967 — Delegates to the 1967 ASEE meeting at Michigan State University will be housed in three of MSU's newest dormitories, one of which is nearing completion. Shown are three examples of MSU's coeducational academic-residence halls in which students can both live and attend classes.

Michigan State University, site of the 1967 ASEE annual meeting, has one of the largest on-campus housing complexes in the nation.

ASEE delegates will be housed in three of MSU's newest residence halls -- Akers, Fee and Hubbard Halls -- located on the eastern edge of the campus.

Lansing, the capital of Michigan which adjoins East Lansing, is served by two airlines, United and North Central, at the Capital City airport. There are also the Chesapeake and Ohio, Grand Trunk and New York Central railroads.

Founded in 1855, MSU set the pattern for the system of land-grant colleges and universities founded under the Morrill Act of 1862. Today it is one of the nation's 10 largest universities with an enrollment of more than 35,000.

The campus is considered one of the nation's most beautiful. Its 4900 acres, bisected by the Red Cedar River, include one of the most extensive collections of trees, vines and shrubs.

In addition, East Lansing is just a few hours drive from scenic Northern Michigan, whose Upper Peninsula with its numerous lakes, streams and forests is reached by crossing the famed Mackinac Bridge.

The Graphics Division Summer School is to be conducted in the Kellog Center adjacent to the Michigan State University campus.

Continued from page 4

individual passages of Professor Pozniak's article.

1. There is no objection about considering Descriptive Geometry as a self-contained science. It must be understood, however, that descriptive geometry presented in a truncated form (i.e., by the direct method) does not exhibit any outstanding features of Higher Descriptive Geometry. It has been positively established that the operations with any of the methods of descriptive geometry become extremely effective in construction solution to complex engineering problems when combined with elegant techniques of projective geometry. Such a useful and advantageous arrangement is sharply shaping descriptive geometry into a real working tool for creative engineers.

   This usefulness is the main reason why projective geometry is predominent in the European texts on Higher (or Technical) Descriptive Geometry, written by world famous authors and educators such as: Dr. F. Hohenberg, Dr. E. Mueller and Dr. E. Kruppa, Dr. A. Urban, Dr. J. Krames, and many others. In these texts, the concepts (homology, axis of homology = peculiar line, collineation and affinity) are treated immediately in the introductory chapters.

2. We differentiate between projective geometries of an algebraic, a synthetic, and a purely graphical or geometric-technical character. Projective Geometry is all geometry from the viewpoint of a synthetic geometricist, or engineering graphicist.

   Although topology is a universal science offering more flexibility with respect to elasto-

Continued on page 40

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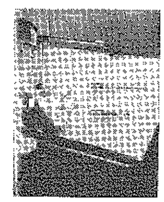

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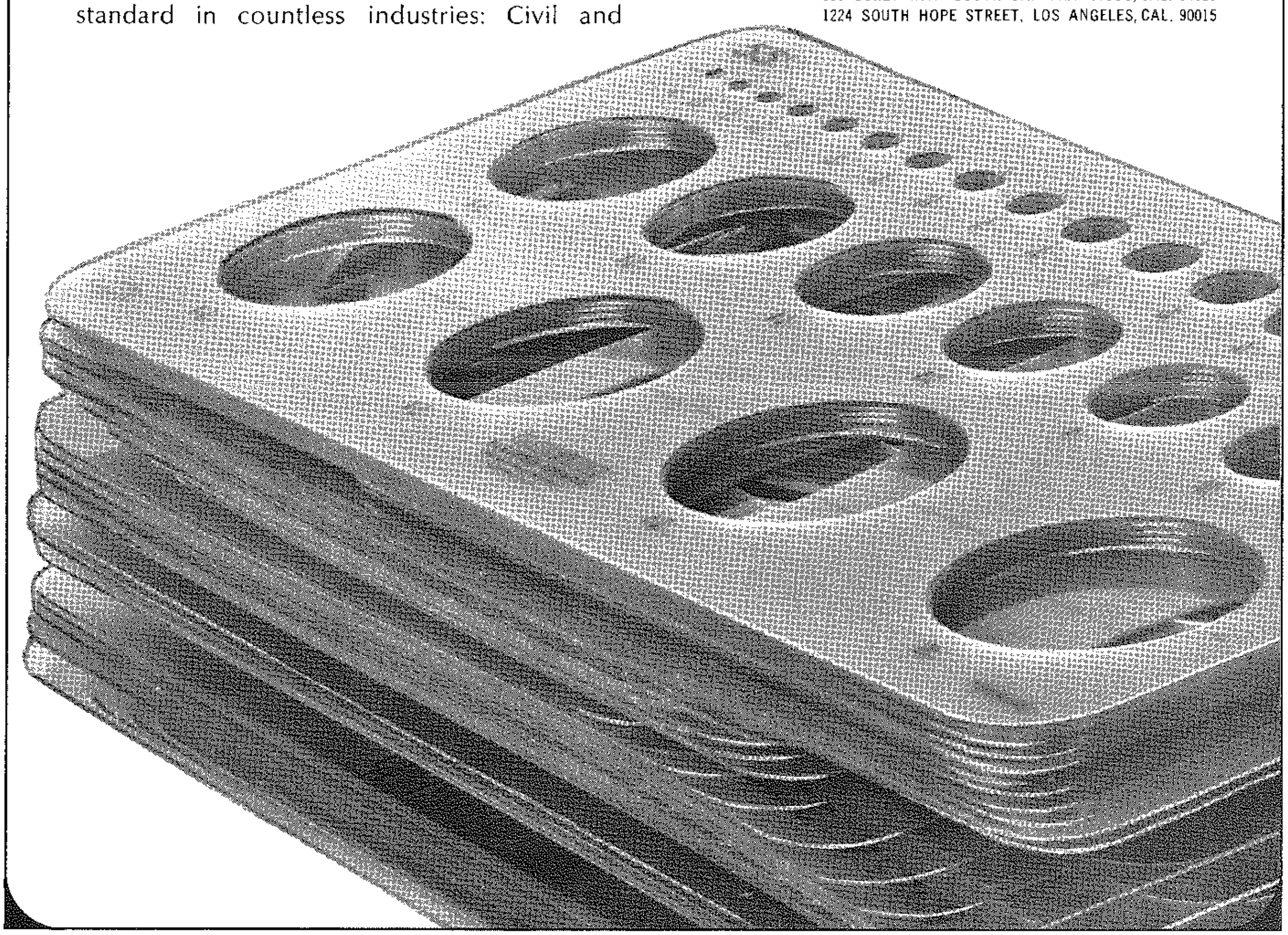
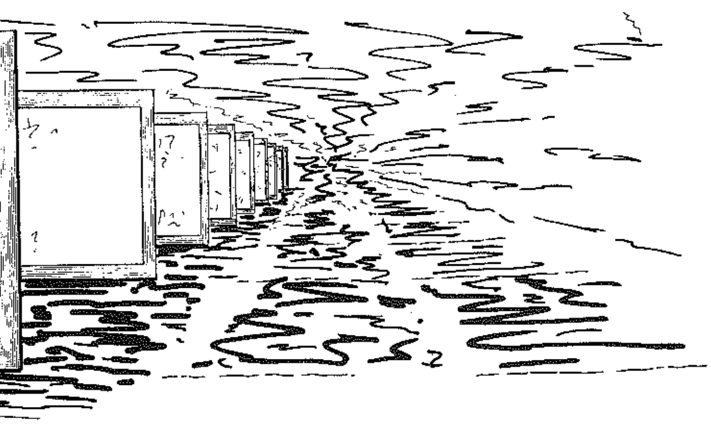


Perspective

KNOW-HOW VERSUS GUESS-HOW

by

Earl D. Black
General Motors Institute
Flint, Michigan



Knowledge is power. Education is like a kit of tools which makes it easier for us to perform our job obligations in life. The big demand for a "warm body" who can read a slide rule and calls himself an engineer is passing. Know-how always surpasses guess-how. The day has arrived when the ability to use applied engineering is at a premium in industry. Business and industry seek adequately prepared engineers and technicians who can combine technical knowledge with human relations, methods with handling, and efficiency with understanding.

Applied engineering is the designing and making of the products which people need and want. The engineer should be an idea man. Good ideas are the stuff from which success in business is made. Ideas do not mean much until they are put into effect. The end result of the product is the decision factor for engineering consideration. Until the student can recognize the process by which decisions are reached, we can hardly expect him to be able to make the best decisions.

The closer an idea comes to solving a current problem, the closer it will come to being accepted. All engineering is dependent in great measure upon the accurate, rapid, and economical transmission and processing of information. Communication in the engineering design and production process is indispensable. The combination of engineering science with the ability to graphically communicate is a requirement to practical engineering.

In general, the public has a favorable image of engineering. However, the general public does not fully comprehend what engineering really is, nor what an engineer actually does. Many students aspire to become an engineer, but when they are exposed to the broader aspect of engineering, they drop the engineering program to follow a different mode of life.

Technology seems to be developing as an end in itself, indifferent to human values. Man is turning into an inmate of a technological concentration camp run by engineers and technicians. But it is one thing to control our environment, and it is another thing to create an environment that controls mankind.

Research and engineering design require essentially different approaches and attitudes of mind. Research is done in the mind rather than in the laboratory. It is a mental attitude. The laboratory must be subservient to the dictates of the individual doing the research. Research must be interesting and knowledge in the field is necessary for arriving at practical decisions. The greatest efficiency of an engineer or scientist is his ability to use good judgment and discretion. Engineering graphics is the common communication media of recording and explaining the findings discovered by research and the designs produced by engineers.

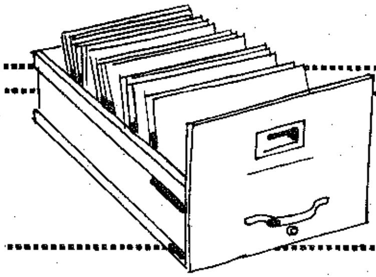
A need for a product must be established before discovery by research can become important and useful. The consumer must be convinced that the product is of value so that sales will eventually support research.

Creative virtuosity is difficult to contain within any single definition of design. Creative ideas in design of products which give service to a market that is eager to consume the product is a self-help to the progress and wealth of the nation. Classes in creative design may cover less of the course outline but the idea is to "uncover" thoughts and new ways of doing things. Research opens the way to progressively larger problems for the engineer and technician. Engineering design and development reduces the size of the problems as the end product comes into being.

Aesthetics, even though related to art, expresses an idea that all engineers should learn. Art combined with engineering graphics is an important tool for recording, communicating, and computer programming of ideas as they are worked out during development processes.

Industry is bulldozing its way through many of its problems today because of a lack of knowledge. Part of the cause is due to the late engineering education emphasis on intellectually demanding tools at the expense of training in how to apply them. Just as pure research is needed as a part of the engineering curriculum, so should what may be termed "the interaction

Continued on page 55



file to file

Many "on the line" teachers have ideas, suggestions, techniques, problems, and questions they would like to share with the society. "FILE TO FILE" provides the place for exchange of professional information. If you have an item for exchange, submit it to "FILE TO FILE."

AN EMPATHY-BUILDING GRAPHICS PROBLEM

by

Norman D. Buchanan
Pennsylvania State University

It is felt by some college teachers that they could teach better if they knew more about their students. Time limitations, large classes, and the fear of losing "objectivity" -- all of these work against personal interest in the student. One way of becoming more aware of some of the current and past values and trials of each student, and quickly, has been tried recently in some engineering graphics sections at the Pennsylvania State University.

Each student was asked to sketch a bar chart or charts as a solution to the following problem.

- -

E G 11 BAR GRAPH PROBLEM

A. Show pictorially the hours per week for, (both in and out of class) the number of credits, and the relative merit of each of your courses this term.

B. Do the same for your two favorite high school and three favorite college courses before this term.

C. Define relative merit.

Things to notice --

1. The planning and layout necessary for good output.
2. The amount of information quickly communicable.
3. The difficulty in quantifying and in making value judgments.
4. Contradictions in the credits, time, and merit ratings.
5. Relative value of courses.
6. Tracing over x-section paper helps.

- -

An example of a typical response to (A) is shown in Figure 1.

Continued on page 57

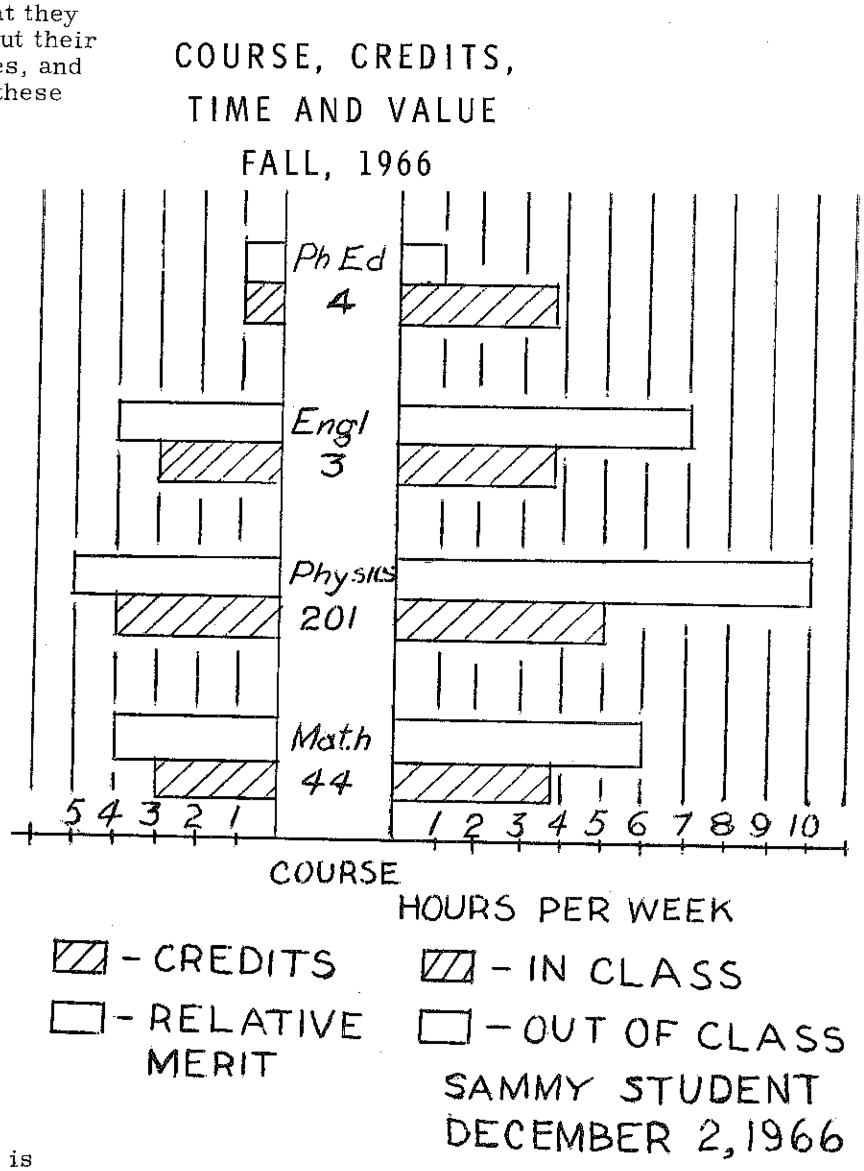


Figure 1

The American Society for Engineering Education

WHEN IS AN ACTIVITY A "PROJECT"? and HOW IS A PROPOSAL SUBMITTED?

DEFINITION OF AN ASEE PROJECT

An "ASEE Project" is defined as an organized function which has as its purpose the study, the evaluation and the promotion of engineering education, and which formally involves the name of the Society in conducting the program or in seeking financial support. Such projects may include faculty development, curricular development, graduate study, engineering college research, engineering technology education, etc.

AUTHORITY DELEGATED BY ASEE

The Projects Operating Unit was established in 1962 by an amendment to the ASEE Constitution to fulfill an urgent need within the Society for administrative responsibility for projects formally involving ASEE. Any project pertaining to engineering education may be proposed and initiated by individual members of ASEE, by Divisions, Councils or Committees within ASEE, or by individuals and organizations outside the Society. Also, the Projects Operating Unit itself is authorized to initiate projects. Historically, the Projects Operating Unit evolved from the former projects Committee (prior to 1960) and the Projects Management Group (1960-62).

According to the Constitution, the Bylaws of the Projects Operating Unit are the responsibility of the ASEE Board of Directors. The objectives and scope of the Projects Operating Unit have been established through these Bylaws as follows:

> The Projects Operating Unit shall be concerned with the development, approval, management and operation of all projects formally involving the American Society for Engineering Education. To achieve these objectives, this Unit will:
>
> Originate new projects to promote and improve engineering education based on the cognizance and knowledge of the most pressing needs in engineering education;
>
> Review and evaluate project proposals for the advancement of engineering education originating from individuals or groups within or related to ASEE.
>
> Approve or disapprove, on behalf of the Society, all projects requiring the use of the name of ASEE in seeking financial sponsorship or in promoting such activity;
>
> Advise and assist project directors in matters pertaining to financing, operating and coordinating of ASEE projects;
>
> Evaluate the programs conducted under the cognizance of the Projects Operating Unit and encourage the dissemination of the results thereof; and finally,
>
> Inform the Executive Secretary and the Board of Directors of ASEE of the actions of the Projects Operating Unit.

APPROVAL OF AN ASEE PROJECT

Any "ASEE Project," whether originated within the Society or by an organization outside of ASEE, must have approval of the Projects Operating Unit. Such approval is deemed necessary to insure the quality of the project as well as consistent contratural arrangements with financial sponsors.

A project or activity which is developed, financed, conducted and utilized entirely within the Society is not considered an "ASEE Project" and does not require the approval of the Projects Operating Unit. Also, the usual activities of the Society in its relation to other organizations, such as EJC and ECDP, are normally authorized directly by the ASEE Board of Directors and do not require Projects Operating Unit approval. Consult the Executive Secretary of ASEE to clarify approval requirements for any proposed object or activity.

CLASSIFICATION OF ASEE PROJECT PARTICIPATION

The degrees of responsibility of the Society in the cooperative performance of a project have been defined on Page 109 of the 1964 ASEE

Yearbook, Journal of ENGINEERING EDUCATION, Vol. 55, No. 4 (December, 1964). These cooperative classifications do not necessarily refer to financial sponsorship. The degree of responsibility with relation to contract, budget, personnel, reports, etc., is established by the following chart:

A - ASEE   B - Other Organization(s)

	Endorse	Cooperate	Co-Sponsor	Sponsor
Who holds original contract	B	B	A or B	A
Who pays bills (subcontract)	B	B	A or B	A
Who keeps overhead	B	B	A or B	A
Who appoints Advisory Committee	B	B with A's help	A jointly with B	A
Who appoints director	B	B with A's help	A jointly with B	A
Who guarantees quality	B	B with A's help	A jointly with B	A
Who issues report	B	B	A or B	A
Who follows up	B	B	A or B	A

PROCEDURES TO BE FOLLOWED IN ESTABLISHING AN ASEE PROJECT

INITIATION OF A PROPOSAL

As stated above, an ASEE Project may be initiated by an individual or group within the Society or by a group or organization outside the Society. In initiating any such project, it is desirable for the initiating group to assess the value of the proposed project in terms of its anticipated results and its value to engineering education. If a team or group effort is required, the men who will constitute this team should be consulted ahead of time to assure their availability and their interest in participating in the work. If deemed advisable, preliminary discussions with the Executive Board of P.O.U. concerning the initiation of a project can be arranged. Preliminary exploration of possible sources of financial support may be conducted after consultation with the Chairman of the Projects Operating Unit or the Executive Secretary of ASEE.

The format of a proposal should be as follows:

TITLE PAGE
Date

Title of proposal

Name of proposed financial sponsor

Name and address of submitting institution

Names of participating agencies, including the American Society for Engineering Education

Signature lines for Project Director, Chairman of Projects Operating Unit, President of ASEE and any other signatures required.

SCOPE
The objectives of the project should be clearly stated including its anticipated effects upon engineering education, and a concise justification of the need for the proposed study.

PLAN OF OPERATION
This section should describe the manner in which the program is to be conducted including the responsibilities of the participating institutions or organizations. The personnel and their respective functions should be designated and their background resumes attached.

BUDGET
The budget shall include all anticipated direct and indirect costs with suitable justifications. The details of the budget, including direct ASEE Headquarters' expenses, indirect cost distribution, salaries, travel, etc., should be worked out in collaboration with the Executive Secretary of the Society.

Twenty copies of the completed proposal should be forwarded to the Chairman of the Projects Operating Unit. If the proposal is approved by the Projects Unit, the Project Director will be notified and requested to furnish additional copies for the sponsoring agency and the ASEE Board of Directors.

The Chairman of the Projects Operating Unit will sign the approved proposal and will forward the proposal to the President of the Society for transmittal to the proposal financial sponsor. If approved in principle, but judged to require additional or revised information, the proposal will be returned to the originating person or group with recommended changes. If disapproved, the proposal will be returned with a full explanation of the reason for disapproval.

The Executive Board of the Projects Operating Unit meets approximately every three months to discuss new proposals and to take action on these proposals in behalf of the Society. If more immediate action is required, contact the Chairman of the Projects Operating Unit directly.

RENEWAL OR EXTENSION OF PROJECTS

All proposals to renew or to amend existing projects for the extension of time, scope or funds must be submitted to P.O.U. in the same manner as the original proposal.

REPORTS ON ACTIVE ASEE PROJECTS

Following approval of an ASEE-related proposal, the Projects Operating Unit shall be kept informed of the progress of the project with regard to such matters as:

Continued on page 62

Continued from page 14
horizontal, contains point "S", and is parallel to the upper surface).

Once the true length of LS is determined for one angle, a shortcut in the rotation procedure can be employed for all of the other angles. Since an edge view of these surfaces is usually available, the base of the edge view of the cone of rotation can be easily constructed parallel to each surface in turn. It is a simple matter to define the limiting element of each cone relative to its respective base. For instance, the angle between LS and the profile plane can be defined (although not needed) in the front view (Figure 3) simply by strik-

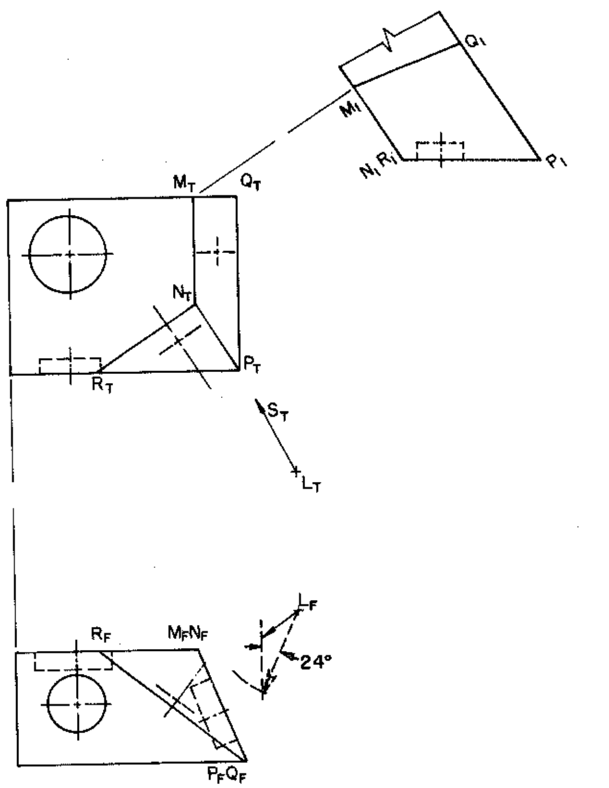


Figure 3

ing off the true length of LS on the edge view of the base of the cone, which is parallel to the profile plane and contains point "S." This angle is measured as 24°. The angle between LS and the frontal plane will appear in true size in the top view (where the frontal plane appears as an edge). Again the true length of LS is struck off (Figure 4) on a base of a cone which is parallel to the frontal plane and contains point "S." This angle is measured as 56°. In Figure 4, the plane MNPQ appears as an edge in the front view; therefore, the base of the cone of rotation is simply defined as parallel to that plane and the true length of LS is struck off as the limiting element of that cone. The angle between LS and plane MNPQ is measured as 31°.

To determine the angle between LS and the

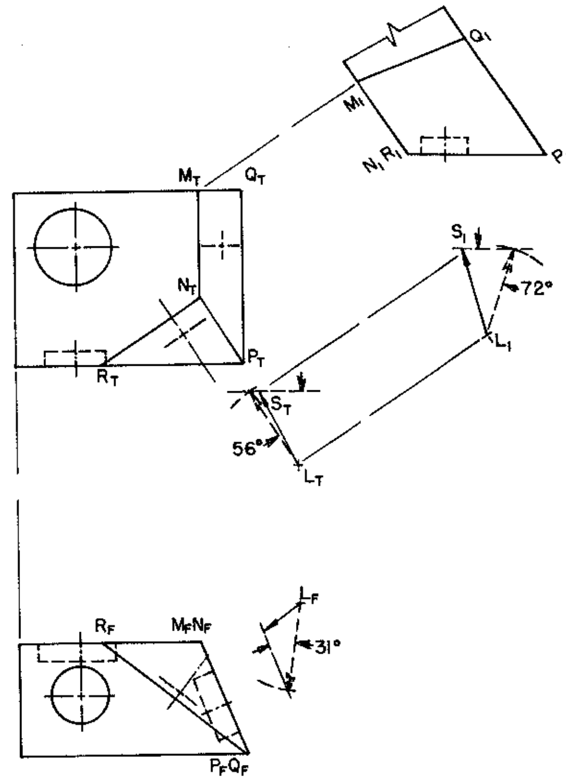


Figure 4

oblique plane (NPR), it is necessary to project LS into an auxiliary view which contains an edge view of the oblique plane. The cone for that angle, as can be seen in Figure 4, shows the angle between the LS and plane NPQ to be 72°.

With the angles defined between the LOS and all planes containing circular features, ellipse templates, if they are of an appropriate angle and size, can be used or, an adaptation of the concentric circle technique to construct the ellipse can be used. Obviously, if the templates are available, it is much simpler and faster to use them. These templates are generally sold in sets in which each template is defined by its projection angle and contains a range of ellipse sizes. Generally, the set contains templates for each projection angle at five-degree increments between 15° and 75° and each template contains ellipses whose major diameters are from 1/4" - 2". Since it is unlikely that the angle required will be the exact template angle, the template with the angle closest to that required can be used if the desired angle falls within the 15° - 75° range. The maximum error that can occur in following this practice is only 2-1/2 degrees (projected angle) and that is sufficiently accurate for most practical purposes.[1] For angles which fall outside of this range (that is, from 0° - 15° and from 75°-90°) the resulting ellipse can be "fudged" by

[1]Loc. cit.

using appropriate portions of existing templates.[3]

If an appropriate ellipse template is not available, a construction incorporating the concentric circle method provides the ellipse needed. This method follows in detail. Since the major diameter is perpendicular to the axis of the circle and is, also, the true length diameter of the circle, it is readily identified and located in an axonometric view. A means to determine the length of the minor diameter is necessary. This is illustrated in Figure 5, where the true angular relationship (35° in this case) between LS and the edge view of the plane of a circle is shown.

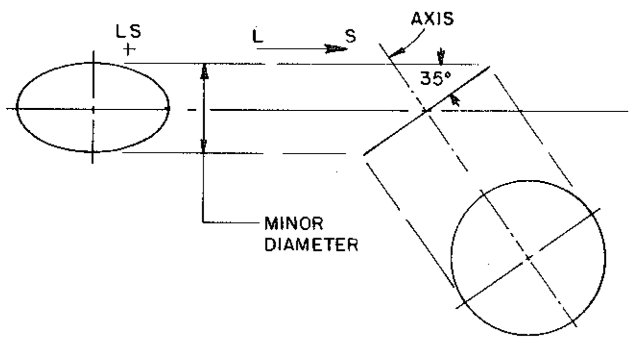


Figure 5

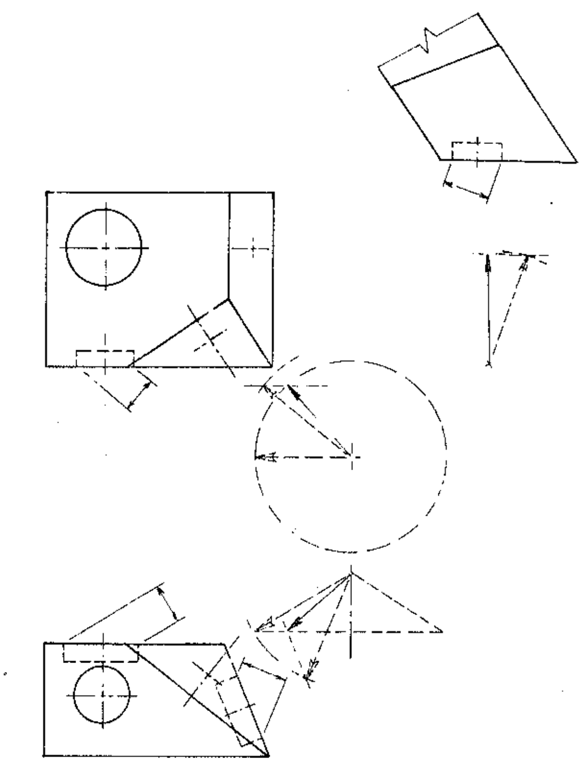


Figure 6

A projection parallel to the major diameter and (LS) will provide a minor diameter for the appropriate ellipse.[2] With the major and minor diameters now available, it becomes a simple matter to construct the ellipse. It is not necessary to construct a separate diagram (as in Figure 5) for each surface of the object. Figure 5 was used simply to illustrate the theory and method for determining the minor diameter. By making this construction in conjunction with the true length of the line-of-sight in the original orthographic views, the minor diameter for each circle can be readily determined. Figure 6 demonstrates how the minor diameter is determined for each of the surfaces. By simply projecting from a true diameter parallel to the rotated line-of-sight and taking a compass measurement between these projectors (perpendicular to the rotated LS), the length of the minor diameter is established and can be transferred directly to the axonometric view.

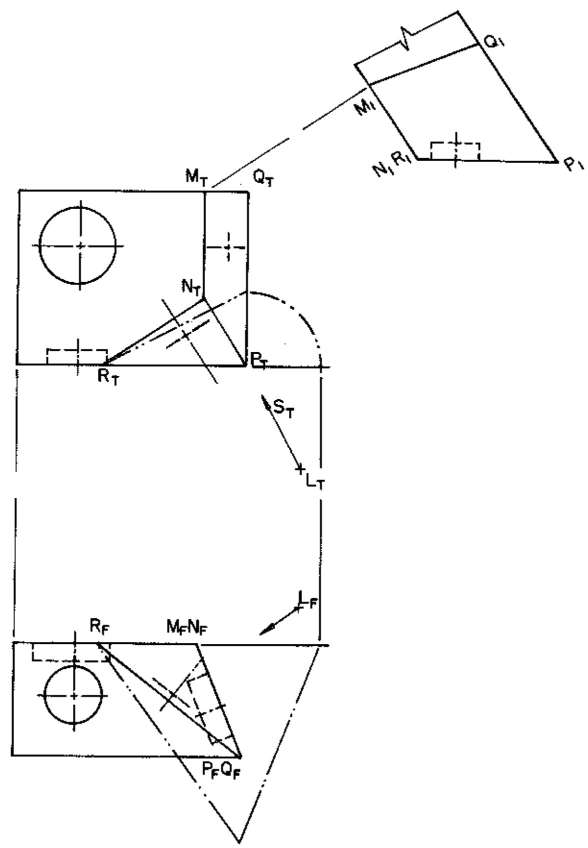


Figure 7

Figure 7 is the orthographic drawing of the object on which the necessary geometric constructions are used to define the axes for the axonometric view.[4] Figure 8 shows the relationship between each of the orthographic views used and the pictorial view as it finally evolved. In this case, ellipse templates were used for all ellipses.

Figures 9 and 10 illustrate an object for which a suitable ellipse template (for the semicircular lug) was not available. The rotated

Continued on page 38

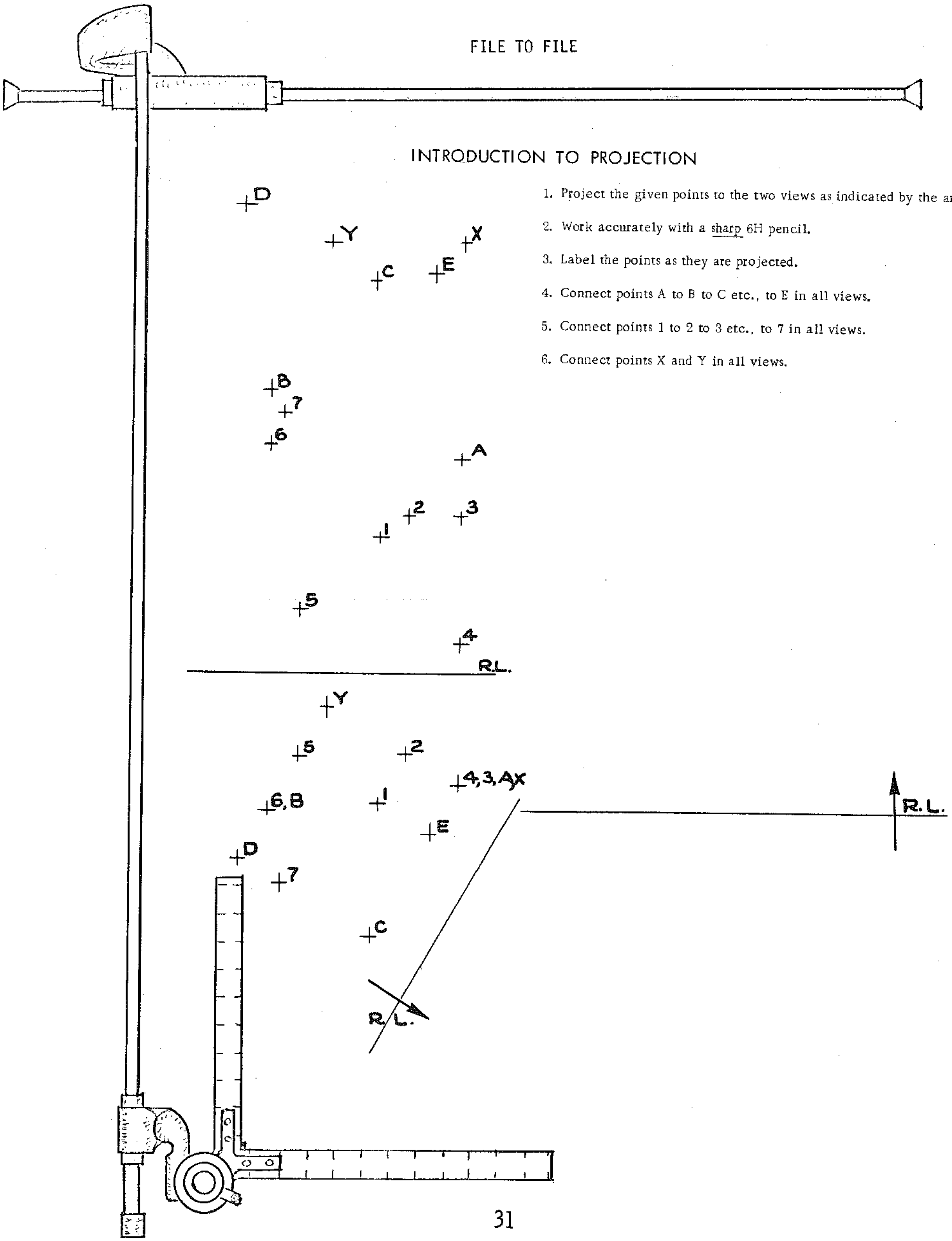
[2] Loc. cit.

[3] Giesecke, Mitchell & Spencer - Technical Drawing, Macmillan Co., 4th Edition, 1961.

FILE TO FILE

INTRODUCTION TO PROJECTION

1. Project the given points to the two views as indicated by the arrows.
2. Work accurately with a sharp 6H pencil.
3. Label the points as they are projected.
4. Connect points A to B to C etc., to E in all views.
5. Connect points 1 to 2 to 3 etc., to 7 in all views.
6. Connect points X and Y in all views.



CONTOURED SURFACE PROBLEM

1-5 Match the points indicated on the orthographic layout with corresponding points on the pictorial sketch. The part as shown in the pictorial sketch is repositioned for better illustration on Page 33

1 Point L =

2 Point J =

3 Point G =

4 Point H =

5 Point K =

6-14 Estimate the distances requested. The small scale printed at the bottom of the layout may be removed from the test booklet if you would rather measure. SELECT THE BEST ANSWER.

6 Space between the plane of curve M and point G.

7 The horizontal distance between points H and L.

8 The vertical distance between points G and Q.

a. 2.5
b. 5.0
c. 7.5
d. 10.0
e. 12.5

9 The vertical distance between points P and Q.

10 Determine the horizontal distance from point K and the point of intersection between curves M and S.

11 The point on the surface which is farthest from curve S is --

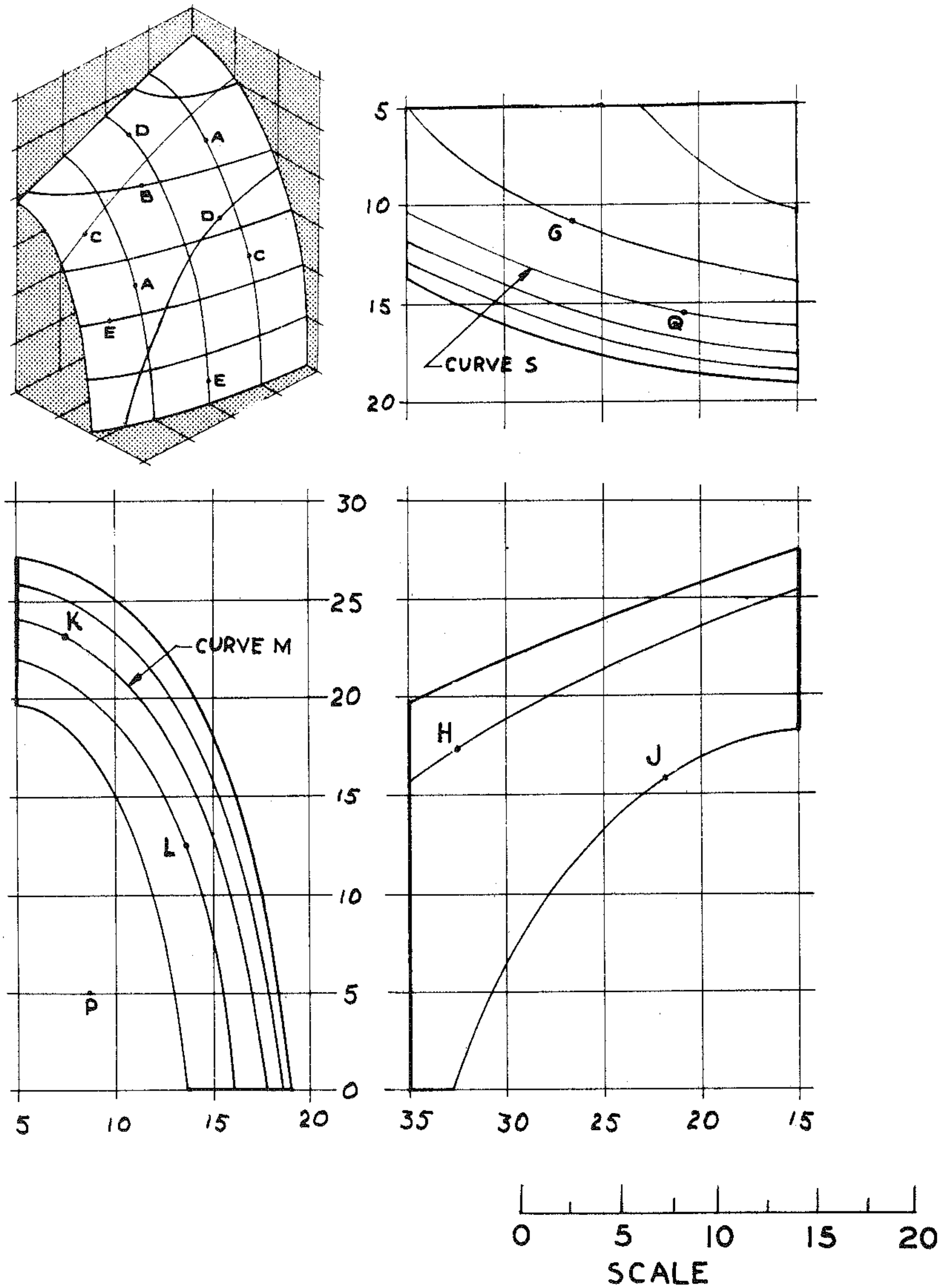
a. G.
b. H.
c. J.
d. K.
e. L.

12 The point on the surface which is farthest from curve M is --

a. G.
b. H.
c. J.
d. K.
e. L.

13 The vertical distance between points G and H.

14 The horizontal distance between points K and L.


D
A
B
D
C
C
A
E
E
5
10
15
20
G
Q
CURVE S
30
25
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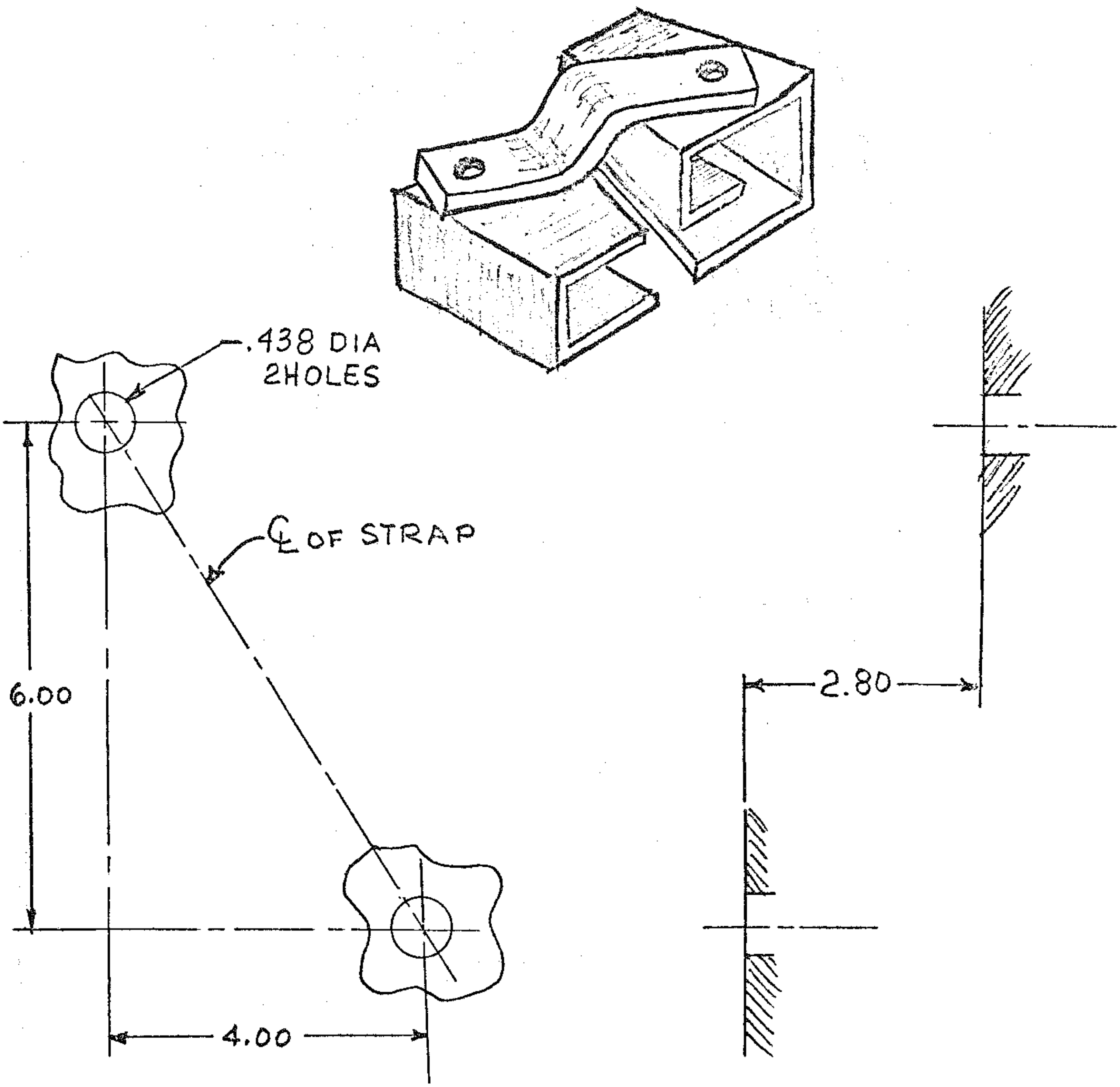
10
5
0
K
CURVE M
L
P
5
10
15
20
H
J
35
30
25
20
15
0
5
10
15
20
SCALE

STRAP BENDING PROBLEM

Design a strap from material .375 thick locus of bend ⊥ to ℄ of strap

Find: A. Minimum size of blank

B. Distance between centers of holes in the blank.



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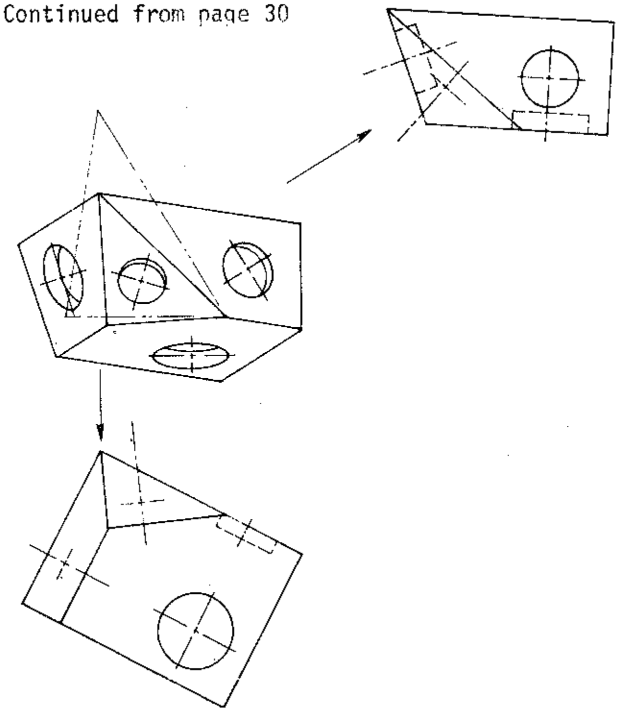

Figure 8

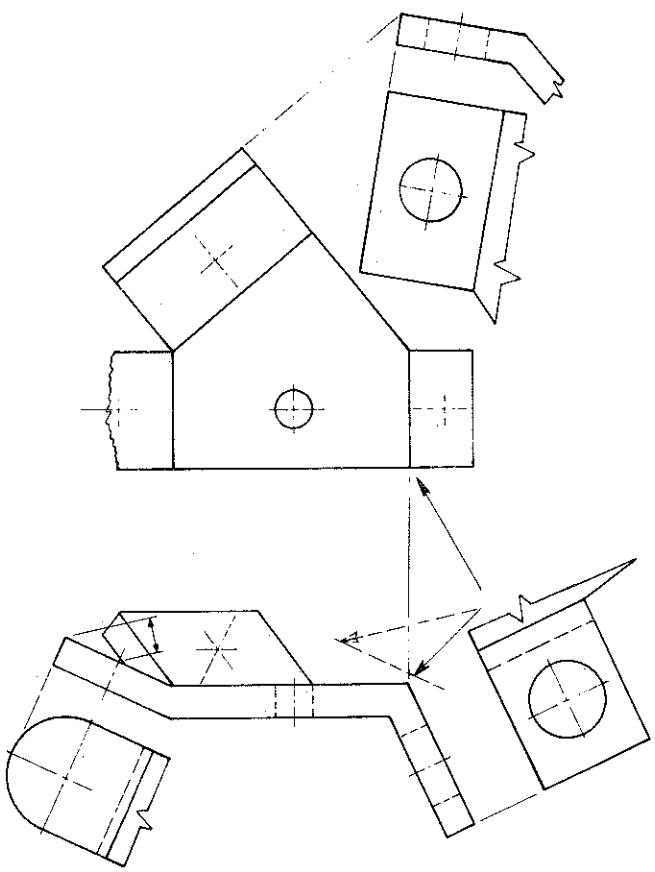

Figure 9

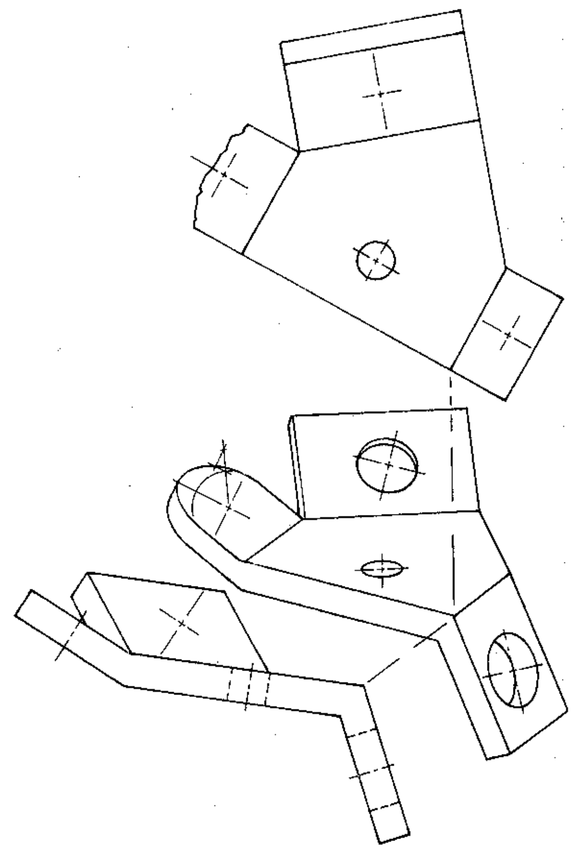

Figure 10

line-of-sight, to define its angle with the plane of the lug, is shown in Figure 9, along with the projected minor radius for the semicircular lug. Figure 10 shows the pictorial view of this object, and a portion of the concentric circle construction for the lug using the minor radius obtained in Figure 9.

Note that in Figures 7, 8, 9, and 10 it was unnecessary for the elliptical representations of circular features to be shown in the orthographic views, nor were they needed for the axonometric views. However, to improve the accuracy of the axonometric view, it is desirable to extend the length of the axes of the oblique circular features as needed to suit the projection conditions. The axis of each of the circular features is the longer of the two intersecting center lines in the orthographic views and, these axes must be in projection in the orthographic views. The major diameter of the elliptical representation is perpendicular to this axis in every view, including the axonometric view. Note, also, that the auxiliary and oblique views were not used to project into the axonometric view. They were used only to locate the axes of the circular features in the principal views.

---

[2] Loc. cit.

[4] "A Direct Method of Axonometric Projection," A. Romeo, ASEE Journal of Engineering Graphics, February, 1967 (winter issue), Vol. 31, No. 1, Series 92.

One caution should be offered in the application of this method. If a circular cylinder is in any way truncated by a surface of the object, this method is not directly applicable because the true shape of the cylindrical feature on the truncating plane would be an ellipse itself. An example of this, is a circular hole in some surface to which the axis is not perpendicular. The application of this method to such a situation requires a few more geometric constructions. However, the relative infrequency of those cases do not warrant a detailed discussion, since there are alternative methods available for these situations.

Continued from page 23

plastic moulding of shapes and distortion of projective planes,[1] (the projective transformations are regarded by British mathematicians as the most general transformations, susceptible to delicate operations especially in computer-aided design (CRT -- Sketch pad and Display Screen DAC-I processes).

An engineer is more interested in a concrete science of the real projective plane in which the one-to-one correspondence has been assured by the incorporation of ideal elements (i.e., located at infinity) than in ambiguous and rather abstract transformations performable in a topological projective plane.

3. The term homology reunites four projective operations, i.e.: collineation, affinity, elation, and homotheticity, whose properties deviate slightly from each other, depending upon the location of the axis and the center of projection. The difference between collineation and affinity, and an appropriate construction on the application of affinity, have again been clearly illustrated by Prof. Robert W. Bosmo, Princeton University, in his article on "An Application of Desargues' Theorem" by Figs. 1 and 2 in November, 1966 issue of J.E.G.

   In the European texts listed above, the fundamental concepts of projective geometry form the introduction to the subject of higher Descriptive Geometry. These concepts are indispensable to engineers dealing with solution-constructions to complex projects based on the notion of Higher Descriptive Geometry.

   In these texts, there also can be discovered that the "peculiar line" of orthographic projection is identical with the axis of homology of projective geometry in meaning as well as in function. This line, for example, allows one to operate with two views of orthographic projection monoplanarly, if need be.

4. The "peculiar line" was discovered some 150 years ago by Gaspar Monge, the inventor of orthographic projection.

   An axis of homology applied to either planar, or spatial projectively related configurations can be regarded as a peculiar line. Projective geometry is not basically a plane geometry in its concepts, but constructions offered by the homological operations can be elegantly applied to spatial configurations by means of monoplanar pictorial representations (or projections) such as axonometry (oblique and isometric), and perspective projection.

5. Direct method and third angle projection (i.e., American) are two entirely different items.

   "Direct method" which is a reduced (truncated) method of orthographic projection because it does not operate with the extremely useful device of traces of a plane with the principal projection planes,[2] may be applied to I., II., and IV.-quadrant projections as well. There is no objection to apply any special angle of projection, if the character of the treated problem so requires.

   Many times it is necessary to pursue the operations of orthographic projection from the first selected into other quadrants. In the elementary problems of engineering drawing the application of the "direct method" is adequate.

   However, since the pictorial representations of objects and surfaces relative to problems in descriptive geometry are more illustrative if shown in conjunction with the I.-quadrant projection, it is advantageous (and advisable) to use the I.-quadrant projection with preference.

   This projection proves superior in axonometric representations of objects and surfaces, and especially in perspective projection, where the orthographic projection is inseparably conjoint with the pictorial solution construction of the problem.

6. Projective Geometry and Descriptive Geometry are both sciences! Therefore, a statement: "a science is superior to projective geometry" is nonsensical and contradictory, unless it means that projective geometry is superior to itself (or may we compare this statement with the conformal mapping of topology, (i.e., mapping of a plane into itself?).

7. Many elementary as well as advanced constructions of descriptive geometry may be treated, or the proofs to the same may be furnished by analytic geometry; e.g., length of a line segment, magnitude of an angle whether plane or dihedral, equation of the trace of a curved surface in the principal projection planes, or in an arbitrary cutting plane, etc. Also the peculiar lines and planes may be expressed by simple equations. Prof. Pozniak's "peculiar line" is the line of intersection (or trace) of a plane configuration represented by two principal views of orthographic projection with (or in) the plane of identity, whose equation may be expressed simply by $y = z$ (in Cartesian co-ordinates x, y, z) where x is the reference line, or the intersection of the two principal projection planes. Whether all these equations are

expressed implicitly, or explicitly (i.e., functionally), they positively represent the same line in both descriptive and projective geometry.

CONCLUSION

The near future will show that projective geometry will remain all geometry for a long time ahead; its incorporation into the science of engineering graphics and in general engineering curriculum will prove indispensable with respect to applications of the elegant, concise and useful concepts of technical projective geometry into the establishment of sub-routines (sub-programs) of the computer-aided design (i.e., computer-plotter combination, CRT-Sketch pad, and Display Screen-DAC-I processes). These sub-routines will be based on the universal computer language system PROJECTRAN elaborated by Dr. R. A. Kliphardt and myself. They will prove definitive in application to projective transformations relative to construction solutions of repetitive (of the same class) problems. They will provide a considerable saving of time and money in programming.

[1]See article by the author: "Projective Geometry and its Application to Engineering Problems," November, 1962 issue of J.E.G., Problems 6, 7, 8, Mapping - Affine Transformations.

[2]E.g.: facilitating solution constructions on warped surfaces of degrees higher than two, relative to problems in mechanical, architectural, civil engineering complex projects.

V. P. Borecky
University of Toronto

EDITOR'S NOTE

We cite the note at the head of the editorial page of the Journal of Engineering Graphics which states:

> "The views expressed by the individual authors do not necessarily reflect the editorial policy of the Journal of Engineering Graphics or represent the official stand of the American Society for Engineering Education or the Engineering Graphics Division. The editors make reasonable effort to varify the technical correctness of material published; however, final responsibility for technical accuracy rests with individual authors."

We, therefore, include C. Ernesto S. Lindgren's letter regarding both articles which we think may be a reasonable summary of the subject.

Dear Professor Black:

On the Borecky-Pozniak discussion on projective-descriptive methods. Is Projective Geometry ALL Geometry?

The answer can be found in the understanding of what is a geometric method. I like to define it through a statement of purposes.

"A geometric method is the manner by which we can, through use of projective transformations, translate or transport to the elements of a frame or system of reference, the geometric relations that exist in a geometric form as it occurs in the space within which the form is embedded; simutaneously, the method should permit the expression of a numerical relationship between one single point and the elements in the frame of reference."

Generally, all methods make use of this combination of projecting and coordinating, including the projective method, as for example in the case of expressing the anharmonic ratio. Here, there ought to be established a relation involving metrics, among the four points. In this case, the line of the four points is, in itself, the frame of reference.

Projectivity and coordination are not relations brought out by any particular method. They are intrinsic to the geometric form. Therefore, they are completely independent of the method as are all other geometric relations or properties of the form.

Four points in a line are related by a ratio. It is there. However, are we to say that the line is there because Projective Geometry express it? In a right triangle, in Euclidean geometry, $a^2 = b^2 + c^2$. What makes it so? The synthetic method? Of course not. It is a relation, a metric relation, intrinsic to the geometric form. Did duality in Euclidean space come about because Poncelet stated it in 1822 through the projective method? Of course not. It was there, long before that, long before Euclid wrote his thirteen books.

Perhaps Professor Borecky wants to say that we can express all these geometric properties through projective geometry. This is true. But it can also be done by other methods.

No method is more general than another. One can only say it better, or express things in an easier way, or make something more obvious. And none can claim to have said it in the BEST way.

No method is ALL geometry. It is just a language. Nothing more, nothing less.

C. Ernesto S. Lindgren
U. S. Steel Corporation

P.S. I love them ALL!

Continued from page 12

should be noted that this proposal does not automatically provide a series of preferred sizes, because there are two types of dimensioning. One is the expression of a size plus a bilateral or unilateral tolerance. For example, with the first type of dimensioning, 1.66 over 1.64 would be considered a better choice than 1.67 over 1.65. But when we are employing bilateral dimensioning, 1.65 + or - .01 (which is the identical size) would be considered a poorer choice than 1.66 + or - .01. In other words, this preference for 20-mil multiples relates to the preferred increments for expressing dimensions rather than to the resulting sizes.

3. Limits and tolerances are defined as absolute. I repeat -- limits and tolerances are defined as absolute -- regardless of the number of decimal places. Limits and tolerances are to be used as if they were continued with zeros beyond the last significant figure. There is no tolerance universally implied by the number of places in an untoleranced decimal dimension, although a tolerance may be assigned on a specific drawing by a footnote which relates the size of the tolerance to the number of places in each decimal dimension on that specific drawing. Nevertheless this must be kept on the basis of individual footnotes on specific drawings, and not as a universal standard.

4. Existing commercial tool sizes and stock sizes may be maintained even though the dimensions are expressed decimally instead of as fractions. This is one important reason for not relating the size of a tolerance universally to the number of decimal places in a dimension.

   We should not be dismayed if some well established nominal sizes continue to be expressed as fractions -- such as 3/8 inch pipe or a 1/4 inch drill. Similarly, we do not worry that we are losing the advantages of our decimal coinage system when people speak of quarters and half dollars. Fractions are used to identify, and are considered as nominal rather than design sizes.

5. Appendices in this standard provide some useful supplementary information. First, there are rules for rounding off dimensions -- an activity which is becoming more frequent due to the increasing need for converting drawings from millimeters to inches. Second, there is some ammunition for you to use when you are asked why it is worthwhile to express dimensions decimally rather than as fractions. Third, there are suggestions as to the best ways to go about converting dimensions from fractional to decimal-inch expressions.

Now for a brief look at the future work being planned by the B-87 Committee. The scope of B-87 has been officially expanded to read as follows: "Preferred systems for the expressions and use of decimalized units of length, mass, time, temperature, electromagnetic energy -- and their derived units for use in engineering. This includes conversion factors and preferred practices for the expression of equivalents in SI and customary U. S. systems of measurements units."

The following tasks must be performed by the Committee:

A. Review and updating of two U.S.A. standards (formerly known as ASA standards) -- namely, Z25, Rules for Rounding Off Numerical Values and B-48.1 -- 1933, Inch Millimeter Conversion for Industrial Use. Both of these standards were originally created by what is known as the "general acceptance method." Hence there have not been any standing committees to keep them up-to-date. After revision, they will be renumbered as a coherent part of a new series of B-87 standards.

B. Page one of the 1966 (and 1967) editions of the SAE Handbook includes a new Recommended Practice J916 entitled, "Metric Equivalents of U.S. Conventional Units of Measure." It will be the job of the B-87 Committee to review this Recommended Practice for the purpose of covering the subject in the new B-87 series of U.S.A. Standards.

C. Decimalization of other units of measure, such as weight and volume. Although the new expanded scope of the B-87 Committee contains no direct reference to weight and volume, these units of measure are considered to be "derived units," as specified in the scope.

In conclusion -- a few words about the metric system. We are sometimes asked whether it is worthwhile to improve our U.S. measurement system in the face of the possibility we may soon be changing to the metric system. It has been estimated that it would cost the United States at least twenty-five billion dollars in direct costs to convert to the metric system. It would mean not just a new language but it would also mean new sizes, new tooling, new gages, and new duplicate inventory. In addition, there would be enormous indirect costs for many decades while the transition is in process.

In the meantime, in engineering work, there is nothing wrong with our United States system except the lack of decimalization. In one area, at least, it is superior to the metric system -- namely, for measurements made with the decimal-inch scale recommended in USASI Z75.1 -- which is ideally suited to the resolving power of the human eye. The scale is shown in Figure 1.

system are loath to express dimensions to a quarter millimeter (0.25mm) because of the additional number of decimal places.

A measurement requiring estimating to the nearest half graduation of our decimal-inch scale, for example, would be 4.99 inches. A corresponding reading on a scale ruled to half millimeters would be 126.75 mm -- requiring five digits instead of only three, and creating a tendency toward excessive "rounding off" of metric scale measurements.

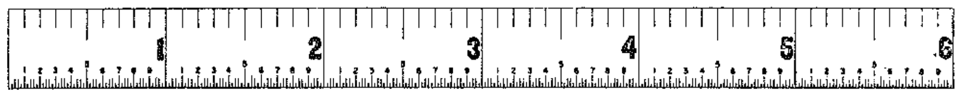

Figure 1. Decimal-Inch Scale

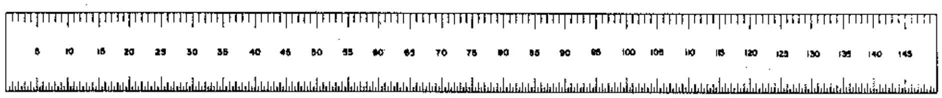

Figure 2. Metric Scale

Twenty-mil increments -- namely 50 per inch -- are well suited as the finest subdivision, but approximate interpolation can be made to the nearest ten-mil increment. Perhaps even more important, is the arrangement of lines where the pairing of medium length lines at .4 and .6 make it easier for the eye to follow than the lines of a millimeter scale, shown in Figure 2.

Normally a millimeter scale is marked only to full millimeters. It might be argued that if a millimeter scale were marked in 0.5 millimeter graduations, as shown on the bottom edge of the above scale, these increments would be approximately the same in size as our 20-mil graduations, and therefore equally useful. However, the scale is not as easy to read due to the lack of the pairs of medium length lines found on the USASI Z75 scale. Furthermore, users of the metric

My own feeling is that the B-87 Committee should be neutral on this debate, but a fortunate paradox is involved. Decimalization of our conventional U. S. units of measure can be useful either (1) as a means of combating the metric system, or (2) as a means of making the transition to the metric system more efficient. At any rate, even if we should agree to adopt the metric system within the next ten years or so, for several decades thereafter we would have to live with both systems because the products already made to the inch system would not disappear from the face of the earth overnight. And during those difficult decades, conversions would be more practical on a decimal basis.

As the new chairman of the B-87 Committee, I shall welcome suggestions from any of you regarding this work.

What you do today determines what you will be tomorrow.

Curiosity is the beginning of the learning cycle.

Engineering crosses so many areas of social significance that one is seldom surprised where he will find need of engineering knowledge.

The exploding mass of information in the laboratories of the world will do little good for mankind unless it is documented and passed on by the several means of communication.

Successful educational methods must have a freshness in knowledge dealt with.

Progressive engineering education does not ride the caboose.

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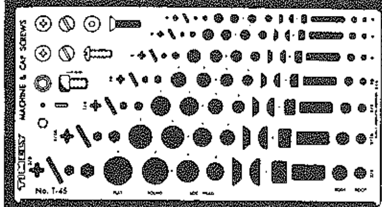

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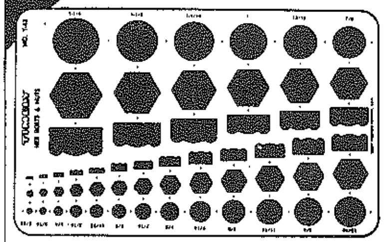

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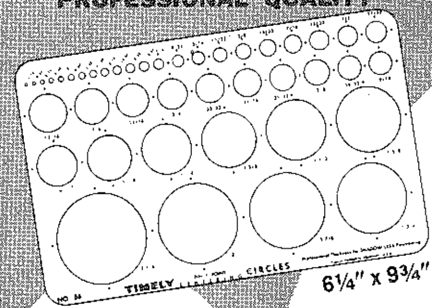

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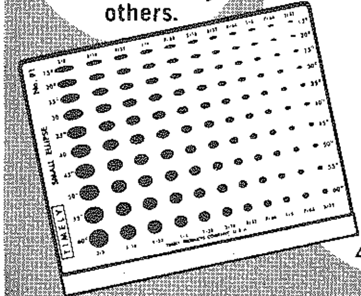

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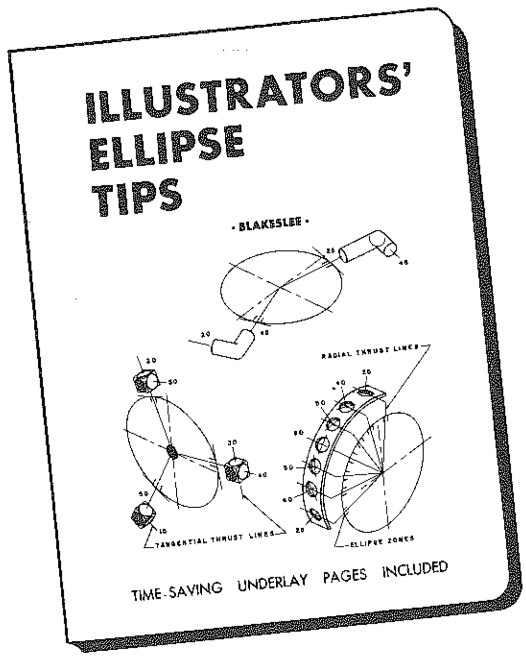

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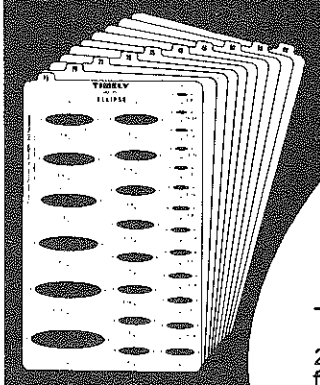

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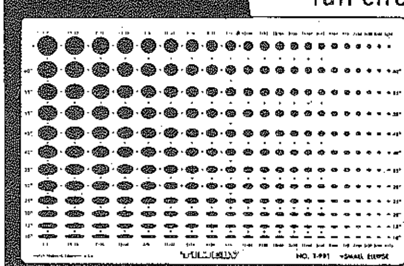

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constitute a powerful tool with which to analyze systems, but when a computer is needed as a tool to analyze equations, efficiency might be realized by going directly from the primary model to the machine, or, at least, to a secondary model more readily programmed.

Rosenberg (5), using the bond graph models proposed by Paynter (6), has developed a means of programming a digital computer directly from a structural system graph. Krigman (7), also working with techniques suggested by Paynter, has demonstrated a method of wiring an analog computer directly from a primary model. Larrowe (8), has a similar method. Other work in this area has employed the Mason flow graph (9) as a secondary model.

To analyze the behavior of a system, physical laws governing interactions among elements and parameters must be considered. These physical laws are inherently part of the system model. A resistor drawn in a circuit diagram is a symbolic statement of Ohm's law between two points. A spring in a free body diagram is an embodiment of Hooke's law. The analysis consists of applying an appropriate algorithm to manipulate the information in the model. This frequently requires considerable skill, but being algorithmic, is automatic and does not require thought.

For example, many electronics problems are solved by first drawing the circuit, then by writing and solving the differential equations. The solution to the equations may be found with no knowledge of the physical system which they represent. Somewhat less obvious is the fact that the equations may be written automatically from the network. Kirchoff's laws constitute an algorithm for a translation from symbols on a circuit diagram to terms in an equation.

The above discussion can be directly applied to mechanics. All of the engineering is done in drawing the free body. The differential equations may be solved without application of physical principles. From the free body diagram, writing the differential equations requires only adding force components in each of the orthogonal directions, and summing moments about some arbitrary point. Astute selection of the orthogonal directions and of the arbitrary point may lead to particularly convenient equations, and hence to simplified mathematics, but all directions, and all points, result in the same solution.

THE VECTOR DIAGRAM IS A SECONDARY MODEL

The vector diagram may be advantageously used as a working model in some plane dynamics problems. For example, a block of mass m is on a plane inclined at angle θ with the horizontal. A horizontal force F acts on the block; the coefficient of friction between the plane and the block is f. Any number of questions could be asked about the ensuing motion, e.g., if the block is initially moving up the plane, will it eventually reverse direction; or, given all other values, what is the maximum value of f which will still permit motion starting from rest?

A possible first step toward answering questions of this type is to construct a primary model, such as the free body diagram in Figure 1. All of the information to be used and derived in this problem is contained in this diagram.

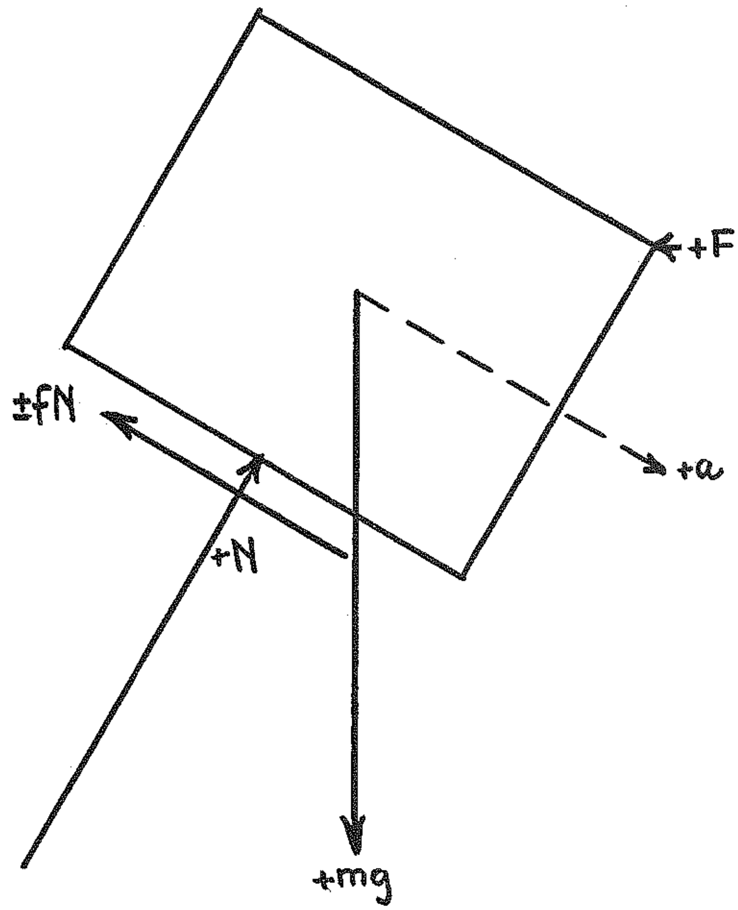

Figure 1

The ambiguity in the sign of the friction force results from the fact that the direction of motion or, in the absence of motion, the direction of the resultant force, is as yet undetermined.

A traditional solution would now entail using Newton's law as an algorithm to write a set of equations from the model. As an alternative, D'Alembert's principle may be used to draw a vector polygon from the model. Assume that F, M, θ , and f are known. In Figure 2, F and mg, may be laid off directly. The friction force and the resultant acceleration are known from the free body diagram to lie along the parallel lines f-f and a-a respectively.

The normal force is the distance between these lines. Once this is measured or calculated trigonometrically, the maximum numerical value of the friction force fN, can be determined, and the

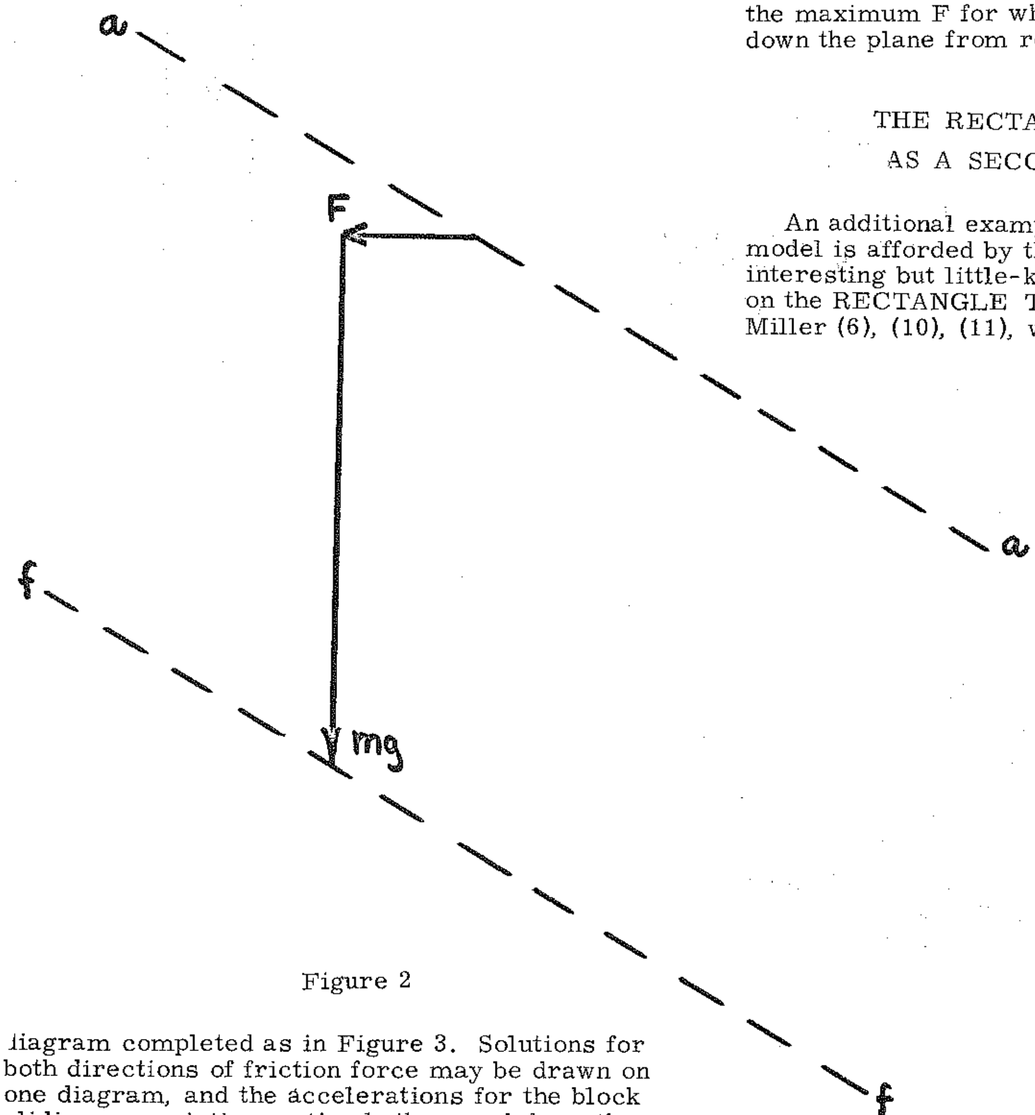

Figure 2

diagram completed as in Figure 3. Solutions for both directions of friction force may be drawn on one diagram, and the accelerations for the block sliding or resisting motion both up and down the plane may be obtained as

$$\frac{(ma)2}{m} \text{ and } \frac{(ma)1}{m}, \text{ respectively.}$$

An advantage of the diagram is that it yields information which otherwise would demand solving the equations several times. More important, the diagram presents operating ranges and results of changing operating conditions. For example, extending line x-x to a-a in Figure 3 gives the acceleration in the frictionless case, and extending line y-y to f-f gives the coefficient of friction necessary for zero acceleration. Accelerations to the left of y-y are up the plane, and to the right are down. Similarly, friction forces represented to the left of x-x resist motion down the plane, and to the right resist motion up. Consequently, the intersection of y-y with f-f gives the maximum f for which starting from rest, the block will slide down the plane.

Inversely, with the given value of f, the intersection of F with N_2 defines the minimum value of F which is required to push the block up the plane, while the intersection of N_2 with F gives the maximum F for which the block will start down the plane from rest.

THE RECTANGLE DIAGRAM AS A SECONDARY MODEL

An additional example of a graphical secondary model is afforded by the rectangle diagram. This interesting but little-known construction is based on the RECTANGLE THEOREM of Cherry and Miller (6), (10), (11), which states that an electric circuit composed of all like elements (all-resistor, all-inducter, etc.) can be represented as a rectangle composed of a set of contiguous rectangles. The ratio of the height to the base of each constituent rectangle, its aspect ratio, is the impedance or transmittance of the corresponding circuit element; the aspect ratio of the overall rectangle is the impedence or transmittance of the circuit. As indicated in Figure 4, for capacitors, resistors, and inductors, the heights of the rectangles represent voltages, while the bases represent the designated functions of current.

The rectangle diagram for a circuit might appear as in Figure 5. To understand the circuit which this represents, note that heights represent voltage levels. Horizontal lines on the diagram therefore map circuit nodes, points at which a single voltage is identified. For reference, the lines may be numbered, as in Figure 6. Rectangle B is bounded by lines 1 and 2 at voltages V_1 and V_2, respectively. Element B is accordingly bounded by nodes at V_1 and V_2 and so forth.

The rectangle and the circuit diagram contains the same information. In the circuit, the topo-

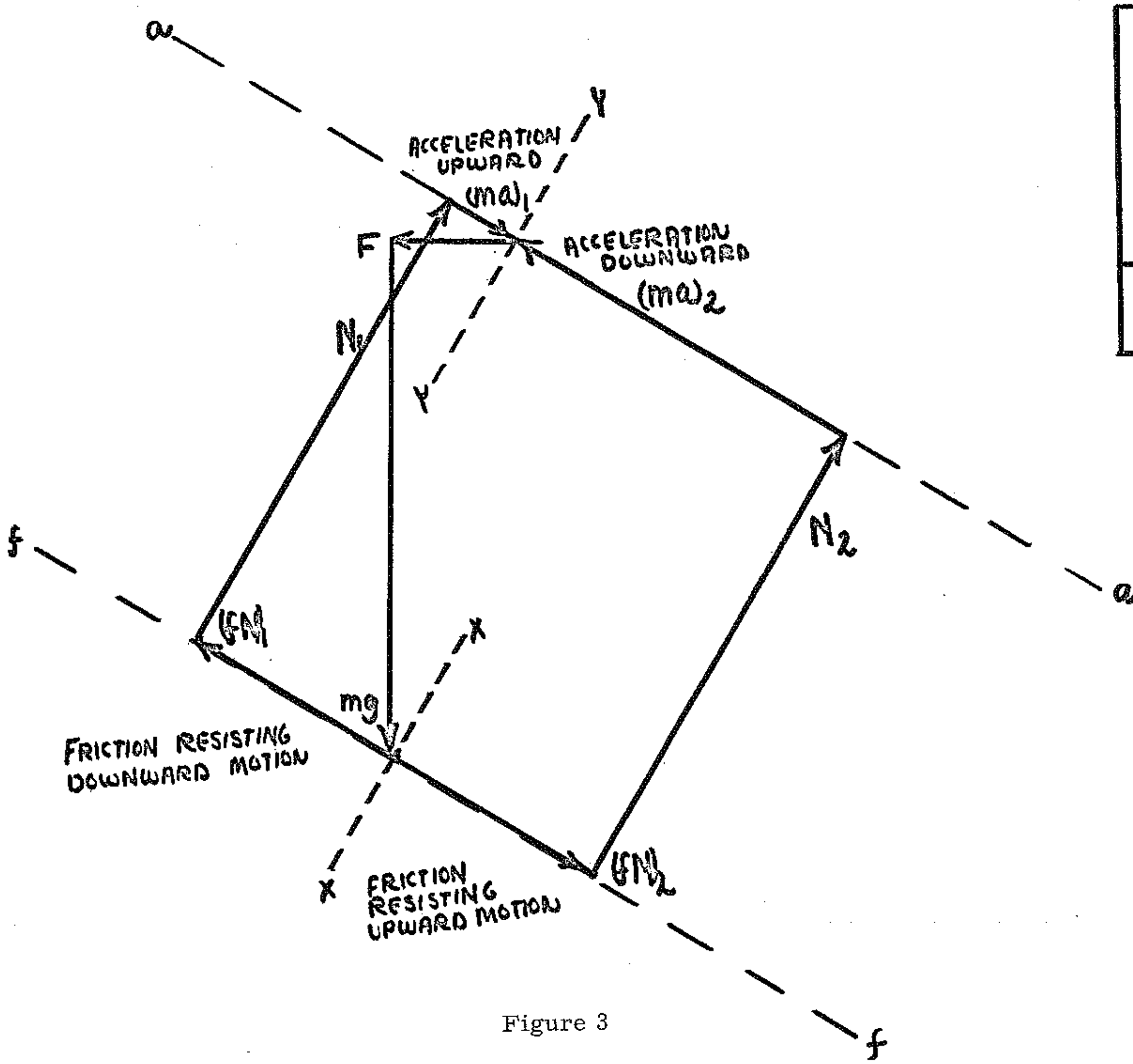

Figure 3

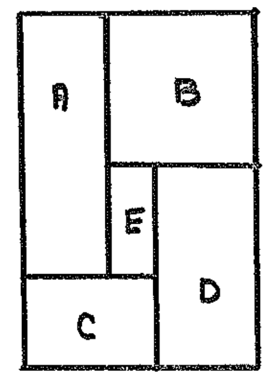

Figure 5

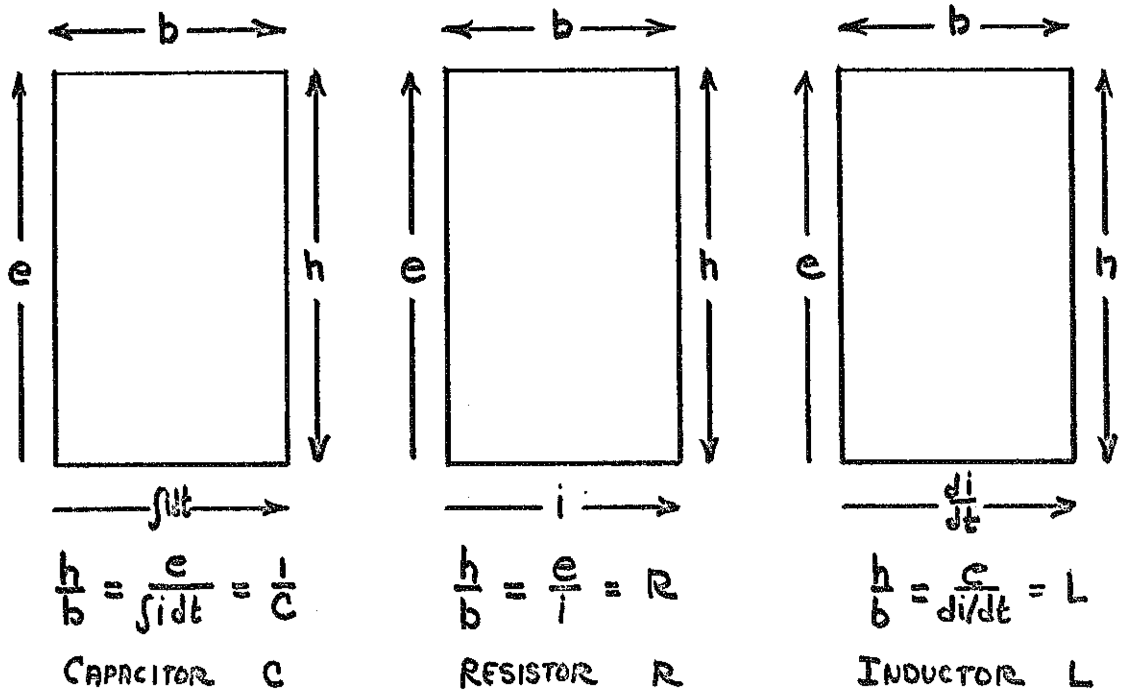

Figure 4

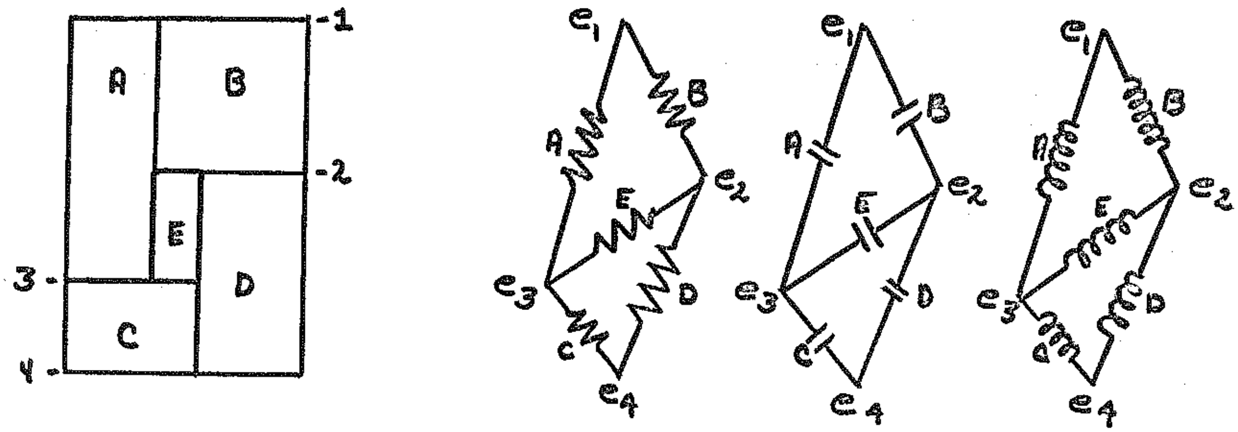

Figure 6

graphy of the prototype is more explicit, but voltage drops, for example, must be extracted using the Kirchof's law algorithm. In the rectangle, voltage drops are explicit, but the topography must be developed.

In general, it would be difficult to determine the impedance of a given circuit by constructing its rectangle diagram, because element rectangles of proper proportions would have to be assembled into a rectangular form without prior knowledge of their areas. Synthesis of a network required to have a specified overall aspect ratio is, however, a practical use of the diagram. One need only draw the overall rectangle with the proper aspect ratio, and then fill it with smaller rectangles according to the values of elements available for physically building the circuit. It is interesting that with the rectangle diagram synthesis of a network is more straightforward than analysis -- contrary to the usual situation.

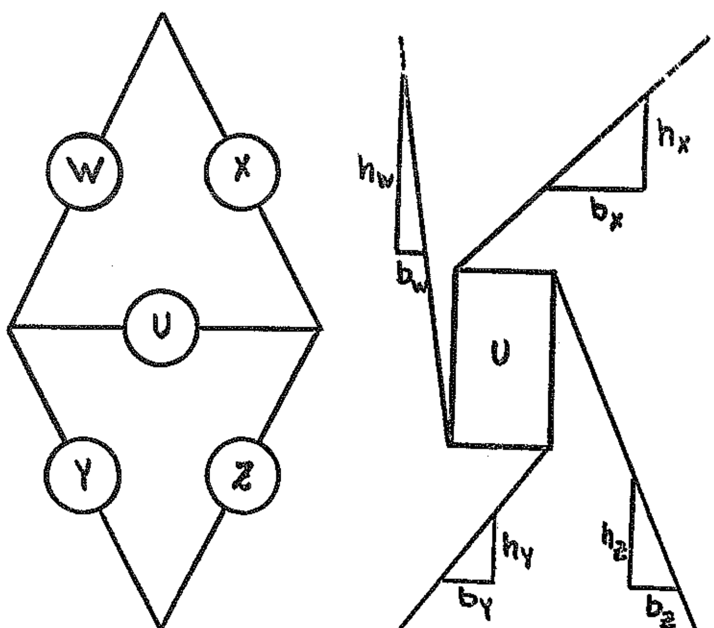

Figure 7

One case in which the rectangle diagram is effective in circuit analysis is the Coons Construction (6) of the rectangle for the bridge circuit. Bridges of the type shown in Figure 6, b, c, and d have rectangle diagrams of the form shown in Figure 6a. To construct the appropriate rectangle, and thereby find the overall bridge impedance or transmittance, a rectangle representing the central element is drawn -- with the proper proportions, and with any area. Diagonals are drawn outward from the corners of this rectangle, each with a slope equal to the aspect ratio of its respective element. This is illustrated in Figure 7.

The rectangle representing the bridge will have sides parallel to those of rectangle U and corners on each of the four diagonals. Coons' method of constructing the rectangle is based on his finding that a line beginning at any corner of rectangle U drawn in a rectangular spiral as indicated by the arrows in Figure 8a along path 1-2-3-etc., will converge to the desired figure.

The advantage of the rectangle diagram as a secondary model lies not only in the ease of its application to a particular problem, but also in the additional information to be derived from it. If the bridge of Figure 7 were composed of resistors, the ratio h/b in Figure 8 gives the resistance of the bridge. The partitioning of the voltage drop across the various resistors can be deduced from the relative heights of the rectangles, the current flowing through each can be determined from the bases, and the power dissipated in each from the areas.

SUMMARY

The engineering model has been discussed as an analytical tool. A distinction has been made between primary and secondary models, the former being a means of codifying the information associated with a real system, and the latter a means of manipulating that information. All information relevant to the prototype system must be contained in the primary model. The secondary, or computing model will be found directly from the primary, using rules or algorithms based on physical laws. The differential equation is the most well known secondary model, but others are

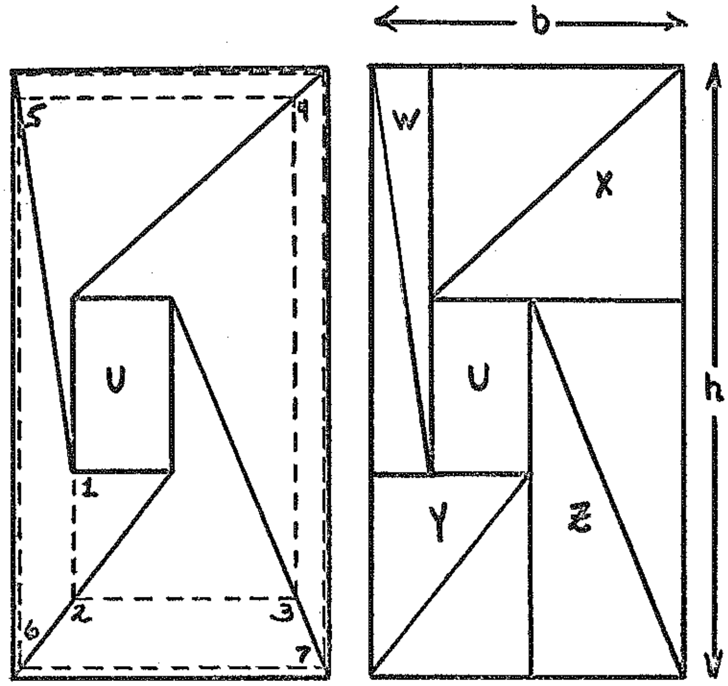

Figure 8

possible, and often superior in terms of answering specific questions or understanding general system behavior. Graphical models, particularly, aid in this understanding. In addition, secondary models formulated in terms of high-speed computer capability may lead to increasingly efficient use of computing machines.

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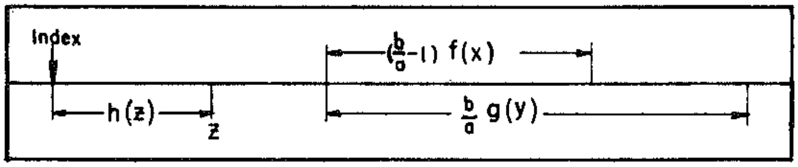

Figure 2

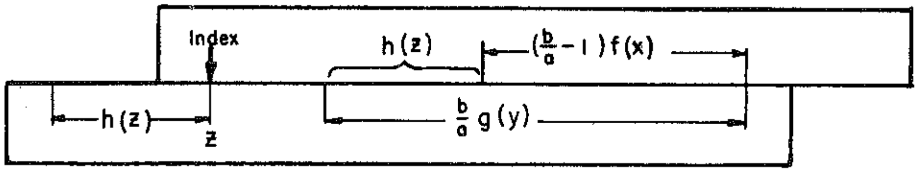

Figure 3

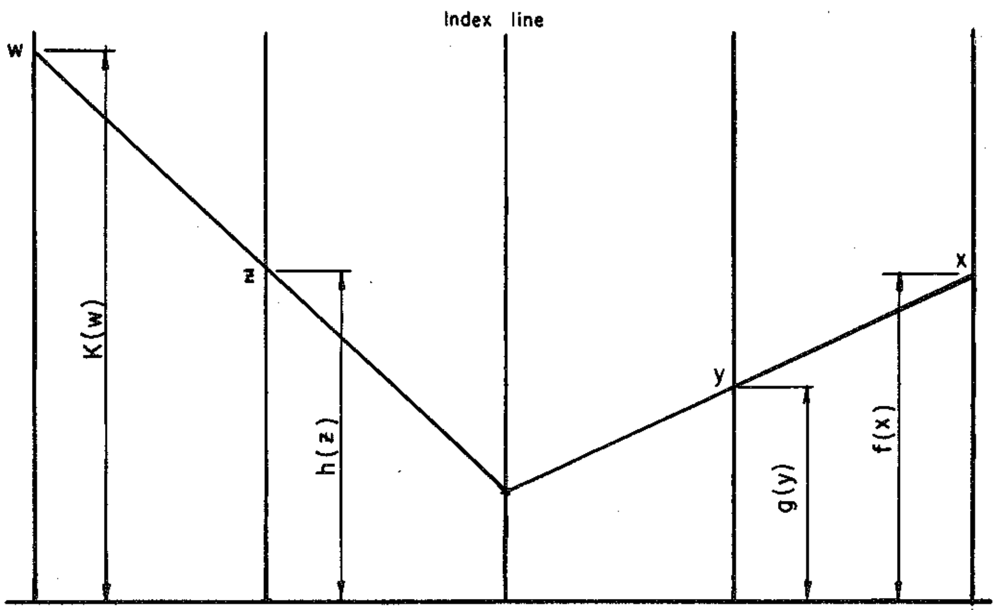

Figure 4

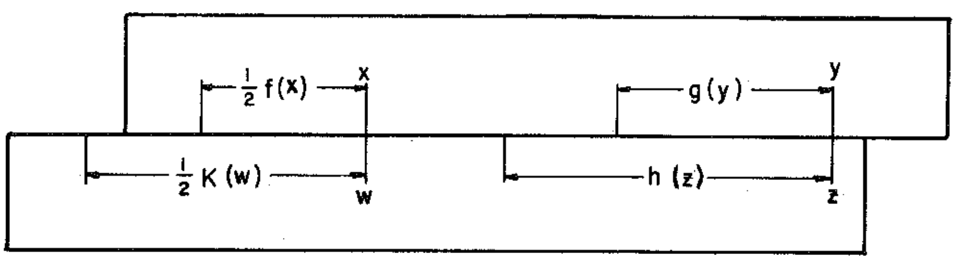

Figure 5

$$\frac{f(x)}{g(y)} = \frac{a - h(z)}{b - g(y)}$$

or

$$\frac{f(x)\left[b - g(y)\right]}{g(y)} = a - h(z)$$

This is reducible to:

$$\log f(x) + \log\left[\frac{b - h(y)}{g(y)}\right] = \log\left[a - h(z)\right]$$

The resulting slide rule is shown in Figures 7

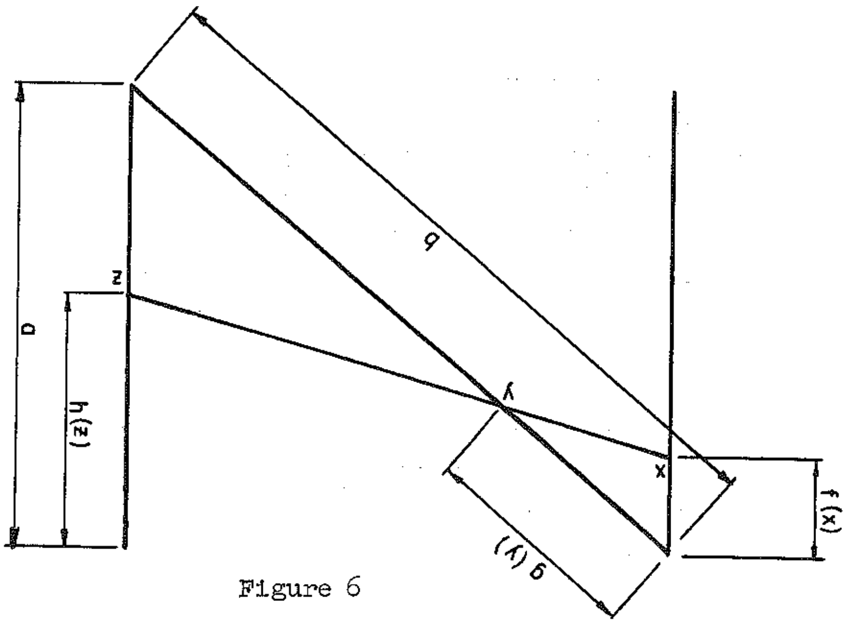

Figure 6

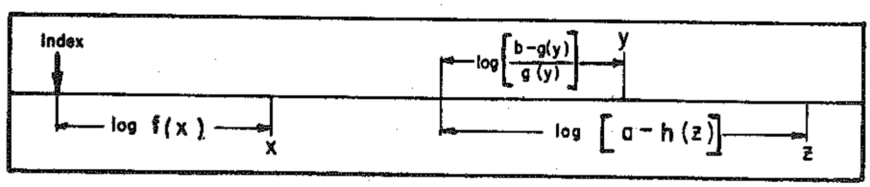

Figure 7

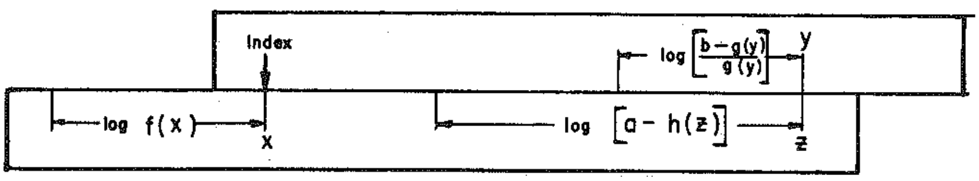

Figure 8

and 8. The nomograms discussed above constitute some of the simpler types.

The more complex nomograms would no doubt require more elaborate procedures to transpose them to slide rules; however, the same principles could probably be applied in most cases to achieve a slide rule which would do the same job easier, quicker, and more accurately.

References

Ford, L. R., Some Slide Rules, The American Mathematical Monthly, V. 52, 1945, p. 328-334.

Weiner, L. M., A Slide Rule For Relationships Involving Three Variables, School Science and Mathematics, to appear in Fall, 1965.

Continued from page 25

between guesswork and analysis under the pressure of economical considerations." Design projects seldom begin or end with the writing of equations or the programming of a computer project for getting definite answers. If tomorrow's jobs require more education and training, our only security is a marketable knowledge combined with skill in making practical applications.

Education is only a tool for doing things.

The trick of being able to convey a maximum of significant information in a minimum of time is a valuable asset to any man.

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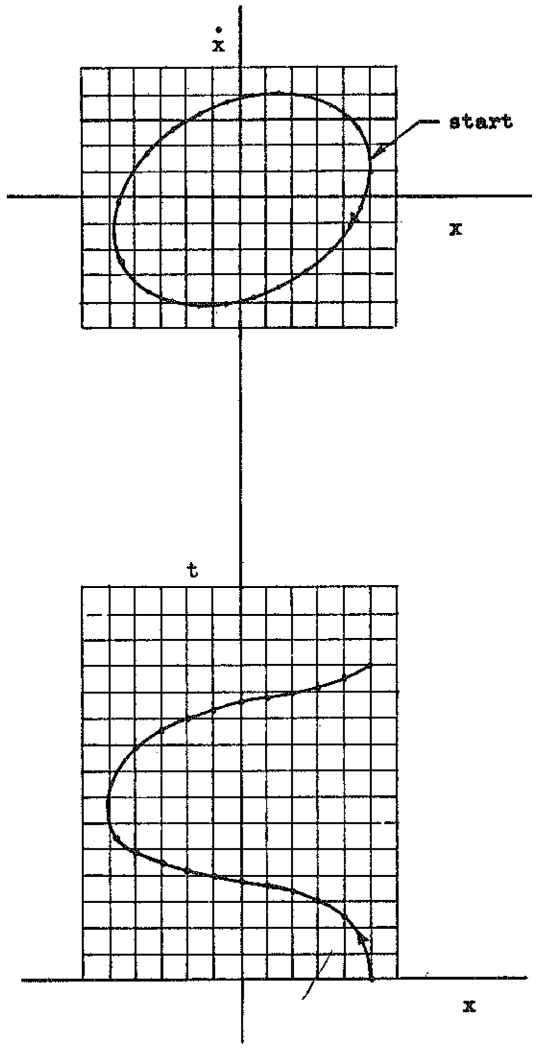

Figure 6. Application of techniques for time-displacement curve

Example 4

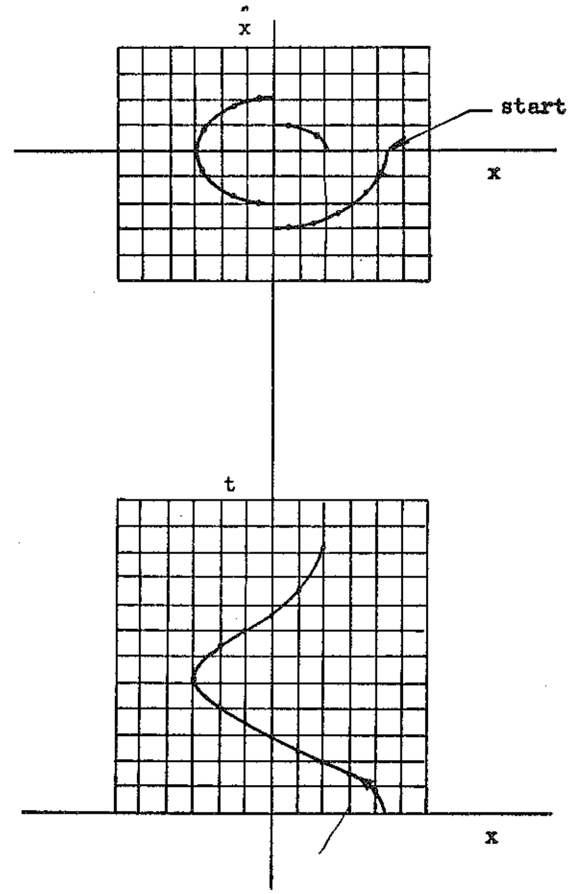

Figure 8. Time-displacement curve as plotted from the phase plot

Example 3

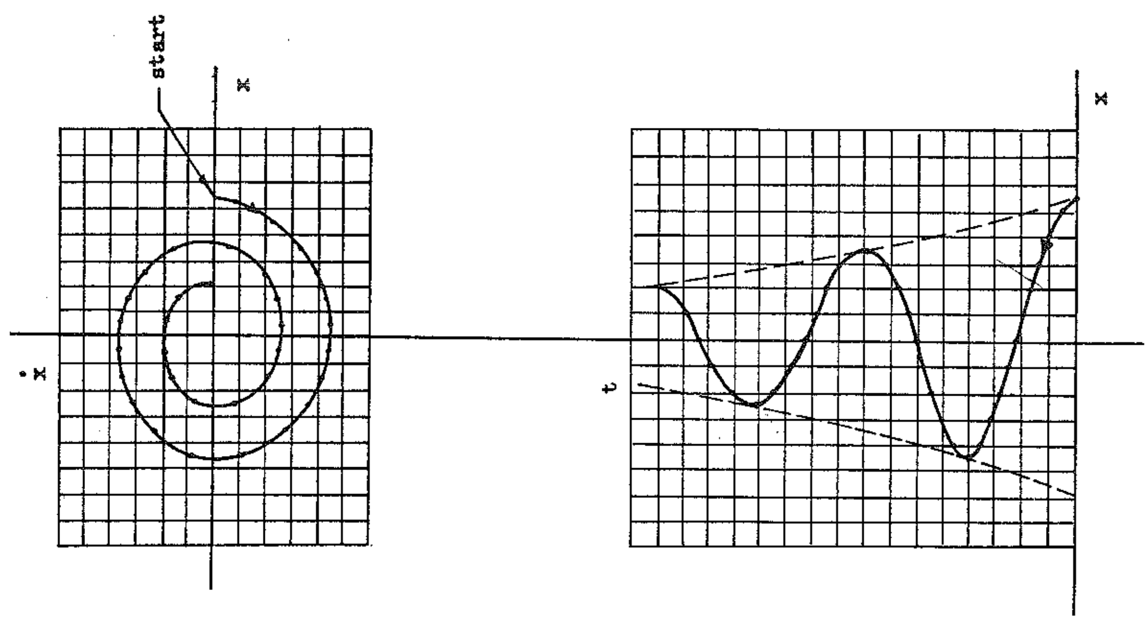

Figure 7. Phase plot with time-displacement curve

Example 5

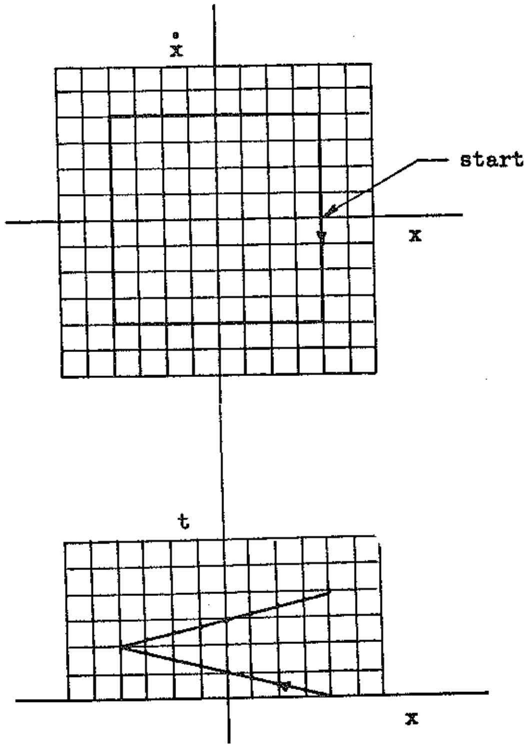

Figure 9. Time-displacement curve and phase plot

Example 6

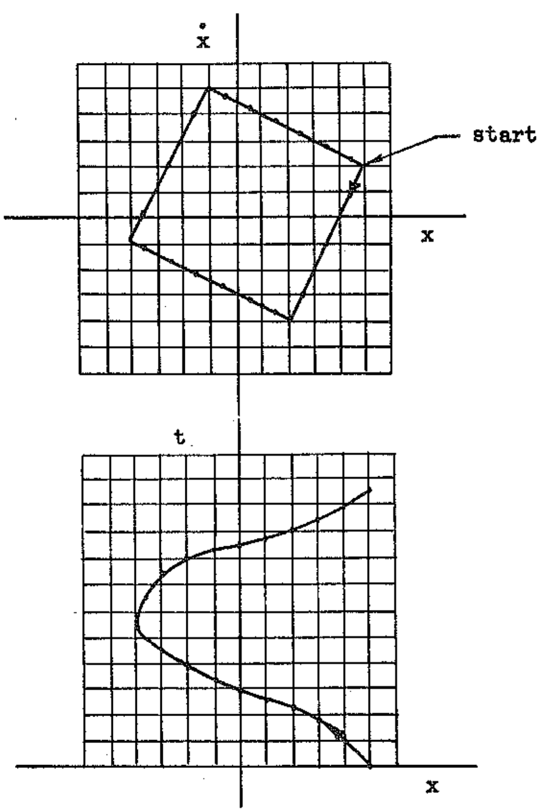

Figure 10. Time-displacement curve and phase plot

Example 7

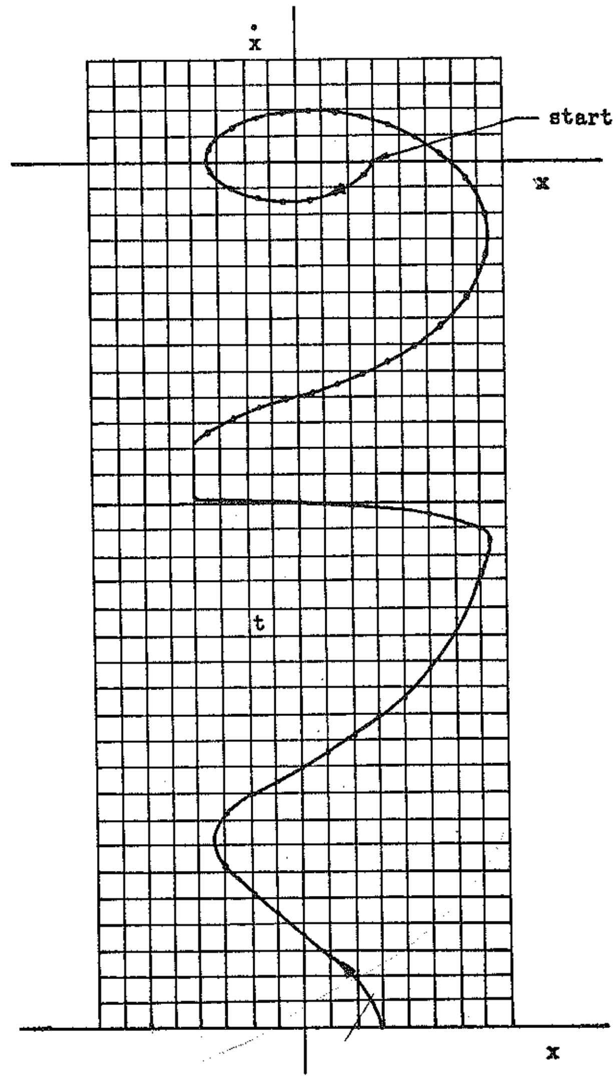

Figure 11. Example and technique of plotting time-displacement curve

Continued from page 26

The definition of "relative merit," done in a sentence or short paragraph, reveals much about the goals and values of the student, and may help to provide insight into course problems.

The time to prepare and to understand the chart is not great compared to the amount of information contained and the potential betterment of teaching.

Any representative engineering organization will work its way out of a tight spot under the pressure of an emergency and a competent leader.

Continued from page 28

Status of financial sponsorship

Selection of manpower

Progress achieved in fulfilling objectives of project

Approval of final report

The Project Director shall submit semi-annual progress reports (December 1 and June 1) to the Projects Operating Unit, and may be invited by the Chairman to attend meetings of the Executive Board of the Projects Operating Unit. The Chairman of P.O.U. may appoint a liaison representative from the Executive Board to monitor the project.

The Society requires a quarterly financial report of an active project. These reports should be submitted directly to the Executive Secretary of ASEE.

FORMAL CLOSING OF A PROJECT

After the work of a project has been completed, a final letter report shall be submitted by the Project Director to the Chairman of the Projects Operating Unit stating the results of the project, giving a final financial report and indicating how the resulting information will be used to benefit engineering education.

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Manuscripts. Articles or papers may be descriptive, theoretical, documentary, tutorial in nature, or they may be reviews. Editorial considerations suggest most papers should be 2000 to 4500 words in length. The topic should receive professional treatment in depth. One or two copies of the manuscript should be submitted. Articles should be typewritten and double spaced with typing only on one side of each sheet. Pages should be numbered to avoid omissions. References, footnotes and illustrations should be listed on separate sheets and not inserted within the text.

Illustrations. Line drawings may be prepared in pencil or India ink with mechanical lettering. If mechanical lettering is not available, freehand lettering should be placed on a separate overlay sheet. Photocopies (same size or reduced) of the original line drawings are accepted if they are clean, clear and sharp in contrast. Illustration width limitations are (1) single column, 4-1/8 inch, and (2) double column, 9 inches. Height limitations is 11-3/4 inches for either column width. When illustrations are reduced 20 per cent, all lettering must be large enough to remain clear and legible. Photographs should be 8 x 10 glossy prints. Figure numbers and captions should be listed on a separate sheet. If there could be any doubt about the positioning of the illustration, identify its top with a blue pencilled note in the margin. Figure numbers should be lightly written on the back of each illustration. If the illustration is prepared on translucent material, a blue pencilled note might be made in the lower margin on the face of the illustration.

Correspondence. Your candid observations via brief communications are welcomed. Your observations; criticism of, or comments on, previously published articles; or other timely notices of interest to the members of the Engineering Graphics Division are welcomed. Please indicate whether submitted correspondence may be published.

Writing Style. Spelling and capitalization should follow Webster's Seventh New Collegiate Dictionary, which also offers guidance in punctuation. For more detailed information of the editorial style, see United States Government Printing Office Style Manual, 1959.

If you have further questions -- write to the Editor.

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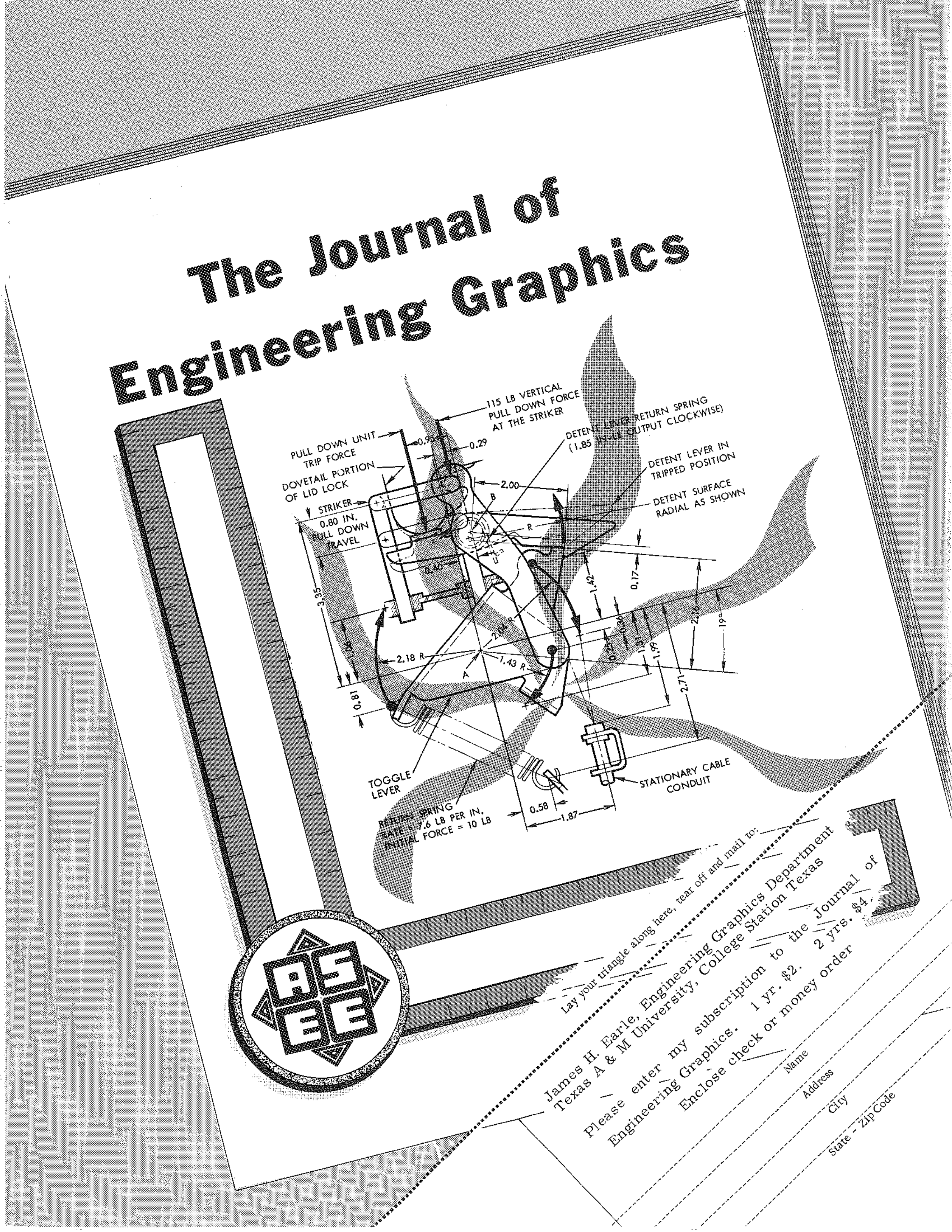

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1967 ASEE PROGRAM

DIVISION OF ENGINEERING GRAPHICS

Sunday, June 18th

6:00 P.M. Engineering Graphics -- Dinner Meeting.
10:00 P.M. Members of Executive Committee and invited guests only.
Presiding: E. W. Jacunski, University of Florida.

Monday, June 19th

10:00 A.M. Engineering Graphics.
11:45 A.M. Theme: THE INDUSTRIAL APPROACH TO ENGINEERING DESIGN
Presiding: E. D. Black, General Motors Institute.
Speakers: 1. A. H. Freeman General Electric Company -- A Case History of the Electric Knife.
2. Edward R. Wiley -- Boeing -- Graphical Applications in the SST Design.

Tuesday, June 20th

12:00 Noon Engineering Graphics. Luncheon Meeting, Open.
3:45 P.M. Presiding: E. W. Jacunski, University of Florida.
Speaker: None Planned.

Wednesday, June 21st

10:00 A.M. Theme: THE ACADEMIC APPROACH TO ENGINEERING DESIGN
Presiding: E. G. Pare, Washington State University.
Speakers: 1. Ernesto E. Blanco -- Tufts University -- A Design Course -- Freshman Level.
2. Paul T. Shannon -- Dartmouth -- Design Education: Problems, Plans and Progress.
12:00 Noon Engineering Economy Joint Luncheon Meeting.
1:30 P.M. Supported by Engineering Graphics and Other Divisions.
6:00 P.M. Engineering Graphics. Annual Banquet, Open.
9:45 P.M. Presiding: E. W. Jacunski, University of Florida.
Speaker: Mr. Nikolai Makarevich -- United Nations. The Industrial Implications of Increased East-West Economic Cooperation.

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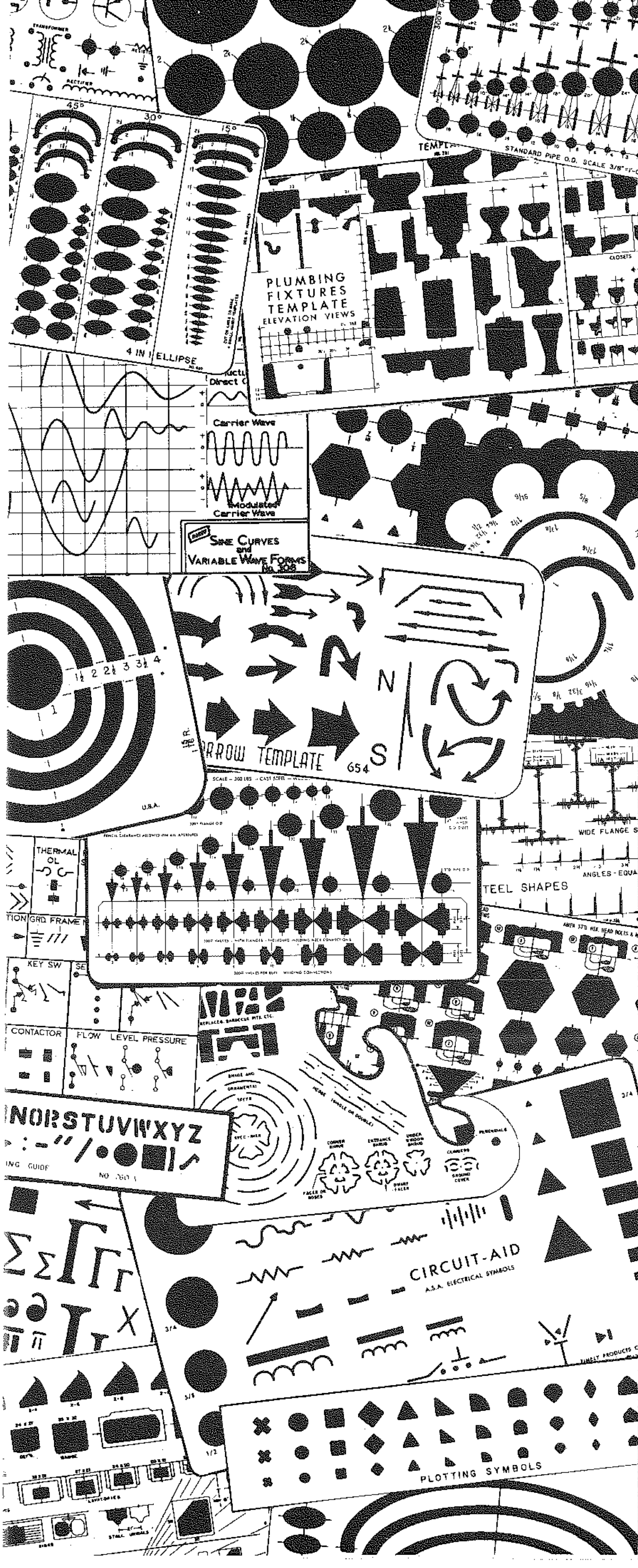

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