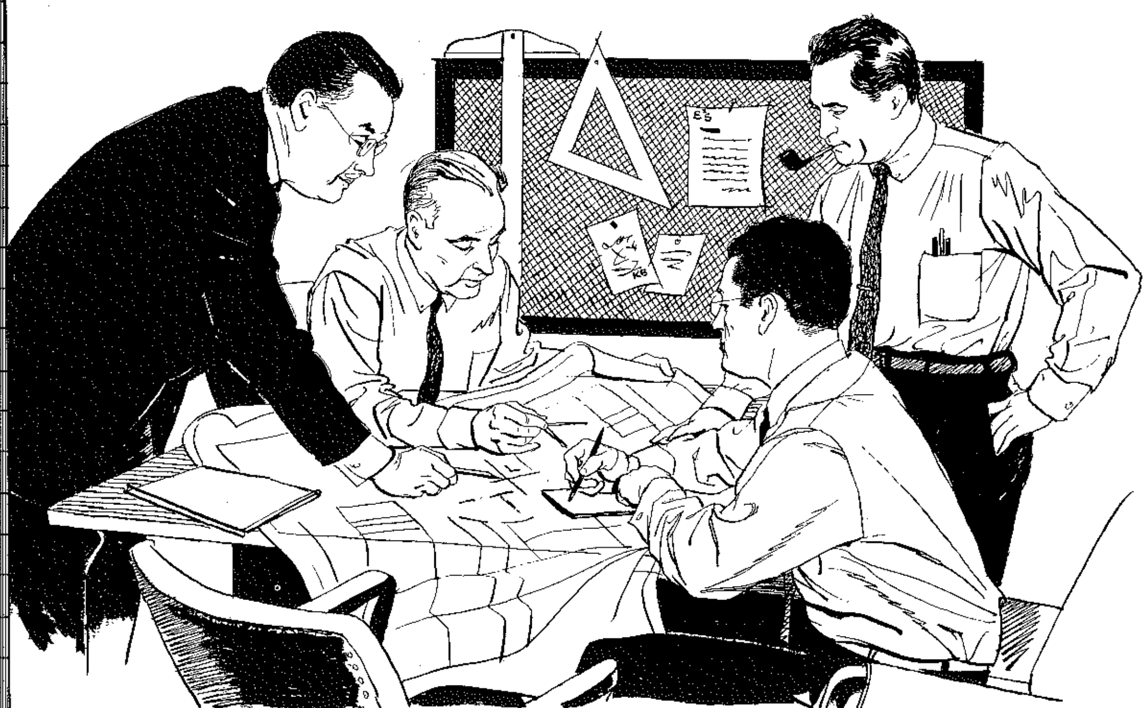
The Journal of Engineering Graphics



WINTER 64-65 Volume 29, Number 1, Series No. 85

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

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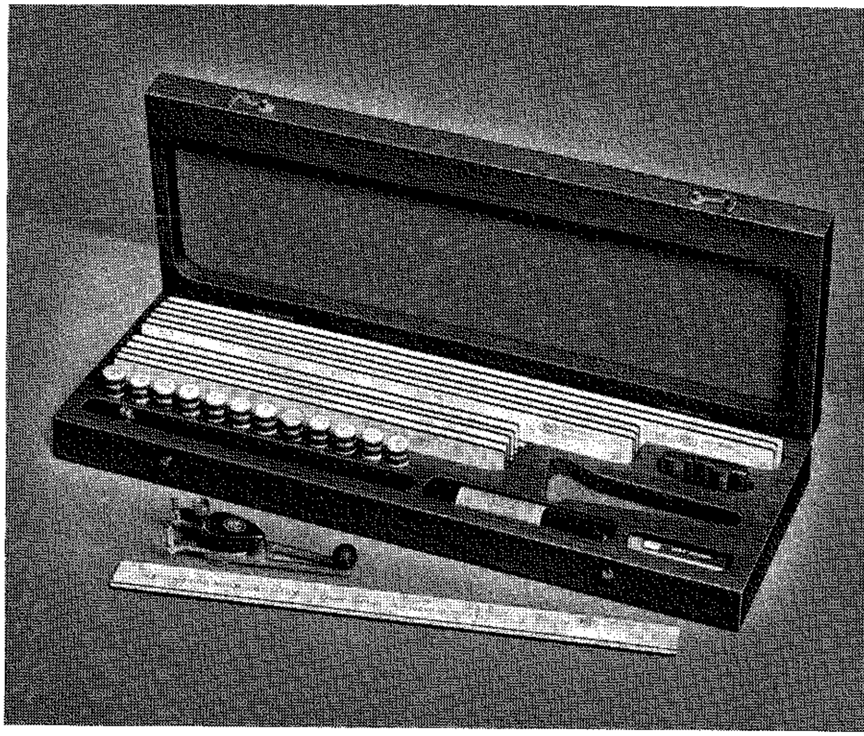

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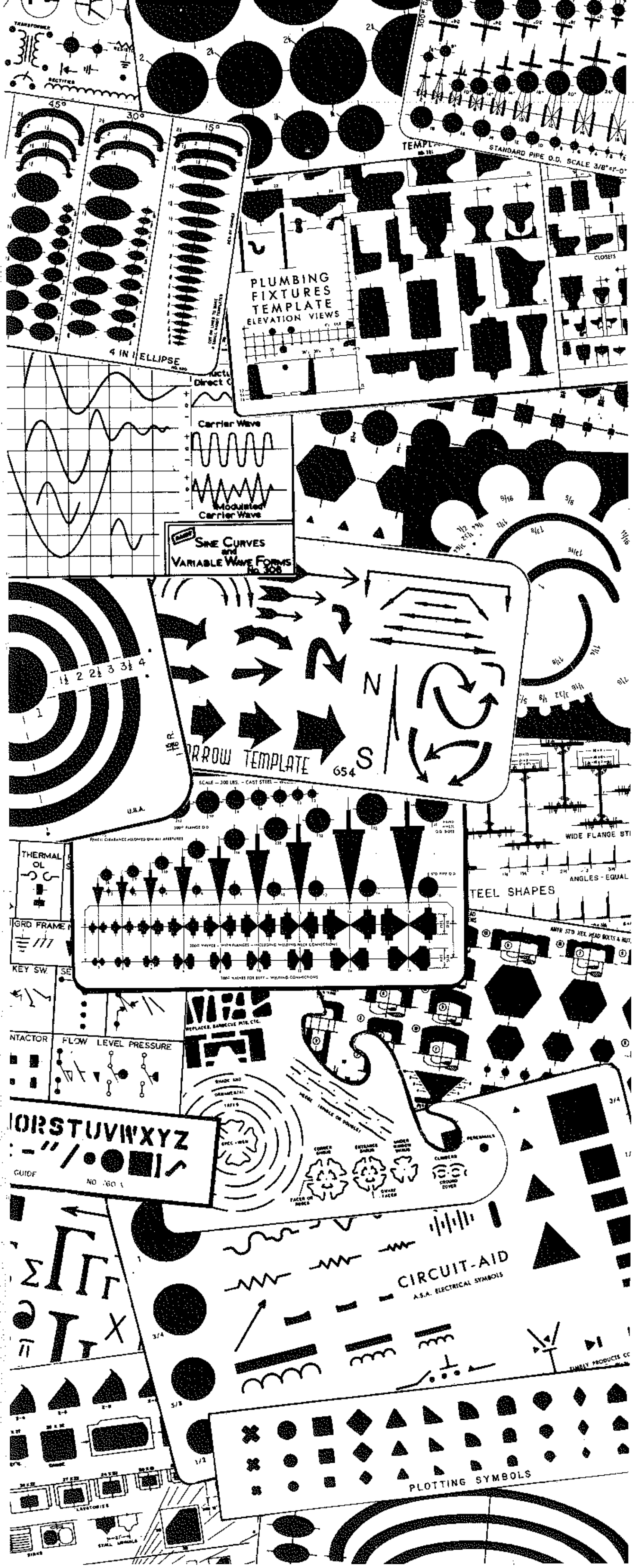

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THE JOURNAL OF ENGINEERING GRAPHICS

WINTER 64-65 Volume 29, Number 1, Series No. 85

This Journal serves the American Society for Engineering Education Division of Engineering Graphics. The objective is to stimulate the graphics teacher and report research and progress in the area of 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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RETURN TO EXCELLENCE

For the past ten years the teachers of "The Engineers' Language" have been more concerned with reminiscing and romancing rather than with the performance of their task. Engineering Education will gradually and inevitably change because of scientific, cultural, and economic developments throughout the world extending even through the space enveloping it. Engineering activities may develop in areas and fields not considered significant, perhaps even unknown at this time. No one will question that our environment is becoming more complex, technically and socially.

Whether or not the engineering profession flourishes in its service to mankind will depend upon the excellence and the competence of the formal education programs and the scholarly attitudes developed in our students to continue their pursuit of useful knowledge throughout their lives. They must learn to discriminate and to weigh choices. The development of these scholarly attitudes is greatly affected by the excellence of our teaching during these formalized programs. We must not only be concerned with what we teach, but we must teach in a style of excellence.

An engineer during his undergraduate training will develop attitudes of inquiry, orderly observation, flexibility of analyses, and optimization of syntheses, including the economic aspects of new situations. No single program of study can be designed to provide all engineers with infinite depth in the several areas of knowledge pertinent to engineering endeavors. Versatility and flexibility of the capabilities of the engineering graduate and his future will depend to a large extent on the excellence of his formal training and his awareness of continual changes and his attitude toward continuing his education throughout life. The development of the proper attitudes will largely be the prime product of excellence of teaching.

We all know that curricula are constantly under pressure to incorporate new material of engineering importance and to reduce or eliminate material, of limited use. A faculty member engaged on the scientific or research frontier is imbued, perhaps with zealous fanaticism, that all new material, practically by definition, is of engineering importance. These new techniques, concepts, or materials ought to assist the flexibility of curricula by their inclusion as elective courses until the engineering importance is clearly evaluated and integrated. Meanwhile, course materials should be up-dated -- not simply by the addition of another new course in the fourth or fifth year with usual consequences -- "squeeze in this new course but keep the curricula under 144 hours," regardless of comprehensive goals.

Administrators are in part to blame for the current excessive research-oriented training in most undergraduate programs. The typical instructor is forced to believe that research and publications are more important than excellence of teaching. Repeatedly, a list of publications will be demanded of a prospective instructor rather than references of other types. Having once met this superficial block, an aspiring engineering educator soon starts rehashing articles with greater vigor than he prepares his teaching assignments! Excellence of teaching diminishes in this environment.

Whenever a large number of practicing engineers get together they will agree that design-oriented courses were the heart of the engineering curricula and were most beneficial to them. These are the courses that suffer most under this current orientation of curricula. Furthermore, excellence of teaching may diminish and the attitudes toward continued scholarly efforts, so essential in the long range, are suffering.

How does all this relate to "The Engineers' Language"? We must do an excellent job of teaching graphical representation, aids to creative thinking, analyses or interpretations, syntheses or optimizations, concepts or evolvements, and communication or elucidation of ideas as related to engineering problems. We must do our job well, call it by the phrase of your choice, as new engineering students need to be challenged early in their undergraduate courses with problems involving engineering design handled by engineering teachers. Perhaps you want to call it Analysis and Synthesis or Design and Development - matters very little - simply extend your teaching capabilities to perform the task with excellence and cease to be obsessed and delayed with change or resistance to change. We must develop the proper attitudes in our students for engineering and their scholarly attitudes to carry them on in Life. Perhaps we must restyle our courses to the phraseology of our changing times - whether we like it or not! In any event, return to excellence in teaching.

K. E. B.

LETTERS TO THE EDITOR

Dear Sir:

I read Professor Michael P. Guerard's article "Solution of Circle Tangent to Three Circles," and wondered if he had read the book "Practical Geometry and Engineering Graphics." This book is published by Blackie & Son; London, England. In this book it shows a solution to this same problem. I have not found another graphics book that shows this solution. Perhaps there is one.

Sincerely,

M. Hamilton
Asst. Prof. of M.E.
New Mexico State U.
University Park, New Mex.

Ed. Note: The original article by Prof. Michael P. Guerard appeared in the May 1962, Vol. 26, No. 2 issue of the Journal of Engineering Graphics.

Dear Mr. Black:

I was surprised and pleased to receive your letter of October 26 and to learn that I am not absolutely forgotten. This is my eleventh year of retirement but I shall never forget the fine men and the wonderful friends I made in the Drawing Division.

I also note that you would like me to write a short article in the hopes of interesting or possibly helping someone. I will see what I can do but I warn you it will be informal and "off the cuff." My first choice of subjects would be the same as Prof. Spencer chose, so I shall try it from a different angle. I have always contended that, in teaching new students, ten per cent of our effort should be spent on teaching the book and ninety per cent should be spent in understanding the student and his problems and in teaching him good habits and a proper perspective in life.

If this meets with your approval, I shall try to write my ideas into a short paper. The subject might be: "For the new student." If this is satisfactory, please let me know about when you would like to have it.

Sincerely,

Frank M. Warner
1417 Park Shore
1630 - 43rd Avenue E.
Seattle, Wash., 98102

P.S. If anyone should ask about me, I am thankful that I am still in good health, past 80 years old, my eyes are not good, but I sang in a barber-shop quartet last week. I could suggest some names but am not sure they are still living. Such as Jud Rising, Prof. Higbee, Clair Mann, etc.

Dear Earl:

Your recent Journal issue was very interesting, as it included an unusual variety of subjects. The article on "Design and the College Freshman" by Prof. W. S. Chalk was particularly interesting, since it emphasized the need to begin student practice in creative thinking in the beginning freshman year.

Prof. Chalk indicated that some of his students commented about their lack of encouragement to use their imaginations in technical courses. He then suggests a Level One definition of creative thinking as: "experienced by anyone who accomplishes something new or different relative to himself."

Similar definitions of creative thinking have been promoted by other writers, such as E. K. Von Fange. I can understand how college teachers have utilized this definition in devising the one-answer type of examination problem to teach principles and laws. Such problems have not usually resulted in creative thinking responses from students, however, in my experience as a student, professional engineer and teacher. I strongly disagree with Prof. Chalk's statement that, "The students experience level one of creative thinking to solve hundreds of these."

I agree with the previously indicated student comments and further maintain that the hundreds of one answer problems commonly used in technical courses not only do not encourage use of their imaginations, but often cause mental blocks within many students' brains to BLOCK creative thinking.

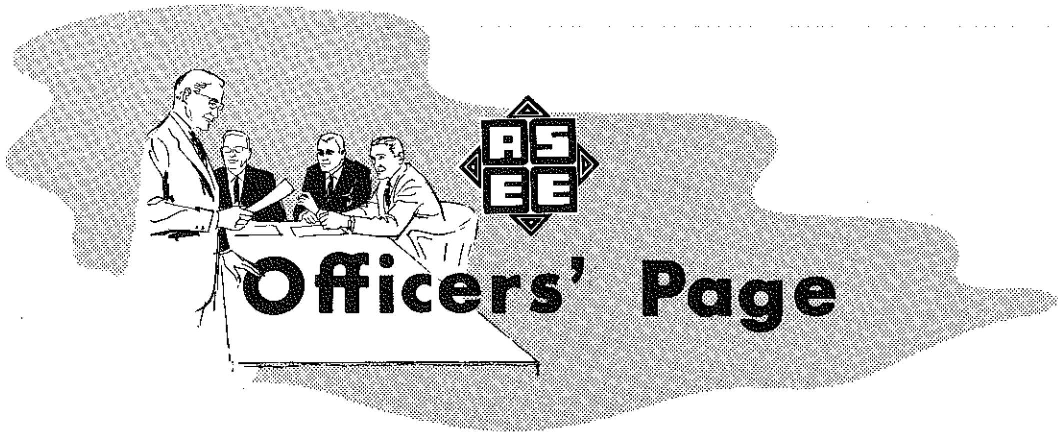
Many teachers develop relatively high skill in adapting one answer problems to effectively demonstrate principles. The solutions of such problems usually require a specific combination of knowledge that relies primarily on memory and understanding of preceding classwork. Use of student imagination is prevented by the requirement of a single answer that is restricted to one teacher's interpretation. Students who cannot do very much on such problems within the brief time allowed have various mental reactions. Such reactions rarely lead to creative engineering results.

Earlier in his article, Prof. Chalk briefly touched on a few reasons for lack of student confidence in expressing their original ideas. The one-answer type problem should be included as a major reason for discouraging student self-confidence.

It seemed to me that Prof Chalk's article was very well done in general. I hope, however, that the one-answer problem habit of college teachers and its effects on creative thinking receives much more attention in future articles in your Journal.

Sincerely yours,

D. Henry Edel, P.E.
General Motors Institute
Assoc. Prof. of Engr. Design



Officers' Page

In trying to decide what I might say in this column, my mind roamed back over the years I've devoted to teaching graphics (in earlier years it was mechanical drawing, later engineering drawing). The years are many -- forty to be exact -- and the changes that have taken place seem incomprehensible, but much less so, I am predicting, than are likely to take place in the next similar interval. The graphics division then was in its infancy, conceived, championed and nurtured by stalwarts -- many of whom were heads of departments and of recognized professional standing. Under their leadership the Division developed into what it now is. There seemed to be an aura around those people, and there was a fascination for the subject that induced young teachers to pursue this field as a lifelong career. Some are with us today, are still well respected, and undoubtedly will have this distinction for their life span.

But what about the status of the subject today and its attraction for young teachers? We have observed the reduction of hours devoted to the subject in engineering curricula over the past ten and more years, the advent of the computer, the rapid growth of applied technology, the ceiling over a teacher without a doctor's degree, loss of prestige, among others. Will we find fewer, as many, or more of those intrepid souls who will choose this subject area and stick with it through thick and thin as some are doing today? In engineering, as we now picture it, will there be a few top men in a department devoting full - or part-time to graphics with temporary graduate students filling in? Will the teaching of graphics be eliminated from engineering curricula, or will it be taught in applied technology, or in the high schools? Will all these unanswerables build up as a deterrent to those capable graduates who might otherwise find interest in and devote their working life to the teaching of this subject?

My efforts at peering into the future do not give me the answers to the foregoing questions, but the following seem reasonably certain. Embryonic engineers and teachers will still have to learn the language before they can use it either as a form of communication or as a tool in design on the drawing board or with the computer. The computer will assert itself ever more forcefully in the actual production of drawings and in solving problems now associated with graphics. Research must and will continue in the development of better teaching techniques and of further adaptations of graphic methods. These leave plenty of room for capable graduates of today to major in and advance the subject of graphics. But before any real gravitation in this direction can take place, the architects of engineering education must define more accurately the need for and the future of graphics in the engineering curricula. The place and need for it in applied technology and high school curricula are rather predictable now, but will the opportunities for research be available in these areas as they are on the college campus? Many events are cyclical, and I am optimistic enough to believe that the swing in one direction of the pendulum will return as strongly in the opposite. We need perseverance, endurance, and visions to lead us on. Graphics is not a dead language!

Reemphasizing Chairman Bob's request in the preceding issue, your choices for committee appointments should be made known. Only a couple of months remain before the convention in June when the final list is presented. You have abilities and enthusiasm! Let's put them to work! DON'T BE MODEST!

Also, ideas for the convention in 1966 should be made known as soon as possible. The mid-year meeting is scheduled for October 1965, at which time plans for the following June's meeting should be made known. Lopping off three months in preparation time at this stage in the year's planning really hurts. May we have some ideas for the Pullman, Washington meeting?

J. Howard Porsch
Vice Chairman

TEACHING VIA TEAM PROJECTS

Robert J. Foster
Department of General Engineering
PENNSYLVANIA STATE UNIVERSITY

It is becoming increasingly apparent that engineering graphics must contribute more vitally to engineering education.

The group project method presented here makes engineering graphics a more meaningful learning experience for the student. By this method retention levels are raised. The Graphics course becomes a more valuable segment of engineering education.

The group project method simulates industrial practice by forming small project groups which work on common problems requiring the use of graphical principles for solution. This method also incorporates student self-motivation making the problems student oriented.

The discussion to follow is in three sections. The first section deals with teacher preparation prior to the first class meeting.

The second section will be concerned with the structuring of the actual class for maximum learning. It will discuss motivation of students plus the creation of operational, problem-solving project groups. It also treats the means of sensitizing teacher and learner to ways of facilitating learning within the project groups as well as analyzing ways of utilizing feedback from the project groups.

A study of procedures to evaluate student progress constitutes the third section. Use of peer-group methods is proposed as a possible means of including students in the evaluation process.

······· Teacher Preparation ········

One aspect of teacher preparation relates to curriculum design. Curriculum design may or may not be within the responsibility of a particular teacher. Some graphics departments have a rigid outline of prescribed topics. Others may permit some deviation from a given format. One must assume, for the purposes of this discussion, that a teacher is allowed a degree of flexibility in presenting instructional material. Ways in which this material should be presented to enhance student participation in the learning process is developed in the second section.

One may state at this point, however, some broad principles of curriculum construction toward which the teacher can prepare. G.M. Blair has summarized key features of a curriculum which utilizes student-oriented problems. Such a curriculum:[1]

1. makes provision for maturity and experience levels.
2. gears learning activities to meet needs and goals of students.
3. provides units of experience which possess meaning and structure for students.
4. selects and appraises projected student activities in terms of their transfer value to life situations.

A second aspect of preparation involves background information for the first class meeting. Students are curious as to who the teacher is and what he expects from them. The teacher should have prepared certain information for distribution. This distribution is not mandatory, but it is strongly recommended.

Items for distribution may include a brief description of the instructor himself, his academic background and office hours. A class list of the students present with a discreet amount of student background information, such as home town, and college addresses, could be given the students. In this way, initial tensions might be eased. A bibliography of useful references in graphics is also helpful.

An often forgotten factor in preparation is the need for a pretest. The usual practice is to begin a class by plunging into the subject matter, regardless of student background in the subject area. Nothing can upset young students more than to be dropped into a class in which they immediately feel alienated and incompetent.

A well-designed pretest can help students to express their identity. The teacher should carefully explain that the giving of a pretest is only an aid to enable him to know each student more readily as an individual.

One may ask what the teacher is to do with the result of the pretest. There appear two primary uses of such a test. The first would be to use the median of the test as a guide for setting the pace of the course. The second would be to detect extremes of competence in basic theory. Since students come into engineering education with a variety of high school and industrial experience in drafting, a wide range of ability may be found from the pretest. Excellence in the pretest scores may indicate possible leaders for project groups. A very poor showing may point up the need for counseling sessions with particular students.

Structuring a Graphics Class for Maximum Learning

The individuals in the class must become personally motivated toward realizable educational goals if maximum learning is to occur. What are the goals of an engineering graphics course and how does one motivate students to seek these goals?

The goals could be given in a detailed list of objectives. They could also be given in terms of concepts to be understood. The goals of a college graphics course should include (1) enabling the individual student to understand the background theory of graphical representation and (2) the use of this theory in the solution of realistic engineering problems. The emphasis in graphics should be on understanding and use, not on the perfection of lettering technique, memorization of symbols, and similar "cook-book" manipulations.

It is necessary for the class to develop and appreciate goals if they are to be motivated to learn. Goals dictated to the students are not meaningful goals. Therefore, the sources of goals must originate in the students themselves, with guidance from the teacher.

Early in the course students should be encouraged to offer their own thoughts on possible goals. The teacher could itemize the suggested goals and then integrate them into effective statements. With sufficient discussion, goals acceptable to both teacher and learner would evolve. Goals should stress skillful use of concepts rather than simply manipulation of techniques.

The question remains as to how to develop motivation. A possible solution lies in the use of problem-solving through subgrouping of the class. It is suggested that the class be divided into groups of three or four students each. Each project group acts as an entity, working on its specific problem. This suggestion may run counter to the thinking of many teachers. A few comments on problem-solving by Thelen may help us realize that the traditional approach to problem-solving is not without fault.

> It is in the formulation of the problem that individuality is expressed, that creativity is stimulated ... It is these aspects of inquiry ... that are central in the emergence of insight. Yet it is precisely these aspects of inquiry that schools ignore, for they collapse inquiry to mere problem-solving, and they keep the student busy finding "solutions" to "problems" that are already formulated, externalized, depersonalized, and emotionally fumigated ... as far as the academic work of the school goes, personal stirrings and strivings and self-discoveries have no place. In effect, what is missing is the investment of learning with personal emotion and meaning.[2]

The actual operation of the project groups is a difficulty that must be considered. How does a project group develop motivation for problem-solving? Students usually learn best in a group when there exists among them a common interest. To have educational value, the common interest can be developed through a problem related to course material. It must be a problem, however, of genuine interest to the project group, not a contrived "busy-work" problem. A problem for graphics students should be drawn from the area of industrial applications of engineering graphics.

The teacher can suggest several practical problems originally existing in industrial production or research which can be understood by the students. After a thorough discussion of the specifications of each of the several problems, the project groups should be permitted to select the ones of their choosing. A particular problem can bind a project group together into a working, problem-solving team. The teacher will serve as a consultant to whom they may turn for guidance.

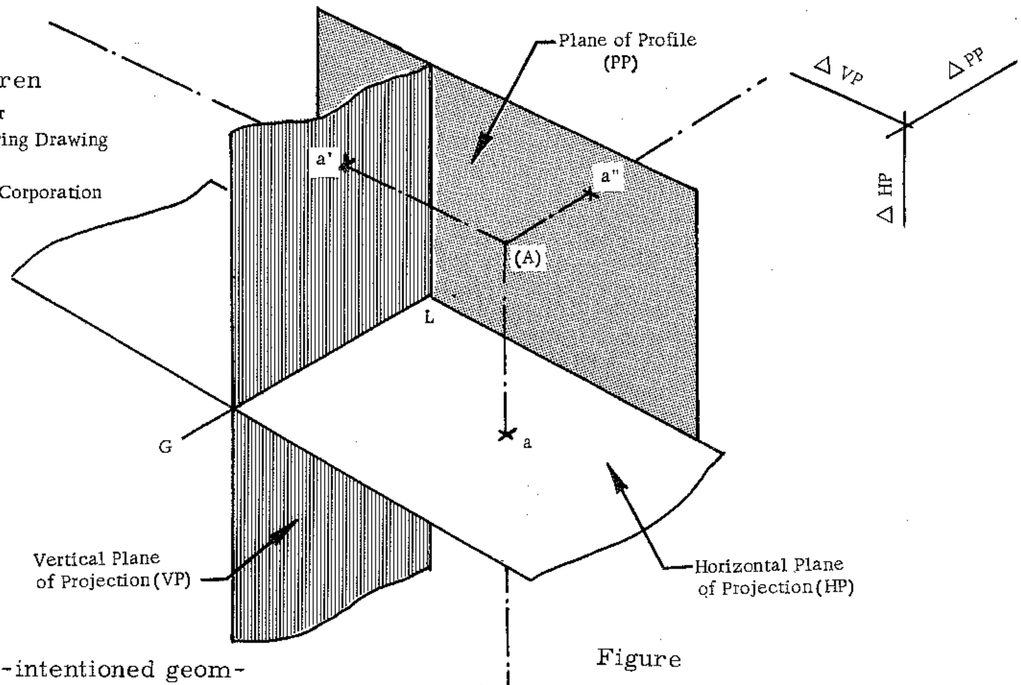
When acting as a consultant, the difficulty for the teacher arises when to present instructional material. The traditional manner has been to lecture the student on details of theory; then to present a problem whose solution incorporates the theory just presented. The amount of student reasoning ability needed in this case is not high. A more modern approach is to permit the student to fully realize the extent and requirements of the problem before offering him information to aid his solving of the problem. This approach tends to increase the motivation of the student so he will desire the theoretical knowledge.

The problem-then-theory approach cannot be allowed to reach an extreme position, however. If a learner struggles long without supporting information, he may become frustrated and may

(continued on page 34)

REFLECTIONS ON THE FUNDAMENTALS OF DESCRIPTIVE GEOMETRY

By
C. Ernesto S. Lindgren
Visiting Research Engineer
Department of Graphics and Engineering Drawing
Princeton University
On Leave from United States Steel Corporation



Figure

(Illustration appears to be in first angle projection. Ed. Note)

Throughout the years well-intentioned geometricians have added to the original work of Monge some concepts and interpretations, perhaps to simplify the understanding of the objectives of the method, but in doing so have overlooked the fact that they have been, time and again, in complete disagreement with the geometric properties of the elements of the Mongean system. It is very obvious that they all agree on the relative position of these elements, but they differ radically on the geometric concept of the plane itself, and the mechanics involved in the determination of the projections of a point on a plane of projection.

I think that there can be no reason, whatever, for variations in the introduction of these basic fundamentals, because they involve the roots of the whole system idealized by Monge.

The "variations" mentioned above are in reference to the transparency or opacity of the planes of the system and to the "existence" of an observer or observers. In my opinion, there is no justification for either. For one thing, we cannot accept the fact that a plane of projection needs to have physical characteristics. In dealing with the system of reference above, we are working with geometric entities and not with planes of a body to which we assign a physical characteristic for the sole purpose of arriving at conditions of visibility of the body itself.

I have felt that the understanding of this basic difference between a plane of the system and the plane surface of a solid being represented in the system, is argument strong enough to support the position which is presented here. I have also looked for justification in the works of Monge and of modern authors.

In the "Geometrie Descriptive" by Gaspard Monge (fourth edition - 1820) there is no reference to transparency or opacity of the planes. The relative position of the two planes, perpendicular to each other, and the method of projection presented by Monge coincides with the one found in the "Treatise on Painting" by Leonardo da Vinci.

A search through treatises by modern geometricians has resulted in the following. In a monograph by Professor R. M. Gregory (University of Brazil), "Visibility in the Mongean System" we find a quotation from the "Descriptive Geometry" of A. Rodriguez (University of Brazil), stating that Monge was aware of a study by Frézier on the stereotomy of the rock, and had his first intuition of the descriptive method as a correction to some unsatisfactory processes used by Frézier in that study. This same quotation also points out that Monge's disciples such as Olivier, Hachette, Dupin, de la Gournerie, Leroy, make no reference to the transparency or opacity of the planes, or to the existence of observer or observers. However, another disciple of Monge, H. Tresca, in his "Traite' Elementaire de Geometrie Descriptive" (Paris, Hachette and Cia - 1852), makes reference to the vertical plane by calling it "wall," a designation that leads A. Rodriguez to consider this plane as opaque. In opposition to this argument R. Gregory points out that, since the descriptive method involves concepts closely associated to those of the perspective method as outlined by Leonardo da Vinci, it should be considered logical that Monge would take the advantage of the transparency of the plane as established by da Vinci.

Putting aside the merits of each argument, I attempted to analyze the reasons for the misconceptions and how much they vary from author to author.

First, it is apparent that the failure in separating the concept of the geometric element, the plane, from that physical plane surface of a solid is more likely to be the reason for considering the planes of projection as being opaque. We have accepted the approach in use in the "applied descriptive geometry" or "technical descriptive geometry" etc., where the study of the representation of the projection plane is made by assuming it as opaque. This is justified because of the specific purpose of the study, which is to introduce the conditions of visibility that exist in a real solid. Such practice has been successfully used by the American geometricians. Also, in order to establish conditions of visibility it was necessary to state the relative position of the individual, who is determining the projections, in relation to the planes of projection, an assumption that is required ONLY for the specific case of APPLICATION of the method and not for the THEORETICAL development of its fundamentals.

In this then we find the basis for more reflections, and ask: "Is it generally assumed that the projections of a point need to be tied into two observers, located at the point of infinity of the directions perpendicular to the planes of projection?" Our answer should be yes, if we are dealing with applications, and no, if we are dealing with purely theoretical concepts.

I think we have a good example that gives some strength to this point of view. Take the study of perspective, one where the plane of horizon, neutral plane, line of horizon, point of distance, vanishing point, observer, etc., are the "tools" used in the method. Now consider the study of perspectivity in the projective geometry where we find limit lines, planes, vanishing point, etc., and the center of perspective. It is very obvious that in both cases we are dealing with the same elements, the difference being, however, that in the first we assign physical characteristics to them, because an individual replaces the center of projection, and a transparent plane surface, like a piece of glass, replaces the plane of perspective. However, one would not write an essay on perspective in projective geometry and make reference to the center of perspective as the "eye" of an observer, or to the plane of perspective as a piece of glass. In other words, there is a clear differentiation between the theoretical and the practical. If this is so, and is followed with consistency, why not do it also, in the study of the theoretical and the practical descriptive geometry?

With the comparison just made, one can realize why we wish to extend the projective concepts to the fundamentals of the descriptive geometry. It is apparent that projective geometry is essentially theoretical, while descriptive geometry seems to imply application or practical use of geometric properties. This should not be.

I think that the concepts of the projective geometry are sufficiently valid to eliminate these discrepancies and in view of the great variation of approaches to theoretical descriptive geometry. I also think projective geometry concepts should be used. For my own peace of mind I have been using the following approach which I would like to see criticized by the reader.

According to projective geometry the graphical interpretation of the fundamental metrical conceptions of parallelism and perpendicularism is as follows:

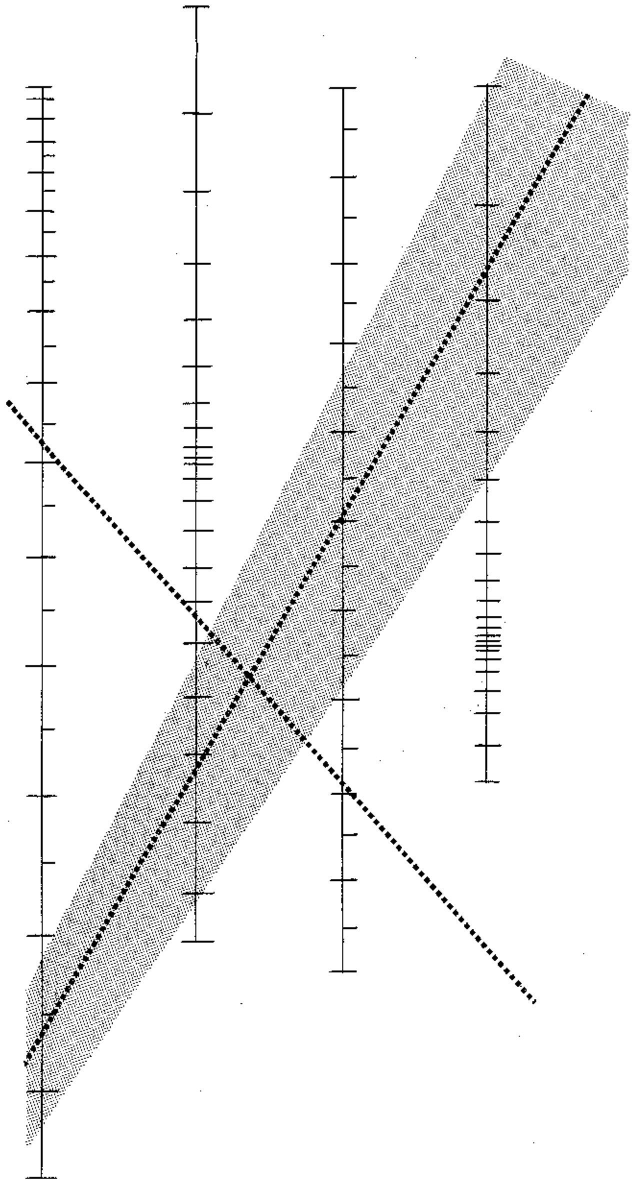
a. The parallelism of two lines is expressed by the property which they possess of meeting in a point on the line at infinity of their plane;

b. The perpendicularity of two lines is expressed by the property that their points at infinity are conjugate in the absolute involution.*

Consider an objective point (A) and the planes of the Mongean system of reference in a position in which each of the planes has its line of the infinity belonging to the points of the infinity of three perpendicular directions, which means that each plane is parallel or also perpendicular to one of those directions. We now PROJECT the point (A) from each of the three points of the infinity and CUT the projecting lines with the three planes of the system. (see figure)

By using the two basic operations projecting and cutting, we have interpreted projectively the fundamental process of the descriptive geometry, and to the result we can apply the fundamental artifice of the method. We think that by doing this we have eliminated any consideration of observer, observers, transparency or opacity of planes of projection.

*See "Non-Euclidean Geometry" (page 155) by Roberto Bonola, Dover Publication; also "Projective Geometry" (page 257) by B. C. Patterson, John Wiley & Sons, Inc., New York.



COMPUTERIZED NOMOGRAM PLOTTING

A. S. Levens
Professor of Mechanical Engineering
UNIVERSITY OF CALIFORNIA

The impact of computers on technology has become quite formidable. Many articles have been written about important uses of computers as appropriate aids in the retrieval of information and in the solution of a variety of problems arising in engineering, science, and business.

Those of us who are especially interested in graphics and design are aware of the experimental work that has been going on in computer graphics. Considerable progress is being made with "graphical input - digital computer-graphical output" machines.

The Boeing Company at Renton, Washington, makes use of computer graphics in transposing orthographic views to isometric, oblique, and perspective views. It should be noted that the designer first prepares the orthographic drawing, places a transparent sheet over it and then marks points which the computer-plotter will eventually connect by straight lines. The graphic points are converted to numerical values on punched cards. A skilled programmer is necessary to tailor the program for a specific need. Final computations are obtained from the computer in the form of a magnetic tape, which is then used to control the plotter mechanism.

During the Spring semester, 1964, we undertook, in our Graphical Analysis course, to write a basic computer program for nomograms of the form, $f_1(u) + f_2(v) = f_3(w)$. In addition, subprograms were written for specific equations. A plot tape was prepared and finally print-outs were made using the Cal-Comp printer.

The economy of using computer methods was not a consideration. We felt that students having an elementary knowledge of the Fortran II computer language and a background in Nomography would profit from this experience.

It should be noted that the equations in the title strips on the nomograms were left in Fortran. (see Figures I and II)

Credit is due Armin Wright, graduate student, for preparing and "debugging" the programs.

It is planned to develop computer programs that might be advantageous in designing nomograms for equations of such forms as:

(a) $$f_1(u) + f_2(v) = \frac{f_2(v)}{f_3(w)}$$

(b) $$f_1(u) + f_4(v) \cdot f_3(w) = f_4(w)$$

(c) $$f_1(u) = \frac{f_2(v)\, f_3(w) - f_4(w)\, f_3(v)}{f_2(v) - f_4(w)}$$

Ed. Note: If sufficient requests are received, duplicated copies of the main programs for equations of the form $f_1(u) + f_2(v) = f_3 \omega$; subprograms for the equation $I = 1/12\ BD^3$ and $M = 1/8\ WL^2$ and print-outs of the nomograms for these equations will be made available. Send your request to Earl D. Black, Editor, Journal of Engineering Education, c/o General Motors Institute, 1700 W. Third Avenue, Flint, Michigan 48502. Please enclose $1.00 with your request to cover cost of duplication and postage.

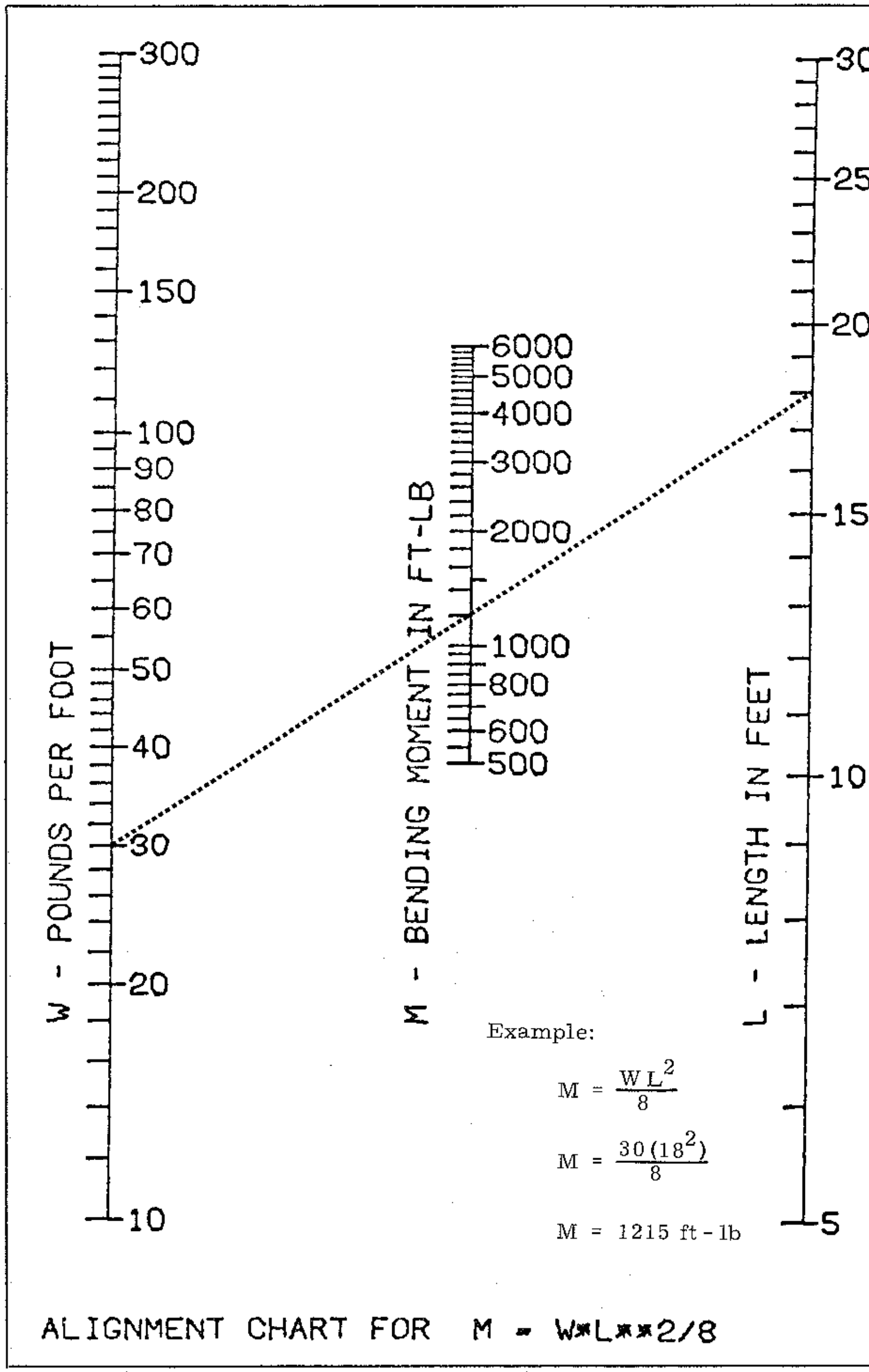


Figure I

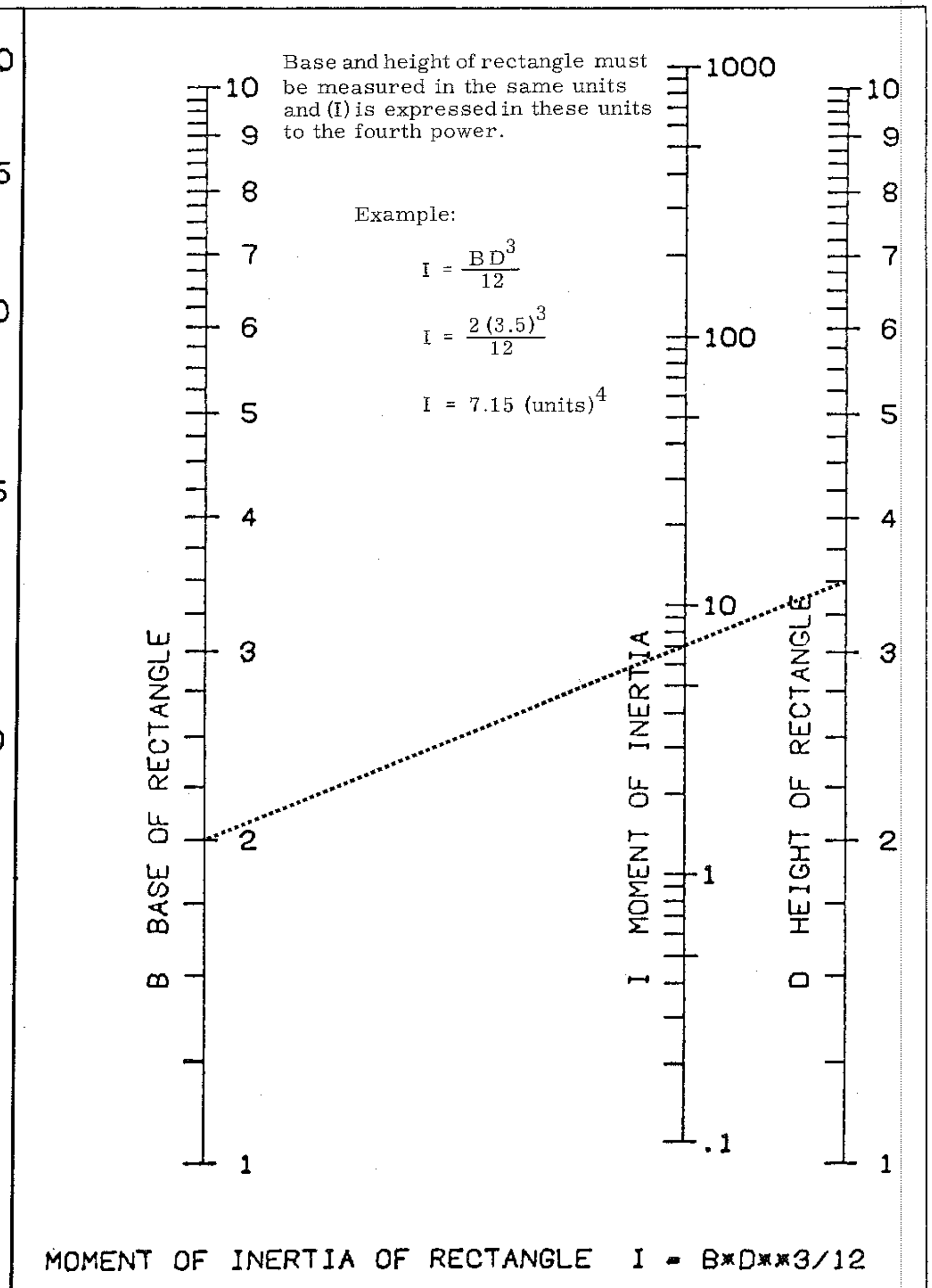


Figure II

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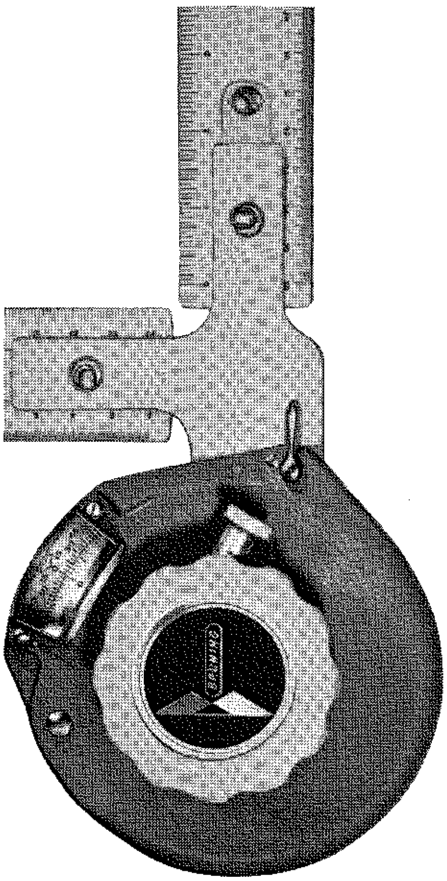

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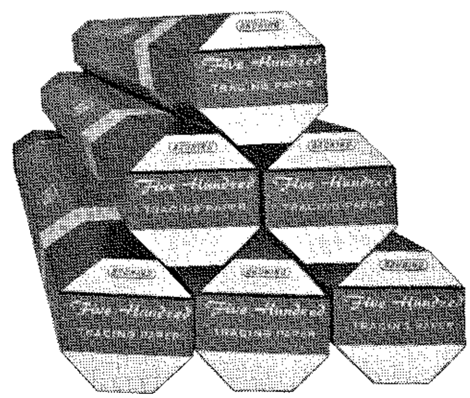

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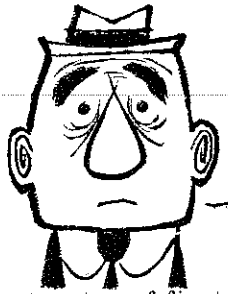
To be run on the right hand column of three consecutive pages in the following magazines. Design News (Feb. 3, March 31, June 9), Graphic Science (March, May, July).



KINEMATICS CAN BE FUN

Tom Short
Assistant Professor of Mechanical Engineering
GENERAL MOTORS INSTITUTE

As an instructor of first semester sophomore students in the subject area of Graphical Kinematics, I was interested in developing a problem which would meet the following objectives:

1. To require the student to use his knowledge of advanced projection principles learned in previous engineering graphics courses.
2. To require the student to think in three dimensions since this ability is necessary in most design problems.
3. To require the student to devise his own graphical techniques. The first items a student usually forgets after completing a course are the various specific methods for solving specific problems. It would be to the student's advantage to have experiences in devising his own solutions to prepare him for future situations when he has forgotten the solution or there is no "book" solution.
4. To permit the student to compare graphical and mathematical solutions to the same problem.
5. To correlate kinematics with statics since the two courses are often taken concurrently, and considerable emphasis may be placed on vector algebra in the statics course.

The first problem developed and used to meet the above objectives is illustrated in Figure 1. The problem assignment instructions to the student are as follows:

Given:

The arm rotates counterclockwise (ccw) about the (y) axis at a constant velocity of one revolution per minute (1 rpm) for 60° of angular rotation from the position shown in Figure 1.

Required:

1. Using full scale, lay out the necessary views to plot the projection of the path of point (P) in the y-z plane.
2. Plot a time-displacement diagram of the (z) coordinate of point (P) versus time. Use a time scale of 1 inch = 2 seconds.
3. Using vector algebra, plot the same projection and time-displacement diagram as requested in steps 1 and 2.

Ed. Note: A graphical solution and a vector solution to the above problem will be printed in a subsequent issue. If you have a solution, submit it for consideration.

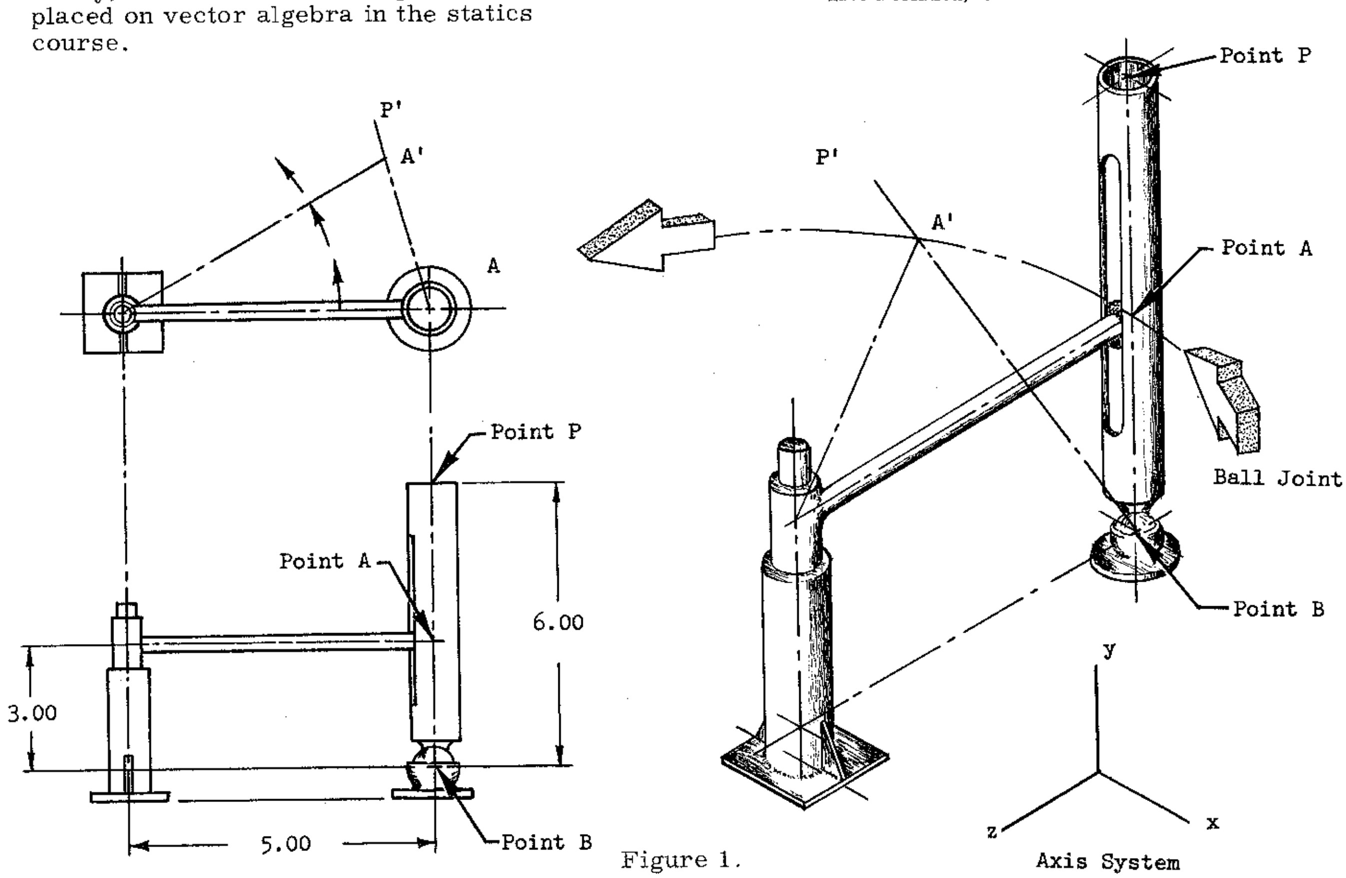


Figure 1.

CORIOLIS' ACCELERATION CLARIFIED THROUGH GRAPHICS

Byron J. Pelan
Assistant Professor of Mechanical Engineering
Rutgers University
New Brunswick, New Jersey

In the teaching of the Coriolis' law of acceleration, the writer has used a method which frequently has led to a better understanding of the law by the students. The method uses a graphical construction, which can readily be made in the classroom in a first course in mechanics and which vividly illustrates part of the Coriolis' concept.

Consider the case in which a point of one body moves along a path on a second body that has rotation. Use is then made of the Coriolis' law in the transfer of acceleration from one point P on, say, body 2 to a momentarily coincident point Q on a second body 3. Here body 1 is considered to be the "ground" reference. When either of the following expressions will correctly represent the relation between the accelerations

(1) $A_P = A_Q \mathrel{+\!\!\!\rightarrow} A_{P/Q} \mathrel{+\!\!\!\rightarrow} 2\,\omega_3 V_{P/Q}$ or

(2) $A_Q = A_P \mathrel{+\!\!\!\rightarrow} A_{Q/P} \mathrel{+\!\!\!\rightarrow} 2\,\omega_2 V_{Q/P}$

it will usually be found that only one of these expressions can be readily handled.

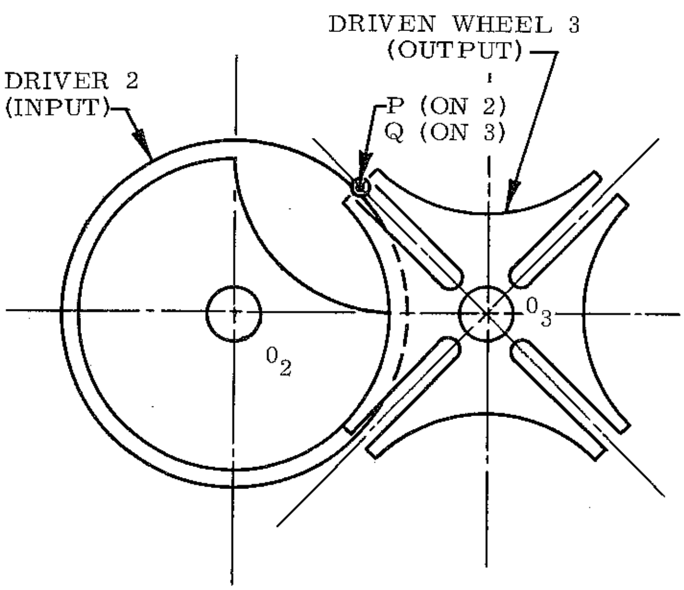


FIGURE 1

For example, consider the case of the Geneva mechanism in Figure 1. Normally it is the angular motion of member 2 that is known, and it is the motion of the driven wheel 3 that must be determined. Here the stationary frame which supports the bearings for the shafts O_2 and O_3 is the "ground," i.e., body 1, and has "zero absolute" motion.

For simplicity in constructing the diagrams shown, the mechanism has been replaced by an equivalent system for the phase indicated. The equivalent mechanism which has the same critical, pertinent dimensions and an identical behavior is shown in Figure 2. The description to follow will refer to Figure 2.

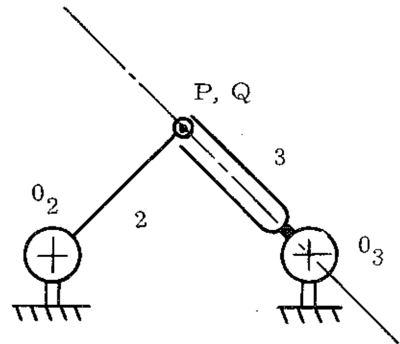


FIGURE 2

The clue to which of the two equations it would be best to use lies in the evaluation of the term $A_{P/Q}$ (or $A_{Q/P}$). Consider equation (1) first. In terms of its normal and tangential components,

$$A_{P/Q} = A^n_{P/Q} + A^t_{P/Q} \quad \text{where} \quad A^n_{P/Q} = \frac{V^2_{P/Q}}{R_c}$$

in which R_c is the radius of curvature of the path being traced by point P (of body 2) on the body 3 in the vicinity of point Q at the instant. It is apparent for the Geneva mechanism that this path is a straight line along the centerline of the slot of member 3. It is also readily seen that the radius of curvature for this path will be of infinite length, since the path is a straight line. Thus, $A^n_{P/Q}$ vanishes, i.e., it is equal to zero. The total acceleration $A_{P/Q}$, then, is directed along the tangent to the path, which means it must fall along the centerline of the slot. This information permits equation (1) to be solved without further difficulty.

Suppose now the student had selected equation (2).

Here $A_{Q/P} = A^n_{Q/P} + A^t_{Q/P}$, in which $A^n_{Q/P} = \dfrac{V^2_{Q/P}}{R_c}$

Once again R_c represents the radius of curvature of a path being traced. Only now it is the path traced by point Q (of body 3) on the member 2 in the vicinity of point P at the instant. (Imagine 2 as having a large sheet of cardboard glued to it.) This radius is not as easily obtained as before. It is not immediately apparent and additional work is required to obtain it before the solution to the equation can be found.

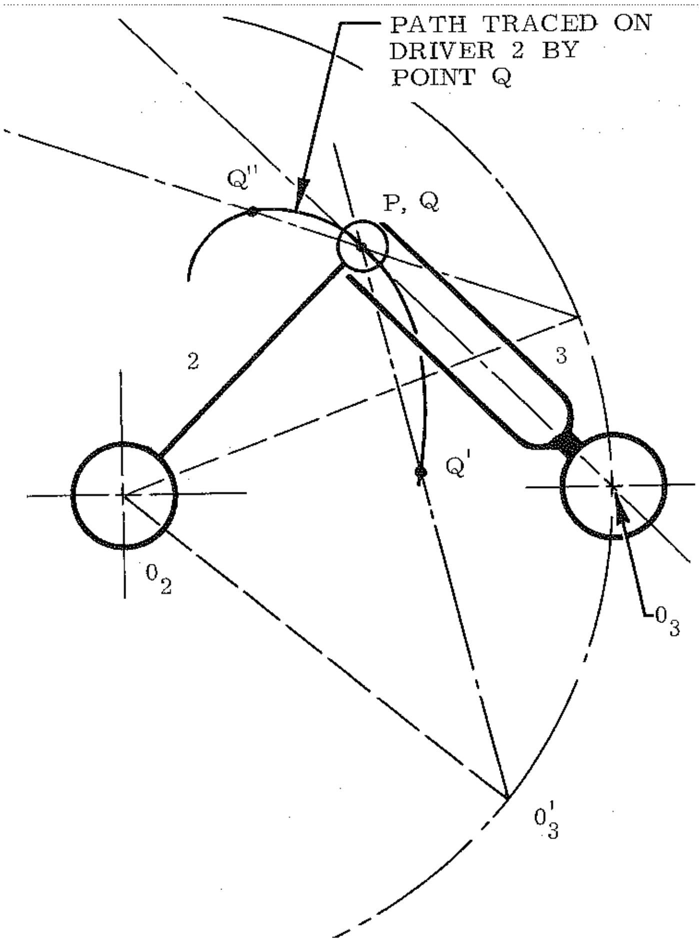


FIGURE 3
(DOUBLE SIZE)

Figure 3 shows both the path being traced by Q on member 2 or on the cardboard attached to link 2 in the vicinity of point P and also the construction necessary to obtain the path. To obtain it, member 2 is considered to be stationary and the remaining members 1 and 3 are rotated through arbitrary angular increments as shown with distances O_2O_3 and O_3Q remaining constant to obtain the desired path traced by Q. Once the path has been laid out, the radius of curvature can be obtained by one of several methods. It is now, however, that a real appreciation of the relative motion involved and of the selection of the most readily handled equation is vividly and forcefully conveyed.

References:

1. Mabie, H.H., and Ocvirk, F.W.: Mechanisms and Dynamics of Machinery, 2nd. Edition, John Wiley and Sons., Inc., New York, 1963.

2. Pelan, B.J.: Unpublished notes.

3. Cowie, A.: Kinematics and the Design of Mechanisms, International Textbook Company, Scranton, Pa., 1961.

THE ENGINEER'S LANGUAGE - DRAWING

Engineering drawing is as useful to successful engineering personnel as the English languate itself. An engineer, without a thorough command of the engineering drawing language, is as helpless as a representative to the United Nations without an interpreter. Even with a good interpreter (the designer) an engineer cannot use his full talent in a development project. Since very few designers are mind readers, it is impossible to really refine an idea or component unless you, the engineer, can express yourself on paper. The more proficient you are in design know-how, the more valuable you are to your management. An engineer, no matter how talented, must depend on a designer for his living unless he can express his own ideas on paper. A crude sketch is not adequate in today's competitive market. A conscientious first effort is seldom much better than a crude sketch, since the success of most components depend on considerable refinement before being acceptable. Without a doubt, the highest paid men in the engineering profession on technical assignments are accomplished designers with engineering educations. The majority of executives are also former design engineers. These men depend on their own ability to accomplish their mission in life.

Mr. Robert P. Ernest
Ford Motor Company

"Graphics is the beginning of productive cycle."

If the engineer does not prepare himself through actual technical knowledge of the science of communication through engineering drawing, he will be unable to answer the questions of technicians even though he knows the answer in his own mind.

GRAPHIC AIDS IN ENGINEERING COMPUTATION

by R. P. Hoelscher, J. N. Arnold, S. H. Pierce

1963 printing
Published 1952
Price $5.75

This well-known text of 197 pages, 6" X 9", in hard covers, deals with alignment charts, empirical equations, the design of special slide rules, and the use of the standard slide rule. Examples are numerous, and there are problems at the end of each chapter.

The seven chapters are: (1) Standard Slide Rules, (2) Empirical Equations from Engineering Data, (3) Alignment Charts, (4) Graphical Calculus, (5) Alignment Charts with Determinants, (6) Special Slide Rules, (7) Movable-scale Nomographs.

Formerly available from McGraw-Hill; now a Balt book.

CREATIVE PRODUCT EVOLVEMENT

by J. Liston and P. E. Stanley

Published 1964
Price $5.00

This timely text of 190 pages, 8-1/2" X 11" page size, in durable plastic cover, is profusely illustrated with example cases of new-product evolvement, and contains a large number of practice problems particularly designed to stimulate imaginative thinking. Probably appropriate for a junior or senior course.

Unique in its field, and particularly emphasizing the methods of synthesis, a step-by-step procedure is presented for conceiving, describing, and proving ideas and proposals for new and better products.

DESCRIPTIVE GEOMETRY PROBLEMS

by S. B. Elrod, C. H. Zacher, H. F. Gerdom

Published 1962
Price $3.50

128 problem sheets, 8-1/2" X 11", on good quality paper, perforated and bound into a book.

Appropriate for an extensive course of 90-100 lab hours. Content includes: basic orthographic projection, fundamental spatial relationships of elements; applications of descriptive geometry to design and manufacture. There is extensive coverage of intersections and developments, including ruled surfaces; also, axonometric and perspective projection are treated.

DESCRIPTIVE GEOMETRY WORK SHEETS

by J. H. Porsch, S. B. Elrod, R. H. Hammond

Revised edition, 1957
Price $3.00

56 problem sheets, 8-1/2" X 11", on good quality paper, perforated and bound into a book.

Designed for a brief course of 35-40 lab hours. Covers basic spatial relationships of points, lines, and planes; includes typical problems on intersection of surfaces. Third angle projection.

WORKSHEETS FOR INTRODUCTORY GRAPHICS - FORM A

by J. N. Arnold, M. H. Bolds, S. B. Elrod, J. H. Porsch, R. P. Thompson

Published 1958
Price $4.00

One hundred sheets, mostly 8-1/2" X 11" with a few 11" X 17", on good quality paper, perforated and bound into a book.

Principal topics are: Lettering, Geometry, Multiview Drawing, Pictorial Drawing, Intersections, Developments, Contoured Surfaces, Functional Design; also a few sheets each on Vectors, Graphical Calculus, Empirical Equations, Representation of Data and Equations.

ENGINEERING DRAWING

by J. N. Arnold, M. H. Bolds, K. E. Botkin, S. B. Elrod, R. P. Thompson

In preparation
Available April 1965
Probable Price $4.00

One hundred problem sheets, 8-1/2" X 11" on good quality paper, perforated and bound into a book.

Major topics are: Geometrical Constructions, Lettering, Multiview Drawing, Detail Drawing, Assembly Drawing, Dimensioning, Intersections, Developments. In addition a number of problems on Graphing, Vectors, and Graphical Calculus are included.

Examination copies of any of these are available upon request.

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Perspective

WHY ENGINEERING DRAWING?

by Federic G. Higbee

Professor Emeritus of Engineering Drawing
UNIVERSITY OF IOWA

Much is written about the ability -- or perhaps the lack of it -- to communicate ideas. In the technical, engineering, and scientific areas of production, the graphic language has long been recognized as having no superior as a means both of recording and transmitting information. For this contribution alone the graphic language is worthy of an important place in engineering education.

But if teachers of engineering drawing and related subjects consider training engineering students to read and write in the language of their chosen profession as their only obligation they are not discharging their professional responsibility.

Important as such training is, i.e., to make young engineering students competent in the language of their profession, there are many -- and I am among them -- who consider the by-products of such training certainly of equal importance to the students' complete engineering education.

Do not overlook the place engineering drawing has in the freshman engineer's schedule of courses. Among a whole array of freshman subjects which are to him but continuations of subjects he had in high school, he discovers this one course in engineering conducted by an engineer. This discovery provides an important bit of consolation to a boy who came to college to study engineering.

And as he pursues this lone course in engineering, the freshman becomes aware that he is acquiring and using a vocabulary of engineering terms. He is being made to realize the indispensable contribution engineering drawing makes in the creation of a product by the information displayed on the drawing, that the standards of engineering do not permit of less than exact delineation, that nearly correct is far from satisfactory.

The freshman may not realize the effect all this has on him in these precise terms, but he is being trained in engineering standards and in engineering methods of doing work.

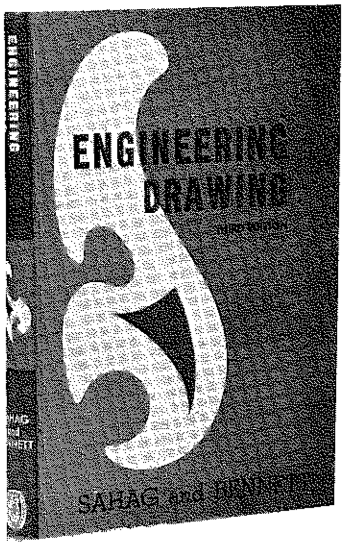
Any competent and dedicated teacher of engineering drawing and related subjects knows all this and is acutely aware of his opportunities as he stands shoulder to shoulder at the freshman's drafting table with a boy who needs his help in understanding the complexities of this mysterious -- to the boy -- vehicle of engineering design.

A competent and dedicated teacher will and does welcome the privilege of getting close enough to his students not only to help them understand the subject but also help them make adjustments to engineering college life.

Fortunate indeed is the engineering college whose curriculum makers have arranged adequate time for the teaching of engineering drawing and related subjects in a fashion to take full advantage of their full worth in the training of an engineer.

Unfortunate indeed is the engineering college whose curriculum makers have failed to recognize the practical and educational values of engineering drawing and related subjects and have, in some instances, eliminated this teaching and educational experience and in others have shockingly curtailed the time allowed for this work.

Students studying engineering in such colleges are being "short changed" in engineering education.



American Southern TECHNICAL TEXTS

ENGINEERING DRAWING

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3rd Edition, by LEON MARR SAHAG, M.S. in M.E. Head Professor (Emeritus) of Engineering Drawing, Auburn University, and JOSEPH A. BENNETT, B.S.E., M.A., Professor and Head Engineering Drawing, University of Alabama.

This textbook provides engineering students with the fundamentals of graphic representation for the purpose of the communication of design ideas. It gives the engineering student the basic knowledge necessary to read, make and supervise the making and use of engineering drawings. It is in agreement with the recommendations of the latest standards of drafting practice.

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3

By JOSEPH A. BENNETT, B.S.E., M.A., Professor and Head Engineering Drawing, University of Alabama.

Many applications such as are found in other texts have been deliberately omitted to allow the student preparing for a career as an engineer to concentrate on acquiring a knowledge of the fundamental principles rather than on learning a series of routine procedures which would be more appropriate to the training of engineering technicians. The solutions in this text make full use of the idea of projection onto principal and auxiliary planes, whether these planes are considered real or imaginary.

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ANNOUNCEMENT

ANNUAL
DESCRIPTIVE GEOMETRY AWARD

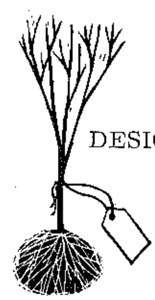
The Committee for Descriptive Geometry Award of the Engineering Graphics Division is pleased to announce that the Gramercy Guild Group, Inc., has again offered to provide $100 for an award in the Descriptive Geometry competition. The Committee has established the following rules for eligibility:

1. An article involving descriptive geometry in the solution of a problem or an article on descriptive geometry may compete.
2. The article must have been published in a periodical.
3. The article must have appeared in an issue between the dates of January 1964 and December 1964 inclusive.
4. Descriptive Geometry must be the primary interest of the article.
5. The article must be brought to the attention of the Committee. The Committee will naturally search diligently for all such articles but is not responsible for finding all such articles.
6. The article will be judged on originality, resourcefulness, and effectiveness. The drafting and the use of drafting aids, etc., should be competent, but are secondary considerations.
7. A majority of the committee votes received will determine the winner.
8. The winner will be announced at the Annual Dinner meeting in June and the award will be made at that time.

The Committee is undertaking a search of the periodical literature and as this is an extensive job any suggestions of suitable articles or references will be greatly appreciated.

Kindly send any information regarding possible articles to

Ivan L. Hill, Chairman
Illinois Institute of Technology
Chicago 16, Illinois



DESIGN FOR BARKIN' UP THE WRONG TREE

Irwin Wladaver
Box 5, NYU Heights
Bronx 53, N. Y.

"A nation that forgets its history has to repeat it." My mechanical drawing teacher made us spend the first six hours sharpening 6H, 4H, 2H, and HB pencils with a penknife. If he saw a point he didn't like, he broke it off. Yes, I now know how to sharpen a pencil with a penknife, but the importance of this great skill may be open to debate.

Nor do I have anything against pretty arrowheads. The trouble is that not many engineering students are making any kind of arrowheads - or sharpening pencils, either.

Fifteen years ago we began to become aware of open discontent with the content of our courses. As one result, nomography was resurrected. To most of us, at least to me, nomography was a new subject even though it had long lain buried in dusty library shelves. Anyway, we embraced nomography the way a drowning man would a life-preserver. Whether nomography really belonged in our courses was quite secondary, even immaterial.

Graphical calculus was another life-preserver. So also were curve fitting and empirical equations. We continued to drown, down for the second time. Apparently we had learned no useful lesson. A nation that forgets its history has to repeat it.

Three, four years ago we began to hear about "creativity" and "creativity in design," and then "design" by itself; despite the incontestible fact that most engineering colleges were tossing design out of the curriculum. Were it not for the lucky circumstance that "creativity" and "design" were being sponsored by some of the most capable people in engineering graphics, I think we would have been heavily ridiculed.

I claim we are barking up the wrong tree. I claim we are clutching at straws. I claim we are ignoring the basic problem, especially now that some sense seems to be coming back to the minds of our scientific curriculum makers. It is the problem that we have consistently refused to face in all the years that I've been connected with the Division of Engineering Graphics. If you go back to Volume 1, Number 1 of this JOURNAL, you'll see how old the problem is. (continued on page 26)

REPORT OF THE BIBLIOGRAPHY COMMITTEE

Ted Dolan, Chairman

Books Published 1960 to 1964

Authors	Title	Publisher	Ed.	Year	Pages	Price
Almfeldt, M.W. Arnbal, C.A.	Engineering Graphics Problem Book II	Wm.C.Brown		1964	128	$4.50
Baer, C.J.	Electrical and Electronic Drawing	McGraw-Hill	1	1960	218	6.00
Bellis, H.F. Schmidt, W.A.	Arch. Drafting	McGraw-Hill	1	1961	118	2.95
Caldario, E.J. Carlson, C.I. Goppert, H.P. Walraven, H.D.	Probs. in Engr. Drawing & Geom., Series 13	Stipes	2	1964		3.30
Carlson, C.I. Caldario, E.J. Cramer, G.E. Goppert, H.R.	Probs. In Engr. Geom., Series 3	Stipes	3	1961	3.00	
Caldario, E.J. Setton, H.A. Mysiak, E.J. Walraven, H.D.	Probs. in Engr. Drawing Series D	Stipes	4	1962		3.30
Cushman, O.F.	Engr. Drwg. Probs.	Holt	1	1960		4.50
Dobrovolny, J.S. Hipskind, J.F. O'Bryant, D.C. Rimbey, D.H.	Probs. in Engr. Drawing & Geom., Series 22	Stipes	1	1964		3.30
Dobrovolny, J.S. Springer, C.H. Hall, S.G. O'Bryant, D.C.	Probs. In Engr. Drawing & Geom., Series 12	Stipes	2	1964		3.30
Douglas, C.E. Hoag, A.L.	Descriptive Geometry	Holt	1	1962	208	5.00
French, T.E. Vierck, C.J.	Fundamentals of Engineering Drawing	McGraw-Hill	1	1960	552	7.50
French, T.E. Vierck, C.J.	Graphic Science	McGraw-Hill	2	1963	718	9.50
Hoelscher, R.P. Larson, B.O. Pearson, J.E. Springer, C.H.	Probs. in Engr.Drawing & Geom., Series 11	Stipes	2	1963		3.30
Hoelscher, R.P. Larson, B.O. Springer, C.H. Pearson, J.E.	Probs. in Engr. Geom. Series 1	Stipes	3	1961		3.00
Hoelscher, R.P. Springer, C.H.	Engr. Drwg. & Geom.	Wiley	2	1961	630	8.95
Hoelscher, R.P. Springer, C.H. Larson, B.O. Pearson, J.E.	Probs. in Engr. Drwg. Series A	Stipes	4	1961		3.30
Holladay, D.M. Wilson, G. Shick, W.L. Shapiro, S.E.	Probs. in Geom. for Architects, Series C Part I	Stipes	1	1960	75	3.00
Levens, A.S.	Graphics with an Intro. to Conceptual Des.	Wiley	1	1962	743	9.50
Levens, A.S. Edstrom, A.E.	Prob. Sheets (to acc. Graph. in Engr. & Sci.; Book I; Des. Geom.)	Fearon	3	1962	106	3.50
Levens, A.S. Edstrom, A.E.	Prob. Sheets (to acc. Graph in Engr. & Sci.; Book II; Tech. Drwg. Pract. & Graph. Comp.)	Fearon	3	1962	98	3.50
McNeary, M.	Probs. in Appl. Des. Geometry	McGraw-Hill	1	1961	136	4.25
Mochel, E.V.	Engr. Drwg. Probs. Alernate Edition	Holt	1	1961	65	4.95
Nelms, H.	Thinking with a Pencil	Barnes & Noble	1	1964	346	1.95 or 4.95
Pare, E.G. Francis Kimbrell	Introd. to Engr. Des.	Holt		1962	544	8.50
Rising, J.S. Almfeldt, M.W.	Engineering Graphics	Wm.C.Brown	3	1964	438	7.25

Authors	Title	Publisher	Ed.	Year	Pages	Price
French, T.E. Vierck, C.J.	A Manual of Engr. Drwg. for Students & Draftsmen	McGraw-Hill	9	1960	593	8.95
Fryklund, V.C. Kepler, F.R.	General Drafting	McKnight	3	1960	204	3.60
Giachino, J.W. Beukema, H.J.	Amer. Tech. Soc'.s Drafting	Amer. Tech. Soc.	2	1960	280	4.75
Giachino, J.W. Beukema, H.J.	Drafting Technology	Amer. Tech. Soc.				6.75
Giachino, J.W. Beukema, H.J.	Engineering-Tech. Drafting & Graphics	Amer. Tech. Soc.	1	1961	784	9.75
Giachino, J.W. Beukema, H.J.	Study Guide No. 1 (for authors' engr. text): Basic Draft. Tech.	Amer. Tech. Soc.	1	1962	50	1.60
Giachino, J.W. Beukema, H.J.	Study No. 2 (for authors' engr. text): Work. Drwg. & Des. Geom.	Amer. Tech. Soc.	1	1962	100	1.75
Giachino, J.W. Beukema, H.J.	Study No. 3 (for authors' engr. text): Gears, Cams & Tool Drawing	Amer. Tech. Soc.	1	1962	50	1.25
Gibby, J.C.	Technical Illustration	Amer. Tech. Soc.	1	1962	224	6.60
Grant, H.E.	Engr. Drwg: Combin. Text and Workbook	McGraw-Hill	1	1962	192	9.75
Grant, H.E.	Engr. Drwg. Probs. Ser. 1	McGraw-Hill	1	1960	60	5.50
Grant, H.E.	Pract.Des.Geom.Probs.	McGraw-Hill	2	1963	75	4.75
Hammond, R.H. Buck, C.P. Rogers, W.B. Walsh, G.W. Ackert, H.P.	Engr. Graphics - For Design and Analysis	Ronald Press		1964	502	9.50
Heacock, F.A.	Graphics in Space Flight			1964	128	2.00
Hoag, A.L.	Des. Geom. Problems	Holt	1	1962	128	4.00
Hoelscher, R.P. Dobrovolny, J.S.	Basic Drawing for Engr. Technology	Wiley		1964	396	6.95
Hoelscher, R.P. Hartley, T.C. Martin, G.E. Berkow, W.F.	Probs. In Engr. Drwg. & Geom., Series 21	Stipes	1	1963		3.30

Authors	Title	Publisher	Ed.	Year	Pages	Price
Rising, J.S. Arnbal, C.A.	Engineering Graphics Problem Book I	Wm.C.Brown	1964		100	3.50
Robinson, A.H.	Elements of Cartography	Wiley	2	1960	343	9.75
Rowe, C.E. McFarland, J.D.	Engineering Des. Geometry	Van Nostrand	3	1961	375	6.00
Rule, J.T. Coons, S.A.	Graphics	McGraw-Hill	1	1961	496	8.95
Svensen, C.L. Street, W.E.	Engineering Graphics	Van Nostrand	1	1962	739	9.75
Thomas, T.A.	Technical Illustration	McGraw-Hill	1	1960	149	6.50
Vierck, C.J. Hang, R.I.	Engineering Drawing Problems	McGraw-Hill	1	1960	109	5.50
Vierck, C.J. Hang, R.I.	Fundamental Engr Drwg. Problems	McGraw-Hill	1	1960	78	4.50
Vierck, C.J. Hang, R.I.	Graphic Science Probs.	McGraw-Hill	2	1963		5.95
Walraven, H.D. Carlson, C.I. Mysiak, E.J.	Probs. In Engr. Drwg. Series C	Stipes	4	1962	64	3.30
Walraven, H.D.	Quiz & Study Matl. for Engr. Drwg. & Geom., 2nd ed., by Hoelscher and Springer	Stipes	3	1962	75	1.35
Weidhaas, E.R.	Appl. Des. Geom. Probs.	McGraw-Hill	1	1961	176	3.95
Weidhaas, E.R.	Creative Probs. in Engineering Graphics	McGraw-Hill	1	1961	120	4.95
Weidhaas, E.R.	Creative Probs. in Engineering Graphics (Alt.Ed.)	McGraw-Hill		1963	120	5.95
Wellman, B.L.	Alternate Problem Layouts for Tech. Des. Geom. by Wellman	McGraw-Hill	2	1960	235	4.75
Wilson, G. Holladay, D.M. Shick, W.L. Shapiro, S.E.	Probs. in Geom. for Architects, Series C, Part II	Stipes	1	1960	75	3.00
Wockenfuss, W.A. Elkins, R.	Graphic Analysis Notes and Problems	Wm.C.Brown	2	1963	94	4.05

"Graphics and the Undergraduate"

Taken from the Divisional Committee Report on Goals of Engineering Education, June 1964.

The Engineering Graphics Division of the American Society for Engineering Education feels very strongly that a rigorous course in engineering graphics at the freshman level is a necessary and important subject in the training of engineers. To be adequately competent in engineering design, the engineer necessarily has to communicate his ideas graphically, as well as mathematically, orally, and by the use of the written language.

Engineering Graphics is one of three modes of thought for the expression and manipulation of technical information. These are the verbal mode of linguistics, the abstract symbolism of mathematics, and the visual symbolism of graphics. For its visual symbolism, graphics utilizes the line for the expression and manipulation of technical knowledge in design, communication, and analysis. In its design phase, graphics, especially sketching, is used as an aid to visual thought and as a memory-fixing device while ideas are being considered and refined. In its communication phase, graphics provides descriptions of objects or relationships that are more compact, precise, and more readily interpreted than descriptions in word form. In its analytical phase, graphics translates mathematical symbolism into a graphical form that may be more understandable and illuminating and whose manipulation is sometimes more logically followed and checked than the symbolic manipulations of mathematics.

Engineering graphics through visual perception and objective analysis produces precise solutions of engineering problems. It helps the student develop the insight and creative ingenuity which are essential for engineering progress. The engineer with a strong background in graphics can think graphically and in many cases can analyze problems that are not easily and completely comprehensible in mathematical form.

To operate at maximum insight, the engineer must have the ability to choose between the visual symbolism of graphics, the abstract symbolism of mathematics, and the written word for the best method of expressing, describing, and solving a problem. To do this, he must be well grounded in graphic concepts and must be able to employ graphics as naturally as he employs mathematics or the written word.

A very important phase of engineering graphics today is the development of the ability to sketch. The theory problems in orthographic theory of projection as well as in some of the other facets of the work could be sketched.

An increasing number of students entering colleges of engineering from high school have not had any previous exposure to engineering graphics. Upwards of 60% of the high school students have never taken a high school drafting course or have had any exposure whatsoever to the graphical means of communication.

To make up this growing deficite in high schools, it is desirable to have two courses in engineering graphics at the freshman level but the absolute minimum should be one 3 or 4 semester hour course. The one course could be basic to engineering communication, and the other to prepare the engineering technician for making engineering ideas practically workable.

DESIGN FOR BARKIN' UP THE WRONG TREE

(continued from page 21)

The basic problem is to find the place of engineering graphics in the education of young engineering candidates. Maybe there is NO place. But if there is one, then there is one course to follow: Proclaim that place proudly, loudly, and insistently. If we can make a solid, substantial place for graphics, we'll have everything we want and need, including our battered self-respect. If we can't make a case, we don't deserve to survive.

It is true that we ought to be well acquainted with nomography, empirical equations, graphical calculus, projective geometry, non-Euclidean geometries - all as items of scholarship related to our basic fields of interest and related to the central theme, contributing to our work but not dominating it. The central theme is the education of young engineers.

Nations that forget their history have to repeat it. If they get the chance.

THE CLARKSON/OSWEGO STATE PROGRAM

FOR UPGRADING HIGH SCHOOL MECHANICAL DRAWING COURSES

College faculty members can encourage high schools to upgrade their mechanical drawing courses to pre-engineering courses for college bound seniors.

SUCH COURSES MIGHT INCLUDE TOPICS FROM THE LIST BELOW:

- **Principal orthographic reference planes.**
- **Auxiliary orthographic reference planes.**
- **Orthographic lines and planes.**
- **Developments.**
- **Freehand sketching.**
- **Isometric drawings.**
- **Oblique drawings.**
- **Detail drawings.**
- **Sectioning.**
- **Dimensioning.**
- **Manufacturing processes.**
- **Logarithmic and linear scales.**
- **Making linear graphs.**
- **Making semi-logarithmic graphs with a uniform abscissa.**
- **Making semi-logarithmic graphs with a logarithmic abscissa.**
- **Making full logarithmic graphs.**
- **The slide rule.**
- **Applications of logarithms.**
- **The vernier.**
- **Orientation to science.**
- **Orientation to engineering.**

Such topics as care of instruments, lettering and geometric constructions are considered by-products of the above.

- **FOR FURTHER INFORMATION** and details of the program, please contact Dr. William Huss, State University College, Oswego, New York or Professor Myron G. Mochel, Clarkson College of Technology, Potsdam, New York.

Do You Use Graphics in Your Classroom?

The Editors of the Journal of Engineering Graphics are seeking articles dealing with practical problem solutions, and articles which explore the theoretical aspects of graphics.

Send your copy to: Earl D. Black, Editor
Journal of Engineering Graphics
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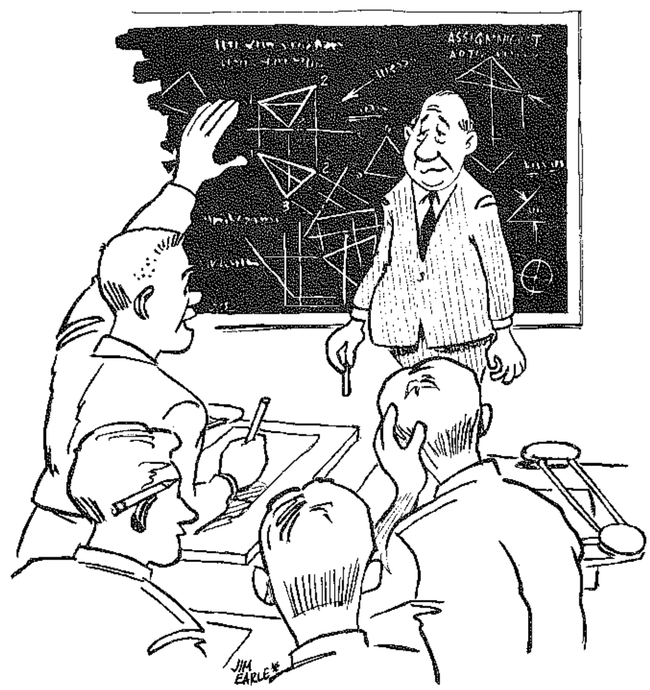


"...SIR -WILL YOU RUN THROUGH THAT AGAIN?"

*Assistant Professor of Engineering Graphics
TEXAS A & M UNIVERSITY

TRISECTION
of an
ARBITRARY ACUTE ANGLE

Walter E. Lambert
Chief Draftsman
DAY & ZIMMERMANN, INC.
Operator
LONE STAR ARMY AMMUNITION PLANT
TEXARKANA, TEXAS

The trisection of an arbitrary acute angle can be accomplished, provided a point can be established through which an arc can be drawn, and on this arc three equal circles can be drawn, so that they are tangent to each other and the two outer circles are also tangent to the sides of the angle.

In the proposed solution, N is the location of this required point. The relation between the radius for the required arc and the radius for the three required circles, is such that only one location of the point N will meet the required condition.

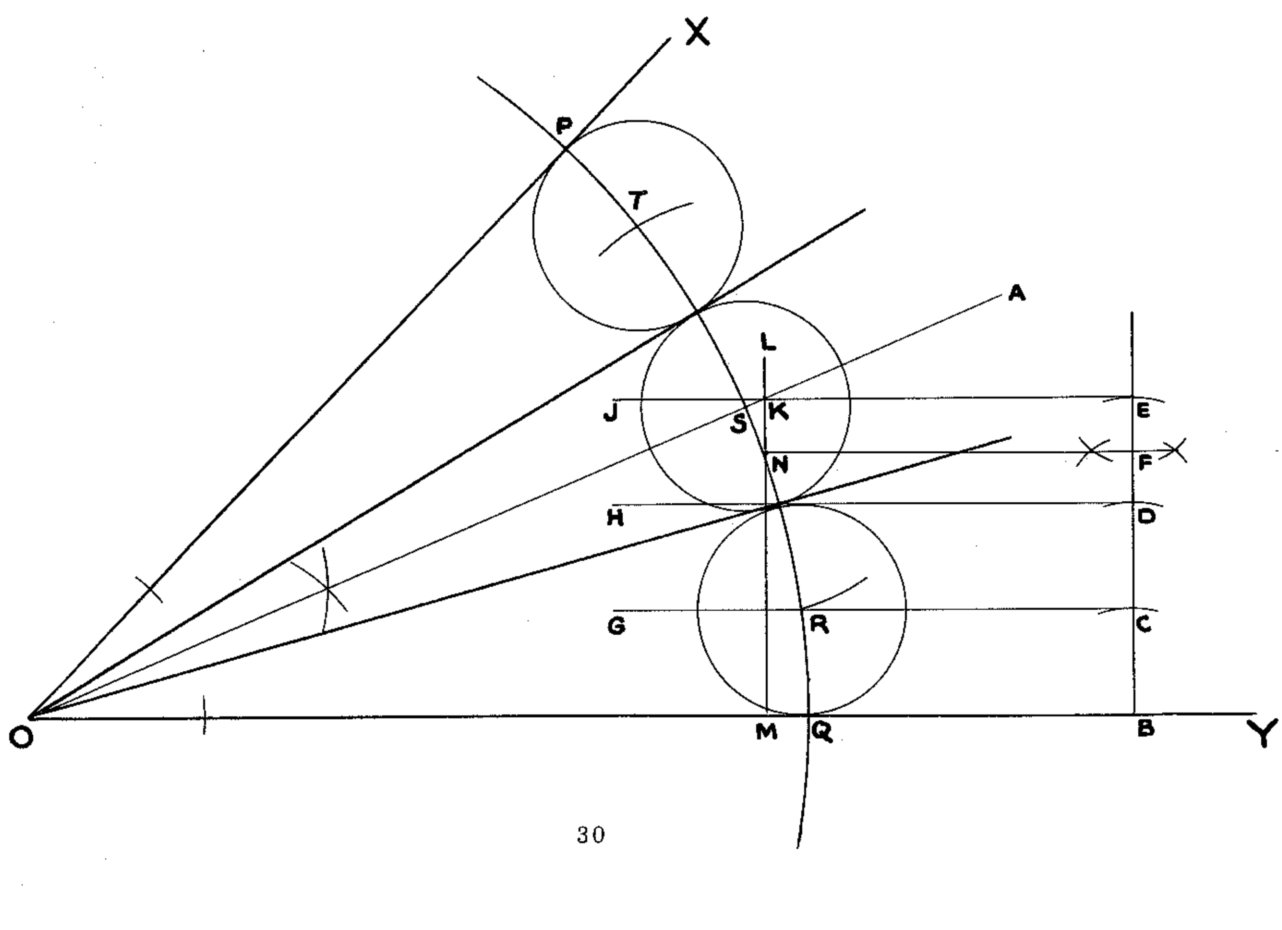
CONSTRUCTION

Given ∠ XOY

1. Bisect ∠ XOY and draw OA.
2. Construct ⊥ at B and lay off 3 equal segments, BC, CD, & DE (BC is any convenient length).
3. Bisect DE for Point F.
4. Through Points C, D, & E, draw CG, DH, & EJ ∥ to OY.
5. Through Point K, (the intersection of OA and EJ) construct LM ⊥ to OY and locate point N from Point F.
6. KN = EF by construction.
7. With O as center and ON as a radius draw $\overset{\frown}{PQ}$.
8. $\overset{\frown}{PQ}$ intersects CG at R and OA at S.
9. With S as a center and RS as a radius locate Point T on $\overset{\frown}{PQ}$.
10. With BC as a radius draw the three circles with R, S, & T, as centers.

Conclusion: The three circles are tangent to OX and OY, the legs of the given angle and tangent to each other.

Therefore angle XOY is trisected.



BOOKS THAT MEET TODAY'S NEEDS...

Introduction to Engineering Design

Eugene Paré and Jack Kimbrell, Washington State University
Lyman Francis, Missouri School of Mines

". . . the most modern text on engineering drawing that I have ever seen. It presents such a comprehensive picture of the engineering profession that it could be a strong motivating force toward engineering in the period of math and science groundwork." Robert H. Siegfried, Cornell University

Problems to accompany the text are available from the author. **1963, 544 pp., $8.50**

Engineering Drawing

Eugene G. Paré, Washington State University

Introduces today's engineer to the many facets of graphical analysis and communication. Recognizes the changing needs of engineering education.

1959, 512 pp., $6.95

Basic Problems to Engineering Drawing, Vol. II

John T. Dygdon, Robert O. Loving, and Joseph E. Halicki, all of the Illinois Institute of Technology

This second volume of a widely accepted workbook delves into the more advanced areas of technical drawing. Covers sectioning, fillets and rounds, true projection, auxiliary views, threads and fasteners, and includes an introduction to descriptive geometry.

1963, 112 pp., $3.00

Volume I by the same authors

Teaches the fundamentals of orthographic projection. Designed for introductory courses in Mechanical Drawing, Engineering Drawing, Graphics, or Technical Drawing. Provides detailed instructions to the student for preparing each sheet, using the same format as Volume II.

1963, 128 pp., $3.75

Problems for the Slide Rule and Calculator:

FOR STUDENTS of TECHNOLOGY, ENGINEERING, BUSINESS, and SCIENCE

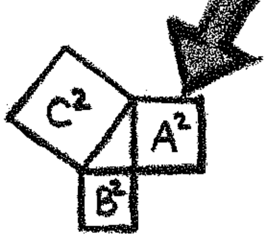
J. Howell Goffe, Daytona Beach Junior College, Florida
Glade Wilcox, Western Michigan University

Designed for students and technicians, this new workbook offers almost 4,000 problems in 44 different classifications. It is usable with all present-day slide rules and calculators.

1964, 192 pp., $2.95, paper

Holt, Rinehart and Winston, inc.
383 Madison Avenue, New York, N.Y. 10017

In Canada: **833 Oxford Street, Toronto 18, Ontario**



CONCEPT OF THE "GRAPHICAL MIND"

by

John T. Rule

Professor of Mechanical Engineering
Massachusetts Institute of Technology

Every intellectual discipline develops over the years successful cognative modes of attack on the kinds of problems with which it deals. Unproductive approaches are abandoned and productive ones expanded until the most successful pattern of thinking for the discipline becomes characteristic of the cognative style of the discipline's practitioners.

Each cognative style is a mental culture operating in much the same way as a social culture. Its practitioners are immersed in it and are generally quite unaware that their thought style, their professional state of mind, is but one of many. Indeed, in the scientific and engineering professions, such states of mind tend to become quite esoteric in nature, developing their own vocabularies and subtleties of viewpoint only fully understood by the initiated. The physicist instinctively thinks in terms of interrelated forces and of immutable laws. He is uncomfortable with ambiguity. The biologist thinks in terms of cycles of growth and decay. The behavioral scientist has the statistical or motivational viewpoint. Such statements are only symbolic of instinctual thought processes built deeply into the mental associative patterns of each individual's mind.

Though the engineer's dominant style is that of judgment between alternatives, and the scientist's that of developing the unique logical hypothesis to explain phenomena, both employ mathematics as a basic tool. Hence a mathematical cognative style must necessarily be possessed by every engineer and scientist.

In America the current mathematical state of mind is that of functional mathematics. This is to say that both engineers and scientists faced with any new problem instinctively enmesh it in the functional mathematical world almost to the exclusion of other modes of attack, modes which in many instances might prove to be more illuminating or more creatively powerful. Europeans, on the other hand, have much more training in geometric thinking and consequently exhibit a much greater tendency to attack problems in geometric terms. The instinct to use geometry is the mark of the "graphical state of mind."

It is quite clear that many, though not most, problems yield more readily to the geometric or graphical state of mind than to the functional, though they frequently will yield to either.

What is the graphical state of mind? It is the instinctive tendency to use lines as symbols rather than equations or numbers, to attack geometrically rather than algebraically. Since either may in any given case prove to be the more insightful, the engineer cripples himself if he is not at least aware of the possibilities of both, if he does not instinctively employ both. The American engineer and scientist is in general relatively graphically blind.

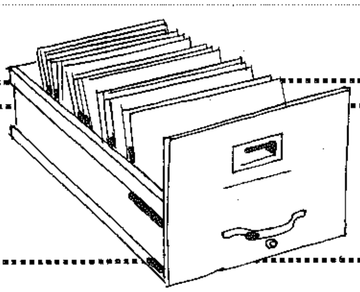
The function, therefore, of any graphics department is to instill the graphical cognative style into its students. The details of how this is achieved is of little importance. If the department fails to achieve it, however practical the material it teaches may be, it has failed in its highest mission and has reduced graphics to a purely pedestrian pursuit.

To succeed in establishing the graphical mind, the student must be given problem material which excites his curiosity, gives him a sense of problem-solving power, and a sense of conquering an intellectual discipline, not a purely practical training. It must also give him a sense of aesthetic satisfaction. Only in these ways can the graphical state of mind be built irrevocably into his thought patterns.

The opportunity to develop this state of mind is now before us. Graphical processes have indeed been raised to this level. Let graphicists no longer get lost in a curricular mass of detailed subject matter, but attend to the higher task of developing a truly, powerful cognative style.

Kites rise highest against the wind -- not with it.

Winston Churchill



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," E. D. Black, General Motors Institute, Flint, Michigan.

PIVOTS FOR LINKAGE MODELS

There are many methods available for building linkage models. One of the simplest and most economical is to use cardboard for the links. The problem is how to connect the links at the pivot points. A simple solution is to use the small clothing snap fasteners. These snaps provide a linkage which has sufficient stability and rigidity for demonstration purposes and which can be easily modified or inverted. The snaps are sold in kits at most notion counters. (sewing goods) The kit includes the necessary tools for installing the snaps. The Dot Snapper kit, for example, includes 20 snaps and tools and sells for about one dollar. Refills for these kits are also available.

Tom Short
General Motors Institute

LIGHT SHIELD

PROBLEM

How can we stop the light that is being reflected through the instrument mounting?

SOLUTION

Design a sheet metal shield to be attached to surface Ⓐ and which terminates along the line 1,2.

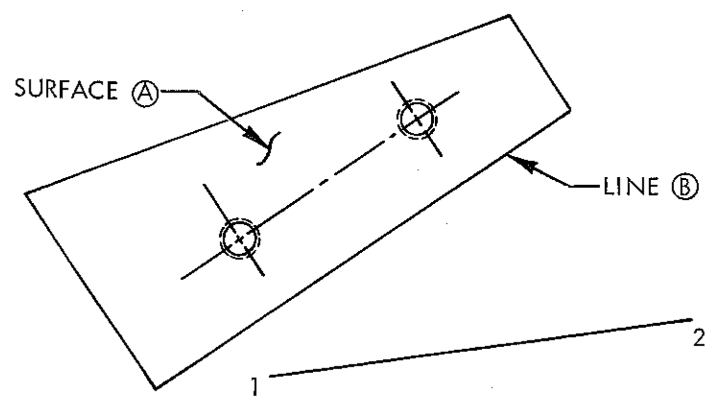
DESIGN LIMITATIONS

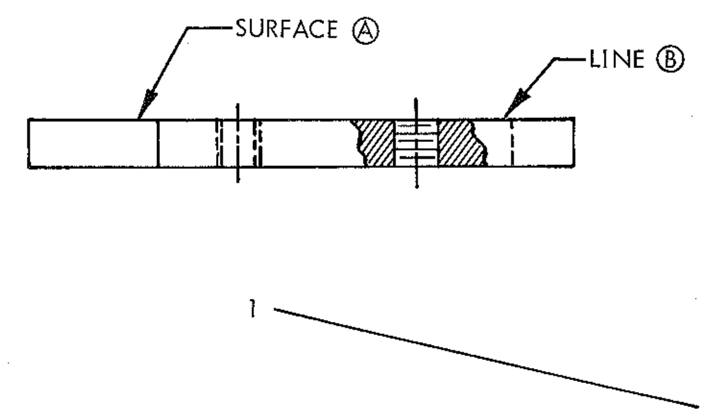
1. The shield must drop from the plane of surface Ⓐ along the line Ⓑ
2. The shield should be made with a minimum number of bends.
3. The shield must be fabricated with simple folds. (draw dies are expensive)
4. The threaded holes in surface Ⓐ may be used for mounting.

DRAWING REQUIREMENTS

1. Show the shield in the given views.
2. Show and dimension the bend angles in the views which show their true size.
3. Label the major points in all views.
4. Make a flat pattern layout of the blank which shows the shape of the shield before bending.

Robert J. Christenson
General Motors Institute





(continued from page 8)
adopt a negative attitude toward the entire course. A reasonable position would be for the teacher to indicate the type of information needed before the problem is begun. He should give the subgroup specific references in its text and in the library. The project group will then know the area in which the needed information can be located.

The class is organized so as to encourage maximum learning with minimum guidance. If left to run on its own, however, the system probably will falter after several class meetings. Difficulties which might arise are (1) a lack of direction within the project group, (2) a lack of feeling that the project group is important, (3) shirking of responsibility or dictation from one or more members, and (4) development of intergroup competition and hostility.[3]

These difficulties may be minimized through the use of two methods. First, instill in the students a sensitivity as to what is going on and help them recognize the role of the emerging leader. Second, utilize feedback from all project groups for discussion in the single class grouping. In a common group, grievances can be discussed and course goals redefined if necessary.

The first method requires the teacher to observe carefully the problem-solving pattern established within a particular project group. Problems of responsibility shirking, apathy, and disorganization may be caused by improper group leadership. This leadership, established by teacher selection or natural emergence, may be too aggressive or inept.

A project group might recognize their leadership problem if the teacher relates their form of leadership to the traditional ones. A classic source lists three basic forms of leadership: (1) authoritarian, (2) democratic, and (3) laissez-faire.[4] The teacher may explain that the democratic form was found to be the best facilitator of learning and includes such features as:

1. All policies are a matter of group discussion and decision, assisted by the leader.
2. Group goals are offered with the possibility of alternatives.
3. The leader is fact-minded and a member of the group in spirit.

In conjunction with a discussion of leadership forms, the teacher should realize that individual differences always exist within a group. Such differences are, in fact, desirable and if understood properly, can aid a project group toward its problem solution. Thelen believes that "team mates use each other to discharge anxiety and hostility, help diagnose what (is) really going on, (and) lay better plans for the next meeting ..."[5]

The problem of lack of feeling that the project group is important can be better handled by the feedback method than by the group-sensitizing method. The use of feedback can be a powerful tool to aid learning and should be considered here in some detail.

The teacher of graphics should be aware of the importance of feedback and of the types of feedback existing in a classroom. He should also have some criterion as to when to use feedback and how to structure a particular feedback session. These topics will be discussed in sequential order.

Feedback can show the members of a project group that they are not an "island unto themselves." The project groups can realize through feedback that they are all involved in the same educational task of learning graphics through problem-solving.

An establishment of a common bond between project groups through the use of feedback can minimize the problem of a group's feeling unimportant. When a project group discusses its problems within the entire class grouping, an esprit de corps will be generated within the project group since it will be defending its position or advancing a cause.

An importance of feedback not to be overlooked is that of incorporating within the feedback session the concept of reality-testing. The teacher's responsibility is to present guideposts during the discussion for evaluation of the validity of the problems and issues. He must help all project groups to focus on principal issues and minimize side-tracking.

The teacher will soon discover that four types of feedback can occur in a classroom. Some types are constructive; others are those which will fragmentize the class. The four types are listed in order of ascending value.

1. an individual in feedback to an individual.
2. an individual in feedback to a group.
3. a group in feedback to an individual.
4. a group in feedback to a group.

The first type is considered least valuable because of its limited scope. Only two persons are involved, often a student and the teacher. This type frequently deals with the situation in which a student will complain privately to the teacher or, conversely, attempt to seek the teacher's favor and personal attention. This type of feedback often turns the class into a collection of hostile individuals.

The second type of feedback is very common. Every teacher knows a case of a student who impulsively "sounds off" to anyone who will listen. If not set within a positive framework determined by whom the students relates to, this form of feedback has little constructive use except to relieve tension. This form is acceptable if the student relates to members within his own project group.

Either type three or four feedback will predominate in a feedback session in which all project groups are involved. Type three concerns the situation in which the spokesman for a project group relates an issue to the teacher. This form requires organization within the project group so as to formalize a verbalization. It is a premeditated offering involving more thought and synthesis of views than spontaneous forms of feedback. It aids in the organization of thinking, a trait valuable to any engineer.

The ideal feedback form is type four. Here one sees communication between project groups, rather than project group to teacher. It is the highest form of organized communication since it requires the ability for one project group spokesman to verbalize with another spokesman. It requires the ability to organize thought and to express it clearly on an extemporaneous basis. It is doubtful that considerable communication of this type will develop at the freshman level, much as it may be desired.

At what time is feedback best suited to an engineering graphics class? This question must be answered. Otherwise too-frequent sessions may occur and so impede progress of actual problem-solving. On the other hand, too few sessions of feedback may cause project groups to wander far from desired goals or to settle into a lethargic indifference to progress.

Types one and two feedbacks cannot be readily time-scheduled by the teacher, however, types three and four can be. Scheduling of these latter types would be dependent on:

1. the need to present new material to the class.
2. the number of problems completed during the course, i.e., three problems solved would indicate a minimum of three feedback sessions.
3. the need for reality-testing of solution tendencies.
4. the need to relieve growing tensions observed by the teacher to exist rather generally in the class.

Feedback sessions to enable material presentation would determine the maximum number of sessions per course duration. One such session per week would appear workable in a graphics course. It is recommended that an announcement be made for a session at least one class period preceding the session. This action will enable students to prepare organized questions or issues if they desire.

During an actual feedback session, it is suggested that the project groups initiate the proceedings by presenting issues for clarification. The students will appreciate this opportunity to grasp the initiative to "run the class." The teacher's role is to redirect questions back to the class after perhaps clarifying a particular question.

An example might be the question from a project group member, "Would it be advisable to draw the completed bearing housing in perspective?" The teacher should clarify the question, if necessary, and then seek viewpoints from the class. The teacher should then summarize the viewpoints and offer his own judgment.

More general questions may also arise, such as, "Why do we have to be concerned with line quality?" "Isn't our function as a designer simply to show our ideas accurately?" This question is related to course goals and should deserve a thorough hearing.

The feedback sessions provide an excellent opportunity to convey new information to the learners. The students will no doubt ask questions which lead naturally into new areas of knowledge. The teacher should then provide as much new information as will be helpful.

Near the end of a feedback session, the teacher may intensify his information delivery. He may give additional information in those areas touched upon briefly in the feedback discussion. He should list on the chalk board those areas discussed plus those areas presently unknown to the students which they will need for further problem-solving progress. When the unknown information is presented in context with that already learned, motivation to learn the new areas should develop. This motivation will be higher by far than if the teacher were merely to give all information in one uninterrupted lecture.

Evaluation of Student Progress

Why is evaluation of the student necessary? This question may bother the students at first. They may reply that good work should be rewarded with a good grade, or they may say that giving of grades is necessary to satisfy the educational "system." The teacher may explain in turn that an evaluation in terms of a grade is necessary as a form of "feedforward" from the teacher to the student. This "feedforward" attempts to place a value on the work of the student in terms of the goals established by the teacher.

The students may question the right of the teacher to judge what constitutes standard work. The teacher should be willing to discuss how the criterion for the letter or numerical grade is established. He should realize that contributions from students for setting norms should be honored. How then can the establishment of grade norms be accomplished?

First, members of the entire class should think out their views on the meaning of true achievement in engineering graphics. Is it an "A" at the course's end? Is it a feeling that the student did as well as was expected?

The teacher may suggest that achievement in engineering graphics contains three elements: (1) the development of a sensitivity to good and poor graphics practice, i.e., the ability to judge the worth of a graphical expression, (2) the ability to see student contribution as a part of a larger problem-solving situation, i.e., to recognize the significance of each particular solution within an overall project, and (3) the ability to apply the concepts of graphics to later engineering practice.

(continued on page 37)

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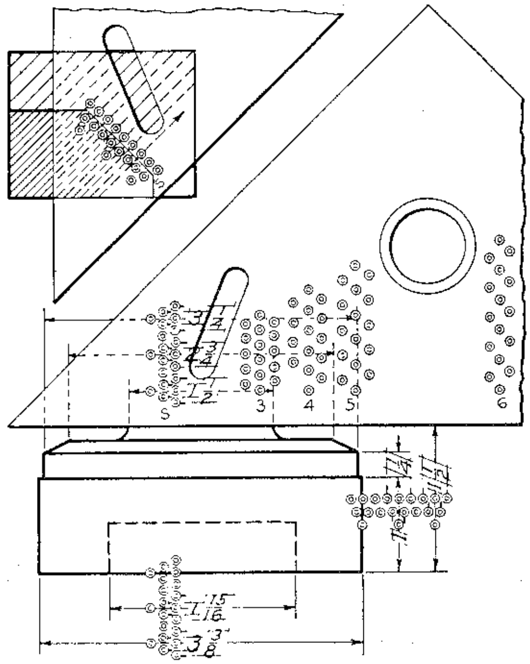
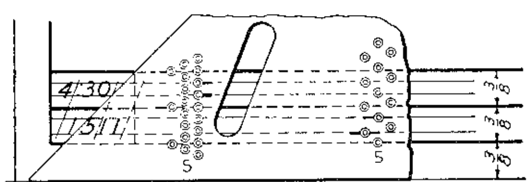


SYSTEMATIC DIMENSIONING



LAYING OUT TITLE STRIP

Style "A"

5"-60
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8"45

6"-45 Brd.-Rowe

8"-45 Style "C"

Style "B"

5"-60
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8"-60
9"-60
4"-45
5"-45
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(continued from page 35)

STUDENT EVALUATION

A system of student evaluation follows. It incorporates a realistic approach, providing for student participation and also adaptability to teacher modification.

Peer-group evaluation can be helpful in enabling the student to participate in evaluation and also in developing a true sensitivity in judging a graphical solution's worth. To implement this student participation, a form can be given each student at the end of a problem-solving task. With these forms, the students of each project group may rate the worth of every other project group's solution. Upon inspection of the posted solutions, a learner can enter his evaluation of any solution according to the sample form below.

	Excellent	Good	Fair	Poor	Unacceptable
Practicality					
Completeness					
Clarity					
Quality					

A checking of the appropriate blocks is all that is necessary.

A problem solution to be rated should consist of a set of drawings representing the corporate effort of a project group. Students within the project group should have contributed particular portions of the solution as agreed upon by mutual consent of project group members. All project groups should have had the same number of class periods for problem-solving.

A suggested correlation to the form is:

Excellent = 95 (A)
Good = 85 (B)
Fair = 75 (C)
Poor = 65 (D)
Unacceptable = 55 (F)

Each of the four items to be rated (practicality, completeness, clarity, and quality) receive an equal weighting of 25%. Computation of a net score by each project group for each project group would not be difficult. The teacher should collect all scores and compute a final score for each project group. This technique will avoid hard feelings by one or more project groups toward other project groups.

Evaluation at this point is not complete. The teacher may assume the responsibility of accounting for individual differences within project groups. It is recommended that the teacher determine a score equal in value to the student-evaluation score. He should base this score entirely on the individual performance of a project group member.

Occasional quizzes, administered on an individual student basis, can aid the teacher in spotting slow learners. Additional help from the teacher may be given such students so that they might better understand the theory needed to undertake problem-solving. The total value of these quizzes should be rated less than the value of problem solutions.

Most graphics courses include a departmental final examination. A graphics section in which students learn through project groups should take the same final as any other section. The final may prove useful in comparing the academic performance of the project-group section with those taught by more conventional methods. For sure a comparison, valid or otherwise, would make for a lively faculty meeting!

A last factor in student evaluation is reserved for those intangibles that enter into any teacher's determination of a course grade. It is suggested that the teacher concentrate here on rate of student progress throughout the course, willingness to learn and contribute to his project group, and amount of effort in areas "above and beyond the call of duty."

A list is given as a numerical account of the various evaluative processes described in this portion of the paper. It is subject to change as a teacher sees fit.

	Percent of Course Grade
Problem Solutions:	
1. Peer-group evaluations	25
2. Teacher evaluations	25
Quizzes:	10
Teacher Evaluation of Student Progress:	10
Departmental Final:	30
	100

The challenge of teaching engineering graphics is before us. It remains for the teacher to stimulate among his students the motivation to learn. When we have acquired more learning on the part of the student, graphics will become a more useful segment of engineering education.

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Papers will be considered for publication written on subjects which will be of help to the graphics instructor in his classroom presentations, problem assignments in some area of graphics, articles which indicate depth of research in graphics and stimulate thought, items of news, historical information, and any other items which will stimulate and promote the professional standing and respect for engineering graphics.

Editorial considerations suggest papers of from 8 to 12 pages of typewritten copy and illustrations. Papers should be typewritten double spaced on one side of the sheet. References and footnotes should be listed on a separate sheet and should not be inserted in the text.

Each paper should be accompanied by an abstract of approximately 150 words. The first one or two sentences should clearly state the subject of the paper. The remainder of the abstract should be informative and summarize significant points covered in the paper.

Line drawings should be prepared in India ink. It is urged that mechanical lettering be used or labels should be placed on a cover sheet. Photocopies (same size or reduced) of the original drawings are acceptable if they are clean, clear, and sharp in line contrast. All lettering should be large enough to be legible when reduced 20 per cent in size. Figure numbers should be placed on the cover sheet for the drawing. Figure numbers and captions should be listed on a separate sheet.

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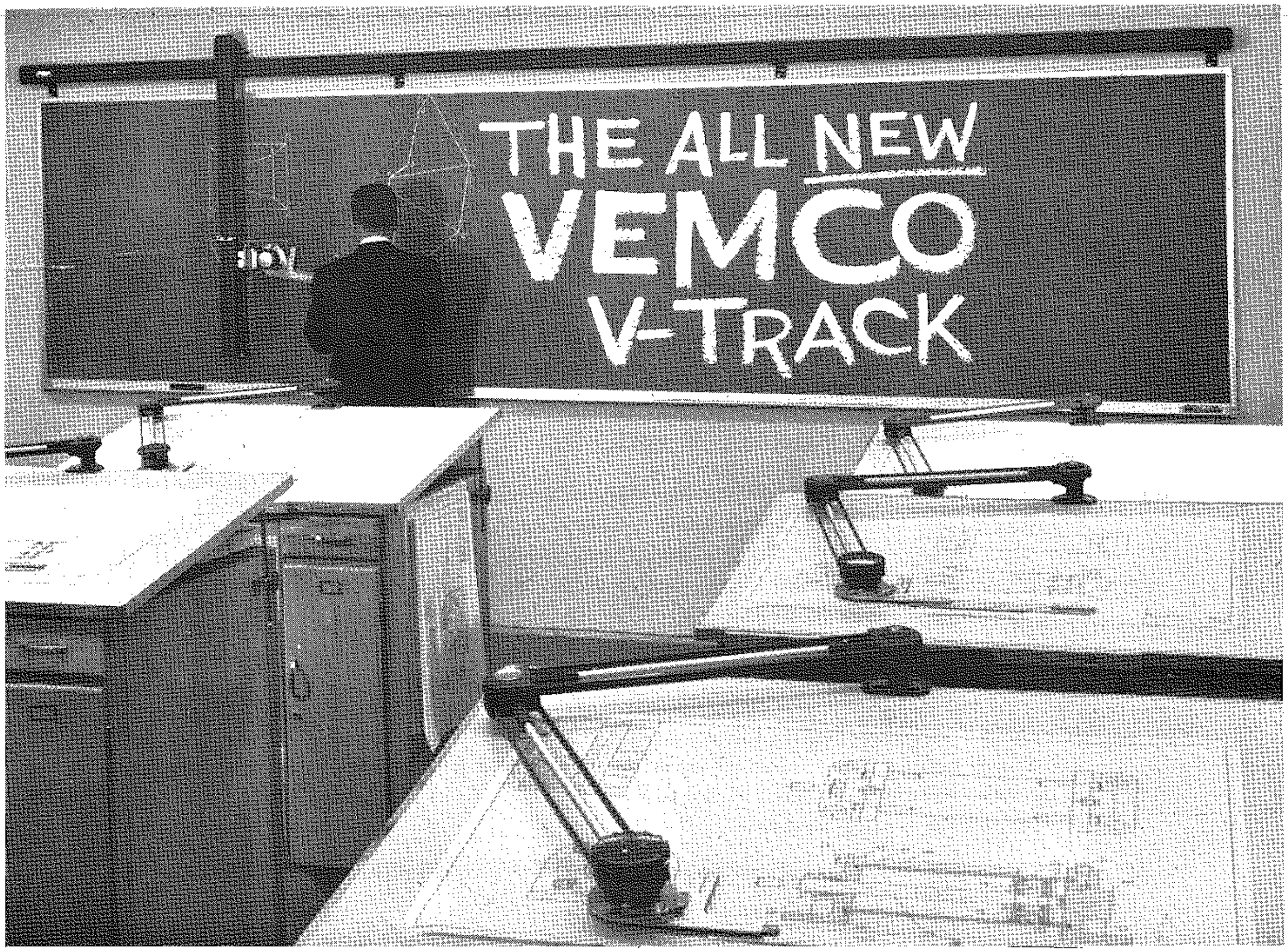

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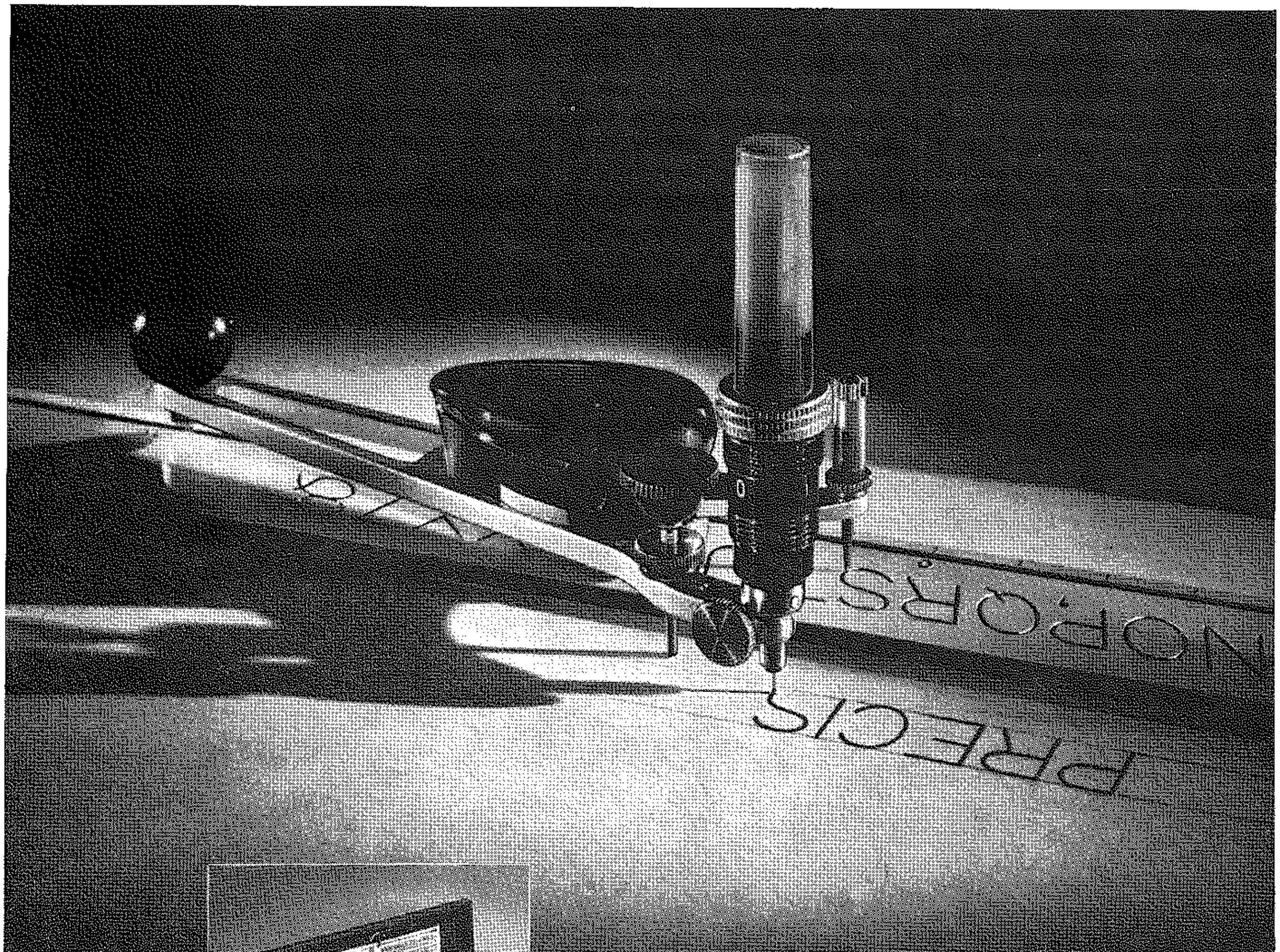

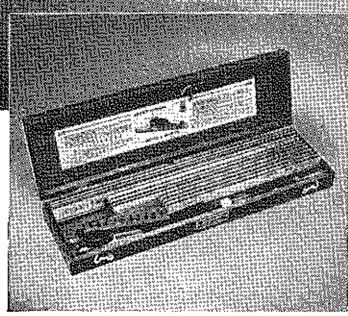

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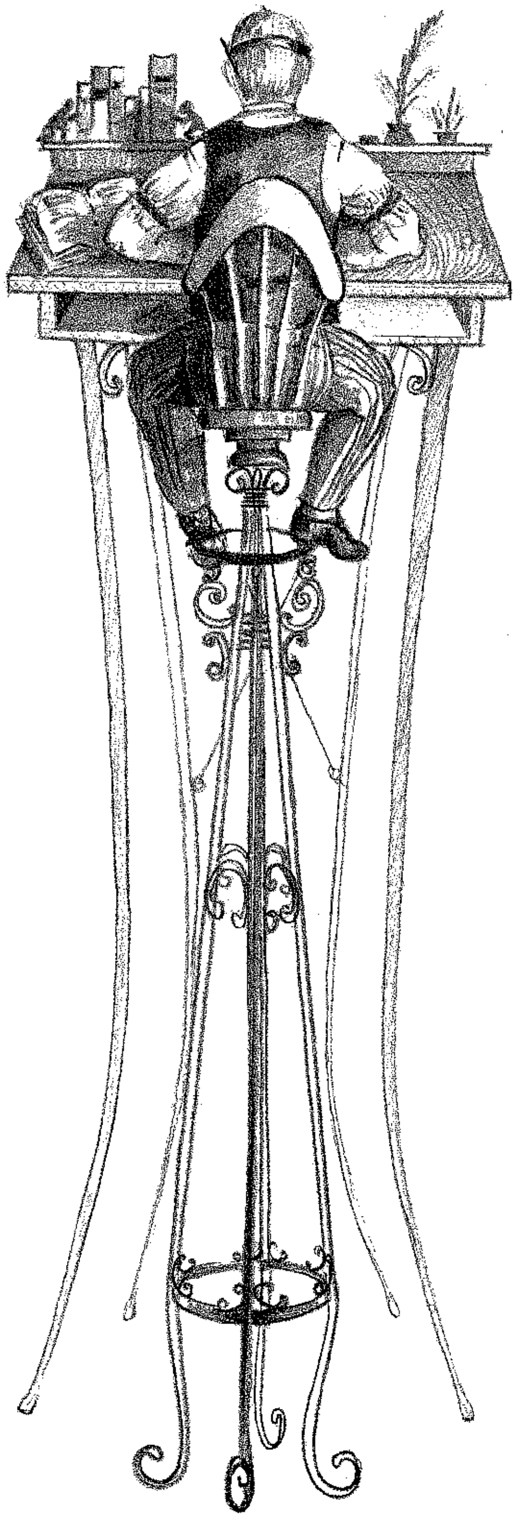

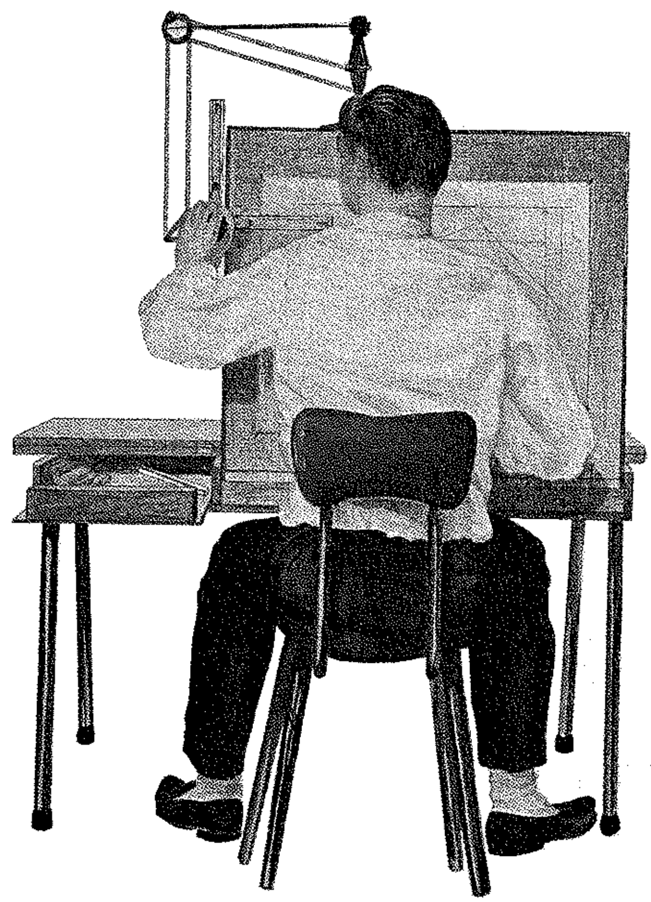

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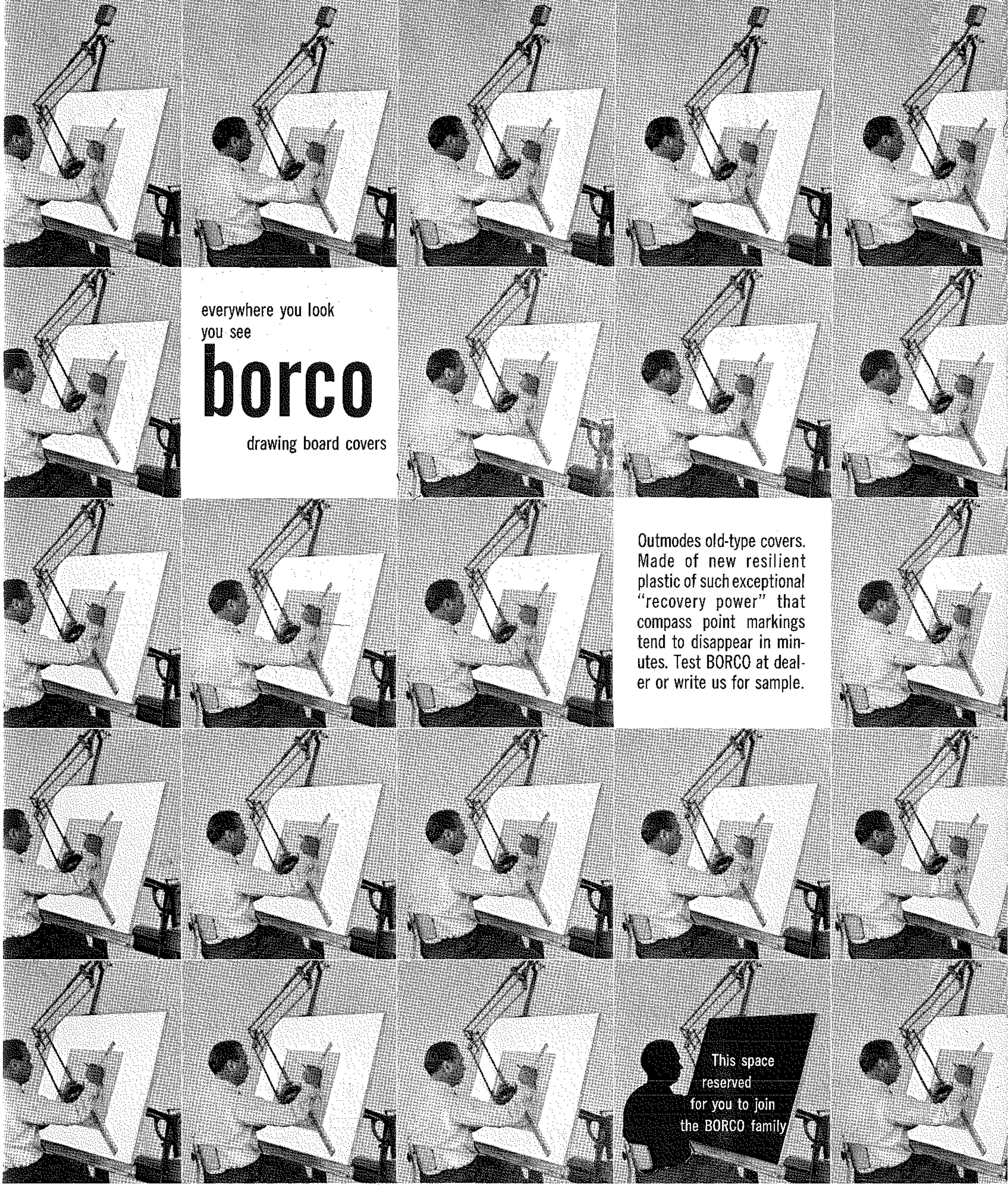
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