# JOURNAL OF ENGINEERING DRAWING

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Louisiana Polytechnic Institute

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BY
THE
DIVISION
OF
ENGINEERING
DRAWING
AND
DESCRIPTIVE
GEOMETRY
A S E E

# JOURNAL OF ENGINEERING DRAWING

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

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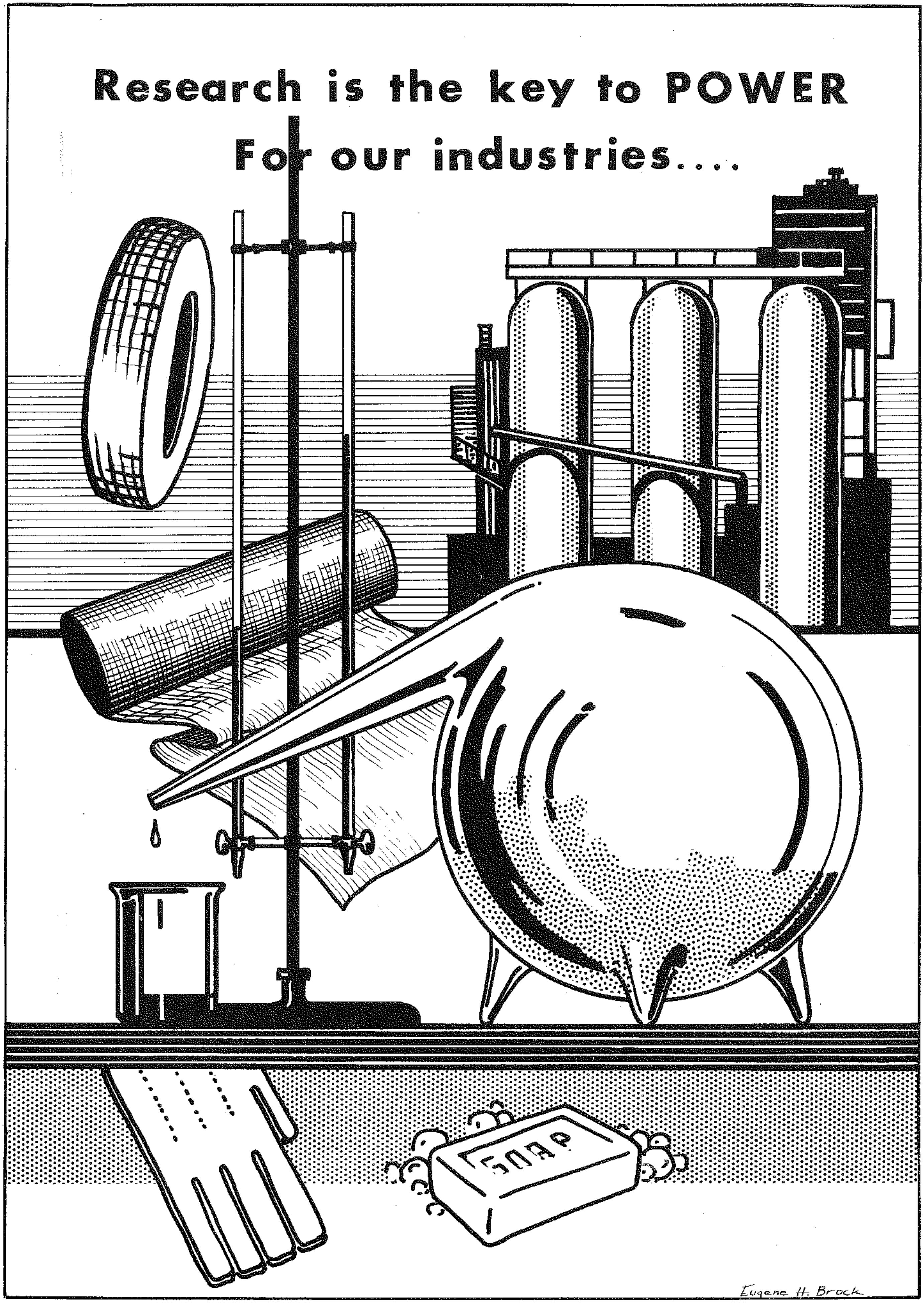
Research is the key to POWER
For our industries....
SOAP
Eugene H. Brock

## LOOKING AHEAD

O.W. Potter, Chairman, Division of Engineering Drawing

The next annual meeting of the American Society for Engineering Education is to be held on June 19 to 23, 1950, at the University of Washington, Seattle, Washington. It is just 10 years since the last meeting of the ASEE was held on the west coast at the University of California, Berkeley, California. All teachers of Engineering Drawing are invited to attend this meeting, especially those from the schools in the western part of the country.

The Division of Engineering Drawing of the ASEE is preparing a very interesting program. It will consist of three conference sessions, a plant visitation, a luncheon, and the annual banquet. We plan to have speakers from both industry and various schools on the program. Committees are already at work and you can be assured of a most interesting and instructive program.

There are a number of the country's finest vacation sites in the northwest, Yellowstone National Park, Glacier National Park, and other interesting places. We hope some of you will plan your summer vacation trip this year to take in some of these places and at the same time route your trip so as to attend the annual meeting of the ASEE at the University of Washington. It is not too early to start making these plans now.

The sessions of the Drawing Division are well organized, the programs are interesting and instructive, and the attendance has been very good. If you have been there before you will want to come again, if you have not attended one of these sessions we invite you to come and see for yourselves. I am looking forward to meeting you next June at the University of Washington.

## A PROPOSED ALPHABET FOR LEFT-HANDERS

by

Melvin L. Betterley

Assistant Professor, Illinois Institute of Technology

In courses I have taught at The Illinois Institute of Technology, students often ask the following question: "I am left-handed; should I learn the order and direction of strokes for letters as shown in the textbook, and will I be held responsible for a knowledge of them on quizzes?" In view of the fact that certain letters are difficult to make if the left-handed student attempts to use the right-handed alphabet, it was the policy of the teachers of the department to advise left-handed students to use the direction and order of strokes which best suited them and to indicate on the quizzes that they were left-handed.

One of the strongest arguments in favor of any system of strokes is that it gives the student a reasonable foundation or starting point from which he can develop habits leading to good form of letters, speed in lettering, and a distinctive style. Perhaps the left-handed students were therefore being taught largely without the advantages of this very important tool, being left on their own to experiment, change, and eventually adopt an alphabet - all of which resulted in a costly expenditure of time and effort.

Such a proposed alphabet should be based upon the natural responses of a large number of left-handed students. Consequently, a questionnaire was prepared and a copy distributed to each left-handed student enrolled in freshman drawing. See Fig. 1.

In four semesters of sampling, approximately one thousand six hundred and fifty students had enrolled, of which one hundred were left-handed. The incidence of left-handedness in the classroom, as based upon the above figures, is approximately six percent. This is slightly below the United States census figure for adults (approximately ten percent).

To the questions asked on the form, the results obtained were as follows:

1. Do you find it easy or natural to letter using the right-handers' approved system?

   Yes 9% No 91%

Since ninety-one out of the one hundred left-handed students indicated that the approved right-handed alphabet was difficult for them, it is obvious that there was need for an alphabet that the left-hander could use as a guide in beginning the study of lettering. The

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# WHAT IS FUNDAMENTAL IN DESCRIPTIVE GEOMETRY?

By

Professor B. Leighton Wellman
Worcester Polytechnic Institute

Although well founded on geometric principles and scientific methods, descriptive geometry is being taught today in various forms and with many philosophies. Like Christianity it has a universal purpose and definite objectives, but its followers are divided into many sects. Form, method, and notation are so different that the student of one school may find the graphics of another school almost unintelligible to him. For a "universal language" this is not a happy situation. Fortunately, these various philosophies all lead to the same end - produce the same precise results. For that we should be deeply grateful. Consider if you will, our colleagues who philosophize in the field of social and economic studies. They all begin with the same facts, the same commodities, the same human beings, and yet all arrive at different conclusions - most of which time ultimately proves to be wrong.

But let me make it clear now that it is not my purpose to convert anybody to a particular system of teaching descriptive geometry. Nor is it my intention to belittle any of the methods now in vogue. Although I am a firm believer in the direct, or auxiliary view, method, I am also convinced that any method or means is valid if it achieves the desired end result. Some instructors are especially skillful in the use of models; others get excellent results with pictorial drawings; still others refuse to use either scheme yet they also get good results. Personally, I believe that the success of any method is largely dependent upon the special talents of the individual instructor.

Yet with all its variations, descriptive geometry is an exact science, and as such it is based upon certain accepted fundamental principles. But how many of these fundamental principles are there? If I asked each of you to make a list, the number would probably vary from as few as three to as many as twenty or more. Perhaps it would be better to ask: how many of these principles are really fundamental? And how many are merely useful secondary principles dependent for their validity on other more fundamental principles? And how many more of our principles are primarily a matter of convenience and not at all essential? In other words, the real question I propose is this: what principles in descriptive geometry are so primary that without them the whole science collapses?

In order to answer this question let us analyze carefully each of our basic concepts, and then classify each one as either fundamentally essential or as only useful or convenient. As a basis for decision, let us agree, tentatively, that if the desired graphical result can be achieved without employing a certain principle, then that principle must be considered secondary and not fundamental. In making such classifications I intend to be very practical and realistic. I do not intend to become embroiled in any purely academic arguments as to the classical acceptance or mathematical rigor of a principle. In brief, if I can get along without it, it is not fundamental. Proceeding then on this basis I think you will be surprised to find that there is only one fundamental principle in descriptive geometry. Let us discover it by a process of elimination.

Consider first the original Mongean system of descriptive geometry. Here the important features were two perpendicular reference planes and a series of parallel projectors from the object perpendicular to these planes. In this way the three-dimensional object was converted into two two-dimensional pictures or projections, and when the reference planes were properly flattened out the whole problem became two-dimensional. The original object theoretically ceased to exist having been replaced by two flat depthless projections. An additional important feature was that lines and planes were represented primarily by their traces - the points and lines where lines and planes intersected the reference planes. This is, of course, but a brief summary of the salient features of a system with which you are all familiar.

From a purely geometric viewpoint the Mongean system is perfectly logical, and Gaspard Monge's ingenious discovery in graphics can be favorably compared with the discoveries of Archimèdes, Galileo, and Newton. Many of his concepts have been retained to this day, but there have been numerous modifications. The changes - and improvements if you wish to call them that - have been in two directions: constructional and philosophical.

I think I may fairly say that one of the disadvantages of the Mongean system is its constructional complexity. With all operations taking place in the original views and

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A Paper Presented before the Engineering Drawing Division at the 57th Annual Meeting, A.S.E.E.. Rensselaer Polytechnic Institute, June 22, 1949.

in four quadrants, the resulting network of superimposed lines frequently becomes confusing even to the expert draftsman. To the perspiring student it becomes hopeless. Then it was discovered that lines and planes could be handled without traces, and that the principle of plane traces was not fundamentally essential but only a convenience of debatable utility. It soon became apparent too that space need not be divided into four or eight compartments: with a little adjustment any object could be adapted to a single undivided space. Thus, with a few exceptions, only the first and third quadrants remain today.

A major simplification occurred with the introduction of auxiliary views. Geometrically, nothing new had been added for oblique planes of projection were already in use. But these oblique planes had to be revolved about a trace into one of the reference planes, and the revolved position frequently fell on top of the original views. Thus this simple operation was attended by a disproportionate amount of confusion. By using auxiliary views the lines of construction are spread out into the clear marginal spaces, and the confusion is eliminated. The price of this achievement is that two auxiliary views are used to accomplish what was previously done with one simple revolution. And there are now four interlocked and skewed reference planes where before there were three. In summary, our constructional progress has been largely a matter of spreading the solution over a larger area. A line by line comparison of the old and new usually reveals little or no saving in the actual number of lines drawn. For any problem solution there seems to be an irreducible minimum number of lines required no matter how the solution is made.

And now what about our progress in the philosophical direction? In the Mongean system the object is projected onto the imaginary reference planes, and what the draftsman sees on his paper are these projections. Each projection is a flat depthless picture of the original solid object. The thickness of a projection is zero, and every line lies in the same plane. The projection is not the object but only a ghost of it. These are the cold facts of orthographic projection. As previously indicated there is nothing wrong with the logic of this; it is abstract and rigorous enough to delight the mind of any mathematician. But it's unreal, and every author and every teacher knows it. The result is that they lecture about projections, but talk about the object. Is it any wonder that students are sometimes confused by this academic double-talk?

One of our finest texts on engineering drawing develops the subject of orthographic projection in very thorough and complete form. There are many excellent pictures of the folded and unfolded "glass box" with the flat projections drawn on its faces. The terms "view" and "projection" are used interchangeably. After some twenty pages of this we find this statement in italics: "When looking at any view, one should always imagine that it is the object itself, not a flat projection of it..." This is a confusing statement for it is entirely inconsistent with the theory of projection drawing.

Such inconsistency is not confined to any one text: it is, in fact, almost a universal practice. Many other texts begin the discussion of multiview drawing by using the direct method of views without the planes of projection. Then after successfully developing this approach they revert to the "glass box" method, thus superimposing another concept on top of one that is already perfectly clear. There seems to be a feeling that the direct view method is not sufficiently rigorous, and that the planes of projection must be retained to keep the subject on a high academic level.

It is now over 20 years since Professor Hood published his text "Geometry of Engineering Drawing," and introduced the direct method. The success of that book is convincing evidence that this approach is sound and logical. The advantage of the direct method, in my opinion, is that it focuses the student's attention on the solid three-dimensional object and removes the distraction of the "glass box." Let me repeat again, however, that I am not trying to convert anyone. My primary purpose in discussing this matter here is merely to show that planes of projection are not fundamentally essential in descriptive geometry. Use them or reject them, as you will, but in either case try to be logically consistent.

If, then, we dispense with reference planes how can we explain the standard arrangement of the views since this traditionally depends upon the unfolding of the "glass box" about its hinged edges? The explanation, of course, is that in the direct method the views are arranged in the standard pattern simply because this aligns and correlates the common dimension in each pair of adjacent views. For example, the top view is placed directly above the front view because each of these two views shows the same length dimension. This admittedly, is very elementary logic, but it can hardly be rejected on the grounds that it is too simple.

But to return to the main theme of this discussion, the real question is this: is the standard arrangement of views fundamentally essential or is it only a convenience? I think we must agree that it is only a convenience, for if the given views are properly labeled and identified, they could be arranged in any desired fashion - even on separate sheets of paper - and we could still solve the required problem. The only difference would be in the additional time required to transfer distances from one view to another.

It begins to appear that most of the standard concepts of descriptive geometry are more a matter of graphical convenience than of fundamental necessity. Thus far, I have classified as of secondary importance the following concepts: (1) plane traces, (2) division of space into quadrants, (3) reference planes and projections, and (4) the standard arrangement of views. It should be clearly understood, of course, that I am not advocating the total elimination of any of these concepts. They have a utility and convenience that we all appreciate. But now that we have stripped the body of our science down to the skeleton, what remains? Only two principles: first, the direction of sight for any two adjacent views must be perpendicular, and second, the lines of sight for every view must be parallel. And of these two remaining principles, only the second is truly fundamental.

Consider first the second principle. In orthographic projection the projectors for a given view are all perpendicular to the reference plane, but the observer is assumed to be at an infinite distance from the object, hence the lines of sight are parallel. If the lines of sight are not parallel but converge at the eye of the observer then we get a perspective view instead of the orthographic view. Without dwelling upon the well known disadvantages of the perspective drawing for engineering purposes, I think we can accept

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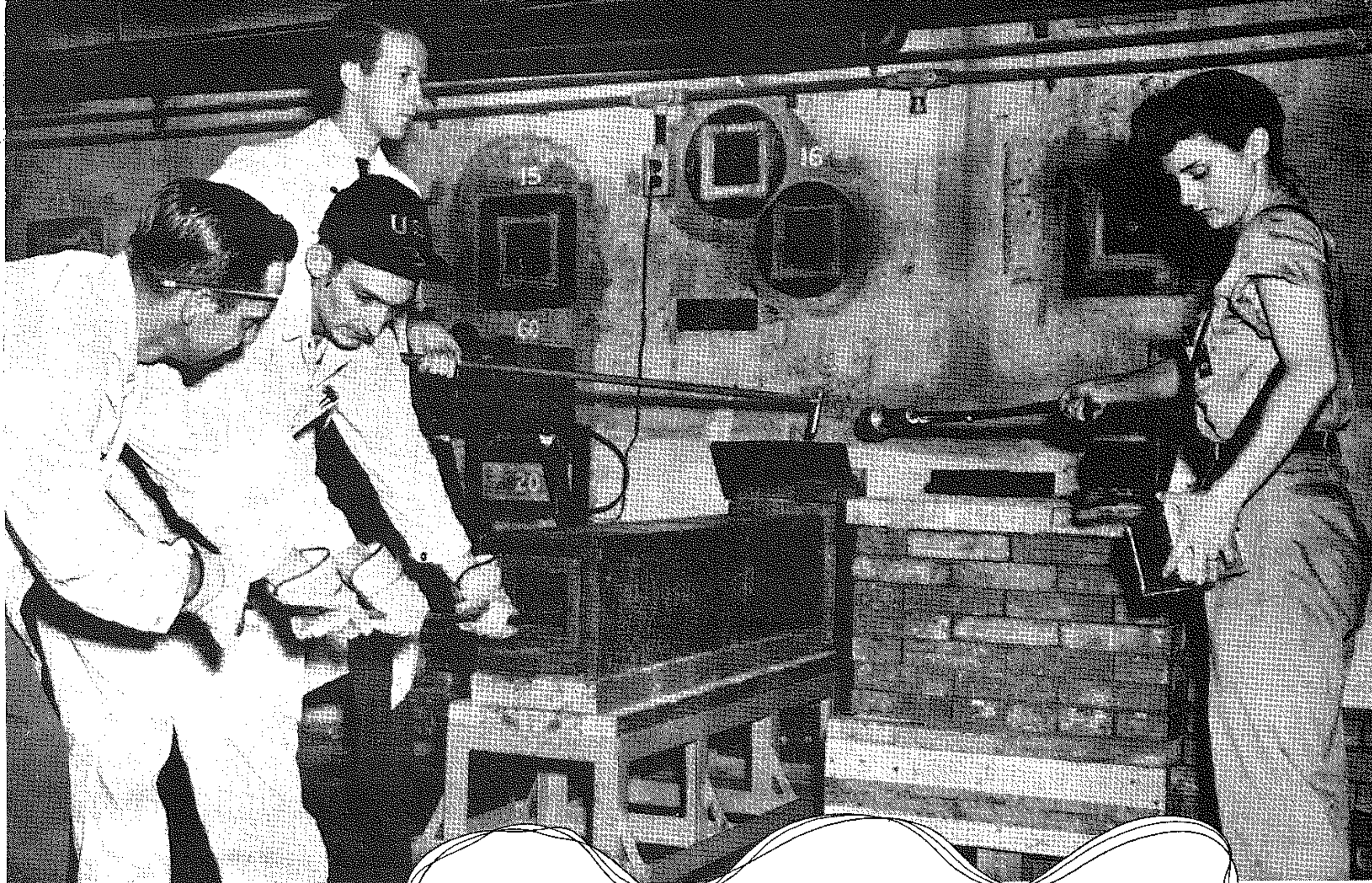

(*Photo by U. S. Army Signal Corps*)

# they must be handled at a Distance

RADIO-ACTIVE isotopes, structurally unbalanced elements, amazingly useful in medicine, in chemistry and in industry, cannot be handled with impunity. They must be handled at a distance, always with safety-shields between them and the technicians.

Similarly, when it comes to handling the unbalanced material that is boy-in-motion-toward-adulthood, those whose responsibility it is to guide him toward personally happy and socially useful goals, must handle him "at a distance." It is not possible to reach past the barrier of flesh and fashion directly the material of the spirit into will, ambition, desire and enthusiasm. So the wise educator works by subtle precept, by apparently casual example, by inspiration based on the familiar things of school and home. Especially does he employ the desire to emulate which is in every youngster . . . the desire to put *aside* the things of childhood, to put *on* the habiliment of maturity. Every boy wants a "genuine" Babe Ruth bat. Every boy wants to get into long trousers. Every boy wants to drive his dad's car.

When it comes to study and school *work*, just as in recreation and play, the *wise* instructor does *not* battle the current or contradict the urge. Instead, he is on the side of the angels insisting that the tools and instruments that implement the starting efforts be of adult quality, fineness and design. To accept less in drafting instruments, for example, is to say to the youngster—"Stay in the world of childish make-believe. Why try to be a man?" Such thoughtlessness may easily sacrifice one of the great opportunities to kindle ambition in a budding career.

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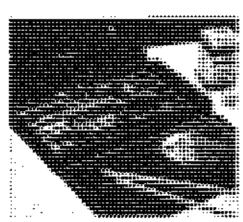

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**EVERYTHING FOR DRAFTING AND SURVEYING**

# CROSS RATIO IN ELEMENTARY ENGINEERING DRAWING

by

Steven Anson Coons
Massachusetts Institute of Technology

If the Boston Red Sox had won either of the last two games of the American League season, they would have won the pennant. The first of these games depended on one pop fly hit by Jerry Coleman. Al Zarilla, the Red Sox right fielder made an heroic attempt to catch the ball, and conversations buzzed about it for days thereafter. Apparently, however, his breakfast was one or two cornflakes short of the breakfast of champions that morning, or there was a wrinkle in the toe of his sock because he missed the catch by inches.

This formed the basis for a problem on an elementary engineering graphics quiz. The statement of the problem said that a photographer had taken two photographs, one showing Zarilla in position in the field (point Z in Fig. 1) and the other showing him just as he missed the ball (point B in Fig. 2). A baseball diamond is laid out in the form of a square 90 feet on a side. How far did Zarilla run?

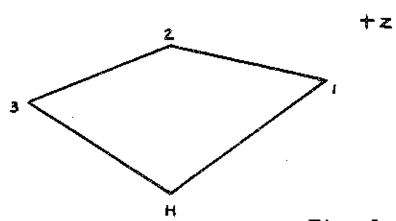


Fig. 1

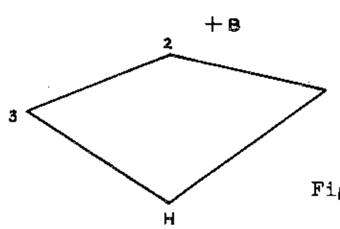


Fig. 2

Now, evidently the solution of such a problem can be accomplished by means of the principle of the invariance of cross ratio. Though many readers will be familiar with this principle, a discussion of it may still be illuminating. It can be stated in the following way. In any pencil of rays, a, b, c, d, whose center is S, the ratio of ratios of segments of the transversal T which we may write:

$$\frac{\frac{AC}{CB}}{\frac{AD}{DB}}$$

is always constant, no matter how the transversal T is drawn. (Fig. 3).

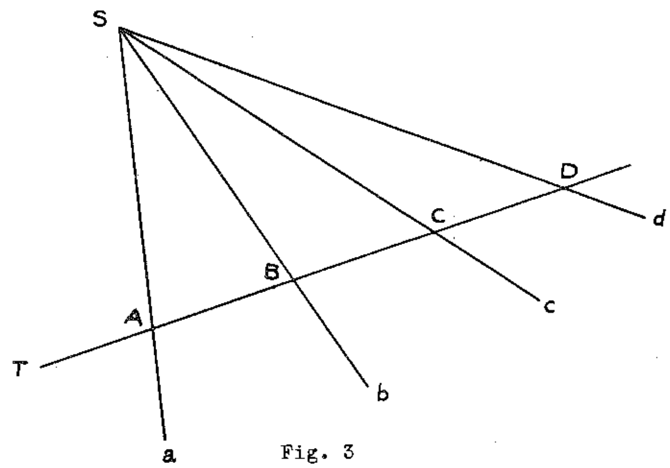


Fig. 3

Thus, the cross ratio as defined above is the same for both transversals $T_1$ and $T_2$ in the pencil of rays, shown in Fig. 4. Also, in the pair of pencils constructed on a common transversal, T, the cross ratio on T is equal to the cross ratio on $T_1$ and on $T_2$. It is important to notice that the segments on the two transversals need not be congruent nor even similar for their cross ratios to be the same.

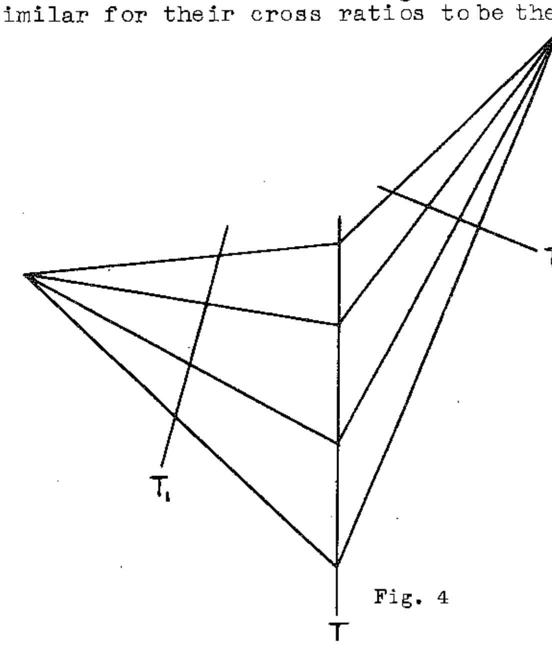


Fig. 4

The proof of this principle is easily accomplished by elementary methods of geometry

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The Engineering Drawing Division was the first division of the ASEE. Throughout its existence, it has operated through a chairman, secretary, executive committee, and such other committees as have been thought desirable from time to time. There were no formal rules of procedure. About two years ago, a committee was created with Professor Justice Rising, Purdue University, chairman. This committee formulated the articles of procedure of the Division of Engineering Drawing, which are published below. These articles of procedure were approved officially at Rensselaer Polytechnic Institute in June, 1949.

## ARTICLES OF PROCEDURE OF THE DIVISION OF ENGINEERING DRAWING OF A S E E

Preamble. This document is intended as a guide for officers and members in conducting the affairs of the Division.

Article I. NAME. Division of Engineering Drawing of the American Society for Engineering Education.

Article II. PURPOSES. The purposes of the Division are identical with those stated in Article I, Section 3, of the Constitution of A S E E, with special emphasis on those objectives as they pertain to the field of Engineering Drawing, Descriptive Geometry and related subjects.

Article III. MEMBERSHIP. The membership of the Division shall consist of those members of the Society who wish to affiliate with the Division.

Article IV. EXECUTIVE COMMITTEE. The affairs of the Division shall be administered by an Executive Committee consisting of:

1. Chairman of the Division - elected for one year.
2. Secretary of the Division - elected for one year.
3. Immediate Past-Chairman of the Division - holds office until his sucessor's term expires.
4. Five members at large - elected one each year for a term of five years.
5. Editor of T-Square Page of Journal of Engineering Education - elected for one year.
6. Three members of the Publishing Board of the Journal of Engineering Drawing (Editor, Advertising Manager, and Circulation Manager and Treasurer) - elected one each year for a term of three years.
7. Representative on General Council of the Society - elected in even numbered years for a term of two years.

Article V. DUTIES OF OFFICERS. The duties of each officer of the Division shall be those usually associated with the office except as hereinafter provided.

1. Chairman (a) shall be Chairman of the Division and of the Executive Committee and ex-officio member of all other committees of the Division, and shall preside at all meetings of the Division and of the Executive Committee.

(b) He shall be responsible for the preparation and publication of the programs for all meetings of the Division and of the Executive Committee.

(c) He shall prepare the annual budget of the Division and submit it to the Vice-President of the Society responsible for Instructional Divisions, and shall receive and transmit to the Secretary of the Society, all claims for reimbursement.

(d) He shall prepare a written report of his term of office and furnish copies to the Secretary and to his successor.

(e) He shall transmit to his successor all correspondence, etc. which pertains to the affairs of the Division and which will assist his successor in carrying forward the affairs of the Division.

2. Secretary (a) shall be Secretary of the Division and of the Executive Committee.

(b) Keep up-to-date the membership list.

(c) He shall keep complete records of all meetings of the Division and of the Executive Committee, and following each meeting or group of meetings shall furnish copies of the minutes to all members of the Executive Committee and their proxies.

(d) He shall receive and preserve copies of all reports and papers presented at the meetings of the Division and of the Executive Committee.

(e) He shall receive and, upon approval of the Executive Committee, transmit to the Rosenwald Museum of Science and Industry and/or to the Engineering Library of the University of Illinois at Urbana, Illinois, such items as may properly be deposited there.

3. Executive Committee (a) The officers and the Executive Committee of the Division shall conduct the business of the Division and report to the Division at the Annual meeting.

(b) The Chairman may appoint proxies for members of the Executive Committee who are absent from any meeting and may invite any other members that he may desire.

(c) Members of the Executive Committee, their proxies and Acting Members must be members of the Society.

(d) The Executive Committee shall arrange for a mid-winter meeting and for the annual meet-

(Continued on page 11)

ing of the Division to be held concurrently with the annual meeting of the Society.

(e) The Executive Committee shall arrange for special summer schools to be sponsored by the Society or by the Society and other co-operating organizations.

(f) The Executive Committee shall administer such other activities as may be desirable for the promotion of the purposes of the Division, including the appointment of special committees.

4. Editor of T-Square Page of Journal of Engineering Education (a) shall be responsible for the preparation of the material for the T-Square Page and shall submit it to the Secretary of the Society for publication in the Journal of Engineering Education. As soon as elected he should consult the Secretary regarding dead-lines for T-Square Page copy. The retiring Editor should furnish his successor with material for the September and October issues of the T-Square Page.

(b) The purpose of the T-Square Page is to promote the interests of the Division with respect to the rest of the A S E E.

5. The Publishing Board of the Journal of Engineering Drawing (a) shall have power to act in all matters pertaining to the Journal of Engineering Drawing, including the fixing of advertising and subscription rates, size of Journal, financing, and etc.

(b) The Editor shall collect and prepare manuscript and arrange for the publication of the same.

(c) The Advertising Manager shall procure advertising for the Journal, deliver advertising copy to the Editor and pay advertising fees to the Circulation Manager and treasurer.

(d) The Circulation Manager and Treasurer shall solicit subscriptions and collect subscription fees; he shall keep the subscription list up-to-date and attend to the mailing of each issue of the Journal to the subscribers; he shall receive all advertising fees, pay all costs connected with the publication of the Journal and in general handle all financial affairs; he shall report at each annual meeting on the financial status of the Journal. At the end of his term of office, he shall transmit to his successor all financial and circulation records, together with all monies in the Journal account.

(e) If the Publishing Board desires, a member of the Division from each institution may be designated to solicit subscriptions, collect subscription fees, and transmit them to the Circulation Manager and Treasurer.

Article VI. ELECTIONS. 1. The Secretary and two members of the Division appointed by the Chairman of the Division at the annual meeting shall be a Committee on Nominations and election for the following year. The Secretary shall be chairman of the Committee.

2. Report of elections shall be made at the Division business luncheon during the annual meeting of the Society.

3. Newly elected officers shall take office ten (10) days after the close of the annual meeting of the Society.

4. On or about March 1, the Secretary shall mail to each member of the Division a ballot for nominations. On April 1 the Secretary shall ask each nominee regarding his willingness to accept nomination and to serve if elected. The Nomination Committee shall canvass the nominating ballots and prepare a slate containing, for each office to be filled, the two names receiving the largest number of votes. On May 1, and returnable by May 20, the Secretary shall mail to each member of the Division an election ballot bearing the slate prepared by the Nominating Committee. The Nominating Committee will canvass the election ballots and report the results of the election at the business session.

5. If any of the elected officers other than the five members at large of the Executive Committee are unable to perform the duties of their offices, the duties of each shall be assumed by a member of the Executive Committee in order of length of service, until the next regular election. Vacancies among the five members at large of the Executive Committee shall be filled by appointment by the Chairman of the Division, such appointees to hold office until the next regular election.

6. Persons elected to unexpired terms of members at large of the Executive Committee, Publishing Board, or Member of Council shall hold office to the end of the term for which the original incumbent was elected.

Article VII. MEETINGS. 1. The annual meeting of the Division shall be held concurrently with the annual meeting of the Society and shall include the annual Division dinner, two conference sessions, and a business luncheon. The annual meeting shall be planned to include and interest teachers of junior and senior college levels.

2. Subsequent to the business luncheon at the annual conference of the Division, there shall be a meeting of the old and new Executive Committees under the newly elected Chairman.

3. Before the dead-line for submitting to the Secretary of the Society the Division's program for the annual meeting, there shall be a midwinter meeting of the Engineering Drawing Division at which time the Executive Committee shall prepare and transmit to the Secretary of the Society the program for the annual meeting.

4. Teachers of Drawing are urged to plan in connection with sectional meetings of ASEE, group meetings of drawing teachers, and are urged to make these meetings of interest to teachers of junior and senior college levels with a view of including such teachers as members of the Division.

5. Members of the Society and other interested persons are eligible to attend all meetings of the Division.

Article VIII. COMMITTEES. 1. The Chairman of the Division shall appoint such standing and/or special committees as are authorized by the Executive Committee or are necessary for the adequate functioning of the Division.

2. Committees are expected to prepare written reports so that they may be filed by the Secretary as part of the permanent record of the affairs of the Division.

Article IX. AMENDMENTS. These Articles of Procedure may be amended at the annual meeting of the Division by an affirmative vote of two-thirds of the members present.

# THE S. A. E. DRAFTING STANDARDS PROGRAM

by

Mr. J.H. Hunt, General Motors Corporation
Past-President, Society of Automotive Engineers

## Reason for Project

The Society of Automotive Engineers some two years ago undertook the development of automotive drafting standards. This is considered to be an important project. There are two important reasons for undertaking such a project. First, uniformity of practice within the industry could save some uncertainty and delay by eliminating possible misunderstandings between purchasers and vendors, and simplify the process of transmitting the detailed information from the engineers in the automobile plane to the workman in the parts factory. This desirability has, of course, existed for a considerable period. It has not been sufficiently pressing to force the present concerted attack on the problem. The obvious explanation of this is that the differences in practice which have continued to exist have in general been of the type causing only occasional minor annoyances, and not the source of acute distress. Two men can work side by side with very fair success even when each has his own ideas as to the selection of synonyms and of grammar provided both use the same language. Likewise, a mechanic who can read drawings can deal with minor variations in form in these drawings.

The second reason for attacking the problem, and the one more responsible for the present activity, comes from various demands for unified practice throughout the American manufacturing industry. Military operations today require the use of equipment which is very technical in its nature. A great deal of this equipment is required in such quantities that no single manufacturer could supply all requirements, also security reasons demand multiple sources of supply. The drawing must be understood by the workmen and inspectors in any plant. In many cases, a factory might have to make something for military purposes which would be quite different from its normal products. Repair work in the field must be carried on by hastily trained mechanics. Uniformity is obviously desirable.

During a military emergency, acceptance of some national drafting practice might be compulsory. The use of such a drafting practice might be justified even it it departed considerably from the best universal practice. In case the standardized practice does not meet all needs after the emergency is past, the practices specified might be departed from in some features by one industry, in other features by another industry. Under such circumstances, the benefits to be obtained from general standardization would be lost.

## S.A.E. View of Problem

Just as soon as a universally used drafting practice becomes a matter for serious discussion, the question arises as how to do the job. The practices followed by various manufacturers must be assumed to be meeting the present requirements of each fairly well. It is equally certain that any extensive changes can involve considerable cost, both direct and indirect, and that there will usually be no immediate gains in operations to overbalance the costs in the cast of most manufacturers. The universal system should be planned in such a way that the overall cost and annoyance of any changes to use it will be kept to a minimum.

This most economical universal drafting practice can only be found after the requirements of each industry are determined. Only after each industry has a clear picture of its own requirements can the system best adapted for all industries be developed. The present S.A.E. program is an effort to establish the facts for the automotive industries. These industries include not only the manufacturers of the passenger cars, trucks and buses usually seen on the highways, but also the manufacturers producing industrial engines and the self-driven equipment using these engines, the makers of completed components, and the makers of the forgings and castings from which completed parts are fabricated.

The difficulty of arriving at agreement and the rather low pressure for such agreement under normal conditions are both illustrated by the experience of one large manufacturer which operates many divisions, under a system of decentralized control. This manufacturer had previously found no compelling reasons for establishing complete uniformity between all of its divisions. It started over two years ago to develop a uniform system for its own use. In spite of the advantage of the aid of a central staff, it has not yet completed its own internal standards, al-

(Continued on page 14)

though this experience indicates that a uniform system for all manufacturing industry will be found to be anything but a simple project.

S.A.E. Organization for Work

Recognizing the importance of being prepared to meet all of its own responsibilities in contributing to an ultimate standard the S.A.E. Drafting Standards Committee has carried on its work with great care. One hundred and eighteen persons organized in fifteen subcommittees are working under the supervision of a steering committee of seventeen, which includes the chairman of each of the subcommittees. With very few exceptions, the men on the steering committee are either chief draftsmen, or men to whom chief draftsmen report. They are thoroughly familiar with today's automobile drafting problems and practices. The total number of individuals involved in the project exceeds one hundred and eighteen since several of the sub-committees have found it necessary to organize subgroups including persons not active on the subcommittee. This is particularly true of the subcommittee on bodies.

Any subgroup responsible for the development of a particular section is composed of specialists well informed in the particular subject. A program for the development of the section is outlined. The industry is then canvassed for suggestions including details of practice. The returns of the canvass are tabulated on comparison charts. An effort is made to reconcile conflicts and secure agreement on the best practice at meetings. Additional canvassing follows after urging that the best practice for the whole industry be kept in mind. When general agreement has been obtained, the report is edited and submitted to the parent group. In many cases this parent group proposes revisions, some of which may be required to meet the requirements of other subgroups, and these revisions will require additional study and canvassing, and in many cases joint discussions between subgroup and parent committee. This work is tedious, but the nature of the problem compels this detailed attention.

The S.A.E. Drafting Standards Committee has followed the usual S.A.E. procedure in taking the following steps.

1 - Assemble men with the necessary information and experience on all committees.

2 - Collect and examine all of the pertinent facts.

3 - Develop a general understanding of all of the problems and issues by adequate discussion.

4 - Record the best judgment of the group in a recommendation in which every effort is made to approach unanimity.

A few of these subcommittees have preliminary drafts of their reports already under consideration by the editorial committee. It is hoped that this important and difficult project can be substantially completed during the coming year.

Advice of A.S.E.E. Desired

The automobile industry recognizes the important part that the American Society for Engineering Education will take in any program to produce a drafting manual usable throughout American manufacturing industries. It hopes that the A.S.E.E. Division on Engineering Drawing will be willing to give the S.A.E. Automotive Drafting Standards Committee the benefit of its counsel on the results of the latter committee's work. The members of the Division on Engineering Drawing have been giving careful attention to the requirements of many industries which employ engineering graduates and can give automotive men much needed and much appreciated advice on questions requiring careful consideration before the final decisions.

The Division of Engineering Drawing recognizes the importance of any project for standardizing drafting practice. Whereas standards in the mechanical area are subject to frequent change, satisfactory drafting standards can and should have a much higher degree of permanency. Any standard proposed with any authority will undoubtedly become the basis of engineering college instruction. It is important for the student, for the college, and for industry that the young graduate shall find no difficulty in dealing with the drawings of the organization employing him at some later date.

It is recognized that the problem is more difficult in the case of drafting standards than it would be for a mechanical standard. The latter might be justified in case only a considerable percentage of manufacturers would decide to use it. A drafting standard must meet the needs of enough manufacturers so that the percentage of uniformity throughout all industry is substantially increased by its introduction.

(Continued on page 15)

Scope of S.A.E. Drafting Standards

The S.A.E. Automotive Drafting Standards will cover general practice and procedure for preparation of engineering drawings. They will not constitute a textbook of instructions on the fundamentals of drafting, in which it is assumed that personnel actively engaged in such work will be sufficiently trained. These standards should be found to be useful supplements to the text books in use in engineering college instruction in drafting.

At present fourteen sections are under preparation, each to be the product of a subcommittee. The fifteenth or Editorial Subcommittee has the task of securing consistency between the different sections. The addition of other sections has been discussed, and may occur. The present sections are listed below - -

I. DRAWING SIZE AND FORMAT

As in industry at large, there was some difference of opinion and practice in the automotive industry with respect to that phase of drafting concerned with drawing size and format. Surveys disclosed preponderant usage of drawings in 9 x 12 size and multiples thereof; and trend over the years away from the 8-1/2 x 11 and its multiples which less than fifteen years before had been the practice of 50% of our industry.

This might be an opportune time to remark that competition in the automotive industry promotes general adoption of any practices that have proven economically advantageous. It is my understanding that lower possible cost was the deciding factor in the automotive trend toward uniformity of drawing size. It is therefore quite understandable that reconciliation of automotive practice in this highly significant detail was comparatively easy.

II. LINES, LETTERING, SECTIONING

III. PROJECTION

IV. DIMENSIONING

This phase of drafting practice can easily become very controversial. S.A.E. surveys disclosed a considerable variation of practice in the automotive industry, and often a lack of adequate reasons for the practice followed. It has been necessary to argue out the comparative merit of all of the suggested methods of dimensioning detail, with the understanding that many established practices will have to be abandoned, if a common practice is to be secured. The objective in this case, as in the others, has been to select the practices best suited for the automobile industry. In making this selection, our own understanding of the needs of other industries was also kept in mind. We hope that the final result will offer a cost saving to the industry.

V. ABBREVIATIONS, DEFINITIONS, NOTES and SYMBOLS

This appears to be another group of subjects likely to require continual study.

VI. THREADS

We have all heard of the excellent progress which has recently been made toward the unification of screw thread standards. The S.A.E. effort to develop drafting practices covering the rendering and specification of screw threads in conformity with Unified Screw Thread Standards is very timely.

Although standardization of screw threads has been well developed for years, the implementation of these standards has been largely left to the individual user. Uniform practices in rendering can be developed and leave the user free to select the desired standard.

VII. GEARS, SPLINES and SERRATIONS.

The design and production of these elements has a record of continuous improvement in the automobile industry. These changes in the future may possibly react upon the drafting standards.

VIII. FORGINGS. IX. CASTINGS.

These elements are frequently produced by specialists. They are usually given extensive processing by the purchaser, and the design of the actual forgings and castings is greatly influenced by the processing planned. These may prove to be subjects where the requirements of various industries will differ to some degree.

X. STAMPINGS.

There is a very great variety of stampings. In spite of this variety, there are

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characteristic of stampings which are general throughout all industries, and some general rules for drafting can be devised which will be generally applicable. Such rules seem necessary since specialists are producing stampings for use by other manufacturing companies.

XI. SURFACE FINISH

The selection and specification of surface for specific applications is not an exact science. Developments, however, during the past few years have vastly increased our knowledge of surface characteristics. Nomenclature has recently been standardized, as has also the ratings of roughness depths, widths, and lay. Standard symbols have been agreed upon. Progress along that line has made it possible to develop standard drafting practices for the specification of surface characteristics on drawings. In this phase of drafting standards, the SAE Committee is maintaining close liaison with parallel outside activities to the end that practices may be more easily reconciled at some later date with nationally recognized standards.

XII. SPRINGS.

XIII. BODIES.

Six sub-sections are scheduled. Some of these are quite specialized.

XIV. CHASSIS FRAMES.

We realize that consideration of the preferred drafting practice on such a range of subjects is formidable undertaking, but we hope that you will find it possible to give it adequate study after it becomes available, and that, in due course, we may have the benefit of your advice.

Introduction of S.A.E. Drafting Standards

The SAE Drafting Standards will be published and distributed without any commitment as to their finality. It is probable that they will be changed later on to assist in the unification of national and international drafting practices. They will, nevertheless, represent the collective opinion of the automotive industry as to the practice best suited to its own requirements, as influenced by the industry's estimate of requirements of industry at large in any future consolidation or unification of practice. They will not be representative in all details of current automotive practice, but we hope that they will tend to consolidate that practice. We can expect drafting standards, after these are published to be constantly in the hands of draftsmen and their supervisors, and therefore to influence decisions in the same way that standards in the S.A.E. Handbook tend to unify practice.

It should be noted that the Automotive Drafting Standards, when completed, will not be the only S.A.E. effort in this field. The S.A.E. has done standardizing work in aeronautical materials - and in the power plant area of aeronautical design. The S.A.E. Special Aircraft Project Subdivision has developed an S.A.E. Aeronautical Drafting Manual which has already appeared in a second revised edition, and revisions leading to a possible third edition are under consideration. As in the case of the Automotive Drafting Manual, the committee responsible for the Aeronautical Drafting Manual has been selected from representatives of the interested industry. Differences are inevitable between the aeronautical and automotive groups, and these differences will require adjustment if any manual for general use by all industry is finally to be a matter of agreement.

Use or non-use of any S.A.E. standard is a matter for voluntary decision of any possible user. The S.A.E. is not in a position to do more than make a recommendation. The manufacturers do not, and in fact could not enter into any joint agreements with respect to designs, processes or materials. Therefore the degree of industry acceptance of any eventual Automotive Drafting Standards will be determined by decisions taken separately by the different manufacturers. Prior to these decisions there will be a period of study during which adjustments would be possible to conform to any practices recommended in a manual for universal use.

Control of S.A.E. Standards

A brief review of the S.A.E. organization for standards activities seems in order. The S.A.E. Council is responsible for all S.A.E. activities. It has delegated supervision of all technical activities, which includes standards, to a Technical Board of 21 persons. Appointments to the Technical Board are for a three year period, and these appointments are staggered, so that a majority of the Board continue in service from one year to the next. Design, production and application of automotive equipment are represented on the Technical Board. Any standard which is the result of agreement by the mem-

(Continued on page 17)

bers of a carefully chosen committee, and which meets the approval of the Technical Board, can be expected to come as close to the best judgment of the entire membership as can be produced.

## Conclusion

We are very grateful for the opportunity to present a general outline of S.A.E. activity in automotive drafting standards, which we hope will be of interest to the Division of Engineering Drawing. The chairman of our committee is Mr. Wm. A. Siler, Chief Draftsman of the Delco-Remy Division at Anderson, Indiana; the Secretary is Mr. R.C. Sackett, New Center Building, Detroit 2, Michigan. The S.A.E. will be glad to supply additional information.

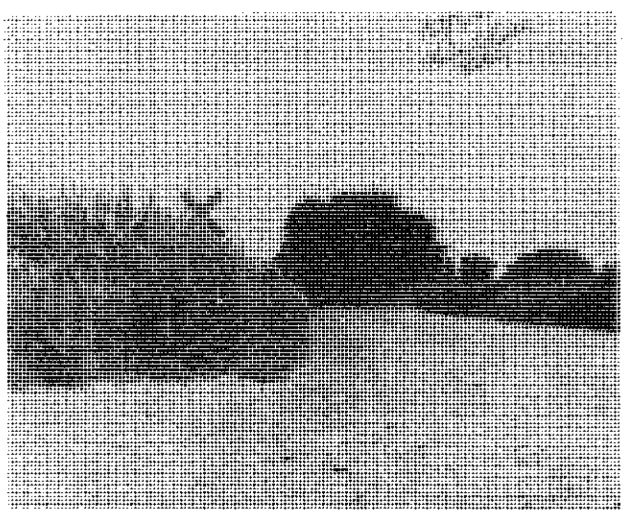
In conclusion I wish once more to emphasize our belief that any drafting standard for universal use throughout industry can be successfully developed only by a group which has the complete picture of all industry requirements before it. Such comprehensive knowledge is only obtainable when each industry develops first the complete picture of its own needs, and then takes the trouble to explain its position fully to the others, at the same time maintaining a sympathetic attitude toward the others' problems. We believe this so thoroughly that we have been making a most serious effort to develop the best possible analysis of our own requirements. We hope that this will receive consideration in parallel with similar analyses from other industries. We believe that any attempt to reduce the amount of study which we consider to be necessary will introduce the risk that many industries will not later follow the proposed new standards in some features. The net result could leave considerable deviation. The percentage of acceptance might possibly be so low that the effort expended will be largely wasted. We believe it would be most unfortunate if any new general standards are issued which fail to receive very much greater acceptance than have similar efforts in the past.

# GRAPHICS AND A LAWSUIT

By

Prof. George J. Hood,
University of Kansas

The landscape presented herewith shows a quite ordinary scene of no particular interest. But this photograph was offered as evidence by a complainant who was injured when his automobile was hit by a train as he was driving over the crossing here shown. This man said that the weeds were so tall that the crossing sign was obscured.



An engineer for the railroad brought this photograph to the department of engineering drawing at the University of Kansas to ask if it might be possible to determine from the photograph the location of the camera when the exposure was made. This was a rather easy problem to solve, especially since there was a pole of a transmission line hidden directly behind and some distance beyond the crossing sign. As a check, there were available drawings and profiles of this area. After drawing half a dozen lines on a sheet of paper, it was decided that the camera lens must have been eighteen inches above the surface of the middle of the road.

The lawyers for the railroad were not convinced by this, and they sent a photographer to take a similar picture on the spot. His camera was seventeen and one-half inches above the road. Professor Russell of the drawing department agreed to act as expert for the railroad. The case was thrown out of court.

This brings to mind another case in which a photograph freed a young man from a charge of murder. This happened in Iowa about forty years ago. The accused presented a photograph showing himself with a group of young people standing in front of a small shed. The sun was shining brightly, and the shadow of a corner of the shed roof showed distinctly on the ground. It was possible from the location of the shadow to determine the day of the year and the time of day when the photograph was taken. The murder had been committed at the same time the picture was taken. And the young man was declared not guilty.

George J. Hood.

January 14, 1950

(Continued from page 7)

The fact that parallel lines of sight are a fundamental requirement in descriptive geometry. In fact, without this condition the whole system of descriptive geometry, as we know it, becomes nonexistent.

There finally remains then only one more principle, and I intentionally reserved it for the last; the directions of sight for any two adjacent views must be perpendicular. In the case of top and front views the directions of sight for these views naturally differ by 90° due to our interpretation of the words "top" and "front." But auxiliary views adjacent to the top view are assumed to have horizontal lines of sight in order to maintain this accepted 90° difference of viewpoint. And each consecutive pair of adjacent views is analogously assumed to be at 90°. But is this a necessary condition, or is it again only a convenient one?

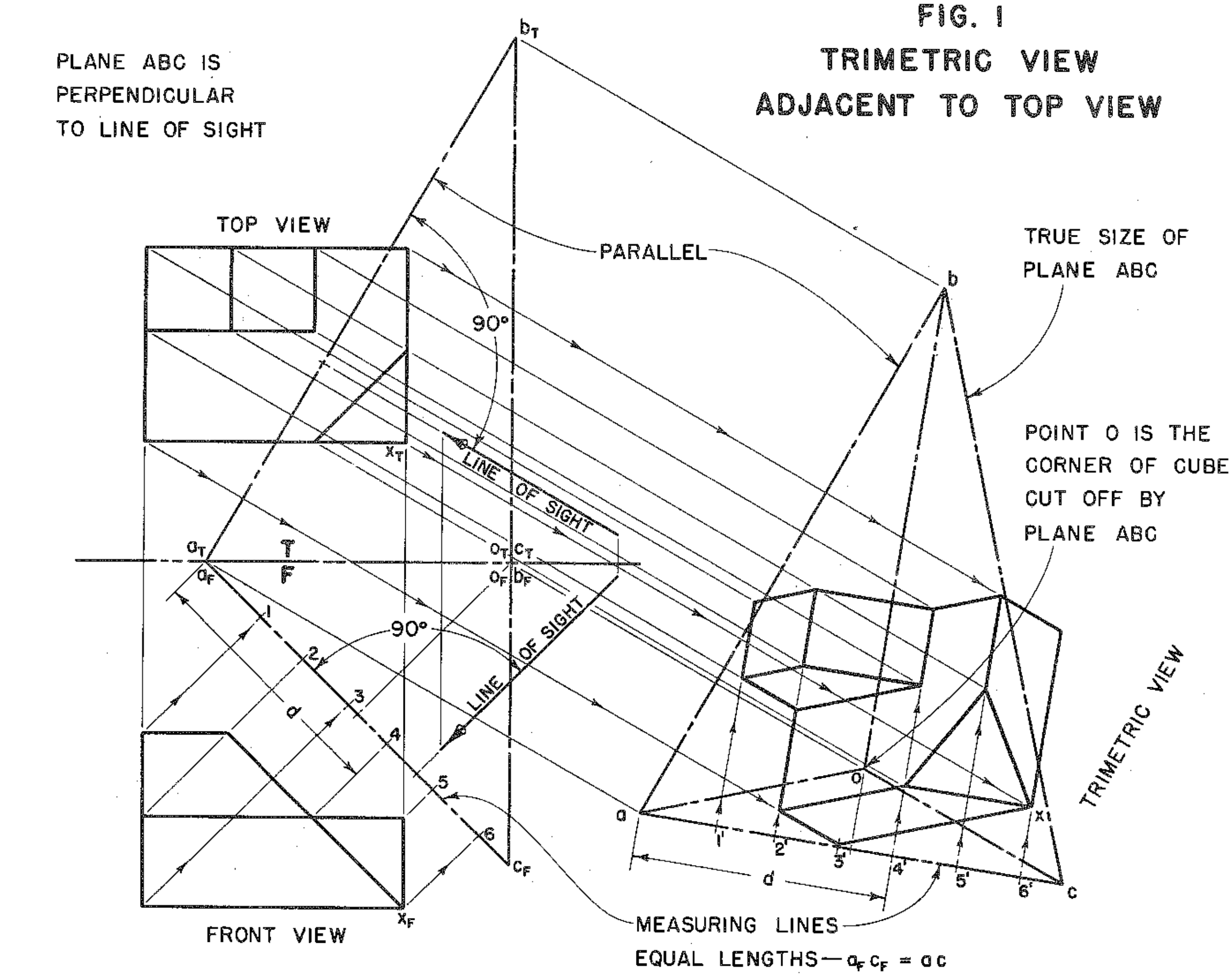
Fig. 1 shows that any auxiliary view can be constructed adjacent to any principal view, and that the directions of sight for such adjacent views need not differ by 90° but can be at any desired angle. Given in the figure are the conventional top and front views of a simple object. It is required to construct a new view looking in the oblique direction indicated by the arrow. By the conventional auxiliary view method this necessitates drawing two additional views because the arrow must first be shown as a true length before it can be shown as a point.

In Fig. 1 the desired view has been drawn directly, adjacent to the top view, as shown. The construction is simple and rapid. The triangular plane ABC is constructed in the top and front views in any convenient position perpendicular to the desired direction of sight. Note that side AB of the triangle is a horizontal line and side AC is a frontal line. A series of parallel lines are then drawn from each point in the top view parallel to the direction of sight. This establishes in the auxiliary view distances to the right or left of the observer. In similar manner parallels are drawn in the front view to intersect line $a_Fc_F$. This establishes distances obliquely above and below the line of sight. In the auxiliary view plane ABC will, of course, appear true size, and side AB will appear horizontal. Point C is located in the auxiliary view by setting off distance ac equal to $a_Fc_F$. The numbered intersection points are then transferred from line $a_Fc_F$ to their corresponding

(Continued on page 23)

FIG. 1

TRIMETRIC VIEW ADJACENT TO TOP VIEW



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and trigonometry. Briefly, the plan of attack in the proof is to compare the areas of the triangles ACS, CBS, ADS, DBS, written in terms of their bases AC, CB, AD, DB, and their common altitude h, with the same areas written in terms of the sides of the triangles and the included angles. It turns out, after algebraic manipulation, that the cross ratio of segments of the transversal is equal to the corresponding ratios of sines of angles at S, and is independent of the position of the transversal. It is easy to find the cross ratio of a pencil of rays, because it is only necessary to draw any transversal, measure the lengths AC, CB, AD, DB, put the measured lengths into the formula, (with due regard for algebraic sign) and compute the ratio of the two ratios. Any two non-parallel transversals will give the same result.

As an exercise in drafting precision for the beginner, this forms an excellent problem. It is vastly superior to the usual plate of repetitive geometric figures. It is an entertaining and highly intriguing property of what are apparently more or less random configurations--a property little suspected from the student's knowledge of elementary geometry and similar triangles. Given a transversal with a certain known cross ratio equal, say, to 2.00, he can construct one or more pencils of rays cut by the original transversal, and then cut new transversals through the pencils and compute their cross ratios in turn. This is a kind of laboratory demonstration and by the small variation from the ideal perfect answer of 2.00, the student can be made aware of the essential nature of drafting precision, the meaning of significant figures in graphical measurements, and he at the same time gets valuable training in the manual skills and techniques of drawing lines through points accurately and in finding intersections. He will learn to draw good straight lines much more quickly if he has the purpose of obtaining an accurate solution than if he is merely drawing straight lines to be drawing straight lines. Also he is able to judge for himself the degree of accuracy of his own work. Such a problem is of a very different character from the "copy a geometric figure" problems.

Although the cross ratio of any transversal can be expressed as a number, from the purely graphical standpoint this is unnecessary, since it can as easily and truly be represented by four points ticked off on the edge of a strip of paper laid along the transversal. Since all transversals of the pencil have the same cross ratio, this one strip is a graphical symbol for the cross ratios of all, and indeed it is a symbol for the cross ratio of the pencil of rays itself. With such a strip, it is an easy matter to construct other pencils of rays not congruent with the first, but with the same cross ratios as the first.

It follows that if three rays of a pencil are known, a fourth ray can be found so that the pencil will have any prescribed cross ratio as given on a strip of paper marked with four points, as in Fig. 5.

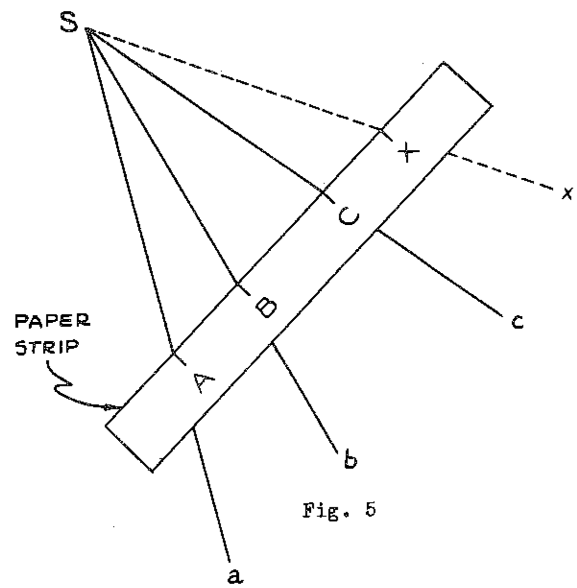


Fig. 5

The strip of paper marked with the points ABCX is moved around on the pencil of rays a, b, c, until point A lies on a ray a; point B lies on a ray b; and finally point C lies on ray c. Then the point X on the strip determines the line SX (shown dotted) so that the cross ratio of the pencil of rays S(abcx) has the given cross ratio, and all other transversals will have this cross ratio too.

It is not hard to point out at this stage that a camera lens behaves to rays of light in exactly the same way as the center S of pencils of lines. A line on the ground marked off into segments with a certain cross ratio will be imaged on the film as a line marked off with the same cross ratio, even though the plane of the film is not parallel to the plane of the ground (Fig. 6).

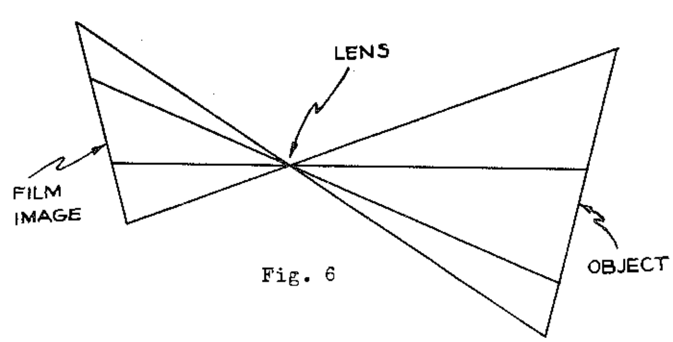


Fig. 6

(Continued on page 27)

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positions on line ac. Parallel lines drawn from these points perpendicular to line ac will intersect the parallels drawn from the top view to locate points on the object in the auxiliary view. This briefly is the procedure, and I shall not dwell upon the theory of the construction for what has been done here is by no means new. In general, the auxiliary view obtained in this manner would be a trimetric view, hence that is what I have called it. If point O - the corner of the imaginary cube cut off by plane ABC - is located in the trimetric view, then lines oa, ob, and oc will correspond to the mutually perpendicular edges of the cube.

Some of you will claim that this solution employs plane traces, that it is really revolution in disguise, that reference planes have been used without acknowledgment. All of which may be true, but my sole purpose here is to demonstrate that adjacent views need not necessarily have perpendicular directions of sight.

Fig. 2 shows how the construction of Fig. 1 can be.

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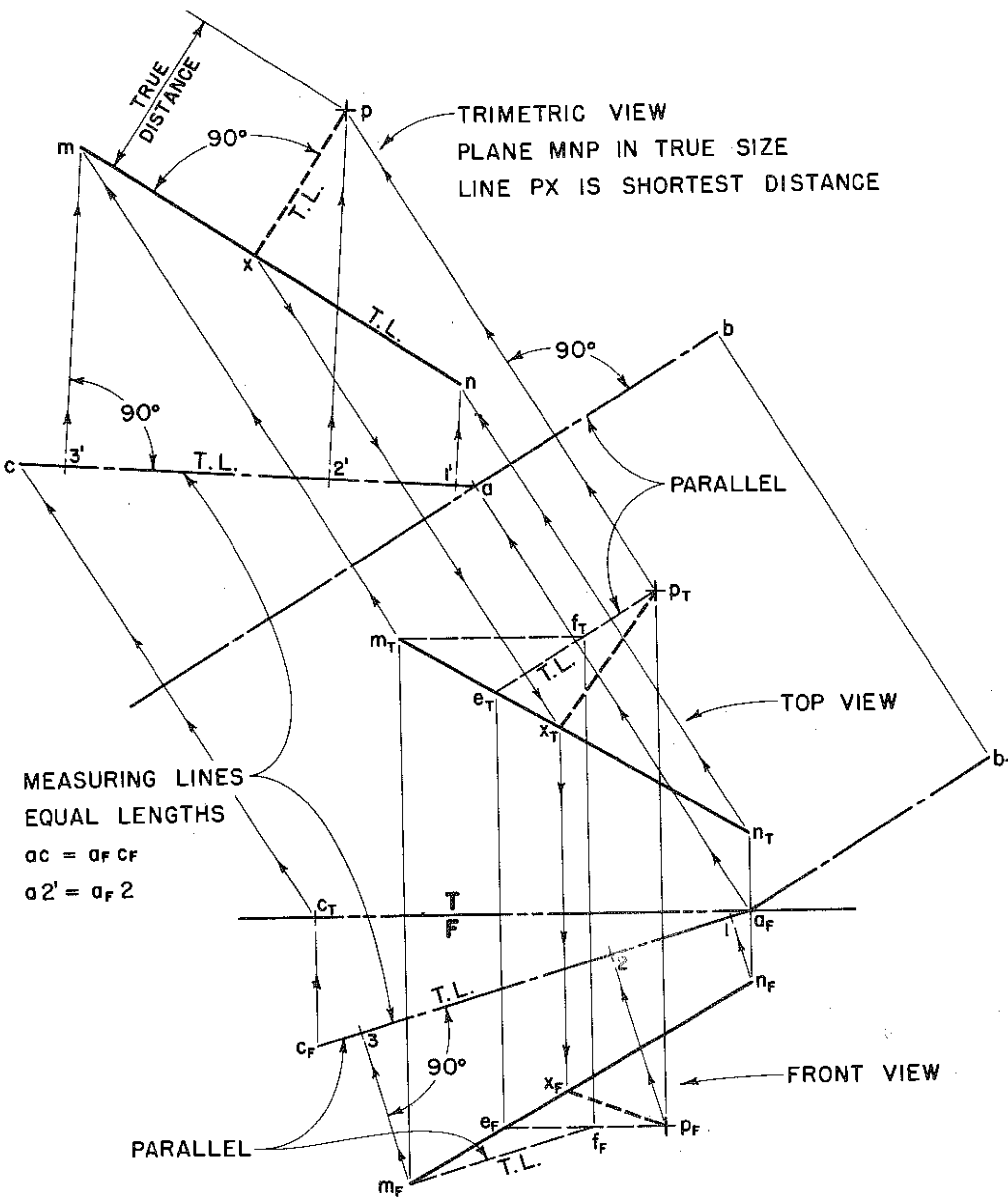
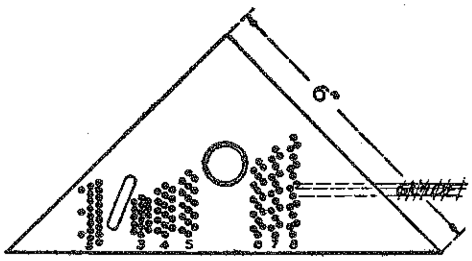
FIG. 2
SHORTEST DISTANCE
POINT P TO LINE MN
PLANE METHOD



# BRADDOCK LETTERING ANGLES

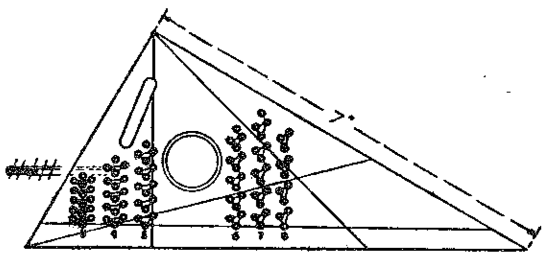
DESIGNED FOR STUDENTS, ENGINEERS,
DRAFTSMEN AND ARCHITECTS



6"-45° STYLE "B" BRADDOCK-ROWE LETTERING ANGLE

**The Braddock Lettering Angle has three uses:**

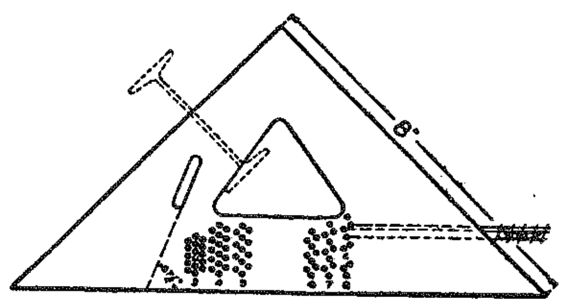
1. As an ordinary standard triangle, it is exceedingly accurate.
2. It is used to obtain uniformly and accurately spaced lines for lettering.
3. It is used to obtain parallel lines at uniform spacings.



6"60° STYLE "A" LETTERING ANGLE

The Lettering Angles are made in twenty-four different sizes and styles.

We are now also making a **very good standard triangle** carrying the same guarantee of accuracy and workmanship as our Braddock Lettering Angle.



8"-45° STYLE "C" LETTERING ANGLE

Write To Us For Descriptive Circulars.
Your wholesale dealer will supply you.

# BRADDOCK INSTRUMENT CO.

PITTSBURGH 18, PA.

(Continued from page 5)

ninety-one students were about evenly divided as regards positions of the hand and of the paper. Forty-one could be classified as "natural position" left-handers and fifty as "hook wrist" position. This classification was based upon the sketch which the student checked to indicate his approximate lettering stance. See Fig. 1. It is interesting to note that all nine of those, who indicated the right-hand system as easy, were natural position left-handers; however, in indicating the most desirable strokes for each letter, even those nine preferred to make horizontal strokes from right to left.

2. Do you find it easy or natural to letter using the right-handers' system providing the letters are made upside down with the paper inverted?

   Yes 25% No 75%

This question was asked in order to stimulate the student into trying a complete reversal of the right-hand system. The results indicate that a complete reversal is not desirable. The two questions above represent the two extremes and the most easily-executed alphabet for the left-hander should be a combination of the easiest strokes from each system. Of the twenty-five students who felt that the complete reversal was easy, seventeen were "hook wrist" and eight were "natural". This verifies other results of the questionnaire in that natural-position left-handers generally find more easy strokes in the right-hand system than do the "hook wrist" position students, and that a left-handed alphabet is of most benefit to the "hook wrist" left-handers.

3. On the portion of the questionnaire involving the sketches, (See Fig. 1) in which the student was given an opportunity to describe the position of the left hand while lettering, the results were as follows:

   Hook wrist 56% Naturals 44%

It may be rather enlightening to learn that the left-handers are about evenly divided as regards position, and the results of this question substantiate the argument for a left-handed alphabet based upon the responses of the left-handed students.

4. The questionnaire provided a sample alphabet, showing only the forms of the letters (Fig. 1), upon which the student indicated the number, order, and direction of the strokes that "felt right" to him.

The results were used to establish the system of strokes shown in Fig. 1. The alphabet represents the majority opinion of one hundred left-handed students for each stroke of each letter shown. The questionnaire was used continuously over a two-year period at Illinois Tech. Most of the vertical strokes are made in a downward direction, and this means that the "hook wrist" student would have to push the pencil rather than pull it. These strokes would be difficult to perform with a pen, a situation overlooked by the questionees since they were considering pencil lettering only. There is an advantage also in that the student can see where he wants the stroke to go, which is very important if we visualize good letter form as we letter. The greatest change from the right-handed system is in regard to horizontal strokes which are most easily executed from right to left. The circular letters are made with strokes very similar to the right-hand alphabet but the point of beginning and ending each stroke is different for the left-hander, as shown in Fig. 1. Certain letters, such as the C and especially the S, are very easily made with a single stroke. The K, V, W, X, and Y are most easily made just as the right-hander would make them. This recommended alphabet is satisfactory for either vertical or inclined lettering.

Page one of the student's first quiz, which contained random test letters was taken a week or so after the questionnaire had been filled in, was filed with the questionnaire so that the correlation between the two could be observed. When the strokes of the test letters for each student were compared with the strokes indicated on the questionnaire, an overall correlation of 85% was obtained. This was much higher than was anticipated and tends to indicate that the students evidently were sincere, both at the time of the initial questioning and at quiz time, since they did not allow any knowledge of the right-hand alphabet to influence them on their quiz responses.

Thirty-five students were asked to fill out the same questionnaire in two consecutive semesters and the results were compared. Again, the correlation was very high which indicated a definite urge on the part of the left-hander to make each stroke in a definite direction.

Many interesting remarks and useful observations were contributed by the students questioned. For example, one student pointed out that pupils in the grades who were attempting to learn to write with the left hand in the natural position were sometimes converted to a hook wrist position by the pertinacious teacher who regulated the position of the paper on the desk. If the teacher insisted upon the paper occupying a position normal for right-handers, then the pupil had no choice but to hook the wrist.

(Continued on page 26)

In conclusion, may the alphabet, as proposed by left-handed students, be considered only as a guide and foundation that left-handers may get a faster, more mature technique in a shorter practice period --- recognizing, of course, that the recommended strokes will not suit everyone - just as they did not suit all of the questionees. All students will vary the system to suit their desires as they become more proficient.

The Technical Drawing Department is conducting a study of left-handedness in lettering, as regards the order and direction of strokes, with the idea of devising a system especially for left-handers.

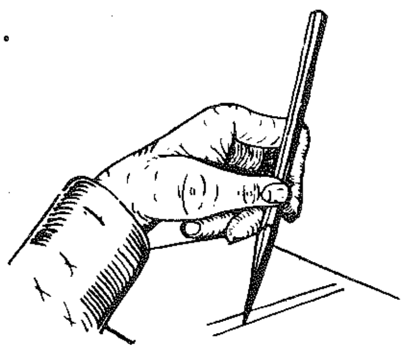
PLEASE COMPLETE THE FOLLOWING

Name:________________ Course and Sec:________________ Instructor:________________

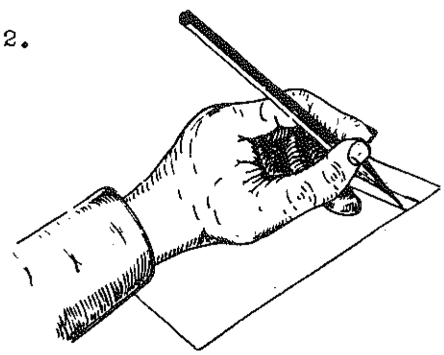
Date:____________ Do you find it easy or natural to letter using the right-hander's approved system? Yes_____ No_____ (check one) Do you find it easy or natural to letter using the right-hander's approved system, providing the letters are made upside down or the paper inverted? Yes_____ No_____ (check one)

Check the sketch which best describes the position of your left hand while lettering.

1.

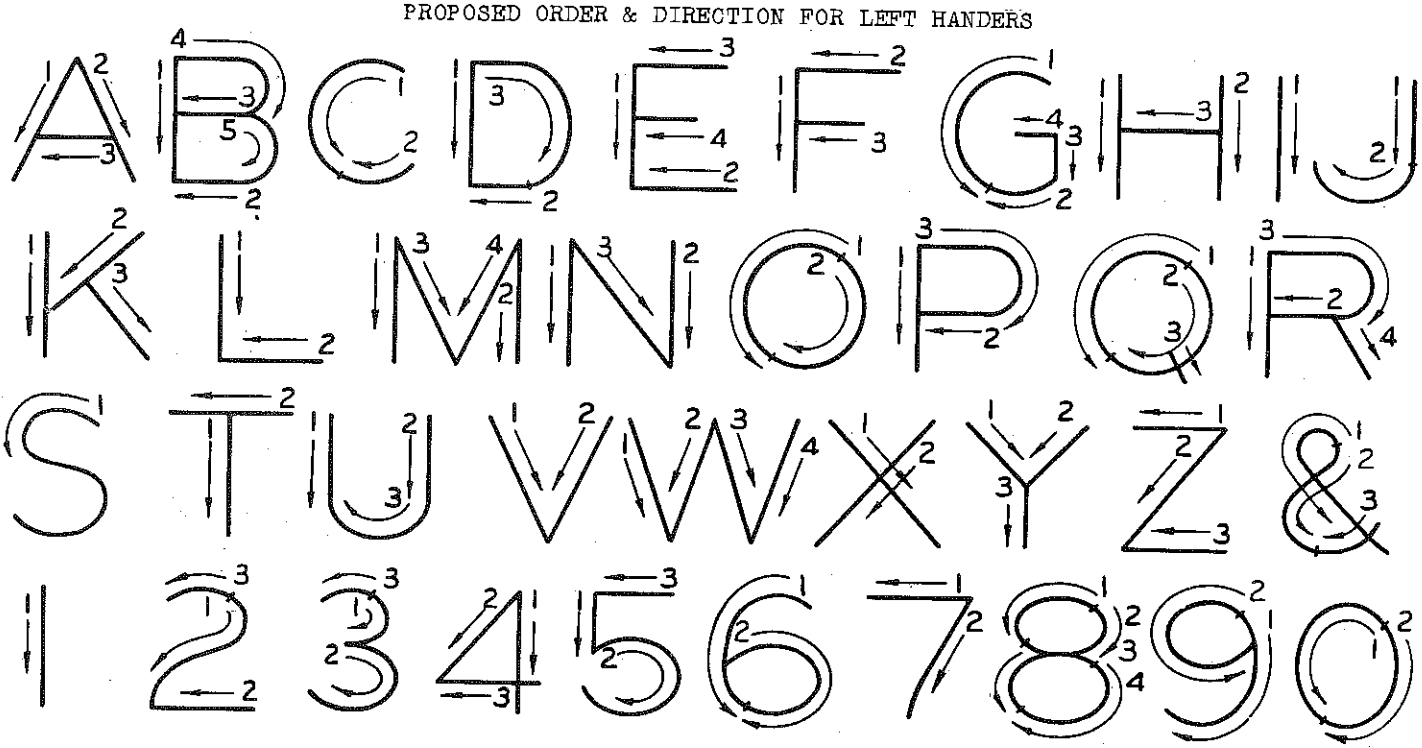


2.



3. or show by sketch.

PROPOSED ORDER & DIRECTION FOR LEFT HANDERS



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Here the film image and the object are two transversals of the same pencil of rays.

The connection between this and a method for transforming points on a photograph to points on a true shape diagram or map is a very easy connection to make; hence the problem of the baseball player.

If the object being photographed is a pencil of four rays, the film image will also be a pencil of four rays with the same cross ratio. Now five points are just sufficient to establish pencils of four lines. Thus the five points ABCDE establish among others, the pencils A-BCDE and B-CDEA.

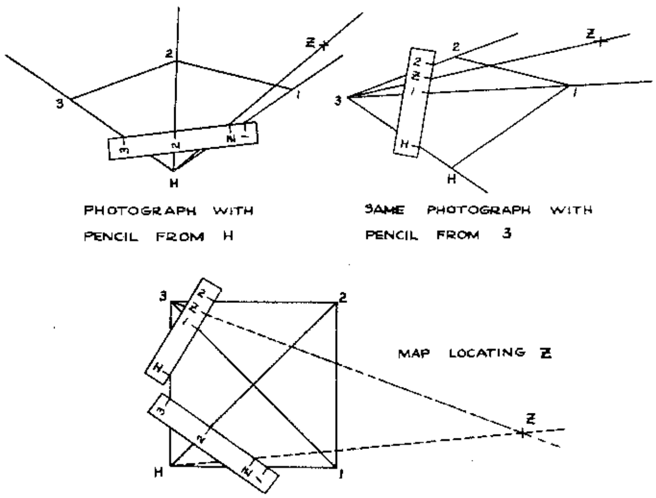



Fig. 7

To return to the baseball problem: Five points are shown in the photographic image, (Fig. 7) and four of these points are shown on the true shape baseball diamond. Point Z is missing from the map, although shown on the photograph. By using the marked strip of paper as a symbol for the cross ratio of the pencil H-32Z1, in the photograph, the fourth ray HZ may be located on the map. Subsequently, the ray 3Z may be located on the map. The point of intersection of HZ and 3Z on the map will be the missing fifth point Z. By similar tactics, point B may be mapped and the distance BZ scaled. This solves the baseball problem. It illustrates (in elementary form) the basic principle of photographic surveying, or photogrammetry.

Cross ratio may also be mentioned to round out the treatment of perspective drawing, since it is a fundamental principle of central projection. All that has been said about mapping points from a photograph may be said in reverse in the problem of constructing a perspective picture from an orthographic view of a plane of an object.

As a further example of the ramifications of the cross ratio idea, consider the application in the construction of hyperbolas, ellipses, parabolas. It is easy to demonstrate that two congruent pencils of rays intersect, ray for ray in a circle.

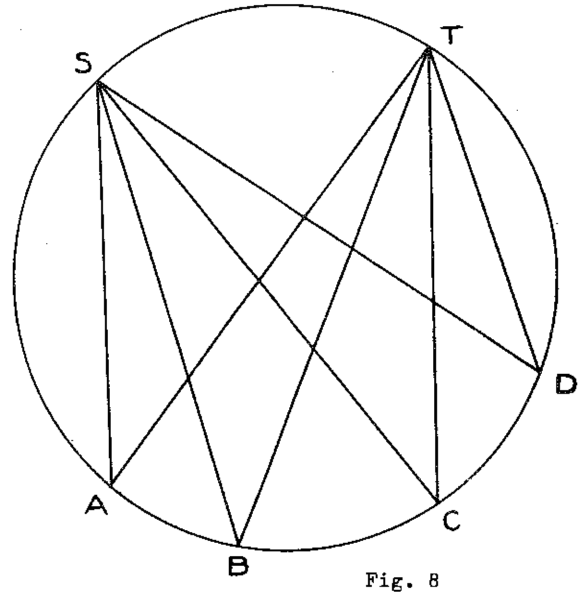



Fig. 8

In Fig. 8, the two pencils S(ABCD) and T(ABCD) are congruent since by elementary geometry angles which subtend the same arc on a circle are equal, and thus the angles about S are equal to the angles about T. Being congruent, these pencils certainly have the same cross ratio.

Now by central projection (for example, by taking a photograph of the circle) the circle may be transformed into ellipses or hyperbolas or parabolas. Then the pencils S and T will go along in the transformation to become pencils no longer congruent, but with their original cross ratios unchanged and therefore equal. Thus, two pencils of equal cross ratio will intersect, corresponding ray for corresponding ray, on a conic section. The student is now equipped to perform the construction of a conic passing through five points. Let the five points be SABCT, Fig. 9.

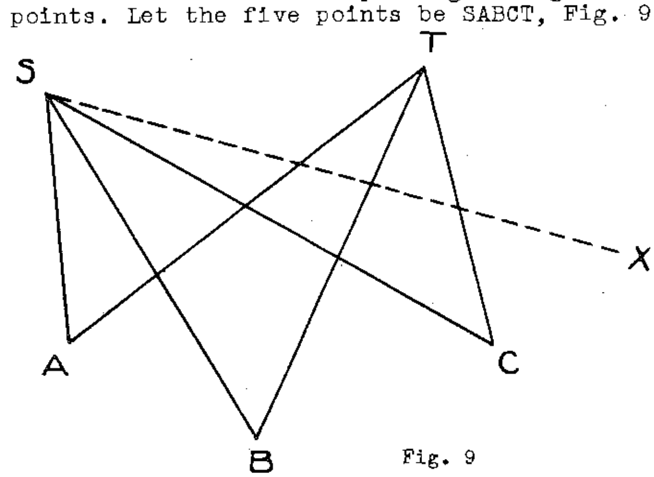



Fig. 9

(Continued on page 34)

(Continued from page 23)

applied to a typical problem to achieve a direct solution by drawing only one new view. The shortest distance from a point to a line in its true size (frequently called "plane method"). Conventionally this plane must first be shown as an edge and then as a true size, hence two new views are needed. But in Fig. 2 the direction of sight must be perpendicular to plane MNP, hence the true length lines PE and MF are drawn first to establish this direction. To draw a trimetric view adjacent to the top view parallels must be drawn perpendicular to line $p_Te_T$. In the front view line $a_Fc_F$ is the frontal side of a triangle ABC analogous to the triangle used in Fig. 1. Line ac is set off equal in length to line $a_Fc_F$, points 1, 2 and 3 are transferred to line ac, and the true size trimetric view is constructed as shown. Point X, located in this view, can be returned along the parallels to the given views. It is interesting to note that if this method is used to show line MN as a point as in Fig. 3, then the true distance PX can again be determined, but now point X can not be returned to the given views.

It thus becomes apparent that even the traditional rule of perpendicularity is not fundamentally essential since views which are not perpendicular can still be drawn adjacent by the method shown in Figs. 1, 2, and 3. Whether this method is better than the conventional method is purely a matter of convenience and individual preference. The total amount of construction in either case is very nearly the same. In general, the trimetric view method can be successfully employed in magnitude problems where angles and distances must be determined, but it may be indeterminate in problems that involve position (as in Fig. 3). In the latter case conventional methods must be used.

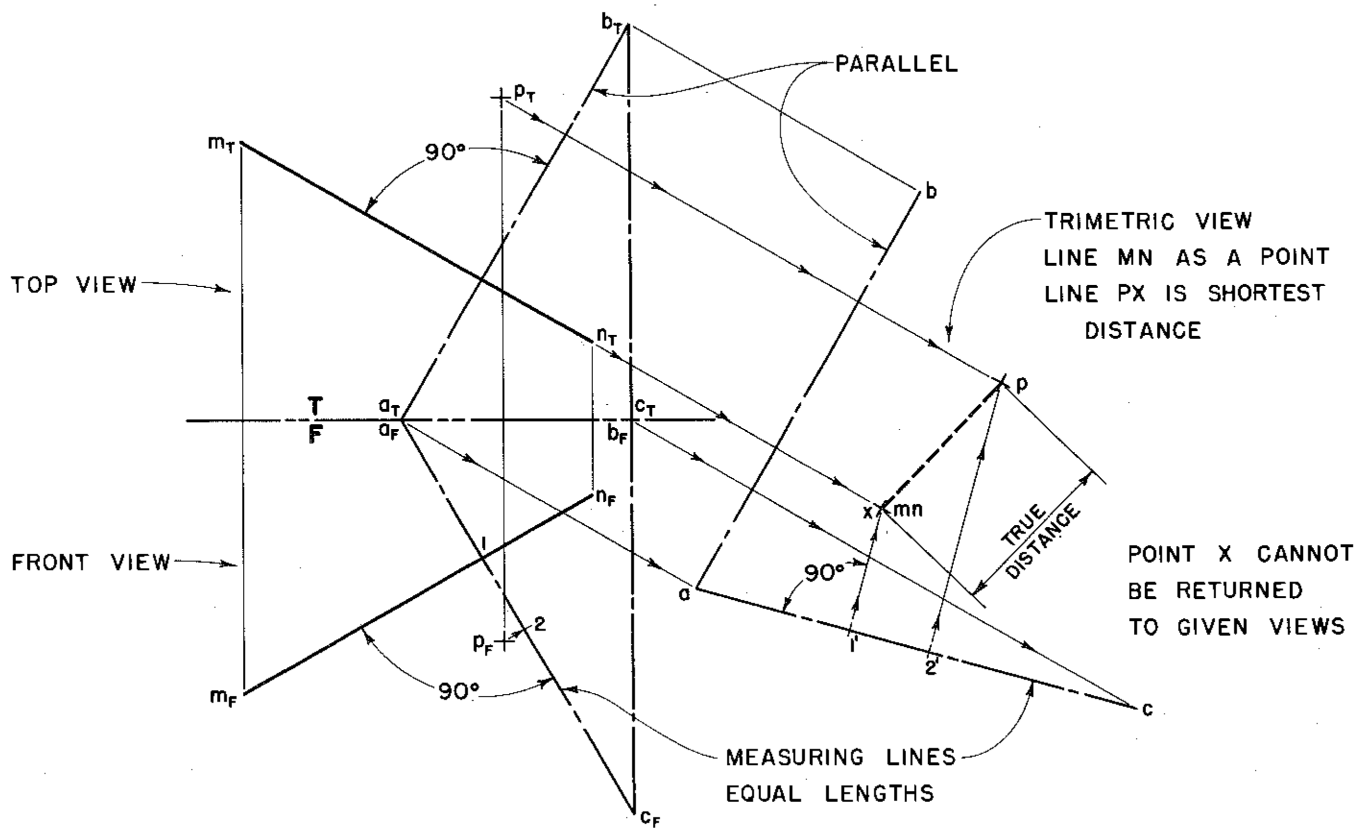
In summary, the purpose of this paper has been two-fold: first, to analyze as objectively as possible the basic concepts of descriptive geometry in order to determine their true status within the framework of the science. Secondly, to loosen a few of the bonds of tradition, stir the imagination, and promote the search for shorter and more powerful techniques in our graphic language. Eight hundred years ago a wise old Persian scientist said:

"Myself when young did eagerly frequent
Doctor and Saint, and heard great argument
About it and about: but evermore
Came out by the same door where in I went."

In the house of descriptive geometry there remain many undiscovered doors: we need not always come out by the same door where in we went.

FIG. 3

SHORTEST DISTANCE POINT P TO LINE MN
LINE METHOD



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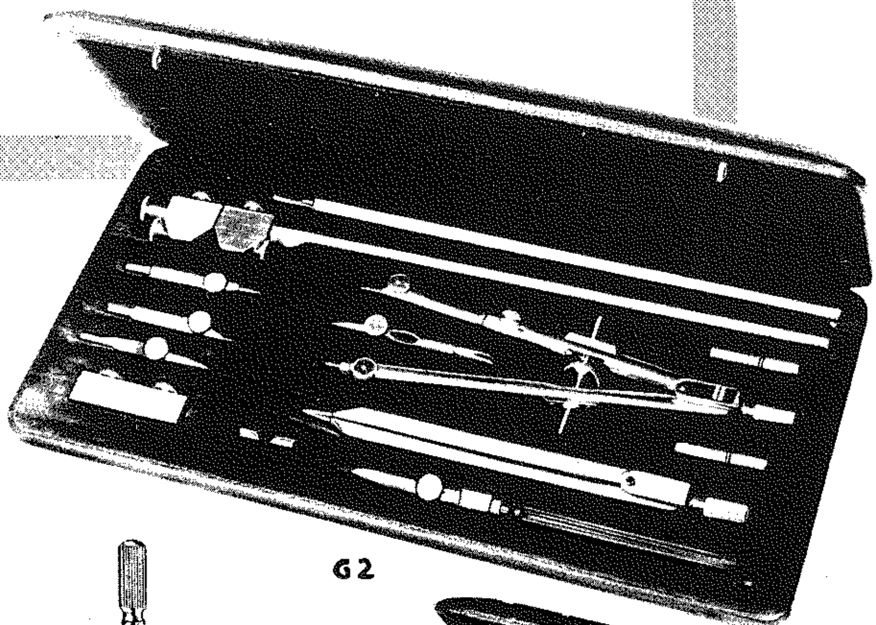

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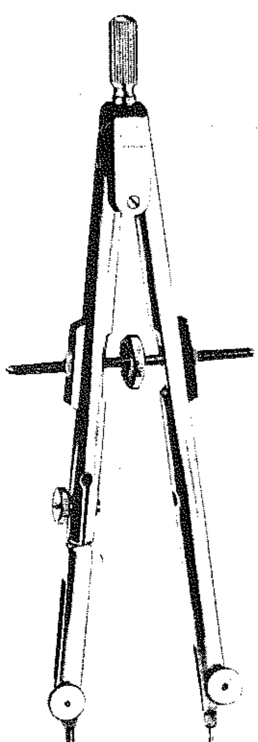

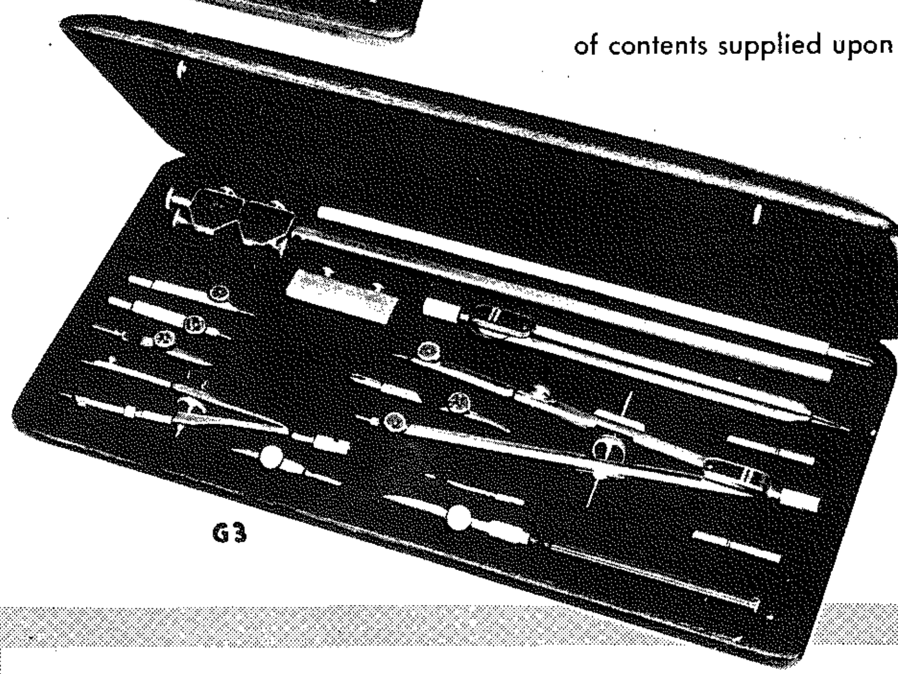

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(Continued from page 27)

Draw the three rays SA, SB, SC, and TA, TB, TC. For any fourth ray from S, say SX, the fourth corresponding ray from T may be found by the use of the paper strip so as to make the cross ratio of the pencil on T equal to the pencil on S. The intersection of ray SX and TX will then be a new point X which lies on the conic. Repeated choice of the variable ray SX will lead to a series of such points on the conic. The student has by this time had a fairly painless introduction into the realm of Projective Geometry. The construction of conics outlined above is certainly not as neat and elegant as that of the Pascal Theorem, and if desirable the rudimentary ideas may now be expanded in this direction.

Constructions of conic sections based upon these principles of Projective Geometry are now used extensively in the design of aircraft fuselages.

Of course, the development of these ideas is in no sense very rigorous in the eyes of a mathematician, but instead makes an appeal to the graphical intuition of the student. It is a laboratory demonstration rather than a theoretical proof and belongs in the graphical laboratory where emphasis is on drafting technique, manual skill and accuracy. The student without being unpleasantly aware of it has had a chance to learn to draw accurately under the stimulus of self-criticism and in the problems in connection with conics has a change to practice drawing curves. But at the same time his imagination has been stimulated by the almost magical properties of the cross ratio principle applied to a rather large diversity of graphical problems, each having a direct connection with some practical engineering problem.

## NEWS ITEMS

The Illinois Institute of Technology was host on January 6, to the annual meeting of Chicago High school teachers, drafting section.

Professor Pare of the Illinois Tech department announced details of the forthcoming drafting contest, sponsored by the Illinois Institute of Technology. Professor H.C. Spen Spencer, Chairman of the Technical Drawing Department, addressed this same meeting, discussing some of the latest types of auditory visual aids.

Professor W.E. Street, Head of the Engineering Drawing Department of the Texas A. and M., is President of the Bryan Rotary Club for 1949-50. The Bryan club is composed of Bryan businessmen, Texas A. and M. College people, and College Station businessmen.

Also from Texas A. and M. College, we hear that they secured an appropriation to purchase equipment for a small model shop during the spring semester, 1949. Mr. Paul Mason, an instructor in the department, was employed full time during the summer of 1949 building testing aid models for the department.

The December, 1949 issue of the Experimental Station News, of the Ohio State University, was sponsored by the Department of Engineering Drawing for that institution. We think that Professor Paffenbarger and his staff at Ohio State should be congratulated for doing a very excellent job.

Two very interesting meetings of staffs of engineering drawing departments have come to the attention of the editor. They are: The Upper New York State Section, with Professor J.S. Rising, of Syracuse University as chairman; and the Drawing Division of the New England section, with Professor E. Leighton Wellman of Worchester Polytechnic Institute as Chairman. Several papers have come out of these conferences which we hope to publish in the Journal at a later date.