VOL. 8, NO. 2 MAY, 1944 SERIES NO. 23

JOURNAL OF ENGINEERING DRAWING

PUBLISHED BY
THE DIVISION OF ENGINEERING DRAWING AND
DESCRIPTIVE GEOMETRY
S P E E

PLANOGRAPHED BY JOHN S. SWIFT CO., INC. ST. LOUIS, CHICAGO, NEW YORK, CINCINNATI
(PRINTED IN U.S.A.)

JOURNAL OF ENGINEERING DRAWING

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

VOL. 8, NO. 2 | MAY, 1944 | SERIES NO. 23

CONTENTS

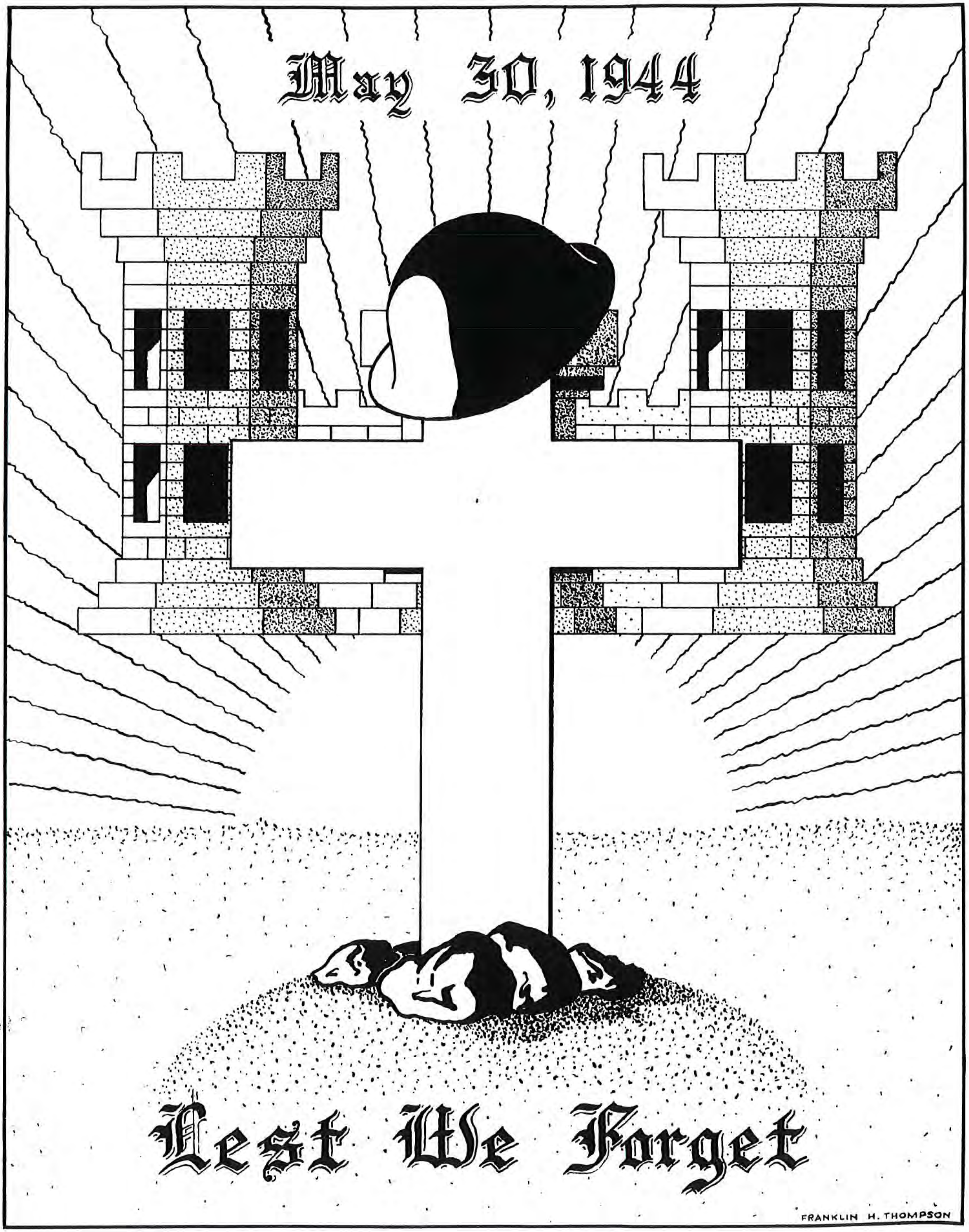
PUBLISHED IN FEBRUARY, MAY, AND NOVEMBER BY
THE DIVISION OF ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

PUBLICATION COMMITTEE

R. R. Worsencroft-Editor
University of Wisconsin
Madison, Wis.

J. N. Arnold-Advertising
Purdue University
Lafayette, Ind.

F. A. Smutz-Circulation & Treas.
Kansas State College
Manhattan, Kan.


May 30, 1944
Lest We Forget
FRANKLIN H. THOMPSON

The Editor's Page

The Division's Committee on the Formulation of National Tests in Engineering Drawing, Prof. C. V. Mann, Chairman, is expected to present a proposed general achievement test at the June meeting. This test will be the result of several meetings of the Committee during the past year, as well as a considerable correspondence among the members, culminating in a meeting in April at Purdue, at which a final draft was made.

It is apparent, from present activities in this field, that a general achievement test is on its way, whether formulated by the Division, or other agencies. The Hoelscher report of last year quite definitely indicated the necessity of such a test to settle questions of college credit, and the Army is now using, among its so-called GI exams, a test of this character to determine the achievement of its A.S.T. students in drawing. Some schools have their own individual test used for the same purpose. Once such a test is formulated, it will be used by many agencies outside the colleges to judge the competence of our students in engineering drawing, as well as our teaching.

Already other educational agencies outside the Division are engaged in this work, not only in connection with engineering drawing, but other subjects as well. But it would seem only logical that where a Division such as ours already exists, this test should come from it. Its membership includes a large proportion of the experienced and mature college drawing teachers, familiar with the content, aims, and objectives of a college drawing course, as well as with the methods of constructing adequate tests. Their approval of the test would be necessary if it were to be used either as a criterion for extending college credit, or of measuring the achievement of their own classes.

It behooves those who are interested in this matter, therefore, to attend the meeting at which this test is to be considered, in order that sentiment of the subject may be so crystallized that the Committee may be able to complete a satisfactory test shortly.

* * * * * * * *

This issue concludes the consideration of pictorial representation begun in November. In it, we have taken up perspective, and covered that subject, figuratively speaking, from soup to nuts.

The article "Orthographic Theory in Perspective Drawing" by the Editor himself (excuse it please, it won't happen again) makes no pretense of covering the whole field of perspective. It includes only the fundamental theory which might be expected to be taught in the usual course in engineering drawing or descriptive geometry. Primarily, it is an attempt to show how perspective construction can be explained by, and correlated with preceding work in orthographic theory already familiar to the student. It represents the presentation of perspective as used in the author's classes for the past few years.

*****

The article following, "Notes on Practical Perspective", by Prof. George F. Bush, presents, as its title indicates, the practical side of perspective. Once the fundamental theory is understood, there are numerous short cuts and special methods available to speed the construction of the perspective drawing, to provide a picture in the desired position, and to cover the frequent condition where vanishing points lie out of reach. Professor Bush's article admirably covers the information to take care of such requirements.

*****

The final article on perspective is by that fertile inventor, and originator of new ideas, Professor George J. Hood, and is abstracted from Areo Digest. - "Perspective Views by Photography". While hardly a method to be presented to our students of engineering drawing, it does represent a very original 'short cut' in making perspective drawings. With it, we conclude our presentation of perspective.

*****

Last, but not least, is Professor Sahag's article presenting another important application of orthographic theory, "Engineering Projection Applied to the Solution of Forces in Space." It has been your Editor's contention for a considerable time that not only should we teach orthographic theory in our engineering drawing, but the practical application of it to the direct solution of engineering problems as well, in short, graphical solutions. Here is one field of practical application.

ENGINEERING PROJECTION APPLIED TO THE SOLUTION OF FORCES IN SPACE

by
L. M. SAHAG
Professor of Machine Design and Drawing - Alabama Polytechnic Institute

In various occasions I have been able to express my opinion upon the usefulness of graphics and its importance as a direct and desirable method in solving problems in Mechanics. Exactly a year ago in an article in one of the issues of The Journal of Engineering Education, I gave a few interesting problems pertaining to coplanar forces. It would have been probably very interesting if the said discussions were extended to cover more complicated problems, such as cranes, derricks, and frictions in machines. But because of space and time this was not possible at that time.

The purpose of the present article is to illustrate further usefulness of the graphic solution as applied to vectorial quantities, and also to emphasize the fact that the engineering projection as a medium can also be used in solving the forces in space.

The design of modern machines and structures often involves problems of forces in space. The analytic solutions of such problems sometimes are so complicated and hard to visualize, that one may be in doubt as to the accuracy of his work. If, in such cases, the same problems are solved graphically, the value of this method will undoubtedly be appreciated.

Similar to coplanar forces, we have types of forces in space which are concurrent, parallel, couples, and non-parallel and non-intersecting. The solution of all these types will require the use of projecting planes.

Fig. 1 illustrates an ordinary crane, the mast of which is supported by two concurrent but non-coplanar cables. In (a) we have the pictorial view of the crane. In (b) we have the top, front, and also the auxiliary projections. The auxiliary projection is used to obtain the true lengths and positions of AD and AE legs. The stress in cable AB at joint A is in equilibrium with the stresses in AC and AF as concurrent and coplanar forces. But AF is the resultant of the actual stresses in legs AD and AE. It can be seen that by the use of auxiliary projection we can obtain the true lengths and relative positions of cable legs, in order to resolve af into ad and ae stresses as shown in (d).

Fig. 2 illustrates two parallel couples in space; it is desired to find their resultand. V_P and V_Q represent the values and directions of moment vectors of the given couples. In (b) Q is revolved through 90 degrees so that P and Q couples are in the same direction. Their moment vectors are still acting to the left. In (c), by the inverse axis method and using V_P and V_Q we find the location of the plane of V_S. In (d) P and Q couples are transferred into the plane of S. In (e) we find the resultant couple S with distance d.

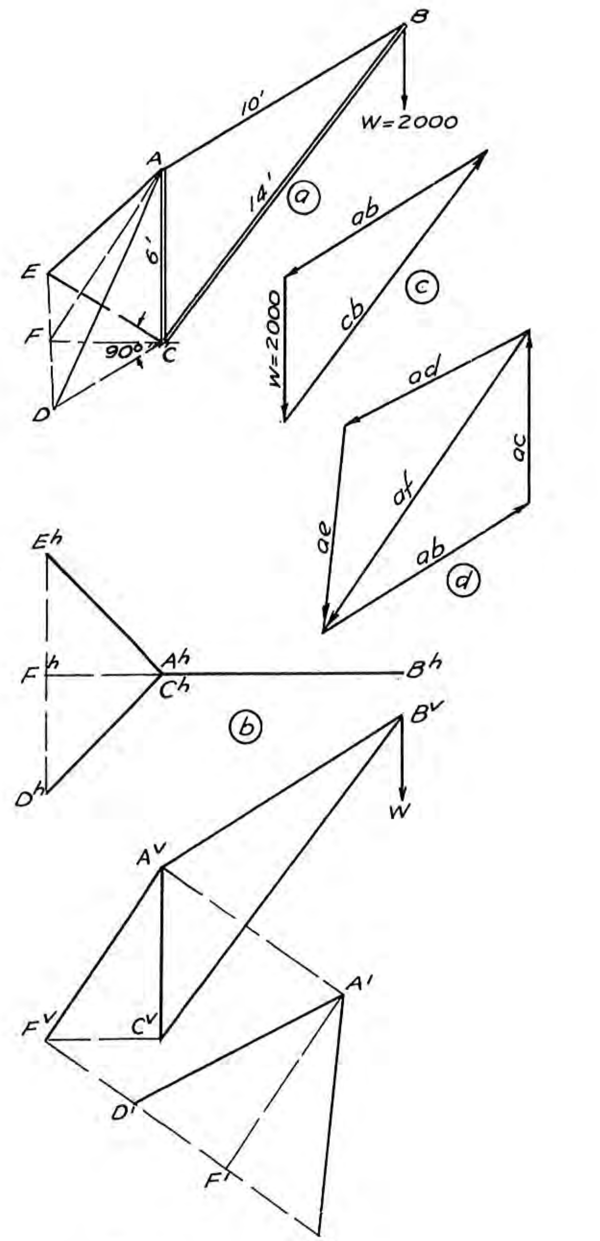


FIG. 1.

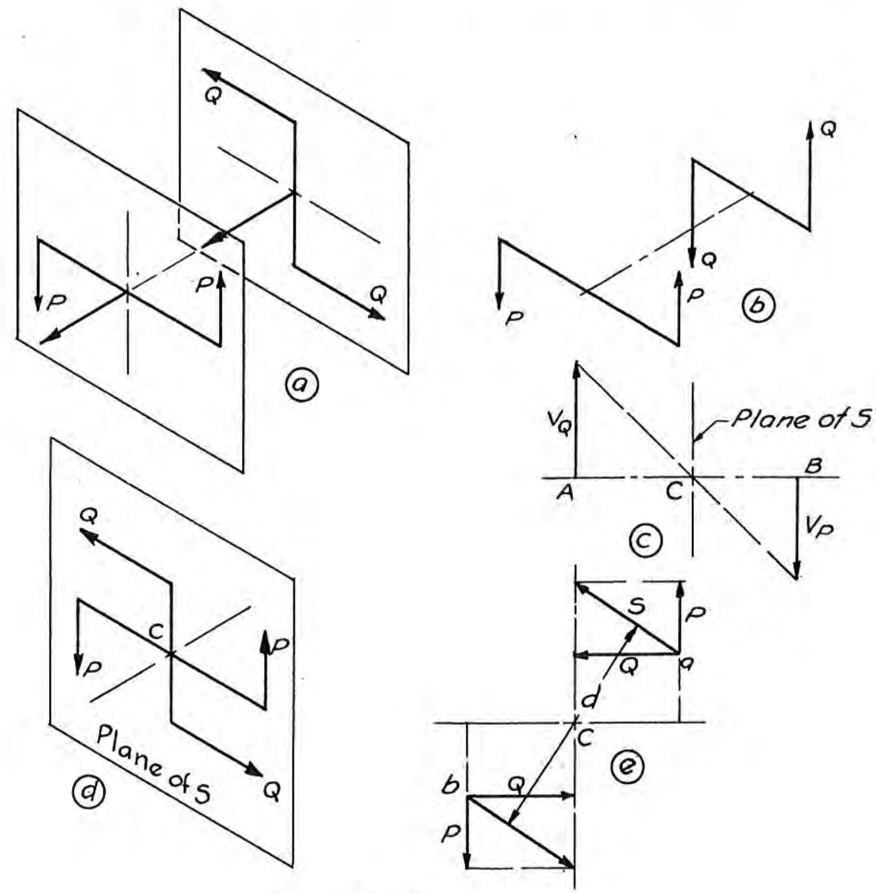


FIG. 2.

Fig. 3 (a) represents the pictorial view of two couples in X and Y intersecting planes; while their resultant is in Z plane. In (b) we not only have the end or profile projection of P, Q, and S couples, but also the moment vectors. QL is the moment vector of couple Q perpendicular to Q plane. PL is the moment vector of P couple perpendicular to P plane. SL is the moment vector of S couple perpendicular to S plane. (b) shows how easily these are added.

Fig. 4 shows a force of 3000 pounds on a plane held by four legs (reactions). This is an example of parallel forces. (a) is the horizontal (top), (b) is the vertical (front), and (c) and (d) are the left and right profile (side) projections respectively. In (b) we first find the sum of $R_A + R_B$, and $R_C + R_D$. In (c) we obtain the values of R_A and R_B; while in (d) we find the values of R_C and R_D. Inverse axis method is used in determining the above values.

Fig. 5 represents four non-parallel, non-intersecting forces in space. In (b), (c), and (d) we have the front, top, and side projections. The front projection is taken parallel to X and Y axes and it is Y plane; the top projection is parallel to X and Z axes and it is X plane; the side projection is parallel to Y and Z axes and it is Z plane. Each force is resolved into its components with reference to X, Y, and Z axes. F_1 has only Y component equal to the force itself. F_2 has Y and Z components. F_3 has X, Y, and Z components. F_4 has X and Z components. To obtain the actual values of the components of F_3, on the auxiliary projection F_3 is drawn to scale and by couterprojection its components are found.

Assuming that all components are concurrent at O, a table is made showing the components of each force. The sum of each column is the component of the resultant. These sums, i.e. F_x, F_y, and F_z are now laid off on the auxiliary and other planes. On the auxiliary plane the true length of S will give its magnitude and direction with reference to three axes. S is equal to 39 pounds acting up, to the right and away from Y plane.

TABLE FOR FORCE S

	F_x	F_y	F_z
F_1-50		+50.0	
F_2-20		-12.0	-16.0
F_3-30	+21.1	-12.7	+17.2
F_4-10	+ 7.75		- 6.4
S -39	+28.85	+25.3	- 5.2

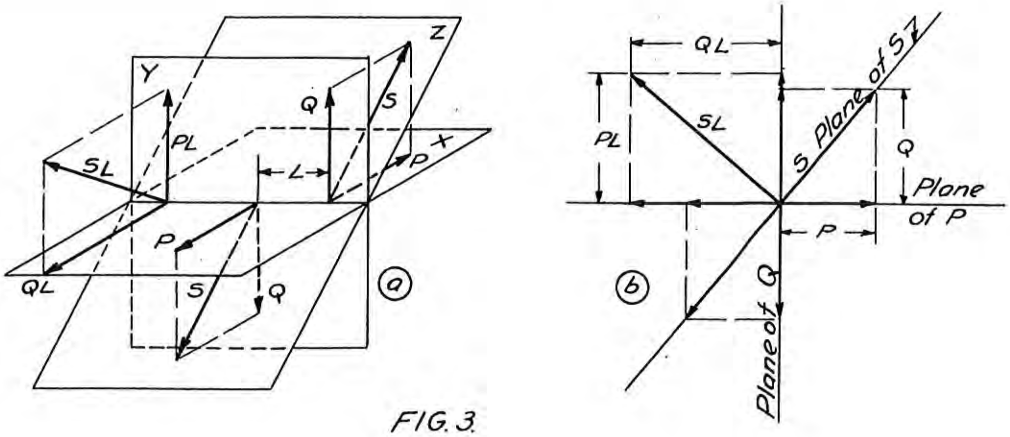


FIG. 3

TABLE FOR COUPLE C

	M_x	M_y	M_z
F_1	-400.0		
F_2		+160.0	-120.0
F_3	+103.2		-126.6
F_4	- 38.4	+ 62.0	- 46.5
C	-335.2	+222.0	-293.1

Since the transformation of the actual forces results a single force, S, and a couple at O, it will, therefore, be necessary to determine also the couple and its moment vector at O. A second table showing the moments of the forces and also that of C is used to obtain the orthographic projection of C given in (e).

Fig. 6 represents the graphical solution of non-parallel, non-intersecting forces in space. Shaft AB is supporting a gear of four feet in pitch diameter at C, and gear of two feet in pitch diameter at D. The load on gear at C is applied horizontally along Z axis and that being utilized at point D is vertical or along Y axis. We have shown three views, front view or Y plane, top view or X plane, and side view or Z plane. In the latter plane we have six forces, P, Q, A_x, B_x, A_y, and B_y. The resultant, S of A_x, B_x, A_y, and B_y is in equilibrium with P and Q. Extend P and Q lines to meet at point O. Connect the center of the shaft with point O. About this point lay off P to scale and draw an equilibrium triangle in which the vertical line will give the value of Q, and the inclined line the value of S. On Y plane Q force is in equilibrium with A_y and B_y, which by the inverse axis method will be, $A_y = 30$ and $B_y = 10$ pounds, both acting downwards. On X plane force P is in equilibrium with A_x and B_x, which will be, $A_x = 5$, and $B_x = 15$ pounds, both acting away from the observer as shown in Z plane. To show the actual magnitudes and directions of A and B reactions, on the side view or Z plane A_x and A_y, and B_x and B_y are combined to obtain the values of A and B respectively, which are acting down to the right. The accuracy in the values of A and B can be ascertained by combining the two reac-

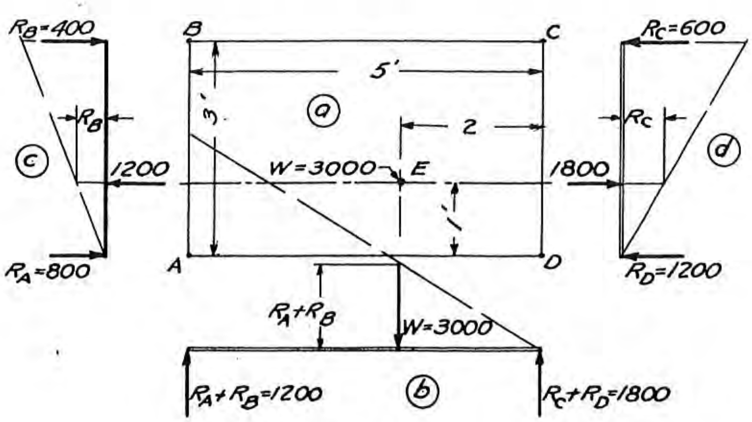


FIG. 4

tions about AB point on Z plane. The resultant will be AE (or BE). This is exactly equal to S or OF in equilibrium with P and Q.

These discussions can be extended to cover also problems in Kinematics and Kinetics.

good draftsman, - be able to design a machine, or interpret a drawing, and comment on its features, then we must see that the tie between college courses is not broken. One instructor in mechanics once stated that because he was not good in drawing, he felt that he could not

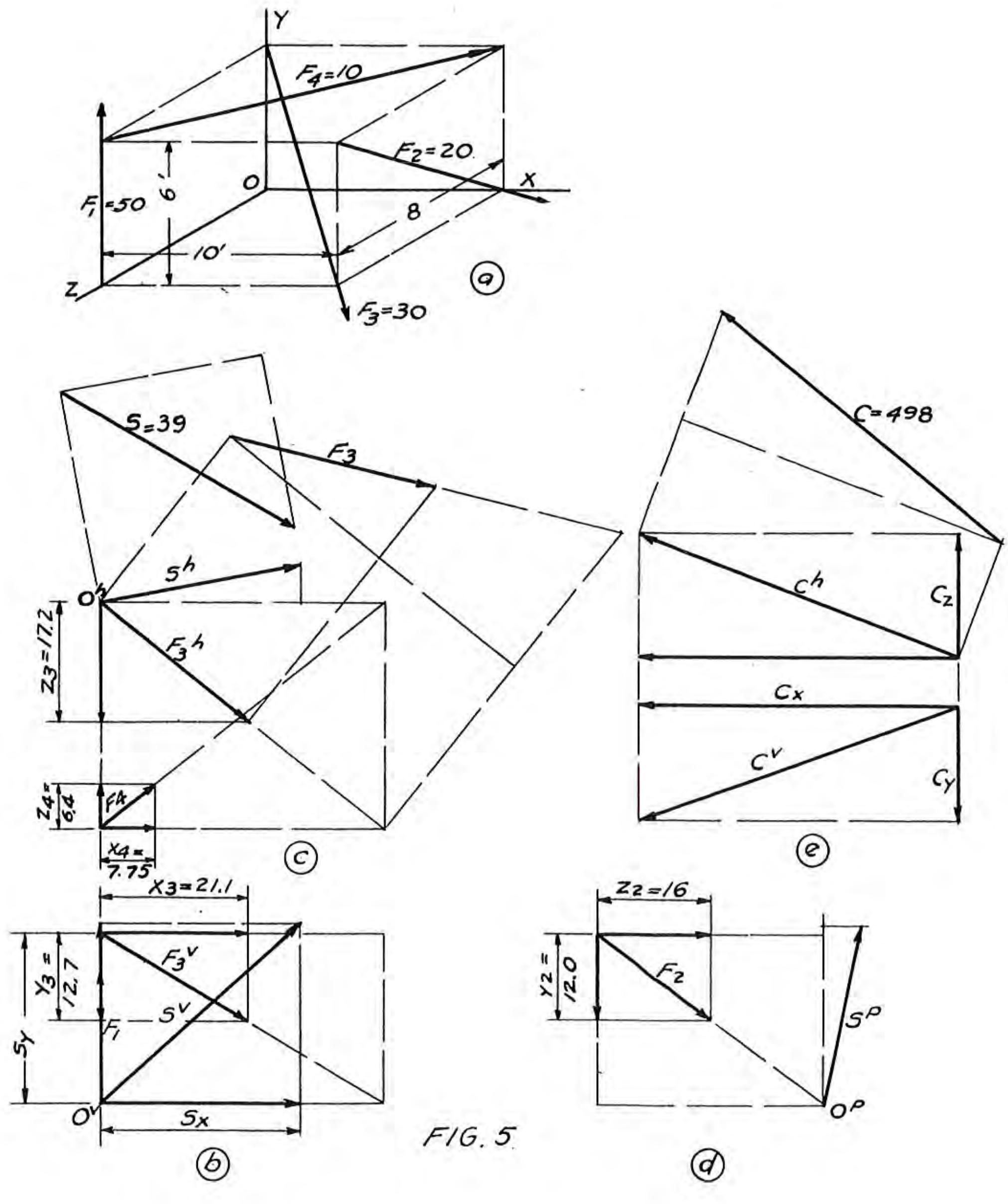


FIG. 5

It is felt, however, that the above examples will be sufficient to point out the usefulness of graphics, and also that of the course of engineering drawing in the engineering curricula. If we admit that the knowledge of one course must be utilized in another course, then we must investigate and discover just how this can be done. If a good engineer must also be a

do quick and accurate work by analytic method. Another stated, that the boys had enough drawing, and therefore, he does not intend to teach some more drawing in his classes.

While we are preparing for a successful victory in the near future, we are also making tentative plans for post-war period. If the

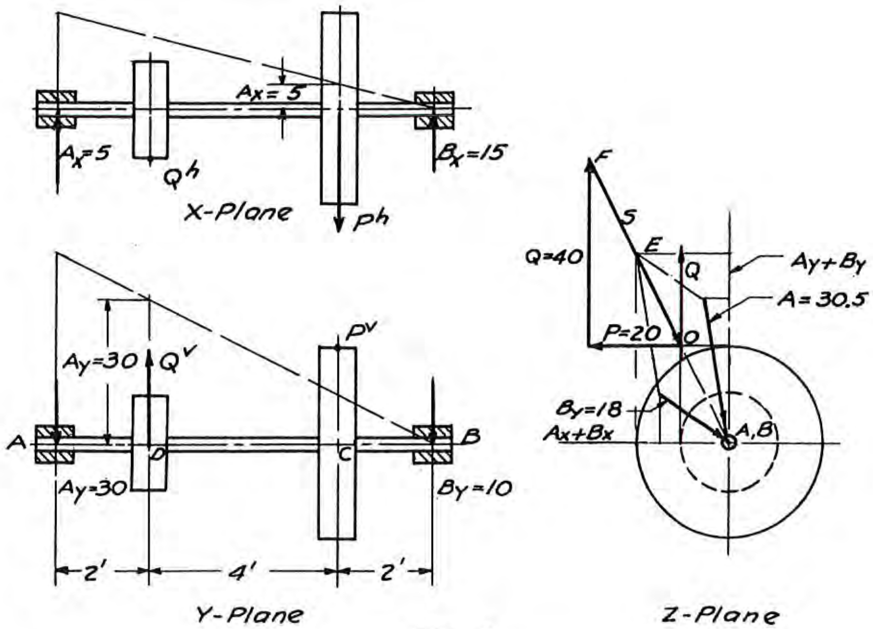


FIG. 6

industry has made us all to realize how important the engineering drawing or drafting is in the production of war materials, then we should continue to look at this fundamental course more seriously, and introduce some changes for better results, - by providing industrially experienced teachers, making better and complete drawings, etc. Finally, if the graphic solution of problems is accepted in industry as a good method of obtaining practical results, we must not omit the teaching of it in any course where vectorial quantities are studied.

MINUTES OF MEETINGS
of

COMMITTEE TO FORMULATE NATIONAL EFFICIENCY TESTS IN ENGINEERING DRAWING
at Purdue University, Lafayette, Ind.
April 21 and 22, 1944

Present: Clair V. Mann, Chairman
Missouri School of Mines, Rolla, Mo.
J. Rising, Purdue
M. R. Graney, Purdue
C. J. Vierck, Ohio State
J. L. Hill, University of Rochester
N. D. Thomas, Ohio University
J. H. Porsch, Purdue (Proxy for H. C. Hesse)
J. N. Arnold, Purdue (Proxy for W. E. Street)
Represented by correspondence: W. E. Street, H. H. Jordan, H. C. Spencer, W. E. Farnham.
Represented by phone calls: H. C. Spencer, H. M. McCully.

Meeting called to order at 1:30 P.M. April 21.

After preliminary discussion of the problem it was voted unanimously to cooperate with Dr. Kenneth W. Vaughan of the Carnegie Foundation in his drawing test work.

Is the task to be accomplished by the committee to prepare a comprehensive test in drawing or a series of unit tests on drawing?

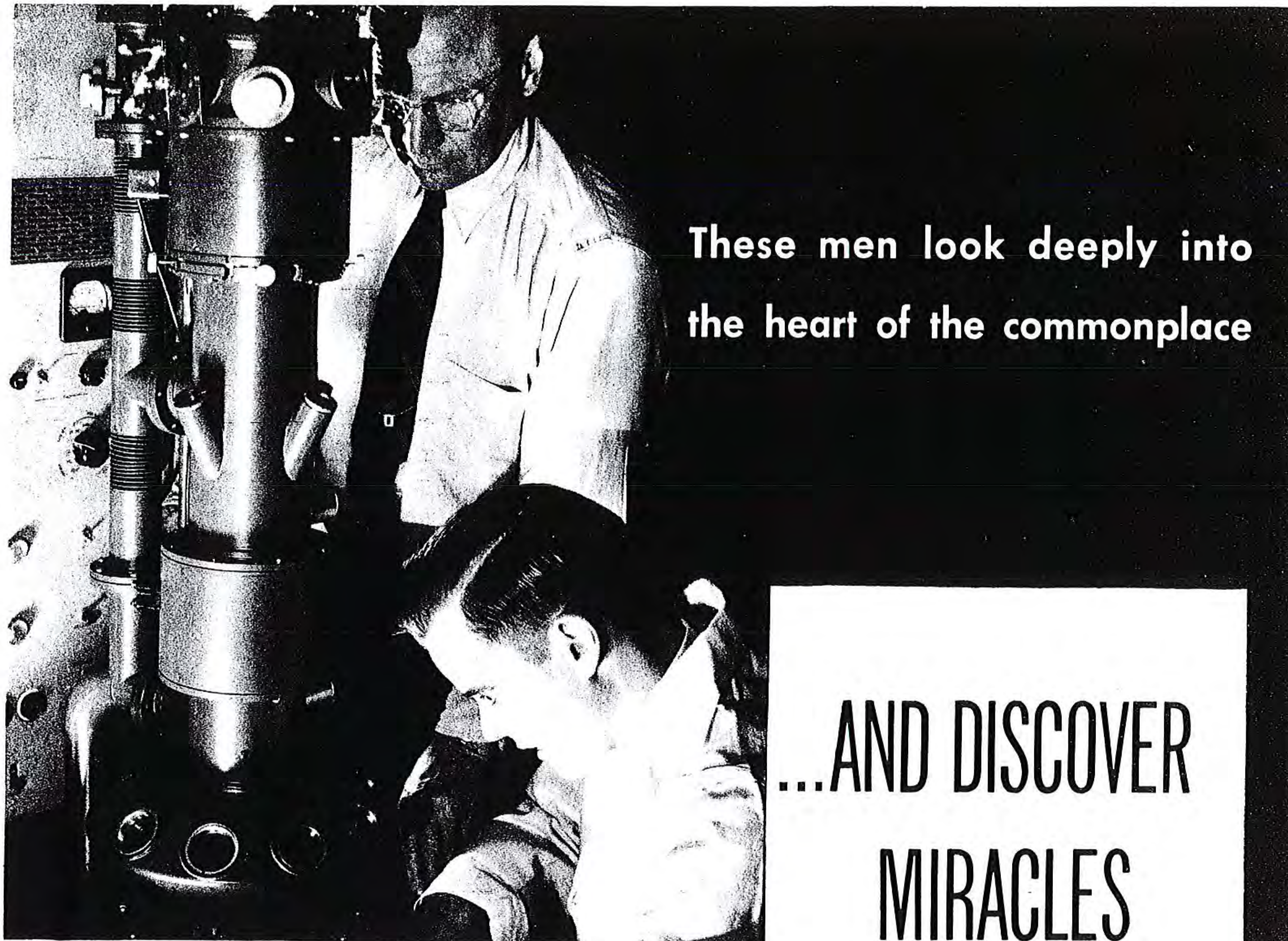
Voted unanimously to attack first the preparation of a battery of unit tests graded as to difficulty for the purpose of: (a) classifying incoming students, (b) determining level of entrance for transfers or army returns.

Another objective is: to prepare a battery of achievement tests for students who have completed a college course in general engineering drawing.

Suggested topics for unit tests
- Use of Inst.
- Applied Geom.
- Lettering
- Projection
- Perspective
- Oblique
- Orthographic

Auxiliary views
Sections

(Continued on page 10)



These men look deeply into the heart of the commonplace

...AND DISCOVER MIRACLES

Photo courtesy Radio Corporation of America

From materials known to man for thousands of years science is now achieving its modern miracles . . . all because it had the wit and the means to discover the true nature of what is called the commonplace.

● Vice-president Henry Wallace has called this the Century of the Common Man. Perhaps in view of the surprising and even marvelous drugs, chemicals and synthetics that science is producing from things as humble as coal, air and water this should also be called the Century of the Common Material. For men at last are learning to look deep into the heart of the commonplace and discover the miracles that are there.

As it is with materials, so it is with men. Just as all elements have their parentage in a universal substance, requiring only the proper handling to produce "miracles" so all human beings possess the fundamentals which can be turned into achievement and success.

The educator who has a sense of his true responsibility recognizes this and constantly seeks to set fire to the imagination of the lads in his charge . . . to foster the vision and inculcate the habit that translates ideas into immediate and directed action, so that they experience early the unique and never-to-be-forgotten thrill of achievement.

Probably one of the greatest opportunities to kindle the flame of desire first arises when a boy enters a mechanical drafting class. For here the world of his future manhood reaches out and touches his own world. Here he can begin that discipline which leads to the firmly fixed *habit* of achievement. Here, if the drawing instruments he uses are chosen with care, they can spur his imagination, kindle his enthusiasm, lift his horizons, break the trail which will lead to success. That is why competent drafting instructors urge the best set of drawing instruments each boy can afford. Such *better* instruments are an investment repaid many times in *any* more fruitful career.

Your Requirements vs. NATIONAL SECURITY

● The demand for Dietzgen Drawing Instruments today greatly exceeds the present available supply. First, the national wartime requirements are making a tremendous demand on our production capacity. Second, the critical materials used in making Dietzgen quality instruments impose a drastic limitation on production for other than the needs of our armed forces and essential war production. Your tolerant understanding of this situation is appreciated.

EUGENE DIETZGEN CO.

Chicago ● New York ● San Francisco ● New Orleans
Pittsburgh ● Los Angeles ● Philadelphia
Washington ● Milwaukee

Dealers in All Principal Cities

DIETZGEN

EVERYTHING FOR DRAFTING AND SURVEYING

Reprint—INDUSTRIAL ARTS & VOCATIONAL EDUCATION—Sept. 1943.

Printed in U.S.A.

ORTHOGRAPHIC THEORY IN PERSPECTIVE DRAWING

by
R. R. WORSENCROFT
Asst. Prof. of Drawing & Descriptive Geometry - University of Wisconsin

Pictorial representation as given in most engineering drawing courses has, in the past, been largely limited to isometric and oblique projections. With the growing importance of Production Illustration in the industrial field, and its probable continuance after the war, it may seem desirable to many drawing teachers to extend this work in pictorial drawing to include perspective projection as well. An examination of production illustrations show that many of them, particularly those used for development and design, are drawn in perspective. This fact would suggest that engineering students should perhaps be equipped with at least the fundamentals of perspective projection.

It cannot be too strongly emphasized, however, that perspective is not a subject that can be taught properly to engineers in an elementary course in engineering drawing. If the student is to properly understand the fundamentals of perspective, and not merely learn "rule of thumb" constructions; if he is to be given a basis upon which he can build a more specialized knowledge if he chooses, then instruction in the subject should come at a point where he has covered the principles involved, and can understand their application.

The amount of actual perspective projection involved in the making of the perspective drawing is very small and quite easily understood. But a much more thorough knowledge of orthographic projection is required to be able to carry on the construction of the view. The student should be able to visualize with facility from orthographic views. And equally important, he should be familiar with those specific problems of orthographic projection dealing with the setting up of lines and planes in space, and finding their piercing points and intersections; in short, the line and plane work of descriptive geometry. It is following this part of his work that perspective drawing may be best introduced into the course and so correlated with the preceding work in orthographic, that a thorough understanding of basic perspective construction, and a further emphasis of orthographic principles is obtained with only a small expenditure of time. It is the purpose of this article to suggest a treatment by which this may be accomplished.

Let us first take up the small amount of actual perspective projection involved. Consider, Fig. 1, the basic set-up for a simple two point mechanical perspective. This is nothing more than an orthographic top view, which includes a vertical picture plane PP, behind which is placed the top or plan view of the object, usually at an angle to PP, and a point of sight, e, in front of the picture plane. Lines representing the perspective projectors are also drawn (ae, be, ce, de, etc.) in this top view. Imagine the points at which these lines pierce the picture plane PP (a_1, b, c_1, d_1, etc.) connected by lines. Thus there is formed on this plane PP, altho not visible in the top view, the required perspective picture of the object. This is the perspective part of the drawing.

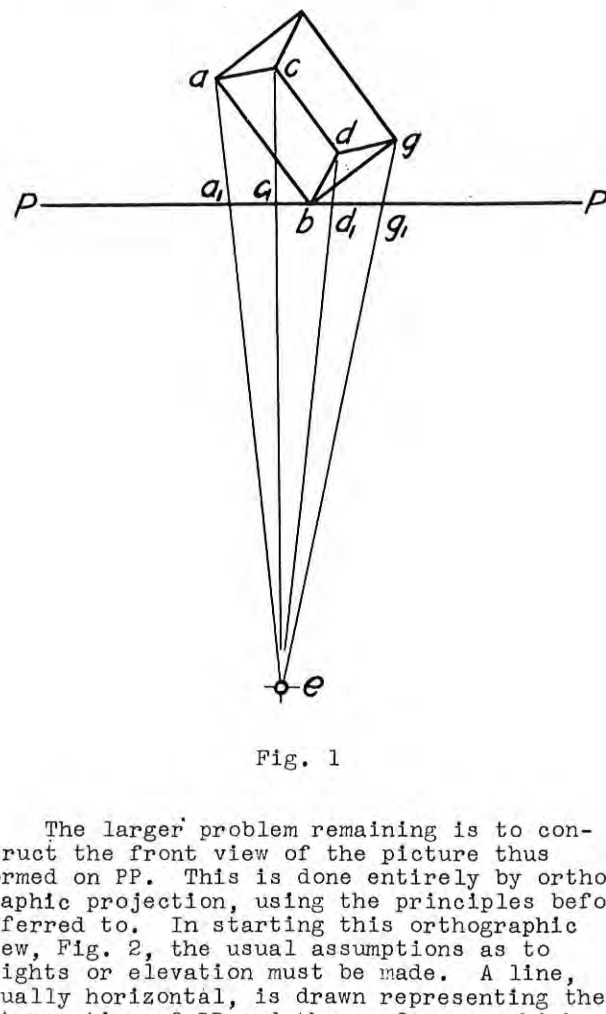


Fig. 1

The larger problem remaining is to construct the front view of the picture thus formed on PP. This is done entirely by orthographic projection, using the principles before referred to. In starting this orthographic view, Fig. 2, the usual assumptions as to heights or elevation must be made. A line, usually horizontal, is drawn representing the intersection of PP and the surface on which the object sits (in perspective terminology, the ground line, G'L'). The elevation of the point of sight e' is fixed, with relation to G'L', at a point which will give the picture that is desired. An orthographic elevation of the object is available to provide heights which do not appear in the top view. Finally the point b, which lies in PP and on the base

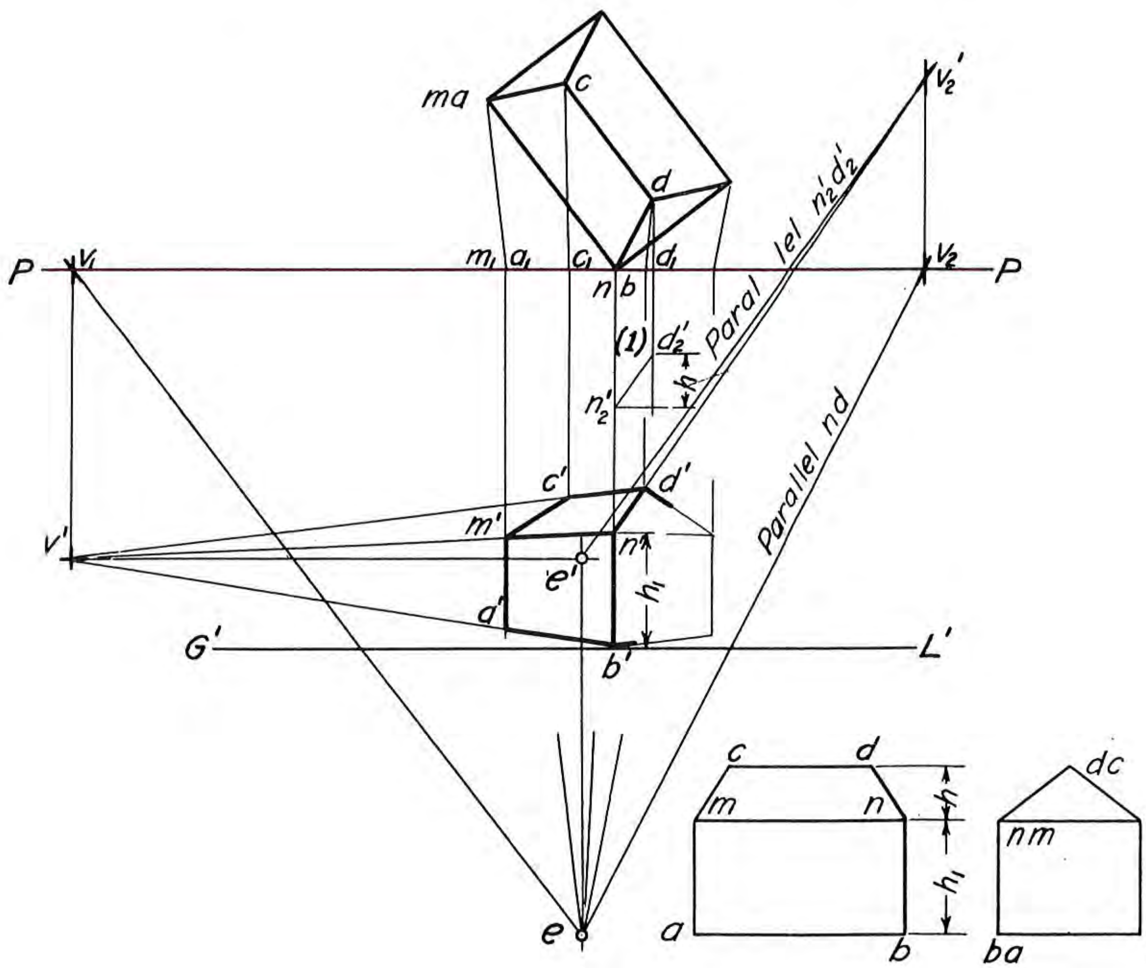


Fig. 2

of the object, is located on the G'L' in b', thus providing a starting point for the picture itself. We are now ready to draw the front view of the lines a_1b, c_1d_1, bn, etc., which make up the perspective picture.

The direction of a_1b in the front view is determined orthographically by drawing thru e a line parallel to ab. This pierces the plane PP in the point v_1 which is projected to v' on the front view of a line thru e' parallel to the front view of ab. (The front view of ab will be in this case a horizontal line). Line a'b' is a segment of bv' and is found by projecting a_1 onto it at a'. This method of locating v_1 and v' utilizes that problem in descriptive geometry for finding the intersection of two planes. Lines ev_1 and e'v' are top and front views of a line of the plane abe, since they are drawn thru e and e' parallel to ab in top and front views. Line a_1b extended is the intersection of planes abe and PP, and will pass thru V in both top and front views, since it is the piercing point of PP and a line on plane abe. Furthermore, the extension of the perspective projections on PP (such as c_1d_1) of all lines of the object parallel to ab (such as cd) will also pass thru the points v_1 and v' since ev_1 and e'v' will be lines common to every plane (such as cde) consisting of e and a line on the object parallel to ab.

At this point it may be well to digress from the orthographic theory to explain briefly to the student that the piercing point v_1 and v' is known in perspective projection as the vanishing point, which, in fact, it actually is, being the projection on PP of the point at which ab would seem to vanish on the horizon if extended indefinitely.

A rule for locating these piercing points or vanishing points orthographically may then be formulated as follows:

THE PIERCING POINT (VANISHING POINT) FOR ANY GIVEN LINE IS THE POINT AT WHICH A LINE THRU THE POINT OF SIGHT, AND PARALLEL TO THE GIVEN LINE PIERCES THE (PERSPECTIVE) PICTURE PLANE.

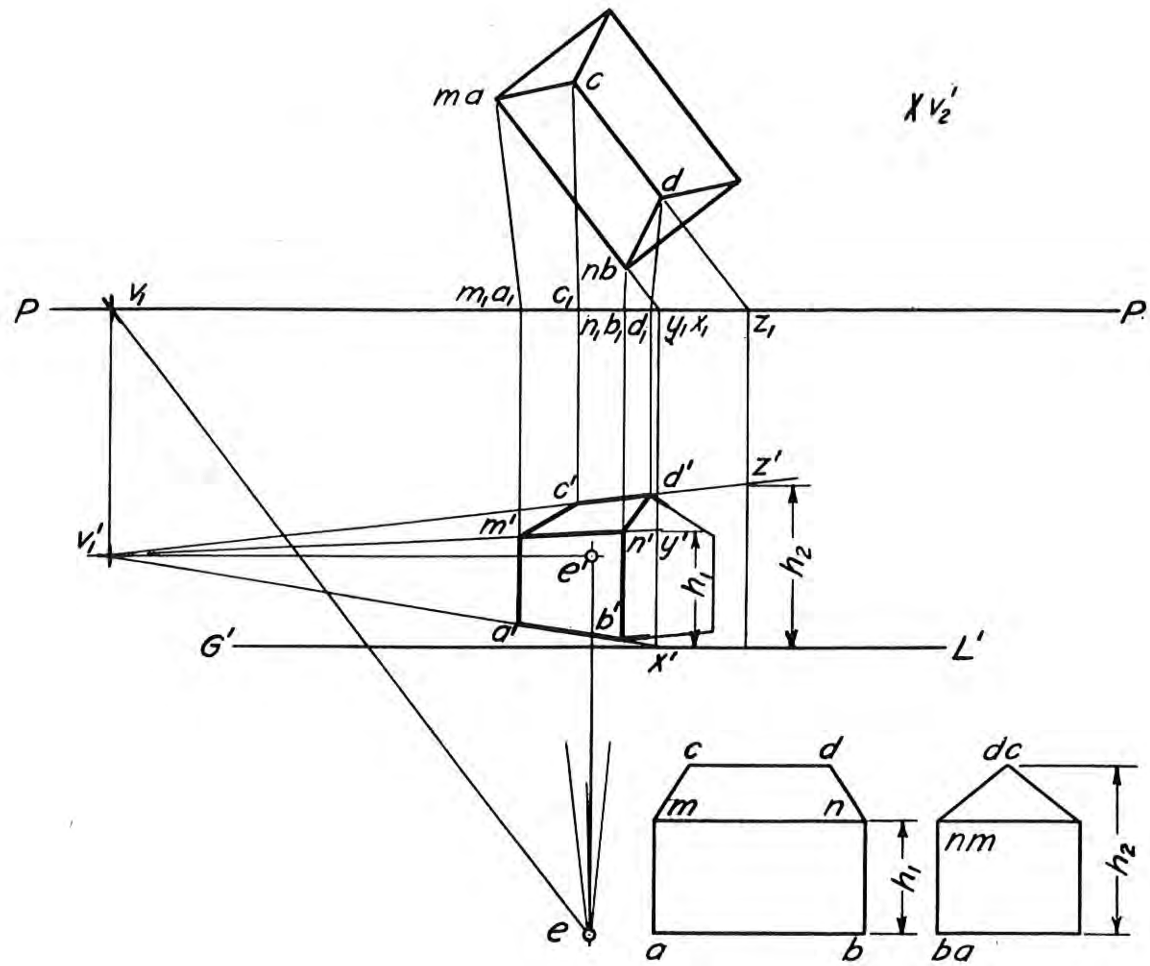


Fig. 3

This rule is entirely general in application, and provides a simple and accurate method of locating the vanishing point of any line. As an example of this, let us locate the vanishing point of the oblique line dn in Fig. 2. The line ev_2 is drawn parallel to dn piercing PP at v_2. A small segment of a true orthographic front view, containing dn is constructed by projecting d and n downward, and taking the difference in their elevation from the given views, as at (1) in Fig. 2. Now $e'v_2'$ may be drawn parallel to this constructed front view of dn, and the top view of the piercing point, v_2, projected onto it orthographically. The front view of the piercing or vanishing point is, of course, the one used in constructing the front view.

This construction, it will be noticed, has been orthographic thruout. It presents the student with a simple and logical method of locating vanishing points by tying them quite definitely into the orthographic principles previously learned. Only incidental reference to perspective has been made to acquaint him with some of the terms used in connection with it. Reference to the familiar "horizon line" has been entirely omitted since it has no particular bearing on the construction.

With vanishing points located, construction of the picture can proceed. This will be a process of building up the view, starting from a known point, locating other points of the object by use of lines thru the known point and the appropriate vanishing point; then working out from these newly found points to others. Point b', for example, was our known starting point; line a'b' was constructed as before described. At a and b are vertical edges of the object (am, bn) both the same in true length, but on the plane PP the one at a shorter than that at b by an unknown amount. However, the vertical edge bn actually lies on the picture plane PP; therefore it will be a true length line. Its true length, taken from the given views, may be laid off vertically upward from b', thus providing another known point, n'. (Note that lines parallel to PP will have no piercing or vanishing point on that plane, and will retain their actual direction in projection onto it.) On the object, mn is parallel to ab. Then drawing a line thru n' and v', the length of the segment m'n' may be cut off by projecting down from m_1 in PP. Vertical line a'm' may now be drawn in.

The line n'd' may be similarly constructed by drawing a line thru n' and v_2, its piercing point, and projecting onto it from d_1 to cut off a segment of proper length.

In laying off the vertical edge b'n' true length, the second and final rule for the orthographic construction of the view was illustrated. It is:

TRUE HEIGHTS OR DISTANCES MAY BE MEASURED OFF ON A LINE WHEN IT LIES IN, OR HAS BEEN EXTENDED TO LIE IN THE (PERSPECTIVE) PICTURE PLANE.

This is an extremely useful and convenient rule. It enables us to find a starting point for the front view when no part of the object touches the picture plane, to lay off vertical distances between parts of the object which do not extend up to the picture plane, and to eliminate the location of a large number of piercing points.

In Fig. 3 the same set-up is shown again, but this time the corner b is some distance back of the plane PP. The method of locating the various piercing points will be unchanged, altho their location will be different due to moving the picture plane. To find a starting point in the front view from which a'b' may be located, extend ab on itself in the top view until it intersects PP in x_1. Then this point may be projected to G'L' in x', the line x'v' drawn and the proper length segment cut from it by projection of a_1 and b_1 onto it.

The true length of bn may not be laid off directly as before, since this line no longer lies in PP. If, however, mn is also extended on itself in the top view until it intersects PP, then the point y' will be the true distance bn above x', and the line m'n' may be located in similar fashion to a'b'.

By use of this same device, the need for the piercing point v_2 for drawing line n'd' may be eliminated. It may be drawn by extending cd to intersect PP in z_1. The elevation of d may be laid off above G'L' on the projection line from z_1, line z'v' drawn, and d_1 projected onto it. Then n' and d' may be connected.

Neither the principles explained herein, nor their application to perspective are original with the writer. He can only claim some small measure of originality for the way in which they have been combined to present a short, simple, and orthographically understandable explanation of perspective view construction. Perspective projection is usually presented in one of two ways - by "rule of thumb" in which the student memorizes certain specified constructions such as for vanishing points, and is beyond his depth when new situations arise, or by architectural drawing courses in perspective which cover the subject minutely. The engineer should not be subjected to the indignity of the former method, and he seldom has time for the latter. But by utilizing his knowledge of descriptive geometry, and applying it to perspective construction, as illustrated here, he may acquire, in as short a period as a week, quite a thorough grounding in the basic principles. And from this point, it is but a short and understanding step to the more specialized branches of the subject.

(Continued from page 6)

Dimensioning	TO BE OMITTED
Fasteners &	Piping
Screw Thds.	Welding
Intersections	Gears, Cams
Development	Aircraft drawing
Detail Dwg.	Structural drawing
Assembly Dwg.	Charts & Graphs
Pictorial Dwg.	Architectural drawing
Isometric Dwg.	Mapping
Oblique Dwg.	Blueprinting
Shop Processes	

It was generally agreed that certain topics should be omitted from the tests, as noted. It was decided to undertake on Saturday the preparation of a unit test on orthographic projection.

Adjourned 5:00 P. M.

April 22, 1944 Reconvened 9:00 A. M.

Chairman Mann appointed a sub-committee to plan a conference on drawing tests at the Cincinnati meeting consisting of Rising (Chairman), Hill, and Thomas.

The suggested program for the meeting on tests is to include:

(1) A general talk on the subject of testing
(2) Experiences with AST drawing tests
(3) Types of objective tests (operational details)
(4) Merits of subjective tests compared with objective tests
(5) Exhibits of drawing tests (N.D. Thomas)

10:30 A. M.

Dr. Graney presiding:

Types of objective test items were suggested for the unit test on orthographic projection. The various members of the Committee were assigned to prepare these items, which are to be circulated among the Committee for comment, and to permit suggestion of substitute items.

The problems of determining the student group on which to standardize the test, the agency to do the statistical labor, etc., were discussed but not settled.

Adjourned 12:30 P. M.

(Continued on page 16)

NOTES ON PRACTICAL PERSPECTIVE

by
GEORGE F. BUSH
Asst. Professor of Graphics - Princeton University

Editor's Note: This article by Professor Bush represents the advanced stage of perspective projection as against the elementary stage as covered in the preceding article. It is concerned particularly with the special methods required (1) when constructing perspectives without the use of top or plan views, (2) when vanishing points are at an inaccessible distance, and (3) when enlargements and reductions of the original drawing are desired. While the Editor hardly suggests that this material is suitable for the usual course in engineering drawing, he does believe that it contains much of interest and value to those who are offering special courses in perspective, either for engineers or ESMWT students.

Some of the material contained herein is original with the author, and parts, particularly that on reduction and enlargement, have appeared recently in the magazine "Aviation". Any comments on the included material from those who use it will be greatly appreciated by the author.

ABBREVIATIONS AND DEFINITIONS

CV - center of vision
diagonal - a level line making 45° with PP
distance point - a point on HL that distance from CV which CV is before SP
DVP - down vanishing point
frontal - refers to a line or plane parallel to PP
GL - ground line
GP - ground plane
HL - horizon line
LVP - left vanishing point
level - refers to a line or plane all of whose points are at the same elevation
perpendicular - a line perpendicular to PP
PP - picture plane
principal distance - length of the perpendicular from SP to PP
RDP - reduced distance point
RVP - right vanishing point
SP - station point; an eye
VP - vanishing point

I. PERSPECTIVE OF A POINT BY A DIAGONAL AND PERPENDICULAR; DISTANCE POINTS.

The determination of the perspective of a point by a diagonal and a perpendicular applies the principle that the perspective of a point is the intersection of the perspectives of any two lines through that point. Two simple lines are a perpendicular and a diagonal to PP. As indicated in Fig. 1, the VP of a diagonal will be the principal distance from CV along HL and it may therefore be located without plotting SP, provided, of course, that CV is first established. This VP is known as a "distance point". In this figure, the diagonal lies in GP and thus its vanishing line can be drawn from D to VP. The vanishing line for the perpendicular is drawn from P to CV, where P may be projected from the plan or laid off from D along GL a distance equal to the length of the perpendicular from PP. Note that if the latter is done then the plan need not be drawn. This is common practice and was followed in Fig. 2.

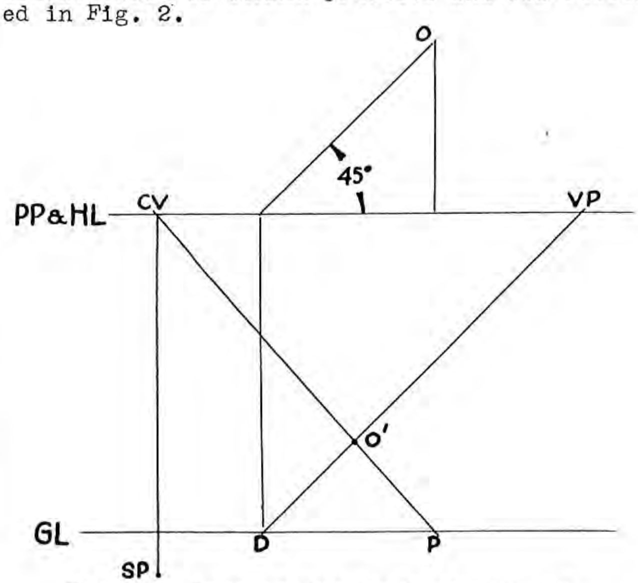


Fig. 1. Perspective by diagonal and perpendicular

II. ONE-POINT PERSPECTIVE OF AN INTERIOR BY SCALING.

Fig. 2, which shows in one-point perspective an interior was drawn to a scale of 1/4" = 1'-0". The room opening of 24' x 14', represented by a rectangle, is laid off to this scale directly in PP. Assuming the floor of the room horizontal and that the observer is standing on it, the base of this rectangle will be GL. HL is 5'-9" to scale above GL. After establishing CV on HL, lay off RVP and LVP 16' to scale from each side of CV, since we shall assume that SP is 16' in front of PP. Recall that this was done in Fig. 1. The perspective of a room corner, or a perpendicular to PP, from P will be a vanishing line from P to CV. The perspective of the diagonal, which intersects the perpendicular to give the required point, is D(RVP), DP is the length of the required perpendicular and, as in Fig. 1, is laid off along GL from P a distance equal to the length of the perpendicular, which in this case was assumed to be 27' to scale.

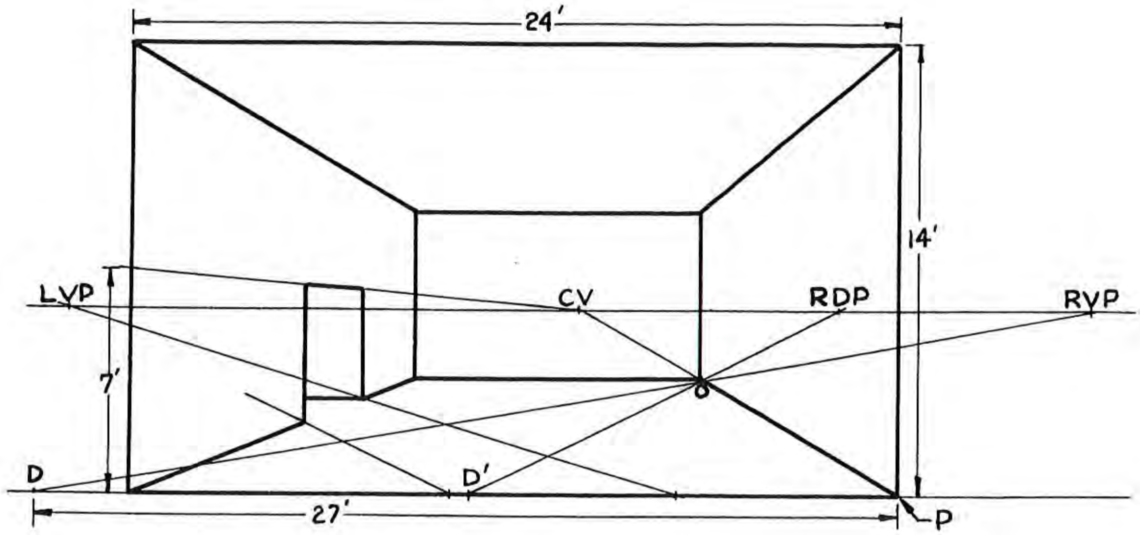


Fig. 2. One point interior by distance points (including reduced distance points)

In the same manner, perspectives of points in the opening in the left wall can be determined.

III. INACCESSIBLE VANISHING POINTS BY REDUCED DISTANCE POINTS, LEVEL FRONTALS, AND PROPORTIONAL DIVISION; MECHANICAL DEVICES.

As indicated in Fig. 2, "reduced distance points" may be used when a VP is inaccessible. Any convenient fraction of the distance from CV to the inaccessible VP may be used to bring the reduced distance point on the paper, but the same fraction must be applied in laying off along GL the length of the perpendicular from P. Thus, in the figure, since the distance from CV to the reduced distance point is one half that to the inaccessible VP, PD' equals one half PD. Any convenient fraction may be used.

If two lines, such as M and N in Fig. 4, converge to an inaccessible VP, and it is required to draw lines from points on a third line P to this VP, then the type of proportional division shown in Fig. 3(a) may be used. If the points are a, b, c, and d, on line P, they are laid off from an artibrary point, such as e, through which a line P' is drawn parallel to the given line P. It will be seen from the figure that the lines aa', bb', cc', dd' and ee' are the required lines running toward VP, because it is known that three or more lines are concurrent if their intercepts on two parallels, taken in the same order, are proportional.

Based on the above construction, perspective scales may be made to expedite the determination of points on vanishing lines.

When a plan view of an object is available, the method of level frontal lines may be used. These lines are used to find perspectives of level planes containing lines which vanish at an inaccessible VP. Such a plane may be the floor plane of a building or the mounting plane of a machine part. If, as in Fig. 5, the RVP is inaccessible, a perspective of a level line through a vertical line, such as AB through AC, is determined. The perspective of another vertical line through the level line and the object, such as DB, is found by the piercing point method. Level

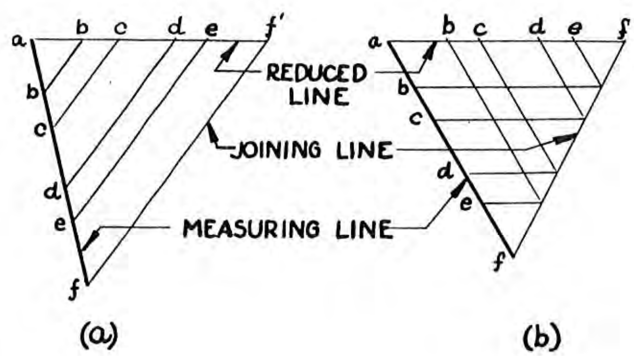


Fig. 3. Proportional division, two types

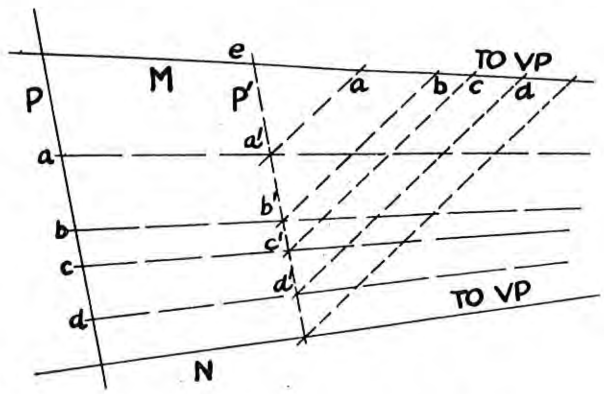


Fig. 4. Inaccessible VP by Proportional Division

lines from points like K and J will intersect BD in points like L and M which lie on vanishing lines to the inaccessible VP.

There are a number of mechanical devices, some of which are indicated in Fig. 6, which can be used to "reach" inaccessible vanishing points. In (a) is shown the curve and T-square, which employs a curve whose center of curvature is the VP and a T-square whose top edge lines up with a radius as shown. No matter what the position of the T-square along the curve, so long as it touches the curve at the contact points, as shown, a line can be drawn which will be a vanishing line. Essentially the same principle is used in the centrolinead of (b), except that the VP lies <u>on the circle</u> determined by the two contact points, usually heavy pins, and the hub center of the centrolinead.

The perspective drawing board of (c) is a recent innovation upon which are mounted perspective scales as shown. It is a convenient instrument in most cases and has been tried successfully in several organizations. The cyclene of (d) is another instrument of wide usefulness.

IV. PERSPECTIVE LAYOUT FOR DESIRED VIEWS; PROPORTIONAL DIVISION.

The procedure for determining the desired perspective view, without disagreeable distortion or "unnaturalness", may have either an artistic or a scientific basis. (One might also use the terms "compositional" and "rational".) This procedure, or layout, as it might be termed, will be explained on the artistic basis.

In determining any common perspective layout, the relative position of the eye, PP, and the object are considered. Each of these three items may be moved relative to either one or both of the remaining two. For example, for a fixed position of the eye, either PP and the object, or both, may be moved. If PP is once fixed relative to the fixed position of the eye, then the object may be moved into any number of reasonable positions. For each of these positions a different perspective view

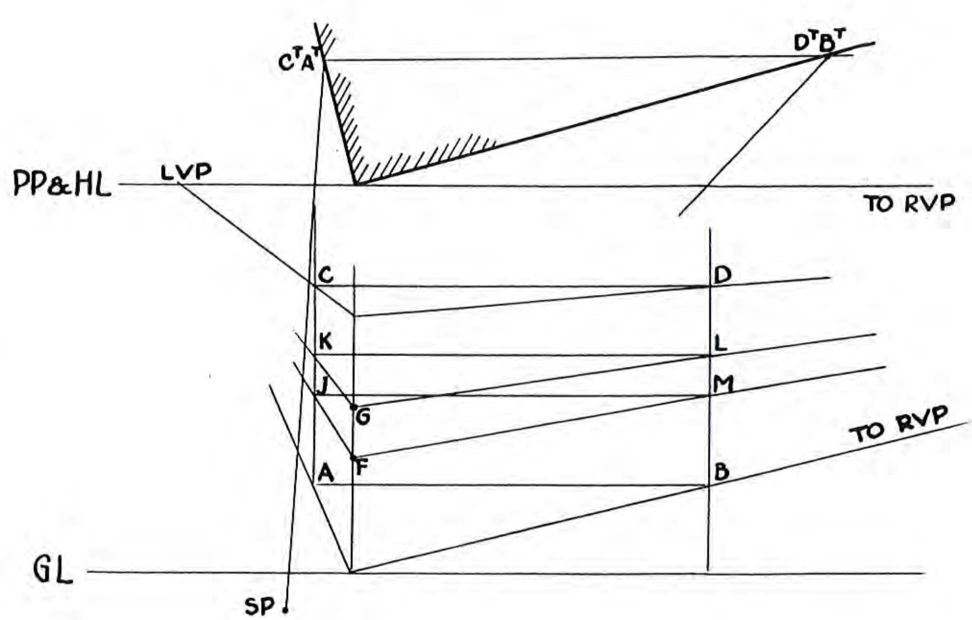


Fig. 5. Inaccessible VP by level frontal lines

will be obtained. If, as in Fig. 7, more is to be shown of the left than the right side of the object represented by plan and elevation, then the object should be turned as in two-point perspective and the eye, or SP, located somewhat to the left of the object's center, as in Fig. 7. If some of the top of the object is to be shown, then the HL should be fairly well above the perspective, as in Fig. 7.

4 - Draw M^LA^P extended to locate A on GL so that the discance "a" is reasonable. Use "a" to find T. Note that it is unnecessary to draw the plan as shown in the figure in order to locate and measure "a".

5 - Along GL, from A, lay off to the left AC to find C^P. Find E^P in a similar manner so that the perspective of the base of the figure, as shown, can be constructed.

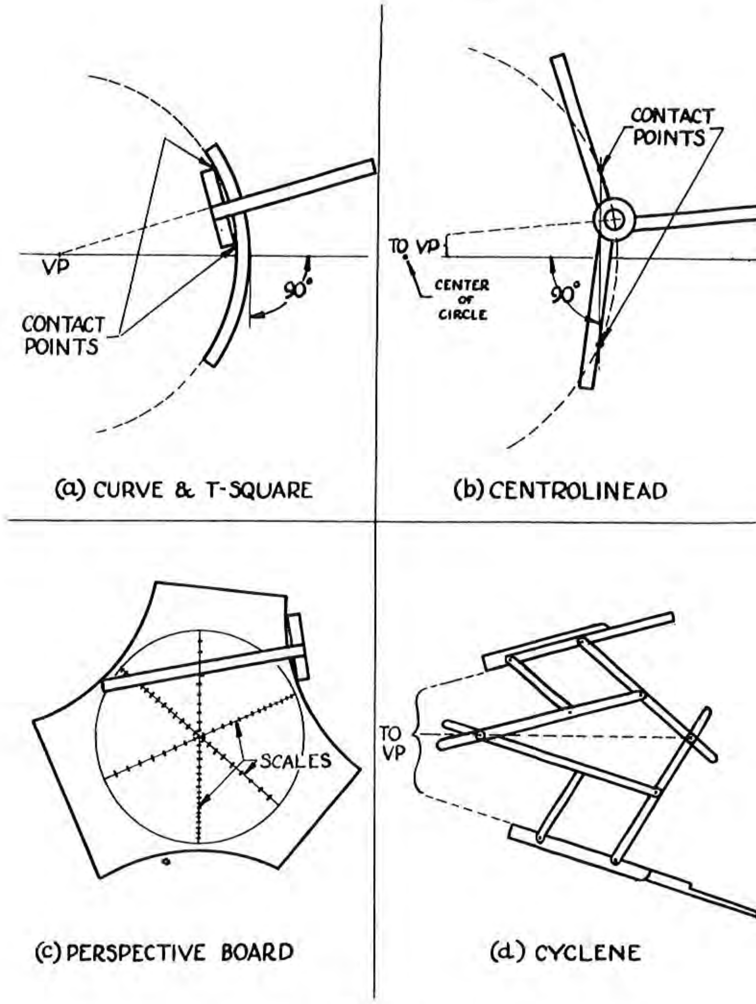


Fig. 6

Using these introductory, yet basic, ideas, we may proceed with the artistic perspective layout in the following order:

1 - Locate HL, A^P, RVP

2 - Locate LVP from RVP and use the 90° triangle to check for SP being in a reasonable position. The 90° triangle has its right angle at SP and the two legs passing through RVP and LVP.

3 - Locate M^L

The "perspective plan" method has been used to construct the complete perspective of the bases of the three blocks, as indicated by the nest of rectangles, the two inner ones of which have been shown dotted. Points for these two dotted rectangles have been determined by proportional division of the type shown in Fig. 3(b). For example, to divide line A^PC^P into parts proportional to AF, FK, KL, LG, and GC of the plan,

1 - lay off these lengths along the perspective of the level line A^PA'. (Any other line

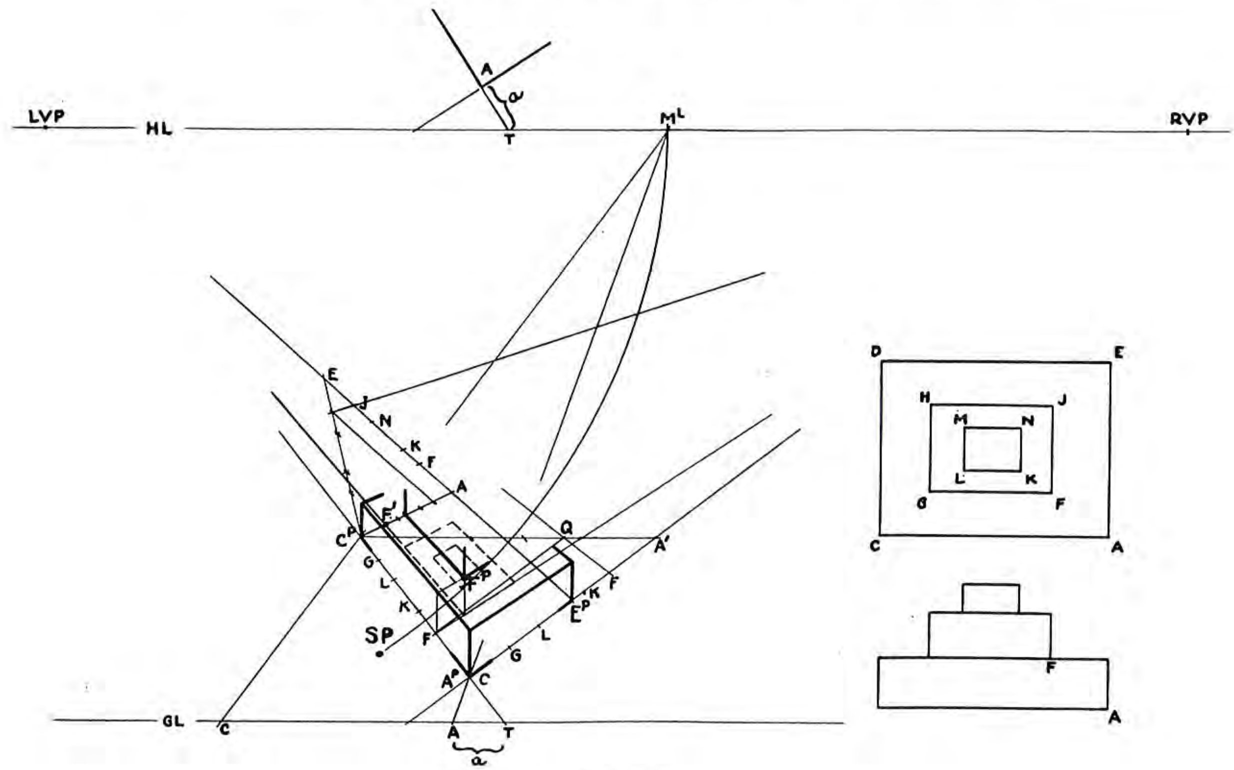


Fig. 7

in a convenient position could have been used).

2 - Draw the joining line $A'C^P$.

3 - From the points of (1) draw lines which are parallel to AC in space and therefore converge to LVP and which intersect the joining line $A'C^P$ of (2). For example, a line from F on A^PA' intersects $A'C^P$ at Q.

4 - From the intersection points of (3), draw lines parallel to A^PA' to intersect A^PC^P in the required points.

In a similar manner, the line AC^P of the base can be divided into parts proportional to AF, FK, KN, NJ, and JE.

Note that in the above application of proportional division, where one set of the lines of the diagram, containing lines like FQ, may converge to a finite VP, the other set containing lines like QF, must appear parallel to the line such as A^PA', along which the true lengths of the required proportions were laid off. This is revealed in the proportional division diagram for dividing the line AC^P.

Note also that when the above-described proportional division is used it is unnecessary to lay off true lengths in PP. The reason for this is apparent from the conclusions regarding reduction and enlargement.

V. REDUCTION AND ENLARGEMENT.

Fig. 8 shows the top and end views of a triangle ACD at (a). ACD is parallel to PP, as indicated. The two triangles formed by sight lines to the points A, C, and D, in the top and end views are shown at (b) referred to a line representing the edge views of the triangle. Here, p is the horizontal distance from SP to PP, and is measured perpendicular to PP. And x is the perpendicular distance from SP to the triangle. From the triangles at (b)

$$\frac{(SP)^RG}{(SP)^RA^R} = \frac{a}{b} \text{ and } \frac{(SP)^TK}{(SP)^TA^T} = \frac{c}{d} \qquad (1)$$

and

$$\frac{(SP)^RG}{(SP)^RA^R} = \frac{(SP)^TK}{(SP)^TA^T} \qquad (2)$$

therefore

$$\frac{a}{b} = \frac{c}{d} = r \qquad (3)$$

If the ratio r is, say, 1/2, then by geometry p = x/2; r is therefore a ratio for reduction or enlargement of perspectives. For

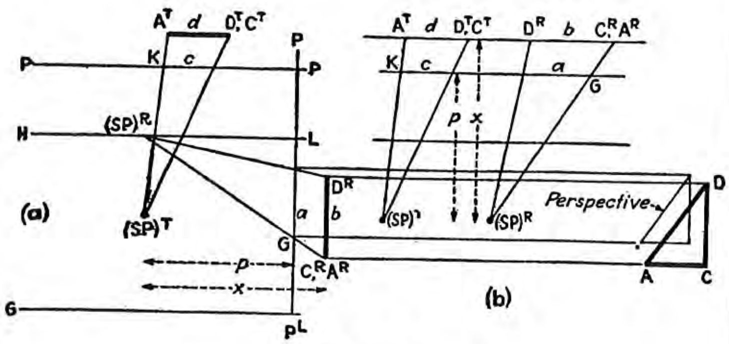


Fig. 8

example, if an auxiliary PP is so placed that $p/x = 1/2$, then the perspective is a half (linear) reduction of the object size; if $p/x = 2$, then the perspective is a double (linear) enlargement of the object size.

Equation (3) shows that lines in a plane parallel to PP and a fixed distance from it are all reduced a constant amount or that L^P, the perspective of a line, is proportional to L^S, the true length of the line in space. From Fig. 3(a), L^S is also proportional to L^R, the reduced line. Hence, in proportional division, the reduced length is proportional to the perspective of the line to be divided. It is therefore not necessary to bring a perspective of a line into PP in order to lay off the true lengths in the process of proportional division, provided the line is parallel to PP. This last provision was a condition in the determination of equation (3).

A useful method of enlargement or reduction is by parallels and a VP as indicated in Fig. 9. The VP is used for the large and small perspective as shown by line aa. Incidentally, point "a" in the large perspective gives a rough indication of the enlargement. To begin, a line of any desired length, such as cd, is drawn as the enlargement of its junior cd, by first determining d on a line dd passing through V as does aa; then a parallel to small cd is drawn in the enlargement from d, and the desired, enlarged cd is laid off. Enlarged e is obtained by drawing large ce parallel to small ce through large c. By so using vanishing lines and parallels, the enlargement can be quite satisfactorily obtained.

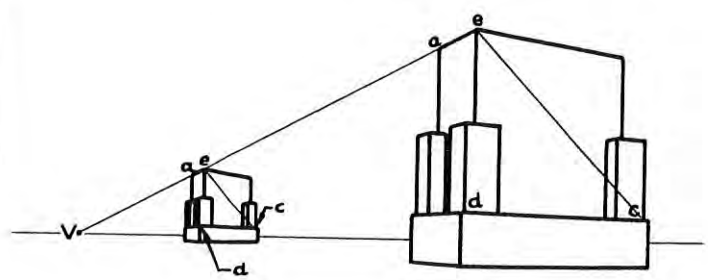


Fig. 9. Enlargement by Parallels and a VP

(Continued from page 10)

Reconvened 2:00 P. M. N.D. Thomas, presiding

Voted unanimously that the committee should meet in the evening before the opening of the SPEE convention in Cincinnati.

Voted that the exhibit of quiz and examination questions of all kinds should be solicited by mimeographed letter to be sent out by Dr. Mann. (The material should be sent to N. D. Thomas, Ohio University, Athens, Ohio.)

It was understood that the subcommittee planning the program on drawing tests (Rising, Hill, Thomas) should also make arrangements for a slide projector, and for display of the test material.

A portion of the afternoon was spent in preparation of test items for the first unit.

Adjourned at 4:00 P. M. until the day before the annual convention.

PERSPECTIVE VIEWS BY PHOTOGRAPHY

by
GEORGE J. HOOD
Professor of Engineering Drawing - University of Kansas
(Abstracted from AERO DIGEST - October, 1943)

Perspective drawings are an aid to both skilled and unskilled workers in production and on the assembly lines, and they also help the technically trained engineer to visualize more clearly the design. Experience has proved that perspective production illustrations save much time.

The plan here illustrated and described provides an easy means for making perspective drawings by photographing the section or hull lines of an airplane, or of any other structure or object. The general appearance of the lage have been traced in ink on sheets or "tabs" of transparent plastic. These tabs fit snugly into slots cut into a baseboard. The spacing of the slots in the baseboard conforms to the scale to which the sections were drawn.

The assembled tabs are now ready to be photographed from any point of view. The image on the ground glass of the camera is studied and the model or the camera is moved until the perspective view is exactly as desired.

The perspective photograph of the model,

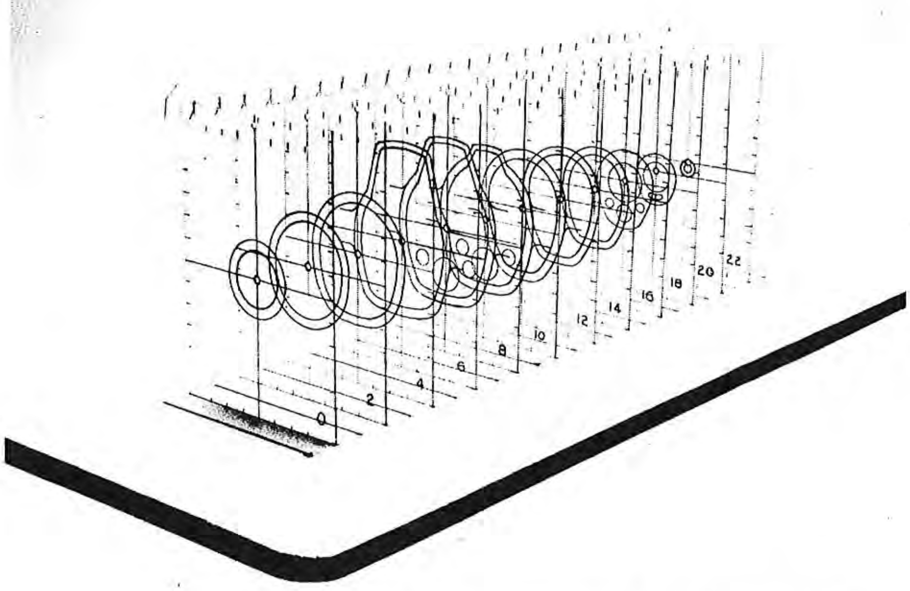


Fig. 1. Perspective Illustration of a fuselage

perspective drawing may be observed on the ground glass of the camera, and the best point of view can be readily determined. This plan does not require a knowledge of how to make basic layouts for perspective drawings, yet it permits the making of any number of perspective drawings of a structure as seen from various suitable points of view. The accompanying photographs illustrate the method and show the results when applied to an airplane.

In Figs. 1 and 2 the sections of a fuse- enlarged to any suitable size, is now placed on the drawing board. The lines of the photograph are traced, and any wanted details added. The resulting perspective drawing is then duplicated to provide production illustrations. The use of this plan should greatly reduce the time required to produce the basic lines of perspective drawings.

Figs. 1 and 2 show two different views of a fuselage. Fig. 3 illustrates the assembly of a fuselage with a part of a wing and a

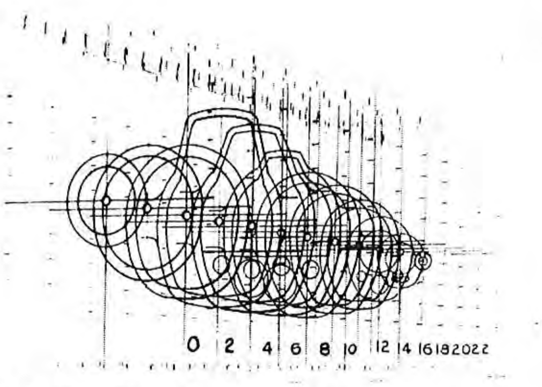


Fig. 2. View from another camera station - same fuselage as Fig. 1.

nacelle. Each part has been mounted on a separate baseboard, so that it may be shifted as desired, or so that each may be photographed independently, or any two in combination. More wing sections may be added, or the nacelle may be removed and wing sections put in its place. The wing assembly may be changed from right to left simply by inserting the tabs in the baseboard in reverse order. Or, a set of tabs may be made for each of the wings.

Glass has some advantages over the transparent plastic used in the models shown in the preceding figures. Glass does not warp. Lines may be drawn in ink on glass quite readily, and these lines do not scuff so easily as when drawn on flexible plastic. In Figs. 1 to 3 the plastic sheet is .020 in thick. The glass tabs are .040 in thick.

The thicker edges of the glass tabs do not seem to interfere materially with the lines of the sections in the photograph, nor does refraction seem to introduce any difficulties. Centers for the compass may be provided on glass by sticking small pieces of paper scotch tape where the centers are to be located.

Vanishing points may be located by extending the center lines of the sections and the edges of the baseboard. Vertical and horizontal scales may be drawn on the tabs before photographing, or separate scaled tabs may be included in the model to aid in measuring in any direction. Half-breadth or profile lines may be used. Models may be made showing lines running in various directions.

The background and the baseboards should be entirely white so as to reduce reflections that otherwise might show in the photograph. Careful lighting will reduce the reflections and also the prominence of the edges of the tabs as they appear in the photograph.

The tabs may be aligned with the aid of center lines on the tabs and on the baseboard. Each tab should be marked with its section number to facilitate assembling the tabs in proper order. Tabs may readily be added, removed or introduced at any angle. A "comb" of transparent material, with notches having the same spacing as the slots in the baseboard, may be placed along the edges of warped tabs to maintain proper spacing. Such a comb is shown in several of the illustrations.

DISADVANTAGES OF OLD SYSTEM

Many difficulties are inherent in the conventional methods of making perspective drawings by laying out front, top and side views on the drafting board, and then attempting to choose a desirable point of view, or point of sight, so that the resulting drawing may clearly show the details to be emphasized without interference from other details. At this juncture many hours of tedious work still remain to be done in locating a multitude of points for the delineation of the perspective view.

The plan here proposed eliminates most of these difficulties and greatly reduces the time required to produce production illustrations. The model itself may be studied by the engineers as an aid in visualizing the appearance and proportions of the structure. Changes may readily be made. Once the model is right, it can be photographed from all desirable viewpoints. The image on the ground glass of the camera may be studied and the model adjusted until the view is satisfactory. The method is universally applicable, and should prove useful in many fields of design and construction.

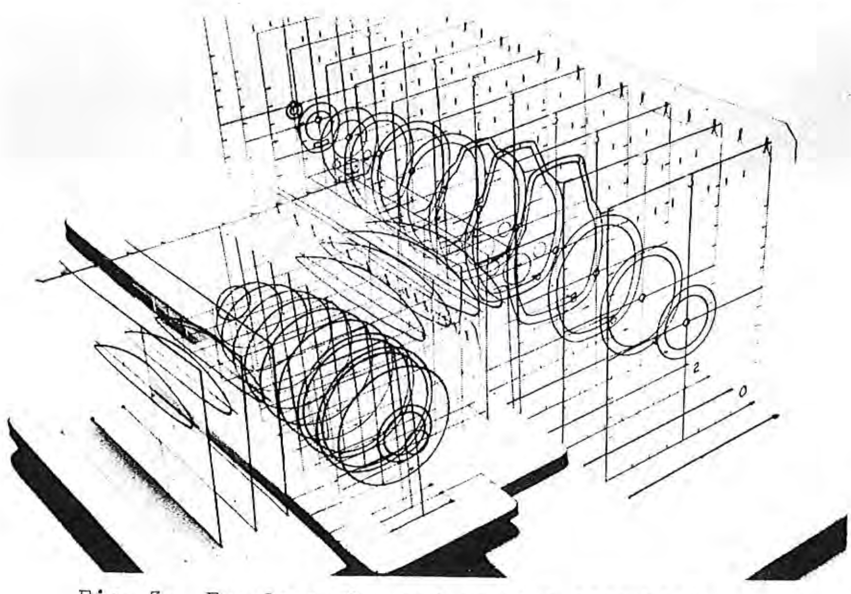


Fig. 3. Fuselage wing and nacelle assembled

PROJECTIONS

Society for the Promotion of Engineering Education
Annual Convention - June 22, 23, 24, 25, 1944

DRAWING DIVISION PROGRAM

First Conference Session.
(a) Prof. B. M. Aldrich, Oklahoma A. & M. College
"Isometric Approach to Descriptive Geometry".
(b) Prof. J. T. Rule, Massachusetts Inst. of Technology.
"Three Dimensional Drawings, Models and Techniques".

Annual Divisional Dinner.
Speaker to be announced.

Divisional Luncheon.
Election of Officers.

Second Conference Session.
Annual Business Meeting.
Report of the Committee on Tests.

Preceding, as this issue does, the annual Divisional meeting in June, and the close of the scholastic year (this latter an expression presently archaic, meaning "school's out"), this column contains a number of items which we hope you will read carefully.

WILLIAM GRISWOLD SMITH
1870-1943

William Griswold Smith was born in Toledo, Ohio, July 18, 1870. After studying two years at Yale, he entered Cornell where he graduated in mechanical engineering in 1892. From 1892 to 1902 he was engaged in the manufacturing industry. In 1902 he joined the faculty of the University of North Dakota, where he remained until 1905. From 1905 to 1920 he was associate professor of engineering at Armour Institute, Chicago. From 1920 until his retirement in 1939, he was professor of engineering and in charge of engineering drawing at Northwestern University.

During the present war period he returned to active teaching, first as special lecturer at the Defense Training Institute, New York, and since last June, until his death on Dec. 25, 1943, in charge of engineering instruction at the Naval Reserve Unit at Franklin and Marshall College, Lancaster, Pa.

Professor Smith was a charter member, and active in the early affairs of the Division of Drawing and Descriptive Geometry, S.P.E.E., being a member of the Executive Committee from 1928 to 1932. He was a frequent and welcome contributor to the Journal after its establishment, and up to within a short time of his death. He was the author of the textbooks "Practical Descriptive Geometry", "Engineering Drafting" and "Engineering Kinematics".

There portends the usual annual change in the Publications Committee which publishes this magazine, but this year augmented by the resignation of Prof. F. A. Smutz, our very competent circulation manager and treasurer for the last two and a half years. Professor Smutz resigns because of ill health, and we know you will join with us in wishing him an early and complete recovery. Prof. Joe N. Wood, also of Kansas State College takes over his duties until a successor is named. May we hope that our readers will give the new committee the same support and cooperation received by the present one.

* * * * * * * * * * * * * *

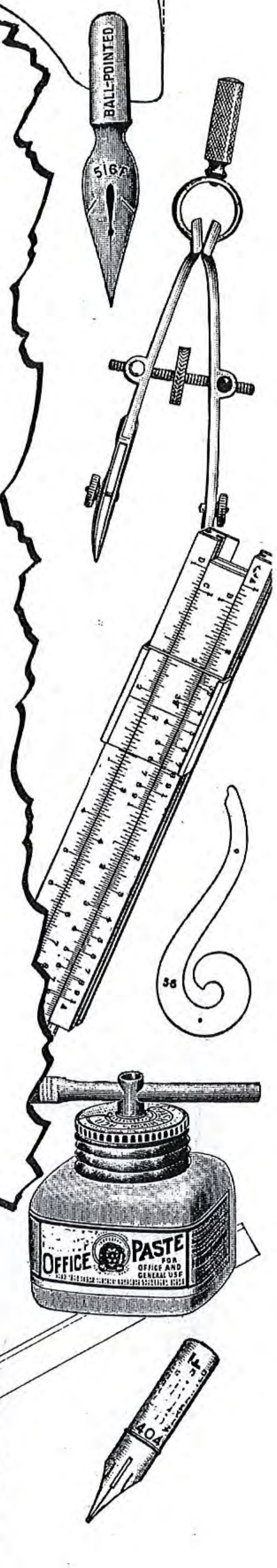
And then there is the matter of the BOOK PLATE COMPETITION, announced in the February issue. May we again solicit your contributions to this contest. We know from experience that there are many competent artists in the Division from whom we should receive designs. It is the intention of the Committee in charge to display all the entries as well as to complete the judging at the annual meeting. And this should be a display worth seeing if we only can induce you artists to contribute freely. The response, at the date when this is written, has been meager. But this is a long way from the closing date, which is June 1st. Send in your designs.

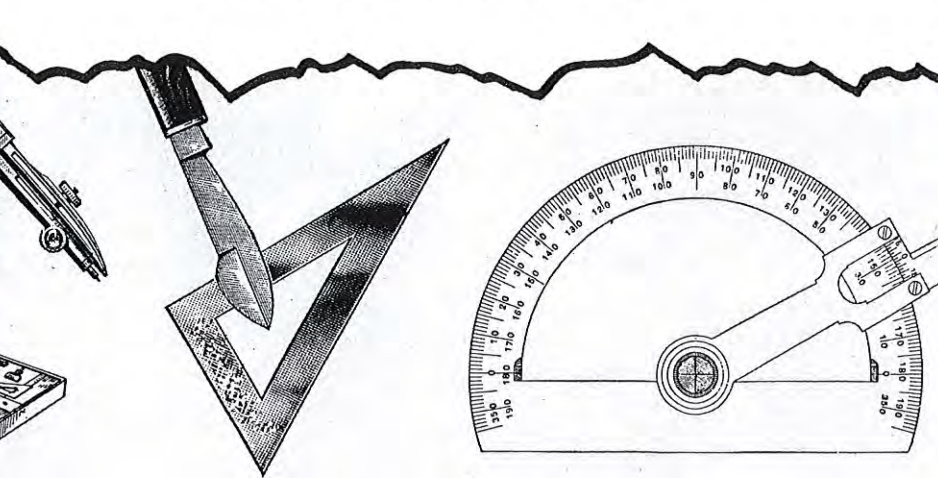
* * * * * * * * * * * * * *

We would like to call your attention to a recent publication by Prof. C. E. Rowe of the University of Texas entitled "Basic Models for Engineering Drawing and Descriptive Geometry", Bulletin #38 of the Engineering Research Series of that University. This booklet illustrates and describes some sixty different models constructed and used by Professor Rowe in his drawing classes, and might well be termed a textbook of model construction. We wish there was space available to tell more of the contents of the booklet. In our next issue, how-


Snow White
VERRINE RUBBER
BALL-POINTED


CHICAGO-NEW YORK


OFFICE PASTE



ever, Prof. Rowe himself will describe in an article, both the construction and use of many of those models.

* * * * * * * * * * * * *

This July, Professor A. V. Millar, Assistant Dean of the College of Engineering, University of Wisconsin, will complete 42 years of teaching and freshman advisory work at this University. Dean Millar joined the staff of the Department of Drawing and Descriptive Geometry in 1902, coming here from the University of Illinois. Rising successively from instructor to professor, he became head of the department, and assistant dean in 1921. With the growth of engineering enrollment, the freshman advisory work which he also handled, increased to such an extent that in 1923 he relinquished the chairmanship to continue as assistant dean in charge of freshman work. His interest in descriptive geometry remained, however, and every semester he taught at least one class in that subject. In 1937-38, following Dean Turneare's retirement, he was Acting Dean of the college.

Dean Millar was among the first to develop and adopt the use of the so-called "direct method" in descriptive geometry, his text employing this method appearing in 1913 as "Descriptive Geometry" by Millar and Maclin. Revised and improved thru several editions, it now appears and is used at Wisconsin as Millar and Shiels' "Descriptive Geometry".

Altho his years increased, Dean Millar has remained as young as his students in mind and spirit. He has been a real father confessor to hundreds of freshman students, always ready to help them with their difficulties, whether concerned with their university work, or their personal problems. Many an engineer owes the successful completion of his University career to the inspiration, and even the physical help of Dean Millar.

His retirement in July will leave a gap in our ranks that it will be difficult to fill.

* * * * * * * * * * * * * *

Now for the "Case of the Three Spheres", the problem in descriptive geometry submitted by H. M. McCully Jr. and published in the February issue. Eight solutions to the problem were received by the Editor, from the following:- B. M. Aldrich, Oklahoma, A. & M. College; W. H. Bowes, Dalhousie University; C. P. Buck, Notre Dame; J. D. McFarland and C. E. Rowe, University of Texas; H. D. Orth, Wisconsin; C. H. Ransdell and L. E. Stark, Texas A. & M. College; J. E. Robertson, Michigan State College; G. S. Stiles, Texas A. & M. College. In addition, Prof. F. M. Porter of Illinois sent us page and article number in the original Monge, where the solution was recorded some 150 years ago! Sic transit gloria!

Your Editor, believing that someone more competent than himself should pass judgement on the merits of these solutions, turned them over to Dean A. V. Millar the senior member of the Department at Wisconsin. After examining them, Prof. Millar stated that in general, the solutions were much the same. All employed the circumscribed cone, and while there was some variation from this point on, it was not sufficient to mark any one as being definitely shorter or better than the other. The solution published herewith was selected because it was the most complete, the clearest in analysis, and (from the Editor's viewpoint) the one which would reproduce the best. We wish there was space to print others of the group.

We give you the winners! Professors J. D. McFarland and C. E. Rowe of the University of Texas. The analysis and solution follow.

* * * * * * * * * * * * * *

PLANES TANGENT TO THREE GIVEN SPHERES

Solution by

C. E. Rowe, Professor of Drawing
and
J. D. McFarland, Associate Professor of Drawing
The University of Texas

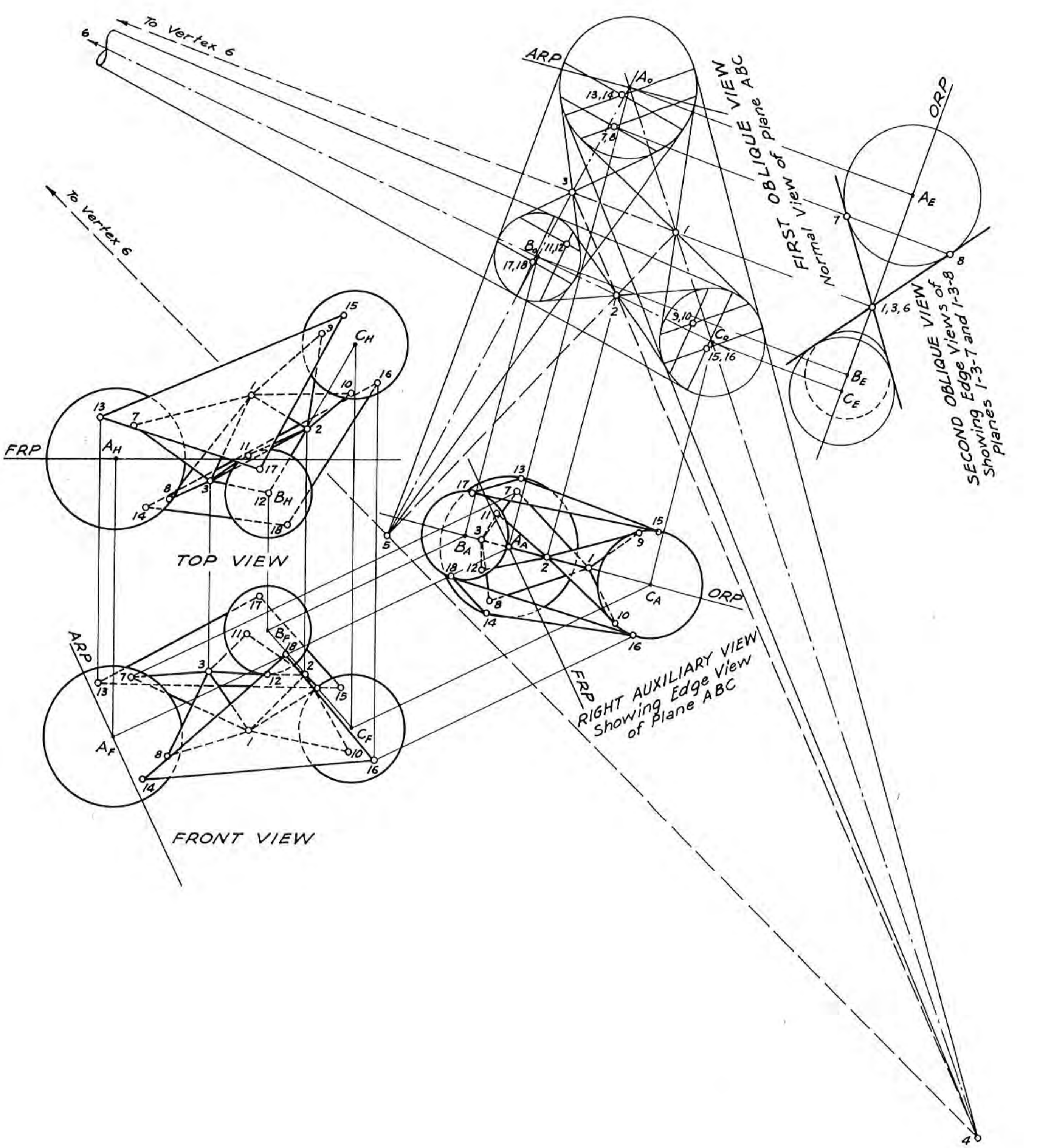
There are eight planes which solve the specific problem proposed by Mr. H. M. McCully, Jr. However, the spheres can be so arranged that the following numbers of planes are tangent to them: none, one, two, three, four, five, six, seven, eight, and an infinite number. It is an interesting problem to make such arrangements.

To solve the given problem, circumscribe each pair of spheres by one cone of two nappes with its vertex between the spheres, and by another cone with its vertex beyond the smaller sphere. Six cones are used. The three outside vertices lie in a straight line, and each pair of inside vertices line up with one outside vertex. Each pair of required tangent planes is tangent to three cones, and therefore to the three spheres. Each pair of planes intersect in the line of three vertices. There is one pair of tangent planes outside the spheres, and there are three pairs between the spheres.

In the drawing, the right-auxiliary view is an edge view of the plane ABC, and the first oblique view is a normal view of it. In the normal view the circumscribing cones are drawn having the vertices 1, 2, 3, 4, 5, and 6. The edge views of all the circles of tangency of the cones and spheres are shown here. Their intersections are the points where the various planes are tangent to the spheres. There are eight points on each sphere, but only four have been numbered.

The second oblique view made by looking in the direction 1-3-6 shows and edge view of a pair of tangent planes, 1-3-7 and 1-3-8. To simplify the appearance of the drawing, which shows all eight planes, each plane is shown as an opaque triangle in the front, top and auxiliary views. In the first oblique view only the corners of the triangles are shown in order to prevent obscuring the layout of the cones.

The six planes between the spheres are 1-2-9, 1-2-10, 1-3-7, 1-3-8, 2-3-11, and 2-3-12; and the two planes outside are 13-15-17 and 14-16-18.


To Vertex 6
To Vertex 6
FIRST OBLIQUE VIEW
Normal View of Plane ABC
SECOND OBLIQUE VIEW
Showing Edge Views of
Planes 1-3-7 and 1-3-8
TOP VIEW
FRONT VIEW
RIGHT AUXILIARY VIEW
Showing Edge View
of Plane ABC
ARP
ORP
FRP

REPORT OF THE BIBLIOGRAPHY COMMITTEE

PROF. H. H. FENWICK, CHAIRMAN
(for the period Nov., 1943 - May, 1944)

Author	Title	Edition	Publisher	Year	Pages	Price
Bradley,H.C. & Uhler,E.H.	Descriptive Geometry for Engineers	2d.	International Textbook Co.	1943	266	$2.50
Davis,Dale S.	Empirical Equations and Nomography	1st.	McGraw-Hill	1943	200	2.50
French,T.E. & McCully,H.	Engineering Drawing Sheets - Series E		McGraw-Hill	1943		2.50
Jones,F.D.	Mechanical Drawing	3d.	Industrial Press	1941	342	3.00
Kern,W.F. & Bland,J.R.	Geometry with Military & Naval Applications	1st.	John Wiley	1943	152	1.75
Maclean,N.F. & Olson,E.C.	Manual for Instruction in Military Maps and Aerial Photographs	1st.	Harper	1943	138	1.75
O'Rourke,F.J. & Moyer,J.A.	Sheet Metal Pattern Drafting		McGraw-Hill	1942	189	2.00
O'Callaghan,E.M.	Reading Drawings & Blue Prints	2d.	State Board of Education Salem,Oregon	1942	36	
Parkinson,A.C.	Intermediate Engineering Drawing including a course in Plane & Solid Geometry	2d.	Pitman		187	3.00
Portland,Ohio Public Schools Div. of Voc. Educ. & War Prod. Training	Basic Blueprint Reading for Ship Fitters	Rev. Ed.	State Board of Education Salem,Oregon	1943	48	
	Blue Print Reading (Supplement)			1943	58	
Roberts,W.E.	Beginning Mechanical Drawing	Rev. Ed.	Manual Arts	1943	111	1.60
Tharratt,G.	Aircraft Production Illustration	1st.	McGraw-Hill	1944	201	3.50
Turner,W.W. & Buck,C.P.	Basic Problems in Descriptive Geometry		Ronald Press	1944	60 Plates $8\frac{1}{2}$x11	1.75
U.S. Office of Educ.	Reading Working Drawings	Misc. 3629	U.S. Office of Education	1942	4	
	Mechanical Drafting	VE-ND		1943		
	Visual Aids	Misc. 3483 VE-ND		1943	109	
Vaughn,W.	Aircraft Descriptive Geometry - (Direct method)	2d.	Aircraft Pub. Co. Glendale,Cal.	1943	200	3.50
Willoughby,G.A. & Matt Lappinen	Elements of Shop Drawing	1st.	Bruce	1943	40	.36
War Dept. & U.S. Army	Map & Aerial Photograph Reading Complete	Rev. Ed.	Military Service Pub. Co.	1943	188	1.00
Zipprich,A.E.	Freehand Drafting	2d.	Van Nostrand	1943	149	1.75

RESEARCH

Rowe,C.E. — Series 38 - "BASIC MODELS FOR ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY". Bulletin No. 4343. 31 P. Illus. University of Texas, Austin, T.

MAGAZINE ARTICLES, ETC.

Drawing Div. of S.P.E.E. - National Survey of Engineering Drawing. Conducted by Dwg. Div. S.P.E.E.-J of Eng. Educ 33:818-52 Fe '43.

Fitspatrick,A.M. - Perspective Illustrations as Applied to Aircraft Design & Production - Aeronautical Eng. P - 2:23,25,27 Fe '43 Ill Diags.

Gonzales,J. & Wiese,R.R. - Rendering & Reprod. Methods for Graphic Illustrations Prod. Eng. 14: 664-7 Oct '43 Ill Diags.

Graham,D.A. - Use of Drawing Tools in Pattern Making Sheet Metal Worker 32: 30 May '41.

Higbee,F.G. - Drafting Standards Revised. Machine Design 15:140 Ag '43.

Hoelscher,R.P. - New Methods of Axonometric Projection. Journal of Engineering Educ. 34:233-4 Nov '43 Ill.

How to do it drawings speed war production; here to stay. Sales Management 52:40 March 15, '43.

Kintner,R.C. - Importance of Engineering Drawing to a Chemical Engineer. Jour. of the Western Soc. of Engrs. 47:202-7 Oct '42.

Krips,J.A.C. & Miller,W.S. - Uses for three dimension Pictorial Dwgs. in the Engineering Dept. - Power Plant Engr. 47:69-71 Nov '43.

Kuhl,F.P. - Standardizing Engineering Drawing Sheets. Machine Design 15:140 April '43 Diags.

Lingberg Engr. Co. - Symbol-Stamps simplify Drafting Room Detail. Steel 114:72 Jan 24 '44.

Mann,C.V. - Engineering Aptitudes; their Definite Measurement and Use. Jour. of Eng. Educ. 32:673-86 Apr '42.

Miles,T. - Selection and Adoption of Template reproduction Methods. Prod. Eng. 15:57-60 Jan '44 & 130-3 Fe '44.

Planes visualized; Graphic Illustration of Aircraft. Bus. Week 82: May 13, '43.

Visualization in three dimensions - Product Eng. 14:131-7 Mar '43.

How to Dimension Perspective Drawings - Product Eng. 14:790-1 Dec '43.