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S P E E

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JOURNAL OF ENGINEERING DRAWING

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

VOL. 8, NO. 1 FEBRUARY, 1944 SERIES NO. 22

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The Editor's Page

With the growing use of production illustration as a means of increasing the productivity of the nation's assembly lines, it is only natural that that phase of Engineering Drawing upon which it is based should receive more and more attention in our college courses in drawing. It is, then, quite fitting that this issue of the Journal should be devoted largely to a consideration of some parts of the newer developments in pictorial representation.

A production illustration, in itself, is no newcomer to the field of Engineering Drawing, as practically all of our courses have, for many years included work in pictorial representation of various types, upon which such drawings are based. It is the adaptation of such drawings to a more important field of usefulness, and to a unique and unforseen labor situation, that has caused the increased interest of manufacturers in their use, and a resulting increase in the emphasis on pictorial representation among many of our drawing departments.

With this brief introduction, we therefore present in this issue, material covering some of the newer developments in axonometric projection theory.

In "A New Method of Axonometric Projection" by Professor R. P. Hoelscher, we have, as you might say, pictorial representation made easy. While the theory behind this method is hardly understandable to one who has not had a thorough grounding in orthographic projection, certainly the application of it by "rule of thumb" can be learned by any tyro in the drafting office. This article, while it has appeared before in the Journal of Engineering Education, and was given as a paper at the last meeting of the Drawing Division, we believe deserves repetition here for our many readers who have not had access to these sources.

* * * * *

Professor J. G. McGuire offers a novel, although logical presentation of the derivation of axonometric views by means of strictly orthodox auxiliary view construction, in his short article "Axonometric Projection via Auxiliary Views". This approach may serve to smooth the path of understanding for many students.

* * * * *

In "The Isometric Ellipse", Professor H. D. Orth points to that curve in the ellipse which has made many an isometric view look awkward and unnatural. Certainly an isometric circle is a true ellipse, and the nearer it is approached in the drawing, the more natural the picture will appear.

* * * * *

We could hardly pass over the present Army and Navy programs without notice in this Journal, for they are occupying a good part of the time and energy of many of our teachers of Engineering Drawing. And not only are they taking our time, but our best thought as well, to keep them functioning properly. Dean A. V. Millar gives you a good "peek" into the workings of the Navy engineering program, and Professor W. E. Street does the same for the A.S.T.P. program. We would wish for further comments from those of you who are engaged in this work, so that we may continue developments in these programs in future issues. May we have them in letter form, or in the more formal attire of short articles.

* * * * *

And finally, Professor C. V. Mann gives us an interesting and delightful account of his researches in the field of testing graphic talent, "A Partial Suggestive Analysis of Graphic Talent", While we may agree or disagree with some of his theories, as expressed here, certainly they make interesting and informative reading when served up by Professor Mann.

A NEW METHOD OF AXONOMETRIC PROJECTION *

by
R. P. HOELSCHER
Professor of Drawing - University of Illinois

In the earlier drawing texts of the present century, little or no recognition was given to the fact that isometric drawings are in reality orthographic projections. Many persons, including some drawing teachers, are still unaware of that fact. Dimetric and trimetric projections were scarcely mentioned. These latter forms are, in general, much more pleasing in appearance than isometric, due in part, to the fact that they avoid the disturbing symmetry of the isometric form. A new, exact and simple method for constructing any one of the three forms, first taught in the United States at the University of Illinois in 1942, is presented in the following paragraphs.

Rule of thumb methods for the construction of approximate axonometric drawings have been in use for many years and for isometric drawings these methods are quite satisfactory, but the use of two different scales for dimetric and three for trimetric made the construction of these forms rather slow and cumbersome. As a consequence they have been little used in teaching or engineering practice. These rules, of course, made no reference to the subject of orthographic projection and there is no need that they should if one is interested only in the production of drawings in the isometric form.

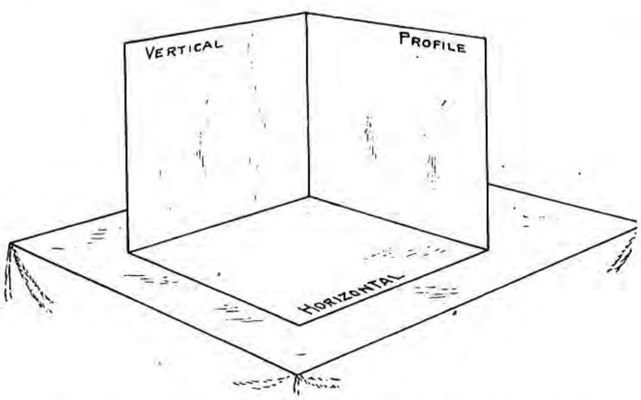

Fig. 1. Principle Planes of Projection

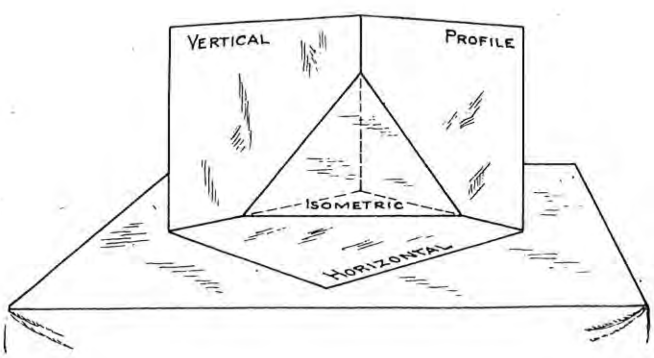

Fig. 2. The Isometric Plane

For training at the collegiate level, however, it has always seemed desirable to introduce the idea of the isometric plane in the teaching of isometric drawing, even though rule of thumb methods were later used for the actual construction. The use of this plane gives a correct theoretical basis for the establishment of rule of thumb methods and hence should give the student better understanding of what he is doing.

In the new method of construction the concept of the axonometric plane, inclined to the three principal planes, is essential. In Fig. 1 the three principal planes are shown in pictorial form, while in Fig. 2 the isometric plane has been included with them.

The position of this inclined plane, relative to the principal planes, determines the type of drawing which will be produced by projecting orthographically upon it. If it is equally inclined to the three principal planes an isometric projection will be produced. If equally inclined to two planes and at some other angle with the third, a dimetric projection results as in Fig. 3, while an unequal angle with each of the three principal planes produces a trimetric as shown in Fig. 4.

In Figs. 3 and 4 the projections on the horizontal, vertical and profile planes have also been shown. Attention to the position of these views is essential to an understanding of the following discussion.

The new method of projection, which greatly simplifies the construction of any axonometric, depends upon two very simple geometric principles with which every student is familiar. These two principles are illustrated in Fig. 5. In the upper portion, we have the well known fact that the chords connecting any point on a semi-circle with the ends of the diameter, form a right angle with each other.

* A paper presented at the Annual Conference of the Drawing Division, S.P.E.E., June 19, 1943, Chicago, Ill.

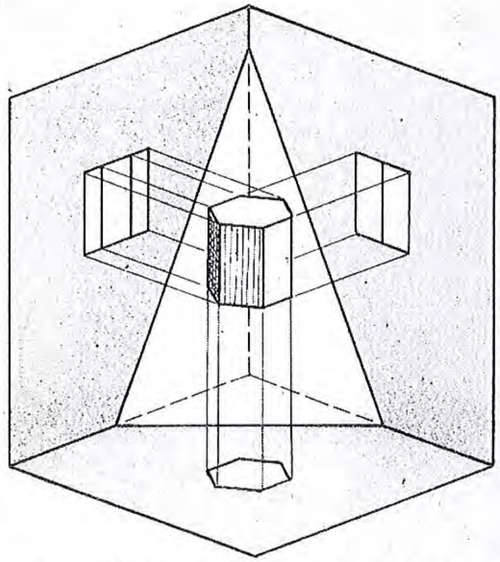

Fig. 3. Dimetric Plane and Projection

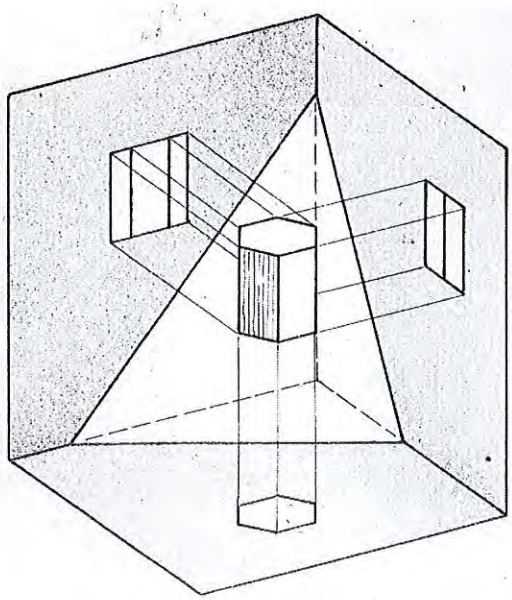

Fig. 4. Trimetric Plane and Projection

The lower portion of Fig. 5, is the one commonly used in descriptive geometry, i.e., if a line is perpendicular to a plane then the projection of the line is perpendicular to the trace of the plane. Thus the projection ab is perpendicular to MN and likewise a'b is perpendicular to MN and hence when the inclined plane MNOP is revolved into the other plane the line aba$'_r$ becomes a straight line.

The application of these principles is shown in Fig. 6 where the profile plane has been revolved about its trace MN with the axonometric plane into coincidence with that plane. The point O moves out along the line OA. Since the corner of the profile plane at O is a right angle it will still be a right angle and show in its true shape when revolved. The point O_r can be located therefore by drawing a semi-circle on the axis of rotation as shown. The points B and C being in the axis of rotation do not move. Note that the other corners of the plane also move out at right angles to the axis of revolution thus enabling us to complete the rectangle which represents the profile plane revolved. The thing of particular usefulness and interest is that the lines of the orthographic view remain parallel to the edges of the plane in the revolved position. Fig. 7 shows the horizontal and vertical planes revolved in a similar manner. In all cases the axonometric plane is the plane of the paper.

In Fig. 8 all three planes, together with the orthographic views have been shown revolved. For simplicity the construction lines have been omitted. From this figure it can be seen that the axonometric view can be constructed by direct projection from any two of the three principal views. The problem in construction is to find the correct position for the two orthographic views and the direction of the projecting lines.

The necessary construction for finding these two things is shown in Fig. 9. Note

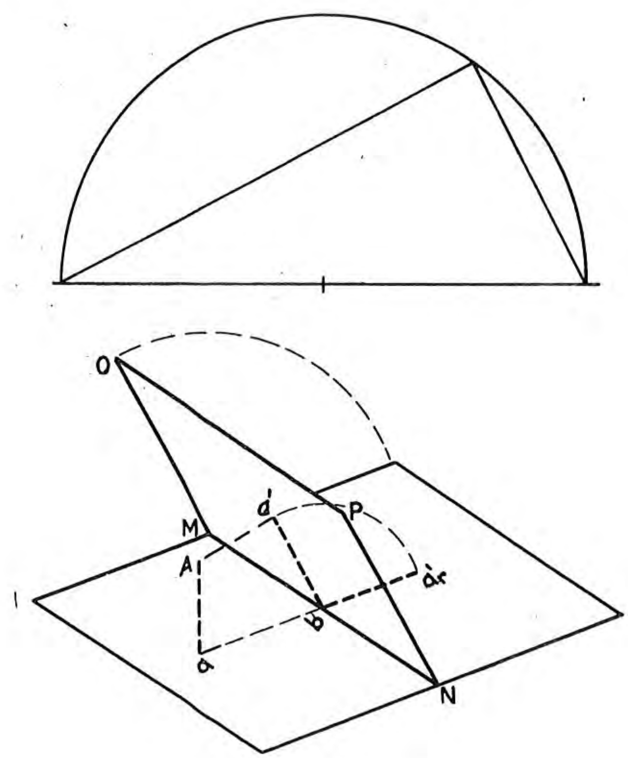

Fig. 5. Geometric Principles

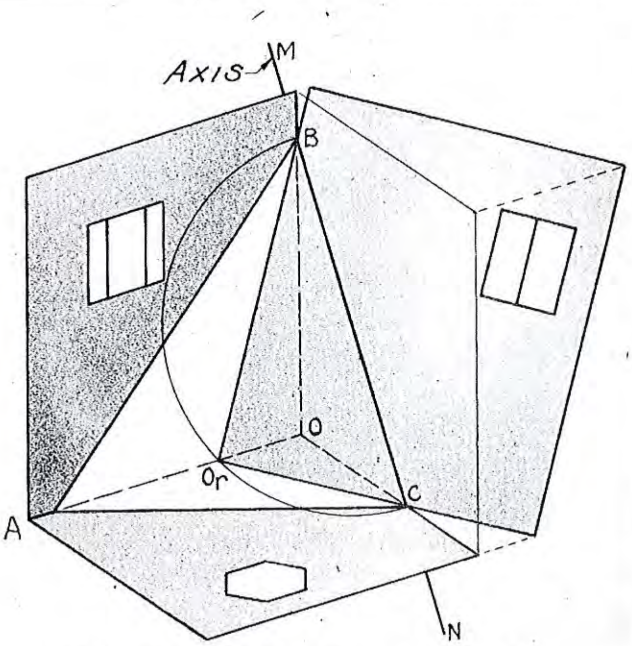

Fig. 6. Profile Plane revolved into Trimetric Plane

that the edges of the orthographic views of the object are parallel to the corresponding edges of the revolved position of the plane of projection.

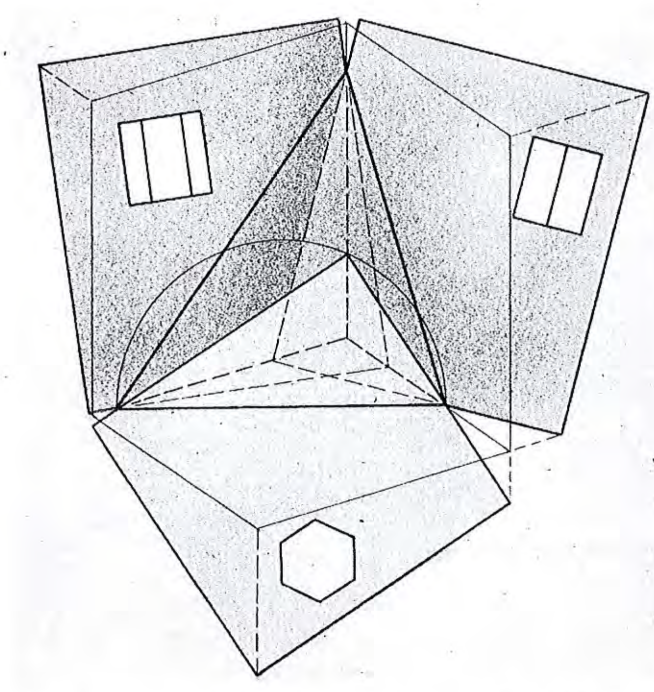

Fig. 7. Horizontal, Vertical and Profile Planes revolved into Trimetric Plane

The procedure is as follows: (1) Select first the position of the three coordinate axes OA, OB and OC, to give the desired position of the object in the finished axonometric. (2) Draw the edges of the axonometric plane at right angles to these lines. Thus BC is perpendicular to OA; AB is perpendicular to OC and AC is perpendicular to OB. (3) Revolve two of the coordinate planes into the axonometric plane by means of the semicircle construction as shown in the figure. (4) Locate the orthographic views at a convenient place on the board with the edges of the views parallel respectively to the corresponding edges of the revolved planes, O_rA, O_rB, etc. (5) Draw the projecting lines parallel to the proper axonometric axis. Thus the bottom view in Fig. 9 which was revolved around AC will have its projecting lines parallel to OB the axis opposite AC. The edges or center lines of the completed pictorial drawing then come out parallel to the three coordinate axes originally chosen.

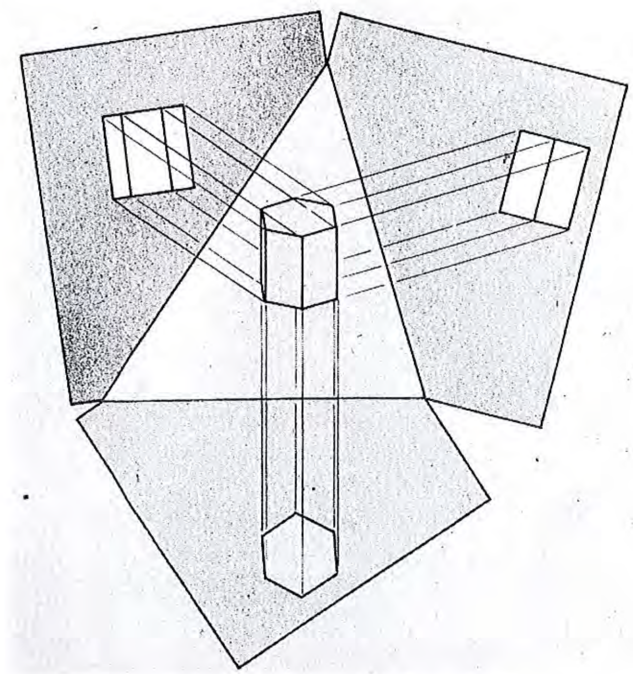

Fig. 8. Trimetric Projection from Orthographic Views

Any face of an object may be emphasized by a proper choice of the three axes. In Fig. 9* the front and top are most prominent while in Fig. 10 the left side has received the major emphasis. To emphasize other faces the object may be turned into other positions as shown in Figs. 11 and 12, using the same two orthographic views. A bottom view may be obtained by using a fourth quadrant arrangement as shown in Fig. 13.

* Figs. 9 to 12 are taken from "Industrial Production Illustration" by Hoelscher, Springer and Pohle, McGraw-Hill Book Co., by permission of the publisher and copyright owner.

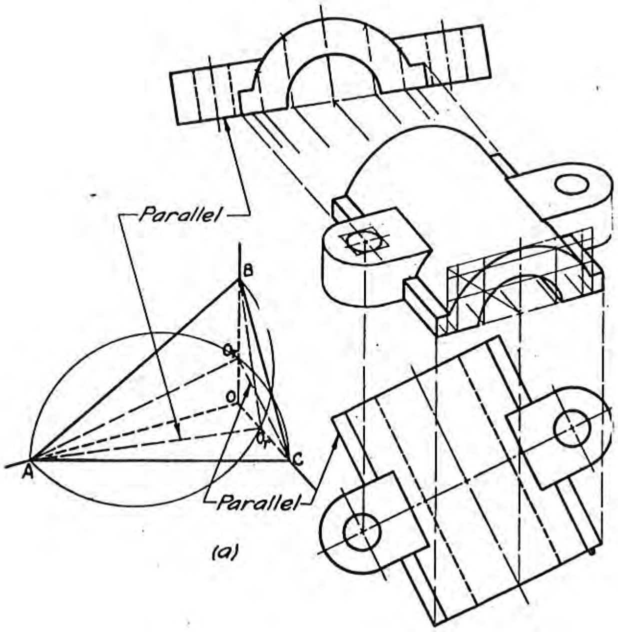

Fig. 9. Finding Position of the Orthographic Views

The simplest method of procedure seems to be to make a thumb-nail sketch of the pictorial view desired, draw the axes and sketch the two orthographic views as shown in Fig. 14. This sketch can be made very rapidly and

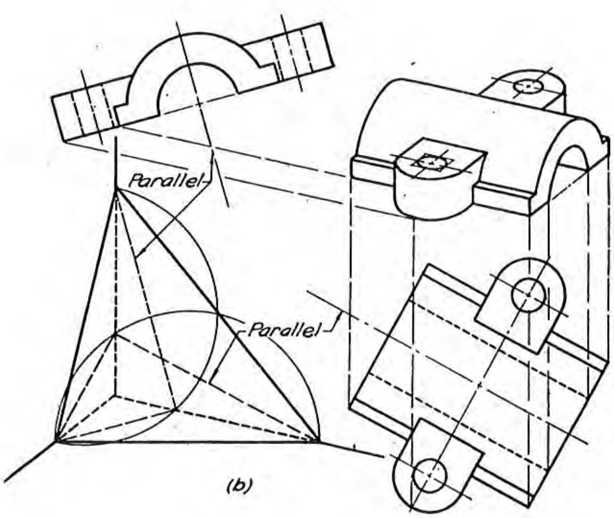

Fig. 10. Shifting emphasis in the Pictorial View

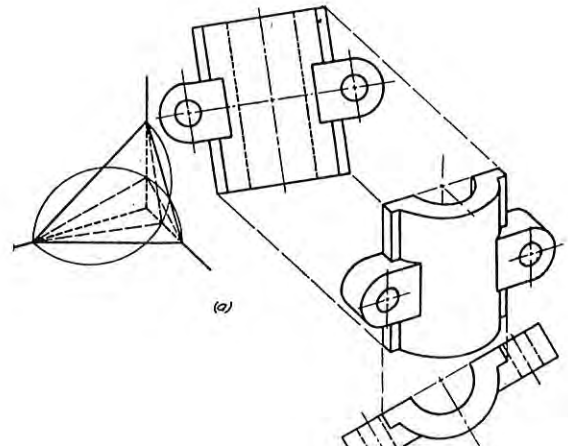

Fig. 11. Object on End

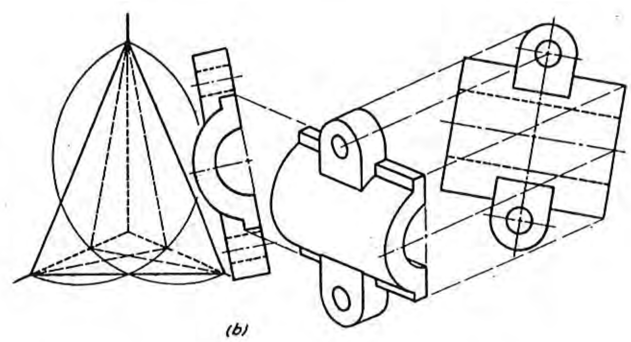

Fig. 12. Object on Side

need show only enough detail to determine the position of the view. With this sketch as a guide a layout similar to that in Figs. 9 to 12 can be made, and the orthographic views then can readily be placed in the proper position.

While the method is very simple it should not be assumed that it is foolproof. By inadvertently interchanging views or the direction of the projecting lines some very queer looking figures will result. For example, when making bottom views it is very easy to get an axonometric view that is opposite hand from the one intended.

In order to avoid such an opposite hand pictorial drawing, care must be exercised in the selection and placing of the views. Note that the revolved orthographic view at (b) above the pictorial in Fig. 13 is opposite hand from the orthographic view at (a). Hence

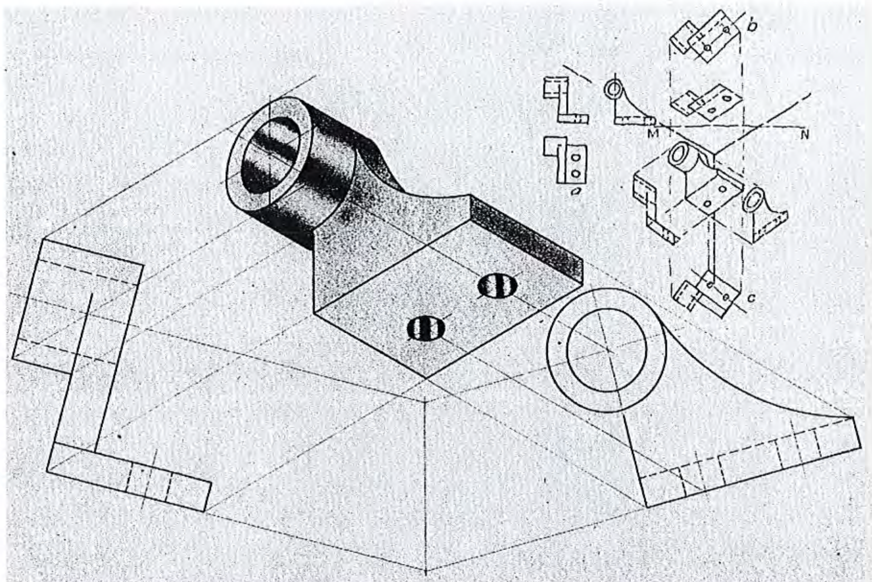

Fig. 13. Choice of orthographic views used in construction

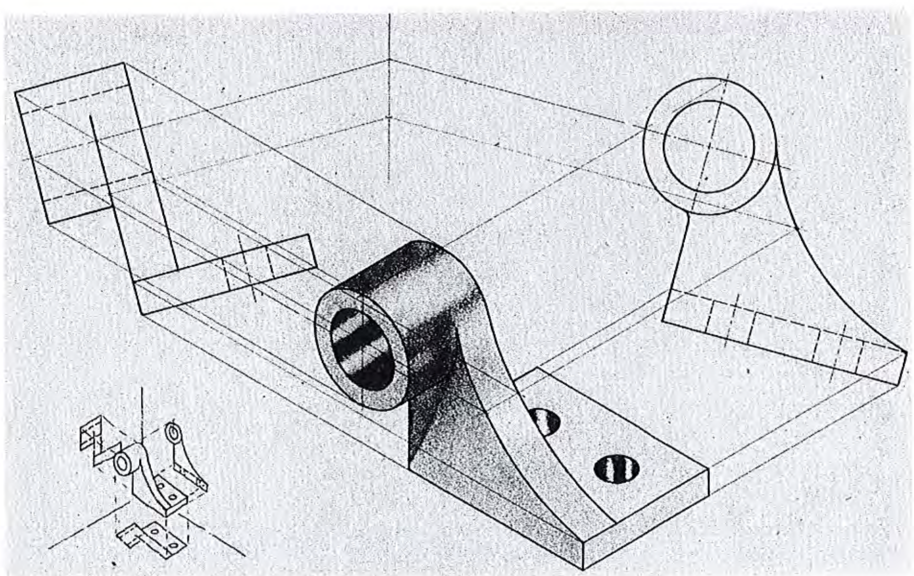

Fig. 14. Use of thumb-nail sketch in planning layout

the view (a) cannot be used with the center-line through the two holes in the position shown at (b).

By revolving the horizontal plane downward about MN, however, the orthographic view (a) can be used at (c). Note the change in direction of the center-line through the two holes at (b) and (c). If desired, for convenience, the view at (c) could be slid up on the paper until it was above the pictorial view. This would not effect the result. If the front and side views are used instead of the top view no difficulty is encountered since these views have the same arrangement in both first and fourth quadrants. These views were used in constructing Fig. 13.

Referring again to Fig. 13, the thumb-nail sketch consists of the three orthographic views in first quadrant arrangement. These same views could be rearranged to conform to third quadrant projection so it is clear that any shop drawing can be used for making axonometrics.

The simplicity and convenience of this method is again emphasized in Fig. 15 where

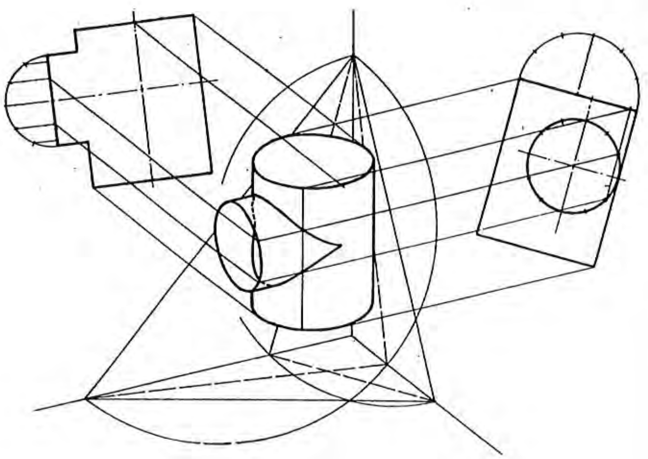

Fig. 15. Intersection of two cylinders

the intersection of two cylinders has been found in the pictorial view without the necessity of finding it in either of the orthographic views. Another typical intersection is shown in Fig. 16.

Theoretically this method serves only for axonometric projection but it can be used to produce a psuedo-oblique within a limited range as shown in Fig. 17. No construction for position of views is required and the entire set-up can be quickly made.

If the original shop drawings are too small or too large a change of scale in pictorial can be effected by the well known scheme shown in Fig. 18. The simplicity of the method is well illustrated in this figure where all construction lines necessary to produce the figure have been drawn. By inspection, it is clear that a projecting line need not be drawn from every point on the object if the draftsman has a little power of visualization.

Where freehand pictorial sketches will not suffice and accuracy of representation as well as speed is desired this method is to be recommended. For teachers and students it is an interesting development in the theory of projection and a very useful aid in the development of skill in the teaching of pictorial drawing and freehand sketching.

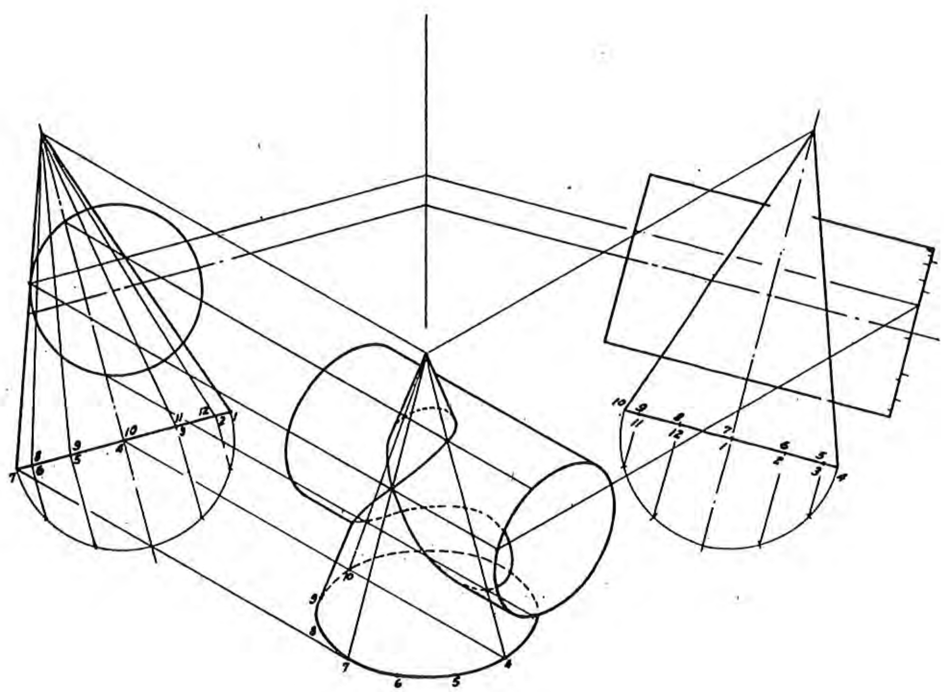

Fig. 16. Intersection of cone and cylinder

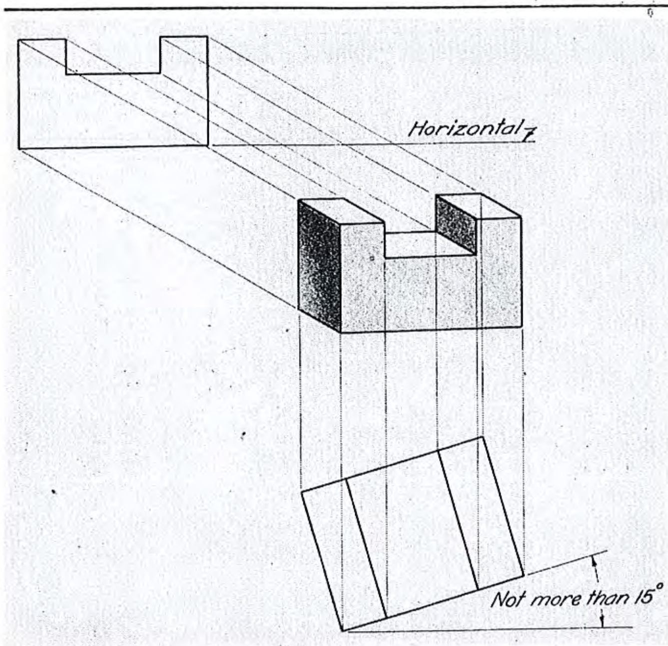

Fig. 17. A Psuedo Oblique

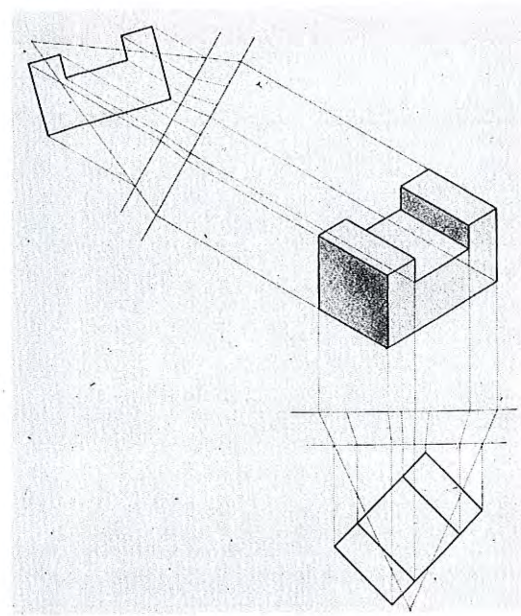

Fig. 18. Changing Scale.

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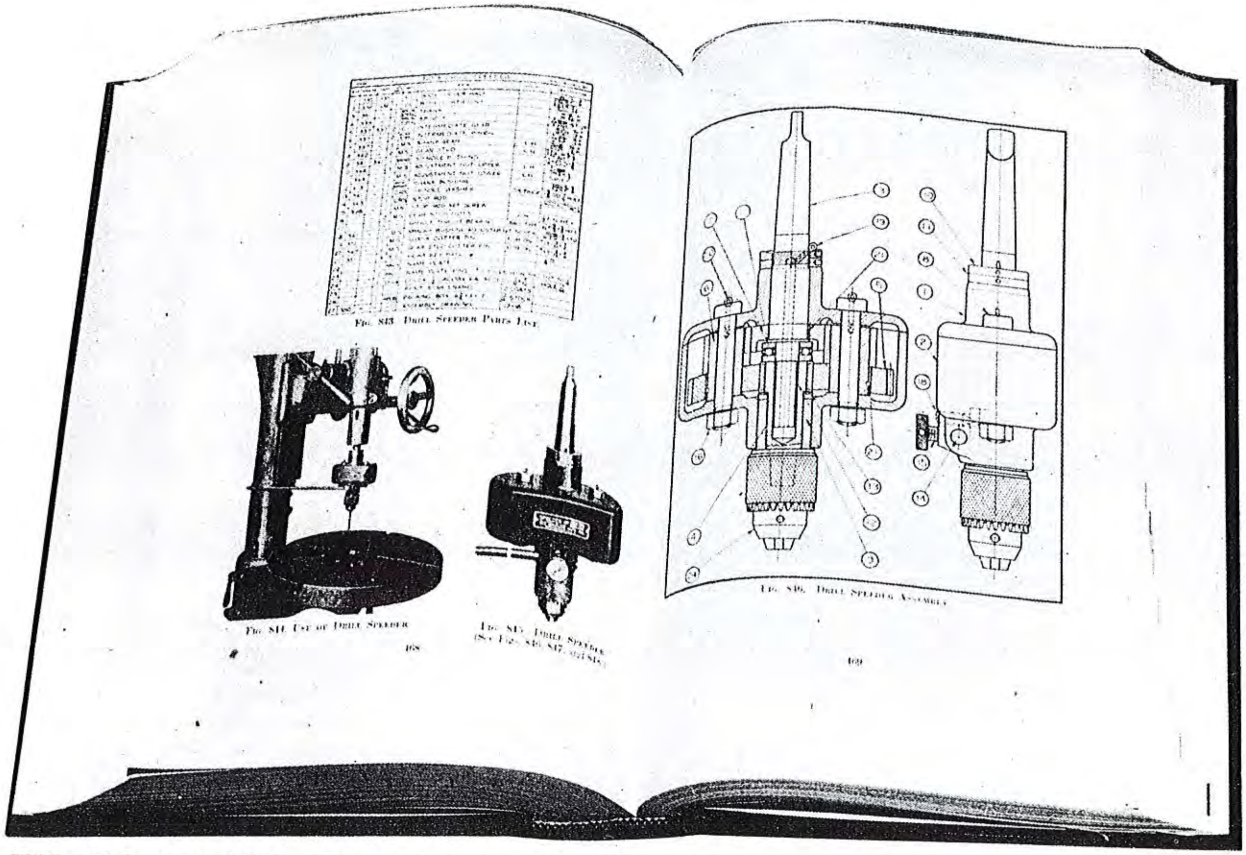


THE NAVY V-12 PROGRAM AT WISCONSIN

by
A. V. MILLAR, ASS'T. DEAN
College of Engineering - University of Wisconsin

Those who are not familiar with the plans and the purposes of the Navy V-12 program are referred to Bulletin No. 101 - Navy V-12 - Curricula Schedules - Course Descriptions - November 1, 1943. From this bulletin we learn that the plan calls for a school year of three 16 week terms. "Students will be ordered to report to all undergraduate Navy V-12 units on 1 July, 1 November, and 1 March of each year." The number of 16 week terms allowed a candidate varies with the type of service for which he is training. The curricula for the first two terms is the same for all candidates with the exception of those in the Pre-medical and Pre-dental Corps.

Students were admitted to the Navy V-12 program who had already completed part of a college course and who had enlisted in V-1 or V-7. Engineering students of this group were allowed to continue their college work in the curriculum they had begun with a few additional studies prescribed by the Navy. Other students were selected for the Navy College Training Program by an examination offered to students in most high schools, colleges, and universities in the United States and given April 2, 1943. Men who took this examination and who expressed a preference for the Navy on their admission blanks and on their examination answer booklets, were asked by the Navy to appear before a Joint Selection Board consisting of an educator, a civilian, and a Navy officer. If chosen by the Board, the student was called for a physical examination which, if passed, meant inclusion in the Naval Reserve V-12 Program.

There are at present 73,486 students in the Navy V-12 program in the various colleges and universities of the United States where Navy Programs have been assigned. Of this number about 10,000 students were selected from active duty with the fleet and sent to the various colleges and universitites for the Navy College Training Program.

The Navy V-12 program in the College of Engineering of the University of Wisconsin began July 1, 1943. At that time about 440 Navy V-12 students entered the college. 155 of these students entered as freshmen without advanced college credit and were registered in the Navy V-12 curriculum as outlined in Bulletin #101. The remainder of the 440 students entering the college came with varying amounts of college work and were given programs which best fitted their aims and previous training.

The times selected by the Navy for the beginning of each term is unfortunate so far as the University of Wisconsin is concerned. July 1, 1943 did not agree with the beginning of any other Summer Session offered by the university. Consequently upper class students in engineering could not elect courses offered in other Summer Sessions. The regular university year began the latter part of September and the second term of the Navy V-12 began November 1. Students were again restricted to courses offered in the College of Engineering since they could not elect courses from other colleges of the university.

This paper has to do primarily with the 155 Navy V-12 students who entered the College of Engineering as freshmen with no previous college experience. Of the 440 entering the college, 22 came from active duty with the fleet. 11 of these were entering freshmen and are included in the 155 mentioned above. These freshmen students were assigned to classes along with 137 civilian freshmen engineers entering college July 1, 1943. In almost every subject, the class was part civilian and part Navy V-12 students. The one exception made was that 49 civilians wished to take chemical engineering and were consequently given 5 credits of beginning chemistry in place of 5 credits of physics.

The students other than civilian chemical engineers were given the following program as outlined in Navy V-12 Bulletin #101:

SCHEDULE OF PRESCRIBED V-12 CURRICULA

First College Year (Terms 1 and 2)

For the first two terms there are two types of curricula:

1. Curricula 101 (first term) and 201 (second term) are for all types of officer candidates, except pre-medical and pre-dental.

CURRICULA 101 and 201

	Periods per week* First term	Periods per week* Second term
Mathematical Analysis I or III, II or IV (M 1 or 3, 2 or 4)**	5 (5)	5 (5)
English I - II (El-2). . . .	3 (3)	3 (3)
Historical Background of Present World War I-II(H-1-2)	2 (2)	2 (2)
Physics I - II (PH 1-2). . .	4 (6)	4 (6)
Engineering Drawing and Descriptive Geometry (D 1-2) .	2 (6)	2 (6)
Naval Organization I - II (N 1-2)	1 (1)	1 (1)
	17(23)	17(23)
Physical Training***	18 ($9\frac{1}{2}$)	17 ($8\frac{1}{2}$)
	35($32\frac{1}{2}$)	34($31\frac{1}{2}$)

* Figures in parentheses indicate contact hours per week in class and laboratory. Figures outside parentheses indicate the number of meetings per week in class and laboratory.

** All engineering candidates shall be expected to be qualified for and to complete satisfactorily Mathematical Analysis III and IV.

*** First Term

PT1A Calisthenics, 20 minutes daily.
PT4 Muster and Inspection, 15 minutes daily.
PT1B-C-D Conditioning Activities, 5 hours weekly
(or)
PT3 Intercollegiate Sports.
PT5 Military Drill, 1 hour weekly.

Second Term

PT2A Calisthenics, 20 minutes daily.
PT4 Muster and Inspection, 15 minutes daily.
PT2B Maintenance Activities, 5 hours weekly,
(or)
PT3 Intercollegiate Sports.

Civilian students took military science three times per week and physical education twice a week in place of the Navy Physical Training as given above.

This is a heavy program for college freshmen. The course in mathematics was the first semester of mathematical analysis. The work in English included quite a little public speaking along with composition and English literature usually included in such a course given to college freshmen. Historical Background of the Present World War is a course previously offered to Wisconsin students but modified to suit Navy V-12 students.

In the civilian curriculum for engineering students at Wisconsin, physics comes in the sophomore year and has as prerequisite at least the first semester of college mathematics. The regular students are beginning calculus at the time they are beginning physics. Since the Navy V-12 curricula give physics in the freshman year, our regular course in engineering physics was modified to suit the preparation of the students. Physics is normally a five credit course, so V-12 students were given five credits in place of four credits as stated in bulletin #101.

Engineering Drawing and Descriptive Geometry have for many years been given at the University of Wisconsin in two semesters of three credits each in mechanical drawing and one semester of three credits in descriptive geometry. The three semesters are given in two terms of three credits each in the Navy V-12 program. The second term is devoted almost entirely to descriptive geometry. Since we require some home work in addition to six hours per week in the drafting room, three credits per term are allowed in place of the two credits named in Bulletin #101.

Naval Organization is a course given by naval officers primarily for V-12 students. Many civilian students took the course the first term but were not required to take it the second term. The course did not carry college credit.

The Navy V-12 students were assigned faculty advisers and were given the same personnel supervision as the civilian students in engineering. Midterm reports were made on all freshmen and sophomores and individual counseling given on the basis of these reports. A sincere effort was made by both the instructors and the advisers to encourage the V-12 men in their desire to make good in college.

After a review of algebra which lasted about a week, the department of mathematics gave a written test in the subject. On the grades made in this test and any further information available, each student was assigned to one of three courses in mathematics. Thirty-nine were required to take sub-freshman work while ten were placed in an advanced course which covered the first two terms of mathematics in one term. The remainder of the 155 V-12 freshmen took the regular course required in engineering. The percentages of the class taking sub-freshman mathematics and those in the advanced course are not far different from those found in recent years in an entering class of civilian freshman engineers.

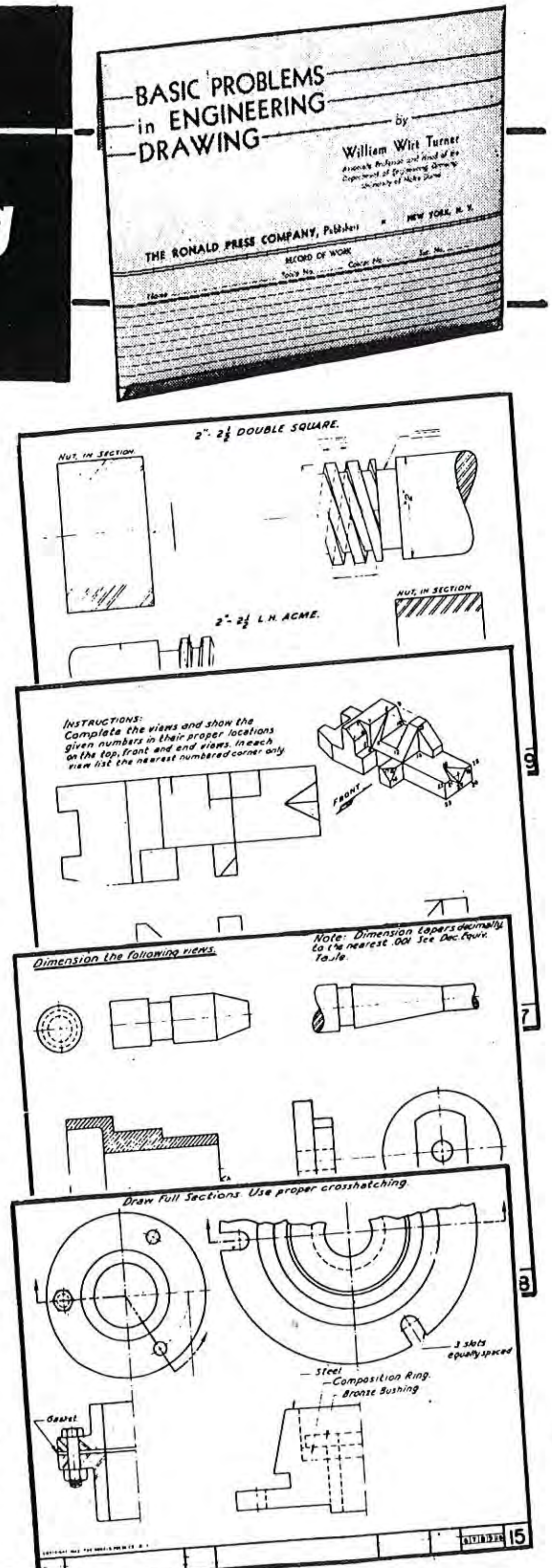
Entering the College of Engineering July 1, 1943 were 137 civilian freshman engineers. These students were given the same placement test in mathematics as the 155 V-12 students. Of the civilians only 21 were required to take sub-freshman mathematics while 10 were placed in the advanced course. Thus the civilians showed a much better preparation in mathematics than did the V-12 freshmen entering July 1, 1943. This civilian class of freshmen showed a better preparation in mathematics than any class entering the college in recent years. I think they were a younger group than usual and were making an effort to get as much college training as possible before being called for military service.

At the close of the first term, the latter part of October, there were 11 graduates from the 440 in the V-12 program and 79 others transferred out of the university. Most of the 79 transfers were because of low scholarship. In the freshman group, numbering 155, two were taken out because of physical unfitness and 25 because of low scholarship. Had these been civilian students, 18 of them would have been dropped and 7 advised to withdraw from the university. An additional 26 were placed on probation because of low scholarship. The number of freshmen separated from the program because of low scholarship, between 16% and 17%, is quite a little higher

BASIC PROBLEMS in Engineering Drawing

By William Wirt Turner

Head of Department of Engineering Drawing, University of Notre Dame



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The problems cover in logical progression, both as to subject matter and degree of difficulty, those basic phases of engineering drawing which are commonly given in the beginning course. When supplemented by the customary lectures and tests the sheets should be adequate without the assignment of additional class problems. In their preparation great care has been taken to have them conform to the recommendations of the American Standards Association.

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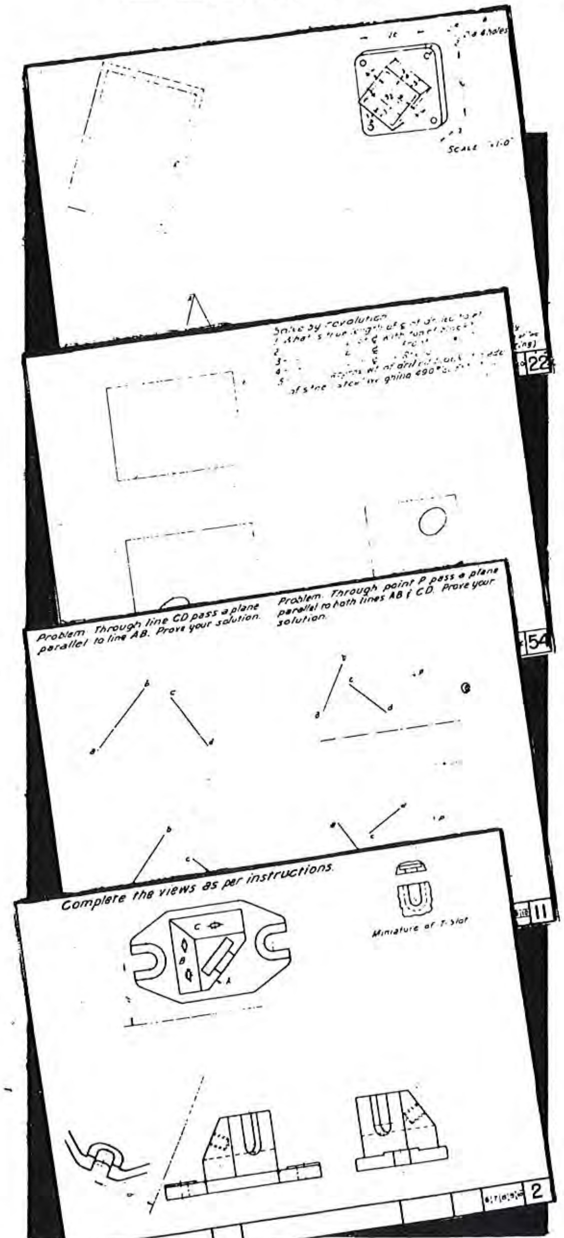

By **William Wirt Turner** *Head, Department of Engineering Drawing, and* **Carson P. Buck,** *Asst. Professor of Engineering Drawing, both of the University of Notre Dame.*

HERE, THE *DIRECT METHOD THROUGH WORK SHEETS* is applied to the subject of descriptive geometry in an intensely practical series of problems. They provide a thorough grounding in elementary principles and are suitable for use with any text using the direct method. All problems have been thoroughly tested by the authors in classroom use with civilian and Navy V-12 students. The series is based on the premise that FOUR major principles form the basis for the solution of any special problem, solved by means of auxiliary views. These are:

1. The true length of a line
2. The true size of a plane
3. The perpendicular relationships of lines and planes
4. Piercing points

Certain basic constructions applicable to orthographic projection are included, such as, the determination of a plane in space, the point view of a line and others of related significance.

In designing the problems the method of revolutions has been made to follow the method of auxiliaries for *THREE* reasons:

1. Production work generally makes use of auxiliary view method
2. Separation of the two methods keeps student from becoming confused by trying to learn two methods at once.
3. Postponement of the study of revolutions until the method of auxiliaries is firmly established enables the student to make better application of both methods in his later work.

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CONTENTS

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percentage than is normally found in our civilian freshman engineers at the close of their first term in college.

At the close of the same term, 7 civilian freshmen were dropped and 22 placed on probation out of a class of 137. This is a better than normal record for freshmen engineers.

At the beginning of the second term, November 1, 1943, 98 new Navy V-12 students entered the College of Engineering; 7 of them coming from the fleet. 65 of this number entered as freshmen with no college credit. After the test in algebra was given, we found that 25 were assigned to sub-freshman mathematics, and the remainder to the regular first term of mathematical analysis. The percentage of the class assigned to sub-freshman mathematics was much higher than in the class entering July 1, 1943, and much higher than the normal civilian class entering the college.

There were also 106 civilian freshman engineering students entering the college November 1, 1943. Of this number, 27 were assigned to sub-freshman mathematics. This is about the normal percentage assigned to sub-freshman work. The course in advanced freshman mathematics was not offered in the term beginning November 1.

On the whole, the Navy V-12 students are a splendid lot of young men. They are very courteous and responsive and are very appreciative of everything done for them. A few have not cared for college work and were anxious to get into active service. A goodly number wanted training for deck officers. The curriculum for the first two terms of this course are the same as for the engineering specialist course which is given in this college. Nevertheless, those students wanting to be deck officers would have been more content had they been in a college where the majority of their classmates were also interested in becoming deck officers.

The Navy College Training Program is new and there are many problems arising which are new both to the college and to the Navy. After a few terms, these problems will be solved and the program will run more smoothly. It is to be hoped that the selection board will, with experience, be able to place students in training programs to which students are better suited in interest, in native ability, and in secondary school preparation.

DRAWING IN THE ARMY SPECIALIZED TRAINING PROGRAM

by
WILLIAM E. STREET
Professor of Engineering Drawing - A. & M. College of Texas

Texas A. & M. College has carried three groups of trainees through the Army Specialized Training - Drawing Program. Most of these students were in ASTP 001 - three hours per week; ASTP 001 - six hours per week; and ASTP 406 - four hours per week.

There are problems encountered that seldom occur in peace time Engineering Drawing classes. Instead of normal homogeneous groups, the trainees for ASTP Drafting are composed of heterogeneous classes. Previous training and experience of many of the trainees were directed toward vocations outside of the engineering field, hence their educational background is so varied that they would need to be sub-divided several times to secure homogeneous groups. Due to limited classroom facilities and teaching personnel, it is not desirable to do this. Many of the trainees have not had drawing in high school or college and they are placed in advanced work because of other training. Some trainees have had several years drawing in either high school or college, or both. After they have attended class and demonstrated their drafting knowledge, where the Army will permit, comprehensive examinations are given and those passing with a C grade or higher are recommended for credit in drawing. (C = 80%). In the advanced classes, the trainees usually could be grouped into two groups. Those with drawing pre-requisites and those who have had very little if any drawing. If possible, it would be desirable to divide these trainees into two groups and require more drawing of the retarded group. If the two groups are kept together, then the teacher must teach them simultaneously, and it is necessary to devote considerable time to those that are deficient.

Transferring of trainees from one branch of the program to another is time consuming, although it is very desirable as it allows flexibility. Some trainees are advanced, others are retarded, and still others are re-assigned to troops. These transfers are based on progress reports every three or four weeks. Many are transferred to other branches of the service. Some trainees do not arrive on time and are from one to five weeks late entering school. All trainees are required to make up back work, and this burdens the teachers with additional work as they must keep their records up to date, on every trainee for frequent progress reports. It is difficult for the trainees in a crowded program, like ASTP, to find time to make up back work in drawing, because very few of them own their drawing equipment and instruments and cannot work in their dormitories or barracks. Usually it is necessary to come to one of the ASTP drafting rooms during some regular class period where there are tables and equipment not in use, to do make-up work. Therefore, it is best to have a few extra sets of equipment and tables in each drafting room for trainees to use in make-up work. Military class rolls and Drawing class rolls do not always conform and the Drawing Department must keep constantly checking the rolls of trainees to make sure that each trainee receives a progress report. This alone requires considerable time where several hundred students are involved and especially where you have constantly changing class rolls. Still other trainees who have had some previous drawing training and are doing well in their ASTP drawing work are transferred into extra Mathematics and Physics sections where they are retarded in these basic subjects. Such problems make it necessary to have close cooperation between the Drawing Department, the College ASTP Executive, and the Army Officer in charge.

It is desirable to start and run the ASTP work concurrently with regular College classes, as it is much easier to distribute teachers' loads and plan classroom facilities if the two programs are synchronized. Since nearly all groups of trainees are heterogeneous and require more personnel supervision by the teacher, it is desirable to keep the drawing sections as small as possible. Thirty students are handled in each class, but experience has shown that much better work can be done if the sections have from twenty to twenty-five trainees.

If feasible, drafting rooms should be used for ASTP trainees only, (unless the school furnishes instruments and equipment to their regular college students or have access to quick easy methods of transporting instruments from one room to another), in order to use the same equipment and instruments for several sections in the most economical way. The shortage of drawing instruments and equipment, and the economical handling of funds makes it necessary to use drawing instruments and equipment every hour of the day. Classes are held six days a week, running until six o'clock evenings. This makes for more economical use of drawing equipment. Good drawing instruments should be obtained as constant use demands good quality instruments. Cheaper instruments need to be repaired too often and many of the parts are soon beyond repair.

All equipment is furnished with the exception of consumable supplies. Trainees furnish all consumable supplies, such as pencils, erasers, paper, pen points, etc. The furnishing of instruments and equipment eliminates most of the home work with the exception of studying the lesson assignment, unless a means is provided where the student will have access to drawing instruments and equipment in their dormitories or barracks. Some schools have successfully solved this problem by placing a few sets of drawing instruments and equipment in the trainees' quarters, permitting them to be checked out to the trainees.

Careful planning is needed to facilitate the covering of the material outlined in the ASTP drawing program. Carefully planned lectures and demonstrations to go with suitable problems with definite teaching points are advisable to properly cover the Army syllabi. Planning of class work for the Army curricula giving consideration to the most suitable placing of each subject is advantageous. As an example, experience has demonstrated that it is much better for physical education and military drill to follow drawing classes rather than precede them. As pointed out by the Army, their curricula are not designed to give professional engineering training but are abbreviated and reduced to achieve three main purposes. Namely; (1) Give basic military training. (2) Officers training. (3) Sufficient academic training to achieve the first two. Drawing teachers should keep these view points in mind when they are planning ASTP drafting programs. As set up, the drawing curricula are too brief to prepare engineers for professional careers.

Quizzes and examinations are given at regular intervals. These examinations are comprehensive and form a basis for about 50% of the trainees drawing grade. Triplicate sets of all quizzes, examinations, laboratory sheets, course outlines, and other work should be kept on file as the Army requires two sets of this material at frequent intervals. The third set will give the Drawing Department copies of all work for future reference.

Securing of competent drawing teachers for the ASTP Program is critical. Industry is more attractive to most engineers and

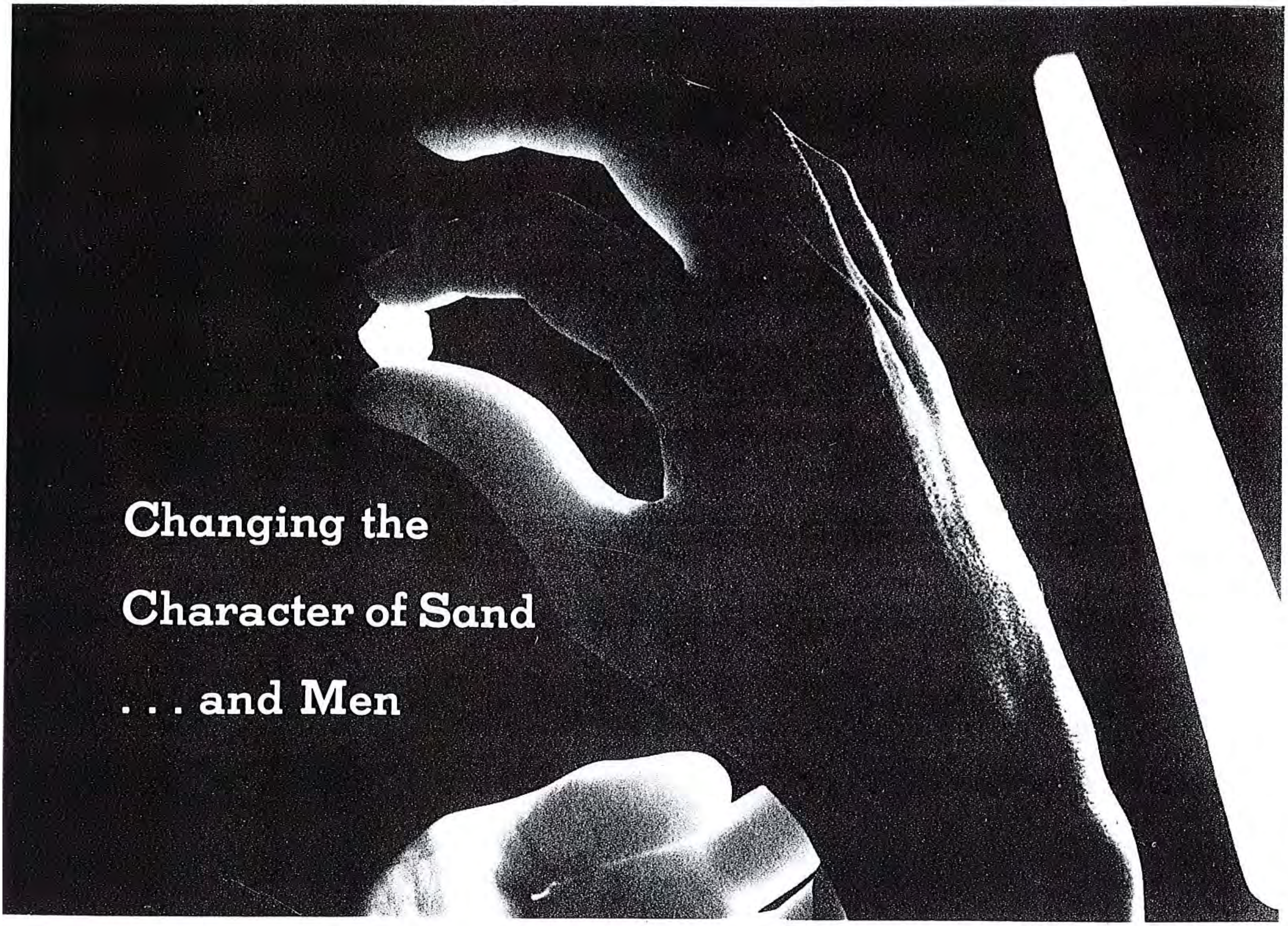

Photo courtesy Monsanto Chemical Company

NOT too long ago, if anybody had said: "I saw sand bouncing about like a rubber ball, and then I saw sand that flattens out like pancake batter, and then I saw sand that disappears like smoke in the air," his listeners would have replied: "You don't know what you are talking about."

But that just goes to show you never can tell. For science has been at work on sand, and out of the laboratory has come a marvelous new product technically called silica aerogel and commercially Santocel. What it is is simply *puffed sand,* white ocean sand "blown up" to many times its former size, capable of doing all the mysterious things mentioned before and serving commercially in many marvelous ways, among them as a remarkable insulating agent used in quick-freeze processes and as a lightweight flatting agent in airplane camouflage.

Again and again and again it has happened: marvelous results obtained with familiar things . . . provided only that the right treatment and the right influences are used in shaping these familiar things. Most marvelous of all is what can be done with men when the right treatment is accorded them . . . when the proper influences are brought to bear on them during their formative years.

It can be said that in basic mental and physical equipment there is little difference between human beings. Certainly not enough to explain the *tremendous* difference between their achievements. For the explanation of *that,* we must look to the differences in influences and environment. Psychologists know this, and educators are constantly striving to lift the level of influences so that the abilities that so unquestionably reside in *all* children may be freed and developed.

The drawing instruments a boy uses in his mechanical drawing classes can very well be one of these liberating influences. Drawing instruments are likely to be the first instruments in precise thinking, judgment and workmanship the youngster has ever used. They often represent his introduction to the realm where boyish flights of fancy are harnessed to the practical means of achievement, that realm where dream and reality first are joined. Here are instruments that help him to set standards, to distinguish between shoddy workmanship and ideals and good. To say that his boyish fancy can be stirred, captured and made creative by drawing instruments that are cheaply made, carelessly chosen, held in light esteem by his instructor is to deny all the known facts of psychology. Let *these* instruments of creation be chosen carefully, let *them* be the best the boy can afford.

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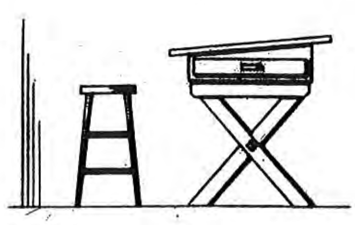
salaries are higher there than they are in colleges. Also, drawing departments are confronted with the uncertainty of the duration of ASTP training and teacher tenure is uncertain. Teaching loads vary from 22 to 24 clock-hours of classroom work per week.

The method of selection of trainees on the basis of general intelligence is good. Trainees' previous training varies so widely that the groups are heterogeneous. The aptitude of the trainees as a whole is good and they have demonstrated an anxious willingness to learn and work hard, realizing that they have an excellent opportunity for service in preparing themselves in the ASTP Program. However, there are some individual cases where the trainees fail to understand the motive for their training and prefer to return to troops. The ROTC-ASTP trainees that were activated last spring and who have recently returned to College are not as enthusiastic in their desire for ASTP Training as are the other groups. Aptitude among ASTP trainees at this Institution is highly commendable. The policies of the Army in permitting students who pass their work to have furloughs, is a good one and encourages scholarship.



THE ISOMETRIC ELLIPSE

by
H. D. ORTH
Professor of Drawing and Descriptive Geometry - University of Wisconsin

The accompanying figures show two different four center methods of representing circles in Isometric. The method of Fig. 1, most commonly used in texts on drawing, is quite inaccurate as a substitute for the plotted ellipse. In the method of Fig. 2 the four center approximation follows the plotted curve much more closely and involves only one additional step in construction. In each figure the plotted curve is shown in dotted line for comparison with the ellipse obtained by the four center method. As a means of indicating the actual deviation of the four center curves from the plotted curve in each case dimensions are given which were determined by calculation. These dimensions are for ellipses representing a one inch circle. The corresponding dimensions for ellipses representing circles of other diameters would, of course, be directly proportional to those given for a one inch circle.

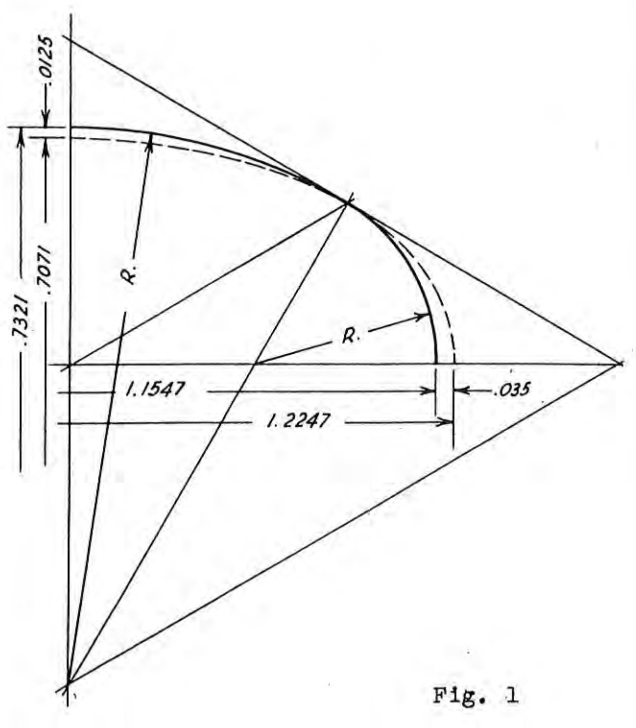


Fig. 1

In Fig. 1 two of the centers are located at the ends of the short diagonal of the rhombus representing the circumscribed square. The other two centers are found on the long diagonal where a line from the mid point of a side to the opposite corner intersects it. It will be observed that the minor diameter of this approximate ellipse is longer than that of the plotted ellipse and that the major diameter is considerably shorter than the major diameter of the plotted ellipse. The fact that these errors are considerable and in opposite directions affects the ellipse so that it is quite noticeably out of proportion to the plotted ellipse.

In the method of Fig. 2 the centers on the long diagonal of the rhombus are first located by striking arcs with centers at the end of the long diagonal and radius equal to one half the length of the side. The other two centers are found on the short diagonal produced, by drawing lines through the centers thus located and at 60° to the long diagonal. The arcs of long and short radius are tangent to each other where this line intersects the side of the rhombus. While this point is a short distance from the mid point of the side of the rhombus it will be evident that the error thus introduced is negligible.

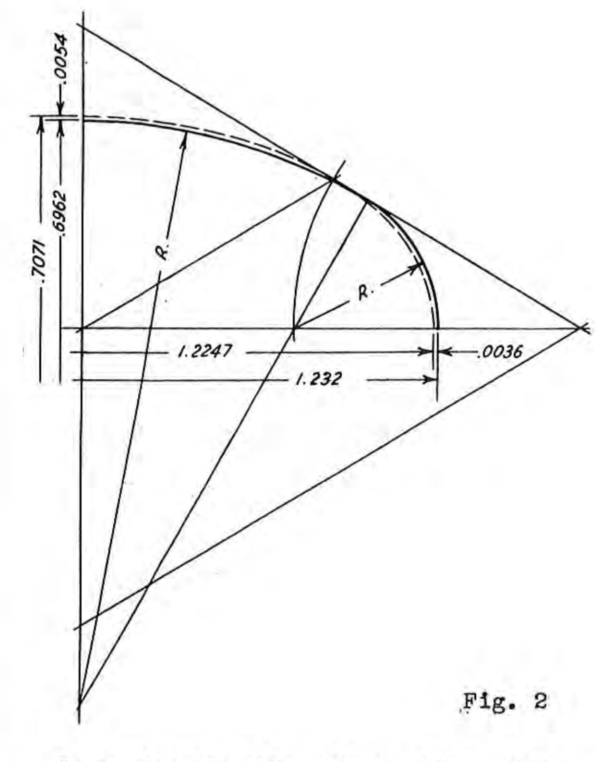


Fig. 2

Comparing the dimensions obtained by calculation for the major and minor diameters of each approximate ellipse in Fig. 1 and 2 with the plotted ellipse we find that the error in the minor diameter by the method of Fig. 1 is 2.3 times that of Fig. 2 and in the major diameter the error in Fig. 1 is 10 times that of Fig. 2.

AXONOMETRIC PROJECTIONS VIA AUXILIARY VIEWS

by
J. G. McGUIRE
Asso. Prof. of Engineering Drawing - A. & M. College of Texas

The theory of axonometric projection may be studied and easily understood with the use of auxiliary views.

Most authorities on Engineering Drawing give a definition of isometric projection somewhat as follows: "To produce an isometric projection, the object is so placed that its principal edges make equal angles with a plane of projection." In other words the object is so viewed that the principal edges are foreshortened alike. If the reader will visualize a cube situated as described in the definition above, he will realize that one diagonal appears as a point. Hence, it is only necessary to obtain the end view of a diagonal of the cube with the use of auxiliary views.

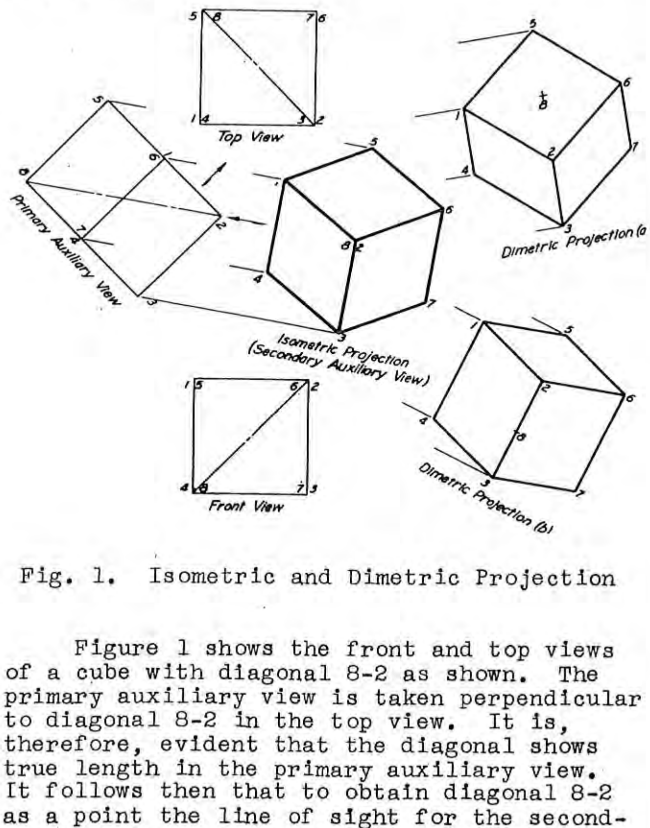


Fig. 1. Isometric and Dimetric Projection

Figure 1 shows the front and top views of a cube with diagonal 8-2 as shown. The primary auxiliary view is taken perpendicular to diagonal 8-2 in the top view. It is, therefore, evident that the diagonal shows true length in the primary auxiliary view. It follows then that to obtain diagonal 8-2 as a point the line of sight for the secondary auxiliary view should be taken so that the observer is looking down line 2-8. The resulting secondary auxiliary view is an isometric projection. It should be observed that this gives an isometric projection with all lines foreshortened properly without the use of an isometric scale.

Figure 1 shows that dimetric projections may also be obtained from the same set-up.

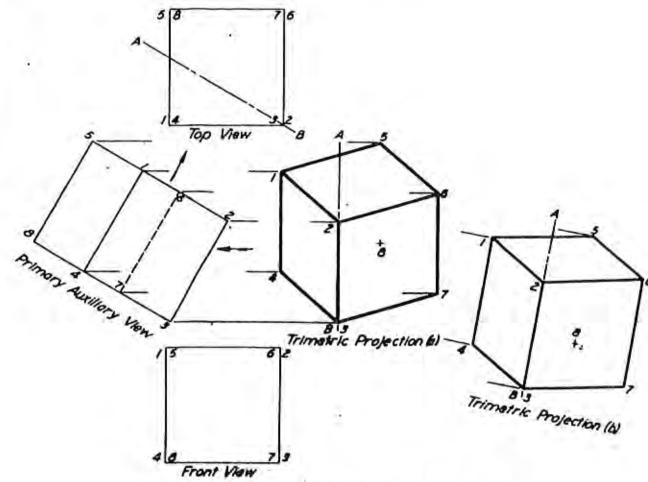


Fig. 2. Trimetric Projection

The views marked Dimetric Projection (a) and Dimetric Projection (b) are examples of an infinite number of dimetric projections that may be obtained by taking the line of sight at various directions to the primary auxiliary view. In dimetric projection the cube must be so situated that two sets of edges are foreshortened alike while the third set of edges are foreshortened more or less than the first mentioned sets. It is obvious that views marked Dimetric Projection (a) and Dimetric Projection (b) of Figure 1 follow the definition for dimetric projection.

If the cube is so situated that the three sets of edges are foreshortened in an unlike amount the resulting projection is classed as trimetric projection. Figure 2 shows a cube with the line of sight taken for the primary auxiliary view such that the secondary auxiliary views are trimetric projections. It should be observed from the views marked Trimetric Projection (a) and Trimetric Projection (b) in Figure 2, that the three sets of edges are foreshortened in unequal amounts. Of course, these are only two of an infinite number of trimetric projections that may be obtained by taking the line of sight at different positions to the primary auxiliary view. The line of sight for the primary auxiliary view may also be varied to suit the conditions of the object at hand.

The writer does not, of course, imply that all axonometric projections should be drawn in the above described manner but believes that this system would be a very valuable aid in teaching the theory of projections.

Book Plate Competition

At the last business meeting of the Division of Drawing and Descriptive Geometry, in June 1943, the Engineering Library of the University of Illinois was designated as the depository for the Division's books. There are a number of volumes belonging to the Division, and the members felt that the ownership of these books should be indicated by the placing of a suitable book plate in each one.

To this end, a committee, headed by Professor T. E. French of Ohio State University, was appointed to conduct a competition among the members of the Division, with the object of securing such a book plate. This competition was to be conducted through the columns of the Journal, in which the competing designs will be published, and the winner announced.

THE COMMITTEE AND THE JOURNAL THEREFORE ASK THAT AS MANY AS POSSIBLE NOW MAKE AND ENTER YOUR DESIGNS IN THIS COMPETITION IN ACCORDANCE WITH THE RULES GIVEN BELOW.

1. The size of the book plate shall be no larger than 5 x 5, and of any shape. The original drawing may be in any multiple of this size, if suitable for reduction.

2. The design shall at least include the following lettering:
DIVISION OF DRAWING AND DESCRIPTIVE GEOMETRY, S. P. E. E.
and in smaller lettering:
Presented by . . . . . .
Space in which date of acquisition may be lettered shall also be provided.

3. The plate shall be designed for reproduction in black and white.

4. The design shall have no identification of the artist on its face. The winning design shall be returned to the artist for insertion of name and date in some part of it. Other designs will be returned to their owners.

5. (a) All plates entered shall be sent directly to:
R. R. Worsencroft, Editor
Journal of Engineering Drawing
Engineering & Education Bldg.
University of Wisconsin
Madison, Wis.
and shall include with them a sheet giving the name and address of the artist.
(b) The Editor will inscribe each design with suitable identification, and forward to the Chairman of the Committee for judging.

6. Any member of the Division or subscriber to the Journal may enter this competition. Designs are particularly solicited from Division members.

7. All designs must be received by the Editor on or before June 1, 1944.

8. The judges of the designs will be selected by the Committee, and their decisions will be final. Judging shall take place at the annual meeting of the Division in June 1944.

9. The name of the winner and his design shall be published in the Journal as soon as practical after the judges decision. The winning design shall become the property of the Division.

10. The Journal reserves the right to publish any or all of the designs submitted, so long as the artist's name is used in connection therewith.

A PARTIAL SUGGESTIVE ANALYSIS OF GRAPHIC TALENT *

by
CLAIR V. MANN
Professor of Engineering Drawing - Missouri School of Mines

The writer's eighteen years of work in the field of objective testing in engineering and engineering drawing and descriptive geometry seems to indicate that there are several major areas or categories of special graphic ability which must be taken into account in constructing suitable tests to measure that "composite" which we have been calling "Graphic Talent."

Let us consider the general nature of the human organism. He is possessed of head, trunk, legs and arms, eyes, ears, nose, mouth, and a bundle of highly sensitive nerves. He is invested with five major "senses" - sight, taste, touch, smell, and hearing - and with quite a variety of what we shall call "sub-senses". These last include such "senses" (if they be such) as the sense of direction, of balance, of pain, temperature, humidity, stereognosis, and kinaesthesis, and perhaps yet others. A goodly portion of the body gets into action throughout a day's professional work as the engineer-draftsman stands before his drafting table - or as the engineering student goes through the complete array of tasks set before him by his teacher of drawing and descriptive geometry.

Let us turn to a further consideration of those body parts which in an especial way contribute to the making of engineering drawings, and the doing of the multiplicity of tasks set for the student by the drawing teacher. Chief among these special parts are the hand, and the fingers on it; the arm, including the forearm and upper arm, and attachments to the body at the shoulder; that most wonderful of all the draftsman's tools, the human eye; and, of course, the human brain, with all the intelligence we are accustomed to ascribe to it. In the person of the skilled, experienced engineer-draftsman, not any one of these parts can shirk or fail in cooperation with the others, if superior and speedy work is to be the result. We may remark, then, that since all these parts contribute to the goal - which is an acceptable engineering drawing - we shall learn much about graphic talent by knowing the objectively measurable qualities of the parts so named.

Under most ordinary circumstances, these special body parts "team up" to produce the drawing **being** made. But when a student is faced with the necessity of taking a "true-false" or a "multiple-choice" test, which is to cover the theory of dimensioning, let us say, or the principles of orthographic projection, the skilled arm, hand and fingers get a good rest. Again, when a student, sitting in a dark room, is handed a box containing fifty stove or small machine bolts, and is asked to first run the nuts off and place them in a saucer, and then to run them all back again - then the eyes get a well deserved rest, and the skillful, sensitive fingers (employing tactual and kinaesthetic senses) ably complete the task.

An immensly interesting situation is created when the student sits down in a booth to the hole in one side of which has been fitted a pair of coat sleeves, through which he may thrust his hands and arms, and be "blindfolded" without tying a handkerchief over his eyes. Outside the booth, his hands move over a table, and about the corners and surfaces of a machine part, all the while completely cut off from the student's vision. The student is asked to explore the machine part with hands and fingers, noting and estimating such things as shape, size, texture, finish, and materials. From time to time he is to withdraw his hands so as to make, with the aid of his vision, a complete technical sketch of the machine part, including his estimate of dimensions, finish, and so on. Here we are dealing with tactual and kinaesthetic senses - stereognosis, as it has sometimes been called. This is the ability the hand and fingers have to sense shape and form, as well as dimension. The hand, unaided by eye, has no power to sense color, although the surface finish may be detected as a painted one.

We have gone far enough in this partial analysis to make it apparent that the eye is a master piece of equipment in the making of drawings, as well as in gathering all manner of information for use of the brain - through observation of color, shape, dimension, texture, and through reading of the printed text. In our comprehensive scheme of testing, therefore, we should fully take account of the ocular equipment of our students - the excellencies and the handicaps or imperfections - and should perhaps be as able as the trained oculist in seeing to it that our students have the best correction of these ocular defects that is available. The up-and-coming teacher of engineering drawing can make a beginning in this process NOW, by procuring and making available to his students several of the basic ocular tests to be found in the office of any country "eye-doctor". These should include at least a standard visual acuity test, a test of color blindness, a test of

* Paper accompanying Report of Committee on Graphic Talent, presented at annual meeting of Drawing Division of S.P.E.E., Drake Hotel, Chicago, Ill., June 19, 1943.

visual reaction time, and perhaps others. Use of the visual acuity test in writer's classes has enables several students to have their oculist make badly needed corrections of sight through fitting of proper glasses. Use of the Ishihara color blind test has made students aware of their color blind condition, with result that they stayed out of army R.O.T.C. training, which required for graduation freedom from color blindness. Our department of mineralogy now regularly uses this color blindness test, having for years borrowed our simple equipment.

Engineering teachers have now for some years dropped into the habit of taking the measure of the student brain by means of various and sundry standard psychological tests, such as the "American Council" or the "Ohio Psychological" tests. Our tests of visualization offer some highly interesting data for further study from a philosophical standpoint. Such questions as the following arise: How would a student "visualize" - see with a "mind's eye" - in a specific case where the student had been born totally blind, and was incurably blind? Could HE experience the type of visualization utilized by the designing engineer not so handicapped, in the planning of a steam turbine? What would be his mental "color" visualization process? Reports on actual cases in which sight has been restored after years of blindness (in persons born blind) give us some most interesting sidelights on the process of "visualization." It appears that we can "visualize" in terms of each of the "sense areas" we possess - and that, in some way, our "visualization" is a complex admixture of previous experiences in one or more of these sense fields. For example, we may "audulize" in terms of the "ear" sense - or "olfactualize" the smell of frying hamburger and onions. We may "visualize" the face of our mother, or "stereognize" the form of our sweetheart. We can "thermalize" with reference to a heated furnace we do not see, and "gustize" a dish of ice cream. All these are processes of imagination - each in a distinct sense field.

We shall want to experiment and test various of these imaginative fields, and have already worked with the "visual imagination", or what we have heretofore called "visualization." With respect to written linguistic tests of brain capacity or ability, we already have available hosts of tests that serve such purpose. It is a fact, however, that our field of Graphic Talent tests of this order still needs coverage and order. We are woefully deficient in tests that apprise us of the qualities of fingers, hand and arm, as we use them in our drafting work. It is here that our Drawing Division testing program needs some real bolstering - needs a lot of individual experimentation on the part of interested and capable teachers. Yet, after fifteen years spent in trying to devise groups of tests in this area, the writer is convinced that success will surely be attained if organized and persistent effort is expended. Any one of you looking for a research field for a master's or doctor's program could not do better than to direct your effort along such lines.

Possibly one of the tentative lines of investigation we started in 1933 may prove to be interesting and stimulating. Let us look at the "hand forms" of a group of students of engineering drawing. Do "form of hand" and "size of hand" have anything to do with excellence of lettering or delineation? After observing the hands of numbers of our students who were proficient in lettering and delineation - and then the hands of some who were not - we formed the impression that students with long, slender hands and fingers were superior at such work. These "hand prints" were taken as a record which we could study after the students left our classes. We evolved a "hand-index", akin to that used by scientific anthropologists, which in a rough way indicates relative "slenderness of hand." This index is found by taking the quotient of the hand length (wrist joint to finger tip) divided by the palm width. An index of 2.000 or better was found, in general, to be indicative of superior lettering and delineative ability.

Thinking we would find in "needle threading" an ability closely allied to freehand engineering lettering, we procured enough No. 7 sharp needles to supply fifty students at a time, when each one was given twenty-five needles. We purchased fifty spools of No. 40 black cotton thread. With the needles laid in order on a suitable piece of paper, and with a small pair of scissors at hand for cutting thread, the students were asked to thread all their needles in the least possible time, pulling the thread through needle eye about five inches, and tying the loose ends of thread together. Their score was the number of seconds required to complete the task, measured with a stop watch. This test DID find the two best letterers, but failed on the third best. For the criterian we collected samples of student lettering later in the course, executed on a standard form card 4 x 6 inches. The card was subjected to twelve different methods of scoring, which included among others correctness of copy, spacing of letters in words, spacing of words in lines, uniformity of letter size, uniformity of stem slopes, alignment of letters along guide lines, and yet other qualities. We had a "near approach" to objective grading on these cards of lettering. The value of these methods exceeded the value of the needle test in predicting lettering ability.

In another experiment, we made of soft steel wire about 0.10 inch in diameter a quantity of "bent wire" forms - fifty to a set. The wires, before bending, were of constant length, weight, color, smoothness. They varied (perceptibly at least) only in the form to which they were bent. Our goal now was to learn something of the student's ability to quickly detect differences in FORM or SHAPE. This ability is certainly one of the major components of graphic talent. It is of major importance in the artist and in the architect, as well as in the engineer. Again, the tendency was for students who excelled in this test to do superior delineation also.

Much more direct and significant are two series of tests that have been gradually evolved in our department since 1931, which require the student to actually use India ink and the ruling and bow pens, the six inch compass, the drop spring bow pen, the contour pen, the fine pointed freehand lettering pen (Gillott's 303 or equivalent Henry tank pen), and the Mann Line Gauge. There is a single and separate 8½ x 11 sheet or page for each of these instruments, and for the ruling pen there are at least three.

Our first set of these tests was on the 8½ x 11 sheet - and the paper was the best grade of Danish ledger paper we could procure. This paper insured good flow of ink, and provided a smooth drawing surface. Trouble with ink was thus reduced to a minimum. Before any student took any of the tests, the ink in his bottle, together with the instrument to be used, was actually tried by the instructor. Poor instruments, or poorly sharpened ones, were not allowed. Our department has started to solve this problem by purchasing a full set of ruling and bow pens, all of the same pattern, which can be kept in standard condition. These exercises were printed by the planograph method, in either a red or a purple ink. These colors were selected as a distinct aid in the scoring process - for no other reason. They made excellent practise sheets, and could be scored by methods which, if not 100% objective, were highly so. Students taking these exercises came to know very quickly the difference between good and poor instruments, and between various line widths. Students whose scores were high on these tests were high also on the drawn plates in the course.

Up to last year we managed to find the time required to completely score these sheets by objective procedure. It was found that the tendency to start and stop inked lines exactly where they should start and stop - or the reverse of that - was an excellent objective basis for grading. The line width, in comparison with the Mann Line Gauge - although not quite so convenient - was nevertheless another good means of scoring. The line quality - uniformity of width, freedom from deviations or blots - proved to be a third available method for scoring. Finally, all lines not marked off for the preceding three imperfections, provided a fourth score. All four combined made up the "total score". Some of the tests had to be scored on the basis of whether heavy lines were accurately "centered" on the test layout lines - or whether lines accurately met at "corners." These six considerations make it possible to objectively score a drawing of a machine part having considerable complexity. We have, in fact, designed and used numbers of classroom plates that were graded with great satisfaction on such bases. We evolved "scoring sheets" for such plates, on which each point scored could be kept for permanent record and study, as for true-false tests, for example. Such grading methods bring out vivid differences between individual plates such as could never be detected by the usual "inspection" methods of grading plates. One plate graded by such methods is worth a dozen graded by the "inspection" method.

Finding that our 8½ x 11 plates were taking more time than we had to spend on them, we decided to abbreviate the tests, and produce a wider range of forms. This resulted in a set of short, objective tests, printed on cards 4 x 6 inches in size, in red ink, the most of which can be administered within a fifteen minute period. Most of the tests take not over half of that time. Possible scores have been so designed as to result in 100, or 120, or 150 points. Each card can be scored in about one minute of time.

In the above series of sheet and card tests - instrumental tests - we have relatively basic and objective and accurate measures of actual delineative skill. These tests still measure a relatively complex "composite" of graphic talent - but involve much less exercise of the brain or thought processes than do any true-false, multiple choice, or similar forms of tests. They involve simply and directly the qualities of visual acuity, coupled with agility and steadiness of hand, arm, and fingers. Development and use of more such tests as these will supply one of the major elements in testing heretofore greatly lacking in our Division's experimental program.

Scaling presents another interesting phase of graphic talent. It is intimately related to the reading of scales on delicate scientific instruments, many of which are provided with various forms of micrometers and verniers. In many such instruments, enough skill of hand is required to bring the scales to a proper setting before the reading can be made. After that setting, the reading is done by the unaided eye - although the hand may have to contribute in the recording of the measurement. This process is present in scaling for engineering drawing.

Nice control of the hand and fingers is required, however, when the problem assumes the form of laying off a given distance along a given line. Our $8\frac{1}{2}$ x 11 proficiency tests cover in a very satisfactory way the principles the student must master in using civil, architect, and mechanical engineer scales. We score his actual scaled measurements with high objectivity.

What we have now said is admittedly little more than a "sketch" analysis of graphic talent, and ways in which it can be measured. We have, in a broad way, indicated fields wherein definite work can be done in the further segregation of various of the graphic abilities. We have broadly indicated the types of tests we have been able to devise, use, and score objectively, and we have brought to the attention of the Division a generous assortment of tests now available for such uses. We did not hope to cover the entire field. If what we have presented results in stimulating others to try their hands in this work, our goal will have been reached. Here is a wide and fertile field for the would-be researcher in engineering drawing.

With educational, industrial, and governmental agencies clamoring for practical tests in these fields, there should be left very little to argue about concerning the value of producing a comprehensive assortment of graphic talent tests. We leave with you the challenge that this Division - including, as it does, the leaders in the field of engineering drawing, owes it to the less well trained and equipped industrial and educational agencies to produce a standardized set of tests covering all essentials in the field of graphic talent.

GUIDE LINES

(Continued from page 22)
pad of "Study and Reading Assignments" has been developed. Each sheet of the pad contains questions which are answered by direct reference to the text. The questions are purposely simple, and can be answered by a word or two, or more usually, by drawing a small freehand sketch in the space or form provided. The text assignment covered is given at the top. Each period, one page is assigned to the student covering some phase of the work to be done at the next period. The questions are so designed that they may be easily and quickly corrected by the instructor, and require not more than about one half hour of the student's time.

They have so far been quite effective in considerably increasing student knowledge of the text. Particularly have the pads been useful in ASTP classes where thorough class coverage of all the material prescribed by the Army has been impossible.

R. R. Worsencroft.

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CAN YOU TOP THIS?

One of the younger members of our Division, himself an experienced teacher of drawing, is now busily engaged in taking the course in drawing prescribed by the Army for its third term ASTP program. We trust that he will be able to get a passing grade in the course.

THE ARMY, THE NAVY, THE MARINES, AND THE COAST GUARD, ACCORDING TO THE 1943 VISUAL REVIEW (SVE), USE MOTION PICTURES TO IMPROVE AND ACCELERATE THEIR TRAINING PROGRAMS. ESMWT ALSO USES FILMS EXTENSIVELY IN CIVILIAN CLASSES TO STEP UP TRAINING FOR ESSENTIAL INDUSTRY.

PROFESSOR JUSTUS RISING HAS PIONEERED IN THE DEVELOPMENT OF THE FOLLOWING FILMS AS A MEANS OF MORE EFFECTIVE INSTRUCTION IN ENGINEERING DRAWING. THE PURDUE RESEARCH FOUNDATION HAS MADE POSSIBLE THE REPRODUCTION OF THESE AND OTHER ORIGINAL TEACHING AIDS SO THAT THEIR WORTH MAY BE DEMONSTRATED BY OTHERS.

DEVELOPMENT OF SURFACES
INTERSECTIONS OF SURFACES
USE OF T-SQUARE & TRIANGLES
TESTING T-SQUARE & TRIANGLES

CAPITAL LETTERS	SCREW THREADS
AUXILIARY VIEWS	SECTIONAL VIEWS
FREEHAND DRAFTING	PICTORIAL DRAWING
LOWER CASE LETTERS	STRUCTURAL DRAWING
MULTIVIEW PROJECTION	INK WORK & TRACING

SHOP WORK   APPLIED GEOMETRY   FOUNDRY

FILMS SLIDES AND WORK SHEETS MAY BE BOOKED FROM L.D. MILLER, ENGINEERING EXTENSION SERVICES, OR PURCHASED FROM JUSTUS RISING, DEPARTMENT OF GENERAL ENGINEERING, PURDUE UNIVERSITY. LAFAYETTE, INDIANA.

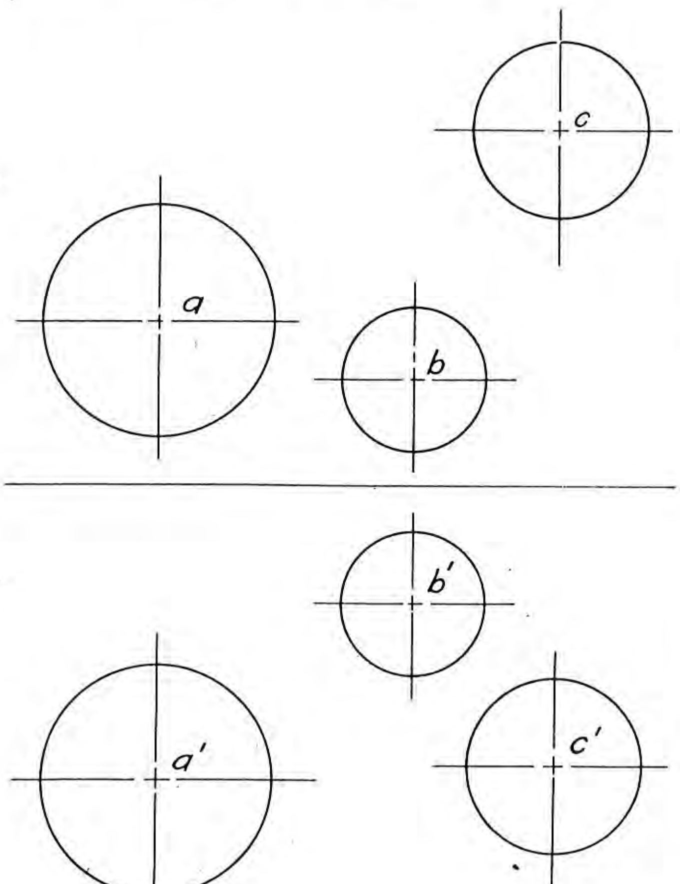
THE FILMS AND THEIR USES ARE DESCRIBED IN EDUCATIONAL SCREEN DECEMBER 1940 VISUAL REVIEW 1942 AND FUNDAMENTALS OF ENGINEERING DRAWING BY LUZADDER 1943.

GUIDE LINES

Here is a problem in descriptive which may be of interest to our readers. Mr. H. H. McCully Jr. provides it for us.

Given: The top and front views of three spheres.

Required: To represent the plane or planes which will be tangent to all three.



This isn't a trick problem - it's straightforward descrip. There are probably several ways of doing it. Send us your solutions and we will publish the simplest one in the next issue.

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THE IOWA DIMENSIONING STUDY SHEET

This sheet (reproduced on the following page) has been found useful at the University of Iowa, by offering an opportunity for the instructor to add the "seeing increment" to the learning curve.

As we all know, dimensioning is one of the most difficult of the many phases of Engineering Drawing to teach. By exemplifying with good drafting, and by correlation this graphical concept to a concisely lettered note of explanation, about 90% of the usual student errors are anticipated.

A blueprint of this sheet is permanently displayed in the student drafting rooms. Reference to it is encouraged at all times, even during exams. Reference to it is required by personal escort of the instructor in some cases of daily assignment.

It is the opinion of the Department that the use of this sheet is a distinct contribution to our teaching efficiency.

John M. Russ.

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STUDY AIDS

One of the problems of the drafting teacher is to persuade his students to read their textbooks with care, and some intelligence. But the student, convinced from time immemorial, that a mere drawing course should require no textbook study, usually contents himself with looking up those items of text which are concerned with his immediate drafting board problem, and even this is often done in class. Using his text in this fashion, he misses much of the information he should obtain, and this naturally shows up in his drawings and quizzes when it is too late for him to correct his neglect.

Some writers of textbooks have attempted to provide for this by placing review questions at the end of each chapter, but these will hardly receive more attention than the text itself, unless forcibly called to the student's notice. One recent new idea along this line of getting the student to "crack" his text is a pamphlet by Prof. J. M. Russ, "Quiz Questions to Accompany French's Engineering Drawing". If used as its author suggests in his preface, and particularly according to the first suggestion therein, it should provide the student with a good knowledge of the contents of his text, as well as some idea of what his classwork is all about.

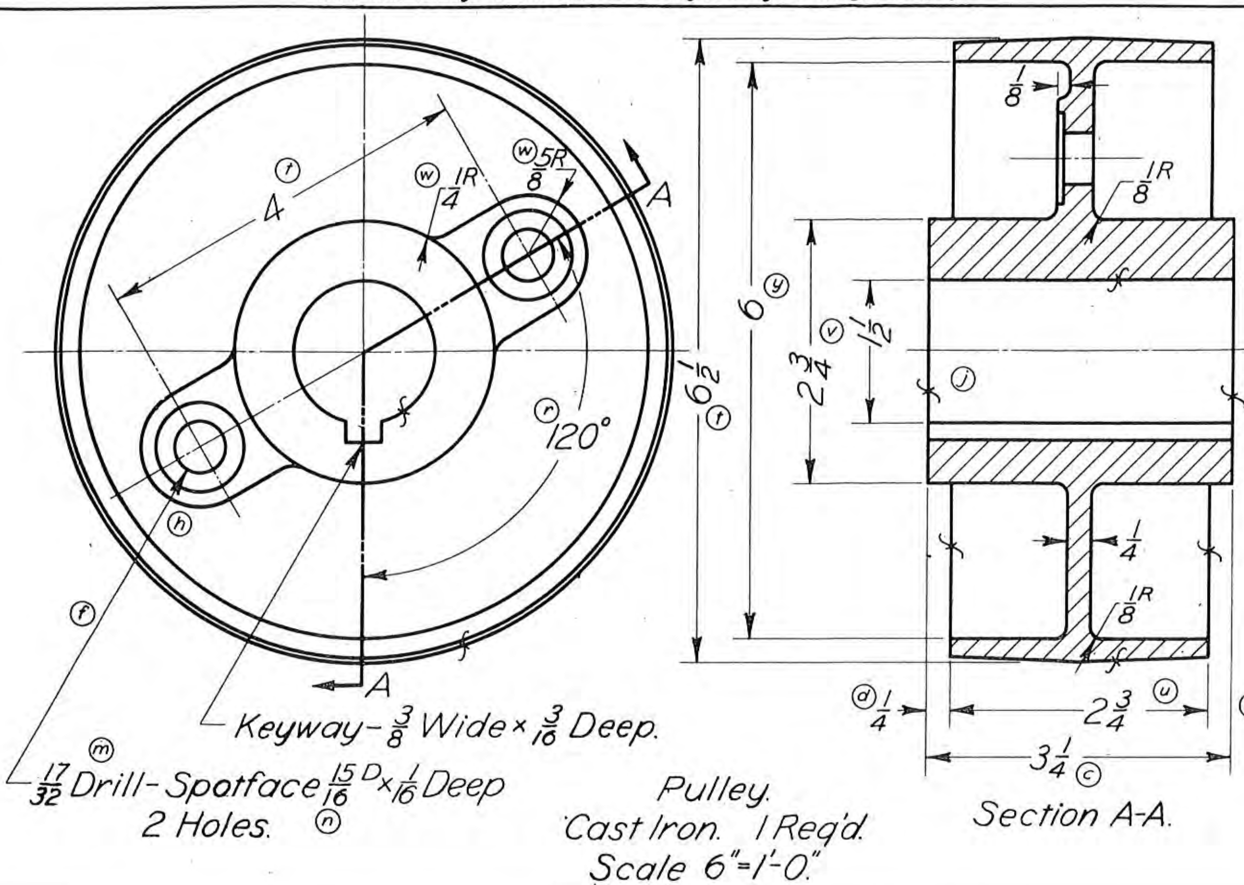
Another recent effort to a similar end has been made at Wisconsin, where an $8\frac{1}{2}$ x 11

(Continued on page 21)

Dimensioning Study Sheet.

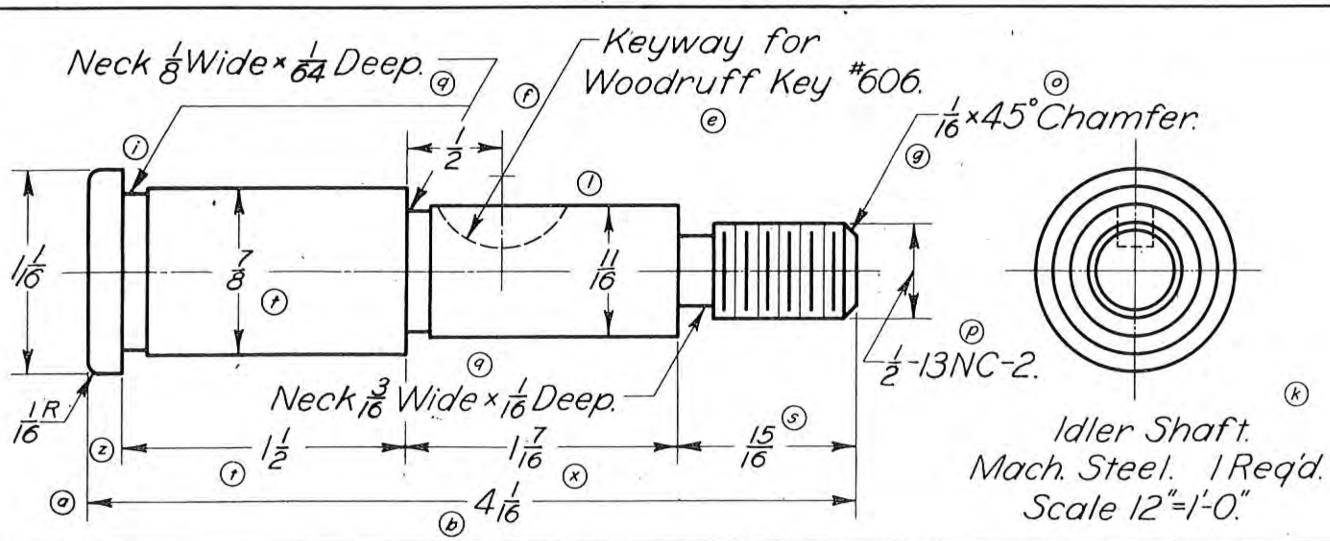
Reference is Page No. in 6th Edition Engineering Drawing. (French.)

422-9-1.



Pulley.
Cast Iron. 1 Req'd.
Scale 6"=1'-0".

Section A-A.



Idler Shaft.
Mach. Steel. 1 Req'd.
Scale 12"=1'-0".

Item	Ref.	Description.	Item	Ref.	Description.
a	178	Good arrowheads.	n	200	Spotface of proper dia. and depth.
b	188	Overall is last of series.	o	200	Chamfer shown and dimensioned.
c	188	Overall is given.	p	217	Threads properly specified.
d	182	Correct arrangement of location dimensions.	q	200	Necks shown and specified.
e	200	Shop notes in good form.	r	188	Angle dimension reads horizontally.
f	179	Leaders at 30° with vertical.	s	179	Fraction line is parallel with dimension line.
g	200	Stem on note end of leaders.	t	185	A.S.A. Standards for placing dimension numbers.
h	179	Leader points at ℄ of hole. (Contour view).	u	186	Parallel dimension lines — dimensions staggered.
i	192	Necks located from shoulder.	v	187	Diameter-not radius of circle.
j	179	"f" marks complete and in good form. (V may be used.)	w	187	Radius — not diameter of circle arc.
k	259	Title complete.	x	188	Dimensions not crowded.
l	179	"f" marks not given on steel shaft.	y	186	Dimension placed between views.
m	200	Size for drilled holes includes 1/32" clearance.	z	Fig. 445	Omitted to control cumulative error. (In manufacture).