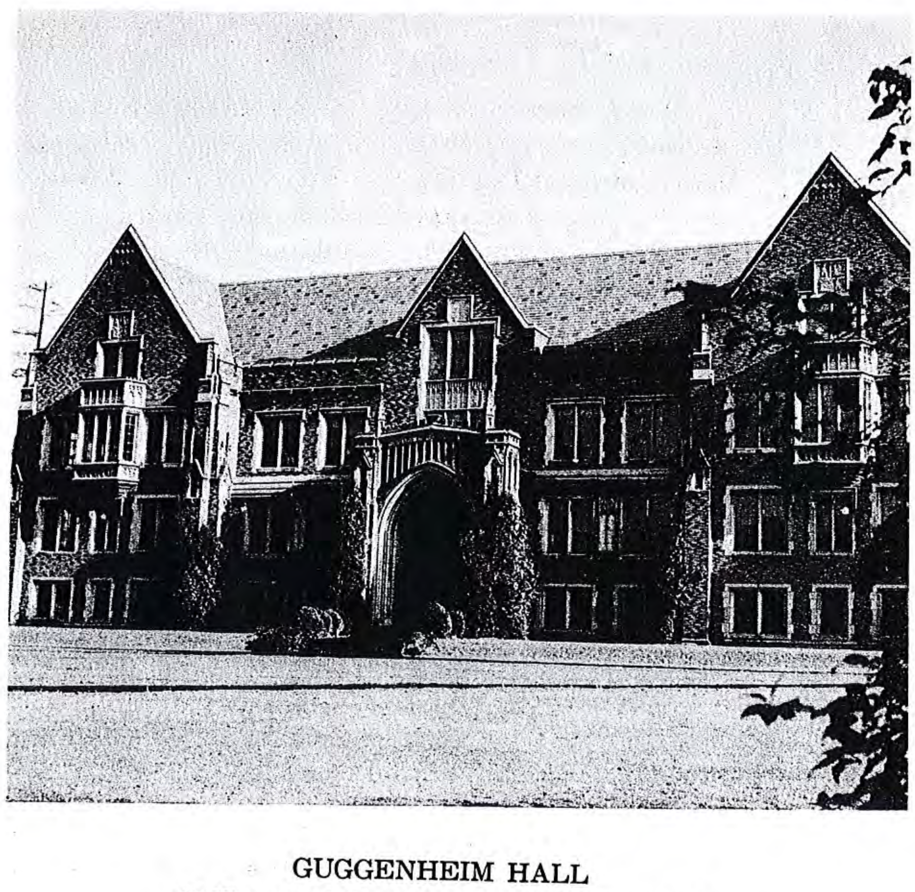
JOURNAL OF ENGINEERING DRAWING

VOL. 10, NO. 2 MAY, 1946 SERIES NO. 29



GUGGENHEIM HALL
(Offices and Lecture Rooms in Civil and Mechanical Engineering)

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON

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

JOURNAL OF ENGINEERING DRAWING

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

VOL. 10, NO. 2 — MAY, 1946 — SERIES NO. 29

CONTENTS

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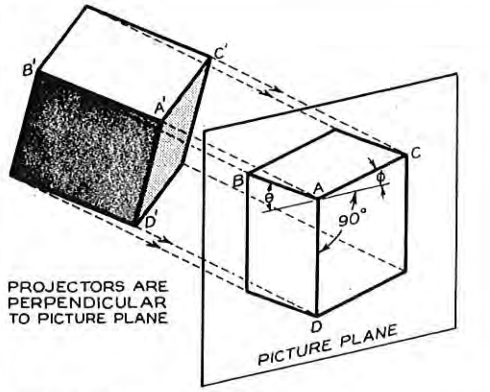


ISOMETRIC: θ = φ = 30°.
DIMETRIC: θ = φ (not equal to 30°, but less than 45°).
TRIMETRIC: θ not equal to φ (θ + φ = less than 90°).

FIG. 1
AXONOMETRIC PROJECTION

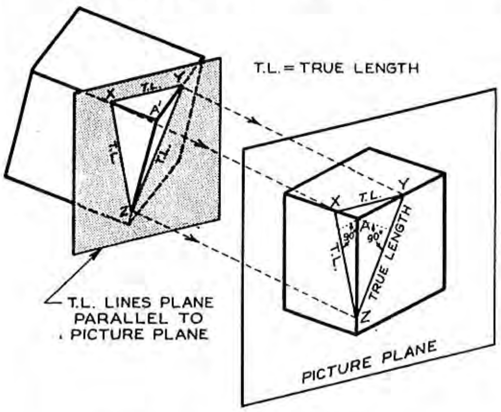


FIG. 2
FINDING TRUE LENGTH LINES ON FACES OF ENCLOSING BOX

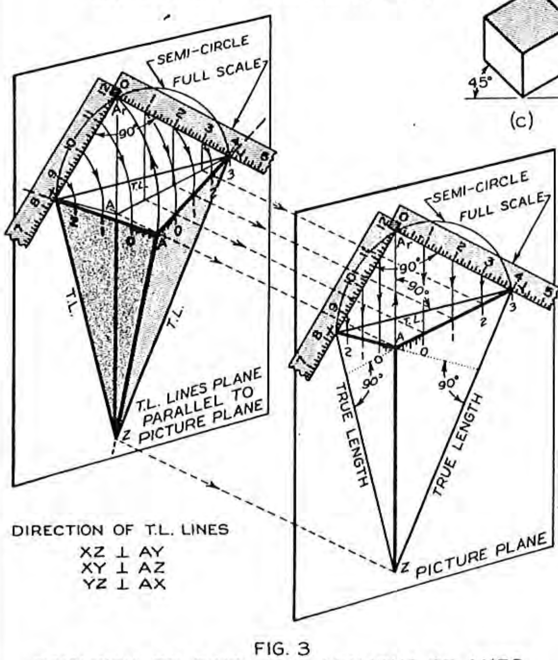
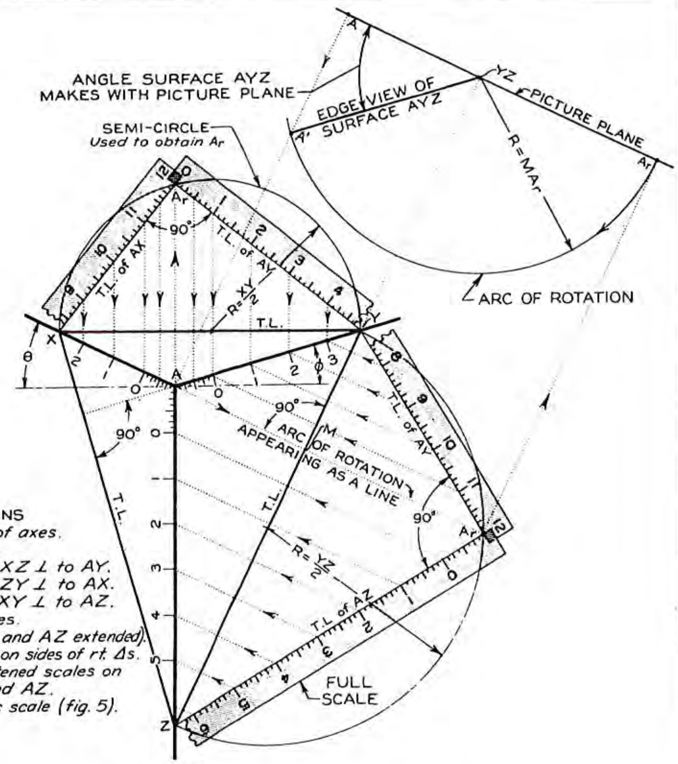


FIG. 3
ROTATION TO FIND TRUE LENGTHS OF AXES AND FORESHORTENED SCALES



STEP DIRECTIONS
1. *Choose angles of axes.*
2. *Choose point X.*
3. *Draw T.L. line XZ ⊥ to AY.*
4. *Draw T.L. line ZY ⊥ to AX.*
5. *Draw T.L. line XY ⊥ to AZ.*
6. *Draw semicircles.*
7. *Locate A_r (AX and AZ extended).*
8. *Mark full scales on sides of rt. Δs.*
9. *Draw foreshortened scales on axes AX, AY and AZ.*
10. *Draw trimetric scale (fig. 5).*

FIG. 4
OBTAINING THE FORESHORTENED SCALES OF AXES

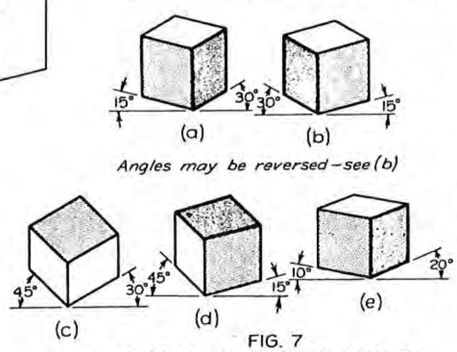


FIG. 7
COMMONLY CHOSEN ANGLES

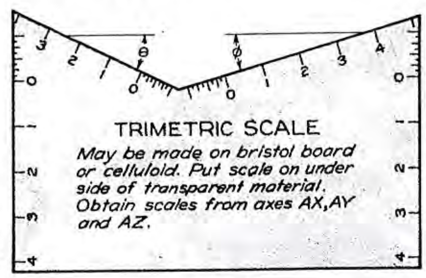


FIG. 5
MAKING OF TRIMETRIC SCALE

STEP DIRECTIONS
1. *Locate center of ellipse.*
2. *Draw centerlines.*
3. *Locate quadrant points M, N, O, P.*
4. *Draw sides of enclosing parallelogram.*
5. *Draw axis of cylinder.*
6. *Draw major axis ⊥ to step 5.*
7. *Locate ends of major axis R and S.*
8. *Locate additional points on ellipse.*

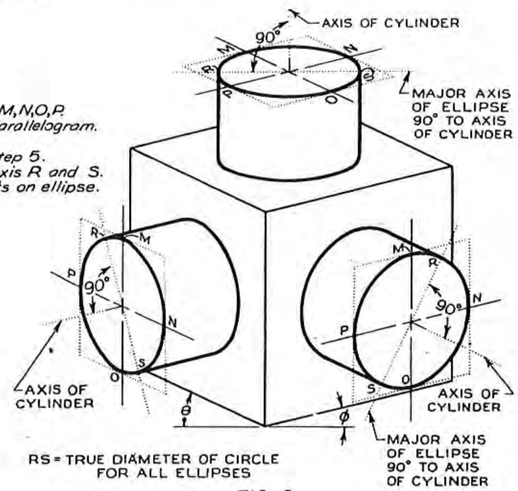


FIG. 6
ELLIPSE CONSTRUCTION

Commercial ellipse guides may be used to draw ellipses if the angles that the faces make with the picture plane are first obtained (Fig. 4).	TRIMETRIC PROJECTION *Theory*	*A British concern makes a trimetric scale somewhat similar to fig. 5 which contains scales for three combinations of θ and φ.*	T–1

The Editor's Page

Drawing teachers in high schools and colleges, the Advertising Manager, the Circulation Manager and Treasurer, and the many contributors as well as the advertising companies are to be highly commended for their assistance in making it possible for the Journal of Engineering Drawing to enjoy something like a 33 1/3% increase in subscribers during the past two years. The editor desires to express sincere appreciation for the wholehearted cooperation of everyone who has had a part in this undertaking and the joy of seeing a growth in circulation is indeed consoling pay. Wishing for the Publication Committee for 1946-47 increased support and success.

* * * * *

Please send in your REGISTRATION form found on Page 11 before June 10, 1946. Enrollment will be limited because of housing facilities and other unavoidable causes. Therefore, it is urgent that you Register at the earliest possible date.

* * * * *

Professor A. C. Gullikson, Engineering Drawing Department, The University of Washington kindly furnished the picture for the front cover of this issue of the Journal.

Send a photograph or glossy print of your most attractive building or drafting room to the editor as it is planned to run a picture from a different institution on the front cover of each issue of the magazine.

* * * * *

Professor H. E. Grant has demonstrated ability to show a great deal of valuable information on TRIMETRIC PROJECTION THEORY well executed on the opposite page.

* * * * *

Professors Rising and Hoelscher and their commitee have worked up a well balanced Drawing Summer School Program. Attendance at this School affords an opportunity to study latest and best methods of teaching Drawing, and an opportunity to renew old friendships and meet new people. Have you examined the program in detail? The best drawing talent in America will appear on this program.

International understanding that is so fundamental in our world of today is certainly being contributed to by Professor Nystron, Technical University, Helsinki, Finland. You will want to read his paper on Page 12 on "Axonometric Pictures".

* * * * *

"Checking Drawings" is a very important subject not only to drawing teachers, but to engineers and draftsmen in industry. Engineer Katz has presented this subject in the light of valuable experience gained as an Aircraft drawing teacher, draftsman, and engineer with several leading Aircraft companies.

* * * * *

"Drawing In Machine Design" by Professor Doughtie contains a lot of food for thought. It would be well to read his paper more than once. He has placed emphasis where it belongs with his advice to all engineering teachers which states, "Teachers of students, after the completion of the drawing course, should insist upon the continued use of the principles learned in the drawing course so that the student will obtain practice."

* * * * *

Have you checked your library list against the books and magazine articles given in the "Bibliography Committee Report" by Professor Fenwick and his committee?

* * * * *

The integration of drawing courses with each other and with a well balanced engineering program is a timely subject that Professor McGuire studied with interest.

PROGRAM

S.P.E.E. DRAWING DIVISION

SUMMER SCHOOL
Washington University, St. Louis, Mo.
June 18 - 28 inclusive
(As of February 15, 1946)

Director of the School -- Dean Alexander S. Langsdorf, Washington University

Chairman of the Faculty - R. P. Hoelscher, University of Illinois

Secretary of the School - R. W. Bockhorst, Washington University

Editor Summer School Proceedings - H. M. McCully, Carnegie Institute of Technology

Chairman Drawing Division - Justus Rising, Purdue University

Chairmen of Reporting Committees -

No. 1. Industrial Requirements of College Drawing
W. W. Preston, University of Alberta

No. 2. Beginning Drawing Course Content
A. B. Wood, University of Tennessee

No. 3. Descriptive Geometry Course Content
C. L. Brattin, Michigan State College

No. 4. Teaching Methods
J. Lawrence Hill, University of Rochester

No. 5. Organization and Administration of Drawing Department
R. F. Paffenbarger, Ohio State University

No. 6. Examinations
B. C. Kent, University of Maine

No. 7. Visual Aids
G. H. Brock, A. & M. College of Texas

No. 8. Advanced Courses and Graduate Study in Graphics
John T. Rule, Massachusetts Institute of Technology

TUESDAY - JUNE 18, 1946

1:00 p.m. - Registration

3:00 p.m. - Address of Welcome
Professor Alexander S. Langsdorf, Dean of the Schools of Engineering and Architecture, Washington Uinversity
Response for the Drawing Division
Professor Justus Rising, Purdue University
Chairman of the Drawing Division

WEDNESDAY - JUNE 19, 1946

Theme: What Training in Graphics does Industry Require of College Men.

8:00 a.m. - The Machine Industry
Speaker - Mr. G. E. Burks, Chief Engineer
Caterpillar Tractor Company
Discussion - Professor John M. Russ, Iowa State University

9:30 a.m. - The Electrical Industry
Speaker - Mr. F. C. Linn, General Electric Company
Discussion - Mr. G. A. Waters, Wagner Electric Company

1:30 p.m. - The Construction Industry
Speaker - Mr. R. E. Salveter, Woerman Construction Co. St. Louis, Mo.
Discussion - Mr. A. P. Greensfelder, Fruin-Colnon Construction Co., St. Louis, Mo.

3:00 p.m. - The Aircraft Industry
Speaker - Mr. Frank H. Rogan, Chief Draftsman Beech Aircraft Corp.
Discussion - Mr. B. D. Washburn, Washington University

7:00 p.m. - Informal Dinner
Speaker - Dean H. P. Hammond, Pennsylvania State College

*MONDAY - JUNE 24, 1946

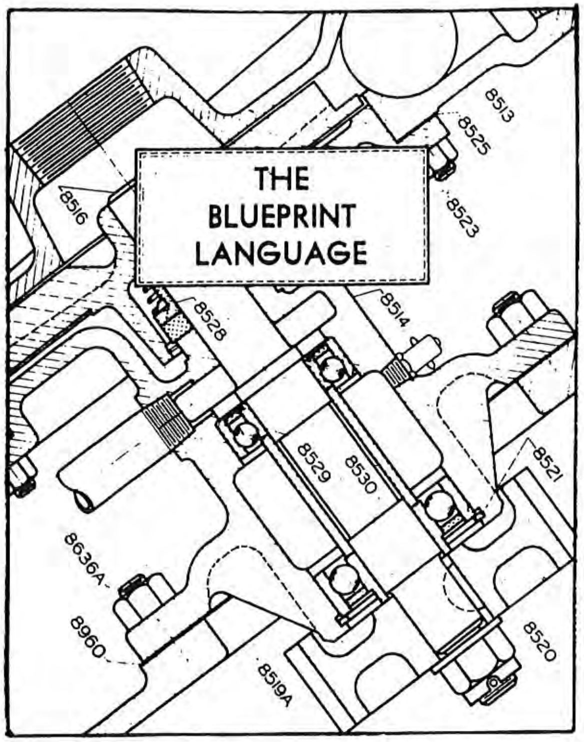
Theme: Course Content in Drawing and Descriptive Geometry

8:00 a.m. - Objectives and Philosophy of Engineering Drawing
Speaker - Professor F. E. Giesecke, Texas A. & M. College
Discussion - Professor W. W. Preston, University of Alberta

9:30 a.m. - Developing Drawing Course Content
Speaker - Professor H. L. Henry, Illinois Institute of Technology
Discussion - Professor E. C. Webb, Purdue University Extension Division

(*See page 9 for Convention Program June 20 through June 23, 1946)

(Continued on page 7)



THE BLUEPRINT LANGUAGE

By **Henry C. Spencer,** *Chairman of the Technical Drawing Dept., Illinois Institute of Technology,* and

H. E. Grant, *Assistant Professor of Engineering Drawing, University of Wisconsin*

This new combination text and workbook provides an unusually complete and realistic training in the essentials of blueprint reading for the machine industries. Over 100 major industrial companies have cooperated with the authors in the development of problems and illustrative material toward making *The Blueprint Language* meet the practical requirements of industry. Emphasis is placed on the visualization of machine parts and their uses. The book contains extensive chapters on shape description, including views of objects; normal, inclined, oblique, and cylindrical surfaces and edges; and sectional and auxiliary views. There is a whole section on modern shop processes.

The Blueprint Language is profusely and entirely illustrated with facsimiles of actual commercial blueprints which cover general principles thoroughly and provide a wide variety of typical industrial problems. Pictorial drawings of the production-illustration type are used liberally throughout. Work sheets are provided for each blueprint, and problem sheets are given at the end of each chapter. A teacher's key, providing solutions for all work sheets, will be available for use with this text.

Summer, 1946. $4.75 *(probable)*

AIRCRAFT DRAFTING

By **Hyman H. Katz,** *Supervisor of Engineering Training, Republic Aviation Corporation*

Written by an "insider"—a design engineer who has worked in a number of large aircraft companies and has supervised the training of hundreds of draftsmen for the aircraft industry—this book includes much practical information useful to the aircraft draftsman in addition to full training in the essentials of technical drawing and their application to aircraft. There is, for instance, considerable aircraft design data, information on lofting technique and processes, and information on such matters as change groups, bills of materials, and weight calculations. All the fundamentals of drafting are very clearly explained and fully illustrated. Wherever possible, illustrations are used in place of lengthy explanations, and the basic topic of orthographic projection has been presented in color to facilitate rapid comprehension. Pictorial drawing, now widely used in industry, and particularly in aircraft design, is stressed. All drafting fundamentals are specifically applied to aircraft problems. All illustrations have been done by skilled draftsmen, experienced in aircraft design.

Summer, 1946. $4.75 *(probable)*

MAKING PATENT DRAWINGS

By

Harry Radzinsky

Patent Attorney

Complete, step-by-step instructions for making drawings for all types of patents and trademarks according to the special requirements of the U. S. Patent Office. Includes much expert advice on all aspects of patent drafting. Fully illustrated, $3.00

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(Continued from page 5)

11:00 a.m. - Report of Committee No. 1 - W. W. Preston

1:30 p.m. - Developing Course Content in Descriptive Geometry

Speaker - Professor F. W. Bubb

Discussion - Professor H. B. Howe, Renssalaer Polytechnic Institute

2:30 p.m. - Navy Requirements in Descriptive Geometry

Speaker - Commander Hugh Eldredge, U. S. Navy (Retired)

Discussion - Lt. Eugene F. Hebrank U.S. Naval Academy

3:00 p.m. - Standardizing Nomenclature in Descriptive Geometry

Speaker - Professor F. W. Porter, University of Illinois

Discussion - Professor H. C. T. Eggers, University of Minnesota

TUESDAY - JUNE 25, 1946

Theme: Teaching Methods

8:00 a.m. - The Teacher

Speaker - Professor H. C. Spencer, Illinois Institute of Technology

Discussion - Professor J. Lawrence Hill University of Rochester

9:00 a.m. - Teaching Shape Description

Speaker - Professor R. R. Worsencroft, University of Wisconsin

Discussion - Professor Oliver Stone, Case School of Applied Science

10:00 a.m. - Teaching Beginning Dimensioning

Speaker - Professor H. D. Orth, University of Wisconsin

Discussion - Professor J. Gerardi, University of Detroit

11:00 a.m. - Report of Committee No. 2 - Professor A. B. Wood University of Tennessee

1:30 p.m. - Teaching Limit Dimensioning

Speaker - Mr. K. T. Kuck, Chief Engineer Monarch Machine Tool Company

Discussion - Professor V. D. Hales, Fenn College

2:30 p.m. - Teaching Shop Processes and Notes

Speaker - Mr. H. C. Hesse, Chief Engineer Mining Equipment Company

Discussion - Professor J. G. McGuire, Texas A. & M. College

3:30 p.m. - Speed and Quality Incentives

Speaker - Professor F. W. Slantz, Lafayette College

Discussion - Professor C. C. Perryman, Texas Technological College

WEDNESDAY - JUNE 26, 1946

Theme: Organization and Administration of Drawing Department

8:00 a.m. - Grading Methods, Standards and Records

Speaker - Professor R. O. Loving, Illinois Institute of Technology

Discussion - Professor J. J. Heimerich, University of New Mexico

9:00 a.m. - Granting College Credit for Previous Drafting Experience

Speaker - Professor O. A. Olson, Iowa State College

Discussion - Professor F. A. Heacock, Princeton University

10:00 a.m. - Methods of Keeping the Staff Abreast of the Times

Speaker - Professor W. E. Street, Texas A. & M. College

Discussion - Professor H. H. Fenwick, University of Louisville

11:00 a.m. - Report of Committee No. 3 - Professor C. L. Brattin Michigan State College

Afternoon Session

Theme: Examinations

1:30 p.m. - Fundamental Philosophy of Examinations

Speaker - K. W. Vaughn, Carnegie Foundation for the Advancement of Teaching

Discussion - F. A. Russell, University of Kansas

2:30 p.m. - Method of Constructing Various Types of Examinations

Speaker - Professor R. F. Schuck, University of Minnesota

Discussion - Professor M. R. Graney, Purdue University

3:30 p.m. - Determining Validity and Reliability of Examinations

Speaker - Professor C. V. Mann, Missouri School of Mines

Discussion - Professor J. N. Arnold, Purdue University

4:30 p.m. - Report of Committee No. 4 - Professor J. Lawrence Hill University of Rochester

THURSDAY - JUNE 27, 1946

Theme: Physical Plant and Equipment

8:00 a.m. - Physical Plant and Equipment

Speaker - Mr. C. D. Ketchum, Hamilton Manufacturing Co. Two Rivers Wisconsin

Discussion - Professor H. S. Weber, Georgia School of Technology

9:00 a.m. - Optical Gaging Methods

Speaker - Mr. Leon Fuller, Jones & Lamson Machine Co. Springfield, Vermont

Discussion - Mr. A. Burgess Washington University

10:00 a.m. - Reproduction Methods in the Modern Drafting Room

Speaker - R. E. Farnham, General Electric Co.

Discussion - Professor L. E. Nollau, University of Kentucky

11:00 a.m. - Report of Committee No. 5 - Professor R. F. Paffenbarger Ohio State University

Afternoon Session

Theme: Visual Aid to Learning

1:30 p.m. - Projection Methods and Material for Visual Aids

Speaker - Professor I. C. Boerlin, Pennsylvania State College

Discussion - Professor L. O. Johnson, New York University

2:30 p.m. - Non-projective Methods and Materials for Visual Aids

Speaker - Professor W. W. Turner, University of Notre Dame

Discussion - Professor O. L. Lock, Rose Polytechnic Institute

3:30 p.m. - Models for Teaching Drawing and Descriptive Geometry

Speaker - Professor C. E. Rowe, University of Texas

Discussion - Professor N. D. Thomas, Ohio University

4:30 p.m. - Report of Committee No. 6 - Professor B. C. Kent University of Maine

7:00 p.m. - Dinner Meeting

Speaker - Professor F. G. Higbee, Iowa University

FRIDAY - JUNE 28, 1946

Theme: Courses in Advanced Graphics

8:00 a.m. - Aircraft Drafting

Speaker - Professor D. W. Dutton, Georgia School of Technology

Discussion - Professor J. C. Klotz, University of Tulsa

9:00 a.m. - Nomography at the Undergraduate Level

Speaker - Professor P. Douglas Adams, Massachusetts Institute of Technology

Discussion - Professor W. H. Burrows, Georgia School of Technology

10:00 a.m. - Pictorial Drawing (Production Illustration)

1. Uses in Industry

Speaker - Professor C. H. Springer, University of Illinois

Discussion - Professor R. T. Northrup, Wayne University

2. Teaching Methods and Special Equipment

Speaker - Professor O. W. Potter, University of Minnesota

Discussion - Mr. G. W. Kadel, Industrial Artist

11:00 a.m. - Report of Committee No. 7 - Mr. G. H. Brock A. & M. College of Texas

Afternoon Session

1:30 p.m. - Need for Graduate Study in Graphics

Speaker - Professor A. B. Mays, University of Illinois

Discussion - Professor E. L. Williams, Texas A. & M. College

(Concluded on page 9)

(Continued from page 8)

2:30 p.m. - Requirements for a Graduate Major in Graphics

Speaker - A. S. Levens, University of California

Discussion - Professor John T. Rule, Massachusetts Institute of Technology

3:30 p.m. - Courses in Advanced Descriptive Geometry

Speaker - Professor F. M. Warner, University of Washington Seattle

Discussion - Professor W. H. Roever, Washington University St.Louis

4:30 p.m. - Report of Committee No. 8 - Professor John T. Rule Massachusetts Institute of Technology

EXHIBITS

Foreign Drawings - Professor H. E. Grant, Chairman University of Wisconsin.

Student Work and Course Material - Professor R. F. Paffenbarger, Chairman Ohio State University

Visual Aid Materials and Sources of Materials - Professor C. H. Ransdell, Chairman Texas A. & M. College

CONVENTION PROGRAM

Thursday, June 20 through Sunday, June 23, 1946
Convention Sessions
(Times to be announced in S.P.E.E. Program)

Justus Rising, Chairman, Purdue University
J. Lawrence Hill, Secretary, University of Rochester

I. Joint Meeting Electrical Engineering Division

A. Contributions which adequate training in Engineering Drawing and Descriptive Geometry can make to Electrical Engineering education.

1. W. A. Lewis, Illinois Institute of Technology, for the Electrical Engineering Division.
2. T. T. Aakhus, University of Nebraska, for the Drawing Division.

B. Lighting the drafting room.

1. R. C. Putnam, General Electric Company

II. Joint Meeting with Mechanical Engineering Division.

A. Contributions which adequate training in Engineering Drawing and Descriptive Geometry can make to Mechanical Engineering education.

1. Speaker for Mechanical Engineering Division
2. C. W. Coppersmith, Case School of Applied Science, for the Drawing Division.

B. Screw Threads for Fastening Devices.

1. W. C. Stewart, American Institute of Bolt, Nut and Rivet Manufacturers.

III. Dinner Meeting
Soil Survey by Aerial Photography, D. J. Belcher, Cornell University

IV. Luncheon

A. Election of Officers
B. Reports of Committees
C. Business

V. Inspection Trips (to be arranged)

A. McDonnell Aircraft Company
B. Emerson Electrical Company
C. Commonwealth Steel Company

"Correction - Professor F. C. Bragg, whose paper on Axonometric Scales that appeared in the February 1946 issue of the Journal of Engineering Drawing from North Carolina State College of Agriculture and Engineering, has moved since his paper was sent in and therefore his old address was given. He is now Associate Professor in the Engineering Drawing and Mechanics Department of Georgia Tech."

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REGISTRATION

S.P.E.E. Drawing Division - SUMMER SCHOOL - June 18-28, 1946.

Name ______________________________ Date ______________________

Title ______________________________

School ______________________________

Address ______________________________ Home Telephone ______________

____

I will arrive by (train) (auto) ________ at ____ a.m. ____ p.m. ____ Date ______________

I will be accompanied by ____

Please reserve a single _____ double _____ room in dormitory _____ hotel _______.

from ______________________ to ______________________.

My choice of committee assignments in order of preference (1), (2), (3) is as indicated below:

______ Committee No. 1 - "Industrial Requirements of College Drawing".

______ Committee No. 2 - "Elementary Drawing Course Content".

______ Committee No. 3 - "Descriptive Geometry Course Content".

______ Committee No. 4 - "Teaching Methods".

______ Committee No. 5 - "Organization and Administration of Drawing Departments".

______ Committee No. 6 - "Examinations".

______ Committee No. 7 - "Standards and Reproduction Methods".

______ Committee No. 8 - "Visual Aids".

______ Committee No. 9 - "Advanced Courses and Graduate Study in Graphics".

I am enclosing herewith my check for $10.00 for registration fee.

(Mail registration to Professor R. W. Bockhorst, Secretary-S.P.E.E. Drawing Summer School, Washington University, St.Louis, Missouri so as to reach him by June 10, 1946.)

AXONOMETRIC PICTURES

By

PROFESSOR E. J. NYSTRON
Technical University
Helsinki, Finland

When representing three-dimensional objects on a plane, it seems quite natural to claim, that parallel straight lines even on the drawing must be parallel straight lines. This demand has been observed of old by the Oriental art and by the Occidental technique in general. The technical drawings are, for the most part, if the object which shall be represented is not very large, made by projecting with parallel rays on the picture plane. Then the demand mentioned above is realized and even the ratio of straight lines on the picture is the same as in reality.

For obtaining an intuitive picture, the drawing plane must be chosen so that it is not parallel to any of the symmetry axes of the representation object or with any other straight line of special importance. There are, however, many alternatives in locating it.

A parallel-perspective or parallel projection is constructed in general by fixing the pictures of the most important points of the representation object with the assistance of their coordinates, measured from the axis, or axonometrically.

In Fig. 1 we see a dimetric projection. There the so called reduction ratios are 1:2:2.

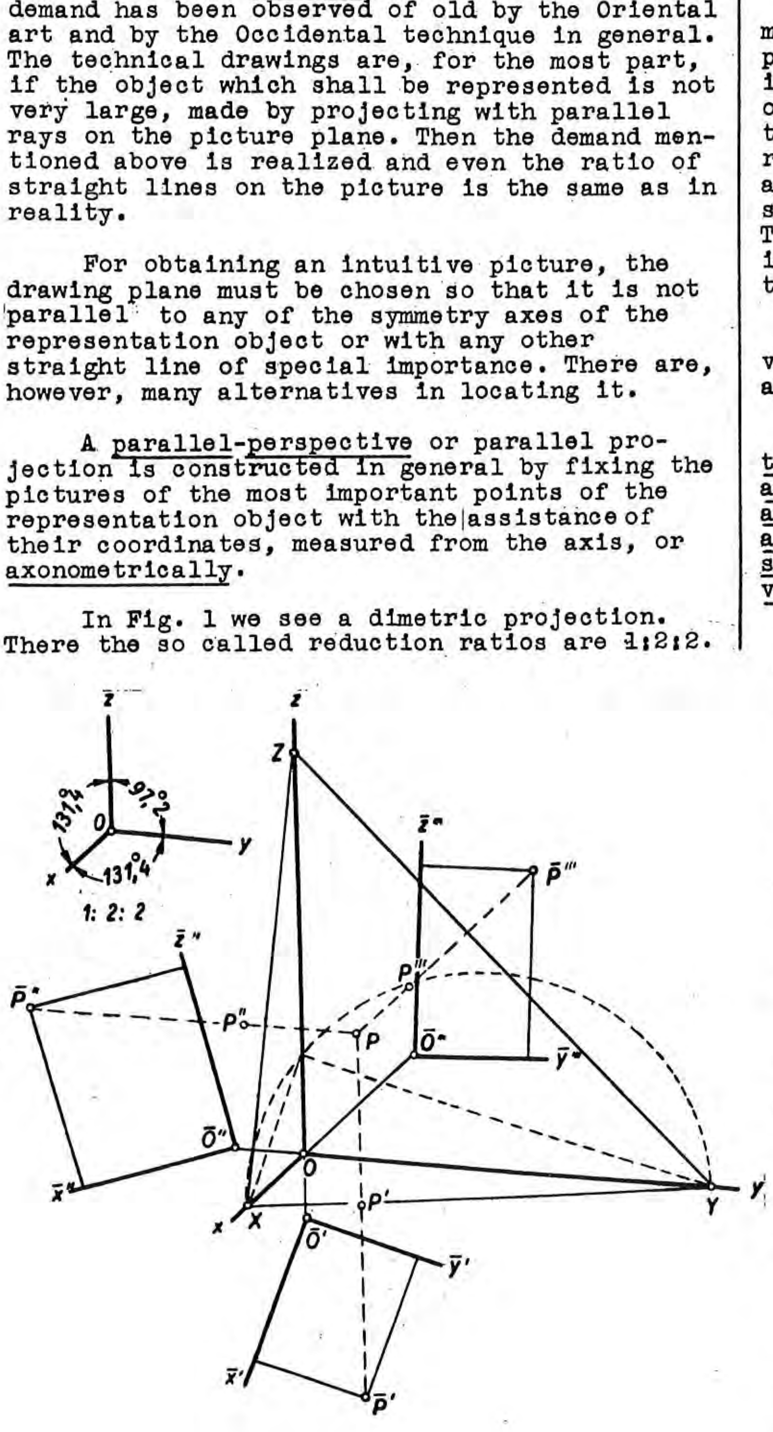

Figure 1

The sides of the trace triangle are XY:ZX:YZ=2:2:$\sqrt{7}$. Along these sides the coordinate planes intersect the drawing plane.

Let us suppose that an orthographic trimetric projection of an object is drawn on any plane together with its orthographic projections on the coordinate planes. When the coordinate planes are revolved about their traces XY, YZ, ZX into the picture plane, we receive their "revolved projections"; these are in Fig. 1, in order to make it clearer, separated from one another with translations. The picture of every point P of the space and its revolved projections P′, P″, P‴ are on the perpendiculars to the traces.

The question arises: doesn't this inversely lead us to a simple method of drawing axonometrical pictures:

We take two projections of the representation object, put them on the drawing paper arbitrarily and draw in both projections auxiliary lines of any given direction through all important points; by locating their intersections the axonometrical picture will be very easily constructed point by point.

This method is described in the textbook by Professor Schmid, published in 1912.

In Fig. 2 the method is applied in order to get a dimetric axonometrical picture of a transformator cabin when two orthographic projections are known. As seen from Figs. 1 and 2, the only necessary thing is that the pictures y′ and y″ of the y axis have to make an angle of 17°1′.

Curiously enough the larger application of the Schmid method was not noticed until in 1937, when another Viennese, Professor Eckhart, began to generalize it. He proved that by the above-explained way you can always get an axonometrical picture, in whatever position the given projection might be, even when they are drawn in different scales. Even the directions of the auxiliary lines can be chosen arbitrarily. And in addition to this Prof. Eckhart's studies proved that the given pictures need not be orthographic projections, nor is it necessary that they should be drawn on perpendicular planes or on different planes. If they only represent the same object, the picture produced through this method ("Einschneideverfahren") will always be a parallel projection.

The picture is generally oblique-axonometrical and trimetric, that is what

(Continued on page 13)

(Continued from page 12)

one gets when the representation object is projected with paralled rays intersecting the drawing plane obliquely. In locating the given projections and in choosing the auxiliary lines there is such a freedom that you can always, unless the scales are not very different, clearly visualize the shape of the object, which is the meaning of all axonometrical representation.

In Figs. 3 and 4, we see two applications of the Eckhart system. The former shows a wooden construction, the latter the intersection of two circular cylinders, i. e., a space curve of fourth degree (twisted quartic.).

Fig. 5 shows a cube projected (a) with rays parallel to some edges and (b) with rays parallel to a diagonal. These projections are not consequently on orthographic planes, neither are they in the same scale, but in spite of what it has been possible to derive an axonometrical picture of the cube. If you look at it perpendicularily to the paper, the cube certainly looks like a little lengthened vertically. But you have to look at Fig. 5 at a relatively long distance in the

(Continued on page 15)

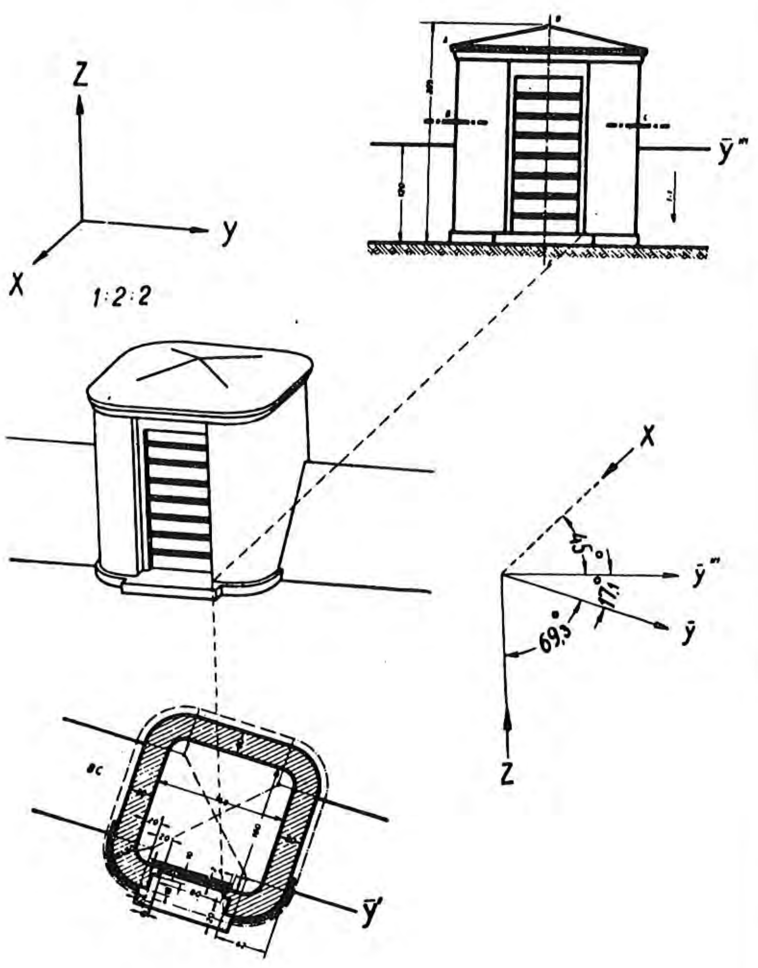

Figure 2

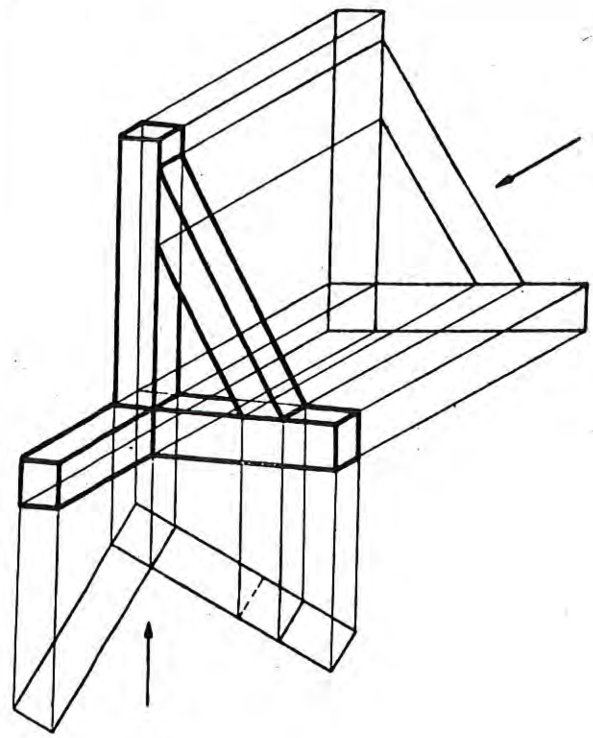

Figure 3

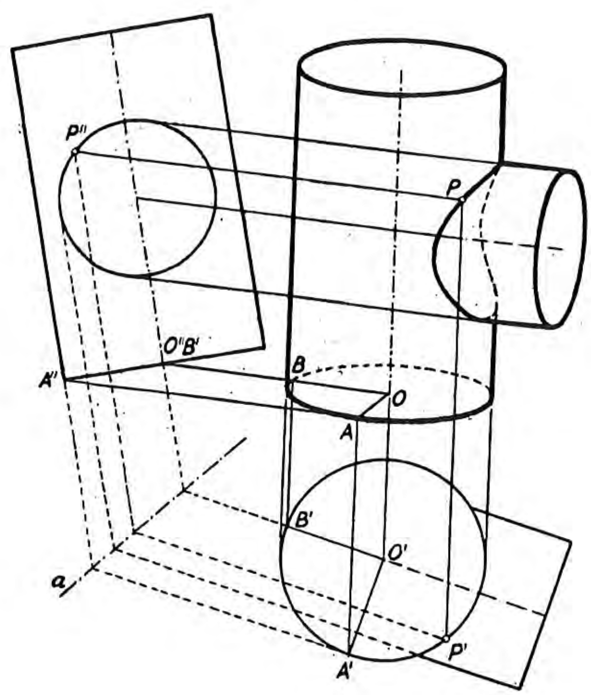

Figure 4

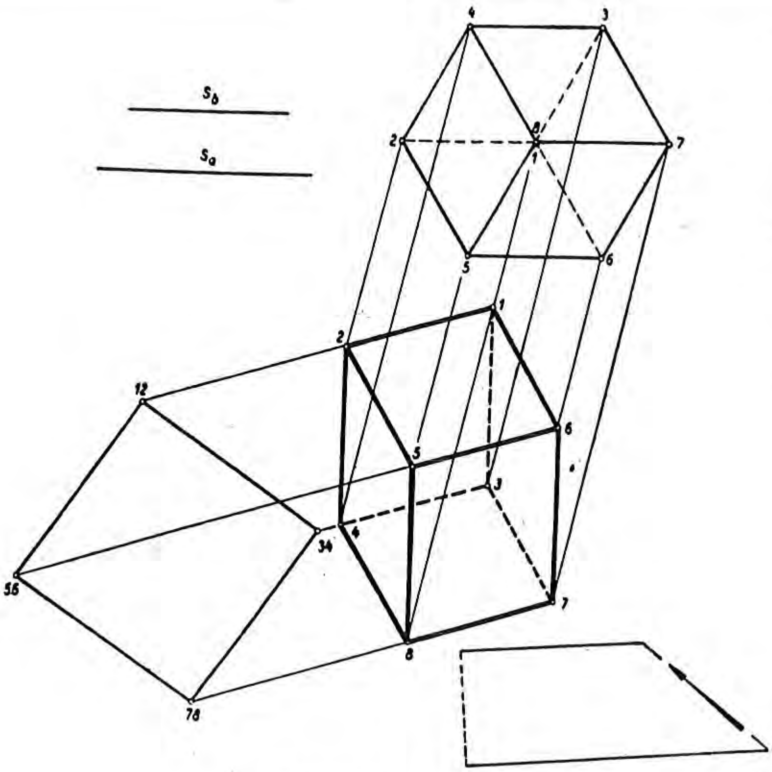

Figure 5

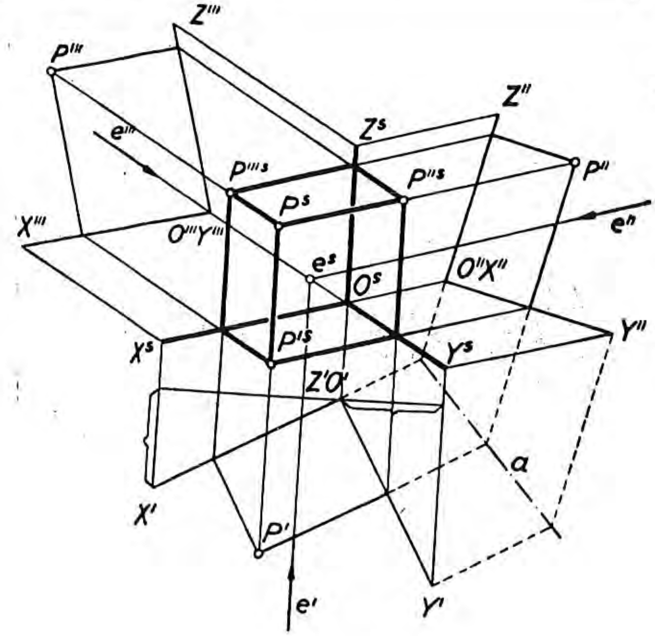

Figure 6

(Continued from page 13)
direction of the projection rays, the inclination of which against the paper is approximately 47°. This direction is indicated in the figure by an arrow, when the connected trapezium is revolved about its shortest side perpendicularily to the picture plane.

It is not particularly difficult to prove Eckhart's method to be correct. If the coordinate axes which are seen in the revolved projection are graduated or furnished with equidistant scale divisions (0, 1, 2....), the auxiliary parallel lines drawn through the corresponding scale points are intersecting on points, even they being equidistant and on three straight lines, that is to say on the picture axis (Fig. 6). This is due directly to the properties of proportionality and to that of parallelity of straight lines. The picture P^s of a space point P will be found by constructing its coordinate parallelepiped. Its edges are even on the picture parallel with the axis and their lengths are proportional to the coordinates of the point P. What is said above is correctly independent of the x, y and z axis being straight or oblique angled. Thus it is possible to construct the whole demanded picture point by point and the method leads, performed in this way, to the same as the usual axonometrical construction, when the parts of the coordinate broken lines are determined through scales and scale angles.

What is said above is not, however, enough for the demanded demonstration, because you can think that there could be limitations concerning directions or lengths of the units of the coordinate axis, which of course ought to be taken into consideration in making the picture. But according to the well known Pohlke theorem the units of the axis O^sX^s, O^sY^s, O^sZ^s can, in fact, be whatever you like. This possibility is however, excluded in practice. Thus the Eckhart theorem is completely demonstrated.

If the drawn picture is essentially oblique axonometrical, it has a natural effect only when seen from a given direction at an infinite distance. This direction can be found by a geometrical construction. In that almost exclusive case, coming in question, when the two used projections are on orthographic planes in the same scale, the wanted direction in the space can be determined much more easily, even without auxiliary lines. (Soc. Scient. Fenn., Comm. Phys. -Math. XI. 11). (2) L. Eckhart: "Affine Abbildung und Axonometric" (Sitzungsberichte d. Akad. Wiss. Wien, Matem. -naturw. Klasse, Abt. IIa, Vol. 146, p. 51-56) and "Ein neues Schragrissverfahren" (Oesterreichs hohere Schule, 1937, x). Figs. 3, 4, 5 are from this publication. Already in 1907 Haeder in his book "Schnellperspektive und Einfuhrung in das technische Zeichen" had described a method, which is a special case of Eckhart's system, but without argumentation, considering it to be only approximately right.

CHECKING DRAWINGS

by

H. H. Katz, Engineer
Republic Aviation Corporation

I. Introduction

It has been a recent problem to install a checking system in the drafting department of the New York Engineering Division of the Republic Aviation Corporation. The department consists of a large number of draftsmen divided into eight component design groups; Wing, Fuselage, Power Plant, Landing Gear, Hydraulics, Controls, Equipment and Armament. The groups are engaged in the design, development and preparation of subsequent production drawings.

Basically, two types of checking systems are used in the aircraft industry---the design group method and the central checking unit.

In the group method, one or more members of a design group are chosen to act as checkers by the group engineer. They are integral members of the group and solely responsible to the group engineer.

In the central checking unit, checkers are members of a separate group. All drawings to be checked may come from the design groups to this central unit or the checkers may be assigned to work directly in the various groups. Here, the checkers are responsible to the chief checker.

The methods of both systems may be argued pro and con. Many feel that in the group system, the checker, as an integral part of the group may lend a hand in the actual design and is thus in a more advantageous position to familiarize himself with the project as it develops. It is also felt that the personal element of being a member of the group tends to bind the group unit closer. The greater flexibility of this system allows the group engineer to manipulate his manpower from checking to design or vice versa as conditions vary.

The checker in the central unit is considered more specialized and since he is not responsible to the group engineer he feels freer to question or criticize engineering matters in which the group engineer has approved or had a hand in. Group engineers are often pressed to meet schedules and subsequently might allow unreasonable leniency regarding deviations from company standards and practices. The central checking unit, it is argued, is an impartial check to this condition.

The checking system set up in this office basically embodies the principles of the group system, in so far as the checker is primarily a member of his specific group, but is responsible to the group engineer mainly for design checking. A coordinator of checking was established, to instruct the checkers on company practices and procedures, to inform the checkers of changes and innovations, to interpret the engineering manual and other company books, and to answer questions pertaining to presentation of material and other factors of engineering drawing. It is the coordinator's responsibility to see that these items are carried out and to act as a central check.

In the planning and operation of this task, one is in a position of proper perspective to observe with what measure the technical success of an engineering project is dependent on diplomacy, or coping with the human element. Some of the methods used to set up this checking system along with miscellaneous observations are outlined below.

II. The Checker.

Perhaps the most important pre-requisite for the potential checker is that he be at least in the minor layout category, that is, capable of breaking the designers basic idea into comprehensive working drawings, or "lay out" component parts in preparation for the detail draftsmen. This actual working experience on the "board" is indispensable.

Since he shall pass on the entire scope of work in his group a formal technical background is desirable. This is especially necessary for the mathematical checking of design and dimensions.

Although not necessarily an inventive individual, the checker must possess a keen analytical mind and an inherent leaning towards mechanics and detail. The best checkers eventually develop a great mental backlog of successful design principles, manufacturing methods and "know how", that qualifies practical suggestions for modification or mutation of the creative work.

More than any other man in his group, he must develop an accurate and rapid interpretation of the graphic language, and criticize a drawing for impractical presentation. Group engineers and other supervisors are usually too absorbed in design problems and are wont to neglect shop or manufacturing aspects of interpretation on the drawing. The checker is the barrier to this costly oversight.

The checker should be intellectually curious, and take little for granted that he doubts or is not quite sure of. He soon finds that one of his greatest differences with some

(Continued on page 21)

DRAWING IN MACHINE DESIGN

by

Venton L. Doughtie
Professor of Machine Design
The University of Texas

THE QUESTION

What does the teacher of machine design desire his students to know about drawing? Naturally, the answer to this question is, how to draw; but is the problem as simple as that? If allowed sufficient time, most of the students who have passed their drawing course and are studying machine design, could make fair drawings. So many students forget or never have thought that the art of drawing is a tool of engineering and may be used to great advantage at other places than on the drawing board. In other words, many students in machine design never think of using the principles of drawing until the final product is designed and is being laid out on the drafting table. No doubt, this is the fault of the design instructor and instructors in other courses after completing the drawing course. This article is not to find fault with the teacher of drawing for it is the author's opinion that a good job has been done in the time allowed; but to indicate how the tool of drawing can be used in machine design and perhaps in ways other than is commonly thought of.

MACHINE CREATION

Before answering the question, it probably would be desirable to refresh our minds in regard to the process of creating a machine. The designer of a machine follows one of two routes, namely: 1. the improvement of an existing machine or using an existing machine as the basis for a new machine; 2. the creation of a new machine or inventing something the like of which is not now in existence. Let us consider the first condition. A thorough knowledge of the existing machine is necessary. The shape, size, fit, and finish of each part in the machine must be known. The relation of these parts to each other or the assembly of these parts into the complete machine must also be understood. Now, the volume of this information will depend entirely upon the size and intricacy of the machine. If the machine is simple or if only a part or a sub-assembly of the machine is being considered, it is possible that the designer may make a mental picture of the set-up. But if the project is a group undertaking or of any magnitude at all, it will be necessary to "picture" these essential facts. This may come about in two ways. If complete blue prints of the parent machine are available, these may be used. In this case, the designer must be able to read and interpret blue prints. If blue prints are not available, it will be necessary to obtain data either for making the blue prints or for recording the essential information. This can best be done by the use of free-hand sketches, to the scale of the eye, with the accurate dimensions placed on these sketches. Should these sketches be perspective, isometric, orthograhic projection, working drawings, or some other type of drawing which has been studied in the drawing course? The answer is negative. They will be free-hand sketches with dimension of the essential parts or elements of the machine and a sketch or sketches giving sufficient information for the combining or fitting together of these parts into the assembled machine. These drawings or sketches are in a true sense what drawing is, namely, a sign language. The manner in which this information is used will depend upon the size of the project and the number of designers employed. If the undertaking is small, the information will be taken directly from the free-hand sketches. However, if the project is of sufficient size and warrants the time and energies of many designers, detail and working drawings and blue prints will be made.

The next step in the design or improvement of the machine is to lay out the essential elements schematically so as to make a kinematic and dynamic study of the machine during a complete energy cycle. This drawing is entirely different from the free-hand sketches mentioned above in that extreme accuracy, with such details as lettering, arrowheads, dimensions, scales, and neatness, must be observed. This is truly an example of the use of the tool of drawing for obtaining engineering quantities. The designer will use information from these drawings to analyse the stresses in the

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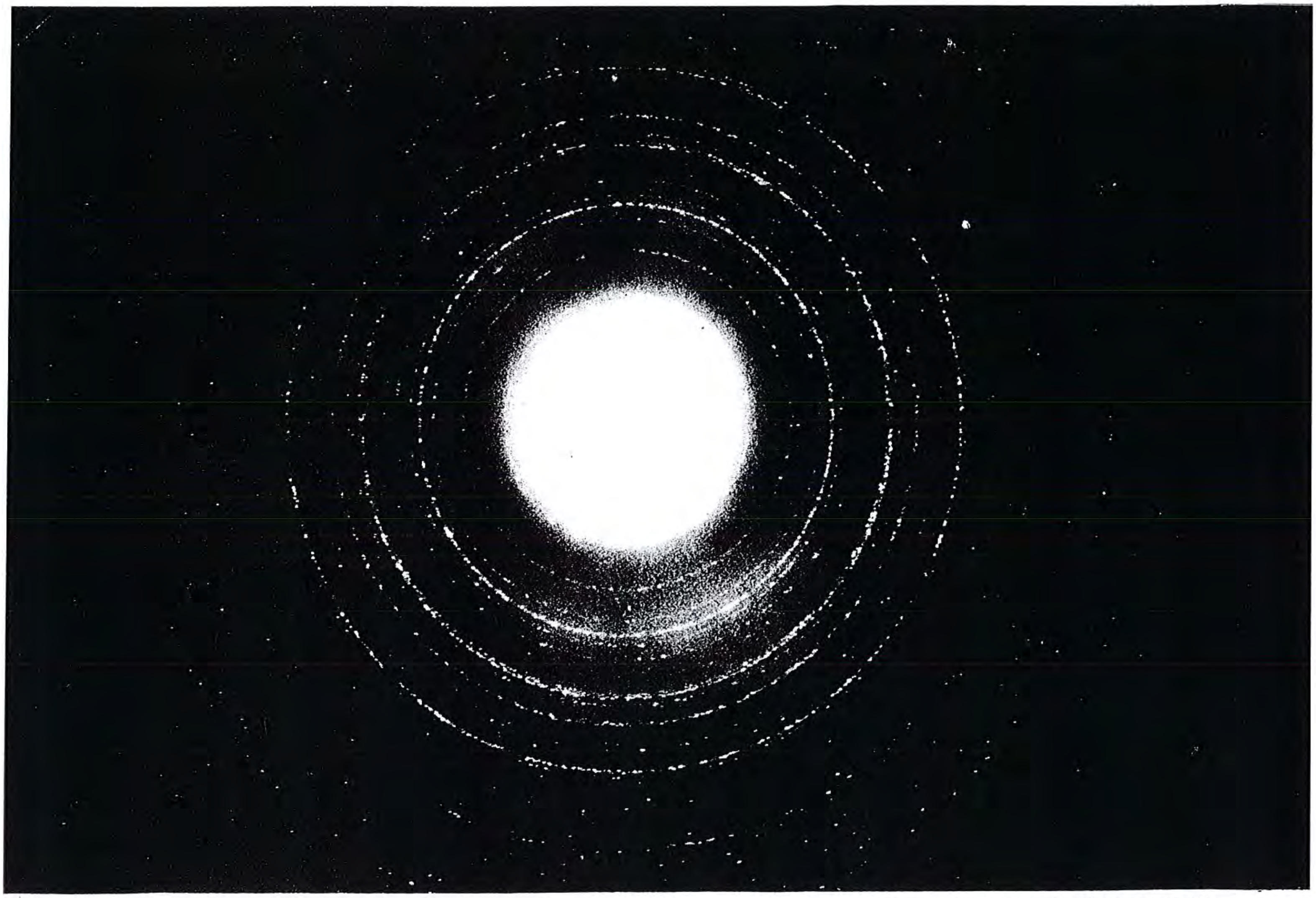


Photo courtesy Radio Corporation of America (For explanation see footnote)*

IT EXISTED SINCE THE BEGINNING OF TIME...

It must strike every well-read and intelligent person that all the achievements, all the accomplishments, all the wonderful things that pour in a steady and breath-taking stream from the laboratories and designing rooms of America existed in potential from the very beginning of time.

Look at the especial magic of today which may revolutionize the social and industrial character of our civilization . . . the magic which on the one hand enables science to look with learned and inventive eye into the atomic constitution of matter and perhaps later into the very atom itself . . . and on the other hand enables men to see, hear and even control events taking place miles away . . . the magic which automatically controls machinery, heats materials and heals mankind . . . the magic of the electrons.

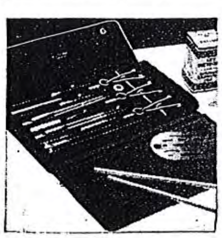
These celestial wanderers of the "inner space" have always existed, yet the prodigious powers they possess have been unsuspected until, relatively, a mere moment ago.

Since the beginning of human time that men possess ability in common has also been so unsuspected that when "All men are created equal" was stated as a political conviction it began an earthquake that is still reverberating around the globe. And today it is the especial responsibility of educators to complete that statement . . . to give each youngster a vision of the possibilities, to create within him a desire and a hunger, to indicate the steps that lead from his hunger to his vision.

In this educational process nothing is trivial. Men who teach mechanical drafting, for example, know the necessity to catch the interest of the beginning student at its flood. For then the instructor can inspire interest into concern and concern into ambition. He can establish habits of work and standards of thought, the consequences of which will be tremendous.

In this critical situation, can the very tools of the student's work be regarded as trivial? Dare the instructor select drawing instruments carelessly and treat them cavalierly? Tools of more than creation, instruments in the vital educational process, the student's drawing set should be, must be the very finest the student can afford.

*Electronic bombardment of matter reveals diffraction pattern and position of atoms, identifies crystal structure, leading to accurate analysis, crucial to man's struggle to control his environment.



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(Continued from page 17)

various parts in order to determine the size and shape of the elements which make up the new machine.

The designer, becoming a stress analyst, will need sketches, often free-hand, of the various elements whose sizes are being determined. These sketches at first will be the designer's idea of the size and shape of the element. If his analysis proves his idea then the final size and shape will agree with the original; but if the calculations do not bear out his original thinking, a final sketch or sketches of the part is made with the necessary changes. These sketches are used by the draftsman in making the detail and assembly drawings.

The final process in the creation of the machine is to make the detail and assembly drawings so that the various elements of the new machine can be produced and assembled in the shops. Assuming that the design is correct, the dependence which can be placed upon these final drawings will be influenced by (1) the accuracy and clarity of the sketches furnished the draftsman by the designer, and (2) the interpretation of these sketches by the draftsman and his accuracy in portraying his interpretation. Again, drawing is a sign language used by designer, shop, and draftsman to "picture" the machine.

Let us now review the processes in the creation of a new machine entirely foreign to an existing machine. The function or useful purpose of this machine is first conceived by the designer or inventor. Next, the machine to fulfill this purpose is visualized and put on paper. These portrayals of the machine are indeed free-hand sketches. The overall machine or outside appearance must be shown. Then the individual elements or parts which go into the machine and their relation to each other must be shown. Sketch, discard, and sketch again. Eventually, the final product is thought through and drawings are made. The procedure after this first creation is similar to that for improving the design of an existing machine and may fall under the following headings:

1. A kinematic treatment to determine if the machine will operate.

2. A force analysis to determine the forces acting on each part.

3. A stress analysis of all parts and determining the size and shape of the parts.

4. Final detail and assembly drawings.

These items have been previously discussed. The part which the tool of drawing plays should be apparent.

DRAWING INSTRUCTION

The foregoing discussion has attempted to show the absolute necessity of using drawing in the design of a machine. The author hopes that he has presented the design problems so that, if possible, a readjustment of time and emphasis may better show the young drawing student the necessity of mastering certain fundamentals in the drawing courses. It is realized that the space of at least one year and in some cases two years have elapsed from the time of completing the drawing course and starting machine design and that instructors of other courses may not have emphasized sufficiently the use of drawing.

The instructor of drawing should teach the drawing student:

1. Neatness.

2. Accuracy.

3. Speed.

4. The use of drawing instruments including triangles, scales, irregular curves, etc.

5. The art of lettering and arrowhead production.

Many students are of the opinion that the first three items enumerated above cannot be fulfilled on one drawing. Maybe the first two are simultaneously possible but not the third. If speed is desired, neatness and accuracy must be forgotten. The student with all three of these qualities has climbed the summit and is ready to coast to his destination. The drawing instructor should insist upon and demand all three. He meets the student in his first year and has the opportunity of aiding the student in the forming of good habits which he should carry through his entire life. A drawing may be accurate but if it is not neat, its accuracy is questionable. An untidy drawing just does not demand the respect which any drawing deserves. If the drawing is not accurate it is worthless. Accuracy should never be sacrificed. An inaccurate drawing should never be accepted. A line, which should be 4 inches long, is drawn 3 inches long or $3\frac{1}{2}$ inches or $4\frac{1}{4}$ inches or 3.98 inches. It is wrong and the results will be in error, depending upon the accuracy desired. There are many other lines, all of which are correct, on this drawing; the drawing is neat, it is attractive, but it is incorrect. The instructor who devises a method of check and double-check for the student to use in measuring the length of a line should be rewarded. However, the instructor who does not demand accurate work is shirking his responsibility. The student's plea is "I just blundered by reading my scale inaccurately but everything else is correct and I spent two hours and forty-five minutes on this drawing after making this small mistake." The answer is to demand and get accurate work.

Speed! Some people are just naturally slow and there is little to be done about it. Practice is one solution. Place a time limit on the drawing and provide grade incentives for completion ahead of schedule. Do not allow overtime without demerits. Instill the student with the idea that the measure of ones ability is power or rate of doing work and not just work without the time element.

The fourth item, use of drawing instruments, should be the prime function of a drawing course. This is prerequisite to all succeeding information. Without being able to handle with dexterity the compasses, the dividers, the scales, the triangles, etc., there is no neatness, accuracy or speed. There is no drawing. The simple matter of drawing a line, making an angle of 15 degrees with the horizontal, is confusing to some students. Triangles and pencil will change hands several times before the final result, a matter of using instruments incorrectly.

"There is no need of learning how to letter because somebody will do it with a lettering set." The author is not in sympathy with that quotation. In the first place, neatness and dexterity can be taught by the use of lettering. There are so many needs for lettering and arrowheads other than on the final drawings. Lettering and arrowheads are needed on the free-hand sketches, the kinematic and dynamic layouts, and the parts drawings which go to the draftsman. If the designer knows how to letter well and quickly, his results will be more accurate and more readily obtained. A drawing, regardless of what type, demands and gets more respect with neat, clear-cut lettering and arrowheads. So many mistakes can be traced to lettering. A q is mistaken for a g or a 4 becomes a 9. Yes, they can be checked but think of the time wasted. Let us not be too insistent on both the slant and the vertical styles but insist upon a form which is consistent, looks well, and can be performed with a degree of speed. Take two identical good drawings, made by the same person, and place poor lettering and arrowheads on the one and good on the other. Most students will agree that the appearance of the former drawing is ruined and is certainly not worth as much as the latter.

The instructor of drawing should give the student practice in free-hand drawings, projections, and working drawings. The free-hand drawing is not a picture of the machine part with shades and shadows but a free-hand pencil sketch of the part. It may be a cross between a picture and a projection. It portrays sufficient likeness of the object so that it is recognizable and it affords a means of dimensioning. From this sketch, drawn to the scale of the eye, conventional drawings may be made. This sketch may be considered as an adjunct to the student's memory, or his sign language for remembering the details of the part and conveying to others his ideas. It is not a finished drawing, but is a way of recording data for the future solution of the problem.

Students studying machine design usually know the principles of orthographic projection but, from the designer's point of view, stick to the letter too closely. Many students believe that all three views must be fully developed, no lines being omitted. A selection of the necessary views to portray the part should be understood. If a line is not helpful in showing a view, no great harm has been done in omitting the line. Practice in selecting the views by the use of the actual part would be beneficial. The use of auxiliary views and partially developed views are useful.

Practice in making working drawings is desirable. After the selection of the views and sections are decided upon, the finished drawings should be complete. Use standard symbols, conventions and reference notes. These will save time and often portray the draftsman's ideas better than other views or complete drawings. Dimensions with proper extension and dimension lines and arrowheads should be stressed.

THE ANSWER

The answer to the question originally raised, "What does the teacher of machine design want the teacher of drawing to teach the

(Continued on page 21)

(Continued from page 20)

student," is how to draw with accuracy, neatness, and speed. The drawing instructor cannot be expected to turn out a skilled draftsman. Drawing well is usually the result of practice. Teachers of students, after the completion of the drawing course, should insist upon the continued use of the principles learned in the drawing course so the student will obtain practice. In summing up the answer to the question, the drawing instructor will give invaluable service to the student of machine design by causing him to realize that an engineer must portray his ideas to others and that the tool of drawing is the most adapt method of presenting the picture.

(Continued from page 16)

draftsmen is that he is forced (sometimes unjustly) to "dig" into catalogues and similar prosaic engineering data with an expected untiring approach.

To coordinate his technical skill, the checker should possess an amiable personality. This is indespensable not only to the personal success of his job, but to the progress of the entire project, for it is through the checker that the important elements of team work most clearly manifest themselves.

As tolerances must allow for unavoidable error in manufacture, the human error must also be accounted for in basic engineering. Draftsmen will make mistakes, but the most conscientious checker will also err. It has been estimated that the highest degree of efficiency that may be expected from an average checking system is approximately 80%. Nevertheless, the cost of engineering checking is so meager compared to the compensation returned, that it has been a source of wonder to the writer that checking staffs are frequently under-strengthened, and that checkers are often under-rated professionally.

Typical of good checking and its relative financial value are the two examples cited below:

The cost of proposed forging dies was $2,000. With personal initiative the checker discovered an existing forging, that with a minimum of machining, could adequately replace the proposed forging.

The simple suggestion to extrude a member rather than to use the forging process, resulted in a substantial savings. A forging die cost of 1,000 dollars as against $40 for extruding die costs.

III. Responsibility of the Checker.

The checker should feel personally responsible in that when he signs the drawing, the shop will be able to fabricate, assemble, and/or install the parts without recourse to any information (lofting data excepted) other than that supplied on the blueprint. Desirable exceptions to this would of course be references to standard parts and process notations.

The checker should make no attempt to control the design except to point out any features which appear to him to be faulty and after once bringing these points to the attention of the proper authority, he should not hold up the work on their account, unless instructed to do so.

One school of checking thought is for the checker to go into great detail in the careful analysis of complex mechanisms, to construct cardboard models and draw involved check layouts. However, a more recent system allows the responsibility of basic function to rest with the designer rather than with the checker. Of course, the degree of checking time is often directly proportional to the skill and experience of the creative or designing staff. . . . .and a flexibility allowed.

However, the checker should be responsible for the workability of the design...Moving parts must be checked for clearance throughout the stroke, fixed parts must be capable of assembly within the limits specified. The design should also conform to accepted shop practice. Expensive shop operations must be avoided, Hand filing, unnecessary joggling, and additional trimming and fitting operations in final assembly, etc., should be eliminated as much as possible. Every effort should be made to use standard parts whenever possible....the design should be investigated with the objective of substituting "tailor made" parts with standard parts or modifications of standard parts....No detail part or assembly should have more than one company part number, and there should be no duplication of parts.

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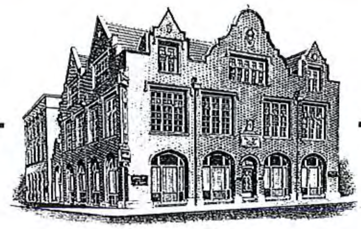

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For his general source of information the checker shall diligently abide by the Engineering Manual (some companies refer to this book as the Drafting Room Manual or D.R.M.) and other authoritative company manuals such as Shop Practice, Materials and Standard Books.

All draftsmen are expected to know and apply the principles of orthographic projection, but should points of differences arise, engineering drawing standards shall be followed as set forth in the A.S.A. Drafting Room Practices (with deviations given in the Engineering Manual). The aircraft industry, almost as a complete unit has accepted certain deviations from the conventional drafting practices. Some of the more outstanding differences are: inch marks are rarely if ever used, all dimensions are understood to be in inches; only upper case lettering is used, the lettering may be vertical or of the conventional slant type--depending on company preference; companies contracting for the Army Air Forces are requested to use numerals of the "open" type, that is, the fours are open on top and the threes, fives and nines are quite open on the bottom curve (although this is a definite break from conventional lettering practice it is felt that a decided legibility is gained); all lettering and numerals are drawn parallel to the bottom edge of the sheet, regardless of the position of the dimensions, whether they be horizontal, vertical or angular.

Every industry contains its own drafting characteristics, and the individual companies within the industry will again employ singular ideas and methods. In the aircraft companies there seem to have been a trend to devise "short-cut" methods. The checker should accept only those short-cut methods authorized by the company.

The checker should receive all the information available pertinent to the drawing, such as layouts, calculations, reference prints, etc. . . . .Whenever possible, the checker should check a complete assembly or installation, including all component parts as a single checking unit.

Checking lists are long and detailed and this space allows for only a few items listed below.

1. Is the drawing legible?....All drawings must be uniformly legible and capable of producing clear, sharp blueprints, van-dykes, and ozalids.

2. Is the drawing standard size?....Have numbering and coding provisions been made?

3. Are all the necessary views, details and sections presented? Are all sectional views in agreement with the direction in which the sections are taken? Rotation of sections and the disregard for placing sectional views geographically close to the section cut arrows are two of the most frequent drafting errors. To strengthen his point regarding the necessity for the correctness of these factors, the checker might explain the great loss of time and mental anguish encountered by the shop in hunting for sectional views in a large complicated drawing, and cite cases of actual expensive misinterpretations caused by rotated views.

4. Are all the necessary dimensions, angles, relief and bend radii, etc. given? The dimensions should be so arranged that they can be used directly to lay out the part. A common error lies in the fact that many draftsmen inexperienced with manufacturing methods, will dimension the part as it was drawn rather than in the manner that it should be made.

The dimensions should read correctly to the scale indicated. If new drawings do not scale within plus or minus 1/32 inch, they shall be changed to comply with this tolerance....Reference and "typical" dimensions should be properly noted.

5. Are all the limits specified?....The limits called for must be sufficiently large to be practical for production work. It seems to be a characteristic of many draftsmen to specify only minimum or very close tolerances when the successful function of the part allows for greater shop leeway....The draftsman should be impressed with the fact that from an engineering and manufacturing viewpoint unnecessary close limits are almost as serious an error as altogether unworkable limits.

6. Is the information under "Notes" (either local or general) complete? On revised drawings, check all notes to see that they are in agreement with latest revisions of the drawing. Heat treatment, protective finish, holes drilled and tapped, countersinks, reliefs, chamfers and similar information must be clearly specified on the drawing. Check notes for standard processes, loft information and material and manufacturing specifications.

7. Are all the necessary parts called for by correct name and number? Do dash numbered parts in the Bill of Materials agree with the field of the drawing? Are alternate

(Continued on page 28)

PROJECTIONS

Professor Forest R. Hughes, Yale University writes "Herewith please find $1.00 for my renewal subscription for the Journal of Engineering Drawing. The publication is much appreciated."

* * * *

Mrs. Marion C. Stannard, Librarian, Wellsville Public Schools, Wellsville, New York has subscribed for the Drawing Journal for Professor Paul Ford, Drawing and Machine Shop teacher of this institution.

This is an excellent example for high schools and colleges. Are you placing the Journal of Engineering Drawing in your school library and with each of your administrators to familiarize them with the work of drawing teachers?

* * * *

Addressed to the Drawing Journal Staff as of February 9, 1946 is the following note from Professor H. B. Langille for many years with the University of California before his retirement: "'Money makes the mare go' the old saying may be paraphrased 'Money makes the Journal go' much better than before, thanks to increasing funds, but more to the greater number of contribution of articles. This last number is very good."

* * * *

Professor R. F. Schwander in charge of Drafting for Theordore Ahrens High School of Louisville 2, Kentucky has subscribed to the Drawing Journal to assist him in enriching their various Drafting classes.

* * * *

Professor George J. Hood, University of Kansas renews the Drawing Journal with this remark: "We are greatly obliged to all of you who are doing a good job of turning out a good Journal."

STUDENT MATERIAL AND COURSE OUTLINE DISPLAY- All colleges and universities are requested to bring or send to the Drawing Teachers Summer School, bound copies of the work done in their school, in all drawing courses during the current or immediate past few years. These firmly bound folders should preferably include course outlines, student work of all problem material and examinations. The student work need not be selected for excellence, but merely to show a cross section of the average work and possibly may be from different students. All of your courses in drawing and descriptive geometry should be exhibited so that we may have a complete and large display. All sheets should be bound together in order of presentation so that sequence may be observed by those viewing them. They should be plainly marked on the outside cover as to School, Course, Credit Hours, and Clock Hours per Quarter or Semester. These will be displayed on tables and not mounted on walls because of lack of space.

Bring or send all display material to: Professor R. W. Bockhorst, Department of Applied Mathematics, Washington University, Saint Louis 5, Missouri.

At the end of the Summer School this material is to be picked up by the various school representatives or returned by express collect to the schools who have not taken up their display.

The object of holding such a display is to acquaint the members of the drawing division with the work that is being done throughout the country.

IT IS ENTIRELY INSTRUCTIVE AND NOT COMPETITIVE. Professor R. S. Paffenbarger, Chairman.

* * * *

ROOMS FOR SUMMER SCHOOL- Housing facilities in St. Louis are acute. Those planning to attend the summer school should register and send their request for room reservations to Professor R. W. Bockhorst, Secretary of the Summer School, Washington University, St. Louis, Missouri before June 10, 1946. REGISTRATION blank for this purpose will be found on Page 11.

VISUAL AIDS EXHIBIT- An exhibit of all types of visual aid material used in the teaching of Engineering Drawing is being arranged for the Drawing Teachers Summer School to be held at Washington University in St. Louis June 18-28, 1946.

We would like to have a copy of all existing motion picture films, film strips, and slide lectures pertaining to the teaching of drawing and descriptive geometry to display and show at this school. A collection of classroom and demonstration models would be highly interesting. There must be an unlimited amount of such material that is of interest to everyone if it could be assembled for exhibit.

Suggestions of material you have that can be used or the names of persons doing work in visual aids will be highly appreciated.

Items used will be properly labeled with the name of the exhibitor and the name of the school represented; and, will be promptly returned at the end of the summer school.

Address your suggestions to: Professor C. H. Ransdell, Engineering Drawing Department Texas A. and M. College, College Station, Texas.

REPORT OF THE BIBLIOGRAPHY COMMITTEE

by

Professor H. H. Fenwick, Chairman
University of Louisville
(For the period November 1945 to May 1946)

NEW BOOKS

Author	Title	Ed.	Publisher	Year	Pages (Plates)	Price
Andersen, N. H.	Aircraft Layout and Detail Design	II	McGraw-Hill	Mar. '46	...	...
Brim, D. J.	Airplane Drafting	..	International Textbook Co.	...	250	$3.50
Bubb, F. W.	Descriptive Geometry Problem Book	..	MacMillan	...	180 12-Pl.	1.75
Kocher, S. E.	Electrical Drafting	..	International Textbook Co.	...	186	2.55
Street, W. E. & Perryman, C. C. & McGuire, J. G.	Descriptive Geometry Problems for Engineers.	I	John S. Swift & Co. St.Louis,Mo.	'45	83	1.90
Rowe, C. E. & McFarland, J. D.	Engineering Descriptive Geometry Problems	..	D. Van Nostrand	'45	118	2.00
Spencer, H. Ç. & Others.	Engineering Preview. (Chapter on Technical Drawing)	I	MacMillan-	'45	581	4.50
Strom, R. T.	Plumbing Drawing	..	International Textbook Co.	...	76	1.40
Treacy, John	Production Illustration	I	John Wiley	'45	202	4.00
Trask, E. P. & Comstock, J. P.	Ship Drafting	..	International Textbook Co.	...	250	3.55
Watts & Rule, J. T.	Descriptive Geometry	I	Prentice-Hall	Jan. '46	...	...

MAGAZINE ARTICLES

Author	Title	Publisher	Vol	Page	Month	Year
Adams, E.	Graphic engineering; method of processing drawings.	Pet. Eng.	16	176+	June	1945
Aviation's	Sketchbook of design detail	Aviation	44	203+	December	1945
Ayerbach, S. F.	Simplefied training for assembly-line workers; isometrics to show assembly of parts in exploded views.	Electronics	18	168 +	July	1945
Benford, F.	Graphics in engineering	Eng.	40	471-3	July	1945
Bischoff, W. A.	A.S.A. speeds drawing-drafting project.	Ind. Stand.	16	113-16	June	1945
Bohle, F.	Analysis of gear tooth contact by line action drawings.	Product Eng.	16	532-6	August	1945
Bush, G. F.	Helicopter-blade geometry analysis.	Aero Digest	50	97-8+	August	1945
Crump, W. C.	Map making - (bibliog paper)	Ind.	27	762 +	August	1945
Griesbach, H. B.	Draw it in isometric. Plumbing & Heating piping layouts.	Dom. Eng.	165	114	June	1945
Gruger, F. R. Jr.	Technical illustration as an aid in marketing.	Ind. Marketing	30	36-8 +	December	1945
Hubbard, H. G.	Photography in drafting; reproduction of pipe structures.	Min. & Met.	26	350	July	1945
Leete	System of isometric drawing.	Automotive & Aviation	93	35	November	1945
Lindsay, F. E.	Visualized spiral gears	Ind. Engineer	179	475-7	June 15th	1945
Photography	Steroscopic-Twin-eye cameras	B.S.S.W.	...	56 +	Dec. 8th	1945
Speers, R. W.	Needed Standard Filing system for Engineering drawings.	Civil Eng.	15	325	July	1945
Thompson, J. E.	Release and control procedures for engineering drawings. (Flow charts)	Product Eng.	16	465-70	July	1945
Trimble, L. S.	New medium for the production of Van Dykes	Soc. Motion Picture Eng. J	45	54-64	July	1945
Whittelsey, T.D.	Composite drawings eliminate interferences in ship production.	Marine Eng.	50	153-5	July	1945
Whittman, R. B.	Fixed angle photos simplify explosion sketches	Am. Mach.	90	90-2	Jan. 3rd	1946

RELATIONSHIP OF ENGINEERING DRAWING COURSES

by

J. G. McGuire
Professor of Engineering Drawing
The Agricultural and Mechanical College of Texas

All teachers and particularly the Engineering Drawing teacher should have a clear picture of the relationship of his course to the others in the curricula. If the Engineering Drawing teacher is a graduate of an engineering department, he probably has a fairly clear conception of the part his course plays in the overall picture. However, it would be well to study the curricula in the College catalog in order to be more fully aware of the problems that his students face in others courses.

Another valuable way to gain information relative to the overall plan of the curricula is to visit classes in other departments. The idea of visiting classes in other departments should be extended beyond the engineering departments to include such allied departments as Mathematics, English, Chemistry, and Physics. Cooperation should, of course, be sought so that visits would be returned. This should lead to healthy discussions of common problems.

Perhaps even more important to the Engineering Drawing teacher is a thorough understanding of the relationship of the courses within his own department. Overall objectives for each course should be available. No attempt will be made to enumerate specific aims and objectives, but rather something of the plan of the Drawing courses at the Agricultural and Mechanical College as it now exists will be given.

The Agricultural and Mechanical College of Texas has three courses in Engineering Drawing that are required by all regular engineering students. These courses are listed as E.D. 111 (0-6), E. D. 112 (0-4) and E.D. 124 (2-2). The overall objective of these courses, to state it briefly, is to provide the student with theory, exercises in visualization, and sufficient practice that he may be able to interpret and execute satisfactorily technical drawings. In other words, upon completion of these courses the student should have a thorough understanding of projection drawing. There are, of course, other objectives more or less minor that will not be discussed in this paper.

As indicated above E. D. 111 is a six hour per week course that runs for one semester. It embraces most of the fundamentals of drawing and includes such units as lettering, instruments and materials, engineering geometry, freehand sketching, multi-view drawing, theory of projections, revolutions, sectional views, auxiliary views, isometric projection, oblique projection, and dimensioning. Although the course is divided into units to facilitate instruction, considerable effort is made when each new unit is taken up to show the relationship to the previous units.

E.D. 112 is prescribed for the second semester engineering freshman. While some new units of theory are taken up in this course, the main objective is to apply the units that were given in E. D. 111. Problems are selected that will more fully show the applications of sections, auxiliary views, dimensioning, etc. The student is required to execute working drawings of a variety that enables him to apply directly all of the theory of drawing. Shop and manufacturing processes are also taken up at pertinent times throughout the course. In this course the instructor must continually review with the student the units of theory that were taken up in E. D. 111.

E. D. 124 (Descriptive Geometry) is also placed in the second semester of the freshman year for the engineering student. Descriptive Geometry has the same overall objective as the two previously discussed Engineering Drawing courses. While E. D. 112 is a course where the theory of drawing is applied to working drawings, Descriptive Geometry emphasizes the theory of projection. The beginning student in E.D. 111 must of necessity, learn some processes by "rule or thumb", while in Descriptive Geometry the underlying theory is stressed. In so far as possible the same terms and methods of projection are used in Descriptive Geometry as in the other Engineering Drawing courses. All problems are solved by methods of projection that were taken up in the first semester drawing course. This course is "laid out" on somewhat the same plan as the other Engineering Drawing courses; i. e., first, problems using straight projection; second, problems requiring primary auxiliary projection for solution; third, problems involving successive auxiliary views; and fourth, those problems requiring the principles of revolution. Under this plan the student as well as the teacher never forgets that Descriptive Geometry is a very necessary Engineering Drawing course.

In summary and in conclusion, the drawing teacher should always keep in mind the part that the Engineering Drawing courses play in the curriculum of the engineering student. The drawing teacher should at opportune times point out to the student the overall plan and relationship of the Engineering Drawing Courses.

(Continued from page 23)

materials correctly noted? Is the Bill of Material properly arranged?

8. Is the assembly information complete? Rivet sizes and locations, welded areas, etc., must be clearly and completely indicated.

9. On drawings of castings and forgings: Draft allowance included in design?....Allowance for machining?...Decalcomania placed on drawing for fillet and corner radii, general manufacturing and design requirements of the part? Is the drawing number correctly assigned?...Is the part number indicated on a portion of the part which is not to be machined?...Is proper material and specifications called for?

IV. Personal Elements

It is human nature for a man to dislike being "told" that he has erred and for him to break away from his present task to rework and correct a job completed some time back. In too many cases a personal conflict arises between draftsman and checker and grows with bitterness throughout the careers of both men. This unpleasant condition is detrimental to the individual and costly to the company. The draftsman realizes that the checker's demands are usually justified, but argumentation and a reluctance to cooperate may result if the demands are presented in a manner directed to lower the ego or prestige of the draftsman. In almost every instance a remark regarding some redeeming characteristic in the drawing might accompany the customary critizism. This does not mean that the significance of the error is minimized, but rather puts the draftsman in a more receptive frame of mind to make corrections and to retain the added information in an effort to raise his standard.

The draftsman normally endeavors to impress the supervisor with his skill and capabilities, and the check print of the drawing is instrumental in the opinion formed. With all due consideration for the draftsman's feelings the errors must, nevertheless, be plainly marked. The errors on a check print, however, may appear to be more glaring and serious than they actually are by indiscriminate markings and unreasonably large "red-penciling".

The draftsman feels doubly hurt when the checker flouts the marked up check print about so that other members of the group may observe or ridicule the errors. The checker should consider the checkprint and the draftsman involved as a private matter.

Certain leeway might be given new draftsmen. For example, when the line work on his drawing is a little weak, but will still print adequately, it is not necessary to require redrawing the entire tracing. The checker might darken a few lines, and in the process explain the necessity of proper line thickness and weight on future drawings.

The checker should endeavor to embody in his approach, the attitude of helping the draftsman progress in his work, rather than to find errors solely. Checkers may argue that this tactful regard for the draftsman's feelings is well and good, but on occasion repeated admonitions do not register with the draftsman and an end comes to their patience. When a decided lack of cooperation exists, the checker should bring the case to the group engineer, and it should be his responsibility to rectify the condition.

The checker is in an unique position insofar as his approach may serve as an educational aid. Many companies are "training conscious", that is, they desire to pass engineering information along to their draftsmen and thus (obviously enough) reap the advantages of added efficiency. This training has been attempted with varying degrees of success in the form of booklets, bulletins, lectures, and actual company classes.

Perhaps the most direct method of administering training is in the line of experience, stripped of theory. Although it places an added burden on the checker, he is the logical man to pass on engineering information at the point of application. This procedure demands a highly trained and qualified checker and is, of course, limited to less men ordinarily assigned to a checker. Training through the checker may be surreptitously emitted in the form of explanations and reasons for the proposed change on the returned drawing.

The draftsman should be his own best checker. By applying the "double check" to his own drawings he achieves two desirable objectives: first, he increases production efficiency by eliminating or reducing the time spent in returning drawings for corrections,

(Continued on page 29)

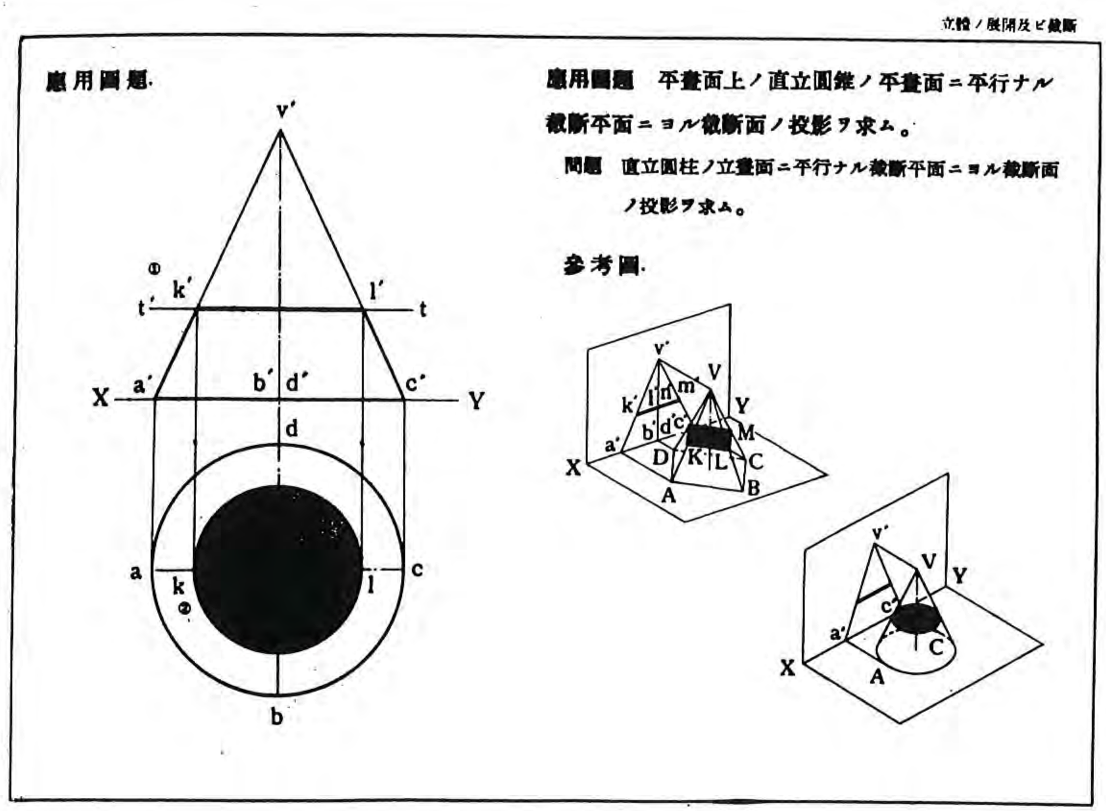
(Continued from page 28)

secondly, he establishes a reputation for himself as a careful technician whose work is consistently well done. Almost without exception, a clean, carefully projected and well balanced drawing contains a minimum of engineering errors. It seems that such drawings are still rare enough today, and every effort should be made to elevate the low engineering drawing standard unavoidably incurred during the war years. From a checking standpoint, the draftsman should be methodical beyond the result of the finished drawing, he should compile a folder of all data, calculations, studies, layouts, and reference prints pertinent to the drawing, and this information passed along to the checker with the actual production drawing.

I recall grading engineering drawings as an instructor, and admonitioning the potential draftsmen on linework, lettering, projection, etc., my present position finds me reiterating the same factors to the checkers of this office. If the students would more vividly realize the value of their engineering drawing training!

The prestige of the checker in the group is obviously necessary and may be maintained by close working contact with the supervisory engineer. Debatable points should first be discussed between them, and when a decision and authorization is obtained the error or change is then related to the draftsman by the checker.

The checker soon gets to "know his man" and proportionally regulates his degree of scrutiny with the reputation and past performance of the draftsman. This experience of the checker may be a valuable and reliable help to the group engineer, who is usually required to evaluate his men at the end of specified lengths of service.



"From a Japanese Descriptive Geometry book found on Okinawa, supplied by Professor H. E. Grant, Assitant Professor of Drawing at the University of Wisconsin in Milwaukee."