DESCRIPTIVE GEOMETRY: PART I

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PART I

By

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PREFACE.

Descriptive geometry as taught in the Massachusetts Institute of Technology is intended to lead to the solution of the graphical problems which ordinarily arise in engineering and architecture; to train the imagination as necessary in these professions; to cultivate the sense of accuracy; and to give facility in drafting and the ability to read working drawings with ease. Consequently this book, an outgrowth of printed notes, treats the subject from the standpoint of the draftsman rather than from that of the mathematician, placing reliance on graphical methods, and omitting analytical methods. Great importance is attached to the drafting exercises which supplement, at the Institute, the use of the book; in these the student works out a set of study plates which give printed data for a large number of original problems and applications.

Considerable work in the projection of solids is given in Chapter VII., since the author believes better results will be obtained if, from time to time, some of this work be combined with the study of the problems on the line and plane. It has also been thought best to give problems in all four quadrants, but the book contains a much larger number of examples in the first and third for the benefit of students in architecture and engineering.

The author desires to express his obligations for general suggestions regarding method and scope to Professor Burton, head of the Department of Drawing in the Institute, who has recently studied abroad the methods of teaching descriptive geometry in the École des Beaux-Arts and other French schools. Mr. Harry C. Bradley, of the Institute, has assisted in the many details of preparation; the selection of data for the examples and the making of the drawings are largely his work.

CONTENTS.

For a list of the problems on the line and plane, see pp. i-ix.

DESCRIPTIVE GEOMETRY.

CHAPTER I.

DEFINITION; VALUE OF DESCRIPTIVE GEOMETRY; GENERAL DESCRIPTION OF ITS MODES OF REPRESENTATION.

1. **Descriptive Geometry** is the science of the graphical representation of form, and of the graphical solution of problems relating to form, by the application of geometrical principles.

2. **General Divisions.** The processes of descriptive geometry may be classed in two general divisions, commonly called *Mechanical Perspective* and *Orthographic Projection*.

Mechanical perspective, though it has the more limited application to practical uses, shows more forcibly than orthographic projection the possibilities of descriptive geometry. In perspective drawing the draughtsman, by means of strictly geometrical methods, reproduces the outlines of geometrical solids, or of objects susceptible of geometrical analysis, as these objects would appear when seen by the eye in natural perspective, or when photographed. In orthographic projection, on the other hand, geometrical objects are represented, not as they would appear under natural conditions, but so as to show their actual relations of position, shape, and size.

3. **Value of Descriptive Geometry.** Descriptive geometry is of value for the training it affords and for its practical applications. As training, it develops the power to visualize geometrical relations, and all magnitudes involving three dimensions; that is, to see them in imagination as figures in space — a

power characteristic of successful inventors and designers and of experienced architects and engineers. Descriptive geometry also teaches analytical methods of thought, and assists in the acquirement of a sense of precision.

The practical applications of descriptive geometry are numerous in science and art, but are most frequently met with in engineering, architecture, and the mechanic arts. Here the principles and methods of descriptive geometry are constantly applied: *first*, in the making of drawings used in connection with building construction and shop work; *second*, in the graphical determination of special forms such as occur in woodwork, metal-work, and stone-cutting.

Mechanical perspective has a valuable although somewhat limited commercial application. It is used principally in connection with architectural designs, to show the prospective appearance of buildings and interiors. A knowledge of the principles of mechanical perspective is also of distinct value to the artist and the freehand draughtsman. It supplements observation, and is indispensable as a means of verifying freehand drawings of geometrical objects.

4. **Representation.** In the representation of form, descriptive geometry is concerned with three kinds of drawing; namely, *pictorial*, *pseudo-pictorial*, and *constructive*.

A pictorial drawing is one which represents geometrically the outlines of an object strictly as seen by the eye.

A pseudo-pictorial drawing is a conventional representation, which suggests the natural appearance of an object, but at the same time gives certain facts of its actual form.

A constructive drawing represents an object so as to show its actual form and measurements.

In order to make, geometrically, a pictorial drawing, it is necessary to understand constructive drawing, but, in describing these two kinds of drawing, it is convenient to consider them in the order stated above.

5. **Pictorial Drawing.** The theory of pictorial representation depends in part on certain laws of vision. Hence

a few facts taken from Optics may here be introduced to advantage.

Let it be understood that the word "object," as here used, always means the boundaries of a geometrical solid or of an object composed of geometrical solids.

THE EYE; CONE OF RAYS; RETINAL IMAGE. In order to eliminate the complications of binocular vision, it will be supposed that we always observe with but one eye. The rays of light transmitted to the eye, Fig. 1, may be represented

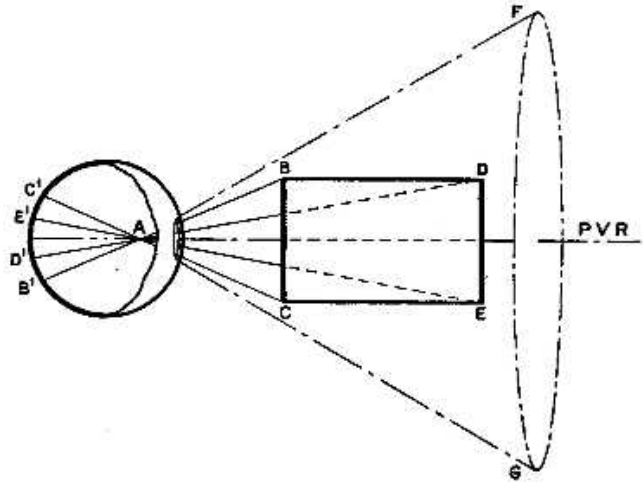

Fig. 1.

by straight lines. They pass through the circular aperture (pupil), and, converging to the point *A*, form the *cone of rays FAG*. Passing through the point *A*, the rays diverge in the form of a second cone, and fall upon the back of the eye (retina), where they form what are called *retinal images*. The common axis of these two cones is termed the *principal visual ray* (*PVR*).