

**DRAFTING INSTRUMENTS AND
OPERATIONS. IN FOUR DIVISIONS.
A TEXTBOOK FOR SCHOOLS, AND
ARTISANS' CLASSES, AND FOR
SELF-INSTRUCTION**

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Drafting Instruments and Operations. In four divisions. A Textbook for Schools, and Artisans' Classes, and for Self-Instruction by S. Edward Warren

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S. EDWARD WARREN

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SELF-INSTRUCTION**

INDUSTRIAL SCIENCE DRAWING.

DRAFTING INSTRUMENTS

AND

OPERATIONS.

In Four Divisions.

DIV. I.—INSTRUMENTS AND MATERIALS.

DIV. II.—FUNDAMENTAL OPERATIONS.

DIV. III.—PLANE PROBLEMS AND PRACTICAL EXERCISES.

DIV. IV.—ELEMENTS OF TASTE IN GEOMETRICAL DRAWING.

A TEXT-BOOK FOR SCHOOLS, AND ARTISANS' CLASSES; AND FOR
SELF-INSTRUCTION,

By S. EDWARD WARREN, C. E.

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SERIES OF TEXT-BOOKS ON DESCRIPTIVE GEOMETRY AND INSTRUMENTAL DRAWING.

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PREFACE.

GEOMETRICAL DRAWING is the proper language of Geometrical Design; while the qualifications conferred by common schools greatly assist nearly every one in conceiving designs, at least for simple dwellings, various minor articles, home improvements, and common conveniences, etc., if not for important inventions.

In the former cases it may be a great convenience, and in the latter one almost a necessity, to be able to express one's designs by intelligible drawings. The power, however, both to make and to understand these drawings—that is, to *write and to read the graphic language*, must be acquired by an orderly study of Geometrical Drawing, beginning with the rudiments. Such study would, therefore, seem fitted to be everywhere, as now in some places, a useful element in common education.

The present work, commenced several years since, has grown from humble beginnings, in teaching a very elementary course, to include topics so numerous, and calling for so much care in arrangement and detail, as to suggest that the preparation of a worthy elementary text-book is by no means a holiday task, or one to be performed any less carefully and studiously than the making of a treatise on the higher portions of the same department of study. In fact, the details of right beginnings, though so important, acquire such a commonplace familiarity to a teacher, as to be overlooked with harmful facility when composing a text-book, unless promptly noted as they are suggested in the course of previous experience.

The perfecting of a life-boat, or a steam-governor, may have cost as much thought as the general design of a vessel or a steam-engine; and it is much the same in comparing the composition of a rudimentary and an advanced text-book.

But to pass briefly to a more particular notice of the contents of this manual.

Its four divisions comprise:—*First*, a full description of the familiar, and the more rarely used drawing instruments; *Second*, a complete study of the various *operations* of the draftsman, considered abstractly, *i.e.*, apart from their application to the drawing of particular structures. Experience has shown the value of this mode of treatment, inasmuch as, according to it, the mind is wholly devoted to one thing at a time, and hence relieved from perplexity; and inasmuch, also, as no time, materials,

or patience are lost by spoiling in *execution*, drawings which have been accurately *constructed* at the cost of some hours or days of labor; *Third*, comes a short collection of practical constructions involving two dimensions, *Fourth*, to complete the draftsman's ability to finish with neatness, correctness, and taste, the previously outlined drawing, some remarks on the principles of taste which are to be observed in making geometrical drawings have been added, which will, it is hoped, contribute materially to the object proposed.

Some topics in the last division, as that concerning colors, may be considered as being treated with unnecessary fulness. But it can never be disadvantageous to an accomplished draftsman to possess cultivated taste, or otherwise than probably very useful to have his knowledge of principles of taste in advance of his foreseen application of them. In respect to the *third* division, especially, I remark that it is not necessary to consistency in a course of drawing of two dimensions, that nothing but surface objects, as figures of two dimensions, should be drawn, but only that no more than two dimensions of the object represented should be considered. Thus, just so far as solids are combined, as in pavements, fronts of brick walls, or arch fronts, with reference to forming a prescribed *superficial pattern* or arrangement, they form proper subjects for drawings involving but two dimensions. The combination, likewise, of spaces or volumes, as rooms in a dwelling, with reference solely to forming a certain ground plan, gives occasion to many entertaining problems of two dimensions, which will probably be found on trial not to be useless in the incidental culture of refined taste in matters concerning domestic and social life.

Problems, like those of compound curves, Div. III, Chap. IV., present themselves under a threefold aspect. First, they may be analyzed and resolved into their abstract geometrical problems. Second, they appear each as one concrete problem, thus: Required to form a compound curve composed of circular arcs and tangent at given points to two parallels. But this concrete problem appears in two forms, its *general* or *generic form*, which is the one just stated; and in its *specific, industrial, or technical form*, as when certain proportions in the required figure are prescribed in denominate numbers, as used in the architectural arts.

These problems, when treated abstractly by the separate solutions of their components, properly appear in a course of simple geometrical problems. When in their ultimate or industrial form, they should be given in works treating primarily of the industrial arts in which they are applied. But in their *general* concrete form, as seen in this volume, they may, I think, be advantageously placed in a course of general geometrical drawing of two dimensions; hence I have included some of them in this form in the present volume.

In respect to the use of this work, it may be suggested that the teacher will find a great saving of time and labor in so conducting the graphic exercises in *construction* as to keep all of the class at work on the same thing at the same time—he explaining at the blackboard, and dictating

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the successive steps of the student's progress, so that, moreover, uniformity will be secured, and many mistakes will be prevented.

It is true that the advantages of this method have, apparently, a compensating evil, which consists in its partial discouragement of self-reliance, resulting in a certain degree of fancied helplessness on the part of the student. But this evil, it is believed, will not be appreciable when students are properly instructed, and encouraged duly to exercise their own powers, and when they aim so to do.

In the instruction of a class with reference to all matters of mere *execution*, after giving to its members, collectively, such general instructions as can thus be profitably conveyed, the time must, to secure the best results, be chiefly spent in giving immediate personal instruction to each one *separately*.

PREFACE TO THE REVISED EDITION.

SINCE writing the foregoing preface, fourteen years ago, great changes have taken place in the field of education. The number of Technical Scientific Schools, both privately supported and nationally endowed, has increased many fold. In the meantime, Secondary Education, while not abandoning or diminishing its former distinctive work of "preparation for business or college," has been slowly beginning to shape itself to the other and complementary side of its total proper work, *viz.*, *preparation for industrial life, and for higher scientific study*. Accordingly, quite a number of schools of high grade are now found, which are either wholly or partly devoted to this form of preparatory work.

Nothing seems more obvious, in this connection, than that *similar grades of all preparatory studies* should be taught in all preparatory scientific schools, or departments; and that the higher Technical Schools should thus be enabled to require for admission the elements of *all* the subjects pursued in them, instead of being compelled, as they generally have been hitherto, to do some portions of preparatory work themselves.

Agreeably with these views, the elementary series on *instrumental, or mathematical industrial drawing*, of which this volume is one, is intended for only provisional use in the Higher Technical Schools, until such time as its subjects can be required for admission therein; while its normal intended use is in connection with *preparatory scientific education*, whether for the many mechanical industries, or for subsequent higher scientific study.

The series is also intended for Artisans' Schools; Normal Schools, in training sections of their pupils for teaching its subjects; and for self-instruction.

In thoroughly revising this volume with reference to the several uses just indicated, the following improvements have been made :

1. Considerable new and useful information has, in a very brief space, been wrought into the Division on Instruments and Materials, embracing additional figures, and one new plate, together with an improved rewriting of portions of the former text.

2. Numerous new or improved paragraphs, with *additional practical exercises*, have been scattered through the three remaining divisions.

3. As an undoubted improvement, rendering the work more complete, both in itself and as a preparation for the "PROJECTION DRAWING," with which it is most closely connected, a selection of fifty of the most commonly useful *plane geometrical problems*, from my separate volume on that subject, has been added to Division III.

4. Two plates have been added to Division III., to supplement the woodcuts, and to serve better as models of execution.

Liberal as has been the favor accorded to this volume, in the comparatively limited field hitherto found for it, the progress of industrial and technical education will, it is hoped, secure a much wider field in the future, in which it may, as now improved, be found worthy of corresponding favor.

NEWTON, MASS., October, 1878.

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