

**CONSTRUCTIVE TEXT-
BOOK OF PRACTICAL
MATHEMATICS, VOLUME
III, TECHNICAL GEOMETRY**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649555369

Constructive Text-Book of Practical Mathematics, Volume III, Technical Geometry by Horace Wilmer Marsh

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

www.triestepublishing.com

HORACE WILMER MARSH

**CONSTRUCTIVE TEXT-
BOOK OF PRACTICAL
MATHEMATICS, VOLUME
III, TECHNICAL GEOMETRY**

TECHNICAL GEOMETRY

CONSTRUCTIVE TEXT-BOOK
OF
PRACTICAL MATHEMATICS

BY

HORACE WILMER MARSH

*Head of Department of Mathematics, School of Science
and Technology, Pratt Institute*

VOLUME III
TECHNICAL GEOMETRY

"These are the realities;
We are the shadows."

FIRST EDITION
FIRST THOUSAND

NEW YORK
JOHN WILEY & SONS, INC.
LONDON: CHAPMAN & HALL, LIMITED

1914

PREFACE

IN this period of education when every study is measured by its vocational value, one must be wise indeed not to be misled into the belief that geometry is of value in the business or industry or profession in which one shall engage, only when its study is interspersed with every conceivable application. Yet the supreme value of demonstrative geometry to a boy or girl or to an older person, consists not in the various ways in which it may be applied, but in the fact that its study, when uninterrupted by extraneous material, gives the ability to think clearly and logically.

The development of reason through the use of the mind in reasoning, and the mind's inherent self-activity, are therefore two of the unchallenged facts which underly the subject-matter and method of this book. The knowledge and acceptance of these principles are as general as is their disregard. With hardly an exception demonstrative geometries from Euclid to the present, in method of presentation are essentially Euclidean. Theorem, figure, hypothesis, conclusion, and "Q. E. D.", succeed each other in undeviating order. The results of the use of this method are inevitable. Students naturally mathematical acquire a formal knowledge of geometry and a restricted development of reason; others develop memory of demonstrations, only.

Counteractive devices, such as inventive and mental geometry, and the requirement of many originals, although in general use, have not materially affected these results. In the study of the great body of theorems—drawn figures, stated hypotheses and conclusions, and printed demonstrations, make thought, origination, creation, and reason, unnecessary for all, impossible for many. To the large majority, knowledge of geometry has meant little more than a repetition of the words of another, and the possession of thought through *thinking* has been exceptional. The relation of the unknown to the known has not been recognized, the act of their relation having been performed by another. The increasing number of exercises, supplementary theorems, and foreign matter in the later geometries only serve to emphasize the fact that educators generally, realize that given figures and printed demonstrations are not suitable stimuli to reason, or factors in development, but that *direct contact with demonstrable truth is necessary*.

In this text this contact is effected in a unique but strictly scientific manner which may be most readily explained by reference to the first theorem. In the development of that theorem, a student locates a point, draws two lines in opposite directions from it, by a study of the definitions discovers that he has drawn a straight angle, by measurement with the protractor determines that it equals 180° , and with exactness and in inevitable form writes theorem 1 in answer to the question "Therefore what kind of angle equals how many degrees?"

A simple, natural process: construction, a name, investigation, generalization; a process which replaces the formal statement of unknown words illustrated by a picture and formulated in printed hypothesis and conclusion; nothing to be committed to memory, but only something to be done, a name to be sought, a measurement to be taken, a truth

to be written. The conception thus formed and predicated, the student visualizes in a figure which to him is not definable as "Any combination of points, lines," etc., but is *his* linear representation of the thing, or relation of things specified in the theorem. Then follows an *hypothesis, conclusion, and demonstration of the student's own creation*. From the first statement to the final word of the demonstration, mental action is vigorous and comprehensive, limited only by the expressed conditions of the theorem itself, the objective becoming existent only through the creative expression of the student.

The demonstrations of the truths of geometry are not forced upon the mind from without, as burdensome to the memory and foreign to the student's normal, mental life, but are developed through individual, unrestricted, necessitated effort. They are *learned* not by a study of key demonstrations, but *by demonstrating*.

A wholesomeness of growth, a vigor and clearness of thought, and a harmony of mental development unattainable by the old, objective methods, are logical and inevitable. Geometry is originated and understood, and other subjects seem easier and more interesting. Self-realization through self-expression is therefore more than an ideal; it is a reality.

Attention is invited to the fact that only commensurable cases are demonstrated in the successive books of plane geometry, the theory of limits with all incommensurables being presented in the last book. By this arrangement the theory and its application, for the first time become intelligible and therefore worth while.

In a book without "pictures" it is necessary to define much more accurately than in one in which an incomplete or faulty definition is supplemented by a graphical representation. Every definition herein listed is strictly **logical**

and therefore defines by **genus** and **differentia**. A large number are original, as necessitated by the constructive and developing method of presentation.

The results of the use of this method in the classes under the immediate teaching or supervision of the author since 1896, warrant the assurance that it will guide, stimulate, and encourage the student; that it will inspire him with an increasing interest and a love of knowledge, a consciousness of mental growth and development, a sense of the possession of geometric truth as the fruit of one's own creating thought, and with confidence in his ability to think and reason for himself.

As in the previous volumes of the Constructive Textbook, acknowledgment is due to my wife, Annie Griswold Fordyce Marsh, for continued aid and counsel in the preparation of this text.

HORACE WILMER MARSH.

BROOKLYN, NEW YORK,
January 4, 1914.

INTRODUCTION

1. Meaning of Geometry. The science whose essential elements are presented in this book, is demonstrative or Euclidian geometry, so named from Euclid, a Greek mathematician, first professor of mathematics at the University of Alexandria, who compiled the first treatise on geometry about 300 B. C.

The name geometry, meaning "earth-measure," was applied by the Greek scholars to the science as used by the Egyptians in the measurement of land and by the Greeks themselves in the measurement of a meridian of the earth.

2. Divisions of the Subject. Geometry is the science of space or of relations in space. It is divided into two parts, plane and solid.

Plane geometry treats of relations involving only one or two dimensions, as the line, triangle, parallelogram, etc.

Solid Geometry treats of relations involving three dimensions as the cube, prism, cone, etc.

Both plane and solid geometry are subdivided into chapters called **books**, according to the Greek custom. The division into books varies with different authors, being determined either by the order of topics in previously