Review

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No attempt was made to give them a special course; except for the calculus (and this was merely a time-table arrangement) they attended my ordinary classes. And I am confident that the outline of general mathematical theory which they obtained was of more value to them than any amount of so-called "heuristic" or rule-of-thumb demonstrations.

To return to the works named at the head of this article, Mr. Cracknell is a more competent mathematician than most authors of books of this kind; at the same time he is eminently practical in the proper sense. His chapters on graphical methods and on logarithms are excellent; so is the one on the slide-rule, though a diagram showing the use of the carrier ought to have been inserted. But this is not very important, because after all the use of the slide-rule can only be learnt by practice with the instrument. The weak point of the book is that lack of space has prevented the author from treating some important subjects in sufficient detail; thus the sections on vectors and on descriptive geometry are very incomplete, and at the same time so good as far as they go as to make the reader regret their brevity.

The treatise of Messrs. Young and Linebarger is based upon that of Nernst and Schönflies. The most interesting thing about it is that one of the authors is a physical chemist, and that examples have been freely drawn from physics and physical chemistry. The book is very well printed, and the integral calculus has been properly introduced at an early stage. There is a preliminary chapter on analytical geometry.

Mr. Graham's work, having reached a second edition, has doubtless been found a useful book. It contains some good illustrations suggested by elastic beams and by electrical problems; in other respects it does not present any very novel features.

Professor Slate's *Principles of Mechanics* is a critical presentation of the subject, influenced more or less by the views of Mach. Probably University students will be those most able to profit by it; it is hardly suitable for beginners. As one of several recent works in which an attempt has been made to free the first principles of mechanics from the appearance of a vicious circle, this treatise certainly deserves attention.

G. B. MATHEWS.

A First Geometry Book. By J. G. HAMILTON, B.A., and F. KETTLE, B.A. 1900. (E. Arnold.)

Inductive Geometry for Transition Classes. By H. A. NESBITT. (Sonnenschein.)

Geometrical Drawing for Army and Navy Candidates and Public School Classes. By E. C. PLANT, C.B.

Geometrical Drawing. By W. H. BLYTHE, M.A. Parts I. and II. 1900. (Cam. Univ. Press.)

Exercises in Graphic Statics. By G. F. CHARNOCK, Assoc. M.Inst.C.E. Part I. 40 sheets. 1900. (J. Halden & Co.)

The opinion is gaining ground among teachers that the method of teaching Geometry adopted in this country may have to be considerably altered. Until quite recently Euclid's *Elements* have held their place as the basis, and though attempts have been made to improve geometrical teaching, the reign of Euclid still continues.

The importance of Geometry in a School Curriculum is due in the first place to its utility, and in the second place to the mental training furnished by a strict demonstration of geometrical truths.

Corresponding to this double purpose there should be a double method of teaching, the one part being in each case the complement of the other. Euclid's treatment is essentially Deductive, and should be accompanied and preceded by an Inductive method of teaching, which leads the pupil to discover geometrical truths for himself.

Is it not true that "in this country too much valuable time is spent in the discussion of neat mathematical unrealities?" How few mathematical students really learn to apply their mathematical knowledge to practical use! The reason is to be found in the fact that the practical applications tend to materialise the subject and to bring it down from the region of the eternal. The danger is more

imaginary than real, but it has prevented many engineers and others from acquiring an adequate knowledge of mathematics and the advantages of a mathematical training. Hence the cry for "Practical Mathematics" at the present time.

Even examining bodies are inclined to move out of the beaten path. In the Army Entrance Examinations Euclid and Mensuration are taken together, and some numerical riders are given to the propositions of Euclid. This is surely a step in the right direction.

Messrs. Hamilton and Kettle guide the young pupil by easy stages, and by continually exercising his intelligence, to a practical familiarity with most of the fundamental geometrical truths. There are few teachers who would not profit by reading through this admirable little book. The arrangement is very good and the exercises well chosen. The pupil, however, should be led to see that a figure, though accurately drawn, can only form an approximation to the mental picture intended.

Mr. Nesbitt has written on much the same lines for children of 8 to 12 years of age. He introduces the pupil to the properties of triangles and circles. Mr. Nesbitt appeals more to that intuitive knowledge which enables a child to see the properties of a geometrical figure with his own eyes. There are fewer mechanical exercises, but a good selection of geometrical examples. There is a capital little chapter on Loci, and another on Heights and Distances treated graphically. The proof that the exterior angle of a triangle is greater than each of the interior opposite angles would seem to be a rather hard nut to crack for a child of eight.

Geometrical Drawing is of great utility, and, if taught in direct connection with pure geometry, serves the purpose of illustrating the exact science, and by appealing to the eye assists in familiarising the student with geometrical facts. In too many cases Euclid and Geometrical Drawing are taught independently, where the two subjects should go hand in hand. Will it never be recognised that no real grasp or certainty of handling can be attained without a mastery of principles?

Mr. Plant's text-book on Geometrical Drawing entitled *Practical Plane Geometry*, is beautifully printed on pages of large size, and is designed to present in its diagrams examples of finished mechanical draughtsmanship. The subject-matter is ingeniously cut up into 26 groups named according to the letters of the alphabet, an arrangement which enables the author to throw all natural sequence to the wind, and occasions a needless amount of repetition. Of the five problems in Group I, three have already been worked in Group C, and one other quoted in a preceding group. The problem *To draw a tangent to a given circle* is worked in Group R, but quoted in a preceding Group O. It would be easy to multiply examples.

There are many errors in the letterpress, and frequently confusion arises through two different points in a figure being denoted by the same letter, or through a letter being misplaced.

Here are some specimens of Mr. Plant's "exactness":

"Find EF = side of square = required area, viz. $\sqrt{3}$."

"A line that expresses the *linear* value of x , the required area."

"Vide Memo on Locii."

"PROPERTIES OF THE ELLIPSE. The ellipse has two foci, and the curve is symmetrical about each of two lines, called the *major*, or conjugate, axis, and the *minor*, or transverse, axis. . . . The foci are obtained by striking an arc from one extremity C of the minor axis, with half the major axis as a radius, to cut the major axis as at F^1, F^2 ."

Here is an interesting piece of Geometry. "*To bisect any triangle by a line perpendicular to one side.* The reader can supply the figure, taking care to draw the triangle ABC , as Mr. Plant does, with BC longer than AC .

Bisect AB in E . Draw CD perp. to AB . Find AG a mean proportional to AD, AE , and make $AH = AG$. At H draw HK perp. to AB . HK will divide the triangle ABC into two equal areas." Mr. Plant is recommended to work this problem again taking the angle BAC nearly a right angle. It would also be well for him to revise his statement, "The remaining regular polygons having an odd number of sides are not capable of containing an inscribed square."

Mr. Blythe's book consists of two parts, of which the second deals with the interesting and important subject of *Descriptive Geometry*.

The arrangement of this work is much better, the problems being grouped according to the geometrical principles upon which their solution depends, but the design is badly carried out. Each chapter commences with a string of geometrical facts, often put together in a very surprising manner and stated with much ambiguity and lack of precision. The frequent references to Euclid seem to suggest that the geometrical truths are based upon the *Elements*. Here is a specimen: "Euclid's propositions about proportion of lines are deduced from the fact that if two triangles are equiangular the sides about the equal angles are proportional." The author then proceeds to prove Euclid vi. 2.

The reader will find that many of the explanations given are very obscure. For instance: "It is necessary to distinguish between linear feet and square feet, thus twice three linear feet is a length of 6 feet, but 2 feet multiplied by 3 feet gives an area of 6 square feet." Here is another example: After stating that a square described on eight-ninths of the diameter of a circle is approximately equal in area to the circle, but that the side so found is really too large by about one-thirtieth of one of the divisions, Mr. Blythe puts the following explanation within brackets:

"To find more exactly the error multiply 81 by 3.141592 and extract the square root, the result is 7.9..." Apart from the numerical mistake, the explanation would appear to suggest that the "one-thirtieth" above is wrong. It would be easy to multiply examples of the lack of mathematical exactness.

We find the term "spherical triangle" applied to a plane figure bounded by three circular arcs, and learn that the normal at any point of the spiral of Archimedes touches a fixed circle. Whenever a geometrical construction is only approximately correct, it would surely be better to say so. For instance, in two consecutive articles a trefoil of semicircular arcs is inscribed in an equilateral triangle, and a quatrefoil in a square. The first construction is exact and the second approximate, but no mention is made of this fact. The second part of the work, as the first, has the same characteristic faults. There is the same apparent effort to put the whole on a satisfactory basis by references to Euclid.

Great prominence is given to the simple proposition: *Given the projections ab and a'b' of a straight line AB upon the H.P. and V.P. respectively, to find its true length and the angle it makes with the H.P.*

The solution of the general case is so simple that there seems to be no advantage in postponing it until particular cases have been discussed. In its actual position the point *A* is at a distance equal to $a'a_1$ vertically above *a*, and the point *B* at a distance equal to $b'b_1$ vertically over the point *b*. Hence, if we draw *aA* and *bB* perpendicular to *ab* and equal to a_1a' and b_1b' respectively, the figure *abBA* has only to be turned about *ab* through a right angle to give the line *AB* in its true position. Thus the above construction gives the true length of the line, and the angle between *ab* and *AB* is the inclination of *AB* to the *H.P.*; also *ab* and *AB* intersect in the *H.T.* of the line. This is much too easy and straightforward for Mr. Blythe, who considers it necessary before attacking the general case to prove that "when two straight lines are equal and parallel their plans and elevations are equal and parallel." This he does by placing the two lines in a convenient position in a figure and remarking that the proposition is evident from the construction.

Pure Geometry is usually taken as one of the chief subjects in a mathematical training, and rightly so, but in too many cases the student abandons the direct use of geometrical methods in favour of the analytical formulæ to which they give rise. This always occasions a loss of power, while a more frequent return to fundamental geometrical principles is likely to cultivate greater resourcefulness. Consider, for instance, the subject of *Elementary Statics*. How rarely does a pupil learn the practical use of the Triangle of Forces and its converse! Yet he has here a most powerful weapon which he ought to use. It seems a pity that Theoretical Mechanics is in schoolwork divorced from Applied Mechanics. The distinction is still much more real than it should be. At a very early stage, perhaps, in the study of Elementary Statics the pupil should consider the equilibrium of a rod under the influence of forces applied at its extremities only, and then of simple frames loaded at the joints. Then he may consider approximately the equilibrium of simple roof trusses by replacing them by the ideal frames to which they most closely correspond. In this way, though he is conscious that the importance of errors arising from the substitution of

an ideal for the actual structure must be carefully considered at a later date, he gets the full value of a mathematical training and, in addition, profits by its utility.

Mr. Charnock's contribution to Graphic Statics is intended for the use of engineers and others engaged in the design of constructional ironwork. It consists of 40 sheets of diagrams with a brief explanation printed on each sheet, and deals mainly with roof trusses under dead loads and wind pressure. The exercises are taken from actual practice, and some of the stress diagrams are those corresponding to the roofs of well-known railway stations.

The author says that he attempts "to build up the subject from the most elementary principles, the various propositions being proved by the aid of pure geometry." The attempt is highly unsatisfactory, and could give nothing but a confused notion of the fundamental principles of Elementary Statics to any reader who derived his information from no other source.

The Parallelogram of Forces is hopelessly mixed up with the conditions of equilibrium of three forces, no distinction being made between the resultant of two forces and their equilibrant. The author is not careful to give in the right order the letters which name a line representing a force. Thus he says " AC represents a force acting towards A "; and in explaining the Polygon of Forces, we read "It is necessary to join the end of the last line I to the starting point A , and the direction and magnitude of the resultant IA is obtained."

Only a very few elementary propositions are needed, and these could be easily built up within the compass of a few pages. The conditions necessary and sufficient for the equilibrium of two forces acting upon a rigid body having been clearly stated and accepted as axiomatic, the Parallelogram of Forces should be carefully enunciated, and in a work of this kind perhaps assumed and illustrated.

The Parallelogram of Forces is equivalent to the following method for determining the resultant of two forces which act along intersecting lines:

Let two given forces P and Q act along lines which intersect at O . With any suitable scale, draw AB equal to P units of length parallel to the direction of the force P , and from B draw BC equal to Q units of length parallel to the direction of the force Q . Then the straight line from A , where we started, to C , where we finished, represents the resultant in magnitude and direction. Suppose that AC contains R units of length; then the resultant of the two given forces P and Q is a force R acting along a line drawn through O parallel to AC .

We can now proceed to the consideration of the equilibrium of three forces, of any system of forces acting at a point, and of any system of coplanar forces, including parallel forces. With this must be included an explanation and proof of the principle of moments, and "the methods of Ritter, Culmann, and Clerk-Maxwell, are reached."

W. J. DOBBS.

Vocabulaire Mathématique. Part I. (Français-Allemand). By FELIX MÜLLER. (Pp. xii.—132). 8 marks. 1900 (Teubner).

This is the first part of a dictionary which should be invaluable to students whose knowledge of the German equivalents of technical terms is as yet in its elementary stage—provided of course that they have some knowledge of French. An idea of the richness of the vocabulary will be given by the fact that there are 119 entries under *angle*, 89 under *axis*, 130 under *circle*, 97 under *co-ordinates*, 363 under *curve*, 189 under *equation*, 220 under *function*, 242 under *surface*, and so on. We have noticed one clerical error on p. 16 (*puissane* for *puissance*). Two entries are appended. HOMOLOGIE (une transformation homographique de figures) (Poncelet) [géom. proj.] *Homologie, collineare Verwandtschaft*—DANS L'ESPACE, *collineare Raumverwandtschaft*—INVOLUTIVE, *involutorisch collineare Verwandtschaft*,—DANS LE PLAN, *collineare Verwandtschaft ebener Gebilde*,—DES POLYÈDRES, *collineare Polyederverwandtschaft*.

INFINI, s. (dans la géométrie, Kepler 1615, dans le calcul Fermat, c. 1630) [phil.; fonct. gén.] *Unendliches*.—ABSOLU [fonct. gén.] *absolutes Unendlich*.—actuel (G. Cantor 1883) [phil.; ar. sup.; séries] *aktuelles Unendlich, kategorematisches Unendlich, eigentliches Unendlich*.—D'UNE FONCTION [fonct. gén.] *Unendlich einer Funktion*.—DE L'ORDRE m [ar. sup.] *Unendliches m^{ter} Ordnung*.—POTENTIEL [phil.; ar. sup.; séries] *potentiales Unendlich, synkategorematisches Unendlich, uneigentliches Unendlich*.