THE GEOMETRY OF FORCES.

Geometrie der Kräfte. By H. E. Timerding. Pp. xii+381. (Leipzig: B. G. Teubner, 1908.) Price 16 marks.

IN this admirable volume Prof. Timerding gives a systematic and original treatment of the geometry of forces and force-systems in which for the first time, so far as we are aware, an adequate knowledge of modern geometrical research has been utilised in a text-book of mechanics.

Ever since the great work of Plücker, that large and most attractive department of mathematics known as the geometry of the linear complex has been found to be intimately connected with the geometry of forces. It is sufficient to recall the fact that whenever six forces applied to a free body are in equilibrium, the forces must lie respectively on six rays of a linear complex. In chapters viii. and ix. of Timerding's book now before us we have an admirable treatment of the application of the theory of the linear complex to the theory of systems of forces. The many interesting matters set forth in these pages show how greatly the advancement both of the geometrical theory and the dynamical theory is promoted by their association.

The statical and dynamical significance of the linear complex is closely connected with the fact that each ray of the complex is reciprocal to that screw of which the axis is the axis of the complex, while the pitch of the screw is the parameter of the complex. Many of the geometrical properties of the complex follow directly from this general principle. For example, on p. 107 it is shown that four linear complexes have two real or imaginary rays in common. This is an immediate consequence of the fact that one cylindroid can always be found of which every screw is reciprocal to any four given screws. As there are two screws of zero pitch on the cylindroid, these lines are, of course, the two common rays of the four linear complexes defined as being reciprocal to each of the given screws. We congratulate Prof. Timerding on his recognition of the proper place for the linear complex in the forefront of a text-book on the geometry of forces.

The theory of screws has received in this volume a treatment even more ample than that which it has already received in the works of Fiedler, Schell, Budde, Minchin, and more recently in the "Encyclopädie der mathematischen Wissenschaften." The excellent work of Harry Gravelius, "Theoretische Mechanik Starrer Systeme," contains a complete account of the theory of screws up to the date of its publication in 1889. Much of the work done on the subject in the succeeding decade has been available for the "Geometrie der Kräfte." It may, however, be remarked that certain developments of the theory which have appeared since 1900 have not been included in Prof. Timerding's volume. The theory of screw-chains, by which the theory of screws has been extended to any material system, is also not discussed. A suggestive reason for this omission is given in the preface (p. vii), where Prof. Timerding says that, in his opinion, the theory of screw-chains would require a new and voluminous treatment of the whole of mechanics in which the rigid body would appear as the first element.

Observing that the laws for the composition of twists and wrenches are identical, the author, as others have done, uses the word *dyname* to signify either a twist or a wrench. For a large part of the subject the use of the abstraction signified by the word dyname is very convenient, and considerable use has been made of the important labours of Study on the geometrical theory of dynames.

In an interesting chapter on "Die Reyeschen Strahlencomplexe" the author brings into its due prominence the fundamental importance of the "Geometrie der Lage" in kinematics. This chapter contains many admirable theorems, and we could only wish that such instructive and beautiful ideas as are here set forth were more generally introduced into the teaching of mechanics. Due acknowledgment is made throughout the work of the important contributions to the geometrical theory of forces by the late Prof. Charles J. Joly.

The chapter on the cylindroid may be specially commended, and prominence is given to the theorem that the projections of any point on the generators of a cylindroid lie on an ellipse. We may, however, note that the proof here set forth is not that by which the theorem was discovered, as shown in the original volume on the theory of screws published in 1876.

A sufficient account is given of the various systems of screw coordinates, and, following the analogy of the resolution of forces, Prof. Timerding uses notation which divides the coordinates of a screw into two groups of three each. It is, however, often convenient to use the six symmetrical coordinates of a screw referred to six co-reciprocal screws.

We are glad, indeed, to commend this most excellent work to the attention of teachers and students of theoretical dynamics. We are sure that if the book were translated into English it would form a very valuable supplement to the existing English books. It would give the student an adequate idea of the extent to which modern geometrical theory and the theory of forces act and react on each other to the vast benefit of both.

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THE DISTRIBUTION OF GOLD ORES.

Gold: Its Geological Occurrence and Geographical Distribution. By J. Malcolm Maclaren. Pp. xxiii+687. (London: *The Mining Journal*, 1908.) Price 25*s.* net.

DR. MACLAREN begins his preface with the remark that "the writer who would add one more treatise to the literature of the study of ore-deposits must needs show justification." Any apology for the publication of his useful book is, however, quite unnecessary, for the increase by four times of the gold yield of the world during twenty years has been attended by a voluminous and scattered literature. Students of mining geology will be grateful to any author who undertakes the great labour of compiling a summary of recent work on gold and its distribution.

The longest and most valuable section of Dr. Maclaren's book is occupied by an account of the geological