how students so immature could profit greatly by the study of such material.

The first memoir on mechanics is again a "Programm" and is intended as an introduction to the subject for students in the gymnasium. Here once more it is difficult to see how the students could have derived much profit from the study. To be sure the presentation is logical and explicit. That seems to be the most serious objection to it. The student would get too much mathematics and logic, too little physics and mechanical intuition from his studies. This would be an excellent argument for having mechanics taught by physicists and engineers rather than by mathematicians, were it not a still better argument for having mathematicians more or less forget their mathematics and really learn mechanics as such before trying to teach it. These two treatises on arithmetic and mechanics are very interesting and highly worth studying. In their way, they are quite distinctive. Grassmann's other work on mechanics is largely a presentation of the subject from the standpoint of the Ausdehnungslehre. The contributions to physics are partly original, partly explanatory. They would not greatly interest anybody now actively engaged in research or in teaching in physical science. This is largely true of all but the highest work done on physics thirty or forty years ago. Mediocrity is short lived in physical science; and it is evident that as a contributor to physics and mechanics Grassmann was not of high rank. This is no reproach: the Ausdehnungslehre and the dictionary to the Rig-Veda are there to silence all specious criticism.

E. B. WILSON.

Die Grundlagen der Bewegungslehre, von einem modernen Standpunkte aus. Von DR. G. JAUMANN, Professor der Physik an der Deutschen Technischen Hochschule in Brünn. Mit 124 Abildungen. Leipzig, Johann Ambrosius Barth, 1905. vi + 421 pp. M. 11; M. 12 gebunden.

IN the author's view the transformation which Fresnel wrought in the theory of light, and Faraday in electromagnetic phenomena, furnishes a prototype for all domains of theoretical physics, mechanics not excepted. The latter, although preserving its old form unaltered, proceeds now in part from points of view which lay quite beyond the reach of its founder and, in this respect, it appears to be nearing a decisive change. This rather remote aim gave direction to the treatment of this book.

It is held that the classical method of deducing a science from the minimum number of experiments and a few fundamental propositions is no longer best; if, indeed, it is admissible at all nowadays. That method furnishes deductive certainty and breadth of development, but it closed the way to progress. The somewhat rigid, dogmatic form of present-day mechanics is due to the manner of its founding. Newton based it upon the very special domain of the motion of discrete rigid bodies in the air. Though this procedure is historically explicable, it can hardly endure indefinitely.

The form of the treatment chosen is that of a systematic textbook of the foundations of mechanics. The pedagogical purpose, of course only a secondary one, has been pursued consistently and seriously. In every appropriate place, the attempt is to make the treatment as easily comprehensible as possible. But where rigor and clearness in main questions called for it, some higher demands have been made upon the reader.

The same point of view is taken regarding the analytic means employed. Advance in theoretical physics depends materially upon the development of suitable mathematical notions. The question of mechanics is always that of disclosing a law to bind observations together. An empirical law for a special series of observations and a general physical law proceed from essentially similar inductions. To discover the form of an empirical law requires choice from amongst appropriate mathematical forms. Without this only naive theories can arise and many geometric relationships must be regarded as erroneous for the fundamental facts of physics.

Reasoning like the foregoing brings the author to the conclusion that it is impossible to desist from employing vector analysis. To avoid narrowing his circle of readers, the author distributes through the book in appropriate places what, in its totality, makes up a brief exposition of the whole theory of vector analysis. The citations for fuller elucidation of the theory are to Gibb's Vector Analysis, edited by E. B. Wilson, New York, 1904, whence the greater part of the notation is taken.

A brief and suggestive introduction sketches lucidly the psychological origin of the mental bias of man which leads him to over-emphasis of the relative importance of mechanical facts and laws as compared with other domains of natural law. As an illustration, the circumstance is cited that on account of the

one-sided development of our senses, we unconsciously ascribe greater significance to the change involved in raising a mass of water 424 meters high, or throwing it with an initial velocity of 91 meters per second, than we do to the change involved in heating the mass of water enough to raise its temperature by 1° centigrade, although these effects have been proved to be objectively equivalent.

The compact language and modes of thought of vector analysis make possible a very condensed treatment of a very extended field of phenomena. The topics that are covered with considerable fulness of detail are the following: motion of rigid bodies in the air, dynamic reaction, rigid media, acoustics (embracing pure acoustics and vibroscopy), motion of deformable media, ideal fluids, elastic and viscous media, and the doctrine of force, including forces in space, and forces on surfaces.

For those who have not accustomed themselves to the form of thought of vector analysis, the book will offer some difficulties, despite the author's attempt to simplify matters, but the elegance of the new mode of scientific thought will repay the effort needed to overcome the difficulties, which are not great. The book is quite as interesting and informing in its interpretations of the various results of the operations of vector analysis, as for its value as a higher presentation of the theory of motion.

The author has made a worthy and a more than fairly successful attempt to do a laudable scientific service. He seeks to bring into organic union the most powerful mathematical language and form of thought yet devised, and a broad field of scientific ideas demanding precisely this sort of language for its adequate expression. The undertaking is too well carried out to merit anything but commendation. To complain of a few typographical errors would only augment the volume of hysteria for criticism already too rampant in certain quarters among us.

G. W. MYERS.

Text-Book on the Strength of Materials. By S. E. SLOCUM, B.E., Ph.D., Professor of Applied Mathematics in the University of Cincinnati, and E. L. HANCOCK, M. S., Assistant Professor of Applied Mechanics in Purdue University. Ginn and Co., 1906. xii + 314 pp.

THIS is one of the series of mathematical texts that are being issued under the editorial supervision of Professor Percey