A HISTORY OF MECHANICS

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HISTORY OF MECHANICS

A BRIEF REVIEW OF THE CHIEF CONTRIBUTIONS OF THE EMINENT MASTERS OF THE SCIENCE, A TABLE OF ITS DEVELOPMENT, A CRITIQUE OF THE FUNDAMENTAL MECHANICAL CONCEPTS, AND A BIBLIOGRAPHY OF THE SCIENCE

BY

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PREFACE.

"As different as East from West" is a proverb. Quite apart from differences of custom, the contrast in the development of Science between the Orient and the Occident might well be considered as a measure of their diversity. The inertia and sterility in scientific production which characterize India and China is nowhere more marked than in the Science of Mechanics.

On the other hand, the ever active, ever achieving minds of the West, with persistent patience, seem at times almost on the verge of solving the cryptogram of nature and of discovering an "Open Sesame" far more potent than that of the Arabian Nights.

Certainly the achievements of the enslaved genii summoned by Alladin's Lamp, compare but poorly with the marvels wrought by the captive forces of nature controlled by our modern mechanism. While this development has been mighty, it has been slow, and it has been achieved only by hard-thinking, patient labor and experiment.

From many sources, ancient manuscripts, books, papers and letters hidden away in various libraries, the development of the fundamental principles of Mechanics may be pieced together. Much of the following short account is the result of research in this country and abroad in connection with studies for the Doctorate in Science of New York University.

With some emendation and alteration it is now offered with the hope that it may interest engineers, instructors and students. It should make clearer the nature of the Science of Mechanics and its evolution, give some idea of the power of mathematical analysis and make evident the dependence of the "practical man" upon the silent meditations of men of science.

D. H. R.

NEW YORK, 1910.

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INTRODUCTORY CHAPTER.

NATURAL SCIENCE.

The word mechanics, though it indicated of old the study of machines, has long since outgrown this limited meaning and now embraces the entire study of moving bodies, both large and small, suns and satellites, as well as atoms and molecules. The phenomena of nature present to us a world of change through ceaseless motion. Mechanics is the "Science of Motion" as the physicist Kirchhoff has defined it, and has all natural phenomena for its field of investigation. Why things happen and how they happen are the questions that here present themselves.

It was a long time before the distinction between "why" and "how" was drawn, but when once the question "why" was turned over to the metaphysician and the theologian, and attention was concentrated on "*how*," then mechanics made progress. Men then began to discover "how things go," and to try their hand at invention.

It is not the purpose here to touch upon either the metaphysical or the psychological aspect of phenomena, nor the mystery of vegetable or animal activities, but to trace the development of Mechanics as a science from the earliest records to the present time, first analyzing the contributions made to it, step by step, and then touching upon their use and value.

As the French philosopher Comte first noted, three stages are apparent in the growth of human knowledge. In the first stage, man ascribed every act to the direct interposition of the Deity, in the second he tried to analyze the Deity's motives and so tried to learn "why," while in the third, men came to regard the inquiry "why" as profitless and ask "how." In this last stage, they accept the universe and are content with learning all they can of how it goes. With this last attitude, called positivism, science flourishes. Out of it grew the notion of utilitarianism,—the devotion of all energies

toward the improvement of the conditions of life on earth. Though this later philosophy cannot entirely justify itself, it is commonly identified with the scientific attitude of mind.

By the long road of experience, by blunder, trial and experiment, men first gathered, it seems, ideas of things that appear always to happen together as by a necessary sequence of "cause and effect." Of the stream of appearances continuously presenting themselves, some are invariably bound together, being either simultaneous or successive, the presence or absence of the others apparently making no difference. Those having no influence may reasonably be ignored and eliminated as of no consequence. In this way, the method of abstracting from the great multitude of phenomena those that are mutually dependent seems to have been evolved.

Barbarous peoples do not possess a clear notion of sequence or of the interdependence of things. They are prone to regard the consequence of an action as accessory, as something done by an invisible being or a god. An action is performed by them, and what is commonly called by us the result is conceived by them as the simultaneous act of their god. Their medicineman is thought of, as one proficient in the art of appealing to the moods and whims of their gods propitiously. Even the Greeks and Romans, the founders of our European civilization, were accustomed to be guided in affairs of state and of the home by omens, by the flight of birds, and the inspection of the entrails of animals,—most naive examples of traditional error in the interdependence of simultaneous phenomena.

Things which we now understand to have not the slightest relation with each other were systematically confounded by the ancients. For thousands of years belief in astrology was general in Europe and the universality of the belief is attested by such words as ill-starred, disastrous, consider and saturnine, all of which are manifestly of astrological etymology. It was only very slowly and gradually, step by step, that men came to think of phenomena quantitatively rather than qualitatively, and to arrive at a more rational conception of nature through experience and reflection.

As the interrelation of things came to be more clearly perceived, people began to say they could "explain things," meaning that they had arrived at a familiarity with, and had begun to recognize certain permanent elements and sequences in the variety of phenomena. By joining these elements, they constructed a chain and attained to a more or less extensive and consistent comprehension of the relations of phenomena by a co-ordination of their permanent elements.

If these elements are linked together logically, the satisfactoriness of "the explanation" depends upon the length of the chain. The longer the chain, the further it reaches, and the more satisfied one is, the more one "understands" the matter. This is the general method of "learning things," and the information so collected may be called, as Prof. Karl Pearson has called it, an "intellectual résumé of experience." But it should be noted that it is rarely the simple correlation of things that will stand the test of experiment.

There is in this method abundant chance to go wrong. It is difficult, and especially troublesome for a beginner, untrained in this process, to decide what things really do not have effect and hence may be excluded from consideration. And if it is difficult for the beginner in science to-day, surely it was immensely more so for primitive men. Students are wont to complain of the artificiality of geometry and mechanics. Factors which they feel do make a difference in reality do not seem to them to be fully allowed for, or they are troubled by a feeling of uncertainty as to the equity of the allowance. The peculiar value of mathematical studies lies just here in the rigorous training in reasoning. Whatever a student's success with his mathematics, few make its acquaintance without receiving wholesome lessons of patient application of the intellectual method by which mankind has won its mastery over natural forces.

We may quote here to advantage Prof. Faraday.[1] "There are multitudes who think themselves competent to decide, after the most cursory observation, upon the cause of this or

[1] Lecture delivered before Royal Institution of Great Britain,—"On Education of the Judgment."