

MISCELLANEOUS.

JOSEPH LOUIS LAGRANGE.

A great part of the progress of formal human thought, where not hampered by outward causes, has been due to the invention of what we may call *stenophrenic* or *short-mind*, symbols. These, of which all language and scientific notations are examples, dispense the mind from the consideration of ponderous and circuitous mechanical operations and economize its energies for the performance of the new and unaccomplished tasks of thought. And the advancement of those sciences has been most notable which have made the most extensive use of these short-mind symbols. Here mathematics and chemistry stand pre-eminent. The ancient Greeks, with all their mathematical endowment as a race, and even admitting that their powers were more visualistic than analytic, were yet so impeded by their lack of short-mind symbols as to have made scarcely any progress whatever in analysis. Their arithmetic was a species of geometry. They did not possess the sign for zero, and also did not make use of position as an indicator of value. Even later, when the germs of the indeterminate analysis were adumbrated by Diophantus, progress ceased at the birth of the science, doubtless from this very cause. The historical calculations of Archimedes, his approximation to the value of π , etc., owing to this lack of appropriate arithmetical and algebraical symbols, entailed enormous and incredible labors, which, if saved, would, with his genius, indubitably have led to great discoveries.

Subsequently, at the close of the Middle Ages, when the so-called Arabic figures became established throughout Europe with the symbol 0 and the positional principle, immediate progress was made in the art of reckoning. The problems which arose gave rise to questions of increasing complexity and led up to the general solutions of equations of the third and fourth degree by the Italian mathematicians of the sixteenth century. Yet even these discoveries were made in somewhat the same manner as problems in mental arithmetic are now solved in common schools; for the present signs of plus, minus, and equality, the radical and exponential signs, and especially the systematic use of letters for denoting general quantities in algebra, had not yet become at all universal. The last step was due to the French mathematician Vieta (1540-1603), and the mighty advancement of analysis resulting therefrom can scarcely be measured or imagined. The trammels were here removed from algebraic thought, and it ever afterwards pursued its way unincumbered in development as if impelled by some intrinsic and irresistible potency. Then followed the introduction of exponents by Descartes, the representing of geometrical magnitudes by algebraical signs, the extension of the theory of

exponents to fractional and negative numbers by Wallis (1616-1703), and other symbolic artifices, which rendered the language of analysis as economic, unequivocal, and appropriate as the needs of the science seemed to demand. In the famous dispute regarding the invention of the infinitesimal calculus, while not denying and even granting for the nonce the priority of Newton in the matter, some writers go so far as to regard Leibnitz's introduction of the integral symbol \int as alone a sufficient substantiation of his claims to originality and independence, so far as the power of the new science was concerned.

For the *development* of science all such short-mind symbols are of paramount importance, and seem to carry within themselves the germ of a perpetual mental motion which needs no outward power for its unfoldment. Euler's well-known saying that his pencil seemed to surpass him in intelligence finds its explanation here, and will be understood by all who have experienced the uncanny feeling attending the rapid development of algebraical formulæ, where the urned thought of centuries, so to speak, rolls from one's fingers' ends.

But it should never be forgotten that the mighty stenophrenic engine of which we here speak, like all machinery, affords us rather a mastery over nature than an insight into it; and for some, unfortunately, the higher symbols of mathematics are merely brambles that hide the living springs of reality. Many of the greatest discoveries of science,—for example, those of Galileo, Huygens, and Newton,—were made without the mechanism which afterwards becomes so indispensable for their development and applications. Galileo's reasoning anent the summation of the impulses imparted to a falling stone is virtual integration; and Newton's physical discoveries were made by the man who invented, but evidently did not use to that end, the doctrine of fluxions.

We have been following here, briefly and roughly, a line of progressive abstraction and generalisation which even in its beginning was, psychologically speaking, at an exalted height, but in the course of centuries had been carried to points of literally ethereal refinement and altitude. In that long succession of inquirers by whom this result was effected, the process reached, we may say, its culmination and purest expression in JOSEPH LOUIS LAGRANGE, born in Turin, Italy, the 30th of January, 1736, died in Paris, April 10, 1813. Lagrange's power over symbols has, perhaps, never been paralleled either before his day or since. It is amusing to hear his biographers relate that in his early life he evinced no aptitude for mathematics, but seemed to have abandoned himself entirely to the pursuits of pure literature; for at fifteen we find him teaching mathematics in an artillery school in Turin, and at nineteen he had made the greatest discovery in mathematical science since that of the infinitesimal calculus, namely, the creation of the algorism and method of the Calculus of Variations, which drew forth the admiration of the great Euler, and which the latter did not deem it beneath his dignity to write a treatise upon, supplementary to his own researches upon the subject. The exact nature of a variation even Euler did not grasp, and even as late as 1810 in the English treatise of Woodhouse on this subject we read regarding a certain new sign introduced, that M. Lagrange's "power over symbols is so unbounded that the possession of it seems to have made him capricious." Lagrange himself was conscious of his wonderful capabilities in this direction. His was a time when geometry, as he himself phrased it, had become a dead language, the abstractions of analysis were being pushed to their highest pitch, and he felt that with his achievements its possibilities within certain limits were being rapidly exhausted. The saying is attributed to him that chairs of mathematics, so far as creation was concerned, and unless new

fields were opened up, would soon be as rare at universities as chairs of Arabic. In both research and exposition, he totally reversed the methods of his predecessors. They had proceeded in their exposition from special cases by a species of induction; his eye was always directed to the highest and most general points of view; and it was by his suppression of details and neglect of minor, unimportant considerations that he swept the whole field of analysis with a generality of insight and power never excelled, while to his originality and profundity he united a conciseness, elegance, and lucidity which have made him the model of mathematical writers.

Lagrange came of an old French family of Touraine, France, said to have been allied to that of Descartes. At the age of twenty-six he found himself at the zenith of European fame. But his reputation had been purchased at a terrible cost. Although of ordinary height and well proportioned, he had by his ecstatic devotion to study,—periods always accompanied by an irregular pulse and high febrile excitation,—almost totally ruined his health. At this age, accordingly, he was seized with a hypochondriacal affection and with bilious disorders, which attended him throughout his life, and which were only allayed by his great abstemiousness and careful regimen. He was bled twenty-nine times in his life, which would, one would think, have affected the most robust constitution. Through his great care for his health he gave much attention to medicine. He was, in fact, conversant with all the sciences, although knowing his *forte* he rarely expressed an opinion on anything unconnected with mathematics.

When Euler left Berlin for St. Petersburg in 1766 he and D'Alembert induced Frederick the Great to make Lagrange president of the Academy of Sciences at Berlin. Lagrange accepted and lived in Berlin twenty years, where he wrote and published some of his greatest works. He was a great favorite of the Berlin people, and enjoyed the profoundest respect of Frederick the Great, although the latter seems to have preferred the noisy reputation of Maupertuis, Lamettrie, and Voltaire to the unobtrusive fame and personality of the man whose achievements were destined to shed more lasting light on his reign than those of any of his more strident literary predecessors: Lagrange was, as he himself said, *philosophe sans crier*.

The climate of Prussia agreed with the mathematician, as did also the national life of the Germans. He refused the most seductive offers of foreign courts and princes, and it was not until the death of Frederick and the intellectual reaction of the Prussian court that he returned to Paris, where his career broke forth in renewed splendor. He published in 1788 his great *Mécanique analytique*, that "scientific poem" of Sir William Rowan Hamilton, which gave the quietus to mechanics as then conceived, and having been made during the Revolution Professor of Mathematics at the new *Ecole Normale* and the *Ecole Polytechnique*, he entered with Laplace and Monge upon the activity which made these schools for generations to come exemplars of practical scientific education, and by his lectures there, systematised in definitive form the science of mathematical analysis of which he had developed the extremest capacities. Lagrange's activity at Paris was interrupted only once by a brief period of melancholy aversion for mathematics, a lull which he devoted to the adolescent science of chemistry and to philosophical studies; but he afterwards resumed his old love with increased ardor and assiduity. His significance for thought generally is far beyond what we have space here to insist upon. With him, not least of all, theology was forever divorced from a legitimate influence on science.

The honors of the world sat ill upon him ; *la magnificence le gênait*, he said ; but he lived at a time when proffered things were usually accepted, not refused. He was loaded with personal favors and official distinctions by Napoleon, who called him *la haute pyramide des sciences mathématiques*, was made a Senator, a Count of the Empire, a Grand Officer of the Legion of Honor, and, just before his death, received the grand cross of the Order of Reunion. He never feared death, which he termed *une dernière fonction, ni pénible ni désagréable*, much less the disapproval of the great. He remained in Paris during the Revolution when *savants* were decidedly at a discount, but was suspected of aspiring to no throne but that of mathematics. When Lavoisier was executed he said : " It took them but a moment to lay low that head, yet a hundred years will not suffice perhaps to produce its like again." Lagrange would never allow his portrait to be painted, maintaining that a man's works and not his personality deserved preservation. The accompanying frontispiece to *The Open Court* is from a steel engraving supposedly based on the sketch obtained by stealth at a meeting of the Institute. His genius was excelled only by the purity and nobleness of his character, in which the world never even sought to find a blot, and by the exalted Pythagorean simplicity of his life. He was twice married, and by his wonderful care of his person lived to the high age of seventy-seven years, not one of which had been misspent. His life was the veriest incarnation of the scientific spirit ; he lived for nothing else. He left his weak body, which retained its intellectual powers to the very last, as an offering upon the altar of science,—happily made when his work had been done. A desiccated liver, a tumored kidney (see the delectable *post mortem* of Monsieur Potel), long since dust, were the sole defects he gave to the grave, but to the world he bequeathed his "ever-living" thoughts now resurgent in a new and monumental edition (Gauthier-Villars, Paris). *Ma vie est là!* he said, pointing to his brain the day before his death.

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BOOK REVIEWS AND NOTES.

INTRODUCTION TO GENERAL CHEMISTRY. A Graded Course of One Hundred Lectures. By *Gustavus Dettlef Hinrichs*, M. D., LL.D. With an Atlas of Eighty Plates. Pages, 400. Price, \$4.00. St. Louis, Mo., U. S. Carl Gustav Hinrichs, Publisher.

Since the invention of the kindergarten, education is undergoing a radical reformation which in the end will make teaching more difficult and learning more easy. Instruction, which in former days consisted in mechanical cramming, has of late become an art employing a definite method of presenting the lesson, not to the mind alone, but first to all the senses and then to the mind. Professor Hinrichs's *Introduction to General Chemistry* is a guide for teachers and pupils according to the modern requirements. The book is full of illustrations and diagrams. It opens with pictures of the most famous chemists, Berzelius, Liebig, Bunsen, Faraday, Berthelot, and others. It contains illustrations of coal and gold mining, the process of quarrying salt, plates explaining crystallisation, a table of spectrum analysis (the latter, however, is not colored as it ought to be) ; parabolæ of fusing and boiling points, etc.

The book contains a great deal of information, but it is not a text-book ; it is, as the title indicates, an introduction into the science. It will therefore be welcome to the man of broad culture as well as to the student of chemistry. In the hands of a pupil for the use of home reading it will be a valuable help to the professor's lessons. It is sufficiently elementary to be attractive even to a beginner.