

The Tangled Origins of the Leibnizian Calculus

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Richard C Brown

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As the title of the book suggests, this book attempts to unravel the threads that lead to the creation of the revolutionary symbolism of differential and integral calculus by the polymath Gottfried Wilhelm Leibniz (1646–1716).

We are all aware that being a kind of language, albeit an esoteric one, mathematics depends very much on concepts and notations for its effectiveness and communicability. One can easily understand this from, to give the most obvious example, the impact of the modern decimal notation to the development of mathematics and, in fact, to daily life by reducing practical calculations to an almost trivial set of rules. Imagine having to slog through the cumbersome and almost impossible Roman numerals if you need to add, multiply and divide! In a similar way, almost any undergraduate student can be taught how to solve certain types of geometrical problems (involving areas and optimisation) in a mechanical way by learning some basic rules of calculus. This is possible only because of the symbolic manipulation available in the calculus first introduced by Leibniz. This kind of process is invariably taken for granted by students of mathematics, most of whom are oblivious to the controversy that once raged over the question of priority for the invention of calculus— Leibniz or Isaac Newton?

The author presents a detailed account of the genesis of Leibniz's introduction and use of the now familiar symbols of differential dx , differential coefficient dy/dx and integral $\int ydx$. He traces the development of this incipient calculus from 1673 to the 1680s through Leibniz's early manuscripts and published articles. He gives the reader a view of the setting of these nascent ideas within the mathematical background in Britain and Europe during that period.

The book has also accumulated much research into the works of Isaac Barrow (mentor of Newton), Pierre de Fermat, Christian Huygens and many other others like René Francois Sluse, Bonaventura Cavalieri and Colin Maclaurin who had some bearing or possible influence on the formation of Leibniz's later ideas. The picture that emerges is one that is not merely a continuous development of mathematical ideas but a fractal-like development that meshes technical, personal, social and political factors. The author contends that the spirit and motivation of Leibniz's novel ideas in his new calculus can be traced back to the work of the 13th century Catalan philosopher Raymond Llull that became popular during the 150 years before Leibniz. Llull had wanted and, indeed, attempted to devise a system of "universal" symbols that would enable all conclusions to be reduced to a mechanical manipulation of these symbols. This is, in some sense, a precursor of symbolic logic.

Leibniz was a polymath with diverse interests in law, religion, philosophy, history and politics besides mathematics. His written output is voluminous and is still being edited and sieved through. In terms of the technical mastery of the traditional mathematical techniques of his time, Leibniz is surpassed by many of his contemporaries. Yet his influence and impact on the development of modern mathematics (and physics) is far greater (possibly with the exception of Newton). The reason is that, as the author of this book points out, the framework of Leibniz's calculus instituted what could be called a kind of Kuhnian paradigm shift in the way mathematics would be done in continental Europe from the 18th century onwards. This shift speeded up inexorably through the work of the Bernoullis and other influential European mathematicians who saw the power of the new calculus over the geometric tradition of the ancient Greeks (or even of Descartes). On the other hand, partly because of national pride over the Leibniz–Newton priority controversy, Britain remained relatively fixed in the tradition of Newton and for many years right up to the early part of the 20th century, there were few mathematicians in Britain of the same caliber as the leading ones in continental Europe.

The author's "Kuhnian" interpretation of the impact of Leibniz's calculus is not strictly the Kuhnian paradigm shifts of scientific changes. (The author is himself a former student of Thomas Kuhn.) Unlike scientific theories, "old" mathematics remains as true as "new" ones. What changes is what the author calls "thought style". Of particular relevance too is "fashion" in mathematical research, especially in modern mathematical research which is often affected by research grants, academic job opportunities and even political priorities.

The author gives his own view on the question of the Leibniz–Newton priority over the creation of calculus. In terms of chronology, Newton invented his "fluxions" and "fluents" that encapsulated the basic ideas of differential and integral calculus a number of years before Leibniz spelled out the seeds of his "calculus programme". However, in the author's view, Leibniz's motivation and fundamental ideas are quite independent of Newton's and that any influence which Newton's ideas may have on Leibniz would not be enough for the final breakthrough, so to speak.

The book has six appendices containing some essential mathematical details and the author's comments. Of these, three deal with Leibniz's work on infinitesimals and on solving geometric problems in terms of his new calculus, one on Leibniz's views on mechanics (the vis viva dispute), one on the classical logic used during the time of Leibniz and one to illustrate the traditional pre-Leibniz geometric methods.

The author himself studied European history and history of science before switching to a research and teaching career in mathematics. This book and an earlier one (*Are Science and Mathematics Socially Constructed? A Mathematician Encounters Postmodern Interpretations of Science*) represent a full circle of his intellectual interests. He is probably one of those few historians of science who are trained in the rigours of mathematics.

The serious researcher in the history of ideas and history of mathematics should find a lot of thought-provoking points of view expressed in this book. It should also be of interest to the general reader who would like to know something about research in mathematics as a human activity and yet does not wish to committing himself to the technical details.

Y K Leong.

National University of Singapore.

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