Witold Marciszewski/Roman Murawski. *Mechanization of Reasoning in a Historical Perspective*. Amsterdam/Atlanta, GA: Rodopi 1995. (*Poznań Studies in the Philosophy of the Sciences and the Humanities*; 43). ISBN 90-5183-790-9, 267 pp.[1]

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The book to be reviewed is written by two Polish authors. Polish history of logic has a great tradition, connected with the names of Jan Salamucha, Jan Lukasiewicz, Joseph M. Bocheński and others. It is a common mark of contributions in this tradition to approach historical texts from the perspective of modern logic. They use modern methods and tools to interpret and evaluate past contributions to this science. As a result of their technique to interpret the history of logic from the standpoint of modern logic as opposed to using the philological method that has long predominated, Aristotle's logic, medieval and early modern Scholastic and Renaissance contributions can be viewed in terms of their significance for today's logic. There is no doubt that this is a great advance for our understanding of the development of logic up to its present state. This advantage, however, is in practice bound up with some shortcomings. Of course, authors using such an approach are not primarily interested in the development of logic in its context, i. e., to use "the standpoint of the past under study", as Marciszewski and Murawski put it (11). In consequence they select only those parts of the development of logic which they consider as relevant for its present shape. From the methodological point of view this bears the danger of a "Whiggish" approach, i. e., to restrict history to the pre-history of contemporary states.

In his great history of logic entitled *Formale Logik* of *1956*, e. g., I. M. Bocheński dared to omit the period of "modern classical logic" from the 16th to the 19th century from his presentation, denying that it was a creative period, but regarding classical logic as "only a decadent form of our science, a 'dead' period in its development" (*1956*, 14, 20). Such an opinion can arise when early modern formal (syllogistical) logic is identified with logic as a whole and regarded as a dead end which was replaced by algebraic and

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logicistic calculi formulated in the second half of the 19th century. The conceptual changes of dialectic and logic as parts of philosophy to mathematical logic as part of mathematics are not considered. These changes, which were connected with changes in the relations between philosophy, mathematics and sciences, are obviously not regarded as relevant, neither questions of reception, tradition, motivations. History becomes a history of geniuses, with whom the historian converses as if they were contemporaries.

Nevertheless, this approach has an advantage if it is used in a careful way when relating judgments on the significance of some contribution to historical facts. The results have to be controlled historically (and philologically), and the historian should be aware of the fact that an interpretation of a historical text using modern means changes the text and may not always meet the significance of the text in its time.

Many problems disappear if one does not follow the authors' suggestion to distinguish strictly between certain "axiological assumptions" related to "the standpoint of the past under study" and "the standpoint of the present state of affairs." Recent methodological conceptions in the historiography of scientific disciplines show that the perspectives can be combined successfully and that it should even be possible to include further perspectives. This is also relevant for the specific approach the authors chose. Namely, they go a step beyond the Polish tradition, writing their history from "the standpoint of an envisaged future development" (11).

The authors' perspective is motivated by the present relations between logic and cognitive science. They envisage these relations as the main motor of future development. Anticipations are seen in the formalization of reasoning originating in the Middle Ages and in the mechanization of reasoning as seen paradigmatically in the logical calculi of Gottfried Wilhelm Leibniz and in George Boole's Algebra of Logic (12). "Reasoning" is used in its narrow sense, standing for deduction. The senior author Marciszewski gives a theoretical foundation of this "envisaged future development" in a systematic opening chapter entitled "From the Mechanization of Reasoning to a Study of Human Intelligence" (11–44). He pleads for a "Leibniz-style Cybernetic Universe" centered on machine generated information processing. He hints at the philosophical problem of the relation between physical objects such as data, and abstract objects like information. He correctly stresses that ontological considerations are not necessary to treat this relation, e.g., in the case of low level programming languages. He recommends rather to introduce abstract objects by using an abstraction theory operating with equivalence classes (23–27).

The historical part of the book comprises six chapters, the first three of which are written by Marciszewski, the other three by Murawski. The historical part starts in chapter 2 with a discussion of the attempts to formalize arguments in the Middle Ages (45–76). The chapter focuses on a criticism of the opinion that Raymundus Lullus, author of the combinatorial *ars magna* (*1517*), was a precursor of modern computer science. This opinion is convincingly disproved by showing its discrepancy to what Lullus really did in his work. The author concludes that "[...] Lull's candidacy of the status of the principal predecessor of Leibniz and the initiator of the mechanization of arguments proves untenable" (47), and "Lullus can hardly be regarded as the pioneer of the combinatorial and algorithmic interpretations of logic" (67).

This judgment seems to be too hard in respect to the combinatorial approach. Of course, there are no traces of formalization and mechanization in Lullus' writings, but one should not underestimate the *belief* of later generations in Lullus as a forerunner. And it was more than a belief. In his *Dissertatio de Arte Combinatoria* (*1666*, 168) Leibniz explicitly says that his combinatorial art is an elaboration of conceptions which can be found in Lullus and Kircher. In his letter to Gabriel Wagner (*1696*) Leibniz is even more explicit. There he says that it was Lullus who brought him to the science of combinations. The authors, however, seem to underestimate the combinatorial approach to logic in general which might be due to their focus on deductive reasoning. They underestimate the eminent rôle which Leibniz conceded to combinatorics in his *ars inveniendi* as a tool to find truths. With respect to Leibniz it seems to be problematic to regard the combinatorial approach to be "quite sterile as far as the development of knowledge is concerned" because of being associated "with the vision of the stationary universe of discourse, in which the set of concepts forming our knowledge, and thus constituting the universe of discourse" is definitely fixed and closed (75). The authors suggest distinguishing the "stationary universe of discourse" from a more promising "evolving universe of discourse" (ibid.). Such distinction veils the fact that in Leibniz's metaphysics both universes can be found. The creator has created the best of all possible worlds, including all truths. But the sum of all truths is only accessible by the creator himself. Man is necessarily limited. He needs devices to get access to as many truths as possible in order to come as close as possible to the creator's full knowledge. Man will, however, never reach it, and thus man's universe of discourse is evolving. Consequently, "the erroneous belief [...] that human knowledge can be definitely and safely established by combinatorial procedures" (76) does not actually but only potentially comprise all possible knowledge. Gaining knowledge is no finite process, and thus combinatorics cannot "definitely and safely" establish all knowledge, but only finite portions of it.

The authors wonder why logicians from Aristotle to Christian Wolff identify a proof with syllogism whereas a little familiarity with Greek mathematics shows that, e. g., in Euclid's *Elements* hardly any syllogism can be found (54). This irritation can be diminished by the observation that Leibniz, Wolff and even well into the 19th century the eminent German logician Friedrich Ueberweg do not really identify mathematical proof and syllogism. For them a typical mathematical proof is an *enthymeme*, i.e., a *shortened*, *incomplete* syllogism. Thus they only claim that every mathematical proof can be rewritten in a syllogistic form.

As a consequence of the authors' interest in deductive reasoning, the combinatorial approach plays no significant rôle in chapter 3 dealing with Leibniz's idea of mechanical reasoning and its historical background (76–112). There Leibniz's algebraic view on logic is compared with the emergence of the Algebra of Logic in 19th century England and its precursors in Renaissance logic. An inaccuracy should be corrected. David Hilbert did not present the task of proving the consistency of mathematics in 1900 as a reaction to set-theoretical paradoxes discovered at that time (90). Although Hilbert had discovered contradictions in Cantor's set theory before the turn of the century, the paradoxes in question were only discovered around 1902. Hilbert's first published reaction was his lecture of 1904 "Über die Grundlagen der Logik und der Arithmetik" (*1905*). Furthermore, the characterization of the "future science, termed *mathesis universalis*, which would cover the whole of knowledge, philosophy included, in the form of a single mathematized theory" (101) seems to be too narrow if applied to all proponents of a *mathesis universalis* like Descartes, Leibniz, Wolff, and Lambert. What does "mathematized theory" mean, e. g., in the work of Christian Wolff? The characterization omits the methodological aspect of the *mathesis universalis* being a method to gain knowledge in non-mathematical branches being as secure as in mathematics itself. Symbolic notation was not necessarily connected with the mathematical method. It belonged to the universal characteristics, another component in the Leibnitian programme to create a general science.

Chapter 4 "Between Leibniz and Boole: Towards the Algebraization of Logic" (113–127) discusses the logical contributions of the brothers Bernoulli, Christian Wolff, Gottfried Ploucquet, Georg Jonathan Holland and especially Johann Heinrich Lambert (who was not born in Mülhausen in Switzerland [cf. 120], but in Mühlhausen or Mulhouse in Alsace which was protected at that time by a state contract with Switzerland; although it is correct that Lambert regarded himself as a Swiss citizen).

It remains a mystery why the fact that Hegel was 20 years old when Ploucquet died "may be interpreted as a symbol of the continuity of logical problems in German philosophy from 17th to the 19th century" (117). Hegel, like Kant earlier, stood for a discontinuity in German research in formal logic. Both were strictly opposed to an application of any mathematical method in philosophy and interrupted the development of German rationalism. It is interesting to observe that there still was continuity in the combinatorial approach from Leibniz, via Carl Friedrich Hindenburg and Martin Ohm, to the algebraist of logic Ernst Schröder.

Chapter 5 deals with "The English Algebra of Logic in the 19th Century" (129–160), discussing especially the contributions of Augustus De Morgan, Sir William Hamilton, George Boole (as the central figure), William Stanley Jevons, and John Venn. Without any evidence it is claimed that "works of English logicians of the 19th century grew out of earlier ideas and attempts of G. W. Leibniz, G. Ploucquet, J. H. Lambert, L. Euler" (129). It will be hard to find any evidence for closer connections between these writers and English logicians anyway. The development of British research on formal logic was blocked by the predominance of empiristic (inductive) philosophies. It was only revived when Richard Whately's successful *Elements of Logic* were published in *1826*. Nonetheless, it is hard to believe it was really the controversy between Hamilton and De Morgan on the priority of having suggested the quantification of the predicate in standard forms (which, of course, neither had) that directed Boole's interest towards logic, as he himself had claimed, and as is repeated on p. 131. Much more important were the developments in British algebraical analysis, especially attempts to apply D. F. Gregory's "Calculus of Operations" in domains outside the calculus. The authors see the main significance of Boole's ideas in that he showed "that logic can be studied without any reference to the processes of our minds" (146), but it should be stressed, that Boole founded logic itself on psychological considerations. It is not without reason that Ivor Grattan-Guinness called Boole's approach to logic "mathematical psychology" (*1982*, 35) and that Joan Richards called Boole a "psychological logician" (*1980*, 31). To illustrate this it is sufficient to read the title of chapter 3 of Boole's *Laws of Thought* (*1854*, 39): "Derivations of the Laws of the Symbols of Logic from the Laws of the Operations of the Human Mind." Furthermore, Gergonne (1777–1851) should not be listed among the later logicians who removed the imperfections of the systems of British logicians (159). His logical contributions (Gergonne *1816/17*, *1818/19*) appeared 30 years before Boole's first logical publication (*1847*).

Chapter 6 deals with "The 20th Century Way to Formalization and Mechanization" (166–208), focusing on Peano's contributions to logic and the foundations of arithmetic, on Frege's formal system, on Russell's and Whitehead's contributions, on "Skolemization", including the contributions of Löwenheim, on Hilbert's programme, Herbrand's and Gentzen's contributions and finally on analytic and semantic tableaux. In this chapter the authors have to comment on the "two logical traditions" of late 19th century logic, namely the algebraic and the logicistic tradition, but they do no justice to the algebraic tradition. It is incorrect that the aim of logicians writing in the algebraic tradition "was to develop a method of expressing unquantitative information in the form of equations" (161). The complete second volume of Schröder's *Vorlesungen über die Algebra der Logik* (*1891/1905*) is devoted to the "propositional logic" as Schröder calls quantifier logic up to nth order. Of course, Schröder got his quantifiers not from Frege but from the Peirce school. The basic operation in Schröder's Algebra of Logic is not the equation but subsumption, interpreted in the calculus of classes as class-inclusion and in the calculus of propositions as implication. It should furthermore be noted that it was not only Peano who used different signs for logical and mathematical operations (cf. 162). Schröder as well used new signs for logical operations such as the subsumption operation. In Schröder's philosophy of logic adjunction and conjunction are logically interpreted algebraic operations. He therefore kept the algebraic signs $+$ and $\cdot$.

The authors write that Gentzen's calculi "stimulate the natural reasoning" and by this falsify Gentzen's own definition of the term "natural reasoning". Gentzen explicitly says (Gentzen *1935*, 183) that his calculus of natural reasoning should present the real procedures of logical reasoning in mathematical proofs as exactly as possible. This is still a highly artificial enterprise. The analysis of really "natural reasoning" should be left to the competence of psychologists and neurophysiologists.

It is not easy to grasp why Gödel's contributions are not treated. At least his arithmetization of meta-mathematics ("Gödel numbering") should have been mentioned since it shows how to fulfill Hilbert's demand to completely formalize arithmetic, and it provides a way to achieve a *characteristica universalis* in the Leibnitian sense.

The final chapter on "Mechanized Deduction Systems" (209–230) focuses on attempts to find automated theorem provers which the authors see as the link to the future rôle of logic in cognitive sciences.

The fact that successful attempts to overcome classical two-valued logic such as fuzzy logic are not mentioned, the fact that attempts to deal logically with networks, like array-based or nested logics, or the fact that graph theoretical attempts to deal with complexities are not presented show the arbitrariness of endevours to foresee any future development. I. e. any other prognosis leads to another history, although it might be that most of the sources are the same.

The authors do not always acknowledge their sources. This is particularly obvious in the passages concerning the logical systems of Jevons and Venn which closely follow Martin Gardner's seminal book, *Logic Machines and Diagrams* (*1958*). Furthermore, the book under review is another example of the consequences of the growing practice of publishers to relinquish the task of copy editing even in the case of books written by non-native users of the language.

Despite the flaws mentioned in this review, the book is a provocative and fruitful contribution to the history of logic, going far beyond a purely descriptive presentation. In most cases the authors master the problems of histories written from a contemporary or even future perspective. That the methodological perspective chosen might hide the view on some developments has been indicated above. Nevertheless, this book does open discussion in a great number of fields.

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