Introduction: Diagrammatical reasoning and Peircean logic representations*

JOÃO QUEIROZ and FREDERIK STJERNFELT

Along with Gottlob Frege, Bertrand Russell, and David Hilbert, Charles S. Peirce is considered one of the founders of modern logic (Lukasiewicz 1970 [1961]: 111; Barwise and Etchemendy 1996: 211; Quine 1995: 23; Hintikka and Hilpinen 1997: ix). Independently of Frege, he developed the concepts of quantification and quantifying logic (Hintikka and Hilpinen 1997: ix; Quine 1995: 31; Putnam 1982: 297). He was author of the term and concept of "First-Order Logic" (Putnam 1988: 28), and "Trivalent Logic" (Fisch and Turquette 1966; Lane 2001), besides his anticipating Henry Sheffer's "Stroke Function" by more than thirty years (*W* 4: 218–221; Houser 1997: 3), and he was working with the computational correspondence between truth functions and electrical circuitry that was later independently developed by Claude Shannon (*W* 5: 421–422; Gardner 1982). He insisted on the relevance of logic in both metaphysics and epistemology and, thus, is a founding father of what Jaakko Hintikka has called the tradition of "logic as calculus" as a current competing with the major modern tradition of "logic as a universal language" (Frege, Russell, Wittgenstein, Quine, etc.). His algebraical logical notation developed in the 1880s was the first draft of a modern formal logic and developed, through Schröder and Peano, into the standard formalism used today. Later, he also developed an alternative logical notation using topological forms (existential graphs) that anticipated hybrid systems of notation — heterogeneous logic — based on graphs, diagrams, maps, networks, and frames (Roberts 1973; Shin 1994; Barwise and Etchemendy 1995; Allwein and Barwise 1996).

Peirce's system of existential graphs (EGs) is a geometric-topological logic notation. According to Gardner (1982 [1951]: 55–56), the existential graph (EG) is the most ambitious diagrammatical system ever built, and the most understandable and versatile system of geometrical logic ever constructed. Developed in different periods, starting in 1882 (Roberts 1973: 18) this *revolutionary* system (Shin 1994: 11) or group of systems (Alfa, Beta, and Gamma Graphs), not only overcomes several limitations of Euler and Venn diagrams (*CP* 4.356), but also allows for the beginning of the diagrammatization of modal logic (Houser 1997: 3). To Peirce, the merit of EGs is double: first, they

Semiotica 186–1/4 (2011), 1–4
DOI 10.1515/semi.2011.043
0037–1998/11/0186–0001

allow to chart logical reasoning in its finest detail, making visible every single step in the reasoning process (as against notations aimed at quick, results-oriented heuristics); second, they aim at portraying logical structure as iconical; that is, as ontologically valid, as possible. Recently, EGs have made possible the development of experiments with graphs in artificial intelligence, in areas such as semantic networks and knowledge representation (Sowa 1984, 1992). According to several researchers, working with the computational treatment of graphs, the EGs form "the first articulate model of knowledge and information processing" (Dickson et al. 1997: 2).

For a Peircean point of view, however, it is important to underline that the common-sense, everyday opposition between diagrammatical and symbolic representation systems, or between heterogeneous and homogeneous logics, does not hold. Rather, the latter appear as a special subset of the former, and even the most formalist, finitist representation systems must conserve some minimum of intuitive representation (e.g., a line subdivided in places that may be occupied by symbols to be manipulated according to rules on that line). This primacy of geometric representation reopens the connections between logic, on the one hand, and phenomenology, semiotics, cognition, and the heuristics of actual scientific and everyday thought processes, on the other.

In the mature version of Peirce's philosophy from the years around 1900, diagrams play two main roles. First and more general, diagrams and diagrammatical reasoning as such play a central and often overlooked role: all deductive reasoning, according to this doctrine, takes place by means of diagrams that furnish an observation-based approach to abstract, ideal, and logical issues (Stjernfelt 2007). This basic epistemological diagram doctrine thus covers all sorts of maps, graphs, formalisms, algebras, etc. Second, the development of EGs demonstrates the fertility of this viewpoint within the core discipline of logic: Alpha and Beta graphs have been shown to be complete and consistent representations of propositional logic and first-order predicate logic, respectively, while the unfinished Gamma graphs are a goldmine of sketches involving modal logic, temporal logic, speech act logic, second-order predicate logic, etc.

The interest in the development of hybrid notation systems — "heterogeneous logic" — based in graphs, diagrams, maps, nets, frames, etc., is amazing. We are witnessing the foundation of research centers dedicated to the creation and development of these systems, an increasing number of books issued upon the subject, articles published in specialized journals, besides the creation of a scientific field based on the EG — conceptual graphs — and the holding of conferences dedicated to this area.

This volume aims to propagate the awakening interest in Peirce's existential graphs and the related issue of diagrammatical reasoning in general. The special issue covers a continuum from specific studies in Peirce's Alpha, Beta, and Gamma Graphs, on the one hand, to more general papers on diagrammatical

reasoning and graphical representations of logic and semiotics, on the other hand.

Here, the reader will find contributions on a wide range of topics, from detailed investigations into Peirce's systems to general surveys of the role of diagrams in reasoning processes: Alpha, Beta, and Gamma systems, Reasoning with Peircean graphs, Diagrams in Peirce's theory of cognition, Pragmatism and existential graphs, Philosophical concerns about Peircean diagrams, Existential graphs and conceptual graphs, Graphical logic representations, and Diagrammatic reasoning.

We hope the reasonings in this special issue will contribute to the further development of diagrams, and of Peircean scholarship in general.

Note

* João Queiroz is indebted to the Brazilian National Research Council (CNPq) and the State of Bahia Foundation for Research Support (FAPESB); Frederik Stjernfelt is indebted to the Center for Semiotics, Aarhus University.

References

Allwein, Gerard & Jon Barwise. 1996. *Logical reasoning with diagrams.* Oxford: Oxford University Press.

Barwise, Jon & John Etchemendy. 1996. Heterogeneous logic. In Gerard Allwein & Jon Barwise (eds.), *Logical reasoning with diagrams*, 179–200. New York: Oxford University Press.

Dickson Lukose, John F. Sowa, Leroy Searle, Mary Keeler, Harry S. Delugach (eds.) 1997. *Conceptual structures: Fulfilling Peirce's dream — fifth international conference on conceptual structures*, ICCS'97. Dortrecht: Springer.

Fisch, Max & A. Turquette. 1966. Peirce's triadic logic. *Transactions of the Charles S. Peirce Society* 2. 71–85.

Fisch, Max. 1986. *Peirce, semeiotic, and pragmatism.* Bloomington: Indiana University Press.

Gardner, Martin. 1982 [1951]. *Logic machines and diagrams*. Chicago: University of Chicago Press.

Houser, Nathan. 1997. Introduction: Peirce as logician. In Nathan Houser, Don Roberts & James Van Evra (eds.), *Studies in the logic of Charles S. Peirce*, 1–22. Bloomington: Indiana University Press.

Lane, Robert. 2001. Triadic logic. In *Digital encyclopedia of Charles S. Peirce*, J. Queiroz & R. Gudwin. http://www.digitalpeirce.fee.unicamp.br/lane/trilan.htm (accessed 11 April 2011).

Lukasiewicz, Jan. 1970 [1961]. *Selected works*, L. Borkowski (ed.). Amsterdam: North-Holland.

Peirce, C. S. 1931–1966. *The collected papers of Charles S. Peirce*, 8 vols., C. Hartshorne, P. Weiss & A. W. Burks (eds.). Cambridge: Harvard University Press. [Reference to Peirce's papers will be designated *CP* followed by volume and paragraph number.]

Peirce, Charles Sanders. 1982–. *Writings of Charles S. Peirce*, 5 vols., M. Fisch, E. Moore & C. Kloesel (eds.). Bloomington: Indiana University Press. [Reference to Peirce's writings will be designated *W* followed by volume and page number.]

Putnam, Hilary. 1982. Peirce the logician. *História Matemática* 9. 290–301.
Putnam, Hilary. 1988. *Lógica combinatória* (Enciclopédia EINAUDI 13). Lisbon: Imprensa Nacional Casa da Moeda.
Quine, Willard V. 1995. Peirce's logic. In Kenneth L. Ketner, Joseph M. Randsell, Carolyn Eisele, Max H. Fisch & Charles S. Hardwick (eds.), *Proceedings of the C. S. Peirce bicentennial international congress*, 23–31. Lubbock: Texas Tech Press.
Roberts, Don. 1973. *The existential graphs of Charles S. Peirce.* The Hague: Mouton.
Shin, Sun-Joo. 1994. *The logical status of diagrams.* Cambridge: Cambridge University Press.
Sowa, John F. 1984. *Conceptual structures: Information processing in mind and machine*. Reading, MA: Addison-Wesley.
Sowa, John F. (ed.). 1992. *Conceptual graphs*. Special issue, *Knowledge-Based Systems* 5(3).
Stjernfelt, Frederik. 2007. *Diagrammatology: An investigation on the borderlines of phenomenology, ontology, and semiotics*. Dordrecht: Springer Verlag

João Queiroz (b. 1963) is a professor at the Federal University of Juiz de Fora <queirozj@pq.cnpq.br >. His research interests include the emergence and evolution of semiotic complexity, the emergence of symbolic based communication, cognitive technologies, and complexity studies. His publications include "Artificial cognition systems" (with A. Loula and R. Gudwin, 2007); "Firefly femme fatales: A case study in the semiotics of deception" (with C. El-Hani & F. Stjernfelt, 2009); "Genes, information, semiosis (with C. El-Hani & C. Emmeche, 2009); and "On Peirce's pragmatic notion of semiosis — a contribution for the design of meaning machines" (with f. merrell, 2009).

Frederik Stjernfelt (b. 1957) is a professor at Aarhus University <semfelt@hum.au.dk>. His research interests include diagrammatical reasoning, semiotics, epistemology, and ontology.