International Conference
Philosophy of Science in the 21st century – Challenges and Tasks
4-6 December 2013 | Lisbon | Portugal

S1

4th of December 2013 | 14h50-16h50 | Room C6.2.48

Imagination and diagrams in scientific discovery

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Introduction

Einstein famously said, "Imagination is more important than knowledge". In MS 905 written in 1908 Peirce writes: "And thus the whole stage Deduction consists of two sub-stages, the first of logical analysis and the second of mathematical reasoning, which I take to include syllogistic reasoning. I may add that the second is again divisible into what I call corollarial and theorematic reasoning, of which the latter requires the invention of a new icon, or imaginary object diagram, while the former proceeds directly by syllogisms, results of previous logical analyses and mathematically reasoned conclusions." The iconic moment is clearly stated here, as well as the imaginative character of theorematic reasoning. But translating the propositions into a suitable diagram language is also needed: "The word 'diagram'", Peirce held, "is here used in the peculiar sense of a concrete but possibly changing mental image of such a thing as it represents. A drawing or model may be employed to aid the imagination; but the essential thing to be performed is the act of imagining" (MS 616, 1906). This symposium investigates the aspects of scientific reasoning and discovery that seem irreplaceably dependent on understanding the nature of both imagination and diagrams.

Abstracts

Ubiquity of Diagrams: Peirce on diagrammatic reasoning

Francesco Bellucci (Tallinn University of Technology)

This paper explores Peirce's doctrine of diagrammatic reasoning with regard to his famous division of inferences into deduction, induction and abduction. For Peirce all deductive reasoning is diagrammatic. Does this imply that diagrams, while crucial in deductive inferences, play no role in non-deductive ones? I will try to answer this question by reconstructing Peirce's later view on the matter.
Peirce emphasised the role of iconicity in abduction since his early works on the logic of science and types of reasoning (1865-66); each leading principle is irreducible to

the others and homogeneous in itself, and each is capable of a semiotic description: hypothesis (later: abduction, retroduction) is iconic, and ampliative reasoning in general requires the introduction of icons. Later (1906-1908) he put the matter differently. Abduction, deduction and induction become now three stages of a unique, general form of reasoning, and abduction and induction become phases or steps of deduction itself: diagrammatic reasoning has its own abductive and inductive phases. But on the other hand, Peirce also thought that, in a sense, induction and *a fortiori* abduction ultimately depend upon deduction. Therefore, diagrammatic reasoning both requires inductive and abductive phases and at the same time constitutes the remote ground of their own validity.
Moreover, diagrammatic deduction presupposes logical analysis. But logical analysis requires an adequate logical notation. Notations can be more or less iconic, and the more iconic a notation is, the more easily analysis is performed. So icons also enter "methoudeutically" into deduction, as instructions as to the construction of good logical notations.
The later theory is richer than the earlier one, and is in part still unexplored. Iconic thinking is for the late Peirce transversal to different processes of discovery; in a way, diagrams are ubiquitous in all reasoning.

New Light from Peirce's Unpublished Works on Retroductive Reasoning

Ahti-Veikko Pietarinen (University of Helsinki & Tallinn University of Technology)

What are the conditions of "facile" and "natural" in the first stage of inquiry in which the logic of retroduction is at work? Retroduction encompasses observation, imagination and guess, and it operates with "visual and muscular experiences" as its material. If these experiences can be rendered diagrammatic, we could get closer to that logic. I look into a number of suggested explanatory conjectures for electricity deriving from the turn of the 20th century that show the workings of the logic of retroduction and its theoric steps. Similar examples are found in the development of Feynman diagrams and in the discovery of the amplituhedron based on twistors.
The second stage, deduction, begins with the "logical analysis", which involves hypostatic abstraction. How does logical analysis, recommended by Peirce to be carried out in existential graphs, relate to the diagrammatic in the first, retroductive, stage of inquiry? I try to make some headway with this. At all events, deduction, which aims at computing the consequences of scientific guesses amenable to comparison with experience, consists of three parts: analysis, corollarial and theorematic reasoning.