Metaphors of Order and Disorder: From the Tree to the Labyrinth and Beyond

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ABSTRACT: By means of historical-critical analysis of the evolution of metaphors for indicating the structure of knowledge, I will try to identify common themes and differences in the transition from a semantic domain expression of confusion or uncertainty (labyrinth, map) to a semantic domain in which metaphors express ordering systems of knowledge, or more generally of large masses of information (Semantic Web, Small World). The study of this evolution is particularly important because it tends to highlight some conceptual networks which today are protagonists of a real scientific revolution in the work of abstraction and application of theories to the domain of knowledge. We will see that there are some concepts underlying this transition, which are common to both domains and that we can identify with the concepts of space for the organisation and linguistic-dynamic structure. The reason for this can be traced to the change in signified and often in signifier of various metaphors, which keep the connection to the same subject, knowledge organisation, and which were initially adopted, especially during the early modern period, to highlight the impossibility of building a reference system capable of guiding a user through the complex encyclopedic order; object of these metaphors were the world map, the labyrinth, the ocean waters.

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1.0 Introduction

I will attempt to briefly examine the period—the eighteenth century—in which the issues hindering a systematic arrangement of knowledge were exactly articulated. These problems are a matter of critical debate when the classifications have as their object abstract elements without any material correspondence, for example in classifying poetry below the imagination, and become obstacles which inevitably arise when dealing with the question from a physical point of view, i.e., when attempting to orient oneself in a library or in an encyclopedia, therefore when we have to map a territory not abstract. In the second part of this work, we will see that the question of the space for the organisation and retrieval of information in a library or an encyclopedia in a digital virtual space currently provide a much more significant arena for philosophical and pragmatic discussion than that of the eighteenth century, in which the space of the organisation, that of the retrieval of the information and that of the archives was influenced not only by the materiality but also by philosophical paradigms ongoing at the time. In cases where a mapping of knowledge, understood as a corpus of information contained in volumes, was required, the complexity of the question led the greatest encyclopaedists (Chambers, Diderot, and D'Alembert) to use and analyse those metaphors which expressed the inability of defining the domain and identifying such a general order, which for convenience I will call "metaphors of disorder." What these metaphors emphasise is the difficulty of conceptually and pragmatically identifying an organisation of information space suited both to interconnections between disciplines and between encyclopedia entries as well as to natural changes in the universe of knowledge over time. In this way, this confused space—the expression of an ineffable order—becomes a labyrinth, a map of the world, the waters of an ocean. Today we use the same metaphors, among others, to transfer meanings technically connoted that relate to management arrangements of the disorder. The crucial period on which I will focus for bringing to the surface a conceptual network that may be useful in complex dialogue between philosophy (above all epistemology and logic) and LIS is the period of scientific and philosophical revolution that, in the nineteenth century, has invested the entire field of logic and geometry, especially in the fundamental concept of space. I will try to pointing out some crucial steps between the nineteenth and twentieth century, and to propose a historical and conceptual interpretation.

2.0 Space, order and disorder in the use of encyclopedic metaphors in the eighteenth century

During the Age of Enlightenment, many classifications of knowledge, understood as either encyclopedic knowledge or as the organisation of a particular science or art, were proposed. These classifications were summarised in schematic drawings showing the conceptual provisions on the basis of relations of an exclusively meronymic type (Tonelli 1975). The most part of these classifications had as domain the knowledge understood as a philosophical abstraction, without any material correspondence, and the dominant metaphor was that of the tree, consistent with the Euclidean-axiomatic order. Christian Wolff (1735), for example, based his system upon a psychological conception of knowledge: the basic organising principle is represented by chains of inclusions; thus cognitio, the root of the tree, has been split at the beginning of diagram into sensibilis and sensibilis-rationalis. What I aim to show is how this application of the metaphor of the tree, understood as a system in which each concept is inclusive (apart from the last, the so-called leaves) or included (apart from the first, the root), does not correspond to the characteristics of conceptual relationships themselves, which do not fit into an exclusively meronymic logic. But Wolff and the other philosophers who developed these classifications did not face the problem of having to construct a tool for orienting themselves in a physical place like a library or a dictionary. It is only when referring to a corpus of real knowledge that the structural and design problems of these forms of organisation emerge: when one must catalogue the material knowledge contained in libraries or supply the reader of an encyclopedic dictionary with a tool for managing the relationship between the search for information and the places where it is located. Yet this request, this need for a map which outlines the vast and labyrinthine universe of knowledge, not in the abstract but in contingency, has often been expressed and nurtured by philosophers, even in regard to their own libraries or those for which they were in some way responsible (Canone 1993).

These attempts to define the general (or specific) field of knowledge in the abstract did not influence the organisation and production of dictionaries and encyclopedias, since, rather than unitary or systematic instruments or devices, they were designed by lexicographers as collections of knowledge (Eco 1981) for which neutral alphabetical order was therefore sufficient, until Ephraim Chambers' *Cyclopaedia* and Diderot and D'Alembert's *Encyclopédie*. According to Chambers, instead, the main value of material encyclopedic construction lay in its organisation, or rather in the theoretical framework underlying the work; in the reasoned dimension of the dictionary, as an encyclopaedist would put it. Less, therefore, in the wealth of the information, and more in how it is organised. For Chambers, this organisation was made up of a meronymic structure essentially identical to Francis Bacon's arbor scientiarum and of dictionary entries and links, the so-called "cross-references," which systematically connected the branches of knowledge (as if they were sets of sentences variously interlinked) making it possible to follow the various paths of a discipline by means of the references laid out in the classificatory tree and the relations of a lemma respect to other entries with which it is connected.

In the author's opinion, this composition of the Baconian pattern and cross-references was to represent, in the eyes of the reader, the essentially linguistic and systematic nature of knowledge (Chambers 1728). Chambers was aware of the limits of the Baconian tree and the arbitrary way in which the classificatory principles were chosen, and was also aware of the difficulty, if not the impossibility, of imposing a non-alphabetical method of searching for information. Chambers (1728, ii) writes, "It seems more natural to consider Knowledge in its proper Parts …; than to consider the whole Assemblage of it in its utmost Composition: which is a thing merely artificial and imaginary." The two systems must therefore coexist, and Chambers materially brought together the dictionary and encyclopedic organisation, to which he added, in what was a decisive step forward in the history of knowledge organisation, the system of cross-references. In fact, in the classification which he proposed and which emerges from his *Cyclopaedia*, he pays particular attention to the connections established by cross-references as a binding agent for the encyclopedic system.

Nevertheless, Chambers acknowledged the main weakness of the system that he himself had constructed, highlighting the relativity and the temporal dimension of each criterion of classification. Using the map-territory metaphor, he compared the work of ordering knowledge with that of geographers, who draw maps based upon contemporary discoveries which they then gradually modify in accordance with new data of various types. There is in the activity of knowledge mapping, therefore, an initial approach which defines the partitions. Later, on the basis of scientific discoveries, differing philosophical positions and new historical research and conceptual definitions, the initial maps are changed. Since the factors of change are constant over time, it is clear that knowledge mapping proves to be an ongoing activity (Chambers 1728). For Chambers, therefore, unlike the principles inspiring abstract classification discussed above, knowledge structure is not related to being, to the relationship with transcendence or some purposive principle. It is related to the complex idea which represents the concept of knowledge itself, a linguistic-conceptual complexity which defies objective definition and the conceptual and relational limits of a schema and which is based upon the subjective convictions of those who conceive it and trace its outline. Any classification, however motivated, always therefore contains an arbitrary aspect and is always relative to a period of time.

In addition to Chambers' work, the encyclopédistes—in particular the two editors—inherited both his organisation, with the innovation of the cross-references of which they made ample use, and the difficulties inherent in the enterprise of building a systematic and unified work in which the territories of knowledge could be explored by means of a map, i.e., a system which would make borders, nuances and connections between sciences, arts and crafts, explicit. This intent is clearly stated at the beginning of D'Alembert's *Discours préliminair*e (Diderot and D'Alembert 1751-1765, i):

> The work whose first volume we are presenting today has two aims. As an Encyclopedia, it is to set forth as well as possible the order and connection of the parts of human knowledge. As a Reasoned Dictionary of the Sciences, Arts, and Trades, it is to contain the general principles that form the basis of each science and each art, liberal or mechanical, and the most essential facts that make up the body and substance of each.

D'Alembert and Diderot found Baconian subdivision, modified after much discussion and controversy in the S*ystème Figuré des Connaissances Humaines*, totally unsatisfactory (Casini, 1970). Therefore, before the usual metaphor of the tree as a spatial model of order and that of the labyrinth or globe, useful for expressing the impossibility of representing or picturing the complexity of the presumed organisation of knowledge, the metaphor used by D'Alembert in the *Discours* takes as its model of order the chain (chaîne) and as an overall image that of enchainment (enchaînement), in other words the system of connections of all the sciences and the arts (Diderot and D'Alembert 1751-1765, *Discours préliminaire*, ii).

Even this point of view, however, which retains the Baconian ideal of the unity of science, did not evolve into a pragmatic-theoretical model suited to a complex vision of knowledge and providing an efficient representation of it for navigating the work's system of articles. What is lacking, in a sense, is that overall clarity which must lead from facts to principles (cf. Cassirer 1932), that opening up to epistemic activity invoked by the esprit systématique. To provide a map for navigating the vast labyrinth, therefore, if one does not wish to do without some sort of systematic and graphic organisation which expresses the connective flow of disciplines and encyclopedia entries, the only feasible order more geometrico is that of the tree.

On the other hand, the same type of order is represented by the effort to define each science from a perspective which takes as its reference model classical (Aristotelian-Euclidean) axiomatic system. In fact, despite the modern tradition, which from Bacon to Locke also influenced the organisation of Chambers' *Cyclopaedia* in the meaning of an inductivist—beginning from *Novum Organum*—and sensationalist critique of the Aristotelian method, Euclidean geometry, as an axiomatic classical construction, remains the unassailable example of scientific certainty, not only the ideal model for every science and the only way of conceiving of spatial knowledge, but also of graphically distributing a pragmatic organisation like that sought by encyclopaedists, which had no typically geometric purpose. It is no coincidence that classical axiomatic system, esprit systématique, the deductive process, Baconian inductivism and the experimental method alternate throughout the concept of order expressed by Diderot in his article *Encyclopédie* (Diderot and D'Alembert 1751-1765, vol. V, 641A):

> There are first principles, general notions, given axioms. These are the roots of the tree. The tree must ramify as much as possible; it must shoot off from the general object as from a trunk, rise first to the large branches or primary divisions; go on from these master branches to smaller ones.

Here Diderot seems to demonstrate remarkable faith in the classical axiomatic method, but once these trees have been gathered in a single trunk, a metaphor for the unity of science, we once again find the world map (641A), and the overall encyclopedic order returns to being ineffable. Therefore, a little later in his article, the search for order, rather than proceeding from the top down (we can imagine the tree removed from the metaphor set upside down), proceeds inductively, from perceivable experience to the science of axioms (642):

> One process which must sometimes be accepted, because it represents rather well the method of invention, is to begin with individual and particular phenomena so as to mount from there to more extensive and less specific knowledge; from there to yet more general knowledge, until one reaches the

> science of axioms or those propositions whose simplicity, universality, and obviousness renders undemonstrable.

This attempt too runs aground, however, in the impossibility of demonstrating the interconnections, the enchaînement, of all the sciences and the arts, being also forced to unite them in a few first principles or even one single principle. This is the limit of D'Alembert's chain of knowledge, which suffers the same fate as the aforementioned uniting of the individual trees of the sciences (cf. D'Alembert 1751, *Élémens des Sciences*, vol. V, 491, in Diderot and D'Alembert 1751-1765). This type of difficulty, which leads from the metaphor of the tree or chain—capable of expressing the axiomatic order—to the metaphors of disorder or confusion—which allude to oceanic waters, the labyrinth or the world map—is due to the powerful epistemological imprint of classical axiomatics which uniquely determine both the logical order in which a discipline can be represented and the graphic and classificatory order with which we define the schema on a sheet. This conditioning prevents us from clarifying the connections and methods of change inherent in any domain of knowledge and hypothesising a complex structure which provides a map and an information retrieval system.

The choice of an alphabetical order which corresponds to the chain model, though (being purely syntactic ordering) lacking any semantic value, therefore remains the only possible one. We could call the inherent weakness of encyclopaedic order "the problem of the world map" and treat it as a matter of a semantic space-time organisation. This space is not metric and cannot be organised by a theory based on a pre-established, subjective and arbitrarily applied order, conceptually external to the system. The construction of an encyclopedic classification requires the use of the esprit systématique, that is, the application of an experimental method which justifies the connections as motivated by experience, modifiable and shared between experts: "communia, propriè; propria, communiter" (Diderot 1751, *Encyclopédie*, vol. V, 647A, in Diderot and D'Alembert 1751-1765); bonds, therefore, which are by definition unstable, or rather, are subject to a precarious balance which allows for continuous revision, like that adopted by cartographers when they detect changes in the work of surveying territories. Thus, to the metaphor of the world map used by D'Alembert in the *Discours* (1751, xv), Diderot (1751, *Encyclopédie*, vol. V, 647A, in Diderot and D'Alembert 1751-1765) adds the image of the complexity to be charted, the contingent world which changes under the eyes of the observer like an immense countryside:

> A universal dictionary of the sciences and arts needs to be thought of as a vast countryside containing mountains, plains, rocks, water, forests, animals, and all the objects that make for the variety of a great landscape.

Yet Chambers, D'Alembert and Diderot had devised a system which gave shape to that vast countryside: the system of cross-references. Moreover, unlike the *Cyclopaedia*, the references from one item to another which the two editors of the *Encyclopédie* created were designed with different semantic values. The cross-references that Diderot (1751, *Encyclopédie*, vol. V, 642A-643A in Diderot and D'Alembert 1751-1765) called de mots (of words) make up a linguistic continuity between the diverse entries which consists principally in using one entry to make explicit that discussed in another. This type of connection reveals analogous relationships between both entries and between the matters with which they deal. The cross-references relating to things (de choses) bring to light the links between the object, which today we would call the entry's theme, and those topics closely related to it, understood as the entry's rheme. These links group common notions and clarify relations between disciplines, or highlight differences and even contradictions.

There are also de génie (of genius) cross-references which, by linking subjects not immediately connected, allow the discovery of new things, thus advancing knowledge. Diderot and D'Alembert were therefore aware that the horizontal dimension, as opposed to the verticality of the tree in the 'systéme figurè,' moved encyclopedic organisation closer to a linguistic dimension and their ideal of knowledge as enchaînement. What has been lacking is the inclusion of this dimension in an organised space coherently with it. Today we can say that the *Encyclopédie's* system of cross-references is the first step towards a complex representation of the architecture of knowledge (Blanchard and Olsen 2002).

3.0 Ordering disorder: how have encyclopedic metaphors changed today?

In an era in which information space is managed by the digital electronics and algebra of the networks, the values of meaning which conveyed the metaphors of disorder have evolved so much as to have abandoned any analogy with disorder and to refer instead to logics of ordering. Despite this, however, the issues that Chambers, D'Alembert and Diderot brought to light regarding the complexity of encyclopaedic order remain unresolved and are still fundamental in opening a space for dialogue between epistemology and archival classificatory disciplines.

Let us briefly examine some of the factors which determined the semantic change in these metaphors and which are at the base of current attempts to manage the organisation of knowledge. In accordance with the point of view proposed here, we identify four in particular: 1) the revolution of the concept of space caused by the discovery of non-Euclidean geometries and the subsequent revolution of the classical axiomatics; 2) the birth of the algebra of logic, brought about by George Boole, which opened the way for the formalisation of deductive reasoning; 3) the development of inductive logic along the lines of the approach theorised by Francis Bacon and perfected by John Stuart Mill; and 4) the birth and development of graph theory, which, with the work of Charles Peirce, became the principal tool for graphically analysing concepts and relationships. As it will not be possible to deal with these issues in detail, it should be emphasised that the aim of this work is to open a discussion of the concept of "knowledge space" and the possibility of organising this space by mapping its dynamic linguistic-conceptual aspect.

As regards those issues related to a schematic vision of encyclopedic organisation, there were two consequences of the revolution in the concept of space which was caused by the discovery of non-Euclidean geometry in the nineteenth century and which radically changed the encyclopaedists' perspective: an experimental empirical approach in the relationship between geometry and spatial perception (Lobachevsky and Papadopoulos 2010, orig. ed. 1856), and the reduction of the classical axiomatic system to a specific case of a general axiomatic system which no longer favours one particular field of investigation but is capable of referring to any structure, as maintained by Henri Poincaré (1905, 50): "One geometry cannot be more true than another; it can only be more convenient." In this sense, the classical axiomatic system's claim to seek axioms which are unprovable, as being true in themselves, as first principles of all science to be later collected into higher-order principles which define the unitary dimension of all sciences, where each concept is naturally arranged in the hierarchy of the resulting tree diagram, fails.

This ideal of more geometrico knowledge, while losing the axiom-evidence relationship, does not collapse, as the modern axiomatic system retains the tree structure and hierarchical references derived therefrom but loses the conceptual absoluteness and certainty which characterised it: it speaks of geometries, no longer simply of geometry, and, above all, of spaces and no longer of space. In this sense, the hypothetical-deductive systems of modern axiomatics offer themselves as languages able to speak of any type of structure, with the single limit of non-contradiction (Hilbert 1899). This situation alters the perspective which faced the encyclopaedists, who on the one hand aspired, as we have seen, to propose a linguistic and dynamic provision of knowledge, and on the other were forced into the straitjacket of the classical axiomatic system. From this it follows that the modern axiomatic system may propose not only non-Euclidean more geometrico structures, not necessarily linked to a metric dimension nor conceiving of space as an intuition of external space, but is also open to other conceptions of spaces, such as conceptual spaces, making the opening of these spaces to logical organisation possible.

The creation of algebraic logic by George Boole (1847), though apparently marginal, played a role which was particularly important in the evolution of metaphors of disorder. Here too I will avoid examining the direction taken by this discipline, ultimately joining Cantor's set theory and the mathematical logic which would emerge from modern axiomatics, but will consider two aspects linked to our reflections on the problems of ordering; in Boolean algebra, logic and mathematics are in a converse position with respect to the modern axiomatic system. In the latter case, mathematics adopts the methods of logic and in some way logicises itself to the point of attempting to seek its own foundations in logic itself. In Boolean algebras the situation is reversed: Boole's objective is to construct an algebraic calculus of deductive reasoning and thereby bring mathematical method and rigour to logic. This fact allows Boole on the one hand to emancipate his algebra of logic from the theory of magnitudes and on the other to conceive of the formal system as a classificatory philosophical language (Boole 1847).

Together with Cantor's set theory (which we cannot examine here), this type of analysis, while not directly affecting the values of the meaning of the metaphors we are examining, represented a significant step forward from the point of view of the powerful algebraic tool it provided for building systems of connections between concepts. As we know, this tradition of studies—Boolean algebra and mathematical logic – leads us to the organisation and information processing of computational systems and systems of knowledge organisation which we can construct with, for example, ontologies in information systems based upon axiomatic theories of first-order logic in their turn based in *Description Logic* (see Baader et al. 2003) and which, using graph theory, are capable of representing their own spatial order.

We have seen how the encyclopaedists, in particular Denis Diderot in his article *Encyclopédie,* considered classification from top to bottom, from the axioms or first principles to the disciplines closer to practice and experience, and the bottom upwards, i.e. from experience to the identification of the axioms of knowledge, following the inductive method proposed by Francis Bacon, complementary. As we know, Bacon (2000, orig. ed. 1620) constructed a method of data analysis based upon elimination, opposing it to Aristotelian-scholastic induction per enumerationem simplicem. Stuart Mill (1843) extended the Baconian method, establishing methodological rules or canons which guarantee, according to his theory, an inductive inference as legitimate as the deductive syllogism, whereas in inductive inference the conclusion contains more elements than the premise.

The aspect which interests us most is the attention to the data and the explicit relational dimension in which they are immersed and studied and which gradually takes shape as an explanatory theory. According to Mill, propositional relations are not between concepts, but are initially relationships between perceived phenomena (i.e., data which traverse our states of consciousness), meaning that there are no universal propositions in themselves but that each represents the union of the individual observations which repeat themselves about particular aspects of facts. Hence any law or universal classification, such as 'x belongs to Y,' is nothing but a generalisation of experience, as are the axioms of mathematics and geometry. The consideration which follows in regard to the principle of non-contradiction, it too subject to experience and therefore true as long as it is observed, and above all the skepticism which invests the principle of the excluded middle, which Mill himself often considered untrue or unascertainable other than in a very few cases, led Mill to a very modern conception of logic.

These tools for study, attributable to the powerful thrust of esprit systématique which pervaded early modernity, may seem feeble in comparison with the sophistication of those available today, but they are at its foundation and bring to light concepts and problems which remain substantially linked to the theories. Today, this empiricist and inductivist tradition is to be found, also as opposition to hypothetical-deductive approaches, in the research methodology of grounded theory (see Glaser and Strauss 1967), which, in its current developments related to textual analysis and correspondence analysis, has provided highly efficient orientation strategies for dealing with large masses of information. Particularly in more recent software programs, interpretation of the results emerging from analysis of data is closely related to the spatial representation of the data in diagrams, and the complex process of coding the primary data allows and indeed fosters the dynamic mapping of the information or corpus under examination, making use also of syntactic and semantic linguistic categories.

As a final factor of semantic change in metaphors of disorder, in accordance with the interpretation here proposed, let us consider graph theory. The characteristics of this theory are particularly well suited to the questions raised by encyclopaedists. This theory allows the construction of systems of connections using hypothetical-deductive theories (e.g., ontologies), inductive theories (e.g., grounded theory), and is useful for examining complex domains of study (e.g. scale-free networks) which are apparently distant from one another, having the ability to facilitate the identification of isomorphisms by comparing the results obtained by researchers.

Euler's ingenious solution to solving a problem of spatial organisation, using vertices (points) and edges (connections) as elements of space and applying to them combinatorics (Euler 1741), during the nineteenth century has been studied and applied by various mathematicians including Arthur Cayley (1874), William Clifford and James Sylvester (Grattan-Guinness 1994, 1265-1266; Houser et al. 1997) to graphically represent and algebraically analyse the structural connections of chemical elements. It is known that Charles Sanders Peirce frequented these mathematicians and drew inspiration from them for his theory of existential graphs (Samway 1995). The logic of these graphs meets the need to clarify any process of knowledge in the space of sheets which themselves become assertions, a form of logical-iconic language which neatly express facts of knowledge (Peirce 1903a). In this sense, they make it possible to bring together all the inferential processes in a survey as they are able to represent deductive and inductive reasoning and abduction (Peirce 1906), and therefore the ability to sort observations, test hypotheses, draw conclusions and lenticularly investigate epistemic processes in the space of logically organised sheets.

Peirce imagined the possibility of constructing a semiotic-linguistic theory of knowledge based upon the making explicit of knowledge processes by graph theory. There are three logical-linguistic stages in his theory (Peirce 1903b). It is interesting to briefly review them, as they proceed from the tree graph, which I discussed extensively at the beginning of this work (and which Peirce used for his theory of classification of the sciences which I will not examine here), and show how it is potentially possible to escape the crippling condition of the metaphors of confusion. The first stage, the alpha theory, essentially represents the inclusive/exclusive tree, and corresponds to predicate calculus. The beta stage, the functioning of which corresponds to first-order logic, is much more complex and can be compared more or less with a knowledge organisation language like SKOS (Simple Knowledge Organisation System) (W3C 2009 SKOS). The gamma stage, which Peirce was unable to formulate completely, was to lead to the theory of existential graphs representing actual complex linguistic structures (Sowa 2008): formal models which can have as a horizon, in addition to the construction of classificatory systems and complex scientific models, the study of the grammatical structures of natural languages; in this sense, today it could be related to the development of second-order logic, modal logics, fuzzy logic.

In mathematics, graph theory has experienced two phases of accelerated development: the first thanks to another mathematician just as brilliant as Euler, Paul Erdős

(Erdős and Rényi 1960), who began to study so-called 'random graphs,' i.e., non-regular graphs (systems of inclusions, for example, being regular) which can enable us to study complex networks. Graphs, therefore, which can be applied to reality, to the landscape and to the world map. With a metaphor taken from physics, I would call this evolution of graph theory a 'phase transition' which leads away from the state of confusion of Diderot's world map, beginning of a journey of discovery of complex network ordering logics which today show their most striking development in the theories of small worlds and scale-free networks (Newman et al. 2006). This journey, which began in the second half of the nineteenth century (Erdős and Rényi 1960) and which is still in full development, has recently produced two metaphors—'small world' and 'scale-free networks'—which express sorting logics which are extremely powerful, above all in the transfer of meaning of the objects of the metaphors which have a very broad domain of application and bring to light a vast number of isomorphisms in disciplines apparently wholly distant from one another (Newman et al. 2006), from cellular biology to linguistics, from the theory of social networks to the food chains of animal species.

The 'small world' metaphor came into being as a metaphor not entirely of order nor of disorder: when Stanley Milgram (1967) studied acquaintance chains, he could not understand rules of regularity in the behaviour of the connection system. Today, the problem has been solved by means of graph theory (Watts and Strogatz 1998) considering the intervention of disorder or randomness into a regular network. Indeed, the possibility to build random connections lowers exponentially the grades of despair between vertices of a connected graph. The 'small world' metaphor, originally used by Milgram, represents a precise theory which we know at the base of a specific and very broad class of graphs which allow us to understand or to map knowledge domains as complex as, for example, the internet, both as a network of hardware systems and as a hypertextual system.

If we compare the metaphor 'small world' with the metaphor of the labyrinth, we immediately see the change in spatial perception generated by the two reference objects of the metaphors. So the labyrinth concerns, even more than the vastness that is not defined, the disorientation and inability to navigate and this is what is transferred from the subject of the metaphor, which is the encyclopedic order or the network connections (the enchaînement) between entries and disciplines. The small world puts us in front of a concept that could be interpreted as an oxymoron, but instead tells us that according to the laws of graph theory, there are worlds or domains (e.g., the system of social relations or masses of interlinked information such as the Web) whose distances (non-metric, but between connected vertices) can be surprisingly short and definable. In this sense, the characteristic of 'phase transition' is due to the introduction of an element of disorder, the random connections, in ordered structures, which have generated geometric-topological organisations extraneous to the Euclidean logic.

A final factor of change in metaphors of disorder is undoubtedly the concept of "hypertext," which in its formal aspect can put together all the factors of change of metaphors of disorder to which I referred. Therefore let us briefly examine how T. Nelson introduces it in *Literary Machines* (1990). In trying to build a system able to contain and manage any kind of information, Nelson focuses upon a simple and strongly libertarian structure which leaves the user the ability to operate and move through the system by following autonomously established routes. Hypertext contains nodes which must always be traceable, which may change (though keeping track of the changes) and, above all, which can be freely connected to one another without restrictions. In a sense, hypertext is the ideal tool which the encyclopaedists had hoped for, because it allows the construction of a space of interlinked relationships between concepts (which are represented by lemmas, sub-lemmas or disciplines), enabling them to be treated in a complex way by assigning values to the relations and therefore making it possible to consider the hypertext paths chosen as a sort of linguistic performance, making the system highly flexible, dynamic and organised, since it is necessary to keep track of all nodes, which remain under control at all times.

With respect to the philosophical paradigms which represented the theoretical field in which the encyclopaedists could move, the change of perspective achieved today is marked by a change of metaphors, which in the past, while maintaining the organisation of knowledge as their subject, were constructed analogously with objects which conveyed semantic values of disorder or confusion, such as the labyrinth or world map. In today's technical and everyday language, they instead refer to objects which express logics of ordering, such as "small world" or "Semantic Web." It is a remarkable fact that we are seeing a proliferation of metaphors which come to life in electronic space and always have as their primary reference a strategic concept for the organisation of knowledge, from the macroscopic metaphor expressed by the multiform 'World Wide Web' to metaphors expressing more technical concepts, such as "browsing/browser," "reasoner," "search engine," "cloud computing," "web crawling," "web scraping," and so on.

Let us consider, emblematically, the metaphor of the "Semantic Web." The concept of "web" conveys the idea of a non-metric space composed of nodes and connections which may be defined in its interior as positions and groups of positions. In this way we can map the system, giving both a macroscopic and detailed vision, the evolution of which we can follow (and in which we can locate information without resorting to alphabetical order). The "semantic" attribute transmits the possibility of building a form of knowledge organisation closer to the ideal of linguistic-conceptual order which was sought, in particular, by Chambers and Diderot. In fact, "semantic" as a primary value refers to the opportunity to construct expressions in decidable logical languages (first-order logic subsets) comprehensible to machines (W3C 2009 OWL). This change, in comparison with the metaphor of the "world map," finds its origins in Peirce's theory of conceptual graphs (Sowa 2011), Boole's algebra and modern axiomatic theories, as well as in the inductive logic of John Stuart Mill, considering for example the way in which the Semantic Web or Web 2.0. are being built, i.e., beginning with the production and network sharing of data and metadata which are then organised by hypothesising various types of ordering.

In a solely Euclidean conception of space, not only the spatial order of complex realities but the electronic space or concept itself, which is also expressed by a metaphor, of "virtual space," would not have been imaginable. Today we are transferring all the information we produce into electronic spaces and a macro-dimension we call "virtual" (which could be a metaphor for confusion). Transferring material knowledge, the encyclopedia and the library, to these organised spaces is causing the research community to combine diverse analysis techniques, such as textual analysis, correspondence analysis, computer ontologies, scale-free networks and others, in which linguistics, graph theory and mathematical logic play a crucial role.

4. Conclusion

I tried to show how the concepts of space for organisation and linguistic-dynamic structure are underlying the conceptual domains of the metaphors of disorder and those of the actual orderings. The underlying conceptual network (or domain) to which they give place may represent a common ground on which to bring the logical and epistemological reflections that have as their object the pragmatic organisation of knowledge. This common ground seems to be represented by a large open set of theories and methods. Their aim is to fit to organisation problems each time, constructing integrated patterns. Beyond the metaphors of order and disorder, these patterns and their metaphors put together abductive reasoning, deductive axiomatic theories and inductive procedures without searching any pre-established order of concepts and their relations.

References

Baader, Franz, Calvanese, Diego, McGuinness, Deborah, Nardi, Daniele and Patel-Schneider, Peter. 2003. *The description logic handbook: theory, implementation, applications*. Cambridge, MA: Cambridge University Press.

Bacon, Francis. 2000. *The new organon*. Cambridge, MA: Cambridge University Press.

Blanchard, Gilles and Olsen, Mark. 2002. Le système de renvoi dans l'Encyclopédie: une cartographie des structures de connaissances au XVIIIe siècle. *Recherches sur Diderot et sur l'Encyclopédie* 31-32: 45-70.

Boole, George. 1847. *The mathematical analysis of logic: being an essay towards a calculus of deductive reasoning*. Cambridge, UK: Macmillan, Barclay, & Macmillan.

Canone, Eugenio. 1993. *Bibliothecae selectae. Da Cusano a Leopardi*. Florence: Olschki.

Casini, Paolo. 1970. Il problema D'Alembert. *Rivista di filosofia* 1: 26-47.

Cassirer, Ernst. 1932. *Die philosophie der Aufklärung*. Tübingen: Mohr.

Cayley, Arthur. 1874. On the mathematical theory of isomers. *Philosophical magazine* 47: 444-9.

Chambers, Ephraim. 1728. *Cyclopædia, or, an universal dictionary of arts and sciences*. London: J. Knapton and others.

Diderot, Denis and D'Alembert, Jean Le Rond. 1751-1765. *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers*. Paris: Briasson, David, Le Breton and Durand. Note: the cited translations are taken from 'The Encyclopedia of Diderot and d'Alembert Collaborative Translation Project.' 2009. Ann Arbor, MI: MPublishing, University of Michigan Library. Available http://quod.lib.umich.edu/d/did/.

Eco, Umberto. 1981. Quattro forme di enciclopedia ovvero le metamorfosi dell'albero. *Quaderni d'italianistica* 2: 105-22.

Erdős, Paul and Rényi, Alfréd. 1960. On the evolution of random graphs. *Publication of the Mathematical Institute of Hungarian Academy of Sciences* 5: 17–61.

Euler, Leonhard. 1741. Solutio problematis ad geometriam situs pertinentis. *Commentarii academiae scientiarum imperialis petropolitanae* 8: 128-40.

Glaser, Barney and Strauss, Anselm. 1967. *The discovery of grounded theory: strategies for qualitative research*. London: Aldine transaction.

Grattan-Guinness, Ivor. 1994. *Companion encyclopedia of the history and philosophy of the mathematical sciences*. Baltimore, ML: The John Hopkins University Press.

Hilbert, David. 1899. *Grundlagen der Geometrie*. Leipzig: Teubner.

Houser, Nathan, Roberts, Don D. and Van Evra, James. 1997. *Studies in the logic of Charles Sanders Peirce*. Bloomington, IN: Indiana University Press.

Lobachevsky, Nikolai I. and Papadopoulos, Athanase. 2010. *Pangeometry*. Zürich: European Mathematical Society.

Milgram, Stanley. 1967. The small world problem. *Psychology today* 1: 61-7.

Mill, John Stuart. 1843. *System of logic, ratiocinative and inductive*. London: J.W. Parker.

Nelson, Teodor H. 1990. *Literary machines 90.1*. Sausalito, CA: Mindful Press.

Newman, Mark, Barabási, Albert-László and Watts, Duncan J. 2006. *The structure and dynamic of networks*. Princeton, NJ: Princeton University Press.

Peirce, Charles Sanders. 1903a. *A syllabus of certain topics of logic*. Boston: Alfred Mudge & Sons.

Peirce, Charles Sanders. 1903b. On existential graphs, Euler's diagrams, and logical algebra. In Hartshorne, Charles and Weiss Paul, eds., 1965. Collected papers of Charles Sanders Peirce, vol. IV. Cambridge, MA: Harvard University Press, pp. 340–397.

Peirce, Charles Sanders. 1906. Manuscripts on existential graphs. In Hartshorne, Charles and Weiss Paul, eds., 1960. Collected papers of Charles Sanders Peirce, vol. IV. Cambridge, MA: Harvard University Press, pp. 320–410.

Poincaré, Henri. 1905. *Science and hypothesis*. London: W. Scott.

Samway, Patrick H. 1995. *A thief of Peirce: the letters of Kenneth Laine Ketner and Walker Percy*. Mississippi, MS: University Press of Mississippi.

Sowa, John F. 2008. Conceptual graphs. In van Harmelen, Frank, Lifschitz Vladimir and Porter, Bruce, eds., *Handbook of knowledge representation*. New York: Elsevier, pp. 213-37

Sowa, John F. 2011. Peirce's tutorial on existential graphs. *Semiotica* 186: 347-94.

Tonelli, Giorgio. 1975. The problem of the classification of the sciences in Kant's time. *Rivista critica di storia della filosofia* 2: 243-94.

Watts, Duncan J. And Strogatz, Steven H. 1998. Collective dynamics of 'small-world' networks. *Nature* 393: 440-2.

Wolff, Christian. 1735. *Philosophia rationalis sive logica methodo scientifica pertractata. Editio tertia emendatior*. Veronae: ex Typographia Dionysii Ramanzini.

W3C. 2009. OWL 2. Web ontology language structural specification and functional-style syntax, W3C Recommendation 27 October 2009. Available http://www.w3.org/TR/2009/REC-owl2-syntax-20091027/.

W3C. 2009. SKOS - Simple knowledge organization system. Available http://www.w3.org/TR/skos-reference.