Unity of Science and Encyclopaedia. From the Idea to the Configurations

by

Olga Pombo

Center for Philosophy of Science of the University of Lisbon
Faculty of Sciences, Lisbon University, Portugal
opombo@fc.ul.pt

Introduction

Let me begin by saying that I am quite aware that Unity has been (and still is) entirely out of fashion. First in art, then in philosophy and afterwards in life itself, we are today most concerned with multiplicity, fragment, difference. If at all considered, unity appears just in the form of a patchwork, a mixture of various and heterogeneous elements. That is to say, we lost the hope in totality, in harmony, in unity. And we have good reasons for that. Mainly political.

In science, too, we have to recognize the absence of unity which seems to characterize the scientific activity of our time. Epistemology, Philosophy of Science and above all Sociology of Science of the XX century have repeatedly stressed the increasing specialization of scientific knowledge[1], the acute fragmentation which characterizes the unprecedented disciplinary situation we witness today. An explosive situation whose critical assessment is made long time ago[2] and whose effects can be felt at different levels of contemporary scientific activity, namely at its institutional forms, organizational structures, heuristic capacity and cultural dimension.

We know that specialization – even if a necessary condition of the progress of scientific knowledge – changes the very nature of scientific endeavour. Because the specialized sciences do not face the World anymore, because, for particular disciplines and specialities, the very idea of World becomes useless: They can turn its back to the explanatory / unifing dimension of science and cheerfully enter the kingdom of practical positivity, looking for efficient yet fragmentary performances. That is, specialization runs together with instrumental reason which reduces science to the calculus of measurable entities and makes science to give up of the explanation and of the understanding of the World[3].

The debate on post-modernity - which has polarized the philosophical community of the seventies and eighties of the XX century – made of this cynical (and sceptical) conception of science one of the main points of its analysis of actuality. Lyotard and Habermas – even if in opposite places of the border which divided moderns and post-moderns – do agree in the consideration that science is not any more legitimated by the search of the truth but *only* by its technical applications. As Lyotard wrote in *La_Condition Post Moderne* in 1979, since performativity depends on financial support of research, “there is no truth without money”. And Habermas, underlying too the increasing dependence of science from the interventionist activity of political and economical power, stresses that science is not anymore legitimated by the attempt of unification of knowledge but rather by the proliferation of its technical effects[4]

However, Unity of Science cannot be dismissed in such an easy way. It is true that there is today a “surface effect” which can lead us to declare the dead of Unity of Science, as we have declared – perhaps in a too much speedy way -

the dead of God, the end of Art, the dead of Ideologies or even the end of History.

But, Unity of Science is a too deep, old and decisive aspiration. An aspiration which runs through the whole history of the western thought, always in tension and constant alternation with the opposite tendency towards specialization. Science is made of both tendencies, of both ingredients. Specialization favours the precise delimitation of the object of research, allows the rigour and profundity of analysis, reduces the number of methodologies and techniques necessary to the research on a specific discipline, helps the checking and establishment of the technical concepts necessary to the theoretical construction of each speciality, makes easy the knowledge of bibliography, restricts the extent of scientific communities and thus facilitates a better communication among the researchers of each speciality. Unity of Science corresponds to the comprehensive aim which underlies scientific activity. We could even argue that Unity of Science corresponds to the very essence of knowledge. In fact, what could it mean to know the World unless to identify similarities and to formulate universal laws, in a word, to have a unified description of it?

That is why - in my point of view - we cannot simply say that today Unity of Science is nothing but a nostalgic, old fashion idea. On the contrary, Unity of Science is something which - at the minimum – has the responsibility of avoiding the complete spread of knowledge and disciplines which would result if a total absence of integration among research would be the case. That is why, after a period when it seemed to be completely surpassed by the increasing and speedy process of specialization of the 19th century and fist half of XX century, Unity of Science appears (today as yesterday) as the transversal rationality which (now, perhaps, even more than before) links the different disciplines.

Signs

Several signs can be interpreted under this light. Let me briefly point just to three. First, the appeal to interdisciplinarity which characterizes our recent epistemological situation, namely the last three decades of the XX century. I am speaking about the fact that the progress of scientific knowledge and the creativity of their researchers is more and more resultant from interdisciplinary practices and their heuristic potentialities, conceptual migration, irradiation and decentring processes, cross fertilization, problem convergence methodologies, etc.[5]). Second, the emergence of new kind of disciplinary arrangements resulting from the internal reorganization of the knowledge cartography. I mean, the constitution of *hybrid disciplines* built on the border of two traditional disciplines (like Biochemistry, Psycholinguistics or Genetics Engineering), of *inter-disciplines* resulting from the intersection of science with industrial and organizational area (like Organizational Sociology or Operational Research) and *inter-sciences*[6], built on the confluence of different areas (such as Cybernetics, System Theory, Cognitive Sciences, Sciences of Complexity, etc.) dealing with too big problems unable to be faced by one unique discipline, as in

the case of cognition, complexity, or climate. Third, the important curricular experiences which are taking place, and which will have to be further developed in the near future, in the generality of universities[7], all over the world. All these experiences are intended for flexibility, transversability and interdisciplinary integration[8] - see the many inter-departamental programs, the diverse nets and inter-universitary groups, licences, masters, phd and pos-doc curricula.[9]

So, the situation at the beginning os the XXI century seems to me to be the following: on one side, we have the (post-modern) abandon of the idea of Unity of Science, the attempt to consider it as an aged, bizarre and entirely surmounted idea; on the other side, we have the (modern) claim for unity of science as a living aspiration whose integrative signs continue to be disclosable under the fragmentary situation of contemporary scientific practice.

We can regret the lost of the idea, or even to glorify is dead. We can live without the aim in Unity of Science, surviving with (or taking profit of) the skeptical (relativistic) situation opened by its throwing away. Or we can go on stressing its regulative nature and actively looking for its renewal, trying to understand its condition, attributes and main features.

In this case, we will argue, as many before us have done ─ Bacon, Descartes, Leibniz, Diderot, Kant, Carnap or Neurath just to quote some of the big names ─ that the idea of Unity of Science coincides with the very idea of science. In its simplest description, Unity of Science is the unification of experiences, of methodologies, of laws and theories. In this sense, Unity of Science is the major cognitive task of Science itself.

If we take this position, we will remind that the idea of Unity of Science gave rise to several important theoretical programs which have crossed the History of Science and Philosophy and we wil look carefully to them. We will commit to memory the remote and magnificent *Ars Magna* (1306) of Rámon Lull (1235-1315),[10] those marvelous monuments built at the beginning of XVII century, as the *Instauratio Magna* of Francis Bacon (1561- 1626)[11] or the *Mathesis Universalis* – that barroc project differently formulated by Descartes and Leibniz[12] – or, more recently, that large movement of *Unified Science*[13] taken up by the logical positivism at the first decades of the xx century[14].

In all this cases – we will stress – we are face to strong programs of Unity of Science taking Mathematics or Physics as the central exemplary science, accepting reducionism and its various implications, or trying to get away from it. Strong programs which require, more or less convincingly, the constitution of a scientific universal language as a major procedure for Unity of Science and which have mostly a logical and methodological content[15]. In all cases, they try to clarify the levels into which Unity of Science should be conceived, to understand its rules and functional procedures, to analyse its mechanisms, to discuss its metaphysical significance.

Unity of Science is in all cases a regulative idea. It can be viewed at the formal level of unity of language, at a mere methodological level, or in its strongest sense, as unity of laws and theories. It can be thought out as a doubling the

unity of world or as expressing of the unity of reason. However, in all cases, those programs and their contemporary developments are acts of methodological anticipation by which one intends to promote, to build up or - at least - to facilitate, the historical process of science unification. That is, the claim for unity of science is in all cases pursued in a normative way**.**

Hypothesis

Now, my hypothesis is that Unity of Science is more than a regulative idea, more than a project aiming to promote science unification, more than a philosophical, normative task.

What I would like to stress is that Unity of Science is also a practical and institutional feature, a set of material forms by which Unity of Science has been and continues to be silently pursued. They are universal institutions embodying the systematic coherency of the knowledge. I mean the Library, the School (namely the University), the "République des Savants", the Museum and the Encyclopaedia. A set of structured procedures, cultural incorporations and concrete practices which – sometimes by imponent or even monumental forms, other times in an almost virtual regime – have as they aim to organize and to promote the coordination of the different sciences.

Some more ostensivelly (University, "Republique des Savants"), others more in a soundless, subterranean way (Museum, Library, Encyclopaedia), they all have descriptive, prescriptive and prospective elements. *Descriptive* in the sense that they all try to distinguish the several particular sciences, to identify its relations, to recognize its more significant articulations. *Prescriptive* because they all establish links of proximity and subordination between the several disciplines, not only puting them side by side but instituting their unifing pole, that is, because they all seek to systematize the work, chaotic in itself, of knowledge production. *Prospective* since they all look for the production of new knowledge, I mean, they all are, not only open to novelties, but able to previously design the structures in which those novelties can be recognized in its newness and integrated in the sysmematic whole. In other words, more or less intensively, each of those configurations pursues the idea of Unity of Science, trying to realize it effectivelly, day after day, in their own functions and competencies.

What I am proposing here is a peculiar way of understanding Unity of Science taking in consideration not only its scope as a regulative idea, independent so to say of its material conditions, but also the set of concrete mechanisms responsible for the effective production of scientific knowledge.

We know that those configurations of Unity of Science (Scientific Community, Schoool, Library, Museum, Encyclopaedia) have a specific historical nature. They were born simultaneously, at a particular historical situation, when the discovery and accumulation of knowledge justified their invention. Against *polimatia* which already Heraclites, at the VI century before Christ, has

denounced[16]; against the additive accumulation of information - a danger to which we are today mostly exposed - Greeks have invented School[17] and, together with it, they invented science as a cooperative task[18]. In that moment, also appeared the Library[19], the Museum[20] and the first Encyclopaedic synthesis[21].

I will not go further on with that narrative. Let me just stress two points. First: the history of these configurations is somehow parallel. All them respond to the movements of History of Science and, at the same time, each of them has its own, particular History. Second, they cross time all together as *constitutive elements of science production.* There will be no science without "république des savants", without school, without library, without museum, without encyclopaedia. Each step in the advancement of scienftific knowledge needs to be prepared by those material structures, recognized by them in its novelty, legitimated, integrated in the already known, in the systematic whole.

In this sense, those material configurations could be said to constitute the condition of possibility of scientific production, a kind of an empirical, transcendental plan, an historical *apriori* (to put it in Foucaultian terms), not epochal (as the *episteme* in Foucault), but material, factual and, simultaneously, universal, necessary, transversal to time.

As different procedures of production of knowledge aiming at a same objective – Unity of Science – they establish among them multiple relations of interdependence and complementarity - a kind of polyedric articulation whose structured relationship is endowed of important descriptive and heuristic capacity.

How could library exist without the community of researchers who produces the books, the journals, the papers, the letters, the documents of all kind which the library ranges in its armoires?

How could the *republique des savants* function without the school (university) where new generations of researchers are prepared to continue scientific endeavour?

How could library survive without its metonymic translation in the pages of an encyclopaedia? Without encyclopaedia, as ordered presentation of knowledge, library would become a Borgian labyrinth of horror. An horror with which the very idea of School and learning would have been impossible.

Yet, how would it be possible to read a simple entry of an encyclopaedia if what we have learned in all the schools, the museums, the books of all libraries, had been forgotten?

What I mean is that each step inside science is already prepared by these configurations of Unity of Science and inscribed in their articulated relationship.

Let me just invite you to contemplate, in a very superficial way, that splendorous configuration of Unity of Science which is Library, and to glance, as if by an angel's eye (may be that of Win Wenders famous movies on angels and libraries), the perfume of its articulations. There, we will see all the books ever written offered to the attention of the universal research community who has left their school classrooms, their laboratories, their amphitheaters, in order to seek for an old, yet precious work concerning a particular, rare species of plant, of stone, of animal, of which, the day before, he saw a splendid exemplar in the Museum and which he has discovered that – perhaps - it could give him the proof, the confirmation, the evidence of an hypothesis he has dreamed, many hears ago, when he has presented his first dissertation. That idea has been afterwards abandoned, under the pressure of other research programs. But it has not be forgotten and now came the moment, in his entire life, in which he decided to freely care about that hypothesis of his youth. He enters the Library, feels the silence of its rooms and corridors, admires the immense sleeping giant who lies over its bookcases, tables, armoires and realizes that he must begin by looking for that extraordinary animal, plant, stone, in the pages of an humble Encyclopaedia.

What is fascinating to see and constitutes a further argument in favour of my hypothesis is that, today, under our very eyes, we witness an unexpected reinforcement of these articulations. The digital, elecronical thecnologies are producing a *medium* in which what I have designated as "configurations" of Unity of Science are beeing virtually integrated. I mean the net, that opened, dialogical structure, connectable in all senses, constantly reformulable, incomplete but allowing the cross connection – the link - of the diverse branches of human knowledge. Yet descentered and adopting proliferation as its regime, never the net falls in the pure disorder, in the complete labyrinth. Made of diverse, heterogeneous elements, the net is above all a combinatory device, an inventive space which accepts the fragment and the spreading of itself but yet aspires to order and to articulation.

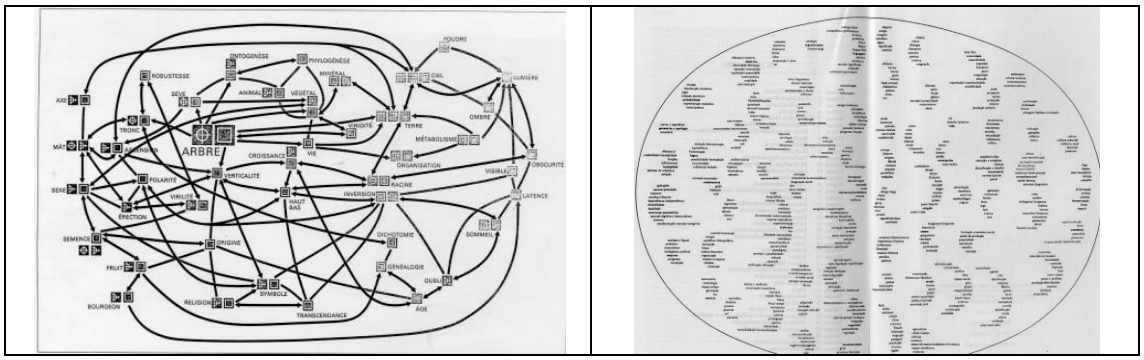
What I mean is that perhaps in the net all the configurations of Unity of Science came to join. By the net pass the destiny, not only of Scientific Communities whose cognitive exchanges are today mostly performed through the net, but also of Encyclopaedia whose combinatory and heuristic regime it develops; of Library which, under our eyes, is becoming an universal electronic institution; of (virtual) Museum which tends to be totally accessible; at last, of School (University) which is being deeply transformed by the net.

Of course, with the net, we cannot speak anymore about Unity of Science in a strong sense. What the net gives us to see is a large, immense, proliferous, enormously extensible – and also dramatically weak - idea of Unity of Science. An ideia of Unity of Science able to live side by side with the plurality of research programs, with the diversity of methods, with the multiplicity of languages, with the variety of subjects, from old findings to the newest discoveries. With the net, Unity of Science is not anymore a regulative idea but turn to a plural entity. The net is also the place where we are confronted with the well-built connection between Unity of Science and Encyclopaedia. I mean, the net is today a material (virtual) structure in which what I have called the configurations of Unity of Science are being congregated and in which the destiny of Encyclopaedia is taking place.

Unity of Science and Encyclopaedia

The connection between Unity of Science and Encyclopaedia can be appreciated from the side of the encyclopaedia and from the side of Unity of Science

From the side of encyclopaedia, it would be necessary to analyse the history of encyclopaedims, at least during the second half of XX century. In fact, the net has been prepared by the recent developments of encyclopaedism, namely at the second half of XX century. At that moment, encyclopaedias[22] set out to offer a set of metadiscoursive resources aiming to improve the decentred use of the information provided.They begun to reinforce the work of indexation, to advise research issues, to suggest reading percourses, to anticipate conceptual nets of possible articulations, etc[23]. The main idea is that "totality is not the fruit of a series of additions but of the complexity of the articulations" (Romano, 1977-1984 a: XVII).



"Relations Tables" of the Universalis and "Reading Zones" of the Einaudi

From the "Relations Tables" of the *Universalis* to "the "Reading Zones" of the *Einaudi*, the recent history of encyclopaedism put us face to face to combinatory processes announcing the "surfing", the "navigation"[24] at the universal electronic encyclopaedia which, everyday, is becoming more and more real.

We cannot analyze here the novelties arising in recent developments of encyclopedism[25]. Another paper would be necessary. Let me just stress - without giving the correspondent demonstration - that we assist today, not only the surprising renewal of encyclopaedism, but almost to its vertiginous accomplishment in the information technologies and in their unitary (see "totalitarian", since there is a danger, here) ambition.

With all its difficulties, discrepancies, imperfections, terrible noise, trash, inconsistencies, yet the net – and the encyclopaedia of which it constitutes the last potentiation – represents the maximum of integration which mankind has been able to attain. As Neurath said, "It is contrary to the principles of encyclopaedism to imagine that we could eliminate all the difficulties. To believe in that is to adopt a kind of the famous Laplace's devil which had a complete knowledge of the present facts sufficient for complete foreseeing of the future. That idea of the system is opposite to the idea of the encyclopaedia: the

anticipated completeness of the system is opposite to the incompleteness of an encyclopaedia" (1938: 20-21).

By the side of Unity of Science, we have to give reason to two big giants of the past and try to put ourselves, as small dwarfs we are, at their back. I mean Leibniz and Neurath, perhaps the architects of the two programs of Unity of Science in which the idea of encyclopedia more explicitly coincides with philosophical activity itself[26].

Concernig Leibniz, let me just briefly remember – without again having the possibility to demonstrate it – that the rational care to the symbolic level is the key note of leibnizian philosophical project of Unity of Science. This means that, according to Leibniz, *Mathesis Universalis* implies the construction of a philosophical language or *Characteristica Universalis* which accurately will be able to express thought and its internal articulations and thus will be able to transform all reasoning in infallible calculations. That is why, in Leibniz, *Characteristica Universalis* - and *Mathesis Universalis* – are deeply articulated with the project of an *Encyclopaedia*.

We know that Encyclopaedia is a deeply anti-cartesian project. In opposition to Descartes, for whom what matters is a lonely search for truth, a brak with all tradition and a new start from the very beginning of his own evidences, the leibnizian encyclopaedic project points out the idea of anchoring the new in the old. What matters to Leibniz is not to despise, but, on the contrary, to take as starting point the work done from all who had precede us and for all who live and work at our side. That is why Leibniz has been so fully commited, all along his life, to the development of what I proposed to label as the material configurations of the unity of science: academies, encyclopaedias, journals, books, etc.

For Neurath too, Encyclopaedia is the most perfect way of setting up the sum total of sciences, the appropriate form of science unification, always incomplete and provisional but nevertheless comprehensive. As Neurath writes: "it is not the system but the encyclopaedia which constitutes the genuine model of science in its all" (1938: 20).

We know that it was Neurath who tied this link and assumed the correspondent charge[27]. Without entering in details concerning that assignment, let me just point some major features of Neurath's project:
1) his anti-sistematic nature, the antifundationalist refusal of any absolute point of view from which would be possible to deduce the propositions of the particular sciences. As Neurath states: "For an empiricist, it is absurd to speak of a total and unique system of science. He must conceive his work as aiming at the exactness and systematization but inside the constantly changeable framework of encyclopaedia" (1936: 188)
2) his acceptance of provisory and historical nature of all synthesis
3) his connection with the search of a scientific language, that is, his leibnizian inspiration. I quote Neurath: Leibniz was "the first and the last of great philosophers to seriously advocate finding a calculus universalis adequate to scientific progress" (1938: 15). What allows us to stress that, apparently

modest, Neurath's encyclopaedism was after all extremely ambitious. It aimed to conciliate the empiricism of Bacon and Diderot (not interested at the logical formalization) with the rationalism panlogicist of Leibniz.
4) his large, ideological, political and social purposes. As we know, in addition to its primordial cognitive functions, the movement for Unified Science was committed to the belief in the capacity of Unity of Science for answering the problems of men's life.

Significantly, in a posthumous text, wrote few time after the end of the second World War and three days before his dead, Neurath still imagines that Unity of Science movement can contribute to the international co-operation: "I hope that we, who have tryed to create a kind of universal jargon as a lingua franca for sciences, have given support to the intellectual synthesis, offering people a proper medium of communication their arguments (…), a sort of platform where all the types of discussion could have place" (1947: 82).

Maybe that - as Leibniz and Neurath pointed out - encyclopaedia is the very model Unity of Science.

Conclusion Remarks

Let me finish with some remarks regarding encyclopaedia as a possible model of Unity of Science.

1. What is lovable in encyclopaedia is the possibility it offers of a plural unity. What, in my point of view makes of encyclopaedia "the genuine model of science as a whole"(Neurath, 1938: 20), is that it concerns a kind of knowledge which, simultaneously, is total and various. In fact, encyclopaedia supposes, not a totalitarian vision but a comprehensive, harmonious framewok able to integrate the diversity of elements.
2. Encyclopaedia is a deeply leibnizian endeavour aiming at synoptic view but which, at the same time, caring for the minimum detail, listening to the most humble idea. Encyclopaedia is an excessive design, much immoderate, much extravagant, but also very much attentive, gentle and compassionate. We need to escape schematic totalities. We have learned that need. They are not interested in the fragile, in the insignificant, in the concrete and tangible. Of course, the dream of a totality which stands close to the particular is an immense, impossible dream. But that does not mean that it should not be desirable.
3. We know that encyclopaedia is a very immoderate, extravagant, exorbitant, unfinished project. Rigorously impossible to achieve. But we also know that it is a generous project or, as Neurath used to say, "A program's life for men of good will" (1936: 200).
4. Further, encyclopaedia does not have any territorial imperialist conception of knowledge. To progress in knowledge is not to conquer a foreign country. To know is to discover new articulations, to invent a new interdisciplinary forum, to establish new fraternities.

5. Behind that, encyclopaedia follows a combinatory regime. One can enter wherever one wishes to. Everyone can enter. There is no royal entrance...

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[1] As mentioned by Carrier and Mittelstrass (1990: 17), a catalogue of German universities in 1990 already declared more tha 4.000 research areas. By its side, the National Science Foundation at USA, at 1940 declared 54 specialties, at 1954 74 only in Physics, and at 1969 several thousands.

[2] Already in 1929, Ortega Y Gasset vigorously denounced what he called the "barbarian specialist"(1929: 173). And precisely thirty years latter, in 1959, Lord Snow (1959: 15) considered as sociological evidence the break between the natural and the human sciences. As he wrote in his celebrated *Essay*, the rupture is such that "Scientist never read a single work of Shakespeare and literary intellectuals do not know the second law of termodinamics" (1959: 15).

[3] As Prigogine and Stengers write (1988: 208): "some people try to reduce science to a simple research of general relations allowing to foreseen and dominate the *phenomena*. But this 'adult' and not enchanted conception of rationality can never prevent the belief which is at the root of the passion of physicists: their research aims to understand the world, to make intelligible the movement of nature and not only to describe the way it behaves".

[4] As Habermas states in *Technick und Wissenschaft als Ideologie* (1968): "the autonomy of disciplines is the epistemological *correlatum* of the non autonomy of science in its whole, face to the technical world where it gets its legitimacy".

[5] Something which I have tried to systematize elsewhere according to a set of proposed categories for the analysis of scientific practices (importation, cooptation, convergence, decentration, commitment, crossings, etc) (cf. Pombo, 2004)

[6] Which Boulding (1956: 12) names as "multi-sexual interdisciplines".

[7] In what concerns University, the aim is to recover the interdisciplinary vocation of University while metaphor of the very articulation of the diverse kinds of knowledge, as it has been presented in Kant's *Der Streit der Fakultäten* (1798) and later theorized by Fichte, Schelling, Schleiermacher, Hegel and Humboldt during the famous reform of the University of Berlim at 1810. As Schleiermacher wrote, it is the aim of university "to examine the particular, not in it self, but in the net of its scientific relations, to inscribe it in a vast set without never putting it apart from the unity and the totality of knowledge". Later, Carl Jaspers (1883-1969) will recognize the dangers to which University is submitted, namely those whitch come from specialization of scientific knowledge and from the fragmentation of University in an amount of schools (cf. Jaspers, 1965: 103-107). Also Habermas (1987) will recognize the integrative capacity of University which he defines as the place of the "convergent interaction" (Habermas, 1987: 8) of the "subjectively shared awareness according to which some do things different from other but all together fulfil, not a function but a set of convergent functions" (*ibid*). Habermas grounds this possibility, not anymore at the hierarchical position of philosophy as the basis for culture and for unity of science (cf. 1987: 6) but in the communicative rationality which subsists at the heart of the public community of researchers (cf. 1987: 9).

[8] Put forward in France during the events of May 68 as a student reivindication, interdisciplinarity is in fact at the root of multiple experiences, of various scope and amplitude. Curiously enough, in France, philosophy is the leader of the movement in favour of interdisciplinarity. See for instance the *Rapport de la Comission de Philosophie et d'Épistémologie* put forward by Jacques Bouveresse and Jacques Derrida, at 1988 for the French Minister of National Education (cf. Derrida, 1990). On the contrary, in England and in the majority of anglophonic countries, it is science teaching which seems to go in front of the process. See the case of the celebrated projects "Nuffield Combined Science", "Scottisch Integrated Science" and "Harvard Project Physics: an integrated science course", created in the seventies (cf. Rutherford, 1971).

[9] See the case of the strong interdisciplinary program developed since 1971 at the University of Chicago, the "Midwest Faculty Seminar" (cf. Walshok, 1995: 207-224).

[10] With a first version in 1271, the *Ars Magna Primitiva*, Lull will go on rewriting the *Ars* during 23 years, always looking for a more simple, more accessible, universally appropriate form. However, the two last versions, one more extensive under the title of *Ars Generalis Ultima*, another shorter and easier to manipulate, under the title *Ars Brevis*, are both from 1308. See the classical study by Tomás and Joaquín Carreras y Artau (1939: I, 427-455).

[11] Bacon's *Instauratio Magna* is the proclamation statement of modern science and of its future discovery (see exploration) of the natural and human world. There is no divine light to illuminate the voyage unless the doubtful light of senses. Science is a human, collective task whose Unity is resultant from a plural set of determinations. In fact, for Bacon, Unity of Science is the outcome of several features: a common object (the Unity of the World which science must mirror), a final hedonistic aim (the happiness of humankind), a common organizational structure (the organic community of men whose life is devoted to science) and, last but not least, a new universal methodology. Bacon is aware of the importance and novelty of his inductive logics as the methodological support of modern science. We understand his audacity in the *Novum Organon* (1620): "As common Logics, which covers all by the syllogism, does not only apply to nature sciences but to all sciences without exception, so this inductive method shall be used by all sciences" (*Novum Organon*, 127).

[12] Mathesis Universalis concerns a totally formalized science, unique, universal, free from error, from doubt and from uncertainty. An universal science which would assemblage all human knowledge in an integrative, exhaustive way. Not by additive accumulation, but by a process of deduction and logical engendering on the basis of a set of primordial categories, pure concepts or primitive terms. Two main postulates are present here: reality can be entirely apprehended by reason; mathematics is the key, the method and the model of such intelligibility. For Descartes, Unity of Science has its ground, not in the unity of the World, as for Bacon, but in the unity of human reason. It this in this context that Descartes points to a Mathesis Universalis as an universal science which (I quote the *Regulae* IV) "must contain the first principles of human

reason and which must extend to the rising of truths in any subject" (*Oeuvres*, I: 94). Mathesis Universalis, thus constructed on the basis of the clear and distinct principles, evident for any rational being, is thus warranted, from its beginning, by the return of a solitary reason to indubitable principles, subjectively constituted, on the basis of which all other truth will be deducted. On the contrary, for Leibniz the main point concerns mathematics which he considers to be the centre, the source of any inventions and discovery. However, differently from Descartes – for whom mathematics is valuable most for the intuitive character of its first propositions – for Leibniz is by the formal rigor of its demonstrations that mathematics can constitute the model of true knowledge. As Leibniz states in a classical text against Descartes, *Meditationes de Cognitione, Veritate et Ideis*, published in the *Acta Eruditiorum* in 1684: "logical laws, the same geometers use, constitute the truth criteria for propositions which cannot be despised. Nothing can be admitted as valid and certain which has not been proved, either through an accurate experience, or by a solid demonstration. Yet, a demonstration will be solid only if it respects the form prescribed by logics. (Leibniz, GP, IV: 425). Now, because only logical laws can guarantee the rigor of a demonstration, that rigor cannot lay in dependence for subjective certainties. Such rigor must be conquered inside a symbolic system, which, by making stable and visible the most abstract thoughts, could offer a sensible *medium* that guides, supports, raises or even substitutes natural reason. As Leibniz writes, in a clear anti Cartesian tone: "the true method must provide us a *filum Adiadnes*, that is, a crude and sensible mean, which should lead the spirit as drawing lines in geometry which are usually prescribed to apprentices in arithmetics." (Leibniz, GP, VII: 22). For further developments, see our Pombo (1987).

[13] Unity of Science will get here the character of a movement. In fact, with the neo-positivism the expression corresponds, not only to a theoretical program on the technical problematics of Unity of Science (an articulated, even if not always coherent, sum of thesis inspired by the logical-empiricism of the Viena Circle) but also to a set of concrete initiatives undertaken in order to encourage Unity of Science (the organization of six *International Congress on the Unity of Science*; the foundation, first in Haia (*Mundanaeum Institut*) and then at the USA, of the *Institute for the Unity of Science*, the publication of the *Library of Unified Science*, the edition, after 1930, of the famous journal *Erkenntnis* (afterwards, named as *Journal of Unified Science*) by Rudolf Carnap e Hans Reichenbach, and, above all, the project of the *International Encyclopedia of Unified Science*.

[14] We could, naturally, consider several other projects for the unification of knowledge, each of them actualizing a singular form of articulation between philosophy and the idea of Unity of Science. For instance, a deductive metaphysics, where philosophy is the form of knowledge *par excellence*, as it was the case in Spinoza; a unity which corresponds to the regulative power of a transcendental structure, as for Kant; a theoretical and practical unity which has in self-consciousness its radical ground, as for Fichte; an absolute knowledge with the capacity to enclose in itself the contradictions of a becoming totality, as it was the case with Hegel. For further developments on the most important programs for Unity of Science, cf. Pombo (2006a).

[15] In one case the inductive logic is the paradigm, in the other the primacy is given to mathematics.

[16] We can read on a fragment by Heraclitus, "numerous knowledge does not teaches intelligence" (Diels, 40). From the Greek *poli math*, science of the multiple, the polimatia condemned by Heraclitus, first great philosopher of unity, was though out as the juxtaposition of data and fragmentary information, that is, as the amount of what is seen face to what cannot be seen at all. As Bollack and Wisman write (1972: 152): "unable to identify and to enunciate the unity of things, then men thought out the multiple".

[17] One of the decisive reasons for the emergence of science and philosophy would have been the new language practices that became possible in the Greek cities democratically organized. There, it would have been developed new communicative conditions, habits of dialogue, of discussion and of rational argument, never before experienced in human communities. In contrast to the traditional, millenary forms (mythic and narrative) of knowledge transmission, it

appeared in Greece new forms of transmission of knowledge (the school was invented), new ways of using language that will result in the formation of new types of knowledge, basically, mathematics – a word meaning precisely what can be thought – and philosophy, the mother of all sciences. What we want to stress is that it is not the accumulation of scientific knowledge that is on the basis of the appearance of teaching. Rather, it is the emergence of teaching that makes possible the creation of scientific knowledge. Science and philosophy, as we know them today, are therefore the product of a long history of school along which specific forms of using language were imposed, discursive rules, ways of doing and saying, forms of producing, analyzing and explaining linguistic practices endowed with the rationality inherent in the very practice of communication. For further details, see Pombo (2002: 182-228).

[18] Science is never a solitary form of knowledge. Its *topos* of production is a community of peers which only can accept, recognize, and validate the produced statements. But even before the call for discussing the results of research, the work of invention and production of knowledge takes place within a communicative network. As Schleiermacher wrote "is a hollow illusion to assume that an individual who is engaged in scientific activity can live alone with their work and their projects: how much it seems that he works alone in the library, at the desk or in the laboratory, his knowledge activity is, inevitably, interior to a public community of researchers" (Schleiermacher, 1808: 258).

[19] As Patrick (1972) shows, Aristotle was the first to make a systematic and useful collection of books for his school. According to Patrick: "Aristotle, whom Plato called 'the reader', appears to be the first to recognize the value of organizing a library for a philosophical school" (1972: 97).

[20] Let us think about Alexandria's Library and Museum. As Strabo says, at the Library of Alexandria were together "all the books ever written on the inhabited earth". Those books were there made available to scholars who Ptolemy Soter has invited to Alexandria and installed in the Museum of which the Library was a necessary complement. We know that what it is behind the foundation of these two major cultural institutions is the Aristotelian idea of science a collective undertaking requiring the combined effort of a republic of wise men. The great inspiration for the cultural policy of Ptolemy Soter was Demetrius Falero (350-283 BC), disciple of Teophrastus (372-287), successor of Aristotle in the *Lyceum* where he created, along with the particular library of Aristotle, a *Museion*, true predecessor of the *Museum* of Alexandria. What matters however to emphasize is the symbolic fact that the destiny of the Library is so crossed, and from that inaugural moment for ever, with the destiny of the Republic of the wise. For more developments, cf. Pombo (2002)

[21] Encyclopaedism in Greece happens only in school context. The fragments of more clearly encyclopaedic nature that arrive to us were produced by Speusippo (393-339 BC), nephew of Plato and his successor at the Academy. Speusippo would have assembled and compiled significant part of the content transmitted in the classes, a series of writings on natural history, mathematics, logics and metaphysics. His aim would have been to give students an overall presentation of the material under study. Thus Encyclopaedia is born as a school requirement seeking to preserve and extend by the written word the teacher's spoken word. Regarding Alexandrian encyclopaedism – compilation, *varia*, abstract, collection of fragments, *marabilia* –it was induced by the presence of Library and by the reading and writing practices which were constituted there. For a study on the history of encyclopaedism, cf. Pombo (2006).

[22] That is case of the *Encyclopaedia Universalis* (1968-1975) and the *Enciclopédia Einaudi* (1977-1984) which both became more integrated, more descentered, more interdisciplinar, more combinatory and thus more concerned with heuristics.

[23] As one can read in the introductory note with which Claude Gregory opens the *Organon* of *Universalia*, "it is a reader´s job to work out the project" (1968-1975, vol. XVII: XI). The same at the *Einaudi* whose aim was "to concentrate on the more important elements of the cultural discourse organized in the last half century" (Romano, 1977-1984 a: XIII). The *Einaudi* thus explicitly gains a heuristic and interdisciplinary scope. Interdisciplinar, in that it implies the ability to "enter the logic of various subjects in order to see how could one transmigrated concept be enriched with new abilities in order to become broader and more fertile, in limit, to become

completely different" (Romano, 1977-1984 a: XV). Heuristic because, not wishing to identify the knowledge acquired in the past nor even to review the knowledge of the present, encyclopaedia aims to open itself for new conceptual structures, for the new objects of study and research, aiming to give an account of "the ways which contemporary research is following, the organizational structures and – especially – the possibilities existing in each field (see Romano, 1977-1984 a: XIII).

[24] SIgnificantly, the concept of "navigation" appears explicitly at the *Organon* of the *Enciclopaedia Universalis*, vol. 17: 595.

[25] Namely in what concerns electronic and online encyclopaedias whose main advantage is facility and speed. A second feature of this new type of encyclopaedias concerns its radical actuality.The passage from virtual to actual is always local, dependent on the subjective activation of a specific mechanism.

[26] For a comparative study on Leibniz and Neurath's encyclopaedism, cf. Pombo (2002a)

[27] The original plan, conceived by Neurath around 1920, was presented, discussed and approved at the *First International Congress for the Unity of Science* held at the Sorbonne in Paris, 1935. The Encyclopedia was intended to provide the publication of a series of 260 independent monographs in about 26 volumes. It would be designed to have the structure of an onion, including an heart formed by 20 books dedicated to the foundations of Unified Science and organized into four major sections: the first, devoted to the theoretical analysis of the problem of the Unity of Science, the second on methodological issues, the third, aimed at giving an overview of the current systematization state of the various sciences, and the fourth, intending to give an account of the main applications of science in the field of private education, medicine, engineering and law. All the other books planned would be located around the heart, as overlapping layers. They would be dedicated to the various particular sciences dealing with problems specific to each of them (cf. Neurath 1937: 139 and 1938b: 24-25). Neurath also envisaged the publication of a supplement in ten volumes comprising one *Atlas* or *Isotype Thesaurus* that would include maps, graphs and other pictorial representations as "means of unified visual aid" (Neurath, 1938b: 25). Neurath also believed it would be possible to hold simultaneous editions in English, French and German aiming to gather the input from a wide range of European and Asian collaborators.