DEFINING THE DIALOGUE BETWEEN SCIENCES: A VIEW ON TRANSDISCIPLINARY PERSPECTIVE IN THE HUMAN SCIENCES

Giorgia Rimondi*	Russian Institute for Advanced Studies (Moscow State Pedagogical University), Moscow, Russian Federation & University of Parma, Parma, Italy	giorgia.rimondi@gmail.com
Marco Veronese	Independent researcher, Milan, Italy	marco.veronese.dmm@gmail.com

* Corresponding author

ABSTRACT

Aim/Purpose	The authors argue that *inter*disciplinarity, together with the more recent concept of *trans*disciplinarity, can be seen as a coherent attempt not so much to reassemble the fragmented structure into a whole, as to create a fruitful collaboration and integration among different disciplines that takes into account their specificity.
Background	At the threshold of the Modern Age, a series of paradigm shifts in Western thought caused its fragmentation into a variety of academic subdisciplines. Such diversification can be considered the result of epistemological shifts and changes in the division of intellectual labor.
Contribution	Which semantic horizons can this new approach open, and on which theoretical foundations could *a dialogue between disciplines* be produced? The growing importance of this problem is evidenced by the emergence, during the last decades, of philosophical reflections on the interactions among different research fields.
Findings	The possibility of transdisciplinarity in modern science finds its theoretical premise in M. Foucault's seminal work on the organization of knowledge, *The Order of Things*, which hinted at the existence of gaps in the grid of knowledge, leading, as a result, to the possibility of creating transdisciplinary connections.
Impact on Society	The paper aims to contribute to the contemporary discussion of the need to overcome boundaries between disciplines. Consequently, it has both a methodo-

<table>
<tr>
<td></td>
<td>logical and theoretical impact, since all branches of knowledge aspiring to go beyond their traditional theoretical boundaries would benefit from a coherent theoretical perspective which tries to reconceptualize the transfer of knowledge from one field to another.</td>
</tr>
<tr>
<td>Future Research</td>
<td>The authors' critical discussion of transdisciplinarity aims to revive the French epistemological tradition that in the last decades has often been rejected by researchers as not being rigorous nor analytical. This choice is motivated by the belief that, despite such evident defects, at its bottom lies a genuine theoretical intention that does not take for granted the possibility of transcending the usual division of intellectual work. In addition, the authors offer a brief account of the Russian conception of transdisciplinarity, relatively little studied in the West, which is presumed to integrate and solve the difficulties of other similar models.</td>
</tr>
<tr>
<td>Keywords</td>
<td>transdisciplinarity, critical epistemology, philosophy of boundaries, status of humanities, Michel Foucault, Russian school of transdisciplinarity</td>
</tr>
</table>

INTRODUCTION

The paper's research theme derives from a contemporary necessity to broaden approaches to research within client disciplines. Noting that empirical research methods do not necessarily provide useful results in many client disciplines, many researchers propose alternative approaches (Gill, 2011), pointing out that the principal goal of the epistemology of transdisciplinarity is to explore better ways to communicate that knowledge effectively. The theoretical perspective of this paper is based on the need to find concrete and effective ways to insert the development of research methodologies within one's own research work (integration) and to make results as collaborative as possible (transdisciplinarity). Such a demanding task requires the awareness that, besides the *contents* of single disciplines, the *processes* underlying the acquisition and re-elaboration of those contents must be considered as well. The main issue then will be that of highlighting, explaining and systematizing what within the existing body of knowledge already tends to call for greater awareness of how information about transdisciplinary practices is created and disseminated.

The present analysis points out areas of research that need further investigation with regard to the issue of the reunification of knowledge ad cross-fertilization between disciplines. Current research in this field aims to explain the impact of a philosophical discussion of transdisciplinarity on the Information Systems discipline, showing how and why a comprehensive theory enriches research and product knowledge in the philosophy of science in the form of meta-research (Mende, 2005). Exploring the transfer of knowledge from one field to another, the transdiscipline of Informing Science (Cohen, 1999) aims to break disciplinary boundaries, which lies at the heart of the authors' critical discussion.

The paper aims to provide a summary of the scope of what is being discussed with respect to transdisciplinarity. The authors provide a general view of an approach aiming to conceive the question of interaction between different kinds of knowledge in a philosophical and historical perspective, while linking it to some macro phenomena which, from an epistemological point of view, have profoundly altered scientific paradigms by means of introducing a rigid specialization of disciplines and their more or less rigid division. The notions of interdisciplinarity and transdisciplinarity are examined on the basis of a philosophical tradition that could be defined as "holistic", which has proposed an essentially "spatial" and pragmatic interpretation of the connections between areas of knowledge. The theoretical discourse shifts from what could be called Louis Althusser's critical conception of interdisciplinarity to the properly "spatial" conception of Michel Foucault, which addressed, for the first time, the theme of relationships between disciplines in terms of boundaries. In this paper, we pre-

sent a transdisciplinary approach that amends (or removes) the inherent problems (methodological, foundational, functional) found within the inner structure of interdisciplinarity and then make a comparison between interdisciplinarity and transdisciplinarity, to assess if transdisciplinarity is able to keep its promises (overcoming the boundaries between disciplines by means of synthesizing the research in individual domains of knowledge and showing how information is created).

HISTORICAL BACKGROUND

More generally, it is necessary to reconsider the interaction between knowledge as a *historical* production, which at a first glance might seem trivial, but actually allows one not to misunderstand this concept as if it were a recent theoretical abstraction. A fundamental breakdown of the traditional *epistème* took place at the threshold of modernity, with the birth and development of modern science. This phenomenon, as well as introducing something that previously did not exist, raised the need for the systematization of knowledge and disciplines. In this way, for example, the spread of scientific institutions, such as Accademia dei Lincei (Rome, 1603), Accademia del Cimento (Florence, 1651) and the Royal Society (London, 1662), is considered a fundamental step towards the progressive institutionalization of sciences. As a matter of fact, from the eighteenth century to the Second World War, science specialized in various academic disciplines and, at the same time, became associated with industry as applied research, and then matured with a shift from little science to big science, whose birth sociologists trace back to the explosion of atomic bombs and the start of the Manhattan Project. Although the authors' concern here is not to reconstruct how this rapid and exponential diffusion has unintentionally contributed to the reduction in the autonomy of humanities, it is clear that at their actual stage of development, the latter are confined to a field that, borrowing M. Foucault's words, could be defined as lying "outside the field of truth" (Redaelli, 2011, p. 191), i.e., unable to produce *authentic* discourses on contemporaneity, except for discourses that are irrelevant and cannot deal with the question of philosophically understood truth. Truth in Michel Foucault's thought should be understood not as correspondence to reality, but rather as "truthfulness" (*veridicité*), as the philosopher "understands the true/false opposition, which governs knowledge in the Western world, no longer in terms of reference (it is true what corresponds to reality, according to the principle of *adequatio intellectus rei*), but in terms of power [...] looking at the discourses not in terms of their veridicity but in the light of their positivity, analyzing them in their simple existence, in their taking place and imposing themselves" (Redaelli, 2011, p. 200).

Indeed, it can be then assumed that the problem of interaction between disciplines can be linked to this division and to this supposed decline, though at the same time it remains outside it. Indeed, this is an ambivalent notion, since if on the one hand it tries to re-establish a lost unity, at least in terms of intents – which inevitably seems an illusory attempt because of the anti-historical character of this approach –, on the other hand it can be a valuable starting point for pragmatic collaboration.

In this regard, it is interesting to examine briefly the critics that Louis Althusser moves to the concept of interdisciplinarity in his essay *Philosophy and the spontaneous philosophy of the scientists & other essays* (1990). Dealing with the interactional relationships between disciplines and their mutual relationships, Althusser argues that there are three main levels, each characterized by a different depth of analysis, in which philosophy represents a valuable aid to the underlying epistemological problem, namely to the definition of such relationships. Firstly, he argues, "there is what can only be called the fashion for interdisciplinarity. These days, an encounter between representatives of different disciplines is supposed to hold all the promise of a miracle cure" (p. 78).

Although further on in his essay Althusser (1990) defines this fascination with interdisciplinarity as derived from a "slogan", it represents an important acquisition as an ideological myth, a method of comparison between axioms and different sciences, whose diffusion is due to the prevalence of the big science over individual research, to the recent emergence of new disciplines - such as cybernetics - and to the dialectics existing between human sciences and physical-biological sciences. Althusser argues that the interdisciplinary slogan is based on an ideological myth, in other words, a myth is based

on an ideological proposition, which he defines as "a proposition that, while it is the symptom of a reality other than that of which it speaks, is a false proposition to the extent that it concerns the object of which it speaks" (Althusser, 1990, p.7 9). Moreover, the problem of interdisciplinarity resides in the presence of ideologies that try to assimilate part of the scientific field to philosophical categories implicitly rooted in practical ideologies, which at the same time could be read as a symptom of science's lack of solid foundations.

On a deeper level, the question of the interaction between different kinds of knowledge and disciplines could be read as the more general problem of the massive development of sciences and technologies, as the problem inherent in the disciplines and their relationships, and the emergence of new disciplines "in zones that might retrospectively be said to be border zones" (Althusser, 1990, p. 79). At the end of his analysis, Althusser considers the most general issue of concrete reality and the practical and political relations that these themes share with it.

Therefore, assuming that interdisciplinarity is based on an ideological myth, the task of philosophy will consist in drawing a demarcation line between its ideological claims and the reality of which it is a symptom, although it is evident, according to the philosopher, that "something like interdisciplinarity corresponds to an objective and well-founded necessity when there exists a "command" that requires the co-ordinated co-operation of specialists from several branches of the division of labour" (Althusser, 1990, p. 87).

This distinction - the demarcation line mentioned above - that philosophy can draw is that existing between a justified and unjustified appeal to technical and scientific cooperation. The first case is that of a specific request addressed to specialists by a discipline so that they can solve problems that have emerged in it. The second case, the ideological aspect of the matter, concerns the use of the *ideology of interdisciplinarity*.

In what way can one speak of a *slogan*? According to Althusser, the underlying proposition of interdisciplinarity is ideological – that is, false –, but at the same time it designates a reality other than the one it explicitly speaks of. This dimension consists in the actual relationships that historically have been forming between different disciplines, between literary and scientific disciplines and old and new disciplines.

The intervention of a science in the practice of another is a recent phenomenon, the result of the formation of *border areas* that define, as it will be shown, spaces of non-definition and closeness that in the past seemed like definitive boundaries.

> These relations are typical of contemporary scientific phenomena. Increasingly, so-called "neighboring" disciplines are brought into play in 'zones' which were once considered to be definitive 'frontiers'. From these new relations new disciplines are born: physical chemistry, biophysics, biochemistry, etc. These new disciplines are often the indirect result of the development of new branches within the classical disciplines: thus atomic physics had its effects on chemistry and biology; in conjunction with the progress of organic chemistry, it contributed to the birth of biochemistry (Althusser, 1990, p. 89).

Nevertheless, Althusser draws a quite pessimistic conclusion about the possibilities of interdisciplinarity, except for the possibilities of interaction already mentioned and their relative space, and at the same time he introduces an important distinction between a justified use of technical and scientific cooperation and an unjustified use of the interdisciplinary slogan, considering the first case legitimate, the second problematic. Therefore, Althusser, despite his evident scepticism towards the interdisciplinary hypotheses, proves that the essential question of such hypotheses, that is to say, the aspect that in most cases constitutes a preliminary problem in their deployment, is in fact of a metaphysical and theoretical nature. It is necessary to determine what such boundaries consist of, how they operate and how they can, if necessary, productively function by creating interdisciplinary (or transdisciplinary) theoretical overlaps. As it will be further explained, it is interesting to note that this

specific insight of Althusser's, not only concerning interdisciplinarity in the strict sense, or the existence of such liminal zones, but the broader "spatial" conception of knowledge fields as well, will be subsequently developed by Michel Foucault (2002) in *The Order of Things*.

THE MIDDLE AREA OF KNOWLEDGE

In any case, it is possible to conceive, with a certain degree of approximation, the current order of culture as the product of an epistemological break, in the Kuhnian sense of the word (Kuhn, 1962), or as the creation of an order of knowledge more respondent to the theoretical and practical needs of contemporary times. Within this order, capillary specialization is a cornerstone principle, since it is more effective in terms of division of labour, in other words, it is more productive, both quantitatively and qualitatively. To clarify, if the specialist's condition results from a division of intellectual work that considers appropriate the introduction of such division in order to define a variety of microscopic research fields, the need for an interdisciplinary approach becomes a requirement, which inherits the division of labour itself, so as to avoid fragmentation that could result in aridity. The same division between humanistic and scientific culture, which itself is problematic and difficult to define, has thinned progressively in recent years, giving rise to a labile boundary that makes it even more difficult to collocate certain bridge-areas such as sociology or culturology. On the other hand, it is worth reminding one that attempts at formalization or quantitative output - or mathematization - of traditional disciplines started with Comte (1798-1857).

Despite its problematic aspects, and in spite of the hypothesized rigid division of work, the plurality of current approaches could come to a synthesis in an interdisciplinary approach. Though from an historical point of view it may appear as an attempt to restore a decayed order that has been cancelled by gradual specialization, the greatest emphasis is to be given to the purposes for which interdisciplinary action is being accomplished.

In a humanistic perspective, the productive division allows a successful *practical* collaboration, which implies dealing with the issue of *truth* (here Foucaultian "truth" it is to be understood as an *event* or a concrete *production*, partially similar to the concept of *praxis*).

The possibility of a positive and functioning interdisciplinary approach can be read between the lines of Michel Foucault's *Preface* to one of his masterpieces, *Order of Things* (2002), where he claimed that

> The fundamental codes of a culture – those governing its language, its schemas of perception, its exchanges, its techniques, its values, the hierarchy of its practices – establish for every man, from the very first, the empirical orders with which he will be dealing and within which he will be at home. The fundamental codes of a culture define from the beginning, for every man, the empirical orders with which he will have to do and where he will find himself. At the other extreme of thought, scientific theories or interpretations of philosophers explain why there usually is an order. (p. xxii)

It should be noted that in Foucault's philosophy an "empirical order" is a set of historical conditions that determine a set of knowledge, power and discourse, over which the empirical man is at the same time a product (that is, he is determined by them) as well as a potential critic of them (Catucci, 2010).

The organization of culture, in other words, inevitably proceeds towards a solid and not permeable order (Canguilhem, 1998). Nevertheless, argues Foucault (2002),

> […] between these two regions, so distant from one another, lies a domain which, even though its role is mainly an intermediary one, is nonetheless fundamental: it is more confused, more obscure, and probably less easy to analyze. It is here that a culture, imperceptibly deviating from the empirical orders prescribed for it by its primary codes, instituting an initial separation from them, causes them to lose their original transparency, relinquishes its immediate and invisible powers, frees itself sufficiently to discover that these orders are perhaps not the only possible ones or the best ones. (p. xxii)

For the philosopher this area, which opens up between *spaces* of a culture, spaces of uncertainty and non-influence, pre-coded, and even pre-linguistic, is the place of a *middle* area, which "in so far as it makes manifest the modes of being of order, can be posited as the most fundamental of all" (Foucault, 2002, p. xxiii). Thus, "in every culture, between the use of what one might call the ordering codes and reflections upon order itself, there is the pure experience of order and of its modes of being" (Foucault, 2002, p. xxiii).

This area of such quintessential indefiniteness, which the actual order of knowledge leaves free and indefinite, opens up to the possibility of fruitful sharing and collaboration, to an interdisciplinary field of action that does not appear excessive to connect to such epistemic openings, and it also defines the possibility of a new *positivity*, the production of new knowledge and a better interaction between already existing ones.

Although Foucault does not treat directly the theme of interdisciplinarity, the ambitious reflection he has undertaken in *Order of Things* has opened up a number of critical and theoretical possibilities that are particularly urgent. Indeed, the number of themes relating to a fundationalist and critical epistemological discourse, such as that undertaken by the French critical epistemology, is huge. Certainly, it represents an essential theoretical basis for any reflection that goes in the direction of co-operation of disciplines (multidisciplinarity, interdisciplinary) or of overcoming their historical divisions (transdisciplinarity). These issues involve a reopening of the discussion of the theoretical reasons of such disciplinary shifts and of the basis upon which they can actually be achieved. At the same time, this reflection leads to an in-depth analysis of the question of the incorporation of human sciences into macro-academic areas and, more generally, the problem of the growing and steady influence that they appear to hold in any non-specific field, as well as the increasing fragmentation of their results in hyper-specialized and closed micro-areas. Therefore, it would be desirable to return to these fundamental and only apparently theoretical issues, since behind these disputes lies a well-defined and concretely operating praxis, only partially revealed and intelligible. In this way, whereas French critical theory adheres to a highly critical understanding of the interdisciplinary approach, Foucault's epistemological conception was implicitly defining an area of possible interaction that aimed to protect science from a rigid subdivision of knowledge.

Formally a very similar problem to that put forward by Foucault returns in the contemporary debate, as exemplified by Bruno Latour, who seems to address the issue in terms of space, hence the reference to the conception of border-crossing, which refers to the possibility of transdisciplinarity (Latour, 2017). Criticizing the modern division between Science and the World, Latour proposed an epistemology that mediates subjects, objects and discourses, thus creating the premises for transdisciplinarity. His Actor Network Theory shows how boundaries between science and society, namely Nature and Culture, are not fixed once and for all, but rather are fluid.

The topic of scientific communication is the research object of a wide multidisciplinary field (Davies & Horst, 2016) that explores - through methodological approaches typical of the human and social sciences - all the topics related to the production of scientific knowledge, from the impact of scientific innovation in society to the relationship between disciplines and the opportunities to access knowledge that new approaches open for a wide category of subjects, inside and outside the scientific community.

The informing system of science is made up of a large number of elements and actors in multiple and non-linear relationships between them. In a transdisciplinary perspective the flow of information of science takes place through a constellation of different relevant channels and defines a largely chaotic and unpredictable dynamic, typical of complex systems. Integration and scientific collaboration is an essential element of the contemporary paradigm of knowledge, where the communication of knowledge is called to fulfill the decisive role of a "lymphatic system".

FROM *INTER*DISCIPLINARITY TO *TRANS*DISCIPLINARITY

In recent decades, the issue of the interaction of disciplines has been the subject of attention and debate. In this regard, the notion of transdisciplinarity, a relatively recent notion, has replaced the more general ones of interdisciplinarity and multidisciplinarity. The term "transdisciplinarity" was first formulated by J. Piaget in 1972 during his discussions with astrophysician E. Jantsch and the mathematician A. Lichnerowicz at the international conference held in France, "L'Interdisciplinarité: Probleme d'enseignement et de recherche dans les universités". Subsequently, in 1986, following the Transdisciplinary Symposium held in Venice in 1986transdisciplinary research found a further formalization with the creation of the Center for International Research and Transdisciplinary Studies in France. Finally, in 1994, Portugal hosted the first International Congress on transdisciplinarity, during which were defined the general lines of development of the transdisciplinary approach in the Charter of Transdisciplinarity.

Indeed, in the effort to overcome the current fragmentation of knowledge, neither the multidisciplinary nor the interdisciplinary approach can be considered as effective methodological solutions since they are based on simple comparison or interaction of disciplinary approaches and do not seem to achieve profound integration. The distinction between interdisciplinarity and transdisciplinarity was first introduced by Piaget (1974): "At the stage of interdisciplinary relations, one can hope to see the succeeding of a higher 'transdisciplinary' stage, which would not be satisfied with reaching interactions or reciprocities between specialized research, but would place these connections within a total system without stable boundaries between disciplines" (p.170).

After all, the main problem that needs to be faced with regard to interdisciplinarity, is the same ontological (and methodological) problem that was raised by O'Rourke (2013) regarding Integration and Implementation Sciences (I2S): "My concern is that I2S is too broad in scope to be anything more than a family of research activities [...] that is an umbrella area covering a number of more or less loosely connected disciplines" (p. 408).

On the other hand, "Transdisciplinarity is therefore conceived as 'meta-methodology': a transdisciplinary approach takes as its object precisely the different methodologies of the various disciplines, in order to 'transform' and to 'transcend' them" (UNESCO, 1998, p. 38).

In this sense, the reference to transdisciplinarity as meta-methodology and not as meta-science or hyper-science is fundamental. Basarab Nicolescu, president of CIRET (Center for International Research and Transdisciplinary Studies), prefers to characterize transdisciplinarity as what goes beyond discipline. Basing his position on the critique of the idea of a "total system", which avoids the danger of considering transdisciplinarity as a hyper-discipline, a science of sciences, he does not accept the definition of transdisciplinarity proposed by Piaget, which would lead to a closed system contradicting the fundamental requirement of the instability of boundaries between different fields of knowledge. "The key-point here is the fact that Piaget retained only the meanings 'across' and 'between' of the Latin prefix *trans*, eliminating the meaning 'beyond'" (Nicolescu, 2006, p. 142). Therefore, it must be carefully distinguished between "superscience" and "interdisciplinarity", as some researchers have recently used the terms "transdisciplinary" and "single science" as synonyms, but the difference between them is remarkable:

> The *unitary science* presupposes, first of all, the reception, accumulation and organization of the organic coexistence of a multitude of isolated knowledges on the outside world; knowledges, permeated by disciplinary, *inter*disciplinary and *multi*disciplinary approaches. This situation allows us to speak of "transdisciplinary science" as one of the properties of science in general.
>
> *Transdisciplinarity* presupposes the investigation of every phenomenon, object, and process into its internal unity and unitarily with the outside world. This is the reason why the specific term "transdisciplinary approach" is used. We emphasize the term "transdisciplinary ap-

proach", and not approaches that "can be considered transdisciplinary." In this case, it is fair to talk about the "*science of transdisciplinarity*" as an important element within a single science (see the Institute for Transdisciplinary Technologies website http://anoitt.ru/index3.php).

Transdisciplinarity thus opposes the coexistence and integration between sciences, as an attempt to analyse the subject of the investigation - always interpreted as a complex object - while interdisciplinarity remains confined in a mono-disciplinary perspective and its internal goals related to a specific discipline. In other words, the latter remains a space between disciplines, which is unable to lead to real integration or dialogue between them. On the contrary, the prefix "trans-" is a way to emphasize the overcoming of fixed boundaries between areas of knowledge and the conquest of a new space of reflection, which brings with it the need to find a common language:

> The limits of marginal assumptions jointly create a space (traducibility) between general and individual, scientific and non-scientific, cognitive and pragmatic, reflexive and non-reflexive, observable and unobservable, true and contingent, productive and reproductive imagination, text and context, causality and definition of expressed and unexpressed objectives, etc. The common thing to all them, their invariant, is the fact that they are in reversible dependence on the existence of a middle area between them, which removes their opposition. This is the only and one space in which the experience of transdisciplinarity can occur, in which the practice of communicative relationship finds its expression. Attention to the field of language communication, the search for "esperanto" of transdisciplinary communication, as well as the development of the practice of mutual translation, lead to the fact that the language of science needs to master the principle of "reverse translation", of crossing the border (Moiseev & Kijaščenko, 2009).

Referring again to Foucault, it does not appear without consequences that, in the order of knowledge, the existence of such a space allows escape from the rigid determinations of a culture defined by overabundance, in other words to escape the continuous accumulation of mutually meaningful confirmations, or the existence of a *secondary language* that proliferates in the constitutive inability to say anything true, or even within a commenting culture. In this regard, it does not seem excessive to argue that a fruitful dialogue between disciplines allows avoidance of this kind of result, while at the same time being an effective aid to specialized knowledge which finds itself with the need to transcend its own boundaries.

Table 1. Comparing the two theoretical approaches

	Interdisciplinarity	Transdisciplinarity
Boundaries between disciplines	Stability of boundaries (interaction of disciplinary approaches)	Instability of boundaries (complex and total system)
Scientific status	Meta-science (going *across* disciplines)	Meta-methodology (going *beyond* disciplines)
Approach to the object	Comparative (the object from *different* perspectives)	Complex (the object in its internal *unity*)
Structure	Complementarity	Spiral pattern

Within a transdisciplinary perspective, the experience of the limit from regulatory principle becomes a constituent moment of interaction between sciences. Consequently, it is necessary to place ourselves in a perspective that is not vertical but horizontal -- by placing different disciplines on the same level, a real integration between the different areas of knowledge is possible, thus avoiding therisk of a new "closure" within a particular area of specialty. The research conducted simultaneously at multiple levels allows re-evaluation of the object of such research through its inclusion in a new conceptual framework. As J. T. Klein (1996) points out discussing the issue of boundary crossing between disciplines, "at this historical point, however, the interactions and reorganizations that

boundary crossing creates are as central to the production and organization of knowledge as boundary formation and manteinance" (p. 2).

With relation to the field of Informing Science, the transdisciplinary task is configured as the overcoming of boundaries in a double sense. On the one hand, transdisciplinarity intends to analyze the practices of scientific communication in order to understand the competences, values, expectations and models of communication of the actors involved. This implies the awareness that, when communicating, not only scientific contents are conveyed, but also specific ideas of science and its methodology. The second objective concerns the possibility of experimenting with information practices that involve greater involvement and participation in the scientific issues of different actors in the interaction process, using unconventional and transdisciplinary methodologies. This dual approach ultimately allows experimentation with models and practices that are more aware of the critical aspects of transformations taking place in the process of knowledge production, and which contemplate greater involvement and participation by the different actors involved in this process.

If one accepts the traditional distinction, carried out in the philosophy of science, of scientific knowledges in the twentieth century in two periods, neo-positivism and post-positivism, transdisciplinarity could be defined as *trans-positivism* (Moiseev & Kijaščenko, 2009), a perspective that transcends both historical versions of positivism by proposing a new criterion for understanding the phenomenon of science. One of the reasons for the rise of transdisciplinarity is in fact linked to a change in the character of the sciences. Current science comes out of the space of the laboratory, where it was confined, to become a form of social production, a hybrid of fundamental research - that is, aimed at the achievement of authentic knowledge – and pragmatic (in the sense of experimental sciences). "Transdisciplinary research arises when, despite the multitudes of disciplinary approaches isolated in the treating of existential, bioethical, ecological and other issues, it is felt their inadequacy" (Moiseev & Kijaščenko, 2009, p. 29).

The Russian school of transdisciplinarity has provided an extended conception of the different types of transdisciplinary approaches by developing theoretical reflection in practice and employing a transdisciplinary methodology when addressing complex problems in pedagogy, economics, physics and other fields. In Russian science, the consideration of the phenomenon of transdisciplinarity, first of all, is connected with the unification of philosophical and technological grounds for the solution of anthropological problems; using the transdisciplinary system approach as a methodology for recognizing and investigating the world, conceived as unity. In this way, interest in transdisciplinary problems is expressed by scientists in the field of synergetics, such as V.I. Arshinov, G. Budanov, A.A. Krushanov, E. Knyazeva, and others (Kolesnikova, 2014).

The modern Russian school of transdisciplinarity was established in the early 1990s at the International Institute of Biosphere Informatics at the Moscow State University. In 1996, theoretical and practical work was continued at Kabardino-Balkar State University. At present, the Institute of Transdisciplinary Technologies, founded in 2007, operates in Moscow as an autonomous non-profit organization. However, it should be pointed out that there are multiple understandings of transdisciplinarity. For instance, the work of Vjačeslav Moiseev and Larisa Kijaščenko originates from a different perspective than the one traditionally held by the Russian transdisciplinary school. In their *Philosophy of Transdisciplinarity* (Moiseev & Kijaščenko, 2009), the Russian scholars lay out a series of features of the new methodology, which is proposed as an approach that embraces the antinomies of reality, recognizing its stratification – that is, multiple levels of reality – the complexity and the need to rely on a "logic of *included* middle", as already pointed out by Nicolescu (2010, p. 30). At the same time, they claim that transdisciplinarity belongs to contemporary orientations of scientific research in which "the philosophical element within the sciences is evidently expressed", which seems to refer to Nicolescu's danger of considering a particular discipline (in this case, philosophy) as the basis of other disciplines.

THE STRUCTURE OF TRANSDISCIPLINARITY

According to the Belgian scholar E. Judge, in modern science there are four stages in the development of transdisciplinarity, which received the following definitions: transdisciplinarity-1, transdisciplinarity-2, transdisciplinarity-3 and transdisciplinarity-4 (Judge, 1994). To these it must be added the so-called "Transdisciplinarity-0", a term often used to define an initial form of transdisciplinarity based on an illustrative use of metaphor and figurative language. In this, it differs from transdisciplinarity-3 connected with the use of general metaphors having a fundamental *cognitive* meaning. Each type of transdisciplinarity has a different degree of usage and is intended to solve different problems. The first stage (Transdisciplinarity-1) of development is represented by the discussion of Piaget at the abovementioned conference on the problems of education (1974), where the idea of a more complex research model than interdisciplinarity was discussed. This type of transdisciplinarity is based on the formal interconnection of individual disciplines, thus contributing to the formation of logical meta-frames through which knowledge can be integrated at a higher level of abstraction than it does in *inter*disciplinarity. This circumstance requires the multifactorial work of different specialists in the complex study of the research object. In this way, transdisciplinarity-1 shows a closer connection to multidisciplinarity research.

The second stage of the evolution of transdisciplinarity was started from the adoption of the Transdisciplinarity Charter at the First World Congress on Transdisciplinarity held in Portugal in 1994. Transdisciplinarity-2 shows a closer inner connection with the researcher's personal experience, including meditation and self-reflection. However, the methodological principle of "integrity" does not allow for exploration of the world from the position of homogeneity of being, and therefore generates methodological difficulties in the study of complex objects.

The principle of holism lies at the basis of transdisciplinarity-3, as exemplified by the approach of Moiseev and Kijaščenko's Russian school of Transdisciplinarity. Despite the fact that transdisciplinarity-3 is realized when a problem is investigated at the same time on several levels, its systematic approach is not able to investigate complicated multi-factor problems of nature and society.

Transdisciplinarity-4 was developed to overcome this difficulty. This kind of transdisciplinarity is based on the principle of one-centeredness in organizing research: in the worldview of Transdisciplinarity-4, the world acts as a "One Orderly Medium" (Mokij, 2001). Objects of any level of reality are regarded as its natural fragments. In this case, the transdisciplinary worldview serves as the main tool of transdisciplinarity-4 methodology. Transdisciplinarity-4 has the form of a scientific approach, involving a definite research object and language, measure units and methods (information analysis and risk analysis). In this context, the transdisciplinary approach represents a useful tool for the general scientific classification and systematization of disciplinary knowledge. After such processing, disciplinary knowledge becomes fully adapted to its use in solving practical problems of any nature and complexity. As V. Mokij (2001, 2013) argues, the conception of transdisciplinarity-4 involves a series of theoretical implications:

> 1. The world is conceived as a One Orderly Medium (OOM). OOM is an ordered set of attributes, causes and consequences of the existence of the world, general and particular laws and phenomena, objects and processes, including as well as their properties, connections and interactions at any level of reality. "This Medium **is not a system** that represents a complexity of matter objects and their relations, but rather an order that provides the medium's unity" (Mokij, 2013, p. 8).

> 2. OOM can be investigated through its main attributes - a multifaceted form and multifaceted content: "phenomena, objects, processes and their interactions at all the levels of this medium are supposed to be the medium itself, its natural elements: fragments" (Mokij, 2013, p. 8).

3. OOM provides a common structure for all its attributes, where "order" is the correct location of something.

4. The use of transdisciplinary models of spatial, temporal and informational aspects of this order makes it possible to understand and describe the OOM in its unity.

This way of understanding transdisciplinarity underlines the need to integrate research methodologies so as to make results as collaborative as possible. Such a task can be achieved only on the basis of a clear distinction between the *contents* of knowledge and the *processes* underlying the acquisition and re-elaboration of those contents. Conceiving information as a *process* rather than as a thing underlines the fundamental importance of dialogue and collaborative research of meaning and emphasizes how the act of informing leads to a change in a discipline's main assumptions and beliefs and to a new complex-system approach.

CONCLUSION

The transdisciplinary state of modern science is characterized by the fact that each discipline is simultaneously viewed as a sovereign and open system, borrowing from the experience of related disciplines and preserving a discipline's own identity. Transdisciplinarity is therefore a perspective that contrasts with complementarity, which is based on dialogue - understood here as a philosophical category -, on openness to the opposite, in opposition to a monological dimension that prefers the discourse of the single scientific perspective and which often originates theories divergent among themselves. The new hermeneutic model evolves according to a spiral pattern, so each new traced circle requires the creation of new conceptions and new scientific paradigms that allow a correction of the previous conception.

A transdisciplinary approach is not only useful to tackle and solve already existing crucial problems, but rather allows new problems to emerge, as some issues are not even identifiable due to the absence of an adequate knowledge structure. On this basis, transdisciplinarity helps to face the complexity of reality, through the generation of new metaphors to increase knowledge. It therefore widens the perspectives of investigation because, in order to improve understanding, it uses notions that do not belong to a single discipline.

Transdisciplinarity is the middle area in which the nature of the relationships between multiple domains of knowledge can be explored and unveiled. This implies a "trans-paradigmatic" approach (Montuori, 2012) which determines both the awareness of how a particular problem can be addressed in many different ways and the consequent understanding of the hypotheses underlying these perspectives. This means the identification of all the possible disciplines that relate to a specific issue from different theoretical perspectives. A complex way of thinking integrates and considers all the contexts, the interconnections of each sector as part of the research process. Using a way of thinking that separates and removes the object from its context would lead to the failure of research. According to this view, transdisciplinarity is not a method of research or simply a dialogue, a modality that uses a certain number of different disciplines. On the contrary, it is a completely different way of thinking about knowledge and offers the opportunity to investigate the fundamental assumptions about knowledge, the generation of knowledge and research. Transdisciplinarity does not require exhaustive knowledge of all disciplines, but rather its focus lies in understanding how knowledge is created. This theoretical perspective implies a cognitive shift towards the humanization of the human sciences, constituted by collective thinking, team research and interdisciplinary reasoning (Laursen, 2018; Lotrecchiano & Misra, 2018).

After all, the question that must be answered when discussing transdisciplinarity concerns both the space and the *way* in which the transdisciplinarity can develop, namely:

1. synthesising not only disciplinary but also stakeholder knowledge—in other words, pulling together what is known about the problem from both academic research and practical experience

2. understanding and managing diverse unknowns or, to put it another way, appreciating that everything about a complex problem cannot be known and that remaining unknowns must be taken into account in decision making and action

3. providing integrated research support for policy and practice change—that is, supplying policy makers and practitioners with a better understanding of the problem (both what is known and what is not known) in a way that supports them in making decisions and taking action (Bammer, 2013).

Thus, it appears clear how transdisciplinary, as an approach that rejects a defined hierarchy between disciplines, can restore both an important space to human sciences - often the subject of a diminished focus - and a "humanistic" dimension to science, avoiding at the same time the danger of making them subservient to purely quantitative models. This could involve a reassessment of the status of human sciences in the contemporary world, which would thus become one of the vectors of the multiple transgression of modern science beyond the space of its own traditional self-identification. Actually transdisciplinarity constitutes a response to a precise need of contemporary science, since it represents one of the directions of transgression, in the sense of trespassing borders, beyond its traditional space of definition: Scientific knowledge, as a consequence of its own internal development, has reached a stage where it ought to reestablish an active dialogue with other forms of knowledge (CIRETS, 1987).

However, this goal can only be achieved if the danger prefigured by Althusser is avoided, namely if the dialogue between disciplines does not remain a mere ideological slogan, a necessary but empty justification. "The need to transcend these limits seems almost too apparent to demand justification. Reality is not divided up along disciplinary lines; if we are to understand the world that we live in, we need to find ways to investigate and portray the world as it actually is, not as it is constructed from different, necessarily incomplete, and sometimes competing or even contradictory disciplinary perspectives" (Sarewitz, 2010, p. 65). The challenge of transdisciplinarity, which is intended as an attempt to compenetrate knowledge, is in fact to be multi-referential, to be constantly corrected. Only in this way can transdisciplinarity really be a valid and productive research method. In this sense, Foucault's contribution is once more predictive, when he outlined the possibility of creating a philosophy of boundaries, a structured knowledge capable of moving between the hidden interstices of a culture.

REFERENCES

Althusser, L. (1990). *Philosophy and the spontaneous philosophy of the scientists & other essays*. London, New York: Verso.

Bammer, G. (2013). The challenge and a new approach. In G. Bammer (Ed.), *Disciplining interdisciplinarity: Integration and implementation sciences for researching complex real-world problems* (pp. 3-6), Canberra: Australian National University.

Canguilhem, G. (1998). *Il normale e il patologico* [The normal and the pathological]. Torino: Einaudi.

Catucci, S. (2010). *Introduzione a Foucault* [Introduction to Foucault]. Roma-Bari: Laterza.

CIRETS. (1987). *Ethical guidelines*. Retrieved from http://ciret-transdisciplinarity.org/moral_project.php

Cohen, E. (1999). From ugly duckling to swan: Reconceptualizing information system as a field of the discipline informing science. *The Journal of Computer and Information Technology*, *7*(3), 213-219.

Davies, S. R. & Horst, M. (2016). *Science communication. Culture, identity and citizenship*. London: Palgrave Macmillan. https://doi.org/10.1057/978-1-137-50366-4

Foucault, M. (1996). *Archivio Foucault. Interventi, colloqui, interviste* [Foucault's archive. Talks, discussions, interviews]. 1. Follia, Scrittura, Discorso. Milano: Feltrinelli.

Foucault, M. (2002). *The Order of Things. An Archaeology of Human Sciences*. London; New York: Routledge.

Gill, T. G. (2011). When what is useful is not necessarily true: The underappreciated conceptual scheme. *Informing Science: The International Journal of an Emerging Transdiscipline*, *14*, 1-32. https://doi.org/10.28945/1348

Judge, A. (1994). Transdisciplinarity-3 as the emergence of patterned experience. *Proceedings of the First World Congress of Transdisciplinarity, Arrabida, Portugal.* . Retrieved from https://www.laetusinpraesens.org/docs/tranpat1.php

Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities*. Charlottesville, VA: University of Virginia Press.

Kolesnikova, I. A. (2014). Transdisciplinary strategy of research in lifelong learning. *Nepreryvnoe obrazovanie: XXI vek*, *4*(8). Retrieved from http://lll21.petrsu.ru/journal/article.php?id=2642

Kuhn, T. S. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.

Latour, B. (2017). On actor-network theory. A few clarifications, plus more than a few complications. *Philosophical Literary Journal Logos*, *27*, 173-197. https://doi.org/10.22394/0869-5377-2017-1-173-197

Laursen, B. (2018). What is collaborative, interdisciplinary reasoning? The heart of interdisciplinary team science. *Informing Science: The International Journal of an Emerging Transdiscipline, 21*, 75-106. https://doi.org/10.28945/4010

Lotrecchiano, G., & Misra, S. (2018). Transdisciplinary knowledge producing teams: Toward a complex systems perspective. *Informing Science: The International Journal of an Emerging Transdiscipline, 21*, 51-74. https://doi.org/10.28945/4086

Mende, J. (2005). The poverty of empiricism. *Informing Science: The International Journal of an Emerging Transdiscipline*, *8*, 189-210. https://doi.org/10.28945/495

Moiseev, V. I. & Kijaščenko, L. I. (2009). *Filosofija transdisciplinarnosti* [The philosophy of transdisciplinarity]. Moskva: IFRAN.

Mokij, V. S. (2001). *Metodologija transdisciplinarnosti-4* [The methodology of transdisciplinarity]. Retrieved from http://www.anoitt.ru/tdbiblioteka/tdmetodol.php

Mokij, V. S. (2013). *Methodology of transdisciplinarity-4 (solution of complicated multi-factor problems of nature and society)*. Retrieved from http://www.anoitt.ru/cabdir/stati_eng/td_metodology_4.zip

Montuori, A. (2012). Five dimensions of applied transdisciplinarity, *Integral Leadership Review*. Retrieved from http://integralleadershipreview.com/7518-transdisciplinary-reflections-2/

Nicolescu, B. (1997, November). *The transdisciplinary evolution of the university condition for sustainable development*. Talk presented at the International Congress "Universities' Responsibilities to Society" International Association of Universities, Chulalongkorn University, Bangkok, Thailand. Retrieved from http://ciret-transdisciplinarity.org/bulletin/b12c8.php#note

Nicolescu, B. (2006). Transdisciplinarity – Past, present and future. In B. Haverkort & C. Reijintes (Eds), *Moving worldviews – Reshaping sciences, policies and practices for endogenous sustainable development* (pp. 142-166). Holland: COMPAS Editions.

Nicolescu, B. (2010, December). Methodology of transdisciplinarity. Levels of reality, logic of the included middle and complexity. *Transdisciplinary Journal of Engineering & Science*, *1*, 19-38.

O'Rourke, M. (2013). Philosophy as a theoretical foundation for I2S. In G. Bammer (Ed.), *Disciplining interdisciplinarity: Integration and implementation sciences for researching complex real-world problems* (pp. 407-415). Canberra: Australian National University.

Piaget, J. (1974). L'epistémologie des relations interdisciplinaires [The epistemology of transdisciplinary relations]. *Internationales Jahrbuch für Interdisziplinäre Forschung*, *1*, 154-172.

Redaelli, E. (2011). *L'incanto del dispositivo. Foucault dalla microfisica alla semiotica del potere* [The charm of the device: Foucault from microphysics to the semiotics of power]. Pisa: ETS.

Sarewitz, D. (2010). Against holism. In R. Frodeman & J. T. Klein (Eds), *The Oxford handbook of interdisciplinarity* (pp. 65-78). New York: Oxford University Press.

UNESCO Division of Philosophy and Ethics. (1998). *Transdiciplinarity: Stimulating synergies, integrating knowledge.* Retrieved from http://unesdoc.unesco.org/images/0011/001146/114694eo.pdf

BIOGRAPHIES

Giorgia Rimondi is an adjunct Faculty member at the University of Parma. Her research focuses on Russian philosophy, comparative pedagogy, the relationship between literature and philosophy. Key themes in her research include Russian philosophy of the 1920s, translation problems in philosophical terminology and critical epistemology. She holds a PhD in Slavic Studies (Russian philosophy) and a MA degree in Philosophy (University of Milan). She is currently a research fellow at the Russian Institute for Advanced Studies (MSPU) based in Moscow.

Marco Veronese holds a degree in Philosophical Sciences (University of Milan). He is conducting independent research in the archives of the former psychiatric hospital in Colorno (Italy). His scientific interests include Foucault's interpretation of madness and mental illness, the relationship between philosophy and psychology and the epistemology of the human sciences.