THE CIRCULATION OF KNOWLEDGE AS AN INTERDISCIPLINARY PROCESS:
Travelling Concepts, Analogies and Metaphors

by

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Abstract: In our society in which communication is so wide-ranging and rapid we are witnessing a significant increase in the pace at which knowledge is produced and disseminated. Bodies of knowledge intersect as they cross borders between disciplines in the human and social sciences, and in the natural sciences, life sciences, and technological sciences. How do concepts, theories, and methods circulate, and how are they exchanged, borrowed, transferred, and transformed, when they cross from one discipline to another? In what ways does this interdisciplinary practice constitute a creative gain in the production of new knowledge, enabling us to understand problems that are impossible to solve from the perspective of a single discipline? The present article addresses these issues by defending the idea that, like other *modi operandi*, interdisciplinarity is promoted by the circulation of concepts, theories, and methods, and by analogy or transfer across and beyond disciplinary borders that appear closed. The article is also an appeal for arbitrary borders between communities of subject specialists to be transcended, for creative but rigorous thinking in all subject areas, and for researchers to adopt an interdisciplinary outlook.

Keywords: interdisciplinary, disciplines, circulating knowledge, nomadic concepts, integration

Introduction

Here one may admire man as a mighty genius of construction, who succeeds in piling an infinitely complicated dome of concepts upon an unstable foundation, and, as it were, on running water. Of course, in or-

der to be supported by such a foundation, his construction must be like one constructed of spiders' webs: delicate enough to be carried along by the waves, strong enough not to be blown apart by every wind.[1]

Nietzsche, *On Truth and Falsity in an Extra-Moral Sense* (1873)

Interdisciplinarity has now become an area of teaching and research in its own right, as distinct from being a mere adjunct to the traditional disciplines of academia. [2] We have only to think of the many centers, faculties, laboratories, research groups, and scientific networks in numerous subject areas that are labeled "interdisciplinary," not to mention the departments or structures specifically devoted to "Interdisciplinary Studies." It is not the intention here to list or to analyze these institutional foundations of interdisciplinarity in detail, but rather to stress the positive role they now play in showcasing this particular field. Numerous teaching and research areas have already been built or are in the process of being built on an interdisciplinary basis. Cases in point are the environmental sciences, the life sciences, and the cognitive sciences, as well as cultural studies, visual studies, gender studies, food studies, tourism studies, and childhood/children's rights studies, to name those with which I am most familiar. These are all areas of academic study involving multiple disciplinary configurations that have been activated in order to analyze and understand complex problems.

The growing interest in interdisciplinarity corresponds to a new awareness of the complexity of the context and the objects of research, and also of the social issues that call for increased synergy between existing competencies in the traditional disciplines. This concern is also reflected in the ambitions and expectations of many researchers who are beginning to look more carefully at the possibilities and limits of their own disciplines and at ways of setting up new links with other disciplinary fields. It is interesting to observe, in this respect, that while the paths followed by researchers conform to an academic pattern that is discipline-based, they also tend to hybridize, evolving and developing through contact with other disciplinary fields. These pathways at the interface of disciplines are clearly visible in the new academic fields being constructed (like those mentioned above) that have been developed through researchers making new connections between traditional disciplines as they move between and among them. The implementation of this approach meets a need felt by today's teachers and researchers, who are called on at an everyday level to solve highly complex issues, of both a practical and a theoretical nature, that resist analysis from the perspective of a single discipline. The need is equally discernible in society at large and among individuals who expect work in academe to provide practical answers to current problems that reach into so many areas of activity. It is apparent that this need has even become a necessity, as much for universities and research institutions as for the steering committees that shape higher education and research.

It is also encouraging to note that in higher education today, interdisciplinary and transdisciplinary teaching and research are thriving, at both the theoretical and the practical levels, not only in Switzerland but also in Europe generally and internationally (see, in particular, Lenoir & Klein, 2010). This field of study has developed in such a way as to cover those aspects – theoretical and epistemological, as well as institutional, practical, methodological and conceptual – that make up the problematic of interdisciplinarity and transdisciplinarity. The contents of publications reviewing the subject confirm the pivotal importance of these complementary dimensions: We might mention, in particular, the book by Newell et al., *Interdisciplinarity: Essays from the Literature* (1998), the *Oxford Handbook of Interdisciplinarity* (Frodeman, Klein & Mitcham, 2010), the *Handbook of Transdisciplinary Research* (Hadorn et al., 2008), and also the bilingual work edited by Darbellay and Paulsen, focusing on the Swiss university context, *Le Défi de l'Inter- et Transdisciplinarité. Concepts, Méthodes et Pratiques Innovantes dans l'Enseignement et la Recherche/Herausforderung Inter- und Transdisziplinarität. Konzepte, Methoden und Innovative Umsetzung in Lehre und Forschung [The Challenge of Interdisciplinarity and Transdisciplinarity. Concepts, Methods, and Innovative Practices in Teaching and Research]* (2008).[3] As we can see, the field of study relating to interdisciplinarity and transdisciplinarity is a vast one.

Within the limits of the present article, I am specifically interested in what could be regarded as an interdisciplinary *modus operandi*, putting ideas,

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[1] All translations in the text are mine unless otherwise noted.
[2] For the definitions of pluridisciplinarity, interdisciplinarity, and transdisciplinarity, as well as the practical and theoretical issues they raise, see my collaborative works which present a synthesis of the literature: Perrig-Chiello & Darbellay (2002); Darbellay (2005); Darbellay & Paulsen (2008); Darbellay et al. (2008); Origgi & Darbellay (2010); Darbellay & Paulsen (2011); Darbellay (2011).

[3] The publication of handbooks and general works remains, in any case, an appropriate indicator of the establishment of a legitimate field of study and its approval by a particular academic community on the basis of theoretical frameworks, methodological tools, and case studies leading to examples of best practice.

concepts, theories, or methods into circulation among and beyond two or more disciplines (Klein, 1990).[4] The article takes as its starting point the notion that circulating knowledge is a necessary if not sufficient means to the end of producing interdisciplinary knowledge, a powerful driving force in interdisciplinary work. To pursue the Nietzschean metaphor used earlier as an epigraph, such work does indeed have the appearance of a "construct[ion] of [pluridisciplinary] spiders' webs," allowing exchanges between different bodies of knowledge and their integration in an interdisciplinary outcome "strong enough not to be blown apart by every wind." I shall also highlight the role played by nomadic concepts, theories, and methods, as well as by analogies and metaphors, when there is circulation among disciplines in the human and social sciences, and in the natural sciences, life sciences, and technological sciences. I will stress the fact that knowledge does not congeal and remain fixed, historically sealed off from other times and places, but is transmitted from generation to generation at a more or less rapid pace that sometimes accelerates, sometimes decelerates: To echo Nietzsche again, it circulates and is transformed on the "unstable foundation" of thought.

Circulating Knowledge: Acceleration/Deceleration

In our society, knowledge is being produced and disseminated at an ever-increasing pace, driven by the use of new information and communication technologies (ICT) and the globalization of the scientific field.[5] Communication tools (internet, e-mail, blogs, Wikipedia, etc.) promote quicker and more dynamic collaborative exchanges, while the digitization of scientific

production (digital libraries) and online journal publication give more fluid access[6] to knowledge resources and products. This "digital turn" continues and enriches the story of "intellectual technologies" (Lévy, 1990; Robert, 2010), at the same time signaling a change of pace and speed in the circulation of knowledge in the technosphere of Web 2.0.[7] Although I am reserving a detailed exploration of the impact of this "turning point" on the production, circulation, and dissemination of knowledge for a forthcoming publication, it is important to spell out now its contextual value, which partly explains the current interest in the subject of the circulation of knowledge. The speed with which knowledge is circulated certainly maintains a brisk momentum of scientific production, a kind of "Fast Science," to borrow an expression coined by Eugene Garfield (1990), functioning as part of a binary pair with Slow Science.[8] Fast Science is sometimes described as the acceleration of instant productivity within a short timescale, specialization, competitiveness, and competition between researchers, all this culminating in the quest for "excellence"[9] and the primacy of the quantitative, whereas

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[4] In response to a suggestion by the publishers, this article is based largely on the new collaborative work I have edited on *La Circulation des Savoirs* [*The Circulation of Knowledge*] (Darbellay, 2012). I use the introductory material and refer systematically to the various chapters in the book.

[5] Without going into detail about the quantification of scientific production globally and by country, it can safely be said that while scientific production as a whole is on the increase, variations, ranging from a sharp increase to an actual decrease, depending on the nation, are being recorded on the "world market of scientific competencies" (Losego & Arvanitis, 2008). Beyond the increase in the overall volume of scientific production revealed by scientometric analyses, inequalities remain nonetheless in the International Division of Scientific Labour (cf. Shinn, Vellard & Waast, 2010). Scientometric data on scientific production worldwide are distinctly scarce, but the data of the Observatoire des Sciences et des Techniques, for example, can be consulted (www. obs-ost.fr). On the state of the social sciences worldwide, see, for example, the World Social Science Report: Knowledge Divides (UNESCO, 2010, www.unesco.org).

[6] Or "liquid," to quote the European project: *Liquid Publications: Scientific Publications Meet the Web. Changing the Way Scientific Knowledge is Produced, Disseminated, Evaluated, and Consumed* (2008-2011). 7th EU Framework Programme for Research and Technological Development (FP7): *Access to borderless knowledge*. Cf. http://project.liquidpub.org

[7] Beyond the arbitrary divisions between scientific cultures (the "hard" sciences vs. the human and social sciences), the field of the humanities is becoming increasingly aware of the changes driven by the digital age: The growth of the transdisciplinary movement *Digital Humanities*, which is in the process of gaining academic respectability, is evidence of this. The movement's strength is reflected in its manifesto-based strategies, which are putting on the agenda the renewal of the field under the impact of the new communication technologies. Examples that might be quoted are the *Manifesto for the Digital Humanities* (2010, http://digitalhumanities.org), the Alliance of Digital Humanities Organizations (2002) and THATCamp (The Humanities and Technology Camp, http://thatcamp.org). As to the implications of digital technology for the analysis of texts and discursive practices, see Darbellay (2005, Chap. 4.): "Du Texte aux Nouvelles Technologies de la Communication. Nouveaux Objets, Nouvelles Recherches."

[8] It is an amusing irony that Garfield, an advocate of *Slow Science*, is recognized as one of the pioneers of bibliometrics and the analysis of the impact factor in scientific production. He founded the Institute for Scientific Information (ISI) in 1960.

[9] Conversely, the *Slow Science* movement advocates a form of "dis-excellence." See the article by O.P. Gosselain (2011): "Slow Science – La désexcellence," *UZANCE*, *1*, pp. 128-140. See also the appeal launched by Joël Candau: "Donner du Temps au Temps de la Science" (2011, http://slowscience.fr), and *The Slow Science Manifesto* of the *Slow Science Academy* (2010, http://slow-science.org).

the opposite movement, Slow Science (metaphorically inspired by the Slow Food, Slow City and Slow Travel movements), calls for deceleration, to give time for deepening our knowledge and for creativity over the medium to long term required for more fundamental research.

While the use of ICT leads to an increased rate of scientific production, we should not forget that the practice of circulating knowledge also allowed fruitful exchanges between researchers in the past, although, admittedly, such practice used "slower" communication channels (written and oral) to transmit this knowledge. But we do need to recognize that knowledge did not necessarily wait for the arrival of the new technologies to circulate among and beyond scientific communities.[10] It is this kind of historical perspective that Jacques Baillé (2012) offers us, as a corrective to a certain type of ideology that accepts communication unquestioningly, but without lapsing into a technophobia that achieves nothing. His contribution digs deep into history, focusing on antiquity and the Middle Ages: "To the dictates of the modern world of scholarship, education, and commerce, which stipulate that the circulation of knowledge saturated with concepts brooks no discussion, we issue a reminder of the long journey that leads from the word to the birth of the concept" (Baillé, 2012, p. 59). Clearly, the author is not one of those "spectators of cognitive capitalism, champions of educational technology, polymaths of training plus team-leadership plus coaching and the majority of the detractors of so-called 'traditional' teaching methods, who tirelessly complain that they are ill-adapted to the complexity of knowledge and techniques, which are now so diverse and mobile" (Baillé, 2012, p. 59).

To take an interest in the problem of the circulation of knowledge is, in the first place, to be confronted with a polymorphous concept. In fact, the concept of circulation (from the Latin *circulatio*) itself circulates through different linguistic expressions, in which it denotes a variety of practices and actions understood from the perspective of their circular movement, transmission, or propagation. From the circulation of traffic to the circulation of the blood or of the sap in plants, the language slides towards the circulation of air, goods, services, and capital, and – of direct concern to the present study – the circulation of ideas, knowledge, theories, and methods among disciplines. Circulation, indeed putting into circulation, are both to

be understood literally as the action of circulating (or of causing to circulate), of coming and going, of being displaced, disseminated and transferred with more or less freedom or constraint in a movement of ebb and flow, exchanges, and dynamic circularity through different communication channels and at different rhythms, more or less slow or fast. This sketch of the concept of circulation is reflected in a stimulating way in the formulation offered by the artist Nicolas Schöffer (1912-1992):

> Circulation is the displacement – at variable speeds controlled either naturally or artificially – of elements of different configurations and densities, of dimensions varying between the infinitely small and the infinitely large, taking different paths, movable or fixed, which, in different kinds of spaces – belonging to the human, the spatial, the biological, or the physical world – and in time, creates a continuum in temporary or permanent movement, a movement that is cyclical, preprogrammed or random, and gives to different life forms at every level – from subterranean to spatial, material to immaterial, visible to invisible and formal to conceptual – their essential characteristics.[11]

How do concepts, theories, and methods circulate, get exchanged, borrowed, transferred, and transformed, when they cross over from one discipline to another? In what way does this interdisciplinary practice constitute a creative gain in the production of new knowledge, enabling the analysis and explanation of problems that are impossible to solve from the perspective of a single discipline? We do not claim to give an exhaustive and definitive reply to these complex questions here, but we at least try to open up some avenues for exploration, to help us understand what factors are brought into play in certain practices of knowledge circulation in various academic fields (philosophy, the human and social sciences, physiology, information and communication sciences, etc.). For a fuller, subject-specific account, the reader is invited to circulate within and among the contributions sought for our book *La circulation des savoirs* (2012), in which an epistemologist, philosopher, historian of science and technology, psychologist, and linguist, and researchers in the communication sciences, the science of education, and cultural studies explore the practical and theoretical issues involved in the circulation of knowledge among and beyond disciplines.

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[10] See, in particular, the studies brought together in Sec. 5 ("Itinérances du Savoir") of the book edited by C. Jacob (2007): *Lieux de Savoir: Espaces et Communautés*, pp 779-915. See also the website *Lieux de Savoir. Histoire Comparée et Anthropologique des Pratiques Savantes* (http://lieuxdesavoir.hypotheses.org).

[11] Online at the Observatoire Leonardo pour les Arts et les Techno-Sciences, devoted to the work of Nicolas Schöffer: http://www.olats.org/schoffer/defcirc.htm. Retrieved on December 24, .2011.

Interdisciplinarity: Circulating Knowledge

The circulation of ideas, concepts, theories, and methods among disciplines is seen to be one of the *modi operandi* of interdisciplinary practices. It draws on disciplinary competencies but, at the same time, transcends the simple, pluri-disciplinary juxtaposition of viewpoints that may be multiple, but that remain compartmentalized for all that. From this perspective, the researcher himself is stricken with nomadism; he is "more than anyone else, a nomad, a king without a kingdom" (Faure, 1992, p. 116) because he allows himself the freedom of crossing disciplinary borders without restricting himself to his own, strictly defined area of expertise. The nomad, unlike the sedentary researcher, who inhabits the space of his discipline, favors displacement and the mobility of new pathways across disciplines: "The sedentary researcher structures inhabited spaces that are centered on the home, the point of origin; the nomad constructs an unstable, multi-centered network of routes, punctuated with stopping points" (Lussault, 2007, p. 347). The nomad's thinking is patterned in networks, networks that are strongly reticular, like "rhizomes," to borrow the botanical metaphor of Deleuze and Guattari (1980): "The rhizome is nomadic: It travels in all directions" (De Coster, 1978, p. 65). Work on circulating concepts and their configuration as networks that transcend disciplinary divisions certainly offers a style of reasoning that is not purely linear, causal, and unidirectional, stringing together disciplines in a relation of juxtaposition, but one that argues for a decentering, an opening up of disciplines to dialogue, to reveal the potential for interrelating disciplines.

It seems that the nomadic, interdisciplinary researcher develops an original competency that could be described as "poly-topian,"[12] in the sense that he becomes capable as an individual, or collectively through his collaboration with other researchers, of inhabiting several disciplinary spaces, across and beyond which he opens up pathways that are diversified, changing, and adaptable in accordance with the complexity of the objects of study and the problematic situations to be dealt with. This interdisciplinarity, which we shall call "poly-topian," in that it takes in several (*poly-*) disciplinary spaces, can also be re-composed in a different space of "heterotopian" integration

[12] Cf. Stock (2006). The study of spatial mobility and poly-topian styles of inhabiting has discovered, in the analysis of tourist practices as a way of inhabiting the world and of confronting the otherness of other places, a field of exploration that is particularly productive from the perspective of interdisciplinary thinking. See, in particular, Darbellay & Stock (2012).

(from the Greek *topos*/"place" and *hetero*/"other"), to use Foucault's term (1967/1984). Simultaneously inside and outside disciplines, this middle space is capable of containing several disciplinary spaces that give every appearance of being incompatible with one another. The interdisciplinary researcher thus takes up the position of an "influential outsider,"[13] insofar as he is a party to several different and seemingly contradictory disciplinary systems of actors, networks, and teaching and research activities, with multiple affiliations that provide him with the opportunity to adopt a position as an intermediary or interpreter-cum-broker among distinct disciplinary logics. In this way, he is able to promote a dialogue between specializations and enable integration, in order to understand and resolve situations of uncertainty. It is this ability to move beyond the "sterile juxtaposition of areas of knowledge" that is investigated also by Jacques Michel (2012), who addresses the tension between their specialized natures and the necessary interconnections among them. He sees interdisciplinarity and/or pluridisciplinarity as research pathways that lead to those places where bodies of disciplinary knowledge do not so much intersect as acquire substance and structure in and through the circulation of ideas, concepts, and models: "When it is not diverted by trivial objectives, the practice of interdisciplinarity or pluridisciplinarity envisages these forms not as hesitant approximations but more as quasi-experimental approaches to phenomena. In this sense, it provides a means of giving an account not only of the uses made of metaphors but also of the status of abstract models and of that hypothetical and lucidly normative procedure we call rational fiction" (Michel, 2012, p. 85).

The circulation of knowledge, involving borrowings and other transfers among disciplines, also determines the establishment of new fields of interdisciplinary teaching and research. The example of pluridirectional circulation and variable transfers among disciplines in the creation of the information and communication sciences is particularly revealing. Bernard Miège (2012) elucidates its various aspects, showing how an interdisciplinary grouping, driven by a complex, dual process involving socio-cognitive and socio-institutional factors, is brought into existence as a "discipline." He also shows that the circulation of knowledge not only takes place within the academic sphere, but also activates contributions from professionals in other areas, helping to transform these areas through vigilance and a critical eye. Along the same lines, Bernard Ancori (2012) shows how the production and

[13] An idea studied in the sociology of organizations, cf., in particular, Crozier & Friedberg (1977) and Friedberg (1993).

circulation of scientific knowledge and of lay knowledge are reconciled in our knowledge-based and communication-based societies. This scenario of a new state of affairs between academia and the social and political worlds calls for a re-assessment of the complex links between science, technology, and society.

This circulation among disciplines must not be thought of as undisclosed and undisclosable, illicit practices involving illegal, undeclared borrowings, nor as tactics involving methodological, theoretical, conceptual or epistemological vampirism, one discipline drawing its life force from the ingestion of other disciplines. Such improper practice would lead to the creation of an interdisciplinarity that was more dead than alive, that enhanced itself at the expense of disciplines and that, taken to extremes, would also end in the death of disciplinary communities, drained of their content. It is obviously not this kind of deadly dynamic that determines the direction of this work, but the very opposite, a more dialogical vision of the translational links and the links that reformulate and transform, woven among and beyond disciplines. The aim of interdisciplinarity is not to eradicate disciplines from the academic realm, but, on the contrary, to capitalize on disciplinary competencies in order to set up a dialogue among them and promote removal of barriers and integration of the insights each provides. We really need to be thinking in terms of the productive paradox of protecting the in-depth disciplinary research that is necessary for advancing cutting-edge knowledge in comparatively well-defined areas of competencies, while at the same time avoiding a simple reproduction of disciplinary and disciplined systems such as leads to a blind overspecialization, with each feeding auto-vampirically on its own blood, perhaps to the point of self-destruction. There is a need, therefore, to promote mechanisms for interaction, even hybridization, among disciplines, so that problems that are irreducible to a mono-disciplinary point of view can be studied and our knowledge advanced.

Travelling Concepts, Analogies, Metaphors

The nomadism of concepts is a relatively common phenomenon in the circulation among bodies of disciplinary knowledge. "Nomadic concepts" are certainly effective heuristic tools that allow transdisciplinary bridges to be built between one "science and another," to borrow an expression from the collaborative work edited by Stengers (1987). Specialists in different disciplines use nomadic concepts to study a whole range of key subjects (concepts like correlation, laws and causality, calculation, problem, selection,

competition, organism, complexity, norms, transfer) that circulate among genetics, economics, logic, biology, anthropology, philosophy, history, and psychoanalysis. Revisiting this approach, Béatrice Fraenkel (2012) retraces the peregrinations and adoptions for theoretical purposes of the nomadic concept *actant* as well as its linguistic and scientific career among linguistics, semiotics, and the sociology of science and technology. She also shows the dialogical role played by the concept in the interdisciplinary experience: "The career of the concept '*actant*' appears at the end of this inquiry as a remarkable case of interdisciplinary propagation. The '*actant*,' a nomadic concept, is endowed with a true power of extension" (Fraenkel, 2012, p. 124).

There can be no real doubt that borrowing and transferring concepts, theories, and methods between disciplines can generate new and interdisciplinary knowledge.[14] These are true cases of "healthy contaminations," as Brigitte Dumas (1999) has shown in her study of cross-fertilizations among Freudian psychoanalysis, physiology, and thermodynamics, and those among molecular biology, anatomy, and physiology.[15] It is interesting to note that the metaphorical language of displacement, of "conceptual migrations" (Fedi, 2002) and propagation among and beyond the space-times of disciplines, has been taken up by Mieke Bal in her book *Travelling Concepts in the Humanities: A Rough Guide* (2002). She tries to bridge the gaps among disciplines in the humanities by studying the "travelling concepts" that actively circulate among them via different intellectual pathways and provide forums for interdisciplinary mediation. In her 2012 publication, Bal takes the idea further by proposing that interdisciplinarity should be based on concepts found at the interfaces of disciplines in the human sciences.

Strategies of borrowing, transfer, or nomadism often operate against a background of analogies and metaphors involving ideas, concepts, or theories belonging to what had previously seemed unconnected disciplinary fields. The use of analogy in the sciences is rightly contested by scientific orthodoxy when it amounts to nothing more than novel comparisons or mere wordplay, served up as a substitute for proof (De Coster, 1978); on the other hand, it proves heuristically fruitful when it uncovers similarities

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[14] The technique of transferring scientific concepts from "one science to another," when properly thought through, is in no sense one of those "intellectual impostures," as Sokal and Bricmont (1997), not without a certain amount of skill, would have us believe through their famous book, which would very quickly give rise to the equally famous *Sokal Affair*.

[15] See also the examples of the nomadic concept *entropy* in information theory, biology, sociology, etc., (Collot, 1992) or of *bifurcation* (Bruter, 1992).

in relationships and resemblances, without positing an identity or reductive equivalence between the terms, areas, or disciplines being compared.[16] From this perspective, Jean-Gaël Barbara (2012) shows how analogical and metaphorical processes function as interdisciplinary practices in the construction of scientific objects generally. He illustrates his argument with two case studies: One concerns the metaphorical language of the English doctor Thomas Willis (1621-1675), explaining the characteristics of animal spirits by analogy with the properties of gunpowder, the other the elaboration of the physical model of the artificial nerve of Ralph S. Lillie (1907-1942), suggesting analogies between an electrochemical reaction and the propagation of nervous influx. These case studies demonstrate how certain concepts can be borrowed from a reference area and put into circulation to enrich a target area; this can be done in accordance with rational and productive procedures of scientific creation and at the interface of seemingly unconnected disciplinary fields, the ultimate goal being the production of new knowledge. It emerges that the processes of analogy and metaphor may allow the transfer of knowledge among disciplines that are more or less widely separated. Taking up the story, Emmanuel Sander (2012) explains that what is involved is a process of categorization that is inherent to interdisciplinary reasoning. This process provides a cognitive tool that enables us to understand a new, unknown situation in terms of a known one. By studying human reasoning, we can go beyond the image of the scientist as a "disembodied, purely logical reasoner who manipulates abstract, asemantic symbols" and put back "at the heart of thought – including the most scientific and most abstract thought – the dimension of experience, the original source of the construction of categories, themselves the subsequent sources of analogies and metaphors" (Sander, 2012, p. 165). A human being is a reasonable and rational being who, when he thinks, is nonetheless an "inveterate abstractor, striving to get beyond the literality of situations in order to attain the reasoning that will take him across disciplinary borders" (Sander, 2012, p. 165).

With regard to borrowing among the sciences, Delessert and Piguet gave the collaborative work they jointly edited the rather neat title *Les Cigales et les Fourmis* [The Cicadas and the Ants] (1996). This literary allusion to Jean de La Fontaine's fable conjures up the preservation and standardization strategies adopted by the teacher-researcher as "ant," who will tend to isolate himself, replicating the identity of his subject domain. The ant is no

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[16] On the role and heuristic value of the transfer of models, analogies and metaphors in the sciences, cf. in particular Perelman (1969) and Molino (1979). See also Hallyn (2000), Fox Keller (2002), and McCormack (2005).

lender, either of grain or ideas, concepts, or methods ("This is the least of her faults"), and is even less inclined to make the odd borrowing or build a few analogical or metaphorical bridges to and from other areas of knowledge. The teacher-researcher as "cicada," on the other hand, is portrayed as more willing to borrow, to violate disciplinary borders, casting caution to the wind, which is, of course, the cause of his undoing in La Fontaine's fable.[17] We should probably avoid being too categorical in contrasting these two seemingly antagonistic figures: We clearly need to strike a balance between the pragmatism, rigidity, predictable determinism, and industry of the ant, on the one hand, and the creative dilettantism, unpredictability, and facility of the cicada, on the other.[18] This should be possible so long as analogical transfers and metaphors are traded among disciplines with rigor and without excess (Bouveresse, 1999). Also, as Jean-Jacques Wunenburger (2012) explains in connection with chaos theory, transfer operations open up a constructive dialogue between science and the imagination. The theory has not only blazed a new trail in the natural sciences; it has also given rise to transfer in literary narration, where we clearly discern that the theory of creativity is in dialogical tension between the causal model of standard science and more random, unpredictable models such as that of organized chaos, with its ambiguities and limitations.

Conclusion

The opportunities for reflection identified in this article show that the circulation of knowledge among disciplines does not involve a simple, linear transfer of a concept, theory, or method from one disciplinary field to another and vice versa. What emerges is the very opposite, namely a complex, dynamic process of multidirectional exchanges, of knowledge production moving across and beyond disciplinary borders (Klein, 1996), a process that

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[17] To use the standard formula: "This is a work of fiction. Any resemblance to persons alive or dead or to events past or present is purely coincidental."

[18] If we were to continue with this pedagogical exercise on interdisciplinarity using the Fables, we could, in the same vein, base our next lesson on *The Hare and the Tortoise* (Book VI/Fable X), to illustrate the dialectic between Fast and Slow Science: "Rushing is useless; one has to leave on time. To such Truth witness is given by the Tortoise and the Hare. […]. He let the Tortoise leave the starting place. Straining, she commenced the race: Going slow was how she made haste. […]. He shot off like a bolt; but all of the leaps he took were in vain: the Tortoise was first perforce. 'Well, now!' she cried out to him. 'Was I wrong? What good is all your speed to you? The winner is me! And how would you do if you also carried a house along?'"

belongs to the realm of heuristic thought (from the Greek *heuriskein*), allowing invention and discovery (Ricœur, 1975). Our brief excursion into the area of knowledge circulation reveals that knowledge is, in fact, profoundly dialogical: All disciplinary discourse that looks homogenous is, in fact, shot through with and enriched by other discourses, ideas or concepts from other disciplines. Putting knowledge into circulation defies the logic of a simple pluridisciplinary juxtaposition that obeys the principle of encyclopedic accumulation (in a vicious circle), and instead promotes a mutual learning experience based on knowledge interaction in (virtuous) cycles – this time, quite literally, a case of *en*("in")-*cyclo*("circle")-*pedia*("education"), in other words "joining up the unconnected viewpoints of knowledge in an active cycle" (Morin, 1977, p. 19). This way of looking at the relationships among bodies of knowledge also entails a questioning of the very nature of disciplines and their borders. In conclusion, we are invited to reflect on ourselves in the mirror of the discipline to which we each belong and on its links with neighboring disciplines and those further afield (Darbellay & Paulsen, 2011). A discipline does, admittedly, define a knowledge area sanctioned by a given academic community, socially and historically situated and governed by a paradigm that determines the presuppositions and objectives of the knowledge that is to be produced. However, it is equally true that every discipline is a construct, the result of a genesis, a birth, and a development, and that there is always a possibility that it could disappear from the academic field, break loose from faculty logic and departmental confines.

Focusing our attention on knowledge that circulates teaches us that a compartmentalized view of knowledge as inhering in specialized disciplines calls for the converse and complementary movement of an opening up to other disciplines. This decompartmentalization permanently reconfigures the discipline as such, by introducing a dialogical style of thinking into it: A discipline is identical to itself, but always has a certain otherness about it. The apparent paradox of belonging to a discipline, being disciplinary, and yet needing to open up to dialogue and become interdisciplinary can be resolved as long as we consider the discipline as a threshold in the development of knowledge, a threshold that is itself complex and shaped from within by other disciplines. Every discipline is thus pulled in two directions, by the abyss and by transformation, to borrow Morin's image (2007). To put it another way, it is caught between its potential disintegration, a victim of sclerosis and a refusal to evolve and change, and its ability to transform itself and become other while remaining itself, in Ricœur's sense of *Oneself as Another* (1990). The interdisciplinary other helps to shape the discipline:

Any discipline can make the change from caterpillar to butterfly, that is to say jettison its old structures and transform itself into something else that both transcends what it was and, at the same time, prolongs its identity. It is this journey through the disciplinary looking-glass, through the de-transformations that circulate, through the breaks and inversions, that we must experience and, in doing so, contribute to the current debate on the practices of interdisciplinary and transdisciplinary teaching and research.

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