The Interfacing Approach to Investigation Beyond Boundaries

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The paper addresses the following three issues: the urgent need for integrated studies; the concept of 'interface' as it was used in the European project 'Acume2: Interfacing Science and Humanities' to question the static idea of 'influence' on behalf of the interface as isomorphism of two fields that have developed new theoretical tools simultaneously *by responding to their respective problematics; and the methodology and results of two case studies carried on by both scientists and humanists: a study of memory and a study of bio-complexity.*

Keywords: integrated studies / networking / interface / travelling concepts / complex systems / memory / bio-complexity

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> Science is that form of poetry […] in which imagination and reason act together synergistically.
> (P. B. Medawar, *The Hope of Progress*, 1971)

There is a clear consensus, put forward by progressive as well as mainstream publications, that the current 'crisis of the humanities' is deep and far-reaching (Nussbaum). The European Research Council, its national equivalents and, say, the European Science Foundation stress the need to discuss the identity and purpose of the humanities. At the same time, however, in the humanities, the consequences of the neoliberal, profit-oriented management of the universities are even more negative than in other academic fields, which seem more productive and competitive, more compatible with entrepreneurship, research and development, and endless research assessment exercises.

Faced with the complex phenomena characterising our 'planetary' society, comparative literary scholars stress the need for eliminating the humanist's age-old fear of other disciplines; they argue that these disciplines might very well furnish new interpretative models and heuristic tools (Bassnett). Under the pressure of complex problems of migration, the accelerated processes of acculturation, the movements of global capi-

tal, the diffusion of media and information networks, disciplines such as comparative literature have been since the 1980s increasingly questioning their own identities. Many scholars realise that comparative literature needs new paradigms; regardless of the differences in their approaches, they all share the awareness that they must not only accept the challenge of complexity, but also search for theoretical and practical solutions for studying and teaching world literature (Simonsen and Stoutgaard-Nielsen [eds.]; Ascari; D'haen, Domínguez and Thomsen [eds.]; Benvenuti and Ceserani). Some keywords are essential to focus on new strategies for overcoming this identity crisis of the humanities: networking, new epistemological paradigms and new perspectives, intersections, or interfaces, between the traditional disciplines of the humanities and the new fields such as gender studies, postcolonial studies and new media studies, and the impact of technology on the humanist thinking and practice.

In this article, I will address the following issues:

1. The urgent need for *integrated studies*. The current crisis of the humanities was brought about by financial problems but also by the awareness that the complexity of contemporary world demands new approaches and methods. Integrated knowledge is necessary to understand the complexity of our current cultural environment. Science and the humanities are no longer two separate spheres of knowledge, but two complementary and integrated ambits. Science has to take into account the epistemological and ethical issues, and the humanities need to acknowledge the new scientific developments. Both science and the humanities could benefit from such practices.

2. *The notion of interface* as sketched above.

3. *The question whether the interface is a metaphor or a methodology*. I use the notion of interface to locate the contact zones between disciplines, since they represent the disciplinary spearheads. From these contact areas, in which contaminations and hybrids emerge, new cognitive paradigms arise.

4. The case studies of *memory* and of *bio-complexity* using the notion of interface.

Ad 1. The urgent need for *integrated studies*. In order to foster an integrated culture, one needs to go beyond the old controversy between the two cultures, and to deconstruct the stereotypes reproduced by both scientists and humanists. Reading C. P. Snow (see Snow), one wonders whether, after almost fifty years, these stereotypes about the differences between humanists and scientists are still present in public opinion, which sees scientists as optimistic, progressive, left wing liberals who look into the future for inspiration, and humanists as pessimistic, right wing conservatives who dwell on the past.

The Italian mathematician Piergiorgio Odifreddi claimed recently that 'the existing cultures and paradigms are but so many faces of an intellectual enterprise that transcends them all, as each of them offers merely a structurally, socially and historically limited point of view' (Odifreddi 53). The issue of an integrated culture is intimately connected to the necessity of eliminating the fences between disciplines, which are still being protected by universities as well as primary and secondary schools. And Ludovico Geymonat, the pioneer of the philosophy of science in Italy, often warned against artificial barriers, saying that borders exist to be crossed. Today, there is an awareness that a parcelled type of culture is no longer adequate to our modernity, and that excessively specialised knowledge is unable to grasp the complexity of the modern world: the crucial questions raised by technological and scientific development, from atomic energy to genetic engineering, require a kind of clarity of analysis that only integrated knowledge can offer.

Various disciplines have demanded a profound reform of teaching in schools and universities, arguing that excessive fragmentation of knowledge transmits a dangerous vision of knowledge as a series of separate, rather than communicating, fields. Here, one may turn to the philosopher Edgar Morin, but also to Paolo Dario, an engineer interested in robotics. Morin argues that our educational systems separate subjects and fragment reality, rendering an understanding of the world impossible and preventing the awareness of fundamental problems that demand a transdisciplinary approach (see Morin). And Dario (263) writes: 'Today, technology must melt with the humanities, which should in their turn proceed in the direction of innovation and open up, with curiosity and receptiveness, to the stimuli of technology. The model of engineering guided by science requires a high level of creativity and *problem-solving* capacity.'

Since the 1970s, studies on the relationship between science and literature have tried to deconstruct this binary opposition by searching for potential cognitive paradigms common to both spheres. Striving to find affinities between the two cultures, these studies have noted that both are crossed by language. Not only literature, then, but even science is a discourse involving the same kinds of rhetorical strategies, literary tropes and unstable meanings as other forms of writing. In a beautifully written essay from 1968, L. J. Jordanova, an eminent historian of science, writes: 'Our primary object of study is language–that which mediates all thought, action and experience. We focus largely on the discourses common to science and literature'. (Jordanova 17)

In this respect, the works of Carlo Levi, a chemist, poet and extraordinary novelist, as well as of Italo Calvino, a writer constantly fascinated by

science, geometric proportions, symmetries and *ars combinatoria*, are rich with assertions that science and literature, far from being two separate activities, share many characteristics. Similarly, Stefan Collini, in his recent edition of Snow's work, stresses that the notion of physics has changed since Snow's times: from the notion of a subject considered

> [a]s the hardest of 'the hard sciences', a discipline traditionally taken to exemplify how rigorously deductive analysis of a few general laws confirmed or falsified by induction from controlled experiment, provided predictive knowledge of the behaviour of the physical properties of the universe. The so-called 'new physics' of the last twenty years has modified this model in two related ways. First [of all], its actual findings about the nature of matter or the origins of the universe appear to install unpredictability, open-endedness (Collini xlvii).

The new conception of physics harmonises with our notion of the world of the humanities and literature.

In order to understand this contiguity, it is necessary to rethink some of the clichés about scientific and poetic languages, particularly the *topos* according to which the former are denotative and transparent, and the latter connotative and ambiguous. One can start falsifying such commonplaces by analysing the use of metaphors in both cultures. The study of metaphors has indeed become one of the central themes of analyses of the relationship between literature and science (Black; Cornell Way; Swinburne). Those who know how to use metaphors, or are capable of inventing them, thus showing that they possess a high level of creativity, are very much aware of the fact that metaphors are a powerful instrument of knowledge, providing an epiphany-like insight into reality. A metaphor is a means of semantic enrichment that is shared by scientific and poetic languages and that renders them capable of producing original mappings of the world. In this respect, the scientist and the poet possess this power of 'estrangement', of looking at reality with a stranger's eyes, and consequently, of discovering counterintuitive and hidden links in the world that surrounds us. In fact, many sciences, such as immunology, regularly use metaphors to explain natural phenomena.

Furthermore, it is claimed that the 'modelling' (the mathematicisation) of the world aspires to soak up the world's infinite characteristics in order to produce a model in which the qualities of reality are surpassed in favour of quantification, while the artistic attitude is one of attention to detail and singularity. This opposition is questionable as well, since descriptions of singularities and fragments lack any artistic or universal value if they fail to at least implicitly propose a vision of the world, that is, a model. Thus, a modelling of the world is a feature of science as well as of literature. As Calvino (687–688) reminds us in his lecture on exactitude ('Esattezza'):

'The formal choices of each artist always presuppose a cosmological model […]; poetry is a great enemy of chance, although she herself is a daughter of chance.'

The other quality that both the poet and the scientist are endowed with is exactitude, the infinite quest for the right word, in the case of the poet, and for precision in the observation and description of natural phenomena, in the case of the scientist.

For Calvino (677), exactitude means above all three things:

1. A well calculated and defined plan of the work;

2. an evocation of incisive and memorable visual images (the Italian language offers here an adjective that is missing in English: *icastico*, from the Greek *eikastikos*).

3. A language as precise as possible, both in its lexicon and its nuances of thought and imagination.

Another important point concerns the current notion of the relation between culture and science, which ought to be more complex than the one proposed by Snow. Philosophers of science, for instance, have importantly contributed to a better understanding of the scientist's method; consider Thomas Kuhn's idea that scientific change does not invariably take the form of a steady accumulation of knowledge within stable parameters: anomalies in the evidence accumulate to the point at which change takes the form of a 'discontinuous jump' or 'paradigm shift'. Furthermore, sociologists of science have demonstrated that the constitution of scientific knowledge itself is dependent upon culturally variable norms and practices, which means that science is merely one set of cultural activities among others, as much an expression of a society's orientation in the world as the art or religion in this society, and equally inseparable from the key issues of politics and morality; science is thus seen as a 'social construct'. In this respect, the discourse on creativity should also be considered: those who watch closely the great watersheds in scientific thought and technological innovations cannot deny that the most creative practices have overthrown all disciplinary fences.

By investigating the humanities–science relationship (the links, affinities, differences, questions and problems) beyond inherited clichés, the idea of mutual influences arises that favours a more dynamic idea of interfacing. Therefore, the starting point must be the acknowledgement of the isomorphism of the two fields (Hayles), which, in order to respond to their own tasks, often simultaneously develop new models and strategies of investigating complex scientific and cultural (artistic, literary) phenomena. This idea of isomorphism is no longer linked to the traditional ideas of cause and effect, but instead implies simultaneity due to which one of the two fields is

no longer seen as influencing or conditioning the other one. Isomorphism implies joint discoveries, as both domains tend to develop, at the same time, new investigative models, which in their turn become analogical mirrors of a world in constant progress. This idea leads us to view sciences and the humanities together, since their mutual interfacing can trigger new dynamics in various fields of knowledge.

During the last two centuries, theories of education developed around the ideas of distinction and choice: the humanities on the one hand, sciences on the other. Today, students are asking for new educational models, models capable of reflecting the complexity and interplay of a world characterised by a different understanding of knowledge and, especially, by the rapid development of new social matrices. As a consequence, new paradigms have begun to emerge in the light of the development of new social phenomena such as globalisation, the changing political sphere and the development of new 'mediascapes'. In such a shifting context, the idea of 'interface', or 'interfacing', seems to offer a suitable paradigm capable of triggering new heuristic implications. Moreover, the very idea of 'interfacing' leads us to the intriguing notion of 'complexity', which is itself a metaphor implying exchange, mutual interlinking, and above all to the notion of 'networking', that is, of new strategies of observing and therefore shaping the world. The notion of networking implies not only a new way of conducting transversal research among different disciplines, but also a new way of conceptualising and representing 'reality'. Networking is at the basis of complexity; it is a new epistemological paradigm common to science and the humanities.

One of the things that both domains have to acknowledge is the fact that we are facing a constantly evolving cultural situation. Among the already existing materialisations of this acknowledgment are the new university programs in medical schools, faculties of engineering and other scientific institutions that offer specific courses in literature, arts, philosophy, as well as courses encouraging creativity. Moreover, there are examples of positive applications of scientific research and knowledge in the humanities, too: from more practical applications, such as the creation of new disciplines within the humanities (consider the case of the 'Humanistic Informatics', the creation of new infrastructures, e-archives, new databases, etc.), to new theoretical developments combining theories of literature/criticism and scientific models of investigation (from 'field theory' to chaos theory). Other interesting examples come from social sciences, which have been playing a pivotal role in developing new lines of research and new concepts capable of breaking down barriers and encouraging interdisciplinary approaches. Anthropology is a case in point as it applies the scientific idea of 'thick description' to analyse culture *tout court*. Following similar patterns, during the last two decades

scholars in the humanities have started to reconsider the idea of 'literary phenomena', with literature perceived as a complex rather than a closed system, that is, as a network of events.

Ad 2. *The concept of interface.* As the second point I will try to investigate the concept of 'interface' as it was employed in the working hypothesis of the European project 'Acume 2: Interfacing Science and Humanities', which I coordinated.

It is not difficult to understand the meaning of the term 'interface' if one reads it as being composed by the prefix *inter*, or *intra* ('between two or more parties'), and of the root *face* ('surface', 'face', 'point of contact'). It is a term, however, that defies monolithic explanations.

The semantic fields to which 'interface' can be applied range from information technology (IT) to geography, from chemistry to metaphor. Generally speaking, it is in IT that the term was used initially; therein, interface was understood as not only a point of contact allowing communication but also as a method of communicating itself. I will use this term, which is obviously an umbrella term that possesses the power of suggesting more than describing, as a methodological point of origin rather than as a simple metaphor. Let us try, then, first of all to propose a few definitions of the term 'interface'.

In computer sciences, or in IT, it is a circuit, a part of the hardware that physically links to different components; consider, for instance, the USB (Universal Serial Bus) port of a computer. But an interface is also a part of a computer's software, that is, a program enabling the interaction, the translation between two languages, and thus allowing the user to interact with the machine. The 'man-machine' interface in the strict sense is then, for instance, the program allowing someone to use his or her desktop or laptop. In other words, an interface is a knot, a minimum in a wider complexity. It is also a description of an exchange, a specification of the limits of a given activity. All information exchange therefore implies the presence of an interface. The utility of this notion is then not that of naming something, but rather of making it visible.

We can examine, for instance, our 'human being–technology item' interface. Are we really facing an interface here (if I may be allowed a pun at this point)? If the answer is yes, then one must view the two systems as distinct and independent because there are continuous exchanges between what is biological, human, and non-biological and non-human space. This last case is evident in artistic representations of artificial being, and especially in medical technologies, with, say, CAT (Computer Axial Tomography) scans and X-rays allowing human space to become readable, as it were.

Sickness or health are literally traced by a tool that allows these traces to become evident, visible, to the eyes of the doctor, who is then capable of reading them. The interface thus works not only in the striking cases in which a hybridisation of the mechanical and the organic occurs, but also as a mediator, as a communication solution between two actors communicating with each other, and even as a new language invented for this communication. The example can again be CAT scanning, a technique for medical imagining that consists of calculating a 3D reconstruction of tissues on the basis of a tomographical analysis obtained by having the patient swept over by an X-ray beam. In this much used diagnostic process there are many 'mediations' of messages on the path from the patient's symptoms to the diagnostician using an instrument of analysis and styling a final report on the basis of data obtained from scanning the patient's body, that is, the data that are in turn interpreted by the practitioner, who will then formulate a therapy. It is no mere diagnosis: in the different stages of the procedure, different levels are involved as the patient's body becomes a network, a multiple system comprising a physiological, an organic, a psychological and an existential dimension. It is also at the heart of the system of medical knowledge, a final point of the meeting between epistemology (all that is known on man and his functioning) and culture (the way illness is perceived by the subject itself, by society, the way a particular illness is imagined by the patient and described to or by others). Interface is thus not a metaphor, but a methodological approach: it is a question of seeing how the two systems, man and technology, interact, and at what level and how, from this observation, patterns, that is, structures, continuities or discontinuities, may arise.

Here, the seminal studies by N. Katherine Hayles and Edward O. Wilson are vital (see Hayles and Wilson, respectively). Both authors, the first being a humanities scholar (who now works also in ITC) and the second a biologist, recognise the need for cooperation between the two fields, proposing new methods and paradigms of knowledge.

Hayles relates literary sign/signs to scientific theories and proposes the idea of field theory, or the field concept, as the epitome of the new way of observing contemporary reality by employing both scientific research and artistic and literary insight. What is interesting and characteristic about her book is the fact that it avoids simplistic and predictable remarks such as 'science influences literature and opens it to new imagery' or 'new scientific discoveries offer literature new models of expression'; rather, Hayles proposes a deeper observation and introduces the new concept of field against a more complex backdrop. In particular, she observes that around *fin de siècle*, the two spheres of knowledge, the humanities and science, both

started to propose similar modes of investigation, less and less attached to an atomistic (Cartesian) idea of knowledge and increasingly linked to a holistic idea, which Hayles grasps as field theory. These new modes of inquiry were built on two fundamental assumptions:

1. All things are linked not by a tidy, hierarchic logic, but by their simultaneous, joint presence.

2. As a consequence, the language that expresses these things is, inevitably, self-referential.

These conditions make observation more complex: any traditional notion of the difference between the observer and the observed – the difference crucial for atomistic (Cartesian or linear) observation – is eliminated, as both actors now belong to the same field of observation, and mutually influence each other:

> In the atomistic view, the gap between subject and object is not 'contaminated' by the circular paradoxes of self-referentiality, because it is assumed that reality can be divided into separate, discrete components. Consequently, it is assumed that language can be used to define the relation between subject and object in a formally exact way. But the field concept assumes that these components are interconnected by means of a mediating field. When language is part of the mediating field (i.e., the means by which the relation between subject and object is described), it participates in the interconnection at the same time that it purports to describe it. To admit the field concept thus entails admitting that the self-referentiality of language is not accidental, but an essential consequence from within the field. (Hayles 41)

The field concept is hence a viewpoint that underpins both scientific and artistic research and that, as mentioned above, can no longer be explained in the terms of a simple cause and effect relationship, since it is perceived simultaneously by both fields. Hayles stresses the importance of observing this new idea in the light of a complex and ever changing cultural background:

> A comprehensive picture of the field concept is more likely to emerge from the literature and from science viewed together than from either one alone. […] A more accurate and appropriate model for such parallel development would be a field notion of culture, a societal matrix which consists […] of a 'climate of opinion' that makes some questions interesting to pursue and renders others uninteresting or irrelevant. (Hayles 10–22)

In turn, the idea of 'consilience' investigated by Wilson proposes a union of the two cultures in order to holistically grasp cultural as well as natural processes: 'Consilience [is] a jumping together of knowledge by the linking of fact and fact-based theory across disciplines to create a common ground-work of explanation.' (Wilson 8)

Ad 3. *Interface as a strategy: a new method of approaching literary studies.* Hayles proposes a new method of literary analysis based on mathematical models. Her basic hypothesis is the idea that the change of the scientific paradigm in the twentieth century determined a new conceptualisation of reality, which necessarily affected the scientific as well as the social, cultural and artistic milieus. However, it is not a case of simple influence between the scientific and the artistic or the social. A revisiting of the notion of comparison thus becomes necessary. It is no longer the case of adapting a scientific method to literary studies, of using metaphors, but rather of seeing the two spheres of knowledge as indissolubly linked, as taking part in the 'cosmic web' that connects a holistic, multistratified universe of science, technology and art. According to Hayles, the twentieth-century theories of chaos and of complex systems have supplied investigative models and brainframes[1] that can be applied to all fields of studies. In other words, the old cause-and-effect chain is to be replaced with the simultaneity of non-consequential relations and with areas of isomorphism in which different levels and materials interact.

Hayles invites us then to reformulate the notion of 'comparison'. It is no longer a question of placing two or more texts on the same level, but rather of keeping the borders of texts fluid and permeable to thematic constructions, languages and structures that make up the contemporary 'discourse', by way of which human beings, technology and art overlap in a continuum.

Starting from specific case studies, the European project 'Acume 2' tried to demonstrate how some concepts, metaphors and narrations acquired new meanings by migrating from one discipline to another, thus provoking new configurations of *savoirs* and opening new frontiers of knowledge. Terms such as 'appropriation', 'translation' and 'reassessment' have become keywords in an attempt to understand the reconfiguration of knowledge that results from this migration from one discipline to another. Hence, an important insight of the project was that in this process of migration the different historical and national contexts must be kept in mind.

Concepts, metaphors and narratives are not only the most important theoretical and analytical tools of academic discourse, but they also provide critical interfaces between sciences, literature and the humanities, enabling debate, research and dynamic exchange on the basis of a common language. However, more often than not, the meaning and operational value of concepts, metaphors and narratives, even of those which appear to be self-explanatory, differ from one discipline, or academic and national culture, or historical period, to another. Notions such as 'communication', 'code', 'complexity', 'life' and 'system', metaphors such as

'crisis', 'network', 'body' and 'text', and cultural narratives such as 'evolution', 'ageing' and 'digression', which are at the core of both sciences and the humanities, are not univocal and firmly established concepts. They are rather dynamic and exchangeable as they travel back and forth between academic contexts and disciplines. In this way, they constitute what Mieke Bal has felicitously called 'travelling concepts' (Bal).

With the move towards a more rigorous transdisciplinarity, the dynamic exchange of concepts between different disciplines as well as the translation of concepts into metaphors and narratives have surged. Through constant appropriation, translation and reassessment across various fields, concepts, metaphors and narratives have acquired new meanings, triggering a reorganisation of prevalent orders of knowledge and opening up new horizons of research. To the extent that their meanings must therefore be constantly renegotiated between different disciplines, travelling concepts, metaphors and narratives can foster a self-reflexive approach to the transdisciplinary study of culture.

Ad 4. The notion of transdisciplinary studies. At this point, I would like to introduce two books, *Memoria e saperi: Percorsi transdisciplinari* (Agazzi and Fortunati [eds.]) and *Biocomplexity at the Cutting Edge of Physics, Systems Biology and Humanities* (Castellani et al. [eds.]), which are the result of our effort to experiment with the notion of interface as a strategy for approaching epistemological paradigms that could potentially be shared by science and the humanities. Both of these books were born from the idea of transdisciplinarity. While in interdisciplinarity studies the various disciplines operate at each other's side, each addressing their common question from its own field of competence, in transdisciplinary studies the research methods and hence the disciplinary boundaries themselves are re-envisaged.

Our first book investigates the state of the art of the studies on memory in six disciplinary macro-areas: social sciences, biomedical sciences, arts and media, the humanities, and religion studies. These are crossed by 'keywords' of the conceptualisation of memory that has taken place in the last twenty years; this means that every area must confront the keywords that constitute a sort of paradigm running across the various disciplines:

1. evolution;
2. individual and collective memory/memories;
3. memory and trauma;
4. memory as a dynamic process;
5. the context;
6. memory and information;
7. memory and oblivion.

The idea of transdisciplinarity is built on the dynamic combination of verticality (macro-areas) and horizontality (common keywords). In this way, traditional disciplinarity remains a compulsory touchstone (for both the writers and the readers), but is 'revisited' by means of common keywords that acquire marked heuristic relevance.

Another example of the work we are carrying out in collaboration with scientists is a book born from a seminar aimed at investigating the paradigm of 'bio-complexity' as a possible heuristic model for the interpretation of complex systems in other disciplines. In this book biological complexity presents a challenge and a possible paradigm for other fields of knowledge whose objects are non-biological 'complex systems' (such as literature). The model of bio-complexity is used as the paradigm for observing complex systems in both the humanities and science: from biology to economics, from literature to physics. The basic idea of the book is the following: There are concepts able to highlight common characteristics of a whole series of complex systems, despite their apparent diversity and their belonging to different fields of knowledge. For instance, the concept of biological complexity may prove as a useful tool for investigating literature considered as a complex system. In the humanities, the paradigm of bio-complexity has been confirmed as a useful analytical tool: in a global perspective of literary systems, the idea of the European and the trans-European literatures and cultures as complex systems interacting with each other in a system of networks is starting to be explored in comparative literature and postcolonial studies. Due to its complexity, the study of literature from a global perspective needs models produced in other disciplines, such as quantitative historical graphs, geographical maps and the genealogical tree of evolutionary theory; only in this way can relations, structures and forms of the literary macro-systems be identified.

The most advanced conceptualisations of biological complexity have proposed the following characteristics of living organisms:

1. Living organisms are constituted by a high number of elements that mutually interact, organising themselves in functional and dynamic *networks*.

2. They possess different *levels* or *strata of complexity*, from molecules, to sub-cellular organelles, to *the cell*. This fundamental unit of living organisms not only constitutes in itself a complex system *par excellence*, but is also the building block of higher levels of organisation, as it is capable of generating a whole series of different tissues and organs that finally constitute a unique body.

3. The different bodies (organisms) organise themselves in *societies* that in their own turn constitute ecological systems that are even more com-

plex, systems in which hundreds or even thousands of different species coexist or cohabit in a dynamic balance.

4. Living organisms are systems with their own *evolutionary history* that conditions their structure and their functional capacities, entailing a series of *constraints*.

5. They are the result of a selection *for fitness*, which optimises networks from the structural and the functional point of view and is exercised at all the above-mentioned levels of complexity, from molecules and cells to organisms.

6. They are organised in *modules*, that is, aggregations of networks with a defined function. Modules are organised by *links*, which organise them in supra-modular organisations.

7. Living organisms are *dynamic*, *open* and *non-linear systems* dominated by *stochastic fluctuations and noise*.

8. They are characterised by *the emergence of unexpected properties and functions* such as symbolic language and awareness.

9. They possess the capacity of *learning* and of remembering (*memory*) at all levels, from the molecular to the highest level of biological organisation, including the most sophisticated cognitive functions.

10. The behaviour of every given element is determined by its *context*: each element is conditioned by all other elements, as they form a continuous interactive and dynamic system.

These two books document the advantages of an approach that questions traditional disciplinary distinctions and demonstrates that seemingly incompatible disciplines share similar methodological problems analysable by a shared set of instruments. This is not a trivial lesson for scientific institutions such as universities, which are still organised according to a vision that does not represent the current dynamics of knowledge. The cases of memory and bio-complexity thus render apparent the need to challenge the traditional separations that are unable to grasp the heuristic and epistemological potentials of a transdisciplinary method.

I would like to conclude by citing two thoughts that emblematically summarise the working hypothesis of my research on complexity in literature and science: according to Italo Calvino (668), 'the function of literature is communication between what is different […], not dulling but exalting the difference'; and Ilya Prigogine (74) writes: 'While classical science used to privilege order, stability, today we recognise the primal role of fluctuation and instability at every level of observation [demonstrating] the multiple choice and the horizons of limited predictability'.

NOTE

[1] A brainframe is a structure designed for the physiological, cognitive and sensorial reception and interpretation of reality created and determined by information technologies. According to this model, the means of communication change the mental configuration of those who take part in communication. Derrik de Kerckhove, a student of Marshall McLuhan, developed this concept, which I use here, modifying, however, its application. All technologies and sciences with their paradigms are in fact considered here as agents of changes in the frame.

WORKS CITED

Agazzi, Elena and Vita Fortunati, eds. *Memoria e saperi: Percorsi transdisciplinari*. Rome: Meltemi, 2007.

Ascari, Maurizio. *Literature of the Global Age*. Jefferson (NC): McFarland, 2011.

Bal, Mieke, *Travelling Concepts in the Humanities*. Toronto: University of Toronto Press, 2002.

Bassnett, Susan. *Comparative Literature: A Critical Introduction*. Oxford and Malden (MA): Blackwell, 1993.

Benvenuti, Giuliana and Remo Ceserani. *La letteratura nell'età globale*. Bologna: Il Mulino, 2012.

Castellani, Gastone et al., eds. *Biocomplexity at the Cutting Edge of Physics, Systems Biology and Humanities*. Bologna: Bononia University Press, 2008.

Black, Max. *Models and Metaphors*. Ithaca (NY): Cornell University Press, 1962.

Calvino, Italo, 'Lezioni americane'. Calvino, *Saggi (1945–1985). Tomo primo*. Ed. Mario Berenghi. Milan: Mondadori, 1995. 631–752.

Collini, Stefan. 'Introductory Essay'. C. P. Snow. *The Two Cultures*. Cambridge: Cambridge University Press, 1998. vii–lxiii.

Cornell Way, Eileen. *Knowledge, Representation and Metaphor*. Kluver Academic Publisher, 1991.

Dario, Paolo. 'Un nuovo ingegnere rinascimentale'. *I classici e la scienza*. Ed. Ivano Dionigi, Milan: Rizzoli, 2007. 255–266.

D'haen, Theo, César Domínguez and Mads Thomsen, eds. *World Literature: A Reader*. London and New York: Routledge, 2012.

Hayles, N. Katherine. *The Cosmic Web: Scientific Field Models & Literary Strategies in the 20th Century*. London: Cornell University Press, 1984.

Jordanova, Ludmilla J. 'Introduction'. *Languages of Nature: Critical Essays on Science and Literature*. Ed. Ludmilla J. Jordanova. London: Free Association Books, 1986. 15–47.

Morin, Edgar, *La Tête bien faite : Repenser la réforme, réformer la pensée*. Paris: Seuil, 1999.

Nussbaum, Martha C. 'Skills for Life'. *Times Literary Supplement* April 30 (2010): 1–7.

Odifreddi, Piergiorgio. 'La guerra dei due mondi'. *I classici e la scienza*. Ed. Ivano Dionigi. Milan: Rizzoli, 2007. 45–54.

Prigogine, Ilya. *La fine della certezza. Il tempo, il caos e le leggi della natura*. Turin: Bollati Boringhieri, 1997.

Snow, C. P. *The Two Cultures*. Cambridge: Cambridge University Press, 1993.

Swinburne, Richard, *Revelation: From Metaphor to Analogy*. Oxford: Clarendon Press, 1992.

Wilson, E. O. *Consilience: The Unity of Knowledge*. New York: Alfred A. Knopf, 1999.

Simonsen, Karen-Margrethe and Jakob Stougaard-Nielsen, eds. *World Literature, World Culture*. Aarhus: Aarhus University Press, 2008.