Biosemiotics *as* Systems Theory: an Investigation into Biosemiotics as the Grounding for a New Form of Cultural Analysis.

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Abstract

This thesis examines the relation of systems theory to biosemiotics. To this end, it considers the claim that biosemiotics is an *uneven* development of systems theory. To do this, this thesis explores theories of 'modelling' and 'information' in biosemiotics from the enhanced point of view of systems theory. It will do so following the example set by Deely's 'archaeology of concepts' (1981).

By means of the concept of 'isomorphism as structural similarity' (Bertalanffy 1945) the thesis argues that biosemiotics and cybernetics/systems theory share a systems thinking which is grounded in 'transdisciplinarity', 'history' and 'function'. This thesis also argues that such a common methodological perspective is an instance of historical *continuity* due primarily to biosemiotics' and systems theory's involvement with Tartu-Moscow semiotics.

Subsequently, the thesis argues that biosemiotics' and cybernetics' systems thinking differ in their view of 'information'. It shows how biosemiotics broadly conceives information in terms of Peirce's notion of 'abduction', whereas cybernetics conceives information in terms of deduction. It also shows, as a consequence, how biosemiotics' modelling strategies are identifiable with logic as semiotics, while systems theory's modelling strategy is more closely identifiable with mathematical logic alone. Such a methodological difference is argued to be an 'uneven development' (Althusser 1965).

The following thesis reveals much that biosemiotics has left unconsidered: the continuing relevance of systems theory, especially in relation to information and observership, and reveals this through the strength of the principle of abduction.

Lastly, the thesis 'Biosemiotics *as* Systems Theory' provides the grounding for a new form of cultural analysis that supersedes the fallacies of semiology. It does so by proposing the following guidelines for the analysis of culture: substituting 'interpretation' with *modelling,* dispensing of 'representation' in favour of *purely objective reality,* and recasting 'motivation' in terms of *cybersemiotic* constraints.

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CONTENTS

CHAPTER 1

Introduction

Biosemiotics is an international and interdisciplinary research field that has continued to flourish over the past 50 years and, as its prefix shows, bio-semiotics is indebted to *semiotics* in respect to its conception of communication as *sign processes*. Biosemiotics, however, currently extends the remit of much semiotics in that it does not limit its object of research to the investigation of human communications alone, but encompasses all types of communications in the biosphere. Before the consolidation of biosemiotics in the 1990s, semiotics was often referred to in textbooks, and sadly also in scholarly work, as a 'method' for the analysis of "a limited range of cultural artefacts which might be susceptible to elucidation using broadly linguistic principles" (Cobley 2007: 45), usually for the analysis of 'media texts'. This approach, i.e. the 'semiotic'[1] analysis of culture, became popular practice in cultural studies after Roland Barthes' collection of critical essays *Mythologies* (1957) was translated from French into English in 1973. At that stage, semiotics and decodification was still considered part of a field devoted purely to *human* communication. It was principally Thomas Sebeok (1920 – 2001) who demonstrated the anthropocentrism of this perspective, first with the concept of 'zoosemiotics' (1963), then with 'biosemiotics' (1991a), finally with 'global semiotics' (2001). Following decades of studies on animal communication Sebeok discovered that communication, before being the province of the human animal, is recognised as a fundamentally animal and biological phenomenon (Sebeok 1963, 1988). As he states:

> All known living organisms communicate exclusively by nonverbal means, with the sole exception of some members of the species Homo sapiens, who are capable of communicating (...) by both nonverbal and verbal means. (...) Nonverbal communication takes place *within* an organism or *between* two or more organisms. (...) The earliest form of interorganismic communication in our biosphere are found in prokaryotes (...) these are commonly called bacteria (Sebeok 2001: 14-15).

The realisation that semiosis takes place, fundamentally, in communication amongst cells, represented an important departure from the traditional approach of semiotics which was theretofore dominated by culture studies. This nascent approach implied that any instance

[1] As it will be shown in Chapter 7, a number of scholars perpetrating this kind of analysis of culture advocated 'semiotics' while in fact using 'semiology' as their grounding theory. Evident examples of this phenomenon, which Deely (2010: 29n) calls the "pars pro toto masquerade", are Bignell's *Media Semiotics* (1997) or Chandler's *Semiotics: the Basics (2001).*

of cultural communication needed to be considered in relation to its grounding in natural communications, a fact which 'cultural semiotics' clearly ignored.

Sebeok was a linguist by training before irreversibly changing the course of semiotic research by enriching it with insights from biology. However the proliferation of biosemiotics is not solely attributable to the work of Sebeok in the humanities, but also to the work of biologists in the sciences. As Favareau explains, in the early 1990s Sebeok's biologically-inspired semiotics met the trend of semiotically-inspired biology and "from this point on, the term biosemiotics is used to refer to this project by all parties involved" (Favareau 2011: 50). Biologists-biosemioticians like Hoffmeyer, Kull, Barbieri and Markoš to name a few, are interested in the way in which semiotics offers new models for the understanding of life. For example, as Hoffmeyer states "Biosemiotics is the name of an interdisciplinary scientific project that is based on the recognition that life is fundamentally grounded in semiotic processes" (Hoffmeyer 2008: 3). Hence biosemiotics possesses, in addition to a humanistic component derived from semiotics, a strong scientific perspective brought about by biology. Because of the entangling of such interests, biosemiotics could be considered as a field that brings within itself the potential of bridging the gap between the scientists and humanists.

The relatively incipient state of biosemiotics entails that questions arise regarding its provenance and its status. In other words, how did biosemiotics develop? What is central to its broad project? And, ultimately, how does it contribute to knowledge? In the attempt to explore these questions, this project puts forth the thesis that biosemiotics is a form of systems theory.

Aims of this study

The main aim of this study is to contribute to biosemiotics by addressing issues that some engagements with it leave unconsidered, that include:

its disciplinary link to systems theory particularly in relation to *modelling*, *information* and *observership*,

its *uneven* historical heritage in cybernetics,

its necessary theorisation of *abduction*, and

the way in which biosemiotics can improve means of performing cultural analysis in the humanities.

In order to explore these issues, the project will take the form of a theoretical investigation. Such a theoretical study will be modelled upon:

1) the interdisciplinary guidelines set by Deely's 'archaeology of concepts' (1981),

2) the concept of 'history as driven by contradiction' from Althusser (1965) and

3) the concept of 'isomorphism as structural similarity' from Bertalanffy (1973 [1945]).

The objective of this study is thus to gain knowledge of

- the features which biosemiotics and systems theory have in common i.e. a common modelling strategy organised around the systems thinking categories of transdisciplinarity, history and function;

- the features which biosemiotics and systems theory *do not* have in common i.e. their differing in their concerns with information – orientated towards abduction in biosemiotics and geared towards deduction in systems theory;

It is posited that gaining knowledge of these facts will consolidate understanding of the parameters of biosemiotics and clarify its project beyond either a 'semiotisation of biology' or a 'biologization of semiotics'. In addition, this study reveals

- the transdisciplinary implications that the thesis 'Biosemiotics *as* Systems Theory' bears for 'cultural semiotics' i.e. the way in which analysis of culture can be improved through *modelling, purely objective reality,* and *cybersemiotic* constraints.

Gap in research and research questions

While biosemiotics is seen to arise from a meeting of biology and semiotics, this thesis seeks to demonstrate that there is also a third field which has strongly influenced the 'rise' of biosemiotics. This field is 20th century Systems Theory. The fact is seldom mentioned in

the literature apart from two instances. Forty years ago Sebeok himself testified to his long interest in systems thinking when, in a 1977 essay, he wrote that:

> The kinship of semiotically based programmes... to the movement known as General System Theory (Bertalanffy 1968), or GST, is seldom underlined yet their common denominator is rather obvious. As a 'natural philosophy', both these variants of a single metatheory can be traced back to Leibniz (...) and his programme for a *mathesis universalis* (Sebeok 1977a: 185).

In the same essay Sebeok also added that despite General System Theory suffering "from an aura of vagueness", he needed to emphasise the historical and logical associations between holism and semiotics "because these are nowadays often overlooked (1977a: 186)." Such a lack of recognition of the link between biosemiotics and systems theory appears even more salient if one considers that a few years later, Anderson *et al.* (1984: 25) explicitly declared that semiotics is fundamentally concerned with systems, yet they recognised that "semiotics has seldom dealt with dynamical systems as a whole: those nonlinear, irreversible realities where energy explicitly fuses with information, such as experience, ontogeny and phylogeny". Thus Anderson *et al.* acknowledged that semiotics had neglected its interaction with systems thinking.

Of note, is how both these observations remained largely undeveloped in biosemiotics, at least up to Brier's (2008) publication of *Cybersemiotics* (at a time during which the work of this thesis was already under way following a similar yet parallel path to that of Brier's). In his book, Brier clearly addresses the question of the link between semiotics and first and Second Order Cybernetics, as the current project also does; however, for Brier such a link is a question of transdisciplinarity principally, instead of historicity. Therefore, the current project will seek to support the claim that the relevance of systems theory for biosemiotics is *historically determined*, amongst other things, through 'Soviet' semiotics[2] (Jakobson and Tynjanov 1929; Lucid 1977) and the work of Lotman (1990) which, as it will be shown, was influenced initially by cybernetics, and which in turn deeply influenced Sebeok's work on 'modelling systems' (1988; Sebeok and Danesi 2000). Indeed, Sebeok has not even been

[2]The expression 'Soviet semiotics' is taken from Lucid (1977) to designate the work of the Tartu-Moscow school of semiotics during Soviet times. However in this thesis, this expression also includes the earlier work done by Russian scholars (e.g. Jakobson and Tynjanov 1929) in Soviet times, hence its use. This expression also designates the work of Lotman (1967, 2001). However, Lotman's heritage initially pertains to Tartu-Moscow semiotics, extending beyond the confines of the limits of the Soviet Union. Therefore when referring exclusively to Lotman's 2001 book , i.e. *The Universe of the Mind*, this thesis refers to it by means of the expression 'Tartu-Moscow semiotics', rather than 'Soviet' semiotics.

acknowledged as a cybernetician as much as he has been acknowledged as a semiotician or, at the very least, the depth of systems theory's influence on his work has not been recognised. It is only recently that this fact has become acknowledged (Cobley 2010d: 10; Cobley *et al.* 2011: 8-9; Brier 2011: 47-48) but there is not a single work that is dedicated to explaining the relevance of systems theory to the whole of the biosemiotic project, conceived as outlined above.To my knowledge, nothing is extant which includes both the biosemiotic project of Sebeok as well as contemporary biosemiotics. Hence this project will attempt to fill this gap in knowledge, and will seek to articulate the neglected (cybernetics/systems theoretical) heritage of biosemiotics.

The issue that systems thinking is implicit in biosemiotics was already raised in previous attempts to devise a way to utilise the only currently existing biosemiotics framework for cultural analysis – Modelling Systems Theory (Sebeok and Danesi 2000) – to perform empirical research on digital culture (Cannizzaro 2005). At that early stage of research I already noted how the lack of contextualisation of biosemiotics within a systemic and cybernetic framework impeded the implementation of biosemiotics as a form of cultural analysis. In fact, while biosemiotics is currently proliferating in relation to the sciences (for example, its 'flagship' journal and book series appear with the hard sciences publisher, Springer), its progress in the humanities and in the context of cultural analysis has been much slower. As Favareau (2011: 46) usefully puts it:

> Interestingly enough... it is not "semioticians" *per se* that one finds attending the conferences and penning the journal articles in the field called biosemiotics today, but molecular biologists, embryologists, philosophers of science, zoologists, roboticists, neurobiologists, psychologists and dynamic systems theorists instead. [...] For it turned out that the nerve that was ready to be hit by the promise of a scientifically informed biosemiotics was not at all one that was calling out for excitation in the academic world of semiotics (with a few conspicuous exceptions of course ...).

The current project seeks to situate itself as one such exception, and, as well as seeking to contribute to biosemiotics by means of the elaboration of its foundations, it will also seek to contribute to semiotic analysis of culture by means of exploring the implications that the thesis 'Biosemiotics *as* Systems Theory' bears for a new form of cultural analysis.

Hence, the set of questions that will be explored in this project can be grouped into three categories:

Key question:

- What is the relation between biosemiotics and systems theory?

Sub questions – related to the main thesis:

- In which way is biosemiotics interdisciplinary and transdisciplinary?
- To what extent is the link between biosemiotics and systems theory *historical*?
- And, specifically, what do biosemiotics and systems theory/cybernetics have in common?
- What do biosemiotics and systems theory/cybernetics *not* share?

Sub questions related to the implications of this thesis for cultural analysis include:

- How can the thesis 'Biosemiotics *as* Systems Theory' create a new agenda for cultural semiotics?
- What constitutes a biosemiotic 'method' for the analysis of culture?

Original contribution to knowledge

This project's overall contribution to knowledge is original in three ways:

a) It posits biosemiotics as a breed of systems thinking, a thesis not hitherto explored.
b) Consequently, it demonstrates that, in light of the above, the biosemiotic perspective is radical enough to have an influence across all subject areas.
c) Finally, it shows that in the area of culture a novel means of carrying out analysis is demanded.

This thesis is unique in explicitly acknowledging that there are several implicit references to systems thinking in biosemiotics' theoretical underpinnings that have not been recognised as such by biosemioticians. By surveying a range of contributions in systems theory (e.g. Thompson 1917; Bertalanffy 1968; Luhmann 1995a) and cybernetics (including, but not limited to von Uexküll 1940; Wiener 1951; Ashby 1956; Bateson 1972; von Foerster 1973; Lovelock 1979; Maturana and Varela 1980) I will extrapolate 'typical' systems theory models. This thesis performs a re-reading of key biosemiotic theories (including, but not limited to Sebeok 1988, 1991; Sebeok and Danesi 2000; Hoffmeyer 1996, 2008; Brier 2008) in terms of these models. The intent of this investigation is to outline those contributions in biosemiotics that are deeply shaped by systems thinking, but that do not explicitly state their systemic affiliation.

Following up from such investigation, the claim is made that the founding father of biosemiotics, Thomas A. Sebeok, was himself a systems theorist whose view of communications was deeply informed by cybernetics. The strongest evidence for this is his final monograph (Sebeok and Danesi 2000) which is explicitly about 'systems analysis', and also his early career where he was the convenor of conferences and volumes featuring cybernetics and communication theory (see Cobley *et al.* 2011). Such a revelation is fundamental as it suggests a reason why Sebeok's biosemiotics has often been presented as an interdisciplinary project or a bridge between the sciences and the humanities (e.g. Hoffmeyer 2008a; Cannizzaro 2011). Most importantly, it furnishes proof that in light of its variegated ancestry in cybernetics and systems thinking, biosemiotics can also be considered as a project with great potential for transdisciplinarity, particularly in areas that deal with systems of communication, be it culture as in popular culture or art, literature and religion, or be it sciences like biology, psychology or even palaeontology.

As a consequence, this thesis argues that by acknowledging its systemic heritage and its potential for transdisciplinarity, 'Biosemiotics *as* Systems Theory' can make a positive contribution in semiotics as envisaged within the humanities. By exploring the potential of biosemiotics for transdisciplinary (a potential which was anticipated in Modelling Systems Theory but that is not fully developed yet), this research recognises that the foundational research field of semiotics (which has been, in effect, semiology) should consider the avenues for implementation that biosemiotic theories of modelling offer.

In outline, biosemiotics itself currently fails to see the issues associated with a), b) and c) and that is why, on this basis alone, my theoretical work is both innovative and is a contribution to new knowledge.

Presentation of the argument

The investigation of the 'disciplinary' and historical overlap between biosemiotics and systems theory will be carried out following closely the example set by Deely in 'The relation of logic to semiotics' (1981). In this long paper, Deely operates a re-reading of texts and concepts from semiotics in light of the history of logic. This method he calls an 'archaeology of concepts', which consists of the charting of disciplines, fields and paradigms in terms of other disciplines, fields and paradigms. The workings of Deely's investigation are very similar to the workings of this project's 'mapping' of the fields of

biosemiotics and systems theory. Such a framework necessarily opens up the project to a *historical* and a *comparative* perspective.

Because the 'Deely Method' is used to produce a new understanding of biosemiotics from the enhanced vantage point of the *history* of cybernetics, this thesis also has to clarify its conception of 'history'. This is drawn from Althusser's (1965) Marxist reading of history as constituted by *uneven developments*. This view of history allows one to envisage a discipline as a collection of principles. It also allows one to see that within the history of that very discipline, the development of such a collection of principles happens to be *contradictory* even more than once. This clarification of history will pave the way for further exploration of *biosemiotics as an uneven development of systems theory*.

Lastly, Deely's 'archaelogy of concepts' opens up a space for interdisciplinarity by means of its comparative perspective. Issues of interdisciplinarity are explored particularly in relation to the difference between multidisciplinarity and transdisciplinarity. The comparison between biosemiotics' and systems theory's contributions make use of Bertalanffy's notion of *isomorphic model.* This concept is defined as a "conceptual analogue of certain universal traits of observed phenomena" (Bertalanffy 1973c [1945]: 89). The isomorphic model is used to chart semiotic, biosemiotic and cybernetic phenomena in terms of what they have in common, namely their theoretical 'organisation', or, in Kuhn's terms, their paradigmatic features, or "model problems" (Kuhn 1996 [1962]: x). The transdisciplinary view embedded in the isomorphic model enables the identification of the *similarities* across biosemiotics and systems theory (e.g. theories of modelling) but also the identification of the fundamental *differences* across these fields (e.g. theories of information).

Contents of the main body of the thesis

This thesis' argument is organised in four key parts:

A detailed description of *the approach to the argument* which provides an outline of the research hypothesis, framework and philosophical method of argumentation in lieu of a 'methodology' chapter as typically found in a social science PhD project.

A literature review, divided in two parts, which presents a selective account of biosemiotics' key contributions, and an historical account of contributions from cybernetics.

An *analysis* proposing the reading of biosemiotics in terms of systems theory, also divided into two parts, which offers a sense of the features which biosemiotics and systems theory have in common (homology) and of those which they do not have in common (information).

A discussion of the *implications* of this thesis which proposes a way to use this project's findings within the study of culture, and also outlines the problems that are raised in the process and the avenues for future research.

These key parts are arranged into chapters in the thesis as follows. Following the current introductory chapter, the chapter on 'Disciplinarity: charting disciplines, fields and paradigms in terms of other disciplines, fields and paradigms' (Chapter 2) thereafter sets the theoretical grounds for the investigation of biosemiotics. This chapter provides an outline of the methodology that anchors this thesis' argument. Such an argument utilises as guidelines the philosophical concepts of 'archaeology of concepts', 'uneven development' and 'isomorphism'.

The next chapter 'Biosemiotics as an open (paradigmatic) system: Steps towards the articulation of "modelling" and "information"' (Chapter 3) discusses key texts in the biosemiotics literature that present contributions on 'modelling' and 'information'. In so doing, the chapter offers a preliminary account of the biosemiotic models which are congruent with cybernetics and systems theory's endeavours.

The literature review continues in 'From cybernetics to systems theory: historical contradictions as the beginning of biosemiotics' (Chapter 4) and unfolds into a historical account of the key contributions that constitute cybernetics and systems theory, especially in those instances in which they have overlapped with biosemiotics' interests. This chapter posits the hypothesis that, perhaps, in a similar manner in which systems theory has developed as an uneven development of cybernetics, biosemiotics has developed unevenly from systems theory.

'The relation of systems theory to biosemiotics: "modelling" understood *as* "transdisciplinarity", "history" and "function"' (Chapter 5) is the first part of this project's analysis, and operates a 'mapping' of the biosemiotic concept of *modelling* in terms of cybernetics and systems theory with reference to notions of transdisciplinarity, history and function. This chapter illustrates the *conceptual* and *historical* affiliation of biosemiotics to

systems theory and, hence, the common theoretical ground between the two fields. By providing key evidence supporting the thesis 'Biosemiotics *as* Systems Theory', this chapter constitutes the core of the entire argument of this thesis.

Building on this finding, 'Rupture in biosemiotics' and cybernetics' systems thinking: the "bias" of the concept of information towards abduction or deduction' (Chapter 6) explicates how biosemiotics and systems theory's modelling strategies differ in their theorisations of *information.* These modelling strategies are underwritten by the informal logic of abduction in biosemiotics, and by the formal logic of deduction in systems theory. This chapter complements the thesis 'Biosemiotics *as* Systems Theory' with the corollary that looking for similarities and historical continuity involves finding differences and historical contradictions. In this respect biosemiotics needs to be envisaged as an *uneven* development of systems theory.

The next chapter explains how, as a means to go beyond the fallacies of semiology, one may need to substitute 'interpretation' for *modelling,* dispense with 'representation' in favour of *purely objective reality,* and reframe 'motivation' in terms of *cybersemiotic* constraints. Thus, '"Biosemiotics *as* Systems Theory" as the demise of semiology: steps towards a new form of cultural analysis' (Chapter 7) outlines the implications of the findings of this thesis for cultural analysis. By means of the guidelines it proposes, this chapter proposes a resolution to the nature/culture divide that has characterised so much of semiological theory and cultural analysis.

Finally, the 'Conclusion' (Chapter 8) to this thesis provides a succinct summary of the findings of the project to date and briefly outlines the problems that the thesis raises but that it cannot solve for reasons beyond the scope of the project. These new issues include the difference between Luhmann's and Lotman's systems theory in terms of hierarchy, the relevance of the work of Spencer Brown for biosemiotics, the relation of Deely's ontology of the object to Althusser's ontology of the subject. Additionally, the chapter indicates the avenues for future research within four broad areas: research methods, biosemiotics, systems theory and semiotics. This chapter hopefully demonstrates that 'Biosemiotics *as* Systems Theory' is not just a thesis but, potentially, also a method.

CHAPTER 2

Disciplinarity: charting disciplines, fields and paradigms in terms of other disciplines, fields and paradigms.

Introduction: justification for a theoretical investigation and presentation of the research hypothesis

This chapter sets the grounds for the theoretical investigation of the research field of biosemiotics. I will also, in what follows, refine some of my intentions, aims and methods for this project. I am indebted to the work of the French philosopher Louis Althusser (1918-1990) for providing me with a convincing model for the defence of philosophical methods in academic argumentation, as required in such a thesis as this. In *Pour Marx* (1965), Althusser affirmed that his work consisted of *'philosophical essays*, with theoretical investigations as their objects, and as their aim an intervention in the present theoretico-ideological conjuncture in reaction to its dangerous tendencies' (2005 [1965]: 12). The purpose of his theoretical work was to admonish the simplistic and misleading reading of Karl Marx's work which was common at his time of writing. In a similar fashion, this PhD work also constitutes a philosophical thesis which 1) has a theoretical investigation as its central outcome, and 2) aims at making an intervention in contemporary biosemiotics in regard to bringing elucidations of one of its neglected aspects, that is, its cybernetic heritage.

Indeed, in the same way in which Althusser's work was concerned with investigating theory, the present research work is also concerned with clarifying theoretical knowledge, for both the benefit of the continuously expanding community of biosemioticians but also for researchers in any discipline interested in future biosemiotic applications. As a corollary, this thesis argues against the production of theoretically unchallenged empirical knowledge, e.g. the taking up of methods or models without an awareness of their philosophical foundations. This approach may cause flawed results due to insufficiently substantiated theoretical assumptions. For example, biosemiotics was conceived as a way to provide a concept of communication that would enlarge linguistically-based semiotics; therefore those biologists that today 'perform' biosemiotic 'experiments' using linguistic models rather than general semiotic models are at risk of producing incoherent results. This way of feeding off the wrong source has been famously referred to by Sebeok as 'dung-beetle research' (in Anderson *et al.* 1984: 44). Thus, this work sets out to

demonstrate that the questioning of theories and methods should not be conceived of as legitimate only within the (imagined and fictitious) boundaries of philosophy but should instead constitute a normal and integral activity within the social sciences also, and not an exception. In fact, a view of research that is not fully mindful of its philosophical foundations is at risk of falling into the Newtonian myth of 'pure observation', also known as 'theory-free observation'. This would be misleading since, as Popper (1959) convincingly taught, all observations are selective and pre-grounded in theory. In this respect, one may argue that philosophy can be seen as constituting the groundings of all human knowledge, including scientific knowledge. Indeed, envisaging semiotics as having a similar role to philosophy would imply an extension of Popper's idea that there is 'nothing before theory' to the idea that there is nothing before *semiotic* theory. In fact in the same manner in which literary critic Stanley Fish (1980) argues that there is not a 'real' text (its ideation) before its reading (its interpretation on the side of the reader), one can argue that there is no scientific observation that is not already an interpretation of the world.

Hopefully the systematicity with which this theoretical investigation is carried out (modelled upon practices of semiotic analysis) and its striving for analytical clarity (modelled upon Althusser) will convince the empirical reader that theoretical investigations can be as explanatory as successfully-conducted empirical works. As McKee (2003: 84-117) shows, theoretical-semiotic works can have methods similar to those in the sciences *and* can provide results that consist in a sound interpretation of phenomena, and these results may bear effects on philosophical as well as scientific and work. This chapter therefore bears a similar function to that of a 'methodology' chapter as found in an empirical study, in that it is dedicated to clarifying the line of approach to the thesis' argument and substantiate its philosophical methods. However, it chooses not to use the term 'methodology' because in its analytical form, this term is better suited for an 'empirical' argument; for the current theoretical investigation, the line of procedure can be better expressed by the term 'approach'. Thus this thesis strives for *analytical* rigour by firstly providing a justification of the choice to proceed with a theory-based project as opposed to an empirically-framed project, as outlined above. Then it seeks to illustrate how the argument develops by providing a clear outline of (1) its hypothesis 2) its principles of analysis, and 3) an indication of how these principles translate into guidelines for the literature reviews and analyses found in the next chapters (Chapter 3 to 6).

Thus, firstly, an illustration of the research hypothesis (1) is required. Note that the articulation of such an hypothesis is cumulative as it 'grows' and becomes more precise as the chapter progresses and further principles of reasoning are presented. Hence, this theoretical investigation is based on the initial premise (hypothesis) that *biosemiotics is a contemporary development of modern systems theory and cybernetics*. The following quotes from scholars in biosemiotics who published research in the 1990s, provide a preliminary justification for such a hypothesis. These passages have been selected because they suggest the systems theoretical and cybernetic past of biosemiotics:

> The same logical mechanism that creates species in the world of organisms is also responsible for creating words in language. First, note that words are reproducible entities: every time we pronounce a word, we actually reproduce it (Kull 1991: 228).

> All living things (...) are interlinked in a highly ordered fashion. Such order, or organisation, is maintained by *communication*. Therefore, communication is that criterial attribute of life which retards the disorganising effects of the Second Law of Thermodynamics; that is, communication tends to decrease entropy locally (Sebeok 1991: 22).

As shown, Kull's quotes denotes a systems theory perspective in that he uses a logical model that characterises one field (e.g. reproduction as used in biology) to shed light on a phenomenon in another field (the 'reproduction' of words in the study of language). His perspective is systemic in that he exploits the formal similarity between what he calls the 'recognition mechanism' in biology and language (1991: 228-229). Sebeok's quote, on the other hand, betrays a conception of communication founded in cybernetics. In fact, similar to cyberneticians he contends that the decrease of entropy as a result of communication favours a local increase of organisation – which is life. Overall Kull's and Sebeok's quotes are a symptom of the singular and, extantly, unacknowledged fact that the mathematical/biological/social sciences of cybernetics and systems theory may have significantly influenced biosemiotics at least in its Sebeokean phase. Such a phase ranges from the 1960s to the early 2000s. Thus this project's hypothesis postulates that biosemiotics is a contemporary form of systems theory and thererefore it seeks to show the high degree of relevance that modern cybernetics and systems theory bear for contemporary biosemiotics.

Research framework: Deely's 'archaeology of concepts'

Since this work's research hypothesis – 'Biosemiotics *as* Systems Theory'– makes reference to two different 'blocks of knowledge' which are 'biosemiotics' and 'systems

theory/cybernetics', it follows that the fundamental approach of this investigation to its subject matter is that of *disciplinary comparison*. Cybernetics and systems theory can be considered as one single disciplinary block because, as the chronologically arranged account of their literature shows (Chapter 4), their theoretical framework often, yet inconsistently, overlaps on the basis of their focus on *systems* and *communications*. The comparative methodology that supersedes the argument of this thesis has been suggested by the work of another theoretician to whom I am deeply indebted, the American philosopher and semiotician John Deely (b. 1942). In his paper entitled 'The Relation of Logic to Semiotics' (1981), Deely, embarks on a re-reading of texts and concepts from semiotics in light of the history of logic, thus framing his work within a comparative perspective, as my work also attempts to do. He calls this method an *archaeology of concepts,* also defined as "the uncovering of the layers by which concepts ultimately taken for granted in some specific population acquired their illuminative power for human culture" (2009c [1981]: 145). Since his investigation is similar in purpose to the one proposed by my research, namely the re-reading of texts and concepts from one discipline in light of models from another discipline, I propose to use the same 'archaeology of concepts' method that Deely employs so effectively in his work. Indeed my thesis proposes a re-reading of texts and concepts from biosemiotics in light of models from systems theory and cybernetics. Following the 'Deely Method', this thesis will explore the extent to which concepts that are taken for granted in biosemiotics, such as *information, communication, systems* and *constraints* to name a few, can be related to a systemic and cybernetic heritage. As Deely states, "the history of logic provides a privileged access to the understanding of semiotics" (2009c [1981]: 210); hence it is hoped that outlining the development of systemic concepts in cybernetics will provide the key for a privileged understanding of biosemiotics. The implications of this comparative method have two imperatives: that the method is *interdisciplinary*, and that the method is *historical*. These constitute the (2) principles of analysis of this thesis.

Interdisciplinarity: defining 'disciplinarity' and the trans-, multi- and inter-disciplinarity distinction

The concept of interdisciplinarity is one that requires elucidations, particularly in respect to its underlying definitions of *disciplinarity*, and its correlation with concepts such as *transdisciplinarity* and *multidisciplinarity*.

The first problem to solve is within the realm of disciplinarity. Such a problem may well be illustrated by the following question: should biosemiotics, cybernetics and systems theory be considered as *disciplines, fields* or *paradigms*? Since the terms 'disciplines', 'fields' and 'paradigms' often recur in this thesis, as a premise for theoretical clarity they should be defined. One effective way to define the terms 'discipline' and 'field' is by proposing a functional definition of these terms. Etymologically speaking, the word 'discipline' comes from the Latin noun *discipulus* (s.v. 'one who learns', or student), thus the original concept of discipline is bound up with the very principle of learning (Gozzer 1982: 285-286) which is dependent on the practice of teaching. Accordingly, 'discipline' can be functionally considered as knowledge developed in a pedagogical context for the practical use of teaching. 'Field' can instead be defined through the dynamic practice of research consisting in the "triadic interaction between individuals, domains (symbolic structures) and their intermediaries, in the creation of novel understandings, methodology and norms" (Csikszentmihalyi 1996, cited in Favareau 2005). This view of 'field' obviously includes practical implications for pedagogy but also more general knowledge-development for the most disparate uses (policy reform, industry, feeding off other research for example). On the other hand, the definition of 'paradigm' betrays not a functional but an organisational conception of knowledge: paradigm can be defined in a linguistic (Saussurean) sense as a system or class of ideas that is organised by a principle which contains its key characteristics. 'Paradigm' can also be embraced in the sense of Thomas Kuhn's view of a revolutionary paradigm as a pattern organising research and raising the type of problems that the research community can solve (1962).

Biosemiotics, cybernetics and systems theory are not considered here as disciplines in the strict sense of having a pedagogical function, but in the larger sense of constituting *research fields*. Following the need of these research projects to consider them as systems, and thus according to their organisational status, biosemiotics, cybernetics and systems theory can be more precisely defined as *paradigms.* This assignation is because the term 'paradigm' can be efficient for analysis since it is reflexive of analytical categories such as paradigmatic *features* and *contradictions* (further explained in section 3 of this chapter). Thus considering biosemiotics and cybernetics as 'paradigms' can allows one to identify the paradigmatic features and contradictions that pertain to them. However, this thesis also uses the term 'interdisciplinarity' which contains the word 'discipline' and not 'paradigm' in it. Following the configuration of biosemiotics and systems theory as 'paradigms', ideally the term 'interparadigmaticity' would be more apposite. However, the term is unwieldy,

adds a layer of unnecessary linguistic complexity to the thesis, and also makes it more difficult to look for related literature, since there is more literature on 'interdisciplinarity' than 'interparadigmaticity'. Therefore for the sake of both efficacy this thesis resorts to the term 'interdisciplinarity 'and, consequently, when addressing the issue, the thesis may refer to biosemiotics, cybernetics and systems theory as disciplines rather than paradigms. Let us remember, though, that where biosemiotics and cybernetics are referred to as disciplines, it is not the functional (pedagogical) definition that is being used, but the organisational definition – disciplines can and should be seen as paradigms or large system of ideas.

The 'Deely's method', or the practice of reading one discipline with another to illuminate tacitly established concepts, gives an *interdisciplinary* status to this thesis. Thus, the second problem that this thesis has to tackle concerns the attempt to provide a workable definition of *interdisciplinarity*. This clarification is made by marking the distinction of 'interdisciplinarity' from related concepts of *transdisciplinarity* and *multidisciplinarity*. Note that this thesis is interested in concept of interdisciplinarity mainly to the extent to which this concept proves useful in guiding the current argumentation and solving theoretical problems in biosemiotics. This thesis is not concerned with solving theoretical problems in interdisciplinary studies. Hence the attempt at making a distinction between 'interdisciplinarity', 'transdisciplinarity' and 'multidisciplinarity' is by no means one that pretends to be exhaustive.

Thus, at its simplest level, *interdiscipline* can be seen as a term that covers a variety of interactions (Klein 1990: 43). There is tension, Klein explains, between those who define interdisciplinarity as a philosophically-conceived synopsis and those who believe that interdisciplinarity is not a theoretical concept but a practical one (1990: 42). Hence under the umbrella term of 'interdisciplinarity' one can find different purposes, those that aim for *integration* and those whose scope is within problem-solving or applied research. However, despite seemingly different research goals, one can still state that fundamentally, interdisciplinary approaches are united at the most basic level through the practice of *borrowing*. This term can be thought of as the *general translation of one term from one discipline to the next*. However one may also note that similarly to interdisciplinarity, *transdisciplinarity* can also be similarly formulated as the "transfer of methods from one discipline to another" (Nicolescu 2002: 43). Thus one has to justify the choice of referring to

interdisciplinarity rather than transdisciplinarity when describing one of the philosophical principles of this thesis, 'Biosemiotics *as* Systems Theory'.

As Klein argues, there are general problems with interdisciplinarity definitions because these can vary from multidisciplinary conglomerates to well-defined integrative paradigms (1990: 64). Multidisciplinarity is an approach that sees disciplines as distinct. An example of multidisciplinarity taken to the extreme could include learning mathematics in a foreign language since in this utilitarian extreme, there would not necessarily be an intention of integrating the two disciplines. Hence one may argue that the main difference in terms of definitions is to be found between interdisciplinarity and multidisciplinarity, rather than between interdisciplinarity and transdisciplinarity, since these last two terms are fundamentally united by an integrative perspective. If one insists on a difference between these two terms, it might be that transdisciplinarity is arguably a more 'ideological' term in light of its prescriptive definition as "a conceptual framework that transcends the narrow scope of disciplinary world views" (Miller in Klein 1990: 66). On the other hand, interdisciplinarity betrays more of a 'functional' character since it refers mainly to the actual practice of integration rather than to its prescription for an ideal form of knowledge-gathering. Therefore one needs to commit to a functional view of interdisciplinarity and uses the term to simply refer to the *integration* of disciplines. Thus interdisciplinarity is here intended as the integration of models and methods of more than one discipline for the sake of reaching a philosophical synopsis; in the case of this thesis, such a synthesisa amounts to a novel framework for cultural analysis informed by both biosemiotics and systems theory.

History (continuity and contradiction) as the grounding principle of interdisciplinarity

Interdisciplinarity does not come without criticism. As Benson contends (1982: 40) "the proponents of integrative studies have given surprisingly little attention to the important work of defining their goals and their methods clearly." However, one may argue that it is not just a definition of methods and goals that makes an interdisciplinary project systematic, but also the identification of a key grounding principle that justifies the very need for interdisciplinarity. This thesis identifies such a grounding principle in *history,* since a historical perspective on interdisciplinarity can provide the project with a degree of *inevitability* and therefore necessity. If it is proved that biosemiotics and cybernetics and

systems theory have converged in history, then one can argue that they have also influenced one another's development. This potential influence is worth researching with the aid of interdisciplinarity. Following this degree of historical inevitability, one can then examine their degree of overlap and thus the possibilities offered by interdisciplinarity as a research method. In other words, an historical perspective could make sure that an interdisciplinary exploration is firmly grounded and justified in historical necessity rather than organisational arbitrariness, as Benson has pointed out.

Deely's 'archaeology of concepts' adopts not only an interdisciplinary but also a fundamentally *historical* method. In 'The Relation of Logic to Semiotics' (1981), Deely presents an account of the discipline of logic consisting of key concepts and authors organised *historically*. He creates his geneaology by date rather than taxonomically, or by issue. This 'vertical' organisation allows Deely to identify two key nodal (conceptual-historical) points in which the history of logic crosses the history of semiotics, one represented by the work of C. S. Peirce (1839-1914) and the other represented by the earlier work of the scholastic John Poinsot (1589-1644). In a similar fashion, it is this thesis' hypothesis that the history of cybernetics has crossed the history of biosemiotics at two key nodal points at least; that is, at the beginning of the twentieth century with the work of the ethologist Jakob von Uexküll (acknowledged as a protocybernetician in Chapter 4 of this thesis and by Lagerspetz (2001), and as a semiotician by Sebeok in 1979b), but also between the 1970s and 1980s, with Sebeok's work on zoosemiotics (1963) and early biosemiotics (1991 [1988]). Particularly, this thesis claims that this last nodal point of overlap between biosemiotics and cybernetics is not sufficiently acknowledged (apart from a remark in Kull 2010b [2009]) and that the young Sebeok was close to cybernetics (Cobley 2010c: 10; cf. Cobley *et al.* 2011: 8-9) to the extent that one may consider him a cybernetician. As it should now be evident, the effectiveness of Deely's fundamentally historical method lies in the fact that when the conceptual timelines of two disciplines are juxtaposed, one can figure out in which moment the principle of one discipline becomes the principle of another, thus uncovering the theoretical heritage that has become invisible, or tacit, in the former discipline and that thus constitutes its interdisciplinary past. Hence this theoretical investigation framed as such by historicity, seeks to identify the implicit but pervasive cybernetics and systems theory heritage of biosemiotics. The notion of heritage as invoked in this work calls for the clarification of its underlying principles: *continuity* and *contradiction*.

A concept that can be used to clarify 'history' is 'continuity'. Historian Robert Shafer (1980) states that "impressed by this fact on the continuity of history, the historian sees problems in a long perspective" (1980: 21), thus underlying how events, or even 'discontinuities' in human affair (citing here the Russian Revolution of 1917) can be seen in an overall continuing, and thus continuous, historical perspective. Followingly, the relation between today's biosemiotics and twentieth century cybernetics would be that of *continuity*. Hence, this thesis contends that one cannot account for biosemiotics' specific contribution to knowledge as abstracted from its historical origins in cybernetics and systems theory and from its potential for applicability in the study of culture. In support of this contention, one may cite McDowell's claim that "the future is, in any case, partly conditioned by the past: it is not entirely predictable, but equally it is not the outcome of pure chance" (2002: 6). Thus, arguably, acknowledging a discipline's adumbrations is fundamental if one wants to develop its future programme of research. However such an outlook on the past does not have to be seen as an instance of naïve causality. In fact it is not only past 'determination' that this thesis claims as a necessity, but also the "*influence of the future* within the present, altering the relevance of past events and presaging... without strict necessity... 'what is to come' out of what has been and is" (Deely 2010: 89). This fundamentally narrative principle expresses the causality proper to the action of signs as identified by Poinsot and referred to by Deely as *vis a prospecto* (2010: 35), and the forward-looking nature of semiotics. In this respect Sebeok also states that "the ideal of semiotic analysis is to combine causal with functional explanation" (1979: 13), thus implying that an understanding of the development of a system (in this case the discipline of biosemiotics), requires an appreciation for both causes (the disciplinary past) and functions (the disciplinary purpose, or future objects of research). It would however be unrealistic to attempt to identify both 'causes' and 'purposes' at once, since the practice of writing (as well as this PhD project) requires a linear exposition. That is why this project first emphasises *initial causes* (through its literature review, as in Chapter 3 and 4), then its *final causes* (or future objectives) such as the synthesis of a new analytical framework for culture (as in Chapter 7).

Unlike superficial or merely deterministic causality (*Post hoc ergo propter hoc* i.e. 'after this, therefore because of this'), semiosic causality (or *vis a prospecto*) promotes that significant *change* may happen within continuity. Hence the second principle that underwrites this project's historical perspective, that is, the view that continuity is one constituted by discontinuities or *contradictions* [2]. This principle is so because the practice

of interdisciplinary borrowing (such as that which characterises cybernetics from the 1920s to 1990s, or biosemiotics in the 1990s as found in Sebeok and Umiker-Sebeok 1992) leads to clashes of research interests, discrepancies of models and of purposes. It also leads to the occurrence of seemingly 'incoherent' switch of objects of research. In other words, interdisciplinary borrowing leads to *disciplinary discontinuities*. In a similar manner to the way in which Anderson and Merrell have emphasised that the modelling of micro- and macro-evolution of the living requires an appreciation for, amongst the other things, "continuity and discontinuity" (1991: 7), one may argue that the modelling of a discipline's past includes conceptual jumps or theoretical voids. These events can be defined along the line of Althusser's Marxist reading of history as constituted by *uneven development*. In 'Contradiction and Overdetermination' (2005[1965]), Althusser reworks this expression[3] and synthesizes a theory of historical development conceiving of historical complexity as made of contradictions. As an example he described the contradictory situation of Tsarist Russia at the dawn of the 20th Century, characterised by the:

> gigantic contradiction between the state of development of capitalist methods of production (proletariat concentration: the largest factory in the world at the time was the Putilov works at Petrograd, with 40000 workers and auxiliaries) and the medieval state of the countryside. (2005 [1965]: 96)

According to Althusser, this contradiction, or the unevenness of capitalist development which was evident in Russia more than in any other European country, created the objective conditions for inevitable change that led, via the 1914-1918 war, to the Russian Revolution. Thus, this event of sudden change, uneven development, rupture or sudden leap forward envisages the underlying conception that the historical condition of a system (a country at a specific point in time, or, for the purpose of this thesis, a discipline at a specific point in time) is always complex, that is, it is constituted by contradictions that produce further incoherent or uneven developments and that are themselves the products of previous seemingly incoherent or uneven developments.

The significance of this realisation for the investigative approach of this thesis is as follows: when studying the contribution of a single discipline, one is forced to choose between envisaging a discipline as a body of arguments which is reflectively coherent with itself, even across time and envisaging a discipline as a collection of principles whose

[3] Althusser's draws the expression and concept of 'uneven development' from Lenin's 'Law of Uneven Development' (in Althusser 2005[1965]: 97) and from Mao Tse Tung's the notion of contradiction found in 'On Contradiction' (1937).

development across the history of that discipline happens to be contradictory even more than once. Choosing the first possibility would imply a simplification of the framework that one is studying and the ease in identification and critique of this same framework. At the same time, the choice of reducing a large body of work to a set of simplistically coherent principles would also churlishly reduce the richness of contributions that the discipline has brought to world knowledge across time and would produce critique that stems from a narrowly contextualised reading of a discipline. For example, the typical critique of cybernetics as a "technocratic management strategy" (Wolfe 1998: 78) stems from a simplistic conception of disciplinary historical development. This view does not take into account that in principle (proto) cybernetics studied living beings' forms and behaviour (see Cannizzaro 2010a) and only subsequently focussed on technology (first order phase), to eventually turn again to the study of living beings (second order phase). This continuous, but 'incoherent' switch of cybernetics' object of research across its proto, first order and second order phases is a clear sign, as the chronological account in Chapter 4 shows, of the uneven development that the discipline underwent in a century of modern history. Thus, eliminating the first possibility for its oversimplifying and a-historical perspective, one is left with the second possibility. This latter approach requires not just a taxonomic and general understanding of the discipline's concepts, but also an understanding of these concepts as evolving along a contradictory and uneven timeline.

Thus, articulating the historical perspective of this theoretical investigation helps to reformulate its research hypothesis from the proposition 'contemporary biosemiotics is a development of modern cybernetics and systems theory' to the more defined thesis *contemporary biosemiotics is an uneven, but nevertheless continuous, development of modern cybernetics and systems theory.*

Isomorphic models

So far, the two general principles of reasoning of this research project have been outlined: that (1) the current project takes the form of a theoretical investigation which explores the neglected cybernetic heritage of biosemiotics; and that (2) this quest is framed by Deely's philosophical method named 'archaeology of concepts' (1981). Using Deely's *archaeology* implies an appreciation for 'interdisciplinarity' and 'history'. These concepts can be understood respectively in terms of Klein's *borrowing* (1990) and Althusser's *uneven development* (1965). These elucidations constitute the *initial theoretical premise* and the

general theoretical framework that shape this thesis' argument. Another feature of this project must now be outlined: that is, an explanation of how this theoretical premise and framework are transformed into practical guidelines for the mapping of the material presented in the literature review and for the organisation of the thesis' analysis and results.

In order to carry out an 'archeological study' of concepts of biosemiotics following Deely's example, this thesis proposes to use as 'principle of analysis', Ludwig von Bertalanffy's view on *isomorphism* (1945). This concept originates in Bertalanffy's *General System Theory* (1968 [1939 - 1967]) which is a transdisciplinary examination of systems or, more broadly, models of a general nature. Boulding describes General System Theory as 'the skeleton of science' (1956) because it can potentially provide different disciplines with a common language with which to discuss problems. General System Theory is based on the premise that reality can be seen and described in terms of *systems.* Conceived as a *model of general nature,* a system is defined as a conceptual analogue of certain universal traits of observed entities (Bertalanffy 1973c: 89). Systems can be described in terms of 'isomorphic models' in that these characterise, describe or express certain general aspects of the (organisational) state of such systems across more than one discipline (Boulding 1956: 198). Particularly, isomorphic models apply "to generalised systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relation or 'forces' between them" (Bertalanffy 1973a: 31). Because isomorphism, or structural similarity, is one of the core principles found at the basis of any trans- or interdisciplinary-work (Miller 1981), then one may argue that such a principle is suitable also for the current interdisciplinary thesis which investigates the degree of commonality between biosemiotics and cybernetics. Thus, the degree of commonality or the disciplinary relevance of cybernetics for biosemiotics will be investigated in terms of isomorphic models.

The 'isomorphic model' is chosen as this thesis' analytical category since it allows the grafting of cybernetic models onto biosemiotic phenomena in terms of their common structural organisation and history. It is expected that identifying isomorphism as analytical category or 'predicate' of this thesis' argument, will justify the juxtaposition of the biosemiotic concept of *modelling* to the cybernetic concept of *system,* or the (bio) semiotic concept of *abduction* to the cybernetic notion of *information.* In this respect, the principle of isomorphism would allow one to argue that despite information theory pioneer

Weaver's words that "information has got nothing to do with meaning" (1949: 15) the concept of 'information' and 'meaning' are to an extent also relevant to *each other* (Chapter 6). Therefore isomorphism does not just enable biosemiotics to share some of its models with systems theory and cybernetics but it also aids interdisciplinary translation. Thus isomorphism can be intended *sensu* Lotman's view on translation as "the transfer into one semiotic space of the structural principles of another" (2001a (1990): 62). Specifically within the context of translation, isomorphic models can be seen as *verbal models* which possess the capacity to provide 'explanation in principle' (Bertalanffy 1973a: 35) or 'qualitative explanations' of general phenomena upon the example set by René Thom in *Catastrophe Theory* (1975). In fact, with its foundation in the mathematical concept of isomorphism, General System Theory can be held to be similar in the explanation it can provide to topology, understood by Sebeok (1989 [1979d]: 24, my italics) as a field that "has the satisfying property of providing a single interpretation to quite disparate data in the world in which we live. The results are expressed in geometric language, hence are *qualitative* rather than numerical". Thus in light of their capacity for providing qualitative and thus flexible descriptions of phenomena, isomorphic models are potentially highly translatable and adaptable to different subject matters, and thus suited to an interdisciplinary project such as the current one.

From theory to practice: how 'interdisciplinary mapping' works

The above analytical framework for analysis, made up of the 'Deely Method', Althusser's view of history as contradiction, Bertalanffy's isomorphism and Lotman's cross-space translation, guides the organisation of material of the thesis. As per aim (3), the following section indicates how these principles of analysis translate into guidelines for the thesis' material. In other words it indicates the workings of the 'interdisciplinay mapping' proposed in this project.

Following the 'Deely Method', biosemiotics and cybernetics-systems theory's key contributions to knowledge are outlined, juxtaposed and then analysed in unison. In order to carry out the comparative-archaeological study of concepts, the two main disciplinary 'blocks' of biosemiotics and cybernetics-systems theory are initially treated as pertaining to a separate history, although their own contributions are still outlined in terms of the relevance to the sister discipline. Then such contributions are compared on the basis of the 'isomorphic models' that they share at specific points in history. These are anticipated to

be the concepts of 'homology' (as developed in Chapter 5) and 'information' (as developed in Chapter 6). The aim of this comparison is to show that there is a *commonality of models between biosemiotics and systems theoretical disciplines* and that because of this reason biosemiotics can be argued to be a (contemporary) branch of systems theory itself. Thus the identification and analysis of isomorphic models sets out to demonstrate both the degree of contiguity but also the degree of continuity that biosemiotics and systems theory bear. However this thesis not only seeks to pay equal attention to both the aspects in which biosemiotics and cybernetics overlap (continuities) but also to the aspects in which they diverge (*contradictions*). In other words, attention is paid to the process of translation and adaptation of the isomorphic models across biosemiotics, systems theory and cybernetics and to the semantic incongruence may emerge. To perform the above, this thesis is organised so as to present:

a) An account of the separate theoretical principles which constitute biosemiotics and cybernetics-systems theory and, where considered appropriate, of the problems that they leave open for scholars in other fields.
b) An indication of the general degree of relevance (isomorphism) that models from cybernetics-systems theory and biosemiotics bear for each other.
c) A clear outline of the areas in which, logically and historically, the two fields overlap and share a degree of similarity in laws, models or scope.
d) And, similarly, but in an opposite fashion, an outline of the areas in which cybernetics-systems theory and biosemiotics profoundly diverge.
e) An indication of how 'Biosemiotics *as* Systems Theory' can provide the grounding for a new form of cultural analysis.

The outline of the thesis offered in the 'Introduction', (Chapter 1), thus takes a more specific shape in light of the 'archaeological' and 'isomorphic' method: points a) and b) shape the mapping of the literature review material which consists of a synchronic account of biosemiotics' contributions (Chapter 3) and a historical account of cybernetics' contributions (Chapter 4). Specifically, the first part of the literature review, seeks to outline those contributions in biosemiotics that, while representing key paradigmatic features of the biosemiotics' field, *approach* cybernetics and systems theory endeavours. On the other hand, the second part of the literature review outlines the major contributions that pertain to the modern history of cybernetics and seeks to demonstrate how some of these contributions strongly *anticipate* biosemiotics' recent endeavours, and

thus constitute biosemiotics' implicit heritage. Subsequently points c) and d) provide a general guidance for the analysis and translation of the isomorphic models that cybernetics and biosemiotics have in common (Chapter 5) and those where they clash (Chapter 6). Specifically, the first part of the disciplinary and historical 'mapping' sets out to qualify the isomorphism between biosemiotics and systems theory by precisely identifying the specific 'universal traits' that constitute it, that is, transdisciplinarity, history and function. The second part of such a mapping indicates that the isomorphism between biosemiotics and systems theory, by means of its uneven historicity, is founded on a contradiction, that is, biosemiotics' conception of information relying on abduction, and cybernetics' conception of information undeniably taking recourse to logic. Lastly, e) proposes to use the results of this overall project as a means to solve problems within the analysis of culture. In this last chapter (Chapter 7), following the reconfiguration of 'Biosemiotics *as* Systems Theory', the so-recognised isomorphic models of 'modelling', 'purely objective reality' and 'cybersemiotic constraints' are set as the practical guidelines for a new form of cultural analysis. The latter is an approach to bridge the newer nature/culture divides first argued convincingly by C. P. Snow (1959) in *The Two Cultures*.

Considerations on the practical problems of interdisciplinary mapping.

Such a proposal for an interdisciplinary mapping of fields is not without difficulties. At a general level, interdisciplinary projects may incur criticism precisely because of their exploratory dimensions. For example by force of its interdisciplinarity, biosemiotics is prone to criticism across many quarters in their pursuit of knowledge. Biosemiotician Hoffmeyer refers to this issue when he states that:

> those readers with a biological background ... [may] think that the biosemiotic approach may be a form of disguised *vitalism*. Empirical researchers may quickly spot a warning sign that suggests *metaphysics*. Humanists, on the other hand, may see a danger marker that points to *reductionism* (2008: 5).

The lesson to learn from this reflection is that, in general, interdisciplinary projects may yet attract scholars from a set of different fields and may be rich in ideas but, at the same time, they run the risk of being seriously criticised from each and every one of these perspectives. Thus, the legitimate question that one may pose is "what are the limits of interdisciplinarity?"

Hence, at the specific level of the current work, it is argued that the limits that this interdisciplinary project encounters are *depth, implicit knowledge, discrimination of the relevance of information,* and *literal transposition.* Brier deals with the issue of *depth* in *Cybersemiotics* (2008: 6) by stating that "in transdisciplinary work, it is best to dig into subject areas only to the depth that is necessary to build one's transdisciplinary framework or else you will be drawn into the details". Following Brier's example, I will delve into arguments and concepts only to the depth which is yet necessary to the scope of this project, and leave out, for example, details about the general context of cybernetics role in warfare technology development or management strategy or existing debates between code-based biosemiotics and interpretation-based biosemiotics (also because I implicitly partake more of the latter position).

Research across disciplines implies that one needs to be prepared to *unfold the underwritten implicit knowledge* that each of these disciplines require. When considering the contribution of a single discipline, one is, in effect, considering a complex intersection of a myriad of other disciplinary contributions that preceded that discipline. A discipline could be described as a 'bouquet of times' using French philosopher Michel Serres' expression, originally employed to describe organisms as a combined result of ontogenesis and phylogenesis (1982 [1980]: 75). Thus, by dealing with biosemiotics and cybernetics-systems theory this thesis simultaneously deals with 1) semiotics, particularly in the version of C. S. Peirce's (1955 [1897]) quasi-necessary logic, but also to an extent, structuralism and theories of reading (Iser 1974, Fish 1980, Eco, 1962); this project also deals with 2) set theory, which explicitly underwrites First Order Cybernetics (Ashby 1956, Beer 1959, Bertalanffy 1968) and to an extent even Second Order Cybernetics (see von Foerster 1973, Luhmann 1986); and, ultimately, it deals with 3) a discursive notion of statistics in relation to entropy (Clausius 1865, in Clarke 2002), negentropy (Schrödinger 1944, Prigogine 1984) and information (Shannon and Weaver 1949; Bateson 1970), which all underwrite first order and Second Order Cybernetics, and, to an extent, even biosemiotics.

The abundance of arguments that one could extrapolate from such extended disciplinary context, highlights the information-*discrimination* challenge that unavoidably characterises interdisciplinary research. One in fact needs to *learn* to discriminate between notions that are fundamental and have to be researched even if they pertain to a separate subject matter, from notions that are trivial. There is not a specific way of predicting precisely which information is going to be relevant for a research project; thus, in research, one

often has to rely on right-guesses (Peirce's abduction, 1867-1893) or strong intimations of truth, which can then be refined through deduction (testing, that is, applying the new knowledge to the current research context) and induction (collecting more proofs).

Lastly, interdisciplinary research also involves issues of *translation*. The qualitative explanation offered by the use of isomorphic models has to be approached with caution, specifically in light of problems of translation. It is remarkable that it is the founding father of General System Theory himself who offers the reminder that there is often incongruence between models and the reality they intimate (1973a: 21). This fact suggests that not all models are fully translatable and that some may not be translatable at all. For example, Bertalanffy explains that cybernetics was an extension rather than replacement of the mechanistic view and machine theory; or that models of equilibrium, homeostasis, adjustment, are suitable for the maintenance of systems but inadequate for phenomena of change, differentiation, evolution, negentropy, production of improbable states, creativity, self-realisation and emergence. Similarly, in *Cybersemiotics* (2008), Brier warns against translating information from the mathematical sciences into biology or semiotics. Therefore "it is necessary to warn against incautious expansion to fields for which concepts are not made" (Bertalanffy 1973a: 21-23). In other words, isomorphism is not enough by itself, since it would be misleading to limit interdisciplinary analysis to uncovering formal similarities across fields, without taking into account the deep *semantic differences* between them. Cobley (2010b) essentially addresses this problem of incongruence (cf. Bertalanffy) or semantic difference in stating that one has to be careful in overemphasising *agency* in biosemiotics. Stressting agency may be beneficial to the biological sciences which have up to today largely underplayed 'agency', but may be counterproductive for the humanities which have instead up to today abused 'agency' (partly for ideological reasons promoting socialised individuality and for the over-emphasis put on the role of verbal language in the analysis of culture).

In light of such an incongruence of foci, this thesis's argument attempts to take into account the implications that conceptual models can acquire when transposed, or envisaged within the context of a discipline different from that in which they originated. As such, this thesis broadly addresses problems of paradigm 'translation' as they are encountered during the chapters dedicated to the analysis of isomorphic models (Chapters 5 and 6) and in the framework for cultural analysis (Chapter 7). The intent is to avoid an oversimplified and yet potentially misleading reading of the overall research project as a

bid to graft cybernetics onto biosemiotics in either a reductionist mode or as a replication of sociobiology and its controversial outcomes.

Conclusion

This chapter delineates the thesis' *approach to the argument in lieu* of a 'methodology' chapter. Such an approach envisages 1) a justification of the choice of pursuing a *theoretical* project as opposed to an empirical project as is perhaps more expected of a PhD project set within the social sciences. Such a theoretical approach is modelled upon the philosophical work of Althusser (1965), among others; 2) an *historical* perspective as embodied in Deely's 'archaeology of concepts' (1981) which in turns touches on a) issues of interdisciplinarity and b) history as continuity and discontinuity; 3) a *transdisciplinary* perspective as embodied in Bertalanffy's notion of 'isomorphic model' (1945); 4) an indication of how these theoretical premises translate in practical guidelines for the organisation of the material of the thesis; and 5) finally, a consideration of the problems and limits that a theoretical-historical-interdisciplinary project of this kind encounters. The effort behind the formulation of this framework has been dynamic in light of the challenges that new readings, constant argument reformulation and the organisation of the thesis' material have posed. A specific example of this process, as embodied in this chapter, is that the hypothesis underlying the thesis has undergone reformulation and precision as the current chapter (hence the state of research) progressed, that is, from positing that 'biosemiotics is a development of systems theory' to positing that 'biosemiotics is an *uneven* development of systems theory'.

CHAPTER 3

Biosemiotics as an open (paradigmatic) system: Steps towards the articulation of 'modelling' and 'information'.

Introduction

This thesis argues that biosemiotics is a modern form of systems theory. To support such a view, this thesis proposes an articulation of the biosemiotic paradigm in terms of cybernetics-systems theory (following the Deely method of reading one discipline in term of the principles of another). This chapter specifically presents the first premise of the thesis' argument: that is, it seeks to outline what biosemiotics *is* before saying in which way it overlaps with cybernetics. Thus, starting from the instantiation that biosemiotics is a 'paradigm', this chapter's main aim is to present the key paradigmatic features that constitute such a paradigm.

Anderson *et al.* (1984), Hoffmeyer and Emmeche (1991), Eder and Rembold (1992) and Kull (1993) have all defined biosemiotics as a paradigm. According to Kuhn, paradigms are "...universally recognised scientific achievement, that for a time provide model problems and solutions to a community of practitioners." (Kuhn 1996 [1962]: x). Thus a scientific paradigm can also be understood as pattern or organising principle for research. However, Hoffmeyer (2008a: 3) argues in favour of using the term biosemiotic *approach* rather than biosemiotic *paradigm* "in the attempt to avoid the premature hardening of the biosemiotic idea into an actual paradigm." Hoffmeyer is right in this choice in the sense that given the different disciplinary affiliations of the scholars that come to biosemiotics, including at the very least molecular biologists as well as Peircean methaphysicians, it seems quite hard to talk of biosemiotics as a unproblematically-conceived paradigm which should offer small and self-contained problems to solve for its practitioners (as in Kuhn's idea). On the contrary, in biosemiotics, debates about the nature of interpretation (Barbieri 2008; Hoffmeyer 2008a), of information (Hoffmeyer 1996a; Brier 2003, 2008) and function (Sharov 1992, Kull *et al.* 2009) are all but small and self-contained problems to solve. One thing however is clear: that a paradigm, as the most fundamental organising principle of a science (which must be intended as a complex system), defines at least *broadly* the structure of such a system and thus broadly defines the *class of problems* that will be legitimate to examine. Thus we shall not embrace the notion of paradigm entirely in the sense of Thomas Kuhn (as a principle defining small and discrete problems for *its* scientists)

but rather the idea of paradigm as an open system defining problems for its scholars *broadly*. In this way one can object to Hoffmeyer's reservations about speaking of biosemiotics as a *paradigm*.

Following this argument, biosemiotics can be recognised as a paradigm and, particularly, a paradigm open to the articulation of some of its grounding principles (paradigm articulation). Kuhn says that if the paradigm undergoes deep articulation, then it will be a failure (Kuhn 1996 [1962]: 35). However, this excessively pessimistic view of change can be phrased more suitably. If one conceives a scientific paradigm as an autopoietic social system (following Maturana and Varela 1980, and Luhmann 1991), then this system is allowed to change configuration to the extent in which such change does not undermine its continuation (or the reproduction of the conditions that produced it in the first place). When this configuration deviates too much from the range of essential states (or variables, following Ashby (1956: 197) of the system, the paradigm changes identity or merges into other disciplines and fields. This simply results in further disciplinary translation (*sensu* Lotman), and not in the 'death' of the paradigm, or failure. Thus, in short, this chapter starts from the premises that biosemiotics is a *paradigm*, which must be conceived as an *open system*. Its openness, to put it simply, refers to the idea that it is legitimate to think that the paradigm can be open to the articulation of some of its core models.

Since this chapter's aim is to outline, synchronically, the general 'class of problems', or the models that constitute biosemiotics as a paradigm, an issue-based approach to the literature is preferable for this review rather than one historical and chronological. It has to be specified that such a review does not cover the entirety of the topics that one can find in biosemiotic literature because the field encompasses so many other fields that attempting to account for all its interdisciplinary influences would be unreasonable for our aims. This is not to say that I have neglected to approach a broad vista of the field. Indeed, to initially plan this chapter, I have revised a vast amount of biosemiotic literature as to gather enough interdisciplinary knowledge of the field (for example, see Cannizzaro 2011). Yet I have decided to rather pursue an analytical focus and to include in this review only those topics that strictly relate to this thesis' central argument. Therefore, this literature review includes discussions of only those scholars who, while developing core biosemiotic issues, contributed to the endeavour of cybernetics. The scope of this section is restricted in two ways: (1) commentary on biosemiotics's contribution is limited to the discussion of the paradigmatic features of *modelling* and *information*. (2) These 'key' paradigmatic features

or models of biosemiotics are introduced here only in respect of their degree of overlap and relevance to cybernetics and systems theory. Such a 'relevance' is hinted at in this chapter in terms of biosemiotics' *contiguity* of disciplinary interests with cybernetics, and is further articulated in terms of its *historical continuity* with cybernetics in chapter 4.

On models and modelling

Cyberneticians (Wiener 1949, 1951; Ashby 1956; Pask 1961; Beer 1967; Bateson 1972; von Foerster 1973; Lovelock 1979; Maturana and Varela 1980; Jantsch 1980; Wilden 1980) and systems theorists (von Bertalanffy 1968; Luhmann 1986, 1990; Serres 1980, 2007) conceived reality and its events in terms of systems, more specifically systems of relations. As Anderson *et al.* pointed out (1984: 25), generally in semiotics there is the need to conceive of systems in their complexity and dynamical aspects, in order to be able to conceptualise the evolution of sign-systems. And in contemporary biosemiotics what is particularly close to the cybernetic notion of system and systems' complexity is represented by the body of literature on *modelling*. Whence my choice to focus on models and modelling in this first part of the review.

In biosemiotics, the notion of model and modelling have been extensively discussed by Sebeok (1988), Anderson and Merrell (1991), Krampen (1997), Sebeok and Danesi (2000), Danesi (2010), Kull (1998; 2010a) and, to an extent, Hoffmeyer (1996a). According to Sebeok (1991b [1988]: 35) the notion of modelling owes much to the Tartu-Moscow school of semiotics' notion of modelling system as developed in the work of Lotman (1967, 1990) and Zaliznjak *et al.* (1977) which in turn, is derived from von Uexküll's model of the *Umwelt* (1940). This section focuses on those works that constitute the 'primary' reading material on 'models', 'modelling', '*Umwelt*', 'semiosphere', hence on the work of Sebeok, Lotman, von Uexküll, Sebeok and Danesi.

Sebeok and Danesi defined a 'model' as

> a form that has been imagined or made externally (through some physical medium) to stand for an object, event, feeling, etc., known as referent, or for a class of similar (or related) objects, events, feelings, etc., known as *referential domain* (2000: 2).

Thus the term 'model' delineates the referential capacity of a sign to stand for something. As Sebeok and Danesi stated, what justifies the interest in models is the fundamental

recognition that "models serve many functions in human life. They allow people to recognise patterns in things; they act as predictive guides or plans for taking actions. They serve as exemplars of specific kinds of phenomena" (2000: 2). An example of this would be the London tube map which is an 'idealised' model of reality, in other words, a simplified model of the real distances and locations that one can actually find represented in a more highly iconic way on a standard geographical map and that one finds in the real world. The function of such an abstract model lies in the benefit it brings, notwithstanding its topographical inaccuracy, to the user in planning a journey with ease. This practical recognition suggests that the study of models is well suited to the study of their functions. Because of this emphasis on function, semiotics or the "science which studies models and their functions" (Sebeok and Danesi 2000: 2), strives for a high degree of qualitative *explanations* of phenomena.

Additionally, an earlier formulation from Sebeok of the term 'model' as "a semiotic production with carefully stated assumptions and rules for biological and logical operations" (Sebeok 1991 [1988]: 57) suggests that he pre-empted the need to study models within a biological framework, and within the context of 'operations' - that is, processes of modelling. These two points bring biosemiotics close to cybernetics' idea of complexity (which include a biological and a historical context) and constitute therefore the epistemological cornerstones of Sebeokean biosemiotics.

Subsequently, the notion of 'modelling' is important to biosemiotics since it provides a framework for discussing how living beings construct the world which they inhabit (through their senses, through language, and through culture) in a manner that is *neither arbitrary nor deterministic*. 'Modelling' also provides the way to theorise the *continuity* between the different worlds of nature and culture.

The classic formulation of modelling systems was provided by Juri Lotman in 1967, who defined them as:

> the structure of elements and of rules for combining them that is in a state of fixed analogy to the entire sphere of an object of knowledge [...] Systems that have a natural language as their basis and that acquire supplementary superstructures, thus creating languages of a second level, can appropriately be called secondary modelling system (Lotman 1967 cited in Sebeok 1991 [1988]: 50).

The notion of modelling systems was central to the Tartu-Moscow school of semiotics (Broms and Kaufmann 1988). Also called 'Soviet Semiotics' in Lucid (1977) this school operated between the 1960s and the 1980s. It has to be noted that the phrase 'Secondary Modelling System' as a staple of the Tartu-Moscow school of semiotics, was used as a euphemism for 'semiotics' more broadly in 1964 because the very term 'semiotics' was elevated as a fashionable Western Europe enterprise and was therefore prohibited by scientific state officials in Soviet times (Chernov 1988: 12). However one can argue that 'modelling system' in contemporary viewpoints, is not just a general replacement term for semiotics but hints at a precise conception of semiotics which mediates a synchronic approach (typical of Saussurean semiology) and a diachronic approach (typical of pre-Saussurean linguistics), giving equal weighting to both structural and historical considerations. In fact, the nomenclature 'modelling system' precisely illustrates the derivational character of culture in relation to 'natural language'. This distinction is specific to the work of Russian semioticians A. A. Zaliznjak, V. V. Ivanov and V. N. Toporov, as well as Juri Lotman, who later taught semiotics in Tartu (Estonia). According to Zaliznjak *et al.* (1977) there is a 'natural language' one can find at the basis of all other sign systems. Such natural language is intended as the linguistic system (that is, verbal language) that presents general linguistic features as *syntagm* and *paradigm*, which can then be found in more complex systems. Thus, in Tartu-Moscow semiotics, linguistic systems were considered as universal sign systems constituting *superstructures* such as cultures, religions, types of sciences.

The functioning of Primary and Secondary Modelling systems is explained in Juri Lotman's work on the 'semiosphere' (Lotman 1967, 1990, 2001). The notion of semiosphere is important to biosemiotics because it provides an effective model of the world as constructed through signs (which includes both system and environment, or organism and niche) but also it provides biosemiotics with a rudimentary model of continuity between Primary and Secondary Modelling Systems, later reworked by Sebeok (1988) as the following section explains. Also, the concept of semiosphere has been important enough to generate allied but different versions of 'semiosphere' in the work of contemporary biosemioticians (Hoffmeyer 1996a, Kull 1998).

Lotman formulated the semiosphere as a model to describe culture in both its general features (a horizontal or synchronic approach) but also in its historical changes (a vertical or diachronic approach). The semiosphere investigates not just how information is

transmitted through culture, but how new information is generated through it and how information is preserved in collective cultural memory (Lotman 2001a (1990): 2).The semiosphere is constituted by centre and periphery, the locations of the primary modelling system and secondary modelling system respectively. *Binarism*, or opposition between *asymmetric* and thus competing language-based systems, causes *dialogue through translation* between primary modelling systems and secondary modelling systems. Lotman presents the Primary Modelling System as verbality (as in the tautology, 'verbal language'), as well as, problematically, pictorial signs and the Secondary Modelling System as cultures and conventional sign systems. Note that Lotman's notion of Primary Modelling System is different from Sebeok's (1988) reworking of the concept, in that Sebeok contends that primary modelling includes only externalised, nonverbal signs and excludes externalised linguistic signs even while it holds their potential. In the semiosphere one can observe the derivational character of culture (Lotman's Secondary Modelling System) in respect to verbal language (Lotman's Primary Modelling System), serving as a model of continuity amongst systems of different complexity (e.g. animal and human), a topic that is a recurrent one in biosemiotics (Sebeok 1979e; Cannizzaro 2005). Also, the idea of a continuous dialogue between asymmetric systems is similar to the idea of continuous adjustments among disequilibrium systems (Wiener 1949, 1951; von Bertalanffy 1968; Prigogine and Stengers 1984) in cybernetics and theoretical biology. This observation on modelling calls for some development.

Taking his cue from the Tartu-Moscow notion of modelling system, and Lotman's model of the semiosphere, Sebeok proposed a reconfiguration (1988)[4] of 'Primary Modelling System' that can be argued to constitute a core distinctive paradigmatic feature of biosemiotics (though an often neglected one, particularly on the side of those biosemioticians who erroneously conflate semiology and linguistics with the 'semiotics proper' which underlies biosemiotics, e.g. Florkin 1974; Barbieri 2008; but also, to a minor extent, T. von Uexküll *et al.* 1993; Krampen 1981).

Sebeok in fact recognises the fundamental contribution that Soviet scholars brought to semiotics with their emphasis on modelling, which implies a necessary concept of *space*,

[4] The reworking of the Tartu-Moscow school's notion of primary modeling system was originally proposed by Sebeok during the 25th Symposium of the Moscow-Tartu school of Semiotics (Imatra, Finland July 27-29, 1987), and then published in the conference proceedings volume, H. Broms and R. Kaufmann eds. (1988) *Semiotics of Culture*, Helsinki: Arator.

history and innovation through translation, and their emphasis on the *derivational* character of culture in relation to verbal language. Yet Sebeok suggested that Soviet semiotics[5] did not sufficiently take into account how humans could communicate and build 'cultures' well before mastering externalised verbal signs. This is because hominids e.g. *Homo habilis, Homo erectus,* used nonverbal communication for so long (at least half a millions year) before developing syntax-based linear communication or externalised verbal communication, which emerged in full in *Homo sapiens* 300000 years ago, that is, before the externalisation of the verbal capacity for communication in Homo sapiens, humans possessed only a *mute verbal modelling device.* This device was a basic capacity for syntax that would allow, for example, to assemble standardised tools but not to yet to encode communication in articulate linear speech (1991c [1988]: 55). This is why this phylogeny of communication of the genus *Homo* , Sebeok gave evidence that there are signs systems (nonverbal communication) which in terms of evolution are *antecedent* to externalised linguistic signs systems. Nonverbal communication is recognised by Sebeok as an adaptive communicational capacity possessed by all living beings (1981, 1988). It is, in fact, only hominids across the whole animal kingdom that possess two mutually sustaining repertoires of signs: zoosemiotic nonverbal and anthroposemiotic verbal (1991 [1988]: 55). Thus perspectives of 'Soviet Semiotics', which put verbal language at the basis of all communications and of the organisation of culture, was at risk of both glottocentrism and anthropomorphism. In light of the recognition that there is communication prior to verbal language, Sebeok proposed a reconfiguration of Soviet Semiotic's notions of modelling systems and observed that (verbal language) "is the modelling system the Soviet scholars call primary but which, in truth, is phylogenetically as well as ontogenetically secondary to the nonverbal."(1991 [1988]: 55) Thus, according to Sebeok, 'natural language' or the primary modelling system is not verbal language, but is 'nonverbal communication' manifested in chemical, thermal, olfactory, acoustic and visual communication. In humans, such primary modelling existed, phylogenetically, alongside the cognitive capacity manifested in the production of externalised verbal signs (secondary modelling system).

[5]The use of the term 'Soviet' could prove problematic today in the negative ideological connotation that it may attach to semiotics. However there is a book named *Soviet Semiotics* (Lucid 1977) and Sebeok himself uses this expression a number of times to refer to the Tartu and Moscow school, e.g. "Soviet semiotics of the Tartu Moscow school" (1988: 49) and "Soviet conceptions of models" (Sebeok 1988: 53). Hence, as a means to make a precise historical and bibliographical reference, the occasional use in this thesis of the phrase 'Soviet Semiotics'.

However, it was not until *Homo sapiens* that such signs (secondary modelling systems) were routinely circulated.

Here, Sebeok develops a core proposition of biosemiotics (possibly the most fundamental of its paradigmatic features): nonverbal means are the repository of real biological communication that carries out the fundamental adaptive function of modelling that ensures a species' survival. In fact Sebeok holds that "[natural] *Language evolved as an adaptation*; whereas *speech developed out of language as a derivative exaptation*" (1991 [1988]: 56). That is, the Primary Modelling System sustaining nonverbal communication had a palpable survival function. On the other hand, the Secondary Modelling System, featuring externalised verbal signs arranged syntactically, or speech, did not necessarily have this. Indeed,

> language - consisting of a set of features that promote fitness [thus meant as nonverbal communication] - has been built by selection for the cognitive function of modelling and, as the philosopher Popper and the linguist Chomsky have likewise insisted, not at all for the message-swapping function of communication (Sebeok 1991[1988]: 56).

Such a message-swapping function of communication can be intended as non-necessary communication. For example message exchange includes communicating a brand image to target audience through advertising, or communicating my weekend experience to friends through Facebook, Twitter or other expressions of new media.

To understand modelling and how this unfolds across the world of human beings and living beings in general, one needs to make clear the way in which it relates to survival. That is, one has to clarify the functional overtone of modelling. The link between communication, modelling and adaptation was suggested to Sebeok (1988) by the concept of *'Umwelt'* as found in the work of early 20th Century ethologist Jakob von Uexküll (1940). By introducing von Uexküll's *Umwelt* into semiotics, Sebeok found a point of contact between the mainstream scientific approach to the study of organisms – evolutionary thinking in biology - and that of the strictly intellectual semiotic cultural tradition. In so doing Sebeok enlarged the object of study of semiotics to encompass biological systems, and effectively inaugurated the biosemiotics enterprise.

Von Uexküll (2001 [1936]:107) introduces the *Umwelt* as follows:

> Everyone who looks about in Nature finds himself (or herself) in the centre of a circular island that is covered by the blue vault of heaven. This is the perceptible world that has been given to us, it contains everything that we can see.

Von Uexküll (2001 [1936]: 107) says of this 'self-world' characterising every species that it is "the island of senses, that wraps every man like a garment, we call his *Umwelt*." Von Uexküll's main concern was the introduction of the notion of 'subject' in biology, particularly in regard to its ability to assign *meaning* to an external world. In fact, von Uexküll was not sympathetic to the mechanicist conception of the forms and behaviours of living beings, since, according to him, "behaviours [...] are not mechanically regulated, but meaningfully organised" (von Uexküll 1982 [1940]: 26). However, one could argue that Sebeok became interested in von Uexküll's *Umwelt* because it was suggestive that communication and modelling may bear a (non-mechanistic) survival function. The *Umwelt* is, in fact, discussed in Sebeok's treatment of the primary modelling system as an adaptive strategy (1988). Sebeok explicitly states that the *Umwelt* "constitutes a cybernetic theory of modelling so fundamental that the evolution of language cannot be grasped without it" (1991 [1988]: 54). This shows that Sebeok reads the utility of the *Umwelt* through cybernetic glasses, which would contend that communication has to be envisaged 'functionally'. That is, the *Umwelt*, or ontogenic biological communications, play an important role in a system's survival which may eventually translate into species survival. Similar claims on the usefulness of communication have also been made by cyberneticians such as Wiener (1951), Lovelock (1979), Wilden (1980) and Jantsch (1980). Von Uexküll (1982 [1940]: 27) claimed that "because no animals ever play the role of objective observers, they never enter in a relationship with a neutral object." Thus the notion of the *Umwelt* fundamentally teaches us that all living beings do not just *refer* to their environment in their daily life as if environment was a 'neutral' reality. Instead living beings need to *create* this environment in order to live and thrive. The *Umwelt* is the realisation that living beings, as living subjects, create their own world *as their best attempt in devising an adaptive or survival strategy*. Thus Sebeok articulated the relevance of *Umwelt* to the notion of Primary Modelling Systems by identifying the adaptive function and survival value of nonverbal communication, evidently present in both. It is not just lower forms of life that possess *Umwelten* (plural), but also the human being that possesses it. So, part of the human's communicative repertoire, which includes the primary modelling system, has an inclusive survival function. In contrast, modelling through externalised verbal signs and culture, or the Secondary and Tertiary Modelling Systems, is an *exaptation*. This 'exaptation' is desirable and potentially an enhancement of the capacity for survival, but

not necessarily indispensable for survival (as demonstrated by the survival of speechless creatures).

To present a complete picture on modelling, Sebeok (1979f) argues that some animals seem to possess an inclination towards the kind of behaviour found in Tertiary Modelling Systems as would be the case, for example, in a system of aesthetics. Aesthetic behaviour in animals includes kinaesthetic signs, musical signs, pictorial signs and architectural signs. However these have to be construed as "artistic products of averbal semiotic systems" (Sebeok 1979f: 12) and thus have to be considered not as 'languages' as such (e.g. chimps supposedly possessing language) but as forms of nonverbal communication. The reason why animals may seem to possess more complex forms of modelling beyond primary modelling (that is, possess an apparent capacity for complex aesthetic behaviour) is the continuity between form and function of the modelling mode in question. While aesthetic behaviour (e.g. the bowerbird decorating its nest) may be considered as a tertiary modelling system in terms of *form* (or its 'symbolic' mode of representation), in animals it still needs to be considered broadly as a primary modelling system in terms of *function* (that is, as a fundamentally adaptive, though not mechanistic, strategy). Sebeok's argument, therefore, is suggestive of the fact that the main difference between human and animal aesthetic behaviour is that it is only in the human that aesthetic behaviour may be based on verbal expression and is superflous to survival. Thus one could argue that in the light of being endowed with verbal capacity, it is only the human that possesses entirely non-necessary modes of modelling (Secondary and Tertiary). However one does not have to either ignore the fact that as soon as one recognises verbal communication in the human, one must also conceive of nonverbal communication, or the adaptive Primary Modelling that necessarily pertains to all species, including the human species. Indeed, this is a fact that has often been neglected by cultural semioticians, but which effectively explains how communication can work at its most fundamental level even in the event of sensorial disability, of non-sharing of a linguistic code or in the presence of code-errors.

The fundamental recognition that there is a form of communication, primary modelling systems, phylogenetically and ontogenetically antecedent to the externalisation of verbal signs, or Secondary Modelling Systems, constitutes the basis for Sebeok and Danesi's 'Modelling Systems Theory' (2000). Over a number of decades, Sebeok's developing appraisal that instances of signs, communications and modelling are found across the

whole realm of life, brought about an enlargement of the object of research of semiotics, named biosemiotics. A systemic, biological and non-anthropomorphic outlook on semiotics thus represents a core paradigmatic feature of biosemiotics intended as global semiotics, a view also supported by semioticians Petrilli and Ponzio (2002) and philosopher Deely (1990). Sebeok and Danesi provide through their Modelling Systems Theory, a comprehensive framework for the analysis of sign systems (2000: 14) attempting to categorise *all* types of signs - and the relations within them - that living beings can possibly produce. This framework represents a viable solution to the extremes presented by other semiotic frameworks such as the overly reductionist schema of sign types based on dyadic Sausurean linguistics (1916), and the unwieldy ones such as Peirce's 59,049 sign types (1966: 407). In this sense, Modelling Systems Theory is a fundamental contribution to biosemiotics because it provides a vocabulary and a nascent methodology for studying 'forms of meaning' across different systems (biological and cultural); also it conceives the biological and the cultural along an evolutionary line, hence in terms of their 'difference through continuity'; lastly Modelling Systems Theory promises a unitary framework for empirical investigation that both scientists and humanists can use. Applications of Modelling Systems Theory to the analysis of cultural artefacts, however, are currently limited to the work of Cannizzaro (2005), Cobley (2009), Danesi (2010).

Modelling Systems Theory proposes that *perception* is sensory knowing, *semiosis* is the biological capability of producing and comprehending forms, *modelling* is the actual activity of producing forms, and *representation* is the capacity of all organisms possessing a nervous system in referring to the world in terms of singularised, composite, cohesive and connective forms (Fig 1)

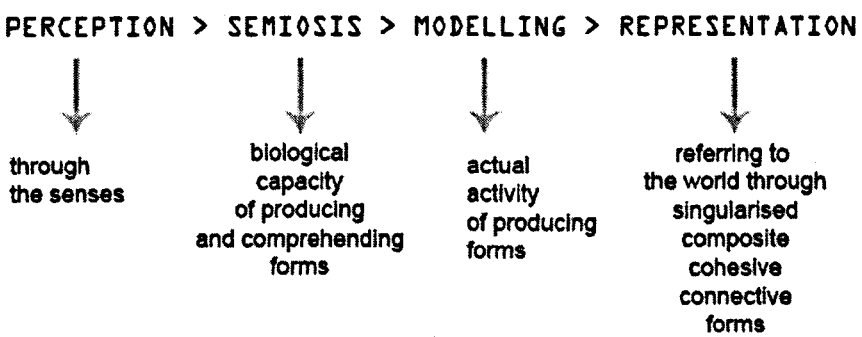

Fig. 1 Distinction among perception, semiosis, modelling and representation

Perception, semiosis, modelling and representation are derivative of one another (this concept of derivation is clearly indebted to the work on modelling of Tartu-Moscow semiotics). Forms of meaning can be mental or externalised (when they are expressed). Externalised forms can be categorised as pertaining to Primary, Secondary, Tertiary Modelling Systems, in their singularised, composite, cohesive and connective characterisation. This is the object and mode of investigation of Modelling Systems Theory.

According to Sebeok and Danesi, the Primary Modelling System (PMS) is the instinctive ability to model the sensory properties of objects through *iconic* representational forms such as those that pertain to nonverbal communication. The Secondary Modelling System holds the potential to make reference to objects through indicative and *indexical* (extensional) forms such as verbal language, media texts (Barthes 1977) or technology in general[6] (Cannizzaro 2005). The Tertiary Modelling System is the capacity to further extend secondary models to acquire *symbolic* values, constituting cultural superstructures which may include mathematics and literature as well as London cycling culture or Spaghetti *hacktivism*[7]. Although particularly apropos for human cultural organisation, Modelling Systems Theory can also be used to grasp the nature of animals models, for example, the iconic character of camouflage, the indexical function of the honeybee dance and the symbolic purpose of the bowerbird mating gift.

The general character of Modelling Systems Theory derives from 1) its *structuralist* principle (Sebeok and Danesi 2000: 11) 2) its *monadic* view as shared with von Bertalanffy's General System Theory and 3) its *extensionality* principle (Sebeok and Danesi 2000: 11). The structuralist principle posits that "all models display the same pattern of structural properties". These structural properties that characterise all modelling systems and their forms are *paradigmaticity, syntagmaticity, analogy, synchronicity, diachronicity,* and *signification.* These are inherited from the 'Soviet Semiotics' concept of modelling (see Chapter 5), as well as René Thom's *Catastrophe Theory* (1975). Sebeok in fact stated that

[6] Secondary Modelling System is an indexical, indicative and therefore *extensional* field of modelling and as such it can be said to comprehend the whole realm of technology, not just the realm of speech. McLuhan's theory of media as extensions of man could therefore easily match Sebeok's theorisation of the indexical secondary modelling system deriving from perceptual, iconic primary modelling systems. As McLuhan (1989: 87) states "All media are a reconstruction, a model of some biologic capability speeded up beyond the human ability to perform: the wheel is an extension of the foot, the book is an extension of the eye, clothing an extension of the skin and electronic circuitry is an extension of the central nervous system."

[7] Italian development of computer hackers' activism.

"linguistics as semiology became interesting only with the injection of Thom's ideas and his application of the machinery or algebraic topology" (1979e: 6). Catastrophe theory specifies a list of *archetypal topological structures* (catastrophes) together with *rules for combining them* (syntax) that could formally model *all the static and dynamic morphologies of the natural world* (Sebeok 1979e: 25, my italics). Thus one can argue that the gist of Thom's work on morphology (dynamic structure) is embodied in the structuralist principle present in Modelling Systems Theory. Also, the structuralist principle bears a degree of relevance to the work of cybernetician von Bertalanffy on *General System Theory* (1945). This work was the first explicit theorisation for a general systems analysis and was concerned with *isomorphic models* – models that described universal traits of reality. Modelling Systems Theory shares with General System Theory the quest for constituting a general language of ideas along the line of Leibniz's *mathesis universalis* (Sebeok 1977a: 185).

The extensionality principle in Modelling Systems Theory posits that "complex (abstract) models are derivative of simpler (more concrete) ones" (Sebeok and Danesi 2000: 11). This statement illustrates the derivational character of culture (abstract forms) in respect to verbal language, and in turn the derivational character of verbal communication in relation to nonverbal communication. Thus, through the extentionality principle, Modelling Systems Theory may suggest that there is a line of continuity between human and animal that is not just genetic and biological but also representational or 'cultural'. That this principle is suggestive of a spatial conception of sign-systems is evident in two instances: firstly what Sebeok praised in Thom's work on catastrophe theory was that it offered "one pure *topological continuum in which causality and finality* are combined. No accident that his dynamical topology was influenced by Peirce and von Uexküll" (Sebeok 1977a: 66, my italics). Secondly, along the line of Lotman's attempt to tackle the study of culture both diachronically and synchronically, Modelling Systems Theory can also be seen as a framework which studies form and its function but in a fundamentally historical perspective; that is, in terms of *cause* and *purpose*. Such impetus comes close to proto-cybernetics ' early formulations of teleology as explicated in Jakob von Uexküll's *functional circle* and in Thompson's *mathematical theory of growth* (as will be seen in Chapter 4 and 5, below). Owing to these two facts, one may argue that the extentionality principle is close to the cybernetic notion of *teleology*. Cybernetic and biosemiotic teleology is not to be intended as mere goal-directedness (simply as the purpose of an action) but as circular causation that occurs along a time axis and does not therefore repeat itself endlessly but

evolves along a spiral which tends towards a future state. Also, circular causation does not exclude causality (Rosenblueth, Wiener and Bigelow 1943: 4), indeed it includes Aristotle's quartet of causes (Stjernfelt 2002: 340).

Because of its underlying teleological framing, the extensionality principle is also perhaps what most lucidly illustrates Sebeok and Danesi's evolutionary concept of modelling, with particular attention on how language may have emerged from attempts at imitating the perceptual quality of the world through onomatopoeia (in the Primary Modelling System) which then extends into Secondary and Tertiary Modelling Systems to encompass translated and less finite meanings (Sebeok and Danesi 2000)[8]. In other words, Modelling Systems Theory introduces in biosemiotics, the cybernetic-topological notion of systems-growth or evolution of meaning (referred to by Sebeok in 1983 as *uberty*) and the notion of *continuity between nature and culture*. However, a treatment of modelling would not be complete without a complementary treatment of information. This is because information is the fundamental start and end point of modelling. Hence I am going to give a brief review of the concept of information as found in biosemiotics.

Information in biosemiotics: between control and freedom

As seen, questions on semiotic modelling beg for a definition of information, particularly in regard with what information is, how it emerges, what it does. The terms 'information' is not very often used by biosemioticians due to its affinity to sciences close to the development of technology and computing methods (information theory and cybernetics) and thus, to its possible mechanicistic connotation. However this section aims to show that 'information' is highly relevant to biosemiotics, and that questions of integration of information with semiotics should not be dismissed on the premise of disciplinary stereotypes (e.g. cybernetics as being a purely mechanicistic-determinist field, semiotics as being a purely humanist-indeterminist field). As Hoffmeyer and Emmeche put it (2007: 51, cited in Cobley 2011) "both 'DNAism' and 'individualism' tend to blind us to the importance of code-duality". This means that information tends easily to be treated solely in relation to either notions of *control* or *unstructured freedom*. Additionally, as Kull, Deacon, Emmeche, Hoffmeyer and Stjernfelt (2009: 169) postulate, information is an implicitly semiotic term but the logical relation between semiosis and information has not as yet been sufficiently

[8] This argument resonates close to Deacon's (1997) attempts at explaining how language emerges from hominids' need for large-scale social interactions rather than disembodied genetic mutation.

clarified. Whence my focus in this second part of the review, on the notion of information as found in biosemiotics. More specifically the literature on information in this section is representative of the fact that in biosemiotics, accounts of information often swing between *determinacy* (Sebeok 1978, 1981, 1991c; Sharov 1992, 2010) or *indeterminacy* (Hediger 1981; Sebeok 1978, 1991c; Emmeche and Hoffmeyer 1991; Hoffmeyer 1996a, 2008a; Brier 2003, 2008) though it has to be recognised that the extremes do not entirely adhere to complete determinacy or indeterminacy (exception made for Barbieri 2008). Moreover, showing the subtler philosophical affiliation that biosemioticians' accounts of information can bear, is useful for a clearer reconfiguration of information in terms of both cybernetics and semiotics (as in Chapter 7).

Those who have emphasised the determinacy of information include Sebeok (1978, 1981, 1991c) and Sharov (1992, 2010). Sebeok explicitly links communication with its capability to reduce entropy and favour adaptation and survival with regard to living entities. Sharov, similarly, declares that information regulates the vital functions of living beings. Tangentially, Kull *et al.* (2009: 168) and Hoffmeyer (2008b: 42-45) have also mentioned the determinacy of information, the former in relation to organisms possessing functions, the latter in relation to organisms being subject to irreversible thermodynamics. What these views have in common is (a) a position in favour of the 'control' or orienting function of information in respect to living beings' behaviour, (b) an overall, general and systemic view of how information works in living beings conceived as systems and (c) an implicit reference to early 20th Century biologist d'Arcy Thompson's (1917) view on environmental forces (e.g. a kind of information) as being a constraint (functional) to the growth of living beings. And thus, overall, an emphasis on information as *constraints* rather than unconstrained or arbitrary choice is Sebeok's and Sharov's main insight here.

In his 1991 essay on 'Communication' Sebeok argued that communication is a criterial attribute of life as it reduces the disorganising effects of the Second Law of Thermodynamics (1991c: 22). He argues that communiation effectively canalises energy, decreases *entropy*, favours the emergence of order, and establishes bonds and creates the conditions for the emergence and evolution of life. In short, Sebeok's claim that communication decreases entropy and favours the emergence of life and evolution suggests his 'functional' conception of communication and information. That is, communication, when successful, plays a role in 'controlling' the development and evolution of living beings. It is important to note here that 'control' needs not be construed

with the ideological and instrumental notion of passive coercion but as the active effort of attaining and maintaining a state of organisation or, in other words, as goal-seeking. This claim, a cornerstone of Sebeokean biosemiotics, demonstrates Sebeok's fundamental adherence to a first order cybernetic view of organisms as control systems regulated by communications and functional information. However, Sleigh notes that (2007: 173) "despite using the language of cybernetics, Sebeok did not cite Wiener or Shannon in his 1968 collection [on animal communication]". Though, one can deduce that his concept of thermodynamic entropy is strictly related to the concept of information if one considers the history of the term. The word 'information' is not explicitly mentioned by Sebeok. A clarification of this moot point follows therefore.

Classical thermodynamics (lead by the study of steam engine in the 19th century) explains that when a mechanical system performs activity (or work) part of the useful energy that it possesses is transformed (or dissipated) in heat energy through friction. This irreversible process of the transformation of usable energy into unusable energy is expressed by the Second Law of Thermodynamics which declares that, with time, systems end up in an unproductive, disorderly state. Such a state is described as entropy. When entropy reaches its maximum level and then remains constant, the system then terminates its spontaneous activity. It is therefore understandable how the concept of entropy has been adapted beyond the discipline of physics in its negative valence as a synonym for melancholy reflections on the devolution of the biological and the human (Thomson in. Clarke 2002: 21). Entropy has been widely deployed both in its intuitive and counter-intuitive mathematical sense in arts and literatures as well as chemistry, information theory and, of course, cybernetics.

The development of entropy in information theory and cybernetics was aided by the work of Austrian physicist Ludwig Boltzmann who integrated into statistics the concept of thermal entropy. He thus framed entropy as a statistical measure of disorder. Concentrating on reflections on probable or improbable states of the systems in question, Boltzmann postulated an extension of the concept of entropy (on the base of probability) to systems that have nothing to do with heat engines (Clarke 2002: 24), as for example information systems. In fact, information theory was the first discipline that came to dominate the mathematical conception of thermal entropy to express information as a measure of one's freedom of choice when one selects a message (Shannon in Weaver 1949: 10). When, in a communication process, the message is selected, entropy decreases

and the communication can finally proceed, thus reducing the indeterminacy of the system. Therefore, it becomes clear how the alignment of entropy *to* information *in* information theory *seems* to contradict the negative valence that entropy bears in thermodynamics and seems rather to hint at the generative, order-creating, potential of information. One in fact, can note that if in a classical thermodynamic system, entropy increases and favours disorganisation, in an information system entropy decreases and the result is the strengthening of the organisation of the system, or the very emergence of it. This mergent concept of 'emergence of a system following a decrease of entropy' was appropriated by first order cyberneticians such as Wiener (1949, 1951) and as it should now be clear, Sebeok (1991c).

Thus Sebeok's view of communication rests upon information theory's functional conception of information: that is, an initial selection of information is necessary for a decrease of entropy and the beginning of life. Following this view, Sebeok (1991c) claims that in light of its capability of decreasing entropy biological semiosis was the very first form of communication that gave origin to life. Sebeok indeed argues that the evolution of living beings was brought by the development of symbiotic, dynamic and self-regulatory communication systems, and that the Earth's Biosphere is a structure held together by these communication processes. As Sleigh (2007: 173) argues, Sebeok's approach was, when considered in the context of biology, functionalist since he was concerned more with whether communications did the job rather than the form they took. Similarly, cybernetician Erich Jantsch (1980) holds that evolution 'kicked off' through the advent of changes in modes of communication; put another way, through the optimisation of pragmatic information (1980: 134). From this, one can deduce how, similarly to Jantsch, Sebeok's conception of information is also a fundamentally pragmatic one. Additionally, Sebeok's argument which sees the whole Earth as a unitary system being regulated by communications is particularly close to cybernetician James Lovelock's Gaia Theory, which holds that the whole biosphere is a giant control system regulated by communications (1979). Thus, if one looks at Sebeok as a cybernetician, one should notice how he interrogates the effectiveness of a communication process, in other words, about its teleological nature: for what purposes in fact do sources formulate messages? Sebeok's answer is that messages are needed to travel because they contain information that is biologically and socially important for the organism (1991c: 26), and thus necessary for survival. Thus, Sebeok's formulation of 'information' in biosemiotics is one that stresses its control function and is intended as a teleological and adaptive strategy.

Similarly to Sebeok, Sharov (1992, 2010) proposes a version of information that presents a view of functional information. He makes evident his debt to cybernetics by using explicit terminology, thus making a stronger stand with regard to the 'constraining' role of information. In Sharov's view, in fact, sign systems have a control function, not just for the human, but also for the animal and vegetative world. As a biosemiotician, evidently interested in a general systems theory's perspective, Sharov argues that the object of research of biosemiotics should not limit itself to organisms, but should encompass all agents, including artificial ones. Agents, whether learning or non-learning, have "goal-directed programmed behaviour" (2010: 1052). Sharov, perhaps provocatively, also explains that agents are always "subjective beings" because non-learning agents are always produced by agents capable of learning. Sharov in fact explains that agents often outsource their functions to server agents which thus become, (as also argued by McLuhan 1964) the *extensions of man*, that is, entities that have 'control' over humans, but that since they are part (extensions) of humans, humans can in turn control. The functions that agents possess vary according to level of organisation. At a cellular level they include resource-capturing, growth, metabolism; at an organismic level, they include eating, digestion, excretion, sensing, movement, mating, reproduction; and at a super-organism level (e.g. colonies, families, societies) they include dance, construction of nests, defence. To preserve themselves and disseminate their functions, the ensemble which Sharov calls the *pragmasphere* (2010: 1055), agents use signs or *functional information*. Sharov defines functional information as the "set of signs that encode and *control* the functions of organisms" (2010: 1050, my italics). Sharov's mentioning of the controlling function of signs recalls 'Soviet semiotics' and (cybernetics) conception that "the sign systems for the collective as a whole and for the individual person serve not only as a means of communication but also as a means of control" (Ivanov 1965: 33). There is an obvious difference between Sharov's and Ivanov's conception of sign systems, in that as a linguist-semiotician, Ivanov conceives signs only within the world of man, whereas as a biosemiotician, Sharov conceives of signs across the whole spectrum of the living. However, beyond this difference, the fundamental common point to these views is the control function of signs. This commonality underlines a view of information that emphasises *constraints*. This view is even more evident in Sharov's original definition of functional information as the "micro-state [of a system] which controls the choice of system trajectories at bifurcation points" (1992: 348, my italics). More specifically, functional information furnishes a set of limitations on the trajectories that a system can follow

(through meaning), but also contributes to the safety of self-maintenance and self-reproduction of the system (1992: 361). Sharov's argument takes a firm stand on the 'affecting', framing or constraining capacity that information has in orienting and thus benefiting, natural and artificial agent's development. Sharov's functional information inserts in biosemiotics a strong argument on the side of developmental constraints or determinacy, an argument which, as the next section shows, stands in opposition to accounts on information that emphasise the *other side* of the information spectrum, that is developmental freedom or indeterminacy.

On this other side, there are biosemioticians who, in explicitly addressing the notion of information, emphasised its indeterminacy, or its subjective and individual aspect. These include Sebeok (1978, 1991c), Hoffmeyer and Emmeche (1991), Queiroz, Emmeche and El-Hani (2010), Hoffmeyer (1996a, 2008a) and Brier (2003, 2008). Amongst these, Sebeok claims that the content of a communication is always a best guess inference due to the abductive nature of information. Hoffmeyer criticises the physicalist notion of information in favour of Bateson's softer view of information as "a difference which makes a difference" (2000b [1970]: 459), and proposes to substitute the term 'information' with the expression 'semiotic freedom' and 'depth of meaning'. Brier affirms that the overly objectivist notion of cybernetic information is not enough to account for first person experience, and proposes a cybernetic and semiotic (cybersemiotic) framework for information that includes Peirce's qualisigns, or feelings. These approaches have two common points: they make Peircean *concepts* central (Sebeok refers to Peirce's *abduction*, Hoffmeyer, through Bateson, refers to *relation*, and Brier refers to *qualia*) to an *agentive* conception of communication; they refer to von Uexküll's theory of meaning (1940) according to which the behaviour of living beings is not mechanically determined by a neutral stimulus but meaningfully suggested by the organism's own unique experience of the stimulus.

Sebeok can be argued as the only scholar in biosemiotics whose conception of communication (and information) includes, in almost equal parts, both determinacy and indeterminacy. In fact, by resting on Hediger's studies of animal communication (1981) and Peirce's notion of abduction (1867-1893) Sebeok stands also amongst those biosemioticians who have emphasised the indeterminate or speculative aspect of information.Though Sebeok must have certainly appreciated cybernetics' firm stand on constraints and the determinacy of information, he also contends in the same essay on

communication (1991) that information can be indeterminate since one can never be entirely sure about what has been originally communicated from the source and, generally, what (where) is the exact meaning of a communication. Sebeok argues that a message can yet be defined as a *selection* out of a code by a source for the purpose of communication (and thus communication bears a degree of determinism). Notwithstanding in an engineering system that the mechanisms of selection are usually given, in biological communication many of the rules governing this act of selection are unknown (1991c: 25). This statement implies that, according to Sebeok, a definition of information as an act of selection does not involve an element of strict determinism but also a degree of indeterminacy. This characterises the human capacity to intuitively select a message or perceive its *relevance*, implicitly along the line of Bateson's view of information as a 'difference which makes a difference'. Thus Sebeok's view on information is functional (tends towards a goal), but also rests on trust and feelings rather than sheerly conceived truth; thus in other words communication is oriented by a goal which is only subjectively definable.

Arguably, Sebeok draws his position on indeterminacy from the ethologist Heini Hediger's (1908-1992) reflections on the role of the observer in the study of animal communication. Put briefly, Hediger investigated what he called the *Clever Hans phenomenon*. Clever Hans was a horse who was believed to be capable to count and to tell the time by both his trainer and the independent commission of scientists who assessed his case in 1904 (Favareau 2010: 240). Yet the horse was later proved to simply respond to the subtle nonverbal cues transmitted to him unwittingly by his tamer. Proof of this was that the animal could not perform any of his intelligent actions in the absence of his trainer. Hediger recognised the role of nonverbal communications played out in this case and 'justified' the trainer and the committee's deception by explaining that nonverbal communication travels along a profusion of channels and is therefore often invisible. Hediger proposed the following general implication of the story of Clever Hans: that animal behaviour cannot be taken in isolation and must be taken in the context of observation that includes trainers' skills and wishful thinking, and the past experiences of both trainer and animal. This means that "in experiments involving animals one does not work not with pure unaltered animal behaviour, but always with the behaviour of the animal plus the influence of the human observer" (Hediger 1981: 244 -245). This result is close to second order cybernetic position of observership (von Foerster 1973; Maturana and Varela 1980; Luhmann 1986) but also hints at the fundamental uncertainty that delineates animal-human communication since

one does not know "how much, through the catalytic effect of man, has been manipulated into the animal" (Hediger 1981: 244). In short, it is hard to tell who is 'responsible' for the message given out by a communication system, whether observed or observer, or whether sender or receiver and whose fault it is in case of failed communication. Following Hediger, one can see how the influence of the observer is one of those factors that makes the content of a communication indeterminate. The indeterminacy of information was also noticed by Sebeok (1978).

While Hediger categorises the Clever Hans effect as a peculiar feature of human-animal communication Sebeok as a cybernetician and systems theorist, instead, recognises that the Clever Hans effect and, by implication, the indeterminacy of information, is a universal feature of all types of communication. Sebeok in fact affirms that the Clever Hans effect 'infects all dyadic interactions' (1979d [1978]: 87) whether human-human, human-non-human animal, or animal-computer. Sebeok himself (1979d [1978]: 95) admits that the Clever Hans Effect can be squared with the 'uncertainty' concept of *observer* with *observed* as found in physics (and as shown, information theory and cybernetics). One can notice however that admitting the indeterminacy of information raises questions about its reliability. How can communication be correctly interpreted so as to result in successful functionality, if one can never be sure about what has been communicated from the source? Sebeok provides an answer to this question by stating that to understand communications, one has to reflect "on the best guessing strategy" (Diaconis cited in Sebeok 1979d [1978]: 93), or in other words, on abduction. The semiotic process of abduction has often been referred to as right-guessing (Sebeok 1983; Sebeok and Umiker-Sebeok 1981; Eco 1983, Bonfantini and Proni 1983) but, on the other hand, Peirce himself held that it would be impossible to guess the causes of a phenomenon by pure chance (i.e. by simply guessing at random). In Peirce's words guessing refers to "an act of *insight*" (Peirce cited in Sebeok 1988 [1983]): 18]) thus more to the process of deriving strong intimations of truth without consciously knowing why one believes that such cases may *be* the truth. A famous example of abduction is Peirce's right guess on the coat and watch stolen from him on a Boston to New York boat (Sebeok and Umiker-Sebeok 1981). Sebeok clarifies that Peirce explains abduction with the fact that man has developed as part of the universe. On the other hand, one may argue that Sebeok, in light of his studies of observership in zoosemiotics, gives a more precise and stronger justification for abduction. In his framework, the unconscious intimations of truth that come to humans through abduction appear to be simply suggested by iconic nonverbal communication. These iconic

ends are captured unconsciously by a communication's destination, and whose study semiotics had neglected up to Sebeok's time. Thus, through the notion of abduction (and of observership which comes with it – see Cobley 2011), information is yet indeterminate, but because of the presence of nonverbal communication and the human's or animal's capability to perform a right guess about it, Sebeok's notion of indeterminacy does not exclude a degree of determinacy.

Amongst the biosemioticians who have advocated a 'subjective' view of information vis a vis mechanicism and genetic reductionism in biology (see also Markoš 2005; Barbieri 1985, 2008), one finds Hoffmeyer. Hoffmeyer proposes to term 'semiotic freedom' (1996a) as a solution to *physicalist* conceptions of information which typically conceive information as discrete. Against this view, Hoffmeyer proposes a *relational* notion of informaton (2008e) and regards information in terms of relevance and continuity (cf. Bateson). By stressing that information is something that has to be interpreted, Hoffmeyer brings his argument on information in line with indeterminacy. It should be noted, however, that the concept of interpretation being discussed here is more a matter of Peirce's notion of *unlimited semiosis* (as discussed in Eco 1992), rather than the kind of infinite deferral associated with, say, Derrida; as such, it results in a less arbitrary and more scientifically accepted articulation of semiotic freedom.

Hoffmeyer demonstrates that the physicalist account of information that refers to information as "isolated facts" or "chunks of knowledge" (Hoffmeyer 1996b: 63) and as objective, is vitiated by a logical error. He brings the analogy of receiving a receipt in the supermarket which describes the total that one has to pay for shopping. The bill certainly contains information about the individual prices of the purchased items, but it is mainly the total, that is, the *processed* information, that becomes information *relevant to us* and that we take on (Hoffmeyer 1996b: 63). This example shows that there is no such thing as objective or neutral information, since the very notion of information presupposes its filtering, thus its degree of relevance and meaningfulness to someone. Hoffmeyer clearly conceptualises information in terms of Bateson's view of information as a difference which makes a difference (1970); in other words, *relevance*. Since the conceptualisation of information must contain a degree of meaningfulness, then it must also account for the subject for which it is itself relevant. Hoffmeyer claims that "the unfortunate thing about the physicists' concept of 'information' is that it no longer refers to a person or to any other subject. The 'information' of the physics world is not something that 'someone' has; it is

there, in the world, quite regardless of whether 'someone' is also there" (Hoffmeyer 1996b: 63).

Thus, Hoffmeyer proposes a *relational* view of information because, as he argues, relation (or continuity) is a fundamental principle of life. Phenomena such as contrast, frequency, symmetry, correspondence, relation, congruence and conformity are not easily described in terms of quantities if at all. They are, as Bateson noted, variables of zero dimensions and cannot be located (Bateson 2000c [1967]: 408) and yet all communicative processes in nature depend upon discontinuities of this kind (Hoffmeyer 2008e: 29). Thus Hoffmeyer's fundamental argument is that it is not feasible to embrace a discrete notion of information, but rather a relational one that can account for the continuity of natural phenomena, like perceptions and their relation to a subject. This is why he proposes to use the expression 'semiotic freedom' in the face of information, since this expresses more the relational or 'indeterminacy' aspect of information, or, in Hoffmeyer's terms, the richness or depth of meaning that the concept can communicate. 'Logical depth', a term borrowed by Charles Bennett from IBM, expresses the number of steps in an inferential process or chain of cause and effect linking something with its probable source (Hoffmeyer 1996b: 64). Hoffmeyer states that he opted for the expression 'semiotic freedom' rather than 'depth' to save giving the (false) impression that one is dealing with a quantitative term on a par with logical depth (1996b: 66), and he concludes that information is based on *interpretation*. However one may argue that this term is an unfortunate choice because of its potential to be read as total indeterminacy of meaning, a conception which is understandably unwelcome in the sciences but also incorrect from a semiotic point of view. In *The Limits of Interpretation* (1992), Eco explains that one should distinguish between interpretation seen as hermetic drift and Derrida's infinite deferral of meaning, and interpretation seen as Peirce's *unlimited semiosis*. Eco clarifies that in Derrida's framework the truth can never be reached because meaning is deferred *ad infinitum*. In an opposing fashion, Peirce's notion of unlimited semiosis is an inferential but speculative process (e.g. based on abduction) which brings one closer to a 'true' or, at least, workable, state of knowledge. Hoffmeyer's notion of 'depth of meaning' is closer to Peirce's unlimited semiosis rather than Derrida's infinite deferral. This is to be expected, simply because Hoffmeyer regularly cites Peirce rather than poststructuralists such as Derrida with reference to the issue of interpretation. Yet, the point about the different connotations of 'interpretation' remains important. Hoffmeyer in fact does not discount that steps of semiosis could be described through principles similar to those of logical depth. Indeed,

this may now seem a necessary step because it would give 'interpretation' a more scientific valence and prevent Hoffmeyer's view of information from falling into the trap of 'infinite deferral'. Thus a view on information rightfully based on interpretation must account for indeterminacy, and also for a degree of determination. This is the task of chapter 7, which aims at providing a view on information that emphasises freedom and also constraints.

Similarly to Hoffmeyer (1996a), Brier argues that the 'objective' conception of information is undermined by its inability to account for the inherently 'subjective' aspect of information (2003, 2008). What he proposes, instead, is a model of information which includes Peirce's ontological categories – Firstness, Secondness, Thirdness – and also Peirce's *qualisigns*. However, similarly to Sharov (1992; 2010), Brier works towards integrating cybernetics and semiotics. One may argue that despite this effort at integration, and, in an opposite fashion to Sharov, Brier' s account of information alludes towards indeterminacy and freedom, rather than constraints.

Brier criticises the 'objectivist' overtone of the concept of information as found in information theory (Shannon and Weaver 1949) and in Norbert Wiener's First Order Cybernetics (1951), but also Bateson's more 'subjective' view of information because it is still predicated on Wiener's statistical information and because one cannot determine to whom "the difference makes a difference" (Brier 2008: 179). In other words, Brier affirms that Bateson does not develop a theory of the observer. Brier explains how Maturana and Varela's second order cybernetic theory of autopoiesis (1980) provides a theory of the observer and yet reveals something important about the relativity of social concepts (2008: 182). But this important revelation aside, it does not explain the rigid constraints that physical things place on our construction of 'objects' in the world. The conclusions to be drawn from this critique are that, according to Brier, the concept of information should not be naïvely realist as in First Order Cybernetics, nor idealist as in Second Order Cybernetics, but must be somewhere in between idealism and realism (as embodied in Peirce's evolutionary philosophy). Also, Brier contends that social systems theorist Luhmann, who extended cybernetics to the study of human social systems, failed to account for qualia and emotions in his communication theory (Brier 2008: 240).

In light of this critique, Brier proposes a cybersemiotic model of communications (2003, 2008) that is articulated along five epistemological levels: *firstness* (qualia), *secondness* (causality), *information* (or quasi-semiotics), *biological communication* (pertains to all living

beings) and *cultural paradigms* (that pertain to humans only). The innovative aspect of this synthesis is certainly the insertion of qualia in this framework, and thus the elevation of *qualia* to a status of researchable entities, at the same level of atoms, energy, information and human language. Thus, the flexibility of Peirce's quasi-necessary (Peirce 1955 [1897]: 98) logic upon which Brier founds cybersemiotics' epistemological levels, allows one to make qualisigns accountable even within a scientific framework. Despite his attempt to provide a balanced transdisciplinary account, Brier's model does appear to emphasise first person experience and qualia (indeterminacy) more than environmental and physiological constrains (determinacy). One may argue in fact that apart from a few synthetic remarks that cybernetics bring the notions of autopoiesis/closure, environment and observer to biosemiotics (2008: 276, 398, 339), Brier does not fully justify the reason why one must be aware of cybernetics when doing biosemiotics. As Chapter 4 shows, the necessity of being aware of cybernetics when studying biosemiotics is that the two fields are historically *continuous* and not just contiguous to each other (also in Cannizzaro 2010a, 2012a).

In light of the critique (and downplaying) of the constraining/cybernetic aspect of information, one could argue that in cybersemiotics, determination is underplayed in favour of what the sociologist and other call *agency*. Cybersemiotics stands seemingly in an opposing position to Sharov's approach to information (1992), which also seeks to merge cybernetics and semiotics. But, unlike Brier, Sharov emphasises mainly the functional and side of the concept of information. Hence there appears to be a shortcoming on both sides because a true synthesis of information should pay equal justice to both notions of uncertainty as well as certainty. As Cobley (2010b: 227) puts it, biosemiotics should steer "a path between over-interpretation and reductionism".

Also, Cobley argues that there is a general tendency to over-emphasise 'agency' in biosemiotics, this being a move that needs to be approached with caution (2010: 225) due to the consequences that the term may cause when translated across the sciences and the humanities. Whereas the sciences struggle to achieve a conceptualisation of 'agency', the study of culture in the humanities "already has agency in bucketloads – indeed, it has more than it knows what to do with" (Cobley 2010b: 241). One may argue that the obsession with agency will constitute a problem for the humanities only if agency continues to be intended as a strictly human phenomenon. With Hoffmeyer and Brier, biosemiotics teaches us that agency is a precondition of living nature, and with Sharov, that it may include not just natural but also artificial agents (in light of the fact that non-learning artificial agents

are always created by a learning agent). These views underline how a conception of agency that pertains to the human being only, is an unscientific-anthropomorphic projection. Arguably, a view of agency reconfigured after biosemiotics and cybernetics requires (a) a balanced view of information that takes into account equally both information's determinacy and the aspect of it that is indeterminate, and (b) an indication of the degree to which such a view is applicable to the different levels of agency: vegetative, animal and social (Kull cited in Sharov 2010). While Chapter 6 seeks to provide the former objective with a comparative discussion of cybernetic and semiotic information, chapter 7 seeks to pursue the latter objective by proposing a framework for cultural analysis which stems from a concept of agency reconfigured in terms of biosemiotics and systems theory.

Concluding remarks on modelling and information

This chapter argues that biosemiotics is an 'open paradigm' made up of paradigmatic features. This chapter did not present a review of *all* the paradigmatic features that pertain to biosemiotics but selectively drew out some paradigm cases that are strictly relevant to the argument of this thesis. Thus, this chapter reflected on the paradigmatic features of *modelling* and *information,* since, these are in need of a clear articulation in respect to cybernetics and systems theory's historical relevance to the whole project of biosemiotics.

The term 'model' can be defined according to capacity to make reference to something (that is, its 'mapping territory' capacity). On the other hand, the term 'modelling' emphasises the derivational character of forms of meaning (Sebeok and Danesi (2000) and draws on von Uexküll's model of the *Umwelt* (1940), Lotman's notion of the 'semiosphere' (1967), Sebeok's reconfiguration of von Uexküll's *Umwelt* and Lotman's 'Primary Modelling System' into pre-verbal natural language (1979f, 1988), and Sebeok and Danesi' s Modelling Systems Theory (2000). These contributions on modelling introduce for scholars in biosemiotics the notion of space, conceived as dynamic rather than static qualities. Through the notion of modelling, biosemiotic space is defined in terms of both 'system' and 'change'. Envisaging a notion of 'system' implies that different things can be described according to similar features (synchronic approach), thus approaching von Bertalanffy's idea of isomorphic models as found in *General System Theory* (1968). At the same time, the notion of 'change' implies that the same things can be described also in terms of their history (diachronic approach). Chapter 5, in what follows, develops this section on

modelling to show that what biosemiotics and cybernetics-systems theory have in common is their quest for homology, or dynamic systems.

Information has been addressed more or less explicitly in biosemiotics in terms of 'control' and 'freedom'. Views that emphasise the control function of information, and thus its determinate aspect (Sebeok 1991c; Sharov 1992, 2010) predicate that communication is functional, and that information is instrumental for the emergence and sustainment of life. Views that emphasise the 'freedom' aspect of information, and thus its indeterminacy aspect predicate that communication bears an unknowable aspect through 'abduction' (Sebeok 1978) or stress 'semiotic freedom' (Hoffmeyer 1996a, 2008a) and 'qualia' (Brier 2008) aspects of information. Adidtionally, it was shown how Hoffmeyer and Brier have respectively foregrounded the indeterminacy aspect of information, arguably without sufficiently underlining the importance of cybernetic constraints. These contributions on information show that in biosemiotics, conceptions of information tend to be predominantly as indeterminate or determinate, *not both*. Works that stress determinacy downplay the importance of semiotic freedom, whereas those works that stress indeterminacy downplay the constraints of information. Thus one may argue in favour of the need for biosemiotic synthesis that gives a balanced account of both 'limits' and 'agency', that is, a model that can account for the *quasi-determinacy* of communications. This review of information primarily sets the ground for such a project, by in fact making a clear connection between *information* and *abduction* as discussed and between *information* and *constraint,* concerns that will be addressed in Chapter 6 and Chapter 7 respectively.

CHAPTER 4

From cybernetics to systems theory: historical contradictions as the beginning of biosemiotics.

Introduction

In this thesis it is argued that biosemiotics is not just a project which takes its impetus from semiotics or theoretical biology, but constantly and implicitly draws from Bertalanffy's General System Theory (1968 [1939-1967]), Maturana and Varela's Second Order Cybernetics (1980) and Luhmann's Second Order Systems Theory (1986). These strands of systems thinking, which, as it will be shown, have their roots in proto and early 1940s cybernetics, have focused on the study of 'communications' well before biosemiotics established itself. Thus the current chapter sets out to articulate the relevance of cybernetics and systems theory to biosemiotics. It does so by identifying a number of historical developments which, by showing relevance to biosemiotics, can also be argued to represent the historical precursors to the whole project. These include:

- The emphasis that proto-cybernetics puts on mathematical homology, the characterisation of function in terms of cause and purpose, the understanding of complex systems in terms of form and function but also meaning. These developments anticipated biosemiotics' interest in modelling and the behaviour of complex systems (Morris 1946; Sebeok 1979b, 1991c; Anderson *et al.* 1982; von Uexküll *et al.* 1993).
- The interest of early cybernetics in a metalanguage capable of encompassing properties common to animal, machine and man, the passage of cybernetics from multi- to inter- to trans- disciplinary research, and the problem of translation. These developments anticipated contemporary cultural semioticians' interests in ecological and physiological understanding of cultural forms (Sebeok and Danesi 2000; Cannizzaro 2005; Cobley 2009; Wheeler 2010) as well as problems of interdisciplinary translation (Cobley 2010b).
- The development of First Order Cybernetics into General System Theory, biocybernetics and what this thesis calls 'the semiotic turn'. These contributions overlap with biosemiotic's interest in information and environment, the continuity between natural and cultural forms (Peirce's and Bateson's synechism) and the need to account for subjectivity (Brier 2008).

- The formulation Second Order Cybernetics of a theory of observation (constructivism), autopoiesis, its transformation into social systems theory and theories of communicational error. These contributions are relevant to biosemiotics in that by embodying opposite perspectives of constructivism and pragmatism, they turn out to be 'complementary' and are unevenly taken on in endosemiotics (von Uexküll *et al.* 1993), in the studies of the Clever Hans Phenomenon (Sebeok 1978, 1981), and in the studies on communicational error and the self (Sebeok 1979c, 2001c; von Uexküll *et al.* 1993).

In the previous chapter, the first premise of this reasoning was presented: that is, a definition of the scope and theoretical models that pertain to biosemiotics. In order to infer the degree of overlap between biosemiotics and systems theory, this chapter sets out to define the second premise of such reasoning and thus to provide a tentative new definition of systems theory. This review aims at doing so by paying particular attention to systems theory's roots in cybernetics. Thus, the question behind setting the second premise of this thesis therefore switches from 'What is Systems Theory?' to 'What is Cybernetics?' This question can be approached through this famous joke, attributed to Stafford Beer (2001 in ASC 2010a):

> ...it concerns three men who are about to be executed. The prison governor calls them to his office, and explains that each will be granted a last request. The first one confesses that he has led a sinful life, and would like to see a priest. The governor says he thinks he can arrange that. And the second man? The second man explains that he is a professor of cybernetics. His last request is to deliver a final and definitive answer to the question: what is cybernetics? The governor accedes to this request also. And the third man? Well, he is a doctoral student of the professor – his request is to be executed second.

As this mildly amusing but instructive joke shows, defining cybernetics is a task that may appear incommensurable, especially to those people who refuse to see patterns of regularities among the diversity of human actions and enterprises, thus to those who are against definitions in general. However, as argued in this thesis, regularity or synthesis does not only express homogeneity or uniformity but can express heterogeneity and historical discontinuity. As this review will show, cybernetics is an example of an irregular 'pattern' (but a pattern nevertheless) that one can perceive amongst the most disparate research efforts of scholars who contributed to the first Macy Conferences in cybernetics (1946-1953) and those who continued developing cybernetic models up to the 1990s. Thus, a first preliminary answer to the question of defining cybernetics is exactly in terms of its

heterogeneity: *cybernetics is an interdisciplinary project* that is grounded in disciplinary *borrowing*, that is, the translation of one term from one discipline to the next. An example of such practice, as presented by Klein, is the use of the cybernetic model in decision making and business management (1990: 85). Here one immediately notices that Klein does not use this example as a coincidence, since cybernetics is maybe the best example of a discipline that has been continuously re-structuring and re-organising itself through *interdisciplinary borrowing*. This practice was not mere eclecticism but an overt paradigm feature. In this respect, the next section will argue that cybernetics starts as a *multidisciplinary project* in which separate research enterprises come together for approaching common problems (e.g. defining communication) while keeping their goals "limited to the framework of disciplinary research" (Nicolescu 2002: 42); subsequently, cybernetics morphs into an *interdisciplinary* project by means of continuous borrowing or the "transfer of methods from one discipline to another" (Nicolescu 2002: 43); and lastly, cybernetics becomes a *trans-disciplinary* enterprise "which is at once between the disciplines, across the different disciplines, and beyond all disciplines" (Nicolescu 2002: 44).

As anticipated in Chapter 2, this thesis claims that the practice of interdisciplinary borrowing leads to *contradiction*, intended in terms of Althusser's *uneven developments* (1965). Thus, it is argued that studying the practice of *borrowing* and consequently generated *historical contradiction* in cybernetics yields the possibility of disciplinary definition in terms of uneven development. Particularly, in this review I set out to explain the evolution of cybernetics into systems theory. As I will argue, such a process of change is contradictory, or characterised by moments of applicative/theoretical discontinuities, sudden epistemological turns and disciplinary bifurcations that end up marking the distinction between cybernetics and systems theory. More precisely, an account of cybernetics in terms of interdisciplinary borrowing and relative historical contradictions will help to (1) define cybernetics, (2) mark its difference from systems theory, (3) infer a historical link with biosemiotics. Thus, the final aim of this historical account of cybernetics is to identify the conditions in which throughout the 20th century, cybernetics becomes systems theory by means of contradictions. This argument allows one to infer that a similar transformation affects systems theory, i.e. that the historical contradictions that emerged in systems theory from 1970s to 1980s, marked the beginning of biosemiotics in the 1990s.

1909 – 1940 Proto-cybernetics: on form, function and meaning

The period between 1909 and 1940 saw the work of three important figures that, coming from different perspectives, have anticipated ideas and contradictions that constituted the (uneven) disciplinary core of cybernetics in its subsequent years. This period is called *proto-cybernetics* because the work presented is not cybernetics as it was later known, but is what precedes it. In other words this is the pre-disciplinary history of modern cybernetics that, as it will be shown, is already founded on a contradiction. The key figures discussed thus represent the precursors to cybernetics and, as this thesis argues, to biosemiotics as a whole.

In 1909 a young Norbert Wiener published a paper in a young scientists' journal named *The Guide to Nature* (Sleigh 2007: 163). In this paper Wiener was interested in ants and their nests, particularly in relation to the diversity of forms that these bear from the primitive burrow to the more complex ant hill. Wiener was 16 at the time and still 40 years away from founding the discipline of *Cybernetics* as we still call it today; however, in his early paper on ants, he anticipated two of the main trends that mark the beginning of cybernetics, or its proto-phase: the practice of looking at living beings to build models of behaviour that work at different levels – e.g. mechanical systems or social systems-, and the preoccupation with the *function* that forms of behaviour have.

Similarly, the two zoologists D'Arcy Wentworth Thompson (1860 – 1948) and Jakob von Uexküll (1864 – 1944) contributed unintentionally to the foundations of modern cybernetics. In 1910 the Scottish zoologist Thompson translated from Aristotle's sixth book of *Historia Animalium*, a work which was concerned with the classification and description of classes of animals, their behaviours and characteristics (this included, among shells, fishes and bird, a treatise on the differences between men and women). This translation job served as an inspiration for Thompson's most famous work which was published seven years later under the title of *On Growth and Form* (1917, 1942 revised edition). In this work, Thompson anticipated cybernetics' core methods, those of a general and *systemic approach* to science. Thompson in fact focussed on the mathematical study of morphology and thus put forth what is a fundamentally geometrical perspective on its object of study i.e. he described different instances of natural things (shells, teeth, insects' flight's coil, tree branches' growth) in terms of what they have in common, namely their form. In other words, he envisaged natural things *as* systems. If one consider that Thompson was not just proficient in zoology and mathematics (which was self-taught) but also in translation from ancient Greek and in business, as his collections of specimens traded from whalers in

Dundee (where he taught) show, one can see how he was a real polymath. Thus one can argue that Thompson's approach was systemic, on the one hand because symptomatic of a fundamental belief in the unity of knowledge, or the idea that there are no disciplinary boundaries in knowledge, and as such no generic (or 'geometrically versatile') models of study may similarly apply to the study of animals, languages and people. Conversely, Thompson's approach can be considered systemic because he envisaged organisms as complex systems of functions.

In fact, Thompson developed the idea that in living beings, form is a function of growth (that is, form is *caused* by growth) and that therefore when considering form, one is really considering the complex system of environmental forces that conditioned its growth, that in turn constrained its form. For example, Thompson argued that small organisms tend to assume either a spherical form or other simple forms because they are subject to surface-tension phenomena (1942: 17). Bigger animals instead are subject to the force of gravity. Indeed, Thompson argued that the form and action of human body is conditioned by the strength of gravity to the point that "were the force of gravity to be doubled our bipedal form would be a failure, and the majority of terrestrial animals would resemble short-legged saurians, or else serpents" (1942: 32).

Similarly, in 1940 the Baltic German zoologist Jakob Johann von Uexküll also published a treatise on living beings, their forms and functions. However this was not mathematically framed, but semiotically framed. This was named *Bedeutungslehre* (1940) or, in English, 'The Theory of Meaning' (reprinted in 1982). In fact, having studied for more than a decade "the muscular movements and reflexes of sea-urchins, brittle-stars, peanut-worms and octopuses" at the Zoological Station of Anton Dohrn in Naples (Rüting 2004: 3), von Uexküll had come to the conclusion that meaning was the main determinant and at the same time, the purpose of the form of sensorial organs and the behaviour of living beings. Meaning, simultaneously constrained and constraining sensorial availability, builds the organism's personal world of experience or *Umwelt* (1982 [1940]: 29). It is because of this emphasis on meaning that von Uexküll's approach has been recognised as proto-semiotic (Sebeok 1979b: 187-207). However, and significantly, von Uexküll has been acknowledged also as a proto-cybernetician (Rüting 2004, Lagerspetz 2001, ASC 2010) for his formulation of the notion of *feedback* taking place between perception organs and receptor organs of the living being's sensorium and thus constituting the *functional circle* (von Uexküll 1940) that sustains an organism's *Umwelt*.

All the three figures discussed, Wiener, Thompson and von Uexküll, contributed to an important extent towards laying the foundations of cybernetics. Firstly, Wiener's early interest in insects, as well as von Uexküll and Thompson's zoological backgrounds show that proto-cybernetics did not just focus on *organisms as objects of research,* but the focus endeavoured to accumulate empirical data, also reflected in their own method. Thus proto-cybernetics is fundamentally grounded in theoretical biology, and not in warfare technology as commonly held. As such models as von Uexküll's feedback cycle are not mechanistic, but naturally inspired. Secondly, proto-cybernetics has been underwritten from the beginning by a fundamentally systemic perspective. In fact, despite the fact that von Uexküll has been officially recognised as a proto-cybernetician (Rüting 2004, Lagerspetz 2001, ASC 2010) while Thompson has not, it is still noticeable that both zoologists have contributed towards laying the foundations of the *theoretical modelling* of complex systems, putting forth the idea that not just form, but also 'mathematical' function and 'semiotic' meaning are irreducible properties of such systems. Thus, considering von Uexküll's and Thompson's work in light of a 'general system theory' perspective, as would later be pointed out by Ludwig from Bertalanffy (1968), one can reconfigure their proto-cybernetic contributions as the *systemic study of the organism.* In this early stage cybernetics was therefore emerging within the context of *theoretical sciences.* Thirdly, proto-cybernetics is characterised by a contradiction in the conceptualisation of function. In fact, Thompson's emphasis on the physical *constraints* of growth (causes), and von Uexküll's emphasis on the *freedom* that organisms have in modelling the objects they encounter (purpose) stress the characterisation of functions differently. Thomas Sebeok's synthetic effort in envisaging both causes and purpose in the study of the forms of meaning (Sebeok and Danesi 2000) in biosemiotics, appears to have drawn from this contradiction that, as will be further expanded in Chapter 5, is only now apparent.

1943 – 1949 Early cybernetics

Subsequently, the 1940s saw a wave of scientific research centred on the development of modern digital machinery (the first digital calculators, or computers) and new communication engineering systems (the telegraph and the telephone). This period of technological discoveries made cybernetics relevant to contemporary semiotics specifically for these four reasons, (a) it anticipated the interest of biosemiotics in the study of similarity and continuity between animal-technology-man (b) it gave rise to the 'problem' of the objectivity of information, (c) it anticipated the interdisciplinary approach of

biosemiotics together with (d) the relative problem of interdisciplinary translation. The early cybernetic work of Rosenblueth, Wiener and Bigelow (1943), von Neumann (1948) and Shannon and Weaver (1949) as well as a selection of key events taking place during the Macy Conferences in cybernetics (1946-1953) serves as evidence of both the contradictory foundations of early cybernetics and of its historical relevance to contemporary semiotics. The following are how the seminal relevance of cybernetics payed out:

a) From animal to machine

The switch of object of research from *organism* (as in proto-cybernetics) to *machines* (early cybernetics) that the 1940s anticipated, evinces how even contemporary biosemiotics' is driven, particularly on the side of cultural semioticians, and aims to study the continuity between biology, technology and culture (Sebeok 1988, Sebeok and Danesi 2001, Cannizzaro 2005[9]). Evidence of this epistemological change can also be found in Rosenblueth, Wiener and Bigelow's paper named *Behaviour, Purpose and Teleology* (1943). This work was pivotal to cybernetics as it conceptualised the notion of *feedback,* intended as 'active purposeful behaviour' (1943: 1-2), and thus definable in terms of activeness or passiveness and measurable in terms of input and output, and the notion of *predictive behaviour*, that is, behaviour tending towards the attainment of a goal and thus with a regulatory function. Regulative behaviour is attested by Rosenblueth, Wiener and Bigelow as 'negative feedback behaviour'. Negative feedback constitutes the principle that by regulating positive oscillations (those events that perturbate the system's equilibrium), regulates the overall system's behaviour. Since negative feedback behaviour is driven by a goal, and adjusts itself continuously to new input-stimuli producing new output behaviour (a path change), regulative behaviour is therefore called 'predictive'. Prediction, Rosenblueth, Wiener and Bigelow clarify can be of different levels of complexity, from the simple prediction of a single path (a cat following a mouse) to the more complex prediction of two paths (an anti-aircraft gun predicting both the path of the airplane and of the missile it shot), or of more paths (1943: 3). Overall, Rosenblueth *et al.*'s main development, i.e. the regulation of positive feedback through predictive negative feedback, is important because it marks the beginning of cybernetics' preoccupation with 'regulation' and thus formulates its most fundamental principle: that cybernetics *is* communication or control within a system. However it must be remembered that this is not a discernible origin, but it is

[9] This is an unpublished manuscript that forms the basis of my undergraduate dissertation named "Contemporary hackers, ravers and the cyberpunk virtual community: a Modelling Systems Theory approach."

continuous with proto-cybernetics, as it bleeds into von Uexküll's work on the regulatory function of the feedback cycle (1940). Also, Rosenblueth *et al.*' s specific interest in predictive behaviour facilitates the development of artillery (anti-aircraft guns to use in warfare) but at the same time initiates the trend in cybernetics of looking at organisms to infer concepts and thus working models that can be implemented in machines. In other words Rosenblueth, Wiener and Bigelow favour the switch of early cybernetics' object of research from *organism* (as in proto-cybernetics) to *machines*. As anticipated, the taking up of a systemic perspective in early cybernetics, historically situates the drive of contemporary biosemiotics, particularly on the side of cultural semioticians, to generalise from biology to technology to culture.

b) The problem of information

The statistical development of the notion of *information* within the context of early cybernetics shows how the two disciplines of information theory and cybernetics became difficult to distinguish from the late 1940s onwards. In turn, this development suggests that whatever is held to be historically continuous with cybernetics, as is arguably the case of biosemiotics, is also to an extent continuous with information theory. This early hybridisation of methods allude rather shrewdly to the origins of the reflections on the status of information in 1990s' biosemiotics (Sharov 1992) and contemporary cybersemiotics (Brier 2008, Cannizzaro 2012a, 2012b) but also of the origins of the biosemiotic critiques of the mathematical-'objective' characterisation of information (Hoffmeyer 1996b, Brier 2008). Evidence of the hybridisation of information theory and cybernetics, but also of the original mathematical characterisation of information can be found in von Neumann's work on automata (1948) and Shannon and Weaver's Mathematical Theory of Communication (1949).

In his paper titled *The General and Logical Theory of Automata* (1948), one of the first working papers on computers, American-Hungarian mathematician John von Neumann (1903 – 1957) anticipated and formulated what later became cybernetics', and to an extent, also biosemiotics', core principles, those of *complexity, information* and *self-organisation*. After observing that natural systems bear a higher degree of complication (von Neumann's word for complexity) and small dimensions as compared to artificial systems e.g. the first ENIAC and the SSEC (IBM) computers, which instead at the time possessed enormous sizes, von Neumann concluded that the reason for this difference in

complication and dimensions was to be found within the *limited reliability* of the components of machines as compared to the reliability of the materials found in nature (for example, metals are not self-healing) (1948: 300), *and* in the capacity of organisms to *self-repair* and to *minimise the effects of error* through the use of redundancy of signal, and, most importantly, the capacity to *self-reproduce*. This conclusion is important because firstly it illustrates that von Neumann's method is contingent with Rosenblueth, Wiener and Bigelow's method of reflecting on natural principles for the purpose of generalising them, of making them trans-disciplinary (applicable between, across and beyond disciplines, Nicolescu 2002: 44) and more importantly can be applied to developing new forms of technology. This process of generalisation and re-specification, or this *organism-machine analogy* can be seen as continuous with Thompson's general method of study founded on mathematical homology, i.e. seeing formal similarities across different instances of things. The only difference being the applied purpose that von Neumann and Rosenblueth *et al.* pursued as compared to the purely descriptive purpose of Thompson. Secondly, von Neumann's reflection on the limitations of machines' materials not possessing the capacity to self-reproduce, is important because it leads him to reflect on *self-organisation* and the logical outline of the self-reproducing algorithm (1948: 314-317). Reflections on self-organisation was taken on by second order cyberneticians 40 years later (Maturana and Varela 1980) thus foregrounding continuity, despite the obvious differences between the state of the arts of early discipline and later discipline, with von Neumann's work. Thirdly, von Neumann holds that to be able to account for the difference in complexity between organisms and computers, one must envisage the need to describe the working of the latter in terms of *statistical information*, a mathematical model able to account for the continuous aspects of reality that would not be fully describable with formal logic alone (1948: 303). Here the history of information theory is inextricably linked to the history of cybernetics, to the point that reflections on the logical and semiotic status of information are still reflected upon even after 60 years in biosemiotics' literature (the cybernetic and semiotic status of information is further expanded in Chapter 6).

Although adumbrated in von Neumann's 1948 paper, the mathematical concept of information was brought to the public's attention only one year later in Shannon and Weaver's 1949 *Mathematical Theory of Communication.* By admission of Weaver himself, it is unclear whether cybernetics or information theory came first, since both Norbert Wiener (the father of cybernetics) and Shannon (the father of information theory) state that they are respectively indebted to their colleague's work for the importance of their own

contribution because this is antecedent to their own (Weaver 1949: 1). Also if considered within the history of cybernetics, Shannon and Weaver's 1949 *Mathematical Theory of Communication* appears contradictory because it was not inspired by the observation of biological systems as Rosenblueth, Wiener, Bigelow's and von Neumann's work was, rather it was inspired by the study of engineering communication systems. In fact, because of the applied interest of their founding body, the Rockefeller Foundation, Shannon and Weaver were primarily concerned with the *effectiveness* of communication, particularly in light of its technological framing i.e. how to transmit signals quickly and reliably over telegraph and telephone wires. To contextualise the technical context of telecommunications and to illustrate its workings and problems, Shannon and Weaver came up with their signature linear communication model, or transfer model. This consists of an *information source* that selects a *message* and sends it to a *transmitter* that will encode it into a *signal* and will send it through a *channel* to a *receiver*, which in turn decodes the signal into a message and delivers it to its *destination*. In the passage of information, *noise* as present in the channel may confuse the signal and thus reduce the effectiveness of the overall communication transfer. The key aspect of this model and Shannon's main contribution to information theory, and in turn, to cybernetics, is in the technical definition of the concept of *information*. This was in fact expressed in terms of thermodynamic entropy as "the freedom of choice we have in constructing messages." (Weaver 1949: 7) So the nature of information for Shannon and Weaver is formal, objective (fully describable in finite terms) and statistical. Information in its mathematical context thus becomes a pivotal model of cybernetics and came to constitute the source of one of the contradictions of cybernetics, both in the uneven passage from early cybernetics to First Order Cybernetics (as will be outlined in the next section) and in the further development of systems theory into biosemiotics. The historical contradiction of information is explored in detail in Chapter 6.

c) The Macy Conferences: multi, inter and trans-disciplinarity

The 1940s was a period which saw the complex and contradictory change of the orientation of cybernetics from problem-focused multidisciplinary science to theory-focused interdisciplinary perspective. Thus, on the one hand, this period provided the general context for the later consolidation of cybernetics as an *interdiscipline* in the 1950s, and on the other hand historically situated the interdisciplinary approach of contemporary semiotics that is indeed, not just (anthropo) semiotic but *bio*-semiotic.

It has to be noted here that during this period of variegated multi-disciplinary production and interdisciplinary exploration, Rosenblueth, Wiener and Bigelow, together with von Neumann and Gregory Bateson (a pioneer of the later First Order Cybernetics), were present at the first Macy Conference held in New York City on 8th-9th March 1946. These first conferences on 'Feedback Mechanisms and Circular Causal Systems in Biological and Social Systems', served as the birthplace of cybernetics. The Macy Foundation organiser, Frank Fremont-Smith, defined this first conference as an "experiment in multidisciplinary[10] science." (ASC 2010) In order to define this expression and grasp its relevance one can resort to a contemporary definition hereof. Multidisciplinary research was defined by Klein as "a spontaneous answer in carrying out problem-focussed projects"(1990: 58) and works through the juxtaposition of disciplines. It is an essentially additive, not integrative process and the relationship of the juxtaposed disciplines may be mutual and cumulative but not interactive (1990: 57). However, it can be the case, and it would appear to have been Fremont-Smith's hope, that multidisciplinary approaches become interdisciplinary, a process that causes "scientific disciplines to change their concepts and structures as they move towards a higher level of coordination based on the axiomatics of a common view point" (1990: 66).

Although Klein remembers that the passage from multi- to inter- to trans-disciplinarity does not necessarily happen in this order, nor that each of these stages occurs at all in disciplinary changes, one may nevertheless argue that this was the sort of evolution that was expected of cybernetics on the side of the Macy Conferences organisers. Since the morphing of cybernetics into a coherent interdiscipline did not happen as linearly premeditated nor within the expected timeframe (within the 6 years of conferences) the cybernetic multi-interdisciplinary project was judged as a failure. In fact, on occasion of the 10th Macy conference (22nd-24th April 1953), McCulloch was asked to write a summing up on the intellectual consensus obtained on cybernetics across the 10 conferences. ASC (2010) report that the only kind of agreement that was learned was of a social nature: that is, the conference attendees learned to know one another a bit better (McCulloch in ASC 2010). Thus he defined the cybernetic project as a "dead end" or as not "having produced a unified theory or meta-discipline of the sort to which Fremont-Smith had aspired". However as this thesis argues, new levels of organisations within the system, or, in other words, historical change is not without contradictions, thus one may argue that cybernetics *did* evolve, though unevenly, from a multi- to an interdisciplinary project. It is in the

[10] cf. trans- and interdisciplinarity - see Chapter 2, above

hybridisation of methods – Rosenblueth, Bigelow and Wiener's notion of biological feedback united with Shannon and Weaver's concept of information – and in the contradictory switch of object of research (from organism to machine) that one can foresee firstly the origins of cybernetics, then the premises for systems theory, and lastly the premises for biosemiotics, *or* the final change of cybernetics from an interdisciplinary perspective to a transdisciplinary one.

d) The problem of translation

Lastly, in the context of the emergence of interdisciplinarity as a palpable feature of cybernetics there emerged the need for a common theoretical framework that could encompass a number of disciplines and that was therefore not immune from the problem of interdisciplinary *translation.* This problem appears to be directly relevant to contemporary semiotics, given both Thomas Sebeoks' frequent invitations in zoosemiotics not to eagerly attribute human language to chimpanzee (1981) and also Cobley's invitation in biosemiotics not to over-emphasise freewill in semiotics as the humanities have already and mistakingly done (2010b).

Thus the problem of translation emerged during the time of the Macy Conferences. Despite the establishment of its staple epistemes such as feedback and information, the consolidation of cybernetics as an interdiscipline was not without its problems: interdisciplinary borrowing in fact implies the growing need for meta-language, as the Macy Foundation organiser, Fremont-Smith noted while making an appeal for collaboration between physics and psychology at the 6th Macy Conference: "the development of effective communication across the scientific disciplines is perhaps the most urgent need of our era" (Fremont-Smith 1949 in ASC 2010). What he called for here was a language flexible enough to be capable of accounting for animal, machine and ultimately human society, in a similar manner in which Thompson's homology was capable of describing both natural products (the structure of a bone) as well as cultural artifacts (a construction crane). This urgent need for meta-language and the systemic approach spreading in early cybernetics, anticipated the problem of translation. In this regard, Sleigh (2007) recalls the warning cast at the 2nd Macy Conference (October 1946) by the American animal psychologist Theodore Christian Schneirla who, having yet been funded by the Office Naval Research to do research on army ants "for the sake of developing machines with colony-like properties of problem solving" (Sleigh 2007: 169), was nevertheless skeptical about incautious

translation, or unsubstantiated borrowing and "always ready to act as a philosophical scourge to those too eager to generalise between species, especially when one of these species was *Homo sapiens*" (Sleigh 2007: 173). Slick generalisation is in fact a contradiction that was later developed within First Order Cybernetics while, contradictorily, developing the discipline itself (see Beer 1967). However it will be shown in the following passages how late cyberneticians were well aware of the problem of translation, invariably, casting the model of study into a new context rather than literally transposing it (for example, Pask 1961; Bertalanffy 1968; and Bateson 1972).

1950 - 1953 The birth of First Order Cybernetics

The early 1950s saw two important events in cybernetics: firstly, the final establishment of one of its key paradigmatic features, that is, its systemic perspective. In other words in this period, and through the first book by Norbert Wiener, *Cybernetics* within its subtitle *Control or Communication in the Animal and the Machine* (1948), systems theory consolidated as the fundamental ontological perspective behind any cybernetic application; secondly, with the birth of cybernetics, a contradiction in the conceptualisation of environment drew the new discipline a step closer to the later characterisation of *semiotic space* e.g. Lotman's (1967, 1990), Kull's (1998) and Hoffmeyer's (1996a) idea of semiosphere. A further consolidation of the problem of the 'objectivity' of information then took place.

a) From machine to man

What contributed to the rise of cybernetics, was a change in the object of research of cybernetics, particularly when the promise of Shannon's communication model enriched with Rosenblueth, Bigelow and Wiener's concept of feedback encouraged the study not just of machines but also of society. In 1949, one year after Wiener's publication, and upon the suggestion of Heinz von Foerster, 'Cybernetics' became the official disciplinary label of the Macy Conferences (ASC 2010). The subsequent Macy Conference (the seventh, in 1950), finally titled 'Cybernetics: Circular Causal and Feedback Mechanisms in Biological and Social Systems' saw the first participation of Shannon. In their mathematical theory of communication, Shannon and Weaver showed little interest in the organism-machine analogy, or in pursuing homology as a method of creating general communication models; they were rather interested in solving specific technical issues in technological systems. However, despite Weaver's insistence that information "has nothing to do with meaning"

(1949: 15), their mathematical communication model was immediately seen to have a general character and appeal outside engineering to the point that the seventh Macy Conference to which Shannon participated was entirely dedicated to exploring how language intersects with relevant features of information theory (ASC 2010). Thus, the mathematical model of communication and the statistically framed notion of 'information' (as entropy) became fundamental for the homology-based method characterising cybernetics and started to be utilised in the description of different instances of communications, including those in human social formations. It is precisely in the contradictory switch of object of research of early cybernetics from machine to society that the conditions for the consolidation of cybernetics as a new interdiscipline were finally set.

b) Contradictions of environment and information

The birth of cybernetics was marked by interdisciplinary borrowing and the consequent emergence of contradictions in the characterisation of environment (which further consolidates First Order Cybernetics) and the consolidation of the contradiction of information, particularly in relation to its origins in von Uexküll's semiotic conceptualisation of 'perception'. Given that von Uexküll is currently considered as a key figure in biosemiotics for the 'semiotic overtone' of his theoretical biology writings, it is no surprise that the 'objective' characterisation of perception in cybernetics was heavily criticised by contemporary biosemioticians (see Brier 2008). However this objective notion of information remains relevant to the semiotic endeavour (the reason being that Peircean accounts of biosemiotics do not exclude the formal aspect of signs, which are well accounted for in cybernetic information).

In *The Human Use of Human Beings: Cybernetics and Society* (1951) Wiener outlines the scope of cybernetics as encompassing the description of social systems. He integrated the feedback model (which was biologically-inspired by Rosenblueth at *al.*'s account of the predictive capability of living things, and by von Uexküll's 'functional circle' as illustration of the workings of an organism's *Umwelt* into Shannon and Weaver's communication model (which was inspired by engineering problems). This pioneering work originated a *general model of communication based on information and entropy*. Yet, this process of *borrowing* and *integration* of differently inspired models – from biology and engineering – caused *contradictions* in the conceptualisation of 'environment'. By admission of Wiener himself "The process of receiving and of using information is the process of our adjusting to the

contingencies of the outer environment, and of our living effectively within that environment" (Wiener 1951b: 17-18). Thus, the view that information is handmaiden to the *environment* in which the perceiving system is immersed is in clear contradiction with Rosenblueth, Wiener and Bigelow' s view that a system's behaviour needs be understood as isolated from its environment (1943: 1).

Additionally, the process of borrowing which gave birth to cybernetics, consolidated the contradiction of the 'objectivity' of information. As shown, through the notion of feedback and the need to account for the environment in systems studies, Wiener implicitly embraced Jakob von Uexküll's model of functional circle. However, in von Uexküll's model, living beings acquired 'subjective' knowledge through their sense organs, whereas the kind of information that a system acquires in Wiener's communication model was mathematical, discrete and objectively existing. This contradiction of subjective perception versus objective information continued to haunt cybernetics in the passage from first to second order developments, but also in its contemporary biosemiotic development (see Brier 2008; Cannizzaro 2012b).

After Norbert Wiener's groundbreaking efforts in studying feedback and communications *as* 'cybernetics', and von Foerster's subsequent suggestion of gathering under this same label the disparate contributions put forth during the Macy Conferences, the period was officially named *First Order Cybernetics*. Contributions in First Order Cybernetics from 1954 to 1979 do vary greatly in scope, however those embodying theoretical-philosophical approaches as *General System Theory* (Boulding 1956; Bertalanffy 1968), theoretical-mathematical formulations as *bio-cybernetics* (Ashby 1956; Pask 1961; Beer 1967; Lovelock 1979), and empirical applications resulting in what is here named as the *semiotic turn* (Bertalanffy 1968; Bateson 1970), closely approached biosemiotics' enterprise.

In this respect, the *semiotic turn*, as the term suggests, indicates a direct movement towards semiotics in that with Bateson a 'milder' conception of information is put forth (and thus subjectivity enters cybernetics) and a reworked cybernetic notion of system-environment which approaches 'Soviet Semiotics', particularly in relation to the concept of Modelling System and semiosphere (Lotman 1967, 1990). In short, 1970s' developments in First Order Cybernetics contribute to an overall pragmatic turn in the sciences (Kull 2010b [2009) which fundamentally grounds the idea of biosemiotics as a form of (pragmatic) biological philosophy (Witzany 2007).

General System Theory

General System Theory (Bertalanffy 1968 [1939 - 1967]) is relevant to biosemiotics for two main reasons: firstly it shares its inter-, but moreover, transdsciplinary endeavour. Secondly, reflections on the similarity of forms taking place in General System Theory hearkens to the notion of mathematical isomorphism, hinting at the relationship of continuity between the forms to be compared. This approach overlaps with biosemiotics' groundings in Peircean philosophy, particularly evident in Sebeok and Danesi's Modelling Systems Theory (2000) which utilises Peirce's categories of *Firstness*, *Secondness* and *Thirdness,* categories or forms of meaning that are continuous to each other. As such, General System Theory represents an important precursor to the biosemiotic idea of modelling. Also, along the line of previous warnings on the translatability difficulty of meta-language as emerged from the Macy Conferences, Bertalanffy refers to the problem of translation of concepts across disciplines; a problem that, as anticipated, is also relevant to contemporary biosemiotics.

The philosophical-theoretical trend of General System Theory was put forth in the 1950s and followed the trend exemplified by Thompson's emphasis on mathematical homology, and von Uexküll's general model of cognition (the functional circle), later revisited by the 1940s early cyberneticians. Developed by Ludwig von Bertalanffy between 1939 and 1967, General System Theory was interdisciplinary to its core. System theorists shared with early cyberneticians the idea that "the most fruitful areas for the growth of the sciences were those which had been neglected as a no-man's land between the various established fields" (Wiener 1948: 2). They were against the idea of a superspecialised science in which the scientist "may be filled with the jargon of his field and will know all its literature and its ramifications, but more frequently than not, he will regard the next subject as something belonging to his colleague three doors down the corridor" (Wiener 1948: 2). General System Theory's major aim was thus to facilitate communications among disparate fields by providing a common language with which to discuss systemic problems; thus, the need for a "lexicon, a consistent terminology or at least a series of clearly defined models that could find applicability in least two disciplines" (Boulding 1956: 198). The development of General System Theory followed three important steps: firstly, the founding of the *Society for the Advance of General System* in 1954 by Ludwig von Bertalanffy and the economist Kenneth E. Boulding; secondly, Boulding's subsequent definition of General System Theory as "a skeleton of science in the sense that it aims to provide a framework or structure on

which to hang the flesh of blood of particular disciplines and particular subject matters in an orderly and coherent corpus of knowledge" (Boulding 1956: 139); thirdly, von Bertalanffy's final officialisation of the field through the publication of his collected essays *General System Theory: Foundations, Development, Applications* in 1968.

In this book Bertalanffy clearly articulated the theoretical-methodological approach of systems theory. Firstly, General System Theory was concerned with systems or models of a general nature:

> (...) there exist models, principles, and laws that apply to generalised systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relation or 'forces' between them. It seems legitimate to ask for a theory, not of systems of a more or less special kind, but of universal principles applying to systems in general (Bertalanffy 1973a: 31).

Secondly, Bertalanffy called these universal principles *isomorphic models* in that they express universal aspects of systems across more than one discipline. Thirdly, isomorphism is clearly articulated along the line of Thompson's theory of form based on mathematical homology or formal similarity in that "if an object is a system, it must have certain general systems characteristics" (Bertalanffy 1973c: 85). Given that one of the aims of General System theory as outlined in the original 1954 programme (1973a: 13), was "to promote the unity of science", one may argue that the justification of isomorphism as a sound model of enquiry, stems from a fundamental belief in the unity of knowledge and the continuity between nature and culture, namely that if problems are found in different instances of reality, these can be studied with similar (isomorphic) models. This possibility is bacuse these instances are not that different and indeed belong to the same classes of elements, or are continuous to each other. This proposition serves as a fundamental articulation of the Peircean-synechistic basis of Sebeok and Danesi's Modelling Systems Theory (2000). However Bertalanffy also warns that "an incongruence between models and reality often exists" and citing information theory's potential but controversial application in psychology and society, concludes that "it is necessary to warn against incautious expansion to fields for which concepts are not made" (1973a: 21).

Lastly, by emerging out of the consolidation of a systemic perspective within cybernetics, systems theory establishes itself as *distinct* from cybernetics to the point that Bertalanffy defines cybernetics as a 'logically inhomogeneous approach' of systems theory (1973a: 21-29), and thus as one of its trend of applications. From this disciplinary contradiction there

emerges the difference between cybernetics as a theoretical perspective committed to mathematical application and systems theory as a theoretical perspective based on the discursive-descriptive principle of mathematical homology. Thus we move closer to a form of material philosophy rather than an empirical science. It is precisely this distinction between cybernetics and systems theory that ultimately lead cybernetics to incarnate into a form of 'second order systems theory' and formed not only the basis of Luhmann's systemic approach to sociology (1986) but also, and in contrast, Sebeok's cybernetic-systemic biosemiotic approach (1979c, 1988, 1991c).

Towards bio-cybernetics

Developments towards biocybernetics extended what was already a bio-technological model of communication with feedback to the study of features of living beings, including the human, such as *survival* (Ashby 1956) as well as *learning* and *choice* (Pask 1961, Beer 1967). This effort approached biosemiotics' commitment to study the 'intelligent' features of the living, and arguably constitutes the historical grounding for semiotics' 1970s expansion of its realm of study from the cultural to the biological, which is initially put forth by Sebeok's with the idea of *Zoosemiotics* (1963) and later taken up by Krampen in *Phytosemiotics* (1981), Uexküll *et al.*'s *Endosemiotics* (1993) and from the biological to the whole physical universe with Deely's *Physiosemiotics* (2010: 40).

Also, biocybernetics' effort is analogous and antecedent to that of contemporary cultural semioticians attempting to re-introduce a biological and cybernetic understanding within the analysis of human structures such as arts (Sebeok 1979f), media (Cobley 2009), subculture (Cannizzaro 2005) and religion (Wheeler 2010). This period of cybernetics' characterised by constant problem-focused *interdisciplinary borrowing* and relative contradictions, ultimately anticipates the biosemiotic idea of understanding human enterprises in terms of their biological framing. However at the same time, this period of cybernetics consolidated even more the problem of subject/agency in describing behaviour. In fact, as based on Ashby's mathematico-logical characterisation of biological function, biocybernetics endeavours became fundamentally grounded in discrete mathematics or set theory rather than semiotics (as it would be more appropriate in the study of man and of the living in general). Thus (first order) biocybernetics did not sufficiently account for agency and attracted critiques of (human) subjectlessness from the political philosopher Dupuy (2000), but also anticipated the basis for Brier's critique of

Second Order Cybernetics in its lack of biological *situatedness* or subjectivity that encompass all living beings (2008). Particularly, the latter critique by Brier aims at re-introducing the subjective notion if agency in cybernetics and thus is fundamental for a sound recapitulation of the biosemiotic notion of information.

In 1956, the English psychiatrist William Ross Ashby (1903 – 1972) wrote *Introduction to Cybernetics*, a work that is a classic in First Order Cybernetics text, to the point that critiques of the movement are typically critiques of this specific work (Dupuy 2000, Bertalanffy 1973e [1962]: 102-108). Here, Ashby proposed a formalisation of cybernetic 'regulation' through the notion of *biological controller*. With the example of a mouse, which has to select within a set of all possible behaviours, those that would not expose it to risks (i.e. would not make it fall prey of a cat). Throughout, Ashby articulates the biological notion of *survival* in finite terms, that is, as a set of permissible behaviours or *essential variables*. By defining survival in terms of discrete mathematics consisting of symbols and notation of set theory, Ashby put forward a formal description of a biological function and made the oft neglected point that cybernetics "does not study machines or 'things' in themselves but the way they behave" (1956: 1). This imbalanced focus attracted the different critiques on the 'subjectlessness' of (first order) cybernetics (Dupuy 2000) and the disembodied and disembedded notion of (second order) cybernetic information (Brier 2008) but at the same time, made cybernetics relevant to Kull's idea of biosemiotics a general science of relations, not of objects (Kull 2009);

Ashby's notion of biological controller was soon borrowed by the English psychologist Gordon Pask (1928 – 1996) and adapted as to encompass issues of *problem solving* and *learning* in the organism. Pask (1961) identified the principles of *survival, adaptation, homeostasis* and *communication* as pertaining to the theory of controller and explained that the connection amongst them is *learning*: this link is because learning is a capacity that helps an active, and not just reactive, organism to hold any instability in relief of its environment, and thus helps the organism to adapt to the imbalance, at the same time creating the conditions for homeostatic behaviour and ensuring the organism's biological survival. What is peculiar about this contribution is that in characterising the notion of biological controller, Pask corrects Ashby's logical reductionism by stating that, although at the level of systems there is no difference between biological and mechanical control (1961: 71), biological systems are quite unmechanical because it is impossible to distinguish in a discrete way, for example, the controller from the input. As such, in biology one may

think in terms of systems, but not in terms of things (1961: 71). In so doing, Pask attempts to smooth out the potential disciplinary contradiction that originates from going straight from maths to biology, as in Ashby's approach. Additionally, Pask (1961: 72) further specifies that an organism is not something described by a control system, but it is itself a control system "with its own survival as an objective." Thus by claiming that it is not possible to distinguish input or output in organisms (and contradicting Rosenblueth, Bigelow and Wiener 1943), Pask addresses the problem of the interdisciplinary borrowing, or translation that took place in this instance of cybernetic application. Pask's effort demonstrates that not all cyberneticians were prone to literal, careless translation of their models and that it is the critics of a vague mechanical reductionism in cybernetics (Wolfe 1998) who should pay more attention to this issue. Pask's view also demonstrates that the contradiction generated from interdisciplinary borrowing generates important development, in this case the correction of one of its models, and the advancement of the whole interdiscipline, in this case, cybernetics.

Subsequently, by borrowing Ashby's model of selectivity and Pask's model of problem solving, in 1967, British professor and management consultant Stafford Beer (1926 – 2002) developed a theory of biological controllers capable of encompassing 'industrial' abstract controllers, or management. In performing interdisciplinary borrowing, Beer showed to be highly driven by his applied goal, i.e. to simplify the complexity of large scale decisions in factory management by envisaging, similarly to an organism, firm management as a control device "which seeks an optimum homeostatic strategy, which amplifies the intelligence of its own human controllers, which learns for its own unfolding experience and which adapts itself to its environment" (1967: 149). Simulatenously he dismissed the humanistic implication of management by affirming that "homeostatic, intelligent and cybernetic machine is in the long run preferable to a human manager, who is also obviously homeostat, intelligent and capable of learning but also yet distracted, emotional and often has to guess" (1967: 152), thus embodying the broadly anti-humanist and subjectless approach that has been held to be so problematic in cybernetics (Wolfe 1998; Dupuy 2000; and Brier 2008). At the same time, Beer's interdisciplinary application of cybernetics represents an important step for the interdiscipline as it consolidates its general, systemic approach, while also anticipating another wave of applicative trends that see to the expansion of the organism-machine structural analogy (cybernetics with emphasis on its biological inspiration) to the vast arrears of human cultures: *biocybernetics*.

Lastly, this period of constant borrowing and transdisciplinary exploration culminates with James Lovelock's formulation of the *Gaia Hypothesis* in 1979. According to Lovelock, Gaia is a cybernetic superorganism which regulates, controls and ensures the survival of the Earth's biosphere. To substantiate this claim, he explains how in cybernetic systems' *circular logic* it is very different to distinguish cause from effect, what is the effect to what, and whether cause or effect comes first. Thus similarly, and continuously with Pask's approach, Lovelock holds that it is impossible to distinguish input from output. Also, he adds, again similar to Pask, it is difficult to identify *who* and *what* is the regulator of a cybernetic system, and thus concludes that it is better to concentrate on proving *whether* there is a regulatory function in the Earth's biosphere if at all. Thus he sets himself the goal of identifying instances of purposive regulation of negative or positive feedback 'behaviour'(Lovelock 1979: 57) in the biosphere, a task that he later accomplishes with his models of environmental disasters as the proof of the existence of Gaia. Seen in light of the history of cybernetics, Lovelock's Gaia hypothesis clearly appears as a further uneven interdisciplinary application of cybernetics to a field that encompasses organism, technology and man. As shown, to put forward the Gaia Hypothesis, Lovelock borrowed Pask' s corrected model of biological controller (with no input or output, and characterised by a greater holistic understanding where control is identified as the whole system). This constitutes further proof that the contradiction arising out of historically juxtaposing Ashby and Pask's notion of biological controllers (the former with input-output, replaced by the latter which is without) proved useful as it allowed further expansion of the scope of cybernetics. This expansion ranges from bio-machine, to bio-human system, to 'the rest' or bio-machine-human systems. This however was a top-down approach based on Ashby's abstract (that is, disembodied) definition of biological behaviour and missed to account for a form of behaviour that is both embodied and situated in an environment, thus lacked in respect to a general theory of biological subjectivity.

The 'semiotic turn'

The epistemological development of cybernetics into General System Theory, and the transdisciplinary applications of Ashby, Pask and Beer, brought about a further articulation of cybernetics known as *biocybernetics*. Towards the end of the 1960s, during a period of political turmoil and educational reforms, particularly towards interdisciplinarity, biocybernetics was further articulated specifically in relation to notions of *environment* and *information*. Bertalanffy did not just put forward General System Theory, but also

elaborated the necessity of envisaging an environment when studying a system. This development was continuous with von Uexküll's theorisation of *Umwelt* or an organism's own model of its spatio-sensorial environment (a notion which Bertalanffy was aware of in 1973d [1955]: 241), bringing his notion of 'environment as necessary' close to modelling and therefore close Juri Lotman's semiotic version of semiotic space or *semiosphere* (2001a [1990]). 'Environment as necessary' lead not just to the emergence of a semiotic overtone in cybernetics, but to a genuine overlap of interest as embodied in the Tartu-Moscow cyber-semiotic project of the late 1970s. Given that through the work of Thomas Sebeok (1991b [1988]: 49-48), biosemiotics is indebted to and built upon Soviet Semiotics, one could entertain that Bertalanffy's (bio)contribution to cybernetics was as a contingent contribution to Soviet Semiotics, and thus constellates itself as an overlooked adumbrator of biosemiotics. Like Bertalanffy, in this historical period Bateson (1972) also reflected on the notion of system-environment in cybernetics, thus consolidating biocybernetics on one side but also bringing the interdiscipline close to biosemiotics. However anthroposemiotics still today has not sufficiently implemented the study of environment in signs system analysis. Additionally, by defining information as a "difference which makes a difference" (2000b [1970]: 459), Bateson inserted the semiotic notion of *relevance* (as opposed to necessity) in cybernetics. As the discipline was inexorably influenced by cybernetics, the field became irreversibly linked to biosemiotics (as biosemiotician Hoffmeyer's work [2008d] on Bateson as a precursor to biosemiotics attests).

In *General System Theory* (1968), Bertalanffy had presented not only his theory of general systems, but also the theory of *the organism as an open system* (1950, 1969). This was thought to be a way to innovate in a mainstream biological tradition which still conceived of living beings as mechanisms or closed systems whose working was independent on their own environment. As opposed to a closed system which does not exchange matter or energy with its environment and that is destined to decay once the free energy internally available is finished, Bertalanffy posited that an open system, by exchanging matter with its environment and through the building-up and breaking-down of its material components, replenishes its level of energy and counteracts the Second Law of Thermodynamics, thus maintaining it life (1973f [1969]: 147-160). Consequently, for Bertalanffy, keeping a system's living identity was its *openness towards an environment*; thus, with his work, *environment became a necessity* in systems study. This epistemological move is in contrast with earlier formulations of a systems study approach by Rosenblueth, Bigelow, Wiener who generally held that systems had to be considered in isolation (1943: 1), thus further

developing the environment's historical contradiction already anticipated in early cybernetics. This uneven development was fundamental for cybernetics since because it became the basis of bio-cybernetics, which emphasised the importance of studying the organism plus its environment, or, to put it generally, systems and their contexts. Consequently this uneven development constituted the basis of Second Order Cybernetics' notion of structural couplings, or system-environment irreducible relation.

Also the biocybernetic work by the British anthropologist Gregory Bateson has semiotic overtones and played a role in the development of biosemiotics. In fact Bateson's work introduced both a biologically-conceived semiotics plus a biologically-conceived cybernetics, in the study of man. In this way this important cybernetician anticipated one of biosemiotics' central endeavours, that is, Sebeok and Danesi's Modelling Systems Theory (2000), a theory which illustrates the continuity between nature and culture through the study of the forms that biological meaning can acquire in the evolution from simpler modelling systems (nonverbal models) to more complex modelling systems (verbal and cultural models). Bateson borrowed the model of 'environment' and the model of 'feedback' in order to describe a number of human phenomena, including, for example, a theory of alcoholism (1972). Theoretically, he held that environment is a necessity in systems study because an organism focusing only on its own survival (considered in isolation), will end up destroying its own environment, and by destroying its environment, the organism ends up destroying itself (2000b [1970]: 457). Also, by emphasising that "the elementary cybernetic system with its messages in circuit is in fact, the simplest unit of mind" (2000b [1970]: 465), Bateson argued that the basic unit of survival (i.e. the most basic object of research he identified) was *organism plus environment*, whereas this 'plus' stood for the feedback communications putting the two in an irreducible relation. Thus, on the one hand, Bateson's work consolidated *biocybernetics*, a perspective taken on cybernetics that makes clear the use of nature-inspired models such as *environment* (proposed by Bertalanffy as a way of innovating the use of physics-models in biology) and *feedback* (deriving from von Uexküll's zoological theories as well as Rosenblueth, Bigelow and Wiener's observation of the predictive capability of living beings); obversely, by applying biocybernetic models to gain a biologically framed understanding of human cultures, Bateson unwittingly contradicts the object of research of early cybernetics favouring the passage from machine, to bio-machine to bio-human society. With this applicative effort he reinforces biocybernetics as a form of systems theory capable of explaining instances of at least two disciplines, the biological sciences and the human

sciences. Also, by underlining the incommensurability of the relation between organism and environment, Bateson casts an argument for the *continuity between mind and matter.* He in fact stated that because environment is a fundamental factor when conceiving of biological systems, then the mind encompasses a whole world of information that is not limited by the skin (2000b [1970]: 460) but that is also present in the communication pathways and messages outside the body. This argument approached von Uexküll's *et al.* (1993) *endosemiotics'* enterprise in defining biological self and non-self according to the sign-exchange that take place within the two, that distinguishes them and that constitute them in unison. Given the semiotic interconnectedness between system and environment, attempts to separate internal mind from external mind, and intellect from emotion were thus seen as monstrous (Bateson 2000b [1970]: 470). With his theory of continuity between mind and matter, culture and nature, man, organism and stone, Bateson put forth the first explicit theorisation of homology in cybernetics that does not just rely on a non-historical, nature-culture analogy, but argues for a common ancestry (continuity) as the cause of such formal similarity. This insight is broadly relevant to both Bertalanffy's idea that the unity (or continuity) of knowledge justifies the search for isomorphic models, and does so with Peirce's semiotic philosophy in mind.

Also, with Bateson, and in this period which precedes the rise of *Second Order Cybernetics* the concept of information takes a less formal, nearly subjective turn. In fact, Bateson (2000b [1970]: 459) defined information as "a difference which makes a difference." Citing Immanuel Kant's statement that "in a piece of chalk there are an infinite number of potential facts", Bateson argued that a potential fact becomes an actual fact only when this is perceived as relevant (or as making a difference) to a living organism. Thus, Bateson stepped away from information theory's and cybernetics' view defining information through *formal correspondence* or *necessity* and, indeed, introduced the non-necessary (thus semiotic) notion of *relevance*. This conceptualisation implies that information does not exist in isolation, but only *in relation* to a perceiving organisation. Thus with Bateson, information is not necessary anymore but relevant, i.e. meaningful or *purposeful* to someone. By hinting at the proto-cybernetics notion of purpose (von Uexküll 1940 and Thompson 1917) Bateson introduced the notion of *pragmatic* information in cybernetics. Presumably he did this because, given his interest in the study of man, Bateson had to face the emerging contradiction found in translating a model originally thought to describe a machine (the telegraph) into a model thought to describe the human. Thus this contradictory aspect of biocybernetics (in which a semiotic-'subjective' concept of

information contradicts the past engineering-'objective' concept of information) is fundamental because it introduced a clear *semiotic turn* (inflected towards pragmatism) in the whole discipline of cybernetics.

In 1960s-1970s' biocybernetics, further contradictions in the object of research and in the conceptualisation of environment and information brought First Order Cybernetics closer to semiotics.

One may accept that Bateson's semiotic and pragmatic reworking of the notion of information in terms of relevance, caused further uneven and entirely opposite currents of thought in Second Order Cybernetics: one that saw *information as pragmatic*, and one that saw *information as constructed*. But interestingly both these views are to be found in the passage between first order and Second Order Cybernetics. However, it is only the *constructivist* strand of cybernetics that is typically recognised as Second Order Cybernetics.

1970 – 1973 From First to Second Order Cybernetics: 'constructivism'

Central to understanding the constructivist development of Second Order Cybernetics is the work of Austrian-born physicist Heinz von Foerster (1911 – 2002). By emphasising the sensorial constraints of living beings' perceptions or models of reality, von Foerster's contribution to cybernetics reveals a parallel in biosemiotics, particularly von Uexküll's emphasis on *sensorium* as affecting the shape of an animal's *Umwelt*, and with Sebeok's interest in sensorial framing and modelling systems (1991b[1988], Sebeok and Danesi 2000), and self-fulfilling prophecy (1979d [1978]: 84-106). *Constraints* in the communication and understanding of signs are yet an underplayed, but nevertheless indispensable principle in biosemiotic knowledge to the same extent in which the seemingly opposite but more affirmed concept of *semiotic freedom* (Hoffmeyer 2008a) is heralded.

Heinz von Foerster had already been contributing to cybernetics since the time of the Macy Conferences. At his first meeting, the 6th Macy Conference, it was he who proposed to adopt the name 'cybernetics' to label the disparate interdisciplinary efforts of the meeting attendees. He was also pivotal in the development of *Second Order Cybernetics*, for which he also proposed the name. In his review of Spencer Brown's *Laws of Form* (1969) in the *Whole Earth Catalogue* (1970, an American bohemian scientific publication that gathered a

wide collection of cybernetic or proto-cybernetic thoughts such as e.g. excerpts of D'Arcy Thompson's book *On Growth and Form*), von Foerster introduced in cybernetics Spencer Brown's idea that *reality is constructed by an observer* while performing observation. The implications of this contribution were twofold: (1) drawing on Spencer Brown's work, von Foerster made logical contradiction[11] a valid criterion grounding the acquisition of knowledge and thus scientific explanation, therefore introducing *epistemology* as a paradigmatic feature of cybernetics. This epistemological turn did not just mark the difference between First Order Cybernetics and its second order, but subsequently would, in turn engender some definitional differences between cybernetics overall and systems theory (see Luhmann 1995a); (2) cybernetics's object of research switched contradictorily from the *observed system* to the *observing system* in that, in order to study reality one needs to study the characteristics of the constituting system first, or its observer. Von Foerster further articulated this point in a short article published one year later in the *Last Whole Earth Catalogue* (1971), where he drew a manifesto of Second Order Cybernetics by inserting Spencer Brown's theory of distinction in a broader cybernetic theoretical context, underlining, amongst the other points, that Second Order Cybernetics must be organised around the clear definition of a specific *search-space* in research, or what Maturana and Varela would later call the *domain of the observer.* Finally, von Foerster identified 'scientific evidence' to justify the introduction of an observer-based epistemology in cybernetics: the 'blind spot' (1973). Although this evidence should be taken as an illustrative example rather than a representative fact, it nevertheless helped him to make the universal point that the world, or "the environment as we perceive it is our invention" (1973: 1). To demonstrate this he invited the readers to experiment with 'a blind spot' in their field of vision, which he explains as the absence of photoreceptors at a certain point in the retina of humans' right eye. The point of this experiment was to show that this blindness is normally not perceived, or, more precisely, the absence of perception is not perceived, and that the world that we have always inhabited does not correspond to what is actually 'there' but to a description or computation that we have made out it. By means of the 'blind spot' as evidence, von Foerster demonstrated how reality is not in actual things but is an epiphenomenon of the human's physiological constitution that puts a *limit*, and at the same time guarantees, the acquisition and dissemination of knowledge. By emphasising the effect that physiological limitations have on human beings' and living beings' general

[11] In fact, the phrase 'reality is constructed' can be coherently translated at 'that which is real is not real". This is clearly a logical contradiction, probably a contemporary concern with 'far out' extremes as was, then, evident in the slang of the 1970s.

perception of reality, von Foerster paved the way towards cybernetics' constructivist phase, thus at the same time favouring its transition *from applied science to philosophy*. However, constructivism formed simultaneously the basis for a fundamental historical contradiction in the conceptualisation of cybernetic information that, like a system's environment, from being necessary (as in First Order Cybernetics), becomes constructed or arbitrary. This problem was further upholstered in cybernetics through the work of Maturana and Varela, and Luhmann.

1980 Autopoiesis as self-organisation

The quest of the two Chilean biologists, Humberto Maturana (1928, -) and Francisco Varela (1946-2001) for a defining principle of life, which they identified with the term *autopoiesis* – the capacity of organisms to recursively self-organise – brought cybernetics to its second order stage. Because of the emphasis on the role of the observer in constructing that which it observes (and constructing its purpose), this new disciplinary phase of cybernetics was contradictory with the first order's conception of teleological systems and purposeful information, and moreover contradictory with biosemiotics' pragmatic conception of communications (see Sebeok on *Communications* 1991b). However, at the same time as constituting the basis for thinking of systems in terms of their complexity, constructivist biocybernetics particularly through the model of autopoiesis was seen as starting point in endosemiotics (Thure von Uexküll 1993: 284), zoosemiotics and thus biosemiotics as a whole.

Constraints and constructivism became further developed in the work Maturana and Varela (1980). Their interest was to find a way to characterise the nature of the living by resorting to use cybernetics models and terminology. As a result, this variety of cybernetics sought as an object of research *biology*. This is an important fact to remember because it shows an uneven turnover of cybernetics from applied science to theoretical science, in a way going back to its original remits as embodied in proto-cybernetics's commitment to theoretical biology (von Uexküll 1940 and Thompson 1917). It is this contradictory move towards undertaking a theoretical approach to science (i.e. the interest in theoretical model-building) that facilitated cybernetics' later metamorphosis into systems theory. The key theoretical model of Maturana and Varela (also found at the basis of the Second Order Systems Theory) is that of *autopoiesis,* also conceived as the fundamental distinctive organisational feature of living systems as opposed to non-living systems. As Maturana and

Varela contended, systems, because of their dynamic nature, need to be understood not in terms of material components (fixed structure) but in terms of their constitutive relations (organisation) (1987: 47). This is the reason why Maturana and Varela posit living beings as *machines* (1980: 77): the word 'machine' expresses better than anything else the *dynamism* of the relations found in systems. Thus, Maturana and Varela resort to using *autopoiesis* to define those homeostatic machines that have their own reflexive organisation (or defining network of relations) as the fundamental variable which maintains them in a constant state, or alive. That is, autopoietic machines, or living systems, are those systems which "transform matter into themselves in a manner such that the product of their operation is their own organisation" (1980: 82). Arguably, Maturana and Varela's contribution to biology brings them closer to biocybernetics, which is also a cybernetic outlook attempting to characterise fundamental aspects of the living. This said, the main difference between Bateson *et al.*'s first order biocybernetics and Maturana and Varela's second order biocybernetics lay however in the *pragmatic versus constructivist* approach of the two perspectives. In fact, influenced by von Foerster's constructivism and relativism of categories of observation, Maturana and Varela specify that despite the fact that autopoietic machines are a kind of *homeostatic* machine, this view does not imply that they have purpose or that living systems are purposeful-teleological machines, as first order (bio) cybernetics would have maintained. Indeed, living systems are *purposeless systems* because the purpose of a machine is not an intrinsic feature of the domain of the machine but a feature of the domain of the description of the machine, and thus belongs to *the domain of the observer*. This 'domain of description' is the continuation of von Foerster's *search area* as outlined in the new cybernetics manifesto in 1971. Maturana and Varela assert that in systems research "an explanation (of a phenomenon) is always given by us as observers, and it is central to distinguish in it what pertains to the system as constitutive of its phenomenology from what pertains to our domain of description"(1980: 75-76). Thus, living systems do not have a purpose but "it is the observer who puts the machines to some use" (1980: 85). These claims are evidently of historical significance because having introduced the notion of the observer and living beings as purposeless systems, Maturana and Varela can be said to have brought the interdiscipline of cybernetics officially into its second order historical phase, thus in a final disciplinary stage clearly defined by its constructivist epistemology.

1986 – 1990 From cell to society: the birth of (Second Order) Systems Theory and the first contradiction of information

Finally, von Foerster's *blind spot* and Maturana and Varela's *autopoiesis* were further borrowed by the German sociologist Niklas Luhmann (1927 – 1998), creating more contradictions in cybernetics and simultaneously marking the beginning of its new disciplinary phase. Luhmann, in fact, borrowed and generalised the concept of autopoiesis in order for it to encompass not just biological systems but also social systems. By enlarging the discipline, his effort was analogous to that of Thomas Sebeok (1991b[1988]) and Sebeok and Danesi (2000) in their attempt to forge an understanding of the cultural-social sphere of human being (Secondary and Tertiary Modelling Systems) in terms of the biological (Primary Modelling System). Also, Luhmann's concept of interpenetration or the interplay between biological and psychic autopoiesis, and socio-communicative system when they use each other as environments and form mutual structural couplings is argued by Brier (2008: 402-406) to be fundamental to, though not sufficiently ensconced in, biosemiotics as a paradigm.

Luhmann, justified the generalisation of autopoiesis to social systems by stating that autopoietic systems are not just self-organising as Maturana and Varela explained, but also *self-referential.* This means that in this kind of system, input and output coincide and this is valid for all systems, ranging from the biological, to the social to the psychological. In so doing, Luhmann turned the biological theory of autopoiesis into a *general theory of autopoiesis* (1986) which, because of his particular interest in the legal system (let us not forget that Luhmann trained as a lawyer), he directed towards the characterisation of social systems. With Luhmann therefore, cybernetics has been re-generalised and re-specified in order to study social systems. In this passage from studying cells (Maturana and Varela's specific object of research) to studying cultural aspects of society, the contradiction arises of the object of research that marks the birth of social systems theory, while at the same time turning Second Order Cybernetics into a general perspective grounding a number of systems theoretical perspectives, ranging from Luhmann's systems theory to, arguably, biosemiotics. Let us not forget also that Second Order Cybernetics does not have a uniform philosophy, so while the impetus to research systems in terms of relations and communications is a trend launched by Luhmann's switch from cybernetics to systems theory, not all second order cybernetic models are grounded in constructivism. Some, as it is arguably the case in respect to biosemiotics, are grounded on a contradictory, and possibly more neglected strand of Second Order Cybernetics, that which leads to *pragmatism*.

Luhmann's move towards generalising a cybernetically-framed concept (autopoiesis) to explain instances of human life was not unproblematic. In fact, Luhmann's systems theory consolidated a relational-formal understanding of human cultural systems, in a way extending Ashby's idea that behaviour could simply and discretely be expressed in set theory terms, and thus that a conventional mathematical definition was a universal principle of nature (Dupuy 2000). The epistemological implication of Ashby's and Luhmann's method is similar: how can a science of man (such as sociology) possibly be studied without man itself? Where did first person experience go (Brier 2008)? By criticising Ashby, and in turn the whole of cybernetics, Dupuy in fact contended that cybernetics provided categories of subjectless processes (2000: 156) and operated a de-humanisation of man. This critique, based more on conceptions of First Order Cybernetics than second order, could however be taken as the basis to understand the way in which biosemiotics takes its cue from cybernetics and systems theory, yet supersedes it by providing at the same time a simultaneous relational outlook on man that it is not without first person experience. In fact, in a later critique of Second Order Cybernetics, Brier affirms that "Luhmann failed to develop a concept of meaning that relates deeply to the flesh, bloof and life conditions of biological systems" (Brier 2008: 402). In this respect, Luhmann's conception of communication comes close to biosemiotics'endeavour but bypassed the much needed emphasis of an embodied concept of meaning that takes into account Peirce's concept of Firstness.

Additionally, by introducing autopoiesis, Luhmann also introduced *the observer* in systems observation, thus putting forth a constructivist systems theory or *second order systems theory*. He in fact posited that in order to be autopoietic and replicatethemselves, systems have to be self-referential, a paradoxical state of the arts in which systems perform both self-observation (self-reference) but also hetero-reference (capable of making a distinction between themselves and an environment). While Luhmann points out that self-reference is paradoxical only in relation to an observer (1990: 89) he also reminds one that hetero-reference requires the modelling of a *construct* of reality. Indeed, Luhmann (1990: 135) argues, "the blind spot of each observation" or the fact that one cannot get to know reality but can only construct it, "[...] is at the same time its guarantee of a world." Thus, along the line of von Foerster's (1973: 1) affirming that "the environment as we perceive it is our invention", of Maturana and Varela stating that autopoietic machines are purposeless, Luhmann defines information as a "purely internal achievement", an act of selection that does not exist in the external world, but is a *construct* (1990: 135). So, Luhmann defined

information, a construct of the observed system while this in turn becomes constituted by its observing system: in fact second order observation is defined by Luhmann as dealing with *observation of constructs* (also paraphrasable as 'construction of constructs' or 'observation of observations'). In a way this is tantamount to saying that in Second Order Cybernetics, information becomes doubly arbitrary (relative to a system and to its observer).

This does not square well with First Order Cybernetics' view that information and environment are necessary or 'objective', giving rise to a historical contradiction, or a discontinuity in the concept of information with the past.

1980 'pragmatism' versus 'constructivism': the second contradiction of information

However this uneven development does not just stand in contraposition with the past but arguably, also with the present of cybernetics that, thanks to the work of Bateson, as noted by Hoffmeyer (2008a) and Brier (2008) develops a pragmatic overtone that is relevant to biosemiotics. Arguably, Sebeok's early work in zoosemiotics drew on this particular pragmatic thread of Second Order Cybernetics. Thus, the 1980s did see the unravelling of a strand in Second Order Cybernetics or second order systems theory that instead of drawing from the constructivist warp brought by von Foerster, Maturana and Varela, and Luhmann's conceptualisation of the observer, drew from a pragmatic woof taken on communication as weaved in early and First Order Cybernetics from Wiener (1951), Ashby (1956), Pask (1961), Beer (1967) and Lovelock (1979). Thus in Second Order Cybernetics one finds two main characterisations of information (also through reflections on 'error): one is pragmatist (Jantsch 1980, Wilden 1980) and the other is constructivist (Serres 1980, 2008). Thus contradiction as found in information and characterisation of error is soluble and that indeed the mediation between pragmatism and constructivism is still relevant today to biosemiotics. Indeed, if one can accept Sebeok's work on sensorial framing (from von Uexküll), Clever Hans effect (observer), and effective/functional communications came close to both second order and first order perspectives in cybernetics, one may also accept Sebeok's biosemiotics as a possible synthesis between constructivism and pragmatism. Thus, one may wonder: in light of biosemiotics, can systems study be pragmatic (i.e. grounded in Peirce's pragmatism, hence be realist) but also be grounded in observership? Does one perspective preclude the other? Any hypothesis that here emerges is that if the

demonstration of a cybernetic-systems theory heritage to biosemiotics is accepted, then one may answer these questions and see the whole biosemiotic project as an initial answer to, or better, the uneven resultant of this epistemological issue.

To go with order, the notion of pragmatic information was put forth by Luhmann's peer, the Austrian astrophysicist Erich Jantsch (1929-1980). Jantsch pragmatic notion of information is relevant to biosemiotics because standing in direct contraposition to its contemporary constructivist counterpart, it casts some light on how biosemiotics may have itself paradoxically originated out of Second Order Cybernetics' constructivism. One can in fact argue that Thomas Sebeok's claim that all living things and their sub-components are organised in a structure held together by *successful* communication processes (1991c: 22-23) betrays Sebeok's concern with effective communications and thus purposesul of pragmatic information. This preoccupation clearly takes its stance form this contradictory development of cybernetics which immediately precedes Sebeok's work. However, despite the functional outlook that Sebeok takes on communication, he also reminds that "the ideal of semiotic analysis is to combine causal with functional (1979f: 13)". Thus he emphasises that not just *purpose*, but also *causes* are to be taken into account in the study of systems behaviour.

Thus, Jantsch defined the biosphere as an *open system* (thus borrowing Bertalanffy's and Lovelock's models), illustrating its workings as importing energy from the universe but also exporting waste energy onto it in the form of radiation, and keeping itself in a condition of dynamic equilibrium (or disequilibrium). Jantsch postulated that this condition of openness and disequilibrium favours spontaneous processes and self-organising and *autopoietic* behaviour, thus favouring the emergence of dissipative structures feeding off negentropy, or the first living systems. In this way he explained how these first and primitive autopoietic systems (prokaryotes and eukaryotes) have helped to regulate the atmosphere 3000 million years ago, and in so doing these cells created their own biosphere and Gaia 1500 million years ago, which in turn granted conditions for the continuous existence of life. Thus, by depicting Gaia as creating her own conditions of life, Jantsch defined the earth's biosphere metaphor as a whole autopoietic system, integrating at once and under a single theory, the second order cybernetic notion of autopoiesis, and the first order model of the open system. This development appears to be uneven since, in Second Order Cybernetics, environment is an invention, while in first order (as embodied in the model of the open system), environment was a necessity.

Through the borrowing of models from within the same discipline but in different historical times, Jantsch leads cybernetics-systems theory to a sudden, forward thrusting stagger forward. The merging of a first order model with a second order model, resulted in the emphasis on purposeful communications or *pragmatic information*. Jantsch in fact held that 'inventions of life' such as *respiration, sexuality* and *heterotrophy* in the prokaryotes, could be seen as new modes of communication – or information transfer, as Jantsch called it (1980: 133) – that favoured the evolution of life from simple unicellular organisms in larger multicellular organisms. As a corollary, the evolution of *pragmatic information transfer* coincided, according to Jantsch, with the evolution of life. Additionally, since evolved organisms "(...) may adapt better to the environment and drive the evolution of the same environment at the same time (1980: 134)", pragmatic information has resulted in the eventual success of macro- and micro-cosmos co-evolution. With his emphasis on pragmatic information and thus purposeful behaviour, one can see how this strand of development that is still to be considered as second order due to its use of autopoiesis, is nevertheless directly at loggerheads with Second Order Cybernetics-systems theory's overall constructivist (or non-teleological) epistemological perspective. One could also add that Jantsch' contribution insists on a way which is symmetrical to First Order Cybernetics, though it unevenly incorporates some of the new second order models.

1980 – 2004 Theories of error: a third bifurcation

From the 1980s onwards, a number of cyberneticians and systems theorists realised that an orthodox categorisation of the workings of communication had to be able to explain *errors* in order to be complete (Wilden 1980, Serres 1980). Thus error, similarly to the principle of historical contradiction informing my thesis, became, during the 1980s, an integral part of any system. It is meaningful here to note how a different declination of the same model – error –, took place following the outline of the pragmatism-constructivism bifurcation in Second Order Cybernetics. Thus Wilden (1980) developed a pragmatic approach to error, whereas Serres (1980) developed a constructivist approach to error. Wilden's work particularly, yielding successfulness of communication and continuity among biological and social systems, appears strikingly along the line of Sebeok's theorisation of *The Semiotic Self* (1979c) a perspective taken on error as it may occur on the immune of psychological system, which hints not just as the analogy between the two, but at a real hereditary continuity between the body's immune system and mental conditions such as anxiety. The presence of two similar approaches (Wilden's and Sebeok's) in the same

historical time, is aruable evidence that they both develop from the same contradictory strand of pragmatic Second Order Cybernetics.

Anthony Wilden (b. 1935), similarly to Jantsch, used a first order approach in the context of the second order stage of development of cybernetics. In *System and Structure* (1980), Wilden illustrates the workings of the emergence of a biological error, which happens when negative (or regulative/adaptive) feedback response to a change may eventually transform in positive feedback and thus destroy the system. Wilden, like Jantsch, focuses therefore on purposeful communication and identifies as error the unsuccessfulness of communication in reaching a goal. Jantsch's position stands in direct opposition to Maturana and Varela's, and Luhmann's idea that systems are self-regulatory but not pragmatic (i.e. that pragmatism does not pertain to the observed system, but is a constituting characteristic of the observer). Wilden operates a logical jump from biological error to social error, stating that the illustrated principle of counter-adaptivity can be applied to psychosocial and socio-economic systems as well (1980: 206). When, in social systems, sender and receiver do not share the same code, socio-biological error originates, inverting negative feedback into positive, and thus resulting in pollution, racism, alienation, exploitation, oppression (1980: 210). Despite its pragmatic outlook (starkly in contrast with constructivism), Wilden's general methodological approach yields implications similar to those brought by Luhmann's theory: like Luhmann, Wilden's view consolidates a new epistemology of systems, thus on the one hand strengthening the rise of a systems theory which is cybernetically-framed whilst staying autonomous as a separate discipline, and on the other hand emphasising an ecological understanding of systems, and thus a bio-cybernetic systems theory or an ecological epistemology. Also, Wilden'statement that the unit of survival in an ecosystem is the *message in circuit* in that ecosystem (1980: 218) and thus the whole system, brings Wilden's contribution along the line of Bateson's similar affirmation in biocybernetics but also of zoosemiotics idea that animals trade with whole messages, not individual signs. The proof that this may also apply to human learning is that upon 'consuming' a media text, for example a comic book, it is not individual signs of 'comicity', 'cartoonicity' or 'narrative devices' that one at first gets, but it is a feel of the whole plot or of the quality of drawings or puns that one gains. This incommensurable, 'whole' feeling, in turn, illuminates the individual (narrative, visual and text-based) devices of which the comic is composed.

Finally, in 1980, Michel Serres, like Wilden, developed a treatise on error and change of sign within message transfer – when negative feedback becomes positive and *vice versa*; however, he added that information theory and theory of noise makes sense *only in relation to an observer* (Serres 1980: 76). Thus, it is:

> [...] no longer necessary to maintain the distinction between introspective knowledge and objective knowledge. There is only one type of knowledge and it is always linked to an observer. This observer is structured exactly like that which he observes. His position changes only the relationship between noise and information (1980: 83).

According to Serres, therefore, the detection of the 'sign' of information, or the distinction between negative or positive feedback, or information and noise, is a property of the observer, not of the observed system. This implies that an error is not a negative event in itself, but it is so or it constitutes information *only* in relation to an observer. One could hold that in Serres' view, error simply expresses *change* in systems. This change has to be understood not in terms of *progress* (towards the betterment of the state of the arts), but more sensibly in terms of the arrow of time (or 'parasitic arrow', see Serres 2007: 209). This change is perceived as meaningful (i.e. as evolution) only in relation to an observer, thus anticipating Bich's (2004: 286) later claim that there is not a fundamental or preferential analytical level in systems, and that levels of a system are inseparable from operation of distinction of the observer. As an example of the relativity of evolution (beside its dependence on time), Serres proposes that language originates from error, or sign change, or the continuous switch between noise and information (but only) as according to the position of the observer. In this sense, Serres' contribution represents the high point of systems theory's morphing into a systemic epistemology (thus a branch of philosophy) that envisages error within the working of a system, but that also requires an observer to make it come to light.

The historical review of cybernetics and systems theory of this thesis ends in the early 2000s contributions because further third order developments of cybernetics into artificial intelligence are posthumous to the emergence of biosemiotics (also developed in the early 1990s) and thus non-relevant to understanding its heritage. Also the implications of third order developments as exemplified by Brier (as in Cobley 2011) will be explored throughout the thesis and especially in Chapter 7. Although one may argue that current developments of systems theory may also be relevant to biosemiotics, I argue that the field must come to terms with its past first, in order to be able to come to terms with its myriad present contradictions, characterised by the ultimate contradiction (outlined by Favareau 2010: 47-

62) found in the biosemiotic work in biology by Barbieri who emphasises code (2008), while Hoffmeyer emphasises interpretation in creating biological meaning (2008a).

Conclusion

As the historical analysis of cybernetic and systems theory key contributions demonstrated, the continuous interdisciplinary borrowing and relative generation of contradictions within applications of cybernetics allowed it to emerge as an interdiscipline in itself, and to develop into *first order, second order cybernetics* and *systems theory.* Overall, the passage from cybernetics to systems theory can be explained through the contradictory journey of cybernetics from being a theoretical science in its proto-phase, to an applied science in its early phase, to an applied science with theoretical overtones (General System Theory and the semiotic turn) in its first order phase, to a philosophy in its second order phase. Read the other way round, this statement implies that any definition of systems theory can only be put forth in terms of its contradictory past in cybernetics. That is, *systems theory is an uneven development of cybernetics*. Similarly, this thesis claims that *biosemiotics is an uneven development of systems theory*. The above account of cybernetics has in fact primarily been framed according to the relevance that each uneven disciplinary development of cybernetics and systems theory held in turn for biosemiotics. The numerous points of contact between biosemiotics and cybernetics – e.g. circular causation (protocybernetics), homology and 'the semiotic turn' (First Order Cybernetics), pragmatic information, observership, error-based communications (Second Order Cybernetics) serve as evidence that systems theory constitutes the historical precursor to the whole biosemiotic project. While these points of historical relevance between biosemiotics and cybernetics and systems theory are further articulated in the following Chapter (5), they suggest an immediate generalisation: that the 'pragmatist versus constructivist' contradiction that second order systems theory finds itself in at the dawn of the 1980s, has constituted fertile ground for the establishment and consolidation of the new *interdisciplinary-integrative* fruits of biosemiotics. In this sense, in a similar way in which systems theory has been demonstrated to have emerged from historical contradictions in cybernetics, biosemiotics is similarly postulated as having originated from the putative contradictions developed in both the uneven development found in the passage from first to Second Order Cybernetics, and in the further uneven development found in the passage from Second Order Cybernetics to Systems Theory. In other words, following historical analysis, biosemiotics can be said to be, using Althusser's terms (1965),

an *uneven development of an already uneven development*, using René Thom's framework (1975), the morphological result of an epistemological catastrophe, or, simply, a contradictory form of modern systems theory.

CHAPTER 5

The relation of systems theory to biosemiotics: 'modelling' understood *as* 'transdisciplinarity', 'history' and 'function'.

Introduction

Our examination that biosemiotics is an uneven development of modern systems theory and cybernetics, the current chapter unpacks the argument highlighted in Chapters 3 and 4, that is, that both fields bear a *general* degree of relevance to each other in terms of 'modelling'. The current chapter sets out to identify with greater precision this area of disciplinary overlap, that is, the relation of systems theory to biosemiotics, starting from the premise that such a relation is unspoken in the biosemiotics literature (except for Brier 2008). To pursue this aim, the present chapter proposes a cross-comparative investigation of the concept of 'modelling' across both biosemiotics and systems theory. More precisely, the objective of this chapter is to propose a 'mapping' of the biosemiotic concept of modelling in terms of both its *conceptual* and *historical* affiliation with cybernetics and systems thinking.

In order to map the conceptual affiliation of biosemiotics and systems theory, this chapter embraces the framework suggested by Bertalanffy's General System Theory according to which:

> there exist models, principles, and laws that apply to generalised systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relation or 'forces' between them. It seems legitimate to ask for a theory, not of systems of a more or less special kind, but of universal principles applying to systems in general (1973a: 31).

These models, which Bertalanffy calls *isomorphic models*, characterise, describe or express certain universal traits or aspects of a phenomenon across more than one discipline. Considering that the broad area of overlap, or the general degree of isomorphism, between biosemiotics and systems theory was already identified in the previous chapters, this chapter sets out to qualify this isomorphism by identifying the specific 'universal traits' that constitute it precisely.

Before outlining these 'universal traits', the thesis that the relevance of systems theory to biosemiotics is not just conceptual but also historical has to be recalled. In order to map

the historical affiliation of biosemiotics and systems thinking, I embark on a practical application to Deely's 'archaeology of concepts' (1981, see Chapter 2) by presenting a reading of theories of modelling in biosemiotics from the 'privileged' point of view of theories of modelling as developed in the history of cybernetics and systems thinking. The intent of such a re-reading is to explore the extent to which certain concepts that are inconspicuously taken for granted in biosemiotics (for example, the very notion of *system*) can effectively be related to a cybernetic heritage and thus treated as a fundamentally cybernetic notion by current and future biosemiotic scholars.

In pursuing these objectives (i.e. the identification of both the conceptual and historical overlap between the two fields), the following analysis re-classifies biosemiotics and cybernetics conceptions of modelling in terms of the common categories of *transdisciplinarity, history* and *function*. These rubrics constitute the 'universal traits' or interdisciplinary categories that allow one to precisely argue in favour of the strict relation between the biosemiotic and the cybernetics' project. Also, in light of the 'archaeological intent' of this thesis these categories can be considered as the 'historical nodes of intersection' between biosemiotics and systems theory because they represent the 'evidence' that allows one to place the two fields along the same disciplinary-historical *continuum*. This placing is possible because, as Deely reminds us 'synchrony inevitably seeps into diachrony' (Deely 2010: 15), and a general outlook on knowledge makes sense only if situated within a historical perspective. In concrete terms, this implies that the categories of 'transdisciplinarity' and 'history' are contextualised in relation to the work of 'Soviet' semiotics (as in Lucid 1977) and the more recent Tartu semiotics (Lotman 1990), while the category of 'function' is contextualised in relation to theoretical biology. In carrying this historical-cross-comparative analysis of modelling, this chapter ultimately prepares the grounds for theorising the degree of discontinuity between biosemiotics and systems theory, as elicited by the fourth interdisciplinary category of 'information' (Chapter 6).

Modelling and transdisciplinarity

The reviews of the contributions of biosemiotics and cybernetics have revealed that both fields include theorisations of *form*. For example, in introducing Modelling Systems Theory, Sebeok and Danesi affirm that modelling refers to the activity of producing *forms* (2000: 6). Similarly, Bertalanffy argued that General System Theory is a science of wholeness or of

systems and is "in itself purely *formal* but applicable to the various empirical sciences" (1973a: 35, my italics). Therefore, one may broadly identify *form* as the key methodological feature that biosemiotics and systems theory have in common. More precisely, research on 'form' may be conceived as research on 'systems'. Thus the main similarity between biosemiotics and cybernetics is in terms of a methodology based on systems, i.e. the study of objects in terms of their common organisational patterns or structure. The first theoretical implication of taking up a systems thinking perspective is the potential for applicability in more than one discipline (Boulding 1956), hence this section proposes a regrouping of biosemiotic and cybernetic theories of modelling in terms of their relevance to transdisciplinarity. Indeed, it is argued that transdisciplinarity is the first feature that theories of modelling in biosemiotics and cybernetics have in common but also that that the transdisciplinary drive that the two projects share is not a case of random disciplinary contiguity but a case of historical continuity. This is evident through Lotman's notion of modelling system (1967) and semiosphere (1990) and his heritage in 1940s Soviet academia which as it will be shown, was inspired by cybernetics'.

a) Transdisciplinarity in (bio) semiotics

In semiotics, the two key theories that are palpably underwritten by a systemic perspective are Sebeok and Danesi's *Modelling Systems Theory* (2000) and Lotman's *Semiosphere* (1990).This is because both theories present general principles which, to use Bertalanffy's words for isomorphic models (1973a: 11), characterise, describe or express certain universal traits or aspects of the (organisational) state of phenomena across more than one discipline. In fact, Lotman's semiosphere furnishes the tools to express the organisational features of human cultural systems, whether art, religion or mathematics (see Zaliznjak *et al.* 1977), whereas Sebeok and Danesi's Modelling Systems Theory is particularly apt for cultural systems, yet can also be used to grasp the nature of animal's models. (Cannizzaro 2010b: 268) Thus, in light of their versatility, both theories yield a strong relevance to systems thinking or transdisciplinarity.

As anticipated in Chapter 3, Modelling Systems Theory (MST) is a methodical study of human cultural systems developed by Sebeok and Danesi (2000) which elaborates the notion of modelling systems present in the work of Tartu Semiotics. Because of Sebeok's identification of natural language as *a priori*, and therefore Primary Modelling Systems to precede verbal language, Modelling Systems Theory can potentially be used to grasp not

just human communications, but also the nature of animals' and possibly all living beings' communication systems. Because of this general aspect of MST, one may argue that such a theory has potential for transdisciplinarity. More precisely this transdisciplinarity is suggested by the *'biological'*, *dimensional* and *structural* principles that underwrite MST. The *'biological'* principle (though not explicitly referred to as such by Sebeok and Danesi, hence my quotation marks), denotes a key feature of modelling systems theory, that is, its relevance to *anything that lives*, hence the general 'biological' nomenclature. The biological principle is based on the fact that *modelling*, or the ability to make models of the world, is grounded in *semiosis*, which as the capacity of a species to comprehend and produce forms (2000: 5), pertains to *all* living beings. Thus, if modelling appears to be a fundamentally biological activity, then it follows that the study of human representations, intended as the capacity to refer to the world in terms of specific forms, cannot be extraneous from a preliminary study of how such a capacity is rooted in semiosis, intended as the biological capacity of producing and comprehending forms. This reasoning shows that modelling bears a biological-cognitive component.

The officially-named *dimensionality* principle (Sebeok and Danesi 2000: 11) poses that modelling unfolds on three levels of dimensions in which iconicity and indexicality are developmentally and cognitively prior to symbolicity (and thus representation). So, there are three types of systems of signification called primary, secondary and tertiary modelling systems – which correspond *grosso modo* to what Charles Peirce called Firstness, Secondness and Thirdness. (Sebeok and Danesi 2000: 10) The above is an instance of transdisciplinarity because, in the realm of relations to objects, iconicity (a firstness), indexicality (a secondness) and symbolicity (a thirdness) are posited as the *general features* that allow an effective categorisation of different types of modelling, whether these pertain to the human species alone, or to all species. For example, Primary (iconic) Modelling Systems, or nonverbal language, would include movements, proximity and gesture, which can all be found in human representation (for example, in ballet), but which are also found as cognitive forms in other living beings (e.g. the honeybee dance). Secondary (indexical-indicative) Modelling Systems in humans include verbal language but also media or technology in general, while in animals they include indicative behaviour such as that of the *Indicator indicator* Picarian bird, that would chatter until followed (by a mammal, including the human) and eventually would indicate through chirps and spreading of a white feathered tail, the pursuer where a wild bee's nest is (Sebeok and Danesi 2000: 96). Tertiary (symbolic) Modelling Systems in humans include cultures and codes such as

mathematics, literature and religions as well as subcultures such as emo-culture, rave culture, London fixed-gear cycling culture, whereas in animals they include anti-predation or mating behaviour such as that of a baboons conveying fear by way of a vertical tail, or that of the male of the carnivorous insect family *Empididae* which offers the female an empty balloon before copulation in order to avoid becoming its prey (Huxley 1966, cited in Sebeok and Danesi 2000: 126). Thus, Modelling Systems Theory is based on the conception that anything that lives and that, as such, produces signs, will reproduce three fundamental types of models – primary, secondary and tertiary models – all models have adaptive (necessary) or exaptive (desidable but non-necessary) functions according to the particular species which produced them in the first place. The dimensionality principle of Modelling Systems Theory describes a universal, and thus necessarily transdisciplinary feature of modelling – its grounding in iconicity, indexicality and symbolicity.

Lastly, the structural principle (Sebeok and Danesi 2000: 11) of Modelling Systems Theory is systemic at its core in that it posits that all models display the same pattern of structural properties, that is, *paradigmaticity, syntagmaticity, analogy, synchronicity, diachronicity* and *signification*. This principle is the crux of the systems thinking that is present in Modelling Systems Theory in that it allows one to categorise the modes of representation pertaining to modelling in terms of the *form* they assume – *singularised, composite, cohesive,* and *connective* forms. A singularised form is a simple model serving to encompass singular referents or referential domain, e.g. a sign, conceived as 'signifier', 'signified' and 'relation of signification' (Sebeok and Danesi 2000: 21). Composite modelling is the activity of representing groups of referents posited in *syntagmatic* relationship one with the other, e.g. a text, which has to be posited in a context and in relation to other texts (Sebeok and Danesi 2000: 29)[12]. Cohesive modelling is the realm of paradigmatic systems or codes, as for example the immune system or a cultural code like geometry (Sebeok and Danesi 2000: 32). Connective forms are the result of *metaphorical* reasoning processes, e.g. a metaform, produced when abstract concepts are represented in terms of concrete ones (Sebeok and Danesi 2000: 37). By positing that all models that a living being, and particularly a human animal, can possibly produce possess common organisational patterns (singularised, composite, cohesive and connective forms), one can see how Modelling Systems Theory conceives of its object of study as *systems* and thus is transdisciplinary at core.

[12] Note that this contextual and intertextual aspect would necessarily confer an interdisciplinary dimension to textual analysis.

Notably, the notion of modelling which contains the systemic foundations of Sebeok and Danesi's MST, comes from Lotman's model of culture, or the *semiosphere* (1990). This model is particularly relevant to biosemiotics in that not only Sebeok and Danesi's theory, but much of contemporary biosemiotic theory intuitively builds on the semiosphere (e.g. Hoffmeyer 1996a, Kull 1998, and Brier 2007). The first 'systemic' feature of the semiosphere is certainly its amenability to the concept of *space*. Indeed as Randviir argues, theTartu-Moscow school of whom Lotman was the most important figure, has been generally a school of the semiotics of *space* (2007: 139). Broms, Riikonen, Tarasti and Kaufmann (1988: 3), the organisers of the 25th Symposium of the Tartu-Moscow School of Semiotics (Imatra, 27-29 July 1987) stated how "the school' s most important trait was that it capitalised on the *totality* of culture, not the segmentation thereof." The category of 'space' allows one to envisage the totality rather than the singularity of phenomena to be studied. As Lotman explains, in fact the unit of semiosis, the smallest functioning mechanism of culture, is not the separate language but the *whole semiotic space* of the culture in question. (Lotman 2001b: 125). Thus, through a spatial conception of culture as embodied in his notion of Semiosphere, Lotman demonstrates his concern with *organisations*, or systems, particularly in relation to both *structure* and *time*. In this section I will limit the discussion to the category of structure only, since reflections on time are specifically dealt with in the next section of this chapter (on history).

Now, Lotman's interest in structure is evident in his frequent definitions of the semiosphere as a system (Chang 2003). By means of Bertalanffy's isomorphism (1945) one could argue that, if the semiosphere is a system, then it must possesses a set of general features that can be found in different instances of cultural communications. Such systemic features of the semiosphere can be identified as *boundary, binarism, asymmetry, centre* and *periphery, subsystems,* and *dialogue*. Lotman explains how every culture begins by separating the internal space from the external space, (2001b: 131) an activity that is made possible by *boundaries*, a functional element of the semiophere which controls, adapts and filters the external from the internal. *Binarism* describes the organisation of the semiosphere, constituted by the opposition between primary and secondary modelling systems. *Asymmetry* is a characteristic of systems which do not have a mutually translatable structure. The difference in structure causes the message or text to acquire a new form whose semantic originality will be proportional to the degree of untranslatability of the two systems. Thus asymmetric relationships "exemplify the creative function of both language and of the text" (Lotman 2001a: 15). Asymmetry can be seen as a 'device' that

ensures that communications in the semiosphere do not just 'transfer information' but rather 'generate new information' by means of translation. *Centre-periphery* is a binary, structural principle of the semiosphere which implies a hierarchical organisation of its structure: at the centre of the semiosphere, in fact, are the most developed, structurally organised and "stable" languages of a culture, while in the periphery are the less stable or canonical aspects of such a culture. The semiosphere does not just have a single outer boundary, but possesses multiple internal boundaries; thus, this implies that the semiosphere is composed of *subsystems*, or 'subsemiospheres'. Lastly, *dialogue* is the mechanism according to which two (asymmetric) languages, at a time, alternatively change their role from transmitters to receivers and thus continuously recreate the cultural semiotic space which *is* the semiosphere. Hence the semiosphere can be defined as a system with a set of general features which may function as a general transdisciplinary framework for the mapping of complex culture.

Many of these general features, particularly the notion of binary opposition, are strongly influenced by Saussurean structuralism, yet the systemic-general character of the semiosphere diverges from a structuralist conception of systems. Lotman was inspired by Saussure's idea that the object of research of semiology should be the structure of language but he departed from Saussure's idea of pure synchrony (whereby languages are to be seen in isolation from their historical contexts) "by reason of a more informed historicity" (Deely 2010: 17). Since the dynamic-historical aspect of the semiosphere is particularly relevant to both biosemiotics and cybernetics, it will be treated in more depth in the following section on historical conceptions of systems.

b) Transdisciplinarity in cybernetics

After an account of instances of systems thinking in biosemiotics, a similar account is needed in cybernetics and systems theory, whence what follows. Because the concept of 'system' has also, and prior to biosemiotics, been envisaged in 20th Century cybernetics, initially in the biological theory of form of Thompson (1917) and then in mathematical theories of behaviour (Rosenblueth *et al.* 1943; von Neumann 1948; Ashby 1956), these formal theories had transdisciplinary implications that have been further developed into overt systems thinking through the work of Wiener on *Cybernetics* (1948), through Bertalanffy's *General System Theory* (1968 [1939-1967]) and through Luhmann's *General Theory of Social Systems* (1995a).

Thompson (1966 [1917]: 269-270) proposes a biological theory of form that has a mathematical approach:

> We are apt to think of mathematical definitions as too strict and rigid for common use, but their rigour is combined with all but endless freedom. The precise definition of an ellipse introduces us to all the ellipses of the world. [In so doing] we discover homologies or identities which were not obvious before.

One may argue that Thompson's work can be considered as 'proto-cybernetic' because it relies on an establishing method of description grounded in *mathematical homology* and a systemic approach. This strategy was developed by early cyberneticians in the form of mathematical theories of behaviour. For example, Rosenblueth *et al.* (1943) formalise the predictive behaviour of organisms and implement its description for the development of technology; similarly, von Neumann (1948) studies the complexity of living systems with the purpose of implementing such a characteristic: identified, amongst other things, in the capacity for self-production in computers. First-order cybernetician, Ashby (1956), develops an abstract definition of biological behaviour (survival) through the use of discrete mathematics. In other words, similarly to Thompson, these scientists subscribe to a general method of description, thus showing a fundamental adherence to (mathematical) systems thinking. Most notably, Ashby reminds us that cybernetics "does not study machines or 'things' in themselves but the way they behave" (1956: 1), a statement that is relevant to biosemiotics not least for the fact that Lotman's student, Chernov (Chernov 1988: 7) similarly defined (Tartu-Moscow) semiotics "beyond doubt [as] a science without an object [...], a search for ways of describing. So, semiotics is, a priori, a metascience." Here one can see how the fundamental logic of mathematical modelling or systemic-description, is common to both cybernetics and biosemiotics.

The cultural context in which cybernetics developed as an autonomous discipline is also important to understand how cybernetics becomes, in effect, a transdisciplinary framework, which is then co-opted in both systems theory (through Bertalanffy) and biosemiotics (through 'Soviet' semiotics). The organiser of the Macy Conferences, Frank Fremont-Smith in fact conceived the first conference (ASC 2010) as an experiment in multidisciplinary science with the hope of creating a common language for effective communication across the scientific disciplines (Fremont-Smith 1949 in ASC 2010). In his first book, which gives the official label of 'cybernetics' to the Macy Conferences, Norbert Wiener describes the cybernetics enterprise as a metalanguage capable of encompassing properties common to animal, machine and man (1948), and in his second book, as

encompassing the description of social systems (1951). The transdisciplinary implications of Wiener's conception of cybernetics are then further extrapolated and condensed in a single metatheory such as Bertalanffy's General System Theory (1968). General System Theory is faithful to its origins in mathematical theories of form in that it conceives of systems as 'mathematical complexes', particularly as *constitutive*, and not summative, complexes of elements and relations (1973c: 53). Bertalanffy explains how, in mathematics, constitutive complexes differ from summative complexes in that they are not made of parts only, but of parts *and* their relations. What Bertalanffy extrapolates from such a formal-mathematical conception of systems upon which General System Theory is based, is a general transdisciplinary outlook on knowledge which posits that instances of different things can be studied and compared through a common method. Bertalanffy's general or transdisciplinary outlook relies on *logical homology*; Bertalanffy (1973c: 85) refers to this term as the adoption of a structural outlook on problems, that is, through homology one can see that "the efficient factors [generating phenomena] are different, but the respective laws [describing them] are formally identical". Thus while analogies, explains Bertalanffy, are worthless, homologies often present valuable models for comparison and explanation (1973c: 85-89). Niklas Luhmann, who subsequently built on General System Theory to put forth his General Theory of Social Systems, explains how he turns to Bertalanffy's approach in that it does not reduce everything to mere analogy but furnishes *conceptual abstraction* that makes comparisons, and thus further analyses across different entities are made possible (Luhmann 1995b: 2). In other words, it renders the conditions for a form of analysis that presupposes transdisciplinarity. Hence logical homologies constitute transdisciplinary models in that they express universal aspects of systems *across more than one discipline* and function as a common language that facilitates communications among disparate fields. Sebeok (1977a: 185) is clearly mindful of the transdisciplinarity embedded in Bertalanffy's systems thinking when he notices that:

> the kinship of semiotically based programmes... to the movement known as General System Theory is seldom underlined yet their common denominator is rather obvious.. both these variants of a single metatheory can be traced back to Leibniz and his programme for a *mathesis universalis.*

The latter Latin being a 'universal language of ideas' understandable to people of all lands (Meschkowski 1964: 49). In short, similarly to General System Theory, biosemiotics and social systems theory are also concerned with what Bertalanffy calls logical homologies. In

particular, biosemiotics' concern with mathematical modelling can be argued to be a case of historical determination, as the account that follows demonstrates.

c) 'Transdisciplinarity' as continuity

It is argued that the transdisciplinary drive that biosemiotics and systems theory share is not simply a case of coincidental disiciplinary overlap but, rather, a case of historical continuity. This section attempts to demonstrate that transdisciplinarity was 'imported' to biosemiotics when Sebeok's attempted to introduce Lotman's work to the West. In so doing, one could say that Sebeok also spread the cybernetic and transdisciplinary approach that was fundamental to Tartu-Moscow semiotics as a whole. Transdisciplinarity, in fact, does not pertain to Lotman's work alone, but is a peculiar character of the Tartu-Moscow school in general (Randviir 2007). As Randviir (2007: 150) argues, "viewing [the Tartu-Moscow School] as a school centred at the study and metalinguistic use of space, thus helps to see its connections with other traditions of thought and research". For example, "Biosemiotics and cultural semiotics are alike in methodology: both favour the treatment of their objects in metaphorical manners" (2007: 145). However, if one posits that the Tartu-Moscow School was grounded in the interdisciplinary developments of 1940s Soviet academia which were in turn influenced by cybernetics, then one can see how biosemiotics, in building on Tartu-Moscow semiotics' transdisciplinarity, automatically inherits cybernetics' transdisciplinarity. In this respect, Waldstein explains that 1940s Soviet academia was strongly influenced by cybernetics in light of the appeal of ideological neutrality and its attributive systematic exactness which it embodied, and which seemed to perfectly suit the needs of an academic environment which was pervaded by a wariness of overtly political projects. Academics in Soviet times were, to say the least, irritated

> ... by the state's and the Party's infringements on the personal and corporate autonomy of academics and academia. (...) Their institutional position, professional competence and personal security were in constant danger – particularly for specialists in the human sciences, where knowledge seemed to be more transparent to the authorities and thus more vulnerable to their interventions (Waldstein 2008: 17).

Waldstein claims that due to its closeness to the mathematical sciences, cybernetics appealed to Soviet scholars as an 'ideology-free' and thus neutral language. This is because cybernetics was believed to aid the *clear* formulation of problems and thus could have favoured the reception and expansion of structural linguistics. Arguably then, cybernetics was being 'marketed' as the maths of the humanities, particularly in light of it being

underwritten, as previously shown, by instances of mathematical modelling (as exemplified by set theory, see below). For example, such a 'rhetoric of exactness' is found in McCulloch and Pitts' theory of formal neural networks which postulates that "any functioning [of a system] which can be defined in its entirety logically, strictly and unambiguously in a finite number of words, can also be realised by such formal neural networks." (McCulloch and Pitts cited in von Neumann 1948: 309), that is, anything that can be put into a question with words can be solved. As Waldstein contends, this impetus towards exactness and the 'ideological neutrality' that is proper of cybernetics constituted a point of appeal for semiotics developed during Soviet times in that it promised to be "a recipe for transformation of linguistics and other human sciences into 'true sciences'" (Waldstein 2007: 18). This is because such a promise was directly in opposition to Stalinist thinking, which impeded scientific discovery. As Schwartz usefully illustrates: "In physics... such fields as quantum physics were sometimes condemned as anti-Marxist, and in biology all progress was rendered practically impossible for twenty-five years because of Lysenko." (1984: 179) Schwartz explains that Lysenko, as a member of USSR academy of science, championed the non-Darwinian theory that, within species, there is no overpopulation nor struggle for survival but only a progressive biological science which was indebted to Lenin and Stalin (Schwartz 1984: 185). On the other hand, "under Stalin, mathematics was probably more secure than other branches of science, doubtless because it is less accessible" (1984: 179). Hence, the reason why academics in the humanities fixated on mathematical models: these were representative of theory that was not accessible to the majority, even intellectually. In fact, in 1964 the term 'Secondary modelling system' (notably, 'modelling is a mathematical term) was used as a euphemism for semiotics because the very term 'semiotics' was prohibited by scientific state officials (Chernov 1988: 12).

In other words one may argue that the 'alliance' of Soviet academia with cybernetics can be seen as the beginning of a process of de-Stalinisation of knowledge, which is the core of what is later dubbed as Eurocommunism, or "the vast process of change involving the left everywhere in the world – that of de-Stalinisation" (Ross: 1980: 15). In fact, as Boggs and Plotke argue, Eurocommunism presents itself as a political formation that sets out to transcend the failures of the past through, amongst other things, involvement in political struggles that take place within institutions and a principled support of social and political pluralism (Boggs and Plotke 1980: 7) much like that which 'Soviet' academics were trying to achieve. Additionally, Salvadori (1978: xxv, my translation) argues that the core basis of

Western European Communist parties (the Eurocommunists) was a desire for autonomy from the [Stalinist] USSR and the adhesion to principles of democracy.[13] Hence one may argue that Soviet' academia's desire for autonomy and its pursuit of 'scientific neutrality' through mathematical models could be seen as a precedent for Eurocommunism, or its historical context.

Concomitantly one can see how such a view was an ideological position in itself. Hence, as a prefigurement of neutrality and transdisciplinary applicability that was in itself fundamentally *political*, cybernetics is said to have favoured (in Soviet academia, but arguably also in West-European countries) the birth of semiotics as a science aimed at the study of "any sign system in human society" (Ivanov 1962: 3 cited in Waldstein 2008: 20). The universal model of applicability proposed by cybernetics, or its transdisciplinary character, was thus assimilated into the 'Soviet Semiotics' project as illustrated by Lucid (1977). Despite its name, 'Soviet semiotics', this anthology embodies the desire for autonomy of knowledge in its transdisciplinary character. For example structural linguistics is here presented as a linguistic branch of cybernetics to the point that, by analogy with cybernetics, semiotics is defined as the examination of sign systems as "cybernetic control mechanisms for information" (Chernov 1988: 7). If one considers that Lotman graduated from Leningrad University in 1950 (in the context of cybernetics-pervaded academia), one could advance the hypothesis that Lotman introduced the cybernetic-transdisciplinary approach to Tartu semiotics when he left Soviet academia to join the University of Tartu in Estonia. Evidence of this claim is that in 1964 Lotman lectured on a course of structural poetics and semiotics, which was promoted as a course for the majors in cybernetics, thus showing his affiliation to the cybernetics-derived and transdisciplinary-conceived version of semiotics present in Lucid (1977). The recognition that cybernetics had a strong influence on the birth of Tartu-Moscow semiotics, is important because this division of semiotics, as shown above and in Chapter 3, is then co-opted by biosemiotics, through the elaboration of Lotman's work on modelling (Sebeok 1988; Sebeok and Danesi 2000) and semiosphere (Kull 1998; Hoffmeyer 1996a; Brier 2008). In this respect, one could argue that an awareness of Soviet semiotic interest in cybernetics constitutes the historical and disciplinary basis for understanding, conceiving and relaunching a biosemiotic

[13] Original text: *La base comune di partiti comunisti europei occidentali si poggia su due punti: 1) la rivendicazione della propria autonomia dall' Urss, e 2) il rifiuto della prospettiva della dittatura del proletariato e l'adesione ai principi della democrazia politica* (Salvadori 1978: xxv)

transdisciplinarity e.g. its impetus towards the study of biological systems in terms of semiotics Hoffmeyer (1996a), or the study of cultural systems in terms of biology (Sebeok 1988) or its impetus towards metatheorisation as found in *cybersemiotics* (Brier 2008).

Perhaps the high point of the systems theory's exemplification of the kind of 'neutrality' favoured by the Soviets, is the invocation of set theory, a branch of discrete mathematics which studies sets, their elements and the relations (if any) among such elements. Set theory in fact can be argued to have furnished 'desirable' analytical models to academics in Soviet times, which have in turn been adopted in recent systems theory but also implicitly co-opted through Tartu-Moscow semiotics in contemporary biosemiotic studies.

Set theory is the formal study of complexes, the mathematical method of much of cybernetics theory (e.g. Ashby's notion of biological controller is expressed in set theory terms) and the precursor to the discursive notion of system as found in General System Theory. Set theory posits that a set is a *collection of objects*, as for example A={a, b, c, d} which means that the set A contains the objects a, b, c, d. This mathematical notion of a set is relevant to systems theory in that it puts forth a notion of *boundary* that also applies to systems. The fact that mathematical sets are well defined – that is, they are *discrete* entities implies that sets have a firm *boundary*. Thus at any point in time one can determine whether an element belongs to a set-system or not, in other words whether an element falls within a system or whether it falls within its environment. This system-environment distinction can be detected in set builder notation but even more evidently in Venn diagrams, which is a way to graphically represent sets.

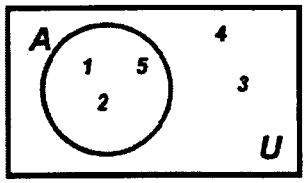

Figure 2. A Venn Diagram.

As figure 2 shows, in a Venn Diagram the set is represented by the circle, the elements of the set are the ones found inside the circle, and the universal set is usually shown as the 'background' rectangle. In Venn Diagram because one has to determine what belongs to the Set A, and what falls in the Universal Set U, the boundary between the system and environment is clearly defined. Thus set theory embeds the theoretical notion of system-environment distinction which is clearly at the basis of systems theory and, to an extent

also of biosemiotics concept of systems. This is not a mere coincidence because as Salthe (1985: 55) states:

> Theories about sets and the relationships among them can be directly related to theories about symbolic systems, and we begin to see that set theory (e.g. Petrich 1973) may provide a basis for representing the symbolic aspects of the world as discussed by Pattee (see above) or hierarchy theory in general... .

Specifically, certain aspects of the hierarchy of nature can potentially be modelled by set theory (Salthe 1985: 58). Such a 'hierarchy of nature' can be intended along the line of Lotman's centre-periphery principle (2001b: 127), as the asymmetry which arises when a system is subject to change, that is, when 'structure' is affected by 'history', and information is produced. But let us consider in more detail the relevance of set theory for biosemiotics and systems theory.

As seen in Chapter 4, Bertalanffy's theory of the organism as an open system underlines the importance of conceiving an environment when one conceives of a (living) system (1973f: 147-160). The 'system-environment' relation which derives from such a theory could be seen as one of the 'constitutive relations' upon which General System Theory is based. Niklas Luhmann notes that Bertalanffy's theory of the open system, which implies the necessity of envisaging an environment in systems analysis, allows one to replace "the traditional difference between whole and parts [as traditionally found in sociology] with that between system and environment" (Luhmann 1995b: 11). However one may argue that such a system-environment distinction as embedded in Bertalanffy's General System Theory and in Luhmann's social systems theory, is an instance of logical homology which fundamentally derives from set theory. This is certainly suggested by the fact that theories that invoke (even if implicitly) the system-environment distinction, invoke the 'typical' concepts of *environment, self-reference, boundary, differentiation, identity* and the *self.*

For example, in Luhmann's social systems theory (1995a), the system-environment differentiation model implies that social systems possess the features of environment, self-referential closure, boundaries, internal differentiation, and identity. The notion of self-referential closure with respect to an environment means that in order to refer to itself and establish its own autonomous identity, a system must construct an 'other', and then distinguish itself from it. Boundaries help such a distinction process in that they "have the double function of separating yet connecting system and environment. (...) as soon as boundaries are defined sharply, elements must be attributed either to the system or to the

environment" (Luhmann 1995b: 29). *Internal differentiation,* as the process through which the whole system uses itself as environment to form its subsystems as a means to increase internal complexity (Luhmann 1995b: 18) is possible thanks to the presence of multiple boundaries of alterity within the system itself. Boundaries are constitutive of a systems' identity "because identity is possible only by difference" (Luhmann 1995c: 177), as for example, precipitated by avant-garde art forms which generally define themselves against mainstream art in order to display alternate possibilities of order (Luhmann 2000: 167). In emphasising the constitutive role of boundaries, Luhmann anticipates biosemiotician's Hoffmeyer's argument on the evolutionary role of boundaries in forming biological identity. This concept somehow replays Salthe's argument that if "we wish to represent the world as a dynamic system that transforms input and output, further considerations and limitations [as the constraints offered by boundaries] must come into play" (Salthe 1985: 69).

Strikingly, in biosemiotics, Hoffmeyer (2008c) and Sebeok (1979c) also unwittingly subscribe to the system-environment distinction model used by Luhmann. This fact is a symptom of the influence that cybernetics-systems theory had on biosemiotics. Such an implicit adoption of cybernetics-systems theory models is evident, again, in the recurrent use of the above cited 'typical concepts'. In fact, along the same line of Luhmann, and Bertalanffy before him, Hoffmeyer tackles the problem of a system's *identity* starting from a theorisation of its constitutive aspect to *environment,* as he points out "[...] one should not forget that life's emergence was inseparable from that of its environment." (2008c: 37) Thus, according to Hoffmeyer, and in line with systems theory, environment is constitutive and supports *self-reference* in that "the self exists only insofar as that which is outside (...) But this outward reference rests upon a corresponding inward reference, such that one could say that other reference presupposes self-reference" (2008c: 26). For Hoffmeyer, *boundaries* clearly play a vital role in the constitution of the biological self. Consequently, he states that:

> If we feel compelled to place personhood somewhere, why not place it in the skin? After all, this is where we encounter the world around us [...]The skin keeps the world away in a physical sense but present in a psychological sense. It is the skin that gives us the experience of belonging (Hoffmeyer 2008c: 18).

Such an experience of belonging must somehow relate to the production of information about a system's identity (that is, self-description through self-reference). In fact, in a conceptually similar fashion, (but with a different language, that of irreversible thermodynamics) Salthe argues that boundaries are the key to a system's identity because

"boundary conditions [are] related to stored information" (Salthe 1985: 97). In supporting the view that boundaries, skins, membranes or 'surfaces within surfaces' (2008c) are essential *constitutive* (information-producing) integuments of the biological *self,* Hoffmeyer reminds that "if any agency in the body deserves to be called directive or controlling, it would not be the DNA but instead the membranes that permeates the body (2008c: 31). It is important to note here that Hoffmeyer recognises that the process of negotiating an external environment for the benefit of the collective is essentially a *semiotic* capacity (2008c: 25, 28) whereas Luhmann does not. Indeed Luhmann argues that "a sign must have meaning to be able to fulfill its function [of creating the system/environment distinction], but meaning is not a sign" (Luhmann cited in Brier 2008: 240).

Similarly to Hoffmeyer, Sebeok discusses the notion of biological identity and identifies it as 'the semiotic self' (1979c) by using systems theory's 'typical concepts' such as the notion of system-environment *differentiation* and the attendant concept of *boundary.* According to Sebeok, the capability to discriminate between self and non-self (thus, in systems theory term, the capacity for self-reference) is connected to cognition. The example that he raises is in relation to the immune system and anxiety, which are conceived by Sebeok as two recognition and defense mechanism systems, responsible for the maintenance of body integrity in light of their capability to distinguishing between 'self' and 'non-self'. Particularly, the immune system performs such a distinction in relation to its capability to recognise antigens (which possess a non-self quality) and to respond to it, while anxiety performs a self/non-self distinction in relation to its capability to reveal the presence of a danger situation and respond by suggesting escape from its awareness. In systems theory terms, the immune system and anxiety, capable of making a distinction could be indicated as performing a system-environment distinction and thus as operating system's identity maintenance. Additionally, Sebeok includes a conceptualisation of boundary when he explains that the arena of immune reaction is contained within the skin (boundary) while arena for anxiety is contained between the perimeter (boundary) of the Hediger 'bubble' and the skin (boundary) of the organism (Sebeok 1979c: 40).

Hence one may argue that Luhmann, Hoffmeyer and Sebeok (as it will be shown) at least implicitly, all build on set theory, as evident by the proximity of their arguments to Salthe's invocation of set theory in the study of evolutionary theory. However the acknowledgment of the link between biosemiotics, systems theory, the Prague School of Semiotics (Salthe) and Tartu-Moscow Semiotics (Lotman) is not without problems and leaves open a question

concerning the extent in which all these theories are underwritten by a hierarchical concept of system. This issue will be discussed as a 'problem left open' in the conclusion (Chapter 8).

What is relevant about the above discussion is that by means of being broadly underwritten by the set theory principle of system-environment, biosemiotics tends to rely on a kind of systems theory whose transdisciplinarity is historically rooted in 1940s Soviet academia's ideological position of 'neutrality'. Thus, through transdisciplinarity, the common, historical ground between biosemiotics and systems theory can be shown to be methodological.

Modelling and history

To note, the kind of systems thinking embedded in structuralisms conceives of systems in terms of structure-network, nodes and relations (Krampen 1996), and thus as *static form.* Instead, one may argue that the kind of systems thinking embedded in biosemiotics and some of cybernetic theory is one which conceives of structure within an overall historical context, and thus as *form in time*. In other words, *logical* homology (based on static form) is not enough to account for systems, particularly of the kind that biosemiotics but also cybernetics set out to study, that is, living systems. In fact, living beings, even when considered as 'systems' are subject to evolutionary and developmental change, hence they can also be 'measured' in terms of *time*. So, one may need to posit a systemic perspective capable of accounting for their structural change as elicited by what Bateson (2002 [1979]: 9, 10) calls "phylogenetic homology" (based on dynamic form). It is not just the formal aspect of systems (logical homology) that biosemiotics and some of cybernetics-systems theories research, but also the dynamic or evolutionary aspect. Particularly, while biosemiotics' evolutionary stance is undoubtedly inherited from theoretical biology[14], one could argue that such a stance is also inherited by both systems theory and biosemiotics through Lotman's semiosphere. Such a link is possible due to the semiosphere's grounding in Prigogine and Stenger's (1984) work on irreversible thermodynamics, a work which contains a fundamental historical conception of systems.

[14] e.g. see biosemiotic reconfigurations of Baldwin's theory of biological inheritance in Depew (2003); also see Hoffmeyer (1996a, 2008a); Marcoš (2008); Barbieri (2008).

a) History in biosemiotics

So far, the notion of system has been presented mainly in relation to *structure*, and in relation to the benefit that conceiving problems or objects in terms of structure brings to analysis, that is, the possibility of cross-comparisons or transdisciplinary applications. Thus, one may argue that systems theory, through its formal-structural outlook on phenomena, approaches the enterprise of structuralism. In fact, as interdisciplinary scholar Miller argues, there are more than superficial similarities between systems theory and structuralism in that they share a number of assumptions including "the relatedness of all things, their organisation into levels of isomorphic structures with laws of transformation, structures (or systems) manifesting homeostatic self-regulation and holism" (Miller 1982: 13). If one accepts that this statement sufficiently illustrates the common methodological ground present in structuralism and systems theory, then, by inferral, a structuralist view of systems must be present in biosemiotics too. However, if one accepts the view that biosemiotics is underwritten by structuralism, then the same critique that is typically lodged at structuralism – that is, that its perspective is ahistorical – can be lodged at biosemiotics as well. However, the literature review (Chapter 3) has already shown how biosemiotics, unlike structuralism, does present diachronic notions of history, and how its theories of modelling are especially grounded in an evolutionary perspective. For example Hoffmeyer (2008a: 103) explains how living beings are literally in a line of "communication with both their ancestors and with their eventual offspring" via the digital code present in their genome. Analogue codes, on the other hand, deal with the 'here and now, (Hoffmeyer 1996a: 50) and consist in the autonomous and contingent choices that an organism makes during its lifetime. The interaction between analogue and digital code (or code duality, as originally formulated in Hoffmeyer and Emmeche 1991) is a way of explaining change as it happens across both *phylogenesis* (evolution of a species) and *ontogenesis* (development of a member of a species). In strikingly similar fashion, Sebeok posits the primary modelling system (or natural language) as an adaptive (philogenetic) device that is present in the ontogenesis of communication i.e. when the infant cannot speak (Sebeok 1988), but and he also posits Secondary and Tertiary Modelling System as exaptations or 'mechanisms' for the ontogenesis of communications (Sebeok 1988; Sebeok and Danesi 2000). In this respect, one could claim that the extensionality principle that undergirds Sebeok and Danesi's Modelling Systems Theory (2000: 11) – as it posits that complex models are derivative of simpler ones, or that culture is grounded in nonverbal language – is the evolutionary basis of this theory. This recognition allows one to cast an

argument in favour of the line of continuity between cultural and natural communication systems which is both genetic (evolutionary) and representational-cultural (developmental). A further example of evolutionary conceptions in biosemiotics along the line of Hoffmeyer's and Sebeok's theories is Anderson and Merrell's view of biological modelling (1991 :8), according to whom the modelling of the micro- and macro-evolution of life

> ...calls for balanced attention to diachronic and synchronic, so as not to muddy the interplay of structures and functions as they weave through geneaological, structurally shaped homologies and ecological, functionally shaped analogies – the first largely enables by genetic information, the second largely limited by environmental energy.

Thus according to Anderson and Merrell, a sound understanding of modelling necessarily involves both ontogenesis (limited by environmental energy, as they state) and phylogenesis (aided by genetic information).

In short, the recognition that much of biosemiotic theory is grounded in a developmental perspective that is historically-evolutionarily-framed helps us realise that biosemiotics is informed by a conception of systems that does not only rely on mathematical homology like that of Bertalanffy (e.g. phenomena bearing different efficient factors, but identical respective laws) but on Bateson's *phylogenetic homology* (e.g. morphological equivalence, possibly due to common evolutionary origin). Therefore, underlining the evolutionary perspective of biosemiotics allows us to argue that *biosemiotics researches systems whose form/structure changes across history*, in other words, *dynamical systems*.

b) History in cybernetics

At this point one may wonder whether the 'evolutionary systems thinking' of biosemiotics is also present in cybernetics-systems theory, and, if that is the case, investigate the modality in which such a view has reached biosemiotics. The hypothesis is that biosemiotics' emphasis on dynamic-evolutionary systems is not just grounded in biology-based theories of evolution but also in quantum-based 'theories of evolution', such as Prigogine's irreversible thermodynamics. It can be shown that the notions of individual development (ontogenesis) and species evolution (phylogenesis) are embedded in cybernetic theory and are getting assimilated in biosemiotics through Lotman's historically conceived semiotics.

Development or ontogenesis can be broadly defined as changes due to contingencies occurring during the life-span of a living system. In cybernetics, the fundamental model of ontogenesis is represented by the notion of *feedback*, which is initially theorised by Jakob von Uexküll (1940). Von Uexküll put forth the notion of feedback through the study of the reflexes, the responsive movements, of sea organisms, and through the formulation of the *functional circle* that is created through the interaction between perception organs and receptor organs of a living being. He stated that "because every behaviour begins by creating a perceptual cue and ends by printing an effector cue on the same meaning carrier, one may speak of a functional circle that connects the meaning-carrier with the subject." (von Uexküll 1982 [1940]: 31). Rosenblueth, Bigelow and Wiener develop this approach into the study of the predictive capabilities of small organisms (for example of a cat preying on a mouse which does not run towards the area where the mouse is, but to an extrapolated future position) which they dub *teleology*, or feedback purposeful behaviour. (Rosenblueth *et al.* 1943: 2). Subsequently, Ashby discusses feedback in relation to its role in the regulation of biological systems, "an essential feature of the good regulator is that it blocks the flow of variety from disturbances to essential variables" (Ashby 1956: 201), that is, as the control mechanism which keeps the systems' behaviours within the set of possible behaviours. Building on Ashby's thermostat, Lovelock (1979) puts forth the Gaia Hypothesis whereby Gaia is posited as a cybernetic super-organism who regulates, controls and ensures the survival of the Earth's biosphere through negative or positive feedback 'behaviour' (Lovelock 1979: 57), that includes environmental disasters.

However Anderson highlights the Gaia hypothesis as a model of ontogenesis, not of evolution (Anderson 1992: 4). Hence all the above cited cybernetic theories of regulation can be useful in accounting for ontogenetic changes in systems, but they cannot account for evolutionary changes. In this respect, Anderson lodges a critique of the notion of ontogenesis in Gaia theory which can be useful for our discussion. Ontogenetic-developmental accounts of systems, she argues, lead to the theorisation of entropy, not of information (Anderson 1992: 10); hence, they do not explain the tendency opposite to entropy (negentropy), that is, the emergence of organisation, or of life. Thus Anderson affirms the need to ground Gaia theory in a metaphor of the organism based on evolution rather than on development. In fact, according to Anderson *et al.* one can use 'evolution' in less technical context, as in applicable generally to all "systems of ideas, such as those of semiotics or of evolution itself [because they] evolve and have ecologies transacting appreciable resources, specifically, energy information" (1982: 28). In this way, Anderson *et*

al. clarify how evolution "designates the processes of continuity and change in *any* dynamical system, including but not limited to biological systems" (Anderson *et al.* 1982: 27, my italics).

Bertalanffy's notion of logical homology, or system appears to be structuralist, and thus mainly concerned with the structural similarity of systems at the moment of observation, rather than with the efficient factors which make such similarity possible. However, one must not forget that Bertalanffy also theorises the organism as an open system (based on irreversible thermodynamics), a view that in light of it being based on information, may be grounded in biological (evolutionary-conceived) homology. Bertalanffy's theory of the open system may be considered historical in that it shows that living beings are not closed systems subject to entropy, but open systems which continuously sustain themselves through the production of information, or negentropy. As Bertalanffy states, from a thermodynamics point of view, open systems can maintain themselves in a state of high statistical improbability, of order and organisation, a state which is explainable through the expanded entropy function of Prigogine (1973f: 151-156). As this is the basis of negentropy, citing Schrodinger, Bertalanffy explains that 'the organism feeds on negative entropy', or *negentropy* (1973f: 151-156). The relevance of negentropy to this discussion is that negative entropy is an entity that can only come about if one conceives systems as open and within a wider evolutionary perspective. So if one concludes that Bertalanffy's theory of the open system is based on negentropy, then it must also conclude that even for Bertalanffy, as for biosemioticians, systems must be considered as dynamic, strictly in relation to evolution, and not only to development.

On the basis of this account, one can see how conceptions of systems in cybernetics have focussed extensively on their ontogenic aspects through the theorisation of feedback, but have also accounted for their evolutionary/phylogenetic aspects when the notion of negentropy, which implies history, has bled into their accounts. One can argue at this point that irreversible thermodynamics' evolutionary conception of systems has not just informed cybernetics but also biosemiotics. In fact, as Anderson *et al.* observe, Prigogine's work allows one to "recognise ubiquity of non-equilibrium in living and cultural systems" (Anderson *et al.* 1982: 29). And in this respect, as an instance of the application of Prigogine's view to the understanding of cultural systems, one can bring Lotman's semiophere. If one posits that the evolutionary aspect of irreversible thermodynamics is in fact present in the semiosphere, then, one has also to posit that such an aspect must be

implicitly present also in all the biosemiotic work which builds on the semiosphere (Hoffmeyer 1996a; Brier 2008; Kull 1998; Cobley 2010c). Thus the relation of continuity between systems theory and systems theory becomes clearer.

c) 'History' as continuity

Previous accounts of Lotman's model of semiosphere show how this model of culture presents structuralist features such as the binary opposition of Primary and Secondary Modelling System. However, despite this structural-linguistic premise, Lotman's account of culture is not purely synchronic (non-historical) as much of semiology-based work, but is also diachronic (or historical). Indeed one may argue that despite its grounding in structuralism, the semiosphere is *de facto* a historical system. To extend this argument further, one may also state that it is Lotman's 'historical' conception of semiotics that has been integrated in biosemiotics through the use of the term 'sphere' by Hoffmeyer (1996a: 59), Kull (1998) and Brier (2007: 392), and not Saussure's a-historical view of language. It is most important to underline at this point the sources of Lotman's historicity, in that these also represent, by transposition, the implicit sources of biosemiotics and thus the object of study of this thesis (Cannizzaro 2012a: 169-170). These are Russian semiotics and systems theory as embedded in irreversible thermodynamics.

Russian scholars Jakobson and Tynjanov (1929]) claimed that structural understanding of systems needed to be envisaged within diachrony. They declared that "pure synchronism [systemicity] is an illusion. Every system has past and future as structural elements of the system" (2003 [1929]: 79). In other words, they claimed that a sound understanding of 'systems' (poetic systems in their case) requires both a synchronic and diachronic consideration. This view is relevant to our discussion because it is also found in contemporary Tartu semiotics, upon which biosemiotics is grounded. Lotman's former student Chernov states how "only the synchronic-diachronic unity in the sphere of semiotics of culture has allowed us to integrate different descriptive modes of complex objects" (Chernov 1988: 14). Similarly, Tchertov (2005: 302) claims that the "difference between synchronity and diachronity is not sharp in spatial semiosis", and Randviir (2007: 138) explains that Tartu Moscow Semiotics (TMS) is a synthesis of a functionalist (processual) and structural approach. The synchronic-diachronic approach to systems is also central to other semiotic work that clearly acknowledges its affiliation to the work of Lotman, such as Even-Zohar's Polysystem Theory, according to which "both synchrony and

diachrony have to be admitted as systemic parameters, so that system is not identified with static synchrony [bur rather with dynamic polynchrony]" (Even-Zohar 1986: 465). Such a view is also cebtral to global semiotics, according to which "synchrony inevitably seeps intro diachrony" (Deely 2010: 15). Thus, one can see how Jakobson and Tynjanov's historical approach to systems constitutes a fundamental source to Lotman's historical conception of the semiosphere, and thus by translation, constitutes also a source to biosemiotics; a conception vindicated by biosemiotics' investment in ontogeny and phylogeny, both clearly exemplified in Lotman's own interest in synchrony and diachrony.

The second source to Lotman's historicity is, as Winner (2002: 426) notices, Prigogine and Stengers' irreversible thermodynamics. Lotman himself underlines how "[Prigogine and Stenger' s] work sheds light on the general theory of dynamic processes and can fruitfully be applied to the study of history" (Lotman 2001c: 232). Clarifications such as this only make sense if one looks at Prigogine's work it can see how it expresses the passage 'from a *geometrical* view of the universe... to a *narrative* expression of the universe... from *being* to *becoming*.' (Prigogine 2000: 833). One could argue that, as a Russian Jew who emigrated into Estonia, the interest that Lotman showed to have for Prigogine was not just theoretical but also cultural. In fact, like Lotman, Prigogine was a Russian Jew who had fled the USSR to escape anti-Semitism: "I was born in Russia in the year of the Revolution. My family left Moscow and I've always wondered whether this migratory part of my life left me with a vivid sensitivity to change." (Prigogine 1983). Arguably inspired by Prigogine's interest in change, Lotman also embraces the irreversible thermodynamics' concept of history by stating that "history is an irreversible (unbalanced) process" (Lotman 2001c: 230), and framing the semiosphere within a historical perspective. One could, in fact, argue that the structural character of the semiosphere that best suggests historicity is *asymmetry*. Asymmetry in fact is the general feature that distinguishes Lotman's historical notion of system from a pure structuralist notion of it, particularly in light of the generative and thus dynamic-historical character that it possesses. In fact, through asymmetry the semiosphere acquires a generative character as opposed to the 'conservative' character of structuralist-Saussurean conception of language (see Levchenko 2003). This is because the asymmetry between primary and secondary modelling systems favours dialogue between these systems, which in turns favour the emergence of the semiosphere (Lotman 2001b: 142). The idea of a continuous dialogue between asymmetric systems implies firstly that the semiosphere is conceived as *form in time*, and secondly that the translations that take place due to asymmetry between primary and secondary modelling systems, are modelled

upon the adjustments between system and environment that take place in disequilibrium systems (or open systems) in irreversible thermodynamics. Thus in a manner similar to that in which disequilibrium systems, in exchanging energy with themselves and their environments, end up importing new energy into the system, translations, prompted by asymmetric modelling systems *within*-the-system and *between*-system-and-environment, generate new information. Potentially, the generative function of the semiosphere, or "the creation of new information, that is, of texts which are not simply deducible according to set algorithms from already existing information, but which are to some degree unpredictable" (Lotman 2001a: 3) is a view that is clearly inspired by irreversible thermodynamic negentropy and constitutes the semiosphere's dynamic or historical mechanism. As such, the semiosphere as a system continuously organised through dialogue (Lotman 2001b: 142) is potentially considered as a *system in disequilibrium*, a system inevitably affected by 'the arrow of time'. One could argue that similarly to Prigogine who inserted the arrow of time in the study of systems in physics, Lotman can be claimed to have inserted the arrow of time into the study of cultural *systems*, and thus, by transposition, into the study of biosemiotic systems too, especially when these are understood in terms of 'signification sphere'. Consequently, the evolutionary stance of biosemiotics is not just inherited from theoretical biology, but also from Lotman's grounding his own 'version' of semiotics in Prigogine and Stenger's 'historical' work on irreversible thermodynamics.

Modelling and function

A processual-historical approach to the study of systems preclude a *functional* approach. As Even-Zohar points out, the historical approach allows one to identify the function of elements of a system, and the function of the system as a whole. The functional approach "does not just ask 'what is this element', rather it asks 'what does it do'" (Even-Zohar 1986: 463) so as to sustain the existence of the system in time. Hence to complete the 'mapping' of the systems thinking embedded in biosemiotics, and appropriated by cybernetics, one needs to investigate in addition to previous outlines of 'transdisciplinarity and 'history', also how 'function' is treated in both to biosemiotics and systems theory.

a) Function in biosemiotics

In biosemiotics, the notion of function has been accounted for with different connotations, according to whether scholars were approaching 'function' from the standpoint of biology

and the natural sciences (e.g. Kull *et al* 2009; Stjernfelt 2002; Emmeche 2002; Hoffmeyer 2008a) or from the standpoint of semiotics and the humanities. (Sebeok 1979f, 1988) Both approaches have generally treated function in terms of its teleological or 'directedness' character, but while biologists, inspired by semiotics, have broached the question in terms of *final cause*, the semioticians, inspired by biology, have approached teleological function in terms of *adaptivity*. In other words, notions of function in biology have tended to emphasise the indeterminacy aspect of teleological constraint (thus, emphasising in turn the agency or freedom of the system in reaching 'purposes') while notions of function in semiotics have tended to emphasise the anchoring aspect of teleological constraint (thus emphasising environmental agency, or the constriction operated by 'causes'), particularly in relation to survival, a constraining factor that is often underplayed in the understanding of cultural systems. What follows is a brief review of these approaches.

In those versions of biosemiotics more akin to semiotic *biology*, Kull, Deacon, Emmeche, Hoffmeyer and Stjernfelt (2009) embark on an explanation of the nature of organic function in relation to its semiotic aspect. They argue that "the concept of function and semiosis (sign processes) are intertwined. Both are teleological concepts in the sense of being *determined* with respect to an end." (2009: 168, my italics) With respect to the semiotic aspect of biological function, they observe, *sensu* von Uexküll, how "functions are plurally realisable and thus subject to considerable variation." Thus, despite claiming that in biology structure and function are interdependent (2009: 169), Kull *et al.* orient their account of function towards the notion of final cause, particularly as they claim that "functional requirements [...] constrain the physicochemical substrates that can be recruited." (2009: 170). In other words, they emphasise the open-ended aspect of teleological function more than the constraining aspect of a system's structure. Similar structure is merely seen as "a vehicle for fulfilling that function" (2009: 169). Emmeche (2002) puts forth a similar argument in that he claims that in biology, function has an informational aspect and therefore, a semiotic or end-directed aspect. In this extended respect, he brings the example of a cell which (citing Santaella Braga) he defines as an interpretation system that is controlled by "final causation", the type of causation that has got to do with organisation, habit formation, memory phenomena, information, appropriateness and purposefulness, evolution (Emmeche 2002: 24). On the other hand, Stjernfelt (2002) stresses that "biology is thus impossible [to work out] without the Aristotelian quartet of causes" (formal cause, material cause, efficient or initial cause, final cause) but similarly to Kull *et al.* and Emmeche, he eventually focuses on final cause by

stating that "final causes should not, however, be identified with purposes (which form special subset of them) but should be identified as *all* processes which are attracted by a future state" (Stjernfelt 2002: 340, my italics). In this way Stjernfelt implicitly recapitulates von Uexküll's argument on the variety that living forms can take, according to which, final causation determines that a general aim will be reached (e.g. avoiding predation in general) but does not determine the exact physical mode in which such an aim is going to be fulfilled (e.g. developing specific anti-predation strategies).

Hoffmeyer (2008a) also proposes a quasi-Aristotelian discussion of biological function in terms of final causality, but he does so with a reminder: that both final cause (general purpose) and efficient cause (initial cause put forth by environmental and material 'agency') are interdependent and not mutually exclusive. However, final cause, he contends, implies a concept of time which is different from that which underwrites efficient cause:

> Event B is not just caused by the preceding event A, for the very fact that A takes place is already part of a pattern of events - a pattern that also includes occurrences of type B – which in the end obeys general laws of a more compelling kind (Hoffmeyer 2008b: 41).

In simpler words, while efficient cause is described by linear cause-effect, whereas final cause is described by circularity. Thus biological function is such that it is described by cause-effect (efficient causality) or *vis a tergo* causation (Deely 2010: 35) typical of traditional evolutionary biology; but biological function is also defined by circularity (final causality), what Deely calls *vis a prospecto*[15], or semiotic causality, typical of biosemiotics. In this respect Hoffmeyer (2008b: 64) states that

> Semiotic causality cannot be reduced to efficient causality but, on the contrary, is dependent upon the workings of efficient causality, since interpretation, even in its most primitive models, is of no need if not followed by habit formation, or, in other words, by anticipatory action – and action unquestionably depends on efficient causality. Semiotic causality thus gives direction to efficient causality, while efficient causality gives power to semiotic causality.

Despite the fact that along the line of Kull *et al.*, Emmeche and Stjernfelt, Hoffmeyer claims that an understanding of function requires an understanding of causal and teleological constraints, Hoffmeyer appears to privilege the working of final causation rather than

[15] Deely (2010: 35) defines *vis a prospecto* as "a real but indirect possibility of the future influencing the relation og past things to the here and now arrangements of things in the present".

efficient causation, particularly through his notion of semiotic freedom (Hoffmeyer 1996b: 66). Thus, one could argue that Hoffmeyer emphasises more strongly the importance of final causes (open-endedness, plurality and indeterminacy) in the understanding of semiotic function, rather than initial causes (determinacy). In short, despite Hoffmeyer's attempts to pay justice to both initial cause (mechanism) and final cause (semiotics), one may argue that the characterisation of 'semiotic' function or final cause is one which foregrounds the open-ended aspect more than the constraining aspect.

On the other hand, in the version of biosemiotics more akin to *biological semiotics*, accounts of the notion of function within the study of culture have tended to focus on *adaptivity* and thus emphasise the constraining-anchoring aspect of function rather than freedom. It has to be noted however that this 'functional' approach to culture in biosemiotics is limited to the work of Thomas A. Sebeok. In his 1979 essay 'Prefigurements of Art', Sebeok explores the aesthetic forms of expression of humans and other animals such as kinaesthetic signs, musical signs, pictorial signs and architectural signs, in terms of what they have in common, or homologies which include both structural homology and functional homology. In drawing an account of research on kinaesthetic signs, Sebeok brings about a discussion on the comparison of human dance and chimpanzees' dancing in the laboratories in terms of their rhythmical structure and justifies this homology on the grounds that "it is plausible [...] to regard both underlying structures as homologous, implying that they owe their similarity to a common origin" (1979f: 26). Indeed it can be productive to compare biological forms with cultural ones "if only to ascertain whether seemingly similar signifiers trigger comparable interpretants" (1979f: 23). Sebeok adds that the analogy between human aesthetic behaviour and animal aesthetic behaviour can throw light on "the role of *function* that rules the evolution of a behaviour pattern" (Eibl-Eibesfeldt 1975 cited in Sebeok 1979f: 23), in other words, he wagers that homologies, considered as phylogenetic, allow one to speculate on the 'adaptive' intended as functional/anchoring character of forms of meaning. Particularly, Sebeok identifies the Primary Modelling System as an adaptive cognitive form (that is, a behavioural pattern that takes the form of a nonverbal communication whose function is determined by final cause and whose shape is determined by both its final cause but is also irremediably determined to its initial cause (the perceived characteristics of the environment which the living system is trying to mimic). Let us not forget that nonverbal communication has a strong iconic component which implies that a form of meaning is fundamentally structurally symmetrical to that to which it refers. Thus, through his research on nonverbal communication, Sebeok

articulates the anchoring/constraining function of animals' forms of meaning more strongly than Hoffmeyer (2008a) and other biosemioticians-biologists who argue in favour of a more open-ended view of function in dynamical systems. Sebeok's reflections on function, that is, the *origins* or *purpose* of form in dynamic cultural systems allow one to account for the law of continuity of forms. In other words, they allows one to argue that cultural systems are continuous to natural systems, or, put simpler still, cultural systems are but a *subclass* of natural systems. This view also underwrites Bateson "philogenetic homology". And his signature phrase "the pattern which connects nature and culture" (2002 [1979]: 9) will be taken up in Chapter 6.

b) Function in proto-cybernetics

I have until now demonstrated how Sebeok's work embeds a systems thinking that relies on a philogenetic-functional homology, and which implies that function requires an appreciation of both *teleology* and *causality*. This view, which expresses the continuity of natural forms and cultural forms, is inspired by Tartu-Moscow semiotics, especially from Lotman's historical-functional approach to the study of culture, as represented by the concept of semiosphere. This aside, Sebeok does notice the 'Soviet semiotic' approach to modelling and how much it owes to von Uexküll's model of the functional circle (Sebeok 1991b [1988]: 53) which in turn can be considered as an instance of proto-cybernetics. Consequently one could argue that a contemporary biosemiotic view of function as causality and teleology is traceable to notions of function as purportedly found in proto-cybernetics , particulary in the work of early 20th Century biologists Jakob von Uexküll (1864 – 1944) but also in the work of D'Arcy Wentworth Thompson (1860 – 1948).

Both von Uexküll and Thompson have explored the topic of form in relation to function, with profoundly different approaches, but in a manner which allows their work to be dubbed equally as 'protocybernetic'. Thompson focussed on function as the *causes* of form, whereas von Uexküll focussed more on function as the *purpose* of the forms of living beings. More specifically, Thompson posits that form is a function of growth, which is itself shaped by physical laws. This position implies that because the growth of a living being's structure is subject to compression forces, tension forces etc. and these forces will also be the *antecedent causes* of the acquisition of that particular form, then according to Thompson, 'function' exemplifies a cause-effect relationship between the physical force constraining and stimulating growth towards a certain direction and the form that physical materials are thus forced to assume. For example, Thompson states that nature

strengthens the bone in same direction in which strength is required and brings the example of the surgeon who "knows when he bandages a broken limb that he is doing more than keeping the two parts together – the pressure he applies suggest the direction of re-growth and repair for the bone" (1966 [1917]: 238).

As a corollary, von Uexküll's notion of function seems to imply not causal but purposeful relation. This is because in his model of the functional circle, the circular exchange of perception cues and effector cues between the living being's organs and the meaning carrier-object seems to be directed toward the attainment of a goal, namely the continuous assignation of meaning. Because of its purposefulness and circularity, von Uexküll's functional circle adumbrated by more than a decade the model of feedback cycle present in cybernetics (Rüting 2004; Lagerspetz 2001) and as such it can be considered proto-cybernetic. However, because 'meaning' is the factor continuously triggering perception and response, von Uexküll's functional circle can also be seen as a continuous causality process (perception is the cause of response, which is in turn the cause of new perception). In the same way, Thompson' s view that physical laws are antecedent causes of form, and thus the causes of the mechanical efficiency of form of living beings, seems to favour continuous causality because mechanical efficiency becomes in turn the general purpose of form, or its final cause. In this sense, form becomes functional in the sense of being 'purposive' or serving a purpose. Thus, the most evident contribution that Thompson' s theory of form and von Uexküll' s theory of meaning anticipate cybernetic and, arguably, biosemiotic notions of function as teleological, whereas teleology includes a balanced interplay between causes and purposes, and thus causality and circularity. The realisation that function as *teleology,* does not exclude (initial) causality is also advocated by early cyberneticians Rosenblueth, Wiener and Bigelow when they explain in 'Behaviour, Purpose and Teleology' (1943) that because determinism and teleology both involve a concept of causality and a time axis, teleology is not opposed to determinism but only to non-teleology (Rosenblueth, Wiener and Bigelow 1943: 4). Therefore, one may argue that determinism is only a particular case of teleology, one with reduced emphasis on the end-result. By implication, teleological accounts of systems should not overemphasise goal attainment over initial cause, but pay justice to both the constraining factors of the system, be it causal or final constraints. This issue will be explored in relation to cultural analysis in Chapter 7.

The comparative discussion of the similarities and differences in Thompson' s and von Uexküll' s work has shown their prescience in anticipating the principle of teleology which includes both cause and purpose. Despite their apparent divergence of methods (Thompson focussing explicitly on function, von Uexküll focussing on meaning) both of them have put forward ideas that pre-meditated the principles of function which can then be found in branches of systems theory, such as cybernetics (pre-figured by Bertalanffy as a trend in system theory 1973a: 21) but also biosemiotics, as this thesis argues. As such both Uexküll' s and Thompson' s work can be considered as furnishing the systemic and 'functional' theoretical foundations of cybernetics, upon which Sebeok's 'biosemiotic systems thinking' is also based. In fact, Sebeok's statement that "the ideal of semiotic analysis is to combine *causal* with *functional* explanation – to show how sign form interrelates dynamically with sign function" (1979f: 13, my italics) shows that his own thought is implicitly informed by proto-cybernetic principles, particularly by Thompson' s effort to understand animals' organic forms in terms of antecedent causes, and by Uexküll' s effort in approaching organs' forms in terms of their place in the functional circle and thus in terms of their purposive, regulative function. Thus one could argue that through his concern with phylogenetic-functional homology, Sebeok draws the different research efforts of Jakob von Uexküll, D' Arcy Thompson under a common denominator – that of biosemiotics.

Conclusion

The aim of this chapter was to investigate the conceptual and historical overlap between theories of modelling in biosemiotics and in systems theory following the example set by Deely's 'archaeology of concepts' (1981). The investigation showed that there is a common unifying perspective between systems theory-cybernetics and also biosemiotics which is metholodogical and consists in the *systemic* outlook that they adopt in scientific observation. It also showed that the very notion of *system* as found in biosemiotics can effectively be related to a cybernetic heritage. More specifically the systems thinking as shared by biosemiotics and systems theory-cybernetics is grounded in transdisciplinarity, history and function.

This chapter accounted for the main similarity between biosemiotics and cybernetics in terms of the transdisciplinary methodology of systems thinking which they share. Such a perspective is transdisciplinary because the practice of focussing on the organisational

aspects of phenomena: that is, on their structure. Such a focus enables the comparison of different phenomena in terms of similar features. Sebeok and Danesi's Modelling Systems Theory (2000) facilitates the comparison of cultural and biological models. Lotman's semiosphere (1990) enables the mapping of different cultural systems. Bertalanffy's General System Theory (1968) facilitates the mapping of different disciplines, be it mathematics, information theory, biology and psychology, in terms of the isomorphic models which they use. Luhmann's General Theory of Social Systems (1995a) is similarly amenable to Lotman in his mapping and comparison of different types of social systems (e.g. the art system or the law system), and similarly to Sebeok and Danesi, in their grounding of social systems in biological theory (at least in terms of autopoiesis). I have also accounted for the transdisciplinary drive that biosemiotics and systems theory share is a case of historical continuity due the influence that cybernetics had on 'Soviet' semiotics (as in Lucid 1977) which in turn influenced Sebeok's account of modelling systems and biosemiotics' conceptions of modelling as a whole. Thus biosemiotics and systems theory-cybernetics share a transdisciplinary perspective because of their quest for knowledge through *systems*.

However, systems are not to be conceived as static or unchanging in time (logical homologies) by both biosemiotics and systems theory, but are conceived as dynamic and thus as historical systems (philogenetic homologies). In this respect it has been argued how representative contributions in biosemiotics, such as Hoffmeyer's *code duality* (with Emmeche 1991), Sebeok' s reflections on the *phylogeny of communications* in terms of primary modelling system (1988), and Anderson and Merrell's *modelling of macro and micro evolution* (1991) rely on an evolutionary conception of systems. Particularly, the chapter argued that representative contributions in cybernetics mainly rely on a model of 'development' (von Uexküll 1940; Rosenblueth *et al.* 1943; Ashby 1956; Lovelock 1979), which is, however, inserted in an evolutionary framing through Bertalanffy's theory of the organism as an open system, grounded in turn in a historical concept of entropy (Prigogine and Stengers 1984). Following these premises, it was argued that biosemiotics and systems theory's common interest in dynamic systems is an instance of disciplinary continuity because much of biosemiotic theory (Hoffmeyer 1996a; Kull 1998: Brier 2008) makes use of the 'sphere' metaphor embodied in Lotman's semiosphere. This latter model is in fact closely related to systems thinking through Prigogine and Stenger's work on irreversible thermodynamics.

Lastly, I identified how a historical-processual understanding of systems requires an understanding of function in addition to an understanding of history and structure. Function is included in biological accounts of biosemiotics through the work of Kull *et al.* (2009), Emmeche (2002), Stjernfelt (2002), Hoffmeyer (2008a). It has been shown how these accounts describe biological function in terms of *final cause* or Deely's *vis a prospecto* (2010), and tend to emphasise its freedom, openness and indeterminacy aspect. But of particular note, in the area of culture, an account of biosemiotics as that of Sebeok (1979f, 1988) has tended to emphasise both initial causes or the anchoring aspect of the 'cultural function' embodied in nonverbal language, but also the final cause or the non-necessary and thus indeterminate aspect of function as embodied in human culture and possibly in animal aesthetic behaviour. This approach seems more cybernetically-centred, when framed semiotically. Thus the continuity between the biosemiotic view of function and the cybernetic view of function could be demonstrated by relating Sebeok's attempt to pay justice to both initial cause and final cause of a system when performing semiotic analysis, to a pre-existing argumentation on function as found in proto-cybernetics. Such argumentation is found in Thompson's groundwork in understanding animal organic forms in terms of antecedent causes, and in von Uexküll's effort in approaching organs' forms in terms of their purposive-but-open-ended regulative function. Both views can be considered as the interdisciplinary sources of Sebeok's own effort at synthesising a kind of systems thinking that is commonly understood as biosemiotics but which is in effect unequivocally cybernetic in its motives and discourse.

Overall, this comparative investigation of systemic conceptions as found in biosemiotics and cybernetics-systems thinking serves as a proof of the disciplinary contiguity and historical continuity between systems theory and biosemiotics. In light of such evidence, this thesis argues that biosemiotics, similarly to Luhmann' general theory of social systems, is a modern development of General System Theory. However, positing that there is a line of historical continuity between biosemiotics and systems theory implies that such a line may be *uneven* and that there may be contradictions between the two fields. One can anticipate that the fundamental contradiction between biosemiotics and cybernetics-systems theory is in terms of *information*. This topic will be dealt with in greater depth (Chapter 6).

CHAPTER 6

Rupture in biosemiotics' and cybernetics' systems thinking: the 'bias' of the concept of information towards abduction or deduction.

Introduction

The previous chapter showed that biosemiotics and cybernetics present a strong degree of disciplinary overlap in light of their common methodological drive based on systems thinking – and particularly on instances of *transdisciplinarity, history* and *function*. It was argued that such a disciplinary overlap is an instance of historical continuity between the two fields; that is, that historically speaking, biosemiotics is a modern development of systems theory. The current chapter will seek to advance this argument by showing how such continuity inevitably involves a degree of discontinuity, and therefore an area of non-overlap between the two fields. This chapter aims to support this project's overall thesis according to which biosemiotics is a modern, though *uneven,* development of systems theory. In this respect, biosemiotics' systems thinking is considered in relation to its rupture with cybernetics' systems thinking. Considering this rupture is important because it allows one to argue that the systems thinking informing in biosemiotics constitute "an 'epistemological break' (Althusser 1969) with 'modern' modes of conceptualising the world" (Cobley 2010b: 225) as that elicited by 20th century cybernetics and systems theory.

This chapter essentially argues that the rupture that one can find in biosemiotics' and cybernetics is in their conceptualisation of 'information.' Information in fact can be considered as a fourth 'universal feature' that together with 'transdisciplinarity', 'history' and 'function' constitutes the area of isomorphism between the two fields. However, while on the one hand transdisciplinarity, history and function have been argued to be representative of the degree of disciplinary and historical overlap between these fields, on the other hand information will be argued to be representative of the degree of dissonance and historical *dis*continuity between biosemiotics and systems theory. In other words, this chapter sets out to argue that the notion of information constitutes the paradigmatic rupture between biosemiotics' and cybernetics' systems thinking and that as such, it is representative of that which the two fields do *not* have in common.

The hypothesis subsumed in this argument is that the methodological rupture or uneven development in biosemiotics' and cybernetics' systems thinking is due to the respective

presence or non-presence of *abduction* in conceptions of information. This hypothesis will be demonstrated by means of an analysis modelled upon semiotic analyses of culture, that is, by defining the analytical term ('abduction' in this case) and by looking for exemplifications of such a term in the texts to be analysed. This analysis therefore (1) proposes a preliminary disentanglement of the principal meanings of information that one can find in biosemiotics and cybernetics, (2) outlines the characteristics of abduction in relation to its difference from deduction and induction, and in relation to scientific and biological discovery and, by translation, also biological adaptation, (3) identifies prefigurements of abduction in biosemiotics, even in those theoretical instances in which abduction is not mentioned explicitly, and lastly (4) underlines the emphasis put on *constraints* of information and the lack of prefigurements of abduction in cybernetics-systems theory, while still admitting that there are instances in which this field approaches abductive thinking.

This analysis will allow us to put forth the idea that the different conceptualisation of information present in biosemiotics and systems theory is due to a difference in their logic of systems-description, that is logico-*semiotic* in the former field, and logico-*mathematical* in the latter field. This has also been the topic of exploration of other projects, notably Brier's *Cybersemiotics* (2008) and Dupuy's *Mechanization of the mind* (2000) however these scholars (especially Dupuy) do not consider the matter specifically and solely from the enhanced point of view of abduction, as this chapter instead does.

Disentangling the multiple meanings of information in biosemiotics and systems theory-cybernetics

This study will proceed by first disentangling the multiple meanings of the notion of information that one can find in biosemiotics and cybernetics-systems theory. Such a "disentangling" of information is carried on following the example set by Collier (2008), who reviews the multiple notions of information in biology, and by Battail (2009) who reviews the different concepts of information that one can find in information theory and semantics.

Apropos Collier (2008: 763), the aim in this section is to review some of the ways that the notion of information has been used in biosemiotics and cybernetics, to disentangle them and to pave the way for further analysis in relation to transdisciplinary modelling and abduction. This account shows that conceptions of information in biosemiotics, with the

exception of those of Sebeok, appear to have swung mainly towards one end of the information spectrum, that is, these conceptions have repaired either in favour of determinacy or in favour of indeterminacy. The account also shows that conceptions of information in cybernetics develop a *historical contradiction* in that in First Order Cybernetics information is explicitly 'objective', while in Second Order Cybernetics information is radically 'subjective' in relation to an observer.

As outlined in Chapter 3, conceptions of information in biosemiotics can be categorised as tending towards (1) determinacy or (2) indeterminacy. Accounts of information underlining its (1) determinacy aspect have dealt with *function*. Sebeok makes a reference to the anchoring function of information when claiming that nonverbal communication is an adaptation (1988). He also argues that the effectiveness of communications (e.g. the successfulness of a message in reaching its destination with minimal noise) reduces the disorganising effects of the second law of thermodynamics (Sebeok 1991c). This development is a clear reference to a pragmatic conception of communication in terms of its capability to successfully canalise energy and informational processes for the sustainment and evolution of the biological system in its ecosystem. Sebeok, much like Sharov (1992) conceives information as signs with the function to preserve the pragmasphere (the ensemble of their functions, 2010: 1055). Since according to Sharov, information regulates the vital functions of the living beings, one could argue that he underlines the determinacy aspect of information.

On the other hand, accounts of information underlining the (2) indeterminacy aspect of information have primarily dealt with *agency* or first person experience. Sebeok (1991c: 25) states that in biological communication the rules which govern an act of selection (that is, the formulation of a message) are unknown. Therefore one can never be sure about what has been communicated by the source. This uncertainty constitutes the indeterminacy aspect of the information present in a 'biological' message. Additionally, by making reference to Hediger's studies on animal communication, Sebeok articulates the indeterminacy through a notion of observership. Hediger in fact, claimed that in experiments involving animals (in other words, in animal-human interspecific communication) one does not work with pure unaltered animal behaviour, but always with the behaviour of the animal *plus* the influence of the human observer, (Hediger 1981: 244 -

245) a phenomenon which he recognises as the Clever Hans Effect[16]. Sebeok claims that the Clever Hans Effect is present in all dyadic interactions (communications) and serves, therefore, both as a proof of the ubiquity of communications and of the predominance of "source [indeterminacy] over the destination." (1979d [1978]: 106) Similarly to Sebeok, Hoffmeyer identifies the fact that the content of a biological communication, whether this takes place among cells or among large animals, does not have a fixed value, but is subject to interpretation (1996a). Proteins, for example, 'interpret' the information contained in the DNA rather than 'executing' an algorithm to extract supposedly discrete information embedded within it. This 'indeterminate' aspect of information is named by Hoffmeyer as 'semiotic freedom', a term which expresses better than 'information' the "depth of meaning" that a receiver could find in a communication (Hoffmeyer 1996b: 66). In other words, semiotic freedom refers to the freedom of choice, rather than the constraints of such a choice, that a living being (and its living components, be it cells or tissues) has in interpreting a message. Lastly, Brier tackles the issue of the indeterminacy of information from the angle of cybernetics and Peirce's semiotic philosophy: that is, Brier conceives of a cybernetic and semiotic model of information that has five levels (2008: 389). These five levels include qualities (which presuppose subjectivity and first person experience), causality, information, biological communication, cultural communication. The indeterminacy aspect of Brier's concept of information is that he clearly begs the question about the 'subjective' as an integral part of information, an aspect that is largely missed in cybernetics' account of information.

On the other hand, as shown in Chapter 4, in cybernetics (and specifically in the uneven passage from cybernetics to systems theory), conceptions of information develop a historical contradiction: information in first order cybernetics is conceived of as (1) *objective* and then in Second Order Cybernetics is considered as (2) *subjective*.

Accounts of information underlining its (1) objective aspect have dealt with *input/output* and *error*. Such a conception originates in the thermodynamic heritage of information theory which underwrites First Order Cybernetics. Such a heritage is briefly outlined in what follows. Before thermodynamics in the first half of the 1800s, science conceived of the physical world as made of matter and energy. This was the ordered world of classical mechanics as described by Newton's laws. Then, in the second half of the Nineteenth

[16] Clever Hans was a horse which was unintentionally cued by its trainer to perform calculations that were deemed 'intelligent'. (See Chapter 3)

Century, thanks to Rudolf Clausius (1865), the two laws of thermodynamics were formulated, an event that brought about the theorisation of entropy. Entropy revolutionised physics since scientists realised that we lived not in a world of order, but in a world of disorder characterised by loss of useful energy through heat. In such a world, systems are destined to end in heat-death (a state in which a system has lost all useful energy and is not capable of spontaneous reactions anymore). However, in 1871, Maxwell proposed a 'violation' of the Second Law (the so called Maxwell's Demon) and demonstrated that there can be a case in which entropy does not increase in a system and no work is getting done. Also, Boltzmann's 1894 work on atomic theory, by concerning itself with *ensembles* of elements (molecules) and *probable* behaviour of systems, establishes statistical thinking in physical systems. Thanks to both Maxwell's and Boltzmann's statistical work probability and not necessity became a formally describable scientific principle. Consequently, the statistical entity of entropy originating in thermodynamics and further worked out by Maxewell and Boltzmann, became pivotal for the birth of information theory. This happened through the work of Leo Szilard (see Brier 2008) who, in 1925 proposed a solution to the contradiction identified in thermodynamics by Maxwell's Demon and described how the solution could operate. Szilard first identified the notion of the *information bit,* that is, the information value as obtained from the answer to a YES/NO question (or for SLOW/FAST in the case of gas molecules). In so doing, he proposed the first explicit link between thermodynamic entropy and information, and thus introduced the concept of information, in its statistical conception as derived from its thermodynamic roots, in the hard sciences. From here, information became a 'thing', like a molecule or an atom, and thus a commonly conceived physical and *objective* entity worthy of scientific study. Subsequently, Shannon and Weaver's *Mathematical Theory of Communication* (1949), within the context of communication engineering, built on Szilard' conception of information as a data unit describable by two values (1 or 0, or True and False) and on thermodynamic formula for entropy, and defined information as the negative logarithm in the base of two (Szilard's two values) of the entropy present in a system. In information theory, information is therefore conceived, similarly to entropy, as the degree of randomness or of 'shuffledness' (Shannon and Weaver 1949: 7) of a system (in the case of communication engineering, a system of possibilities of choices). The "objective" aspect of Shannon's mathematical conception of information is that despite the counterintuitive notion of information as 'the degree of uncertainty of a system' the amount of information contained in a message as it reaches its destination, and the value of each bit of

information that the message contains, can be in fact precisely deduced through mathematical calculation.

But later, Rosenblueth, Bigelow and Wiener (1943) performed research on teleology, that is the predictive capabilities of animals or feedback which they defined as "active purposeful [communicative] behaviour" (1943: 1-2). This behaviour is a variety of 'communicative behaviour' whose messages are measurable in terms of input and output, and thus in term of the value of the information that behaviour transfers and produces. Wiener took Shannon's newly formalised concept of information on board, linked it to his research on teleological systems (Rosenblueth, Bigelow and Wiener 1943) and came up with a general communication model along the line of Shannon and Weaver's own, enriched by feedback. Wiener circularised Shannon and Weaver's linear information-transfer model, where information transfer reduces entropy in the source, effectively canalising information to its destination and, as a consequence, sustaining the system's organisation or its life. With this leap from entropy to information to feedback, cybernetics in its first order conception was born. Therefore, in the exordium of cybernetics, the concept of information was conceived mathematically and with the added purposefulness or functionalist overtone since, as Wiener claimed, "to live effectively is to live with adequate information" (1951b: 18). This short history explains how information has come to be expressed both conceptually and formally by thermodynamic entropy[17] and consequently how it became an 'objective' entity fully describable in finite terms. The fundamentally 'functional' overtone of this conception of information has resisted further developments in cybernetics as shown in the work of Jantsch, who explicitly conceives of information as pragmatic (Jantsch 1980: 134) and explains how evolution of pragmatic information transfer coincided with the evolution of life, and the work of Wilden who explains how biological error (which originates when negative feedback becomes positive feedback resulting in the principle of counter-adaptivity) can transform into social error (1980: 210).

Accounts of information in cybernetics underlining its (2) subjective aspect deal with *relevance, observer* and, again, *error*. With Gregory Bateson (1970), information takes a less formal, nearly subjective turn, a change which constitutes the passage between first order and Second Order Cybernetics. Bateson defines information as "a difference which makes a difference" (2000b [1970]: 459). Citing Immanuel Kant's statement that "in a piece of chalk

[17]And with interesting incongruencies. Entropy in information theory has the positive, discursive connotation of availability of choice, whereas in cybernetics it possesses the thermodynamic, negative discursive meaning of chaos and disorganisation.

there are an infinite number of potential facts", Bateson argues that a potential fact becomes an actual fact only when this is perceived as relevant (or as making a difference) to a living organism. Thus, Bateson steps away from information theory's and the First Order Cybernetics' view defining information through *formal correspondence* or *necessity* by introducing the non-necessary (semiotic) notion of *relevance*. This conceptualisation implies that information does not exist in isolation, but only *in relation* to a perceiving organisation. A further step towards a 'subjective' view of information comes through the Second Order Cybernetics work of von Foerster (1973), Maturana and Varela (1980) and Luhmann (1986) who have all been united by their interest for a theory *of observership*. Broadly, according to all their views, there is no information transfer as such from an environment to an observed system or within a system; instead information is the *construction* of the system's observer. Like Bateson's work, von Foerster, Maturana and Varela and Luhmann's theories imply that information does not exist in itself but that it exists only in function of its relativity. However, and unlike Bateson who does not specify for *whom* information is a difference (Brier 2008: 179), von Foerster, Maturana and Varela and Luhmann specify that information only exists in the observer's, or the scientist's mind. A further theorisation of the subjective aspect of information is in Serres' view of cybernetic *error* as being relative to a system's observer. In regard to informational error, Serres (1980) in fact claims that the detection of the 'sign' of information, or the distinction between negative or positive feedback, or information and noise, is a property of the observer, *not* of the observed system. Building on this relativist view, Bich (2004: 286) states that there is not a fundamental or preferential level in systems analysis, and that levels of a system are inseparable from the operation of distinction of the observer. This account of the history of information in cybernetics leads one to realise a fundamental fact: that in cybernetics the concept of information develops a *historical contradiction* or uneven development (cf. Althusser 1965). Information is in fact 'objective' (or determinate) in First Order Cybernetics, then it is 'subjective' (relative to an observer, or indeterminate) in Second Order Cybernetics.

As shown, both biosemiotics and cybernetics tend towards a polarisation of the concept of information towards either determinacy *or* indeterminacy, and either subjectivity *or* objectivity. However, this does not mean that biosemiotics and cybernetics conceive of subjectivity and objectivity of information in exactly the same manner. One can, in fact, still claim that they bear a 'subject-specific' way in which they conceive such instances of subjectivity and objectivity; that is, they display a 'bias' towards the concept of information

that can be held representative of a qualitative difference between their scientific paradigms. Hence the analysis that follows sets out to demonstrate that the subject-specific 'bias' of biosemiotics and cybernetics in conceiving information is due to a difference in their logic of systems-description. To support this claim, the next section proposes an investigation of the 'bias' of information in biosemiotics and cybernetics that is carried on by 'mapping' the extent in which both fields are underwritten by the logic of *abduction* (Peirce 1955a [1903]: 304). The methodology that subsumes this investigation is modelled upon semiotic analyses of culture, and thus proposes (1) a definition of the theory ('abduction' in this case) that will be used for analysis and (2) a search of instances that can be exemplified by such a term in the texts to be analysed.

On abduction

In order to pursue aim (1) i.e. proposing a definition of abduction, an illustration of its qualities in relation to its difference from other inferential methods as deduction and induction is initially presented below. Additionally, in order to make abduction fully relevant to biosemiotics and cybernetics' systems thinking, it will outline its relevance for a transdisciplinary theory of modelling that encompasses both natural and cultural systems, with an understanding of the latter as a specific subset of the former. Therefore this section will extend the scope of the notion of scientific discovery linked to abduction (Danesi 2005) so as to encompass biological discovery (i.e. learning) and therefore adaptability.

The concept of abduction was originally found in that "semiotics proper" (Deely 1981; Petrilli and Ponzio 2001: 4; Cobley 2007: 45-47) dubbed the "major tradition" by Sebeok (1979a: 63) and which passes through the work of Charles Sanders Peirce (1839 – 1914). Abduction is a concept explored by Peirce with the intent to distinguish general reasoning based on deduction and induction from generic or hypothetical reasoning based on abduction. Abduction can be defined as a logical-inferential process by which hypotheses are formed (Petrilli 2010: 163). Because of its hypothetical character, abduction can be aligned with the concept of interpretation that is usually associated with semiotics. Therefore, one could argue that abduction, as the capacity of forming "interpretations", can be conceived as a primordial form of semiosis used by a living being to construct knowledge about itself and about its environment or, to use von Uexküll terms, to build an *Innenwelt* and an *Umwelt*. (1940) In order to outline the relevance of abduction for a

transdisciplinary systems thinking, or for a general theory of modelling capable of encompassing biological systems, one has to first distinguish abduction from other means of construction of knowledge, such as deduction and induction. To put the difference between these types of inferences succinctly: "Deduction proves that something must be; induction shows that something actually is operative: abduction merely suggests that something may be". (Peirce, cited in Petrilli 2010: 163) In other words, both deduction and induction-based enquiry deals with instances of objective truth whereas abduction-based enquiry overtly deals with possible truth and therefore with ambiguity that one may consider "subjective". In fact, whereas in formal logic (deduction) and in experiment (induction) the conclusion of an argument can only be true or false, in hypothetical reasoning, or abduction, a conclusion can also be *possible*. According to Peirce, abduction is the inference of the case from a general rule. It is about *hypothesising* the *cause* of an *effect.* Following on from Peirce's example (Peirce 1878, cited in Sebeok 1988 [1983]: 8):

Rule:	All the beans in this bag are white
Result:	These beans are white
Case:	These beans are from this bag

One may notice that the conclusion of abduction is *hypothetical.* This is because the assertion that the white beans found on the table may come from the specific bag in the corner which contains white beans only, represents a highly likely possibility, but still only a possibility. The white beans, in fact, may still come from another place. A peculiarity of the workings of abduction is that, as underlined by Peirce "the mode of suggestion by which, in abduction the facts suggest the hypothesis is by *resemblance*." (Peirce 1998 [1893-1913]: 106) Hence abduction is fundamentally concerned with noting a resemblance between two different classes of objects (i.e. the beans on the table and the beans on the bag), and *speculating* on the reasons *why* such similarity (the whiteness) is there. The speculation here is that the beans on the table must come from the bag in the corner for some specific reason, for example, the observer's mother was previously in the room and moved the beans from the bag to a visible place on the table to remind the vegetarian observer about the importance of protein intake in a meal. So, in this sense, abduction is about *inferring* the circumstances that *may* have caused such a resemblance. Therefore, unlike deduction or induction, abduction does not point at 'the truth' but at a *possibility.* This observation implies that an abduction's conclusion can be both 'right' and 'wrong' at the same time. That is, as opposed to logic where propositions have to be *either* true *or* false, an

abduction's conclusive propositions have the capability of simultaneously acquiring two ambivalent values, *both* true *and* false. Let us now look at the way in which abduction can be true because this specific aspect of truthfulness will serve to outline the relevance of abduction for a transdisciplinary theory of (biological) modelling, and thus for both biosemiotics and cybernetics.

In semiotics the concept of abduction has been explored in the light of *right*-guessing (Sebeok 1983, Sebeok and Umiker-Sebeok 1981, Eco 1983, Bonfantini and Proni 1983). Peirce himself defines abduction as a "singular guessing instinct or theory of why it is that people so often guess right." (Sebeok and Umiker-Sebeok 1981: 16) However, Peirce said that it would be impossible to guess the causes of a phenomenon by pure chance. In his words, guessing refers more to the process of deriving strong intimations of truth without consciously knowing why one believes that such cases may be the truth. A celebrated example of this process is given by Peirce (cited in iSebeok and Umiker-Sebeok 1981: 11-16) when he guesses, without any apparent proof, which one of the waiters on the Bristol's boat stole his Tiffany lever watch, chain and overcoat. The following is an illustration of Peirce's real-life abductions. After having discovered the theft of his belongings, Peirce asks for the waiters to gather in a row on the boat:

> I went from one end of the row to the other, and talked a little to each one (...) about whatever he [the potential culprit] could talk about with interest, but would least expect me to bring forward, hoping that I might seem such a fool that I should be able to detect some symptom of his being the thief. When I had gone through the row I turned and walked from them, though not away, and said to myself, "Not the least scintilla of light have I got to go upon." But thereupon my other self (...) said to me, "But you simply *must* put your finger on the man. No Matter I have no reason, you must say whom you will think to be the thief." I made a little loop in my walk, which had not taken a minute, and as I turned toward them, all shadow of doubt had vanished" (Peirce 1929: 271, cited in Sebeok and Umiker- Sebeok 1981: 12).

In a moment of insight – or abduction – Peirce identifies a man whom he believes to be the culprit and after having unsuccessfully tried to convince him personally to give him back his belongings, Peirce reports the case to the police and explains his suspicion:

> Detective: What makes you think he has stolen your watch?
> Peirce: Why? (...) I have no reason whatever for thinking so; but I am entirely confident that it is so (Peirce 1929: 273, cited in Sebeok and Umiker- Sebeok 1981: 12).

This is indicative that Peirce did not have any logical reasons nor evidence to accuse the man – however he held strong feelings in that direction. This recognition is useful to make the point that abduction is based on *feelings* or – a sudden act of insight that comes to us like a flash. (Peirce cited in Sebeok 1988 [1983]): 18) Followingly, contrary to a hired Pinkerton detective's advice (according to whom the thief was another man) Peirce goes to the suspect's lodging in search of his belongings and, by means of feelings-based observation (abduction), manages to identify where they are hidden:

> ...I saw no place in that room where the chain was likely to be, and walked through into another room. Little furniture was there beyond a double bed and a wooden trunk on the further side of the bed. I said, "now my chain is at the bottom of that trunk under the clothes: and I am going to take it..." I knelt down and fortunately found the trunk unlocked. Having thrown out all the clothes... I came upon... my chain (Peirce 1929: 275-277, cited in Sebeok and Umiker- Sebeok 1981: 15-16).

Through another similar striking right-guess, Peirce manages to find the rest of his belongings (except for the watch, which had already been pawned) and have two men arrested for the theft. The above story serves as an example of hypotheses formed through abduction eventually proving 'right'. Peirce explains the potential for accuracy of abduction by returning to the idea of *perceptual judgements* (1891-1902), which are specific sense-induced clues or empirical knowledge that one is not fully conscious of possessing. This refers to the fact, as Wheeler put it, that we know more than what we think we know (Wheeler 2008)[18]. However, accuracy is not a guaranteed result of abduction since, by its hypothetical nature, abduction can also be 'wrong' and therefore fallible and misleading. For this reason abduction has been called by Peirce the "weakest type of argument" (Peirce 1867-1893: 189). However, because abduction is rooted in unconscious perceptions which may point at 'true' but at the same time, 'misleading' connections between aspects of the world, abduction appears to be a *speculative* argument. It is precisely its speculative or risky character that, as Peirce claims, makes abduction "the only kind of argument which may start a new idea"(Peirce in Sebeok and Umiker-Sebeok 1981: 19). Because of its intelligence and fallibility, abduction can be highly creative. Therefore abduction is a necessary part in the process of discovery which applies to man (as in the case of scientific discovery), but one may also argue that by means of the continuity between man and other creatures, *abduction must apply to other and every living beings too*. This claim is justified in what follows.

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[18] Personal correspondence.

Abduction and discovery

In the world of culture, abduction is linked to "scientific discovery" (Danesi 2005) but, following the (methodological and interdisciplinary) example set by Lizska (2008) who extends the concept of meaning to encompass the physical notion work, one can also extend the scope of abduction so as to include 'biological discovery' and adaptability. In order to cast an argument in favour of abduction' s role in biological adaptivity, let us consider Danesi's argument explaining the abductive nature of scientific discovery. As Danesi (2005: 58) states, "discovery is hardly the product of a systematic search for truth, but rather a serendipitous consequence of using our *fantasia.*" Discovery is therefore related to fantasia, "a unique blend of imagination and reasoning" (Bertland cited in Danesi 2005: 54). One could argue that abduction is strictly related to fantasy and discovery because of its links with both imagination (in light of its unexpectedness) and reasoning (in light of its capacity for being fully describable through words by means of an argument). The very notion of discovery, however, points at a degree of truthfulness-accuracy of that which is discovered, therefore one has to assume that the abduction upon which it was based was a right-guess rather than a fallible argument. Another way to put this is that modelling through abduction can be highly predictive.

As an example of such a predictive power, Danesi cites the Fibonacci sequence, that is, a sequence of numbers in which each number is the sum of the previous two e.g. 1, 1, 2, 3, 5, 8, 13, 21 etc. Such a sequence was devised by Fibonacci as the solution to a puzzle, as a means to demonstrate the efficacy of the decimal number system which he had learnt to use during his extensive travels in the Middle East (Danesi 2005: 60). The sequence of numbers turned out to be a recurrent pattern found in several instances of mathematical problems and natural formations. As Danesi explains, Kepler noticed that the Fibonacci sequence converges to the golden ratio, which "has been found to produce aesthetic effects and has been found in a number of reifications in nature" (Livio cited in Danesi 2005: 63) such as the spiral of sunflower heads, of pine cones, of coiled shells of molluscs and cephalopods, of horns etc. . Danesi states that "serendipity characterises the history of discovery in mathematics and science" (Danesi 2005: 57) and argues that the discovery of the Fibonacci sequence was serendipitous, in that Fibonacci was not aware that he had discovered a general law, namely that "a simple recursive pattern constitutes the fabric of a large slice of nature" (Danesi 2005: 64). Along the line of a mathematician who wonders whether mathematics is constructed or discovered, Danesi (2005: 63-64) asks "Why would

the solution to a simple puzzle produce numbers that are interconnected with patterns in nature and human life?" One of the answers to this question may reside in the observation that discovery and serendipity rely on abduction and thus right-guessing or as Peirce put it "unconscious intimations of truth." Therefore the modelling of reality through abduction, that is, the process of acquisition of accurate information, is not an arbitrary process but a *realist* one. Danesi seems to support this point when he argues, citing Devlin, that "the predictive power of signs lies, arguably, in the fact that they are models of things (Sebeok and Danesi 2000): "[...] I would like to suggest that numerical sequences such as the Fibonacci one, are models of intrinsic pattern – whether the pattern in felt unconsciously or expressed overtly"(Danesi 2005: 64). Here Danesi seems to be referring to the fact that every instance of modelling bears a certain degree of symmetry with reality in light of its unconscious but necessary grounding on right-guessing. Therefore, one may conclude that abduction allows *one* to construct systems (or build models) that are by (semiotic, which include logic) necessity fairly symmetrical with reality. By substituting 'one' with 'a living being', then the reach and scope of abduction is extended from the realm of man to the realm of anything that lives. In this sense, abduction allows *a living being* to build models that are fairly symmetrical with reality and which by means of their guaranteed degree of symmetry, aids the adaptation of living beins. If this was not the case and adaptation was not based on right-guessing or broadly correct intuitions about oneself and one's environment, then one could imagine how it would be very unlikely that there would still be life on Earth today.

The extension of the reach of abduction to encompass the realm of the living allows one to turn a semiotic argument into a transdisciplinary and biosemiotic one. For instance, if modelling applies to biological communication (As Sebeok 1988, Sebeok and Danesi 2000, and Anderson 1992 argued) and not just to human communication, then the notion of abduction upon which modelling is grounded, also applies to the whole sphere of biological signification. The roots of this argument may be found in Danesi's (2005: 64) statement according to which "Model-making constitutes a truly astonishing evolutionary attainment, without which it would be virtually impossible for humans to carry out their daily life routines". It follows that if one posits that model-making is based on abduction, thus one can see how abduction may be the staple of biological adaptation and evolution. This statement may be seen as an extension to Sebeok's argument on the 'continuity between nature and culture', according to whom nonverbal communication is a biological capacity enabling living beings to construct their *Umwelten* and adapt to their environment. If one

accepts this argument, then human creative reasoning, based on abduction, must be a subset of a more general instance of biological 'reasoning', that in order not to be accused of anthropomorphism, one may simply intend as 'cognition'. Thus, one may cast an argument in favour of the continuity between biological cognition and human-specific cognition, by stating that the difference between an abduction from a living being and a human abduction is a difference in degree (in relation to the adaptive function) which then becomes a difference in type (in relation to the more expanded forms and functions of modelling that the human animal is capable of having and performing e.g. verbal communication and culture). Therefore, abduction needs to be envisaged as a biological capability before being a human ('cultural') capability and before acquiring species-specific human traits such as for example, high-order intuition and scientific discovery which obviously requires, in addition to abduction, also knowledge-construction by means of deduction and induction. This implies that abduction needs to be considered as a 'universal' feature of the study of biological systems. If this statement is taken as true, then abduction becomes fully relevant to the systems thinking embedded in biosemiotics and cybernetics.

This account shows that abduction is fundamental for a transdisciplinary theory of modelling (i.e. systems theory). The following account will now pursue objective (2) that is, a search of instances of that can exemplified by the term 'adbuction' in biosemiotic and cybernetic theories of information. In other words, what follows is an analysis of key biosemiotics' and cybernetics' contributions in terms of their acknowledgment or non-acknowledgment of the concept of abduction. This analysis will show that, in biosemiotics, representative contributions on conceptualisation of information as exemplified by the work of Sebeok (1978), Hoffmeyer (2008a), and Brier (2008) are underwritten by prefigurements of abduction; it will also show that, instead, First and Second Order Cybernetics's conceptions of information as exemplified by the work of von Neumann 1948, Ashby 1956,Luhmann 1990 and von Foerster (1973) through Spencer Brown (1969), do not embody abduction, despite closely approaching its endeavor for a general and non-trivial theory of knowledge.

The grounding of biosemiotic information in 'abduction'

As shown, the generalisation of the idea of discovery from the world of culture (as in scientific development) to the world of life suggests the connection between abduction and

biology. Abduction can be seen as fully exemplifying phylogenetic homology, or "the pattern which connects" (Bateson 2002 [1979]: 10) the world of culture to the world of nature. This is because abduction allows one to identify that the learning-through-discovery process that takes place in the cultural world is *isomorphic* to the learning-through-discovery process that takes places in the natural world. To expand on this argument, one could posit that abduction constitutes a paradigmatic feature that enables one to distinguish biosemiotics' conceptions of information and modelling (grounded in *phylogenetic* homology) from that of cybernetics (grounded in *logical* homology - see Chapter 5). To support this hypothesis, this section sets out to bring evidence of prefigurements of abduction as purported to be found in biosemiotics' conceptions of information. As it will be shown, the reference to information as including feelings is treated by Sebeok as "best-guessing strategy" (1978), by Hoffmeyer as "semiotic freedom" and "semiotic niche" (2008a), and by Brier as "rependium" (2007). Since these concepts show a high degree of relevance to abduction, one may argue that a biosemiotic conception of information is generally highly 'biased' towards abduction.

Sebeok explicitly mentions the concept of abduction in relation to the content of communication (and thus information) in his studies of nonverbal communication (1978, 1991c, 2001a). He tackles the problem of how one can perform a guess about "the content" of communication and be right, and he does so through a brief reference to Peirce's aforementioned right-guess about the man who stole his watch on a Boston to New York boat (1979d [1978]: 93). Through this example, Sebeok argues that because of the uncertain character of communication, a receiver may need abduction to interpret a communication accurately. As he states:

> a message can yet be defined as a *selection* out of a code by a source for the purpose of communication, but, whereas in an engineering system the mechanisms of selection are usually given, in biological communication many of the rules governing this act of selection are unknown (Sebeok 1991c: 25).

However, Sebeok argues that such rules can be guessed thanks to the help brought about by nonverbal communication. As he observes, nonverbal communication travels along a profusion of channels since "people constantly pass nonverbal signals to each other" (1979d: 91). Because communication is *ubiquitous* it can benefits from a redundancy effect (1991c: 32) in that messages are communicated simultaneously in a number of ways. Sebeok introduces the technical notion of redundancy that may explain the function of the ubiquity of communications, as he states "To circumvent noise and thereby to decrease the

probability of transmission errors, the source habitually introjects redundancy." (1991c: 33) In this sense, redundancy through nonverbal communication maximizes the chance that important parts of the message will reach their destination whatever the conditions. However, because of the ubiquity of communication, some of the messages transmitted are often invisible and therefore receivers are not always aware that messages are being transmitted to them. One could argue that the capacity for abduction that living beings possess ensures that these invisible messages are picked up and combined into a workable hypothesis about the form, content and function of the communication. In this respect, Sebeok contends that in order to understand communications, one has to reflect on "how much usable information is being transmitted in this way [through nonverbal communication] and what the best guessing strategy is" (1979d: 93). Sebeok conceives such a best guessing strategy not as random guessing but as Peirce's notion of abduction. In this sense, abduction would be the key semiotic (nontrivial) 'mechanism' that, by allowing the receiver to perceive invisible communications, at the same time allows it to formulate a right guess on the communication and to devise a response strategy that 'makes sense' and that is therefore 'appropriate' to the context of the communication. Therefore, through a reference to the notion of abduction, Sebeok makes first person experience and a degree of realism (in light of abduction's connection to right-guess and the accuracy of modelling) integral parts of a general, semiotic (non-trivial) theory of communication.

While Sebeok refers to abduction as 'best-guessing strategy', Hoffmeyer refers to it as 'interpretation'. Hoffmeyer (1996b: 65) states that "information is based on interpretation and, in this sense, corresponds to signs as defined by Peirce." In other words, far from simply consisting in the transfer of objective information, communication is a process that requires the construction of information on the side of the organism. Let us now see what the interpretative, constructed (and abductive) dimension of information consists of. Firstly, as outlined in Chapter 3 of this thesis, Hoffmeyer asserts that living beings are endowed with *semiotic freedom*, a term which "refers to an activity that is indeed free in the sense of being underdetermined by the constraints of natural lawfulness" (Hoffmeyer 2008a: 187). This implies the idea that an environment becomes known to a living being not by means of an objective information transfer from environment to system, but by means of a living being's interpretation of the cues present in the environment, and of an unconscious decision of which of these cues are to constitute the living being's sensorial sphere or *Umwelt*. This view is clearly based on von Uexküll's idea that "through every

relationship [communication] the neutral object is transformed into a meaning carrier, the meaning of which is imprinted upon it by a subject" (von Uexküll 1982 [1940]: 27-28). Therefore, according to both von Uexküll and Hoffmeyer, there is no such a thing as a neutral object or objective (in the sense of 'neutral') environment as such.

The impossibility of envisaging a neutral environment when considering the '(living) system-environment' relation, implies that there is a distinction between ecological niche and *semiotic niche* (Hoffmeyer 1996a, 2008a). Hoffmeyer contends that the "traditional" ecological niche concept is grounded in de-semiotised understanding of the interplay between organisms in nature (2008a: 184). 'Ecological niche', Hoffmeyer explains, is a description of the ecological role of the species, its way of life. (2008a: 183) The concept of 'ecological niche' is underwritten by a behaviourist/functionalist perspective of biological systems and it expresses the view that an environment suitable for a species adaptation is objective (which, as it has been seen, is not semiotically possible), can be established *a priori* and is static. Such a view demonstrates that the concept of ecological niche is grounded in *deduction*. On the other side, the concept of semiotic niche implies an interpretative dimension of environment is grounded in the idea that information is subjective. In this sense, the "semiotic niche" embeds an implicit prefigurement of *abduction*. To reach the conclusion that living beings possess a semiotic niche rather than merely an ecological niche, Hoffmeyer posits that organisms possess semiotic freedom. As he argues, through semiotic freedom, living beings possess "an extreme semiogenic capacity, a capacity based on their ability to *read omens* in the broadest possible sense of this expression – in other words, to take advantage of any regularities they might come upon as signifying vehicle or signs" (Hoffmeyer 2008a: 188-189) One could argue that these 'omens' can be envisaged in Sebeokean terms as instances of nonverbal, ubiquitous and often invisible communication, which are caught thanks to the endowment of living beings with semiotic freedom (to use Hoffmeyer's term) or with abduction (to use Peirce's term). As stated above, abduction is about noting a resemblance (contiguity) between elements of a different class, and speculating on the possibility that such elements may belong instead to the same class (and thus hypothesizing a degree of continuity between such elements). Hence Hoffmeyer's reference to 'regularities' or information that becomes distinct from an environment and significant for the living being (or matching a living being's needs) can be seen as an instance of abduction. In other words, one may claim that through semiotic freedom, or the capacity to perform right-guesses-abductions, living beings can establish a

semiotic niche that is 'accurate' and thus functional to their own needs. As Hoffmeyer (2008a: 185, my italics) states, semiotic niche is a term that embraces:

> the totality of signs or cues in the surroundings of an organism – signs that it must be able to meaningfully interpret to ensure its survival and welfare. The semiotic niche includes all of the traditional ecological niche factors, but now the semiotic dimension of these factors is also strongly emphasised. The organism must distinguish relevant from irrelevant food items and threats, and it must identify the necessary markers of the biotic and abiotic resources it needs: water, shelter, nest-building materials, mating partners, etc. The semiotic niche thus comprises all the *interpretive* challenges that the ecological niche forces upon a species.

Following this definition, the 'interpretive challenges' are concerns of those situations that require abduction in order to allow the organism to form a *workable* interpretation of its own environment. An example of an interpretive challenge is that of the bird that lures the predator away from the nest by pretending it has a broken wing – and then flies away as soon as the predator has been misled and delivered a sufficiently long way away from the fledglings (Hoffmeyer 2008a: 189). This situation illustrates instances of abduction in these two animals. The bird's abduction suggested that deception was required to save its nest, whereas the predator's abduction suggested that the clumsy behaviour of the bird means "easy catch". Not all abductions can be "right" or bear the same degree of accuracy and, in fact, this example serves as an illustration of the fact that the bird's abduction has been more workable than that of its predator. One could argue that Hoffmeyer's concept of semiotic niche, which implies a flexible and adaptive notion of ecological niche in light of living beings' capacity to form interpretations (or right-guesses based on abduction), not only embodies a reference to abduction, but also suggests that the concept of abduction could be successfully transposed from the semiotic study of man to the semiotic study of any living creature.

In a similar manner to Hoffmeyer, Brier contends that all living beings must be endowed with the capability to construct their world through an individual, subjective point of view. He argues this point by means of the Reventlow's ethological concept of rependium (Relentlow cited in Brier 2008: 167), a concept that is strictly linked to abduction in that "ethology (...) investigates the subconscious abductive judgements"(Brier 2008: 168). Brier explicitly mentions abduction by discussing the findings of ethology on animals' feelings, and their relevance for a subjective model of information that is applicable to all living systems. Through the book *Cybersemiotics* Brier puts forth the non-reductionist view that

knowledge (information) always originates from feelings because, citing Lorenz, emotions have survival value (Brier 2008: 158). As Brier reports, "aha experiences of sudden insights are known from numerous animal and human experiments" (Brier 2008: 167). Examples include Lorenz's discovery of the imprinting phenomenon among ducklings, Reventlow's discovery of the sudden changes affecting the stickleback in courtship and the realisation of the route to food of Köhler's chimps (Cobley 2010e: 93). These "aha experiences" that take place amongst living beings, are conceived by Brier within the framework of Peirce's abduction in that "abduction allows [us] to produce interpretations from a variety of experiences based on perceptions and memories" (Brier 2008: 114). Brier explains that in ethology, biological feelings (or knowledge through abduction) have been explained through the concept of *rependium* or "creation through a sudden and discontinuous process, of an unforeseen, stable structure, decisive departure from previously existing structures" (Reventlow cited in Brier 2008: 167). Therefore according to Brier, the 'rependium' is an act of insight which brings about structural changes in the animal's behaviour. His argument is that such an act of insight is only explicable by envisaging animals' learning and behaviour as being deeply shaped by biological 'emotions'. In other words 'rependium' is the creation of regularity or habit through abduction. Reventlow's 'rependium' therefore has a semiotic overtone that is strikingly similar to Peirce' s conceptualisation of abduction and which implies, according to Brier, that all biological systems hold, through their capacity for abduction, a degree of subjectivity. As Brier (2008: 168) states, Reventlow admits that:

> The rependium function presupposes mental ability – which means that even a stickleback has intentionality and cognitive experiences. The reaction is non-mechanical (...) The 'stimuli' must often be presented in several times before a stickleback 'reacts'. Furthermore, the stickleback must be in a certain motivational state. This implies that motivation is not simply a physiological concept.

Hence, through the notion of 'rependium', Brier argues that a living being's motivational state can be described by making reference to emotions or abductive judgements. This implies according to Brier, that in *all* biological systems, a conceptualisation of information must include feelings or abduction.

The grounding of cybernetic information in a framework without 'abduction'

As shown above, biosemiotic conceptions of 'information' are highly 'biased' towards abduction. This section will now argue that in cybernetics, conception of information are

instead highly 'biased' towards *deduction*. This formulation will allow us to support the claim that the rupture between biosemiotics' and cybernetics' systems thinking is their diverging concepts of information, that is fundamentally grounded in abduction for biosemiotics, and in deduction for cybernetics-systems theory. Expanding on Brier's argument according to which cybernetics and systems theory attempt to develop a transdisciplinary information science, but lack a theory of signification of the 'inner life' of organism (Brier 2008: 150), this section argues that the failure to develop a cybernetic concept of information that includes first person experience is precisely due to the fact that, with the exception of Bateson (1979), cyberneticians conceive information within a logical framework in the narrow sense (logic as mathematical logic, not as in Peirce's semiotics), and in so doing, they ignore *abduction*. Hence, this section identifies specific instances of concepts of information that ignore abduction across early cybernetics (von Neumann 1948), First Order Cybernetics (Ashby 1956) and Second Order Cybernetics (Spencer Brown 1969; Luhmann1990; von Foerster 1973). This section also acknowledges that there have been cases (e.g. von Neumann) where such impetuses have somehow approached, though not properly embraced, abduction.

In early cybernetics, von Neumann's "general and logical theory of automata" (1948) approaches the idea that organisms have intuitions about the environment they inhabit, and therefore that a concept of information may need to include a degree of indeterminacy. However, to account for such an indeterminate aspect of information he turns to statistics (information theory) and in so doing he ended up relying on a deductive concept of information.

Von Neumann had approached an understanding of information as based on intuition when he states that "the living system contains *necessary arrangement* to form diagnosis of an error and to minimise its effects" (von Neumann 1948: 305). The term 'arrangement' betrays a conception of intuition as *mechanism*, whereas in fact the biological capability to extrapolate information from a contingent situation would be the semiotic capacity for modelling, e.g. semiosis. Von Neumann approaches abduction when he realises that in order to build a machine that mimics living beings' capability to deal with unexpected situations (e.g. deal with error), one has to posit that such a capability does not consist in having an *a priori* description (information) of all possible situations, but a generic or flexible description of a situation that is capable of accounting for a vast arrears of situations, even the ones that are unknown. As he reports:

> DR. WEISS: (...) one of major features of nervous systems is (...) its apparent ability to remedy unforeseen situations that could not possibly have foreseen. The concept for a nervous automaton should, therefore, not only be able to account for normal operation of the nervous system, but also for its relative stability under all kind of abnormal situations.
>
> DR. VON NEUMANN: I do not agree with this conclusion. (...) One can guard against errors that are not specifically foreseen. (...) One can design and build an electrical automaton that *deviates* no more than 10 per cent from its standard design value. You may now try to disturb this machine by experimental treatments which will alter its resistor values (...) As long as no resistor shifts by more than 10 per cent, the machine will function right, no matter how involved, how sophisticated, how "unforeseen" the disturbing experiment is (von Neumann 1948: 322, my italics).

In other words, *deviation* of machine behaviour is allowed within a range of values. The idea of *deviation* that von Neumann identifies, hints at the degree of indeterminacy of information, and at the idea that information is correlated with generic, flexible classification such as that embedded in an abduction's conclusion. 'Deviation' is, in effect, a way to denominate the degree of flexibility or creativity of abductive reasoning. In this respect, one could argue that von Neumann realises that to imitate the intelligence of a living being, machines must be capable of performing *generic thinking*, as he states here:

> So there are many different problems that can modify the machine status within these values, this includes unforeseen problems. In short, errors do not need to be predicted with precisions, or there is no need to predict ALL the individual specific errors, but a class of errors. (...) Errors and sources of errors need only be foreseen *generically*, that is, by some decisive traits, and not specifically, that is, in complete detail. And this generic coverage may cover vast territories, full of unforeseen and unsuspected-but fine, irrelevant details (Von Neumann 1948: 324, my italics).

This reasoning approaches abduction in that abduction is also about noting a resemblance between different two classes of objects, and it is geared to reach the (hypothetical) conclusion that the first object is causally connected to the second object, and thus that both objects belong to the same generic class of objects (1998 [1893-1913]: 106). If one considers that an abduction's conclusion is generic, rather than general, and that such a conclusion is *workable* or potentially accurate rather than precise, then one can see how von Neumann's 'logical theory of automata' implicitly approaches abduction. However, von Neumann does not possess a semiotic vocabulary to express semiotic/generic thinking, and

turns to statistics (as in information theory (to conceive of the indeterminacy of information (generic thinking):

> This new system of formal logic will move closer to another discipline which has been little linked in the past with logic. This is thermodynamics, primarily in the form it was received from Boltzmann, and is that part of theoretical physics which comes nearest in some of its aspects to manipulating and measuring information (von Neumann 1948: 304).

In other words, he argues that information theory, rather than formal logic, is more suitable for a nontrivial understanding of machines. However, despite the move towards probability (through the statistical character embedded in information theory) von Neumann's general theory of automata is trivial in that information theory rests on logic conceived in the narrow sense as deduction, rather than on semiotics which, instead, includes *both* deduction and abduction. As Brier argues, information as conceived in information theory (as well as First and Second Order Cybernetics) in terms of the computing of the information bit, cannot account for first person experience (2007) which, instead, he holds to be a vital component of information. Therefore, since von Neumann's logical framework fails to openly account for abduction, his concept of information lacks individuality and therefore it 'Is not Enough!' (citing the subtitle of Brier's 2008 book) to account for biological information.

Be this as it may, in First Order Cybernetics, Ashby proposes a notion of biological survival as a set or range of essential variables (1956: 195-197) that is entirely based on deductive mathematical logic (set theory). Such a view allows Ashby to cast a strong argument in favour of the (logical) constraints of information, but also leads him to fail in taking into account the value of emotions for survival. This is a serious shortcoming because, as shown in the above section on semiotic and discovery, any explanation of biological adaptation should account for the abductive (semiotic) aspect of information (which include the quality aspect of emotions – see Chapter 7) not just for its logical aspect.

Ashby in fact defines survival as a "set containing essential variables." (1956: 197) These "essential variables" can be intended as the set of states (behaviour, movement, posture, composition) of the organism whose survival is to be measured. He explains that to be alive means to be able to maintain these essential variables within a certain physiological limit. This amounts to say that such variables are *constrained*, or that in order to be 'essential', these variables must possess a limit. Ashby translates the concept of survival and essential

variables in set theory terms (Ashby 1956: 196, 197) and brings the example of a hypothetical situation in which a mouse is trying to escape a cat. To illustrate his example, let M describe all the possible states of the mouse. On the other hand, let M1 describe the states the mouse may be initially in before dealing with the cat. Now let the cat be an operation C on the subset M mouse. The situation in which the cat is dealing with the mouse can be defined as C(M1). If the mouse survives the cat more than once, and all the relations C(M1), C(M2) ,C(M3) are always contained in the set Mk (which represents the mouse), then this representation of survival is identical to that of the stability of a set (1956: 197). The states M are defined as variables. If these states belong to Mk, then these states all retain some essential variables called physiological limit. "The states M1, ..., Mk, that correspond to the living organism are then those states in which certain essential variables are kept within assigned ('physiological') limits" (1956: 197). One can foresee the limitation of Ashby's definition of survival because the set M describing all possible states of the organism (the set of all possible behaviours) does not include emotions. Hence, Ashby's idea of survival as 'fitting the physiological limit' is flawed from the start as it does not acknowledge the importance of feelings which, instead, as Lorenz argued, have survival value for all living beings (Lorenz cited in Brier 2008: 158).

In addition, Ashby posits that in organisms there is a controller which ensures that variables are kept within limits or that posits limits (constraints) to the information that can traverse a system (1956: 199). An example of this principle is that on an aeroplane, a good pilot (regulator) can sometimes act as a filter in the transmission of information about turbulence to the passengers. (1956: 200) Since Ashby does not take into account emotions, his account of 'survival as the constraints of information' is biased towards a narrowly logical, rather than semiotic, understanding of information. In this respect, Dupuy (2000: 149) makes a harsh comment by stating "Ashby's routine consisted in passing off conventional mathematical [logical] definition as a universal principle of nature." One may argue, however, that this critique is too dismissive of Ashby's idea of limits/constraints and that such a critique may stem from a fundamental idea that human behaviour is entirely will-based, hence arbitrarily chosen and unconstrained. The ideological stance of this critique allows one to make the point that while survival (or information) certainly cannot be *reduced* to its constraints and needs to possess a degree of freedom and auto-determination, it nevertheless cannot be entirely abstracted from its physiological constraints. A view that acknowledges the freedom associated with abduction but also its

realist implications, that is, its limits, is explored in the next section and expanded on in relation to culture in Chapter 7.

Spencer Brown's 'information as distinction' versus Bateson's 'information as difference'

Drawing on Brier' argument (2008), it is argued that it is not only First Order Cybernetics which ignores 'abduction' but also Second Order Cybernetics. This is because, as Brier argues, Second Order Cybernetics' developments of information, despite being grounded in 'observership', are still devoid of first person experience and hence lack 'abduction'. In this section, however, such a claim is put forth in a different fashion from Brier (2008): it is argued that the reason that inhibited the development of subjectivity in Second Order Cybernetics is in the fact that its key contributors, such as Luhmann and von Foerster, grounded their concept of information in the theory of 'observership' as suggested in Spencer Brown's *Laws of form* (1969) which as it will be shown is grounded in *deduction,* ignoring abduction unfairly. This is the reason why, arguably, it is concluded that the lack of acknowledgment of abduction by Spencer Brown could explain why "in Second Order Cybernetics, the subject is gone!" (Brier 2008: 225).

As outlined in Chapter 4, Second Order Cybernetics is distinguishable from First Order Cybernetics in light of its emphasis on observership, that is, the realisation that when performing systems study, the observer modifies or, more radically, constructs the reality which s/he is observing. In this respect von Foerster (1973: 1) affirms that "the environment as we perceive it is our invention", Maturana and Varela (1980: 80) state that autopoietic machines do not have inputs and outputs, whereas Luhmann (1990: 135) defines information as a "purely internal achievement", an act of selection that does not exist in the external world, but is a construct of the observer. This implies that in Second Order Cybernetics, information is relative to an observer. Luhmann and von Foerster explicitly draw on Spencer Brown's framework in order to characterise the observer. In this respect, Luhmann notes that observation is both an operation and an employment of distinction, and that the distinction can re-enter that which has distinguished (Luhmann 1990: 134), thus explicitly mentioning Spencer Brown's concept of re-entry (1972: 69).

Von Foerster (1970: 12) affirms that in system observation one has to ask:

> what are the properties of an observer" (1979: 2) and in a review of Spencer Brown's *Laws of form*, he states that "We cannot escape the fact that the world we know is constructed in order (as to be able) to see itself but that since knowledge inexorably starts with a distinction, (...) in this severed and mutilated condition whatever it sees is *only partially itself*.

Therefore positing the observer in systems observation allows second order cyberneticians to emphasise the *indeterminate* side of information. However, one may argue that such emphasis put on the indeterminate side of information is an inadequate account of the degree of subjectivity of information. In fact, as Brier argues, through the theory of the observer (as embodied in the work of von Foerster, Maturana and Varela and Luhmann), Second Order Cybernetics has abandoned an objective view of information, yet it still has not developed a theory of meaning and signification that links the biological and the cultural realms (Brier 2008: 234).

This section will now show that this failure to propose a conception of information that accounts for first person experience is due to the fact that Luhmann (1990) and von Foerster (1970, 1979) draw their theory of observership from Spencer Brown's (logical) 'information as distinction' rather than Bateson's (semiotic) 'information as a difference'. That is, by drawing on Spencer Brown, second order cyberneticians' constructivist systems theory proposes a *logical* observer in systems observation rather than a *semiotic* one. To support this claim one has to perform a reading of Spencer Brown's *Laws of Form* (1969) in light of prefigurements of *deduction,* the logical inference *par excellence*. Spencer Brown's conception of observership in *Laws of Form* (1969) is suggested by his concept of 'distinction'. Von Foerster explains that this concept is based on a symbol, a stemless arrow pointing towards north east, whose meaning is "the injunction 'draw a distinction!" (von Foerster 1970: 12). This symbol:

> ... is a token for drawing a distinction, say by drawing a circle on a sheet of paper which creates a distinction between points inside and outside of this circle; by its asymmetry (the concave side being its inside) it provides the possibility of indication; finally it stands for an instruction to cross the boundary of the first distinction by crossing from the state indicated by the token (von Foerster1970: 12).

In short, the act of making a distinction neatly separates a system from its environment. Spencer Brown states that "once a distinction is drawn, the spaces, states, or contents on each side of the boundary, being distinct, can be indicated" (Spencer Brown 1972: 1) and therefore can be described mathematically. Spencer Brown's reasoning implies that knowledge follows the "primordial" act of distinction, that is "we can begin to see how the

familiar laws of our own experience follow inexorably from the original act of severance" (Spencer Brown 1972: v). In an attempt at interpreting these thoughts and making them useful to the present discussion on information, it can be argued that when one performs a distinction, then information is generated. Von Foerster explores the implications of such a theory of knowledge by stating that after a distinction is performed, practically everything else follows smoothly: the foundations of arithmetic, of algebra, of logic (von Foerster 1970: 12). Hence a view of information as embedded in the notion of distinction implies that information (the content/knowledge that is severed from an environment through a distinction) is *constructed by its observer* (the performer of the act of distinction). By expressing this concept through the idea of *re-entry*, Spencer Brown (1972: 76) explains that "We see now that the first distinction, the mark, and the observer are not only interchangeable but, in the form, identical." In other words, a system is indistinguishable from the part which is severed by an observer through distinction.

Spencer Brown implies that the role of the observer must be taken into account in system observation as this severely affects the 'nature' of the system itself. His is the key contribution that Luhmann and von Foerster take on to develop their constructivist views of systems theory which sees information as constructed by the observer and thus as "subjective". Yet, despite the fact that Spencer Brown's general *Laws of Form*, grounded in distinction, allows him to theorise the observer, (suggesting the indeterminate aspect of information), he neglects to acknowledge the role of first person experience in system observation. He does so by positing the observer in systems-observation as a *logical* necessity. In so doing he also poses subjectivity as a logical (a priori) necessity. But given his statement according to which "the conception of the form lies in the desire to distinguish" (Spencer Brown 1972: 69), one can see that Spencer Brown admits that before distinction comes the *desire* for distinction. In other words, distinction is driven by emotions. But this already contradicts his idea (which is also incorporated in Second Order Cybernetics) that there is no knowledge before distinction. By acknowledging emotions, one instead can clearly see that there is something before distinction. Spencer Brown (literally) dismissed the role of the "desire to distinguish" by stating that "Granted this desire, we cannot escape the form" (Spencer Brown 1972: 69). In so doing, he banishes a key aspect of 'knowing', that is, the fact that 'knowing' requires abduction. And the contradiction rendered by his argument show clearly that his disregard for abduction is carried out at his peril.

The claim that Spencer Brown lacks a theory of signification fully applicable to the study of biological (semiotic) systems can be further supported by comparing his concept of (information as) distinction with Bateson's concept of 'information as a difference'. This is because Bateson's information, unlike Spencer Brown's concept, is inserted in a framework which makes explicit use of abduction. The aim of this comparison is to strengthen the idea that Spencer Brown's general theory of knowledge is biased 'towards' logic because, in addition to the above, he neglects to account for abduction.

As intimated earlier, Bateson's conception of information is grounded in "difference" in that, when a knowing subject perceives "a difference which makes a difference" (2000b [1970]: 459), or perceives something as 'relevant', then information is generated. This sense of relevance can be aligned with Peirce's semiotics according to which a sign is something which stands *to somebody* for something in some respect or capacity (Peirce 1955b: 99, my italics). According to Bateson, information is conceived as a difference in that it "excludes certain alternatives" (2000a [1972]: 381). This concept of exclusion seem to suggest that both Spencer Brown's "information as distinction" and Bateson's "information as difference" may express a similar view on the nature of knowledge, based on the idea that at the origin of knowing there is selection through exclusion, or a clear yes/no, relevant/nonrelevant or inside/outside separation. However, since Bateson states that information comes from outside the system (2000b [1970]: 460), he thus envisages the necessity of positing an inside/outside dichotomy for the perception of the relevance of information. But in this respect, he also states that "contrast between internal and external pathways is not absolute" (2000b [1970]: 460). Therefore one may argue that Bateson's conception of information rests on a conception of system-environment boundary that is not clear-cut, hence that such a boundary is *generic*. Therefore one may argue that his concept of information is less trivial than Spencer Brown's conception of distinction and observership whose mode of representation resembles Venn Diagrams (see earlier section), and hence starts from the necessary logical premise that a system (or set) must be sharply separated from its environment.

Another difference between Bateson and Spencer Brown's information account is in the general theoretical framework in which they are inserted. Such a framework for information is aware of abduction in the case of Bateson, and ignorant of abduction in the case of Spencer Brown. Bateson (1979) in fact proposes the idea of the "pattern which connects" (2002 [1979]: 10) as a means to explore the relationship between "mind and

nature" to the point that the two expressions can be taken as synonyms (Bateson 2002 [1979]: 3-20). In relation to 'the pattern which connects', Bateson (2002: 7) asks

> What pattern connects the crab to the lobster and the orchid to the primrose and all the four of them to me? And me to you? And all six of us to the amoeba in one direction and to the back-ward schizophrenic in another? What is the pattern which connects all the living creatures?

He explains that the pattern which connects is a metapattern, or a pattern of patterns (2002: 10), which never consist of quantities, but always of shape, form and relations. (2002: 9) To illustrate this principle which expresses the basis of his strongly homology-based systems thinking, Bateson brings an example of himself in a teaching situation showing a crab to a group of art students. One of these students observed that in the crab "one claw is bigger than the other, but both claws are made of the same parts" (2002: 8). That is, the two claws of the crab are characterised by embodying similar relations between parts. (2002: 9) The concept of metapattern (effectively another name for *system*) implies that one can study reality in terms of relations, or more specifically, proportions, and speculate on the reasons why such proportions are present. Indeed, Bateson states that another name for "the pattern which connects" is *phylogenetic homology* (Bateson 2002: 9), that is, the metapattern that allows one to make speculations about the historical connections (or the relations of heredity) that may exist between systems that show a degree of aesthetic similarity. Hence, the risky-creative character of Bateson's systems thinking seems to be more 'abductive' rather than merely 'logical' and his notion of homology may be closer to biosemiotics' *semiotic* philogenetic homology rather than cybernetics' *logical* phylogenetic homology (see Chapter 5 for the way in which biosemiotics and to a lesser extent, also cybernetics are claimed to rely on phylogenetic homology). This is further confirmed if one considers the relation between "the pattern which connects", and Bateson's information as a difference.

So, firstly Bateson identifies the fact that homology (the pattern which connects) comes into being through abductive thinking:

> We can look at the anatomy of a frog and then look around to find other instances of the same abstract relations recurring in other creatures, including, in this case, ourselves. This lateral extension of abstract components of description is called *abduction* [...] the phenomenon is enormously more widespread than he or she might, at first, have supposed (2002 [1979]: 133).

Secondly, Bateson's suggests that abductive thinking (envisaging the pattern which connects) is what produces information:

> If I examine the social organisation of an Australian tribe and sketch of natural relations upon which the totemism is based, I can see these two bodies of knowledge as related abductively, as both *falling under the same rule.* In each case, it is assumed that certain formal characteristics of one component will be mirrored in the other. This repetition has certain very effective implications. It carries *injuctions,* for the people concerned (Bateson 2002 [1979]: 134, my italics).

Here, Bateson argues that repetition (or similarity of form or metaphor as exemplified by abduction) allows different things to "fall under the same rule." This quote also suggests that this repetition carries "injuctions." Bateson does not specify what he means by "injuction", however one could argue that injuction brings *information.* If this is true, then one can further argue that similarity-metaphor (abduction) is what 'causes' one to perceive a difference which makes a difference. If it is so, then abduction (similarity) carries information.

In sketching out a timely order in the process of knowing, one needs to envisage abduction (similarity) *before* envisaging difference, or, to use Spencer Brown's term, distinction. As previously seen, instead Spencer Brown dismisses abduction (the desire for distinction) by mathematically taking it for granted. Indeed, as von Foerster states, according to Spencer Brown "Laws are not descriptions, they are commands, injunctions... an exhortation to perform the primordial creative act (Spencer Brown cited in von Foerster 1970: 12). In other words, Spencer Brown explains abduction (the primordial creative act) by way of deduction (the law). In so explaining it, he starts from the end to justify the beginning. To use Peirce's categories (1955b: 99, 104, 108, 112), Spencer Brown neglects to acknowledge that *Firstness* (1955b: 104), vague perception of similarity that constitutes abduction, (or perhaps, Spencer Brown's "desire for distinction") comes first, whereas Secondness (the act of distinction whereby a system is clearly severed from its environment and information is constructed) comes second. As Peirce states, a genuine index and its object (Secondness) may contain a Firstness, and so contains an Icon as a constituent part of it. (Peirce 1955b: 108) Or, to use Sebeok and Danesi's Modelling Systems Theory (2000), one should not forget that models of the world are created primarily by means of Primary Modelling System (that corresponds roughly to Firstness) and at a second remove by Secondary and Tertiary Modelling Systems (that correspond *grosso modo* to Secondness and Thirdness). Therefore, by not mentioning abduction when theorising distinction, Spencer Brown put

forth a theory of observership that is 'biased' towards deduction and that therefore is merely logical rather than semiotic.

In light of this comparison, one could argue that Spencer Brown's bias towards deduction is the reason why all the Second Order Cybernetics work which draws on his *Laws of form* misses subjectivity. That is, following Spencer Brown's failure to acknowledge abduction, in Second Order Cybernetics the observer is also postulated as an *a priori* logical being rather than a semiotic animal. This implies that despite Second Order Cybernetics' move towards the indeterminacy of information through a conceptualisation of observership, their notion of information (and of observer) remains a syntactic and meaningless more akin mathematical modelling rather than semiotic modelling. A deductive concept of information which excludes abduction by definition will never be able to account for first person experience, cannot possess 'real' (in practice and not a priori) subjectivity and, as such, is not fully applicable to the biological world. This also seems to be the reason why as Brier states, cybernetics and systems theory *do* require a semiotic framework in which to function (Brier 2008: 234); for information to be able to embody first person experience, the observer should be envisaged not as a logical being but as a semiotic being endowed with the capacity for abduction.

Conclusion

This chapter set out to complement this thesis' argument according to which biosemiotics is a modern development of systems theory by providing evidence that when historical continuity is considered between the two fields, discontinuity, rupture or uneven developments (*sensu* Althusser 1965) arise. It has been posited that the 'epistemological break' between biosemiotics and cybernetics (which may as well be a symptom of the break between biosemiotics and modern science in general) is in the way in which they conceive information.

This study has been carried on by firstly disentangling the multiple meanings of the notion of information that one can find in biosemiotics and cybernetics-systems theory. It has been found that despite both biosemiotics' and cybernetics' tendency to conceive of information in polarised terms – e.g. either determinacy or indeterminacy, either objective or subjective – each field bears a subject-specific approach towards information or a 'bias.' Such a 'bias' is hypothesised as the respective presence and non-presence of the semiotic notion of *abduction* in their frameworks. Furthermore, abduction as the hypothetical

reasoning involved in semiosis (Peirce 1955a [1903]: 304) has been posited as the analytical term with which to perform analysis of conceptions of information in both biosemiotics and cybernetics.

Analysis has brought to light the fact that while in biosemiotics the concept of information is 'biased' towards abduction, in cybernetics views on information are 'biased' towards deduction, despite occasionally approaching semiotics' endeavour. In biosemiotics the concept of information is 'biased' towards abduction in terms of *first-person experience*: Sebeok refers to abduction as the capacity to perform right-guesses on the content of the nonverbal communications (1978), Hoffmeyer through the concept of semiotic niche (2008a: 183), Brier through Relentlow's notion of *rependium* (Brier 2008: 167). On the other hand, cybernetics' concept of information is 'biased' towards deduction whether it is conceived as objective (in First Order Cybernetics) or as 'subjective'/constructed(in Second Order Cybernetics). Von Neumann implicitly approaches abduction by making a reference to the *generic thinking* but eventually turns to statistics to account for such a process; Ashby proposes a theory of biological survival that is grounded in set theory and that exclude emotions despite these have been deemed by Lorenz as necessary for survival. In Second Order Cybernetics, Luhmann (1990) and von Foerster (1973, 1979) ground their constructivist views of information in Spencer Brown's concept of distinction (1969) which, by means of comparison to Bateson's "information as a difference", has been shown to be essentially based on deduction.

The analysis proposed in this chapter allows one to recognise the fundamental difference in the modelling that biosemiotics and cybernetics propose, the former (biosemiotics) grounded in logic conceived in a broad sense as coextensive with Peirce's *general theory* of signs, the latter (cybernetics) identifiable with logic conceived in the narrow sense as an analytical *method* within the mathematical sciences. This finding bolsters the argument already anticipated in Chapter 5 according to which biosemiotics is endemnified on *semiotic* phylogenetic homology and where cybernetics is instantiated on logical homology.

However, as Cobley argues, there is an ideological tendency in biosemiotics to emphasise *agency*, a practice which may prove useful in mitigating the mechanicist overtone of modern biology, but which is dangerous in the study of culture in the humanities which "already has agency in bucketloads – indeed, it has more than it knows what to do with." (Cobley 2010b: 241) Hence since the ultimate aim of this PhD project is to figure out a

biosemiotic praxis for the study of culture, the demonstration (carried on in this chapter) that biosemiotics has abduction but tends to underplay constraints, and that cybernetics has constraints but ignores abduction is useful to prepare the ground for a concept of information that must contains a theorisation of *first person experience* (through abduction) as well as a theorisation of *constraints* (as cyberneticians propose). Such a synthetic view is articulated in Chapter 7, and constitutes the grounding for a new form of cultural analysis that takes the 'best' of biosemiotics and cybernetics in terms of both 'modelling' and 'information' by being *cybersemiotic*.

CHAPTER 7

'Biosemiotics *as* Systems Theory' as the demise of semiology:

steps towards a new form of cultural analysis.

Introduction

The previous two chapters underline the degree of historico-disciplinary *overlap* as well as *discontinuity* that biosemiotics and cybernetics-systems theory bear. Such a demonstration was pursued with the intent to provide evidence for the claim that biosemiotics is a modern, though uneven, form of systems theory. The current chapter sets out to explore the relevance and implications of such a claim for a new form of cultural analysis that draws on biosemiotics, and particularly on a version of biosemiotics that is fully aware of its cybernetics heritage, as that presented in this thesis. In pursuing the aim of presenting guidelines for a *new* form of cultural analysis, this chapter sets out the preliminary task of recollecting the fallacies of the *older* form of cultural analysis, that is, semiology. Following Barthes' reading of Saussure's *Course in General Linguistics (*1916, trans. into English in 1959 and 1983), semiology was introduced in Anglophone literary and cultural studies areas and is still currently in use today.

Given that it is so date, one may argue that semiology (especially in the model set by Barthes) is an easy target for criticism. However, there are three reasons which make the discussion of the shortcomings of semiology a matter of current interest: 1) semiology is a framework for cultural analysis that is at least 60 years old, yet it is the framework that is still largely being taught at university level in the UK at the dawn of the 21st Century, largely because 2) as Cobley notes, semiological principles are often given the name 'semiotics' (Cobley 2007: 46) resulting in semiologists' anthropocentric endeavours (see below), passing as the model for semiotic analysis in general in cultural studies; 3) in Anglophone media and cultural studies (Cobley 2006a), 'semiotics' has become so conceived as a discipline-specific tool of media studies or, at most, of subjects matters in the humanities narrowly insulated from the concerns, findings and methods of natural sciences. In this respect Cobley indicates that the antiscientific character of such enterprises are inappropriate to our current historical context:

> the further reaches of the humanities, especially areas such as cultural studies, will have to face up the possibility that their dismissal of science as masculinist,

> mechanist, 'ideological' and so forth, is, perhaps, apposite to nineteenth-century modes of thought but is rather misplaced in the context of the twenty-first century (Cobley 2007: 57).

Hence, in light of the need for renovation of the semiotico-theretical framework for cultural understanding in the humanities, this chapter proposes a survey of the *faults of semiology*. It is proposed that the epistemological cornerstone of a new form of cultural analysis wishing to supersede the fallacies of semiology, must be grounded in Peircean *pragmatism*. This cornerstone allows one to prefigure more precisely the following guidelines for analysis, that is: dispensing with 'interpretation' in favour of *modelling,* dispensing with 'representation' in favour of *purely objective reality,* and dispensing with 'motivation' in favour of *cybersemiotic* constraints. It is hoped that these guidelines will foster the exploration of the transdisciplinary potential of biosemiotics reconfigured as systems theory, particularly in relation to the implications of the natural sciences for cultural analysis, but also, possibly, the other way round.

The four faults of semiology

This section identifies the faults of semiology, that is, those philosophical assumptions that have severely limited and vitiated semiologists' analyses of culture. The aim is not to simply repeat the critiques that have already been directed at semiology by scholars in the field (e.g. Thompson 1979; Jackson 1991; Cobley 2007, 2006a, 2006b) but to gather all these critiques in one single account with the aim of producing a general picture of the faults that can be identified in semiology at once. Such an account will also be enriched by observations made from a biosemiotic perspective. The sources in semiology discussed in this section have brought-forward and re-iterated some of the fallacies already implicit in Barthes' version of semiology. These fallacies are (a) linguistic bias and the *pars pro toto* fallacy, (b) the conflation of Barthes' semiology with Saussure's, (c) the excessive emphasis put on representation in signification, and (d) the narrowing of the scope of semiology to the unmasking of power relationships or *ideology* hidden in texts. It is important to underline these fallacies because one may argue that these very faulty enterprises have not only vitiated semiological cultural analyses, but have also hindered the advancements of a 'semiotics proper' in areas heavily invested in sign study such as British cultural studies.

(a) The pars pro toto fallacy and the linguistic bias of semiology

The first fault of semiology consists in proposing and reiterating the *pars pro toto* fallacy. This expression, when used to name the rethorical device of synecdoche, reads as 'a part taken to represent a whole', but when envisaged in the context of semiotics refers to "the fallacy of mistaking the part for the whole, or of treating some part as if ... it were the whole" (Deely, Williams and Kruse 1986: viii). Such fallacy specifically refers to the widespread custom (as evident in Fiske and Hartley 1978; Hall 1980; Dyer 1982; Vestergaard and Schrøder 1985; Fiske 1990b; Bignell 1997; Williamson 2002; Belsey 2002) of mistaking "the minor tradition" of sign study (dubbed as such by Sebeok 1977a: 182, and 1979a) which is semiology, originating less than a century ago with the work in general linguistics of Ferdinand de Saussure (1916), for "the major tradition" of semiotics originating in iatric semiotics, the medical practice of symptom-reading used by the ancient Greek physicians Hippocrates of Cos and Galen of Pergamon (Sebeok 1991c; Cobley 2007) and also developed by Augustine of Hippo and Poinsot, Locke and Peirce (Deely 1998: 558). As Deely explains, this 'major' tradition sees "signs as an intersection of nature and culture through an activity – semiosis – that is confined to neither sides of the divide" (1998: 558).

An example of the *pars pro toto* fallacy can be found in the semiologist Dyer who defines "semiotics, described by its founder Ferdinand de Saussure as a 'science that studies the life of signs within society'" (1982: 115), thus giving both the historically false information that Saussure is the sole founder of semiotics, and the misleading idea that the scope of semiotics is limited to the study of human signs alone. Jhally (1990) is fully guilty of the *pars pro toto* fallacy as he alternates the use of 'semiology' (e.g. 1990: 130) and 'semiotics' (e.g. 1990: 140) as if these terms were synonymous and referred to the same tradition of sign theory. Bignell (1997) claims to be doing 'semiotic' analyses of media texts (as the title of his book *Media Semiotics* suggests) when effectively using semiological models all the way through. Similarly, Chandler (2002) published a book "proclaiming to treat of *Semiotics: The Basics* while treating in fact of Semiology... inasmuch as the work considers nothing beyond the cultural side of anthroposemiotics." (Deely 2010: 29) Out of all the semiologists, Kress and van Leeuwen (2006) distinguish more precisely amongst different schools of semiotics, referring to semiology as "the Paris School of the 1960s and 1970s", but decide to pursue the development of this very approach despite the fact that, as Cobley notes (2012: 225), key contributions of the 'Paris school' were not academic works but entertaining articles (e.g. Barthes' *Mythologies,* 1957, translated in English in 1972) and sensational manifestos

(e.g. Barthes' *La Mort de l' Auteur*, 1968) penned for mainstream magazines. Particularly, Kress and van Leeuwen openly stick with "the way in which the Paris School semiotics is generally taught in the Anglo-Saxon world, through the mediation of influential textbooks such as the series of media studies textbooks edited by John Fiske" (2006: 7). This is a problematic move because, as shown above, these very works are guilty of the *pars pro toto* fallacy hence of the practice of mistaking semiology for semiotics.

This misunderstanding brings about another fallacy: when it is not mistaken for semiology itself, the 'semiotic proper' work of C. S. Peirce (1839 - 1914) is reduced to a mere supplement to semiology. As Cobley states (1996: 27) "...The reductionist manner in which Peirce has been introduced into such areas" is evident in the fact that:

> ...influential commentators have attempted to graft onto structuralism and post-structuralism those theories of signification from Peirce which seem most conducive to the European [literary] project... [Fiske 1991 and Culler 1975] among others perpetuate the notion that Peirce proposed three types of signs: 'icon', 'index', and 'symbol'. As 'symbol' was closest to Saussure's version of the linguistic sign this became a supplement to existing literary theory while the term 'icon' creeps into analyses of analogic communication... This may all seem very convenient from the point of view of many European theorists but Peirce' s work amounts to much more than a mere supplement to 'semiology'.

Accounts of Peirce's *semeiotic* should be at least conceived within his philosophical classification of phenomena based on the three categories of Firstness, Secondness and Thirdness (Cobley 1996: 27). Additionally, far from being reducible to three basic sign types, Cobley explains that Peirce identifies ten basic sign types (as in Peirce 1955b), "which he then revised in order to theorise 66 signs, before eventually coming up with the troublesome figure of 59,049" (Cobley 1997: 30). Notable examples of semiologists who reduce Peirce' work into a surrogate sign-theory consisting of a mere three basic sign-types, and abstracted from its wider philosophical and logical context, are Dyer (1982) and Wollen (1998). Dyer (1982: 124) merges Saussure's terminology with Peirce's by stating that iconic signs are "where the signifier-signified relationship is one of resemblance or likeness." This view is problematic in that it implies that the signified, i.e. Saussure's psychological entity (more on this below), is at the same time Peirce's object, thus creating a theoretical *impasse* in which a mental concept is also a physical object; Wollen (1998: 83), notes that Peirce's "work on semiology (or 'semiotic' as he himself calls it) has been sadly neglected" suggesting not only that Peirce's work which encompasses science, philosophy,

algebra and logic can be unproblematically reduced to semiology but also that the nomenclature 'semiotic' is an instance of author-eccentricity.

The implication of the *pars pro toto* fallacy and of the practice of envisaging Peirce's work as ancillary to semiology, is that, as Cobley posits, semiological analyses of culture are unilaterally performed on the principle of Saussurean linguistics (as transfigured by Barthes, see below) and tend to be *glottocentric*. Such a trend which defines the centrality of language in determining human systems of ideas, values and knowledge can be traced back to the work of Benjamin L. Whorf (1956) and to the 'linguistic turn' in social thought which was inaugurated, as Cobley explains, by Richard Rorty's 1967 collections (Cobley 2007: 45). Taking advantage of the philosophical sea-change of the so-called linguistic turn, Roland Barthes promulgated Saussure's notion of the linguistic sign beyond linguistics as the model for the sign in general through his semiological analyses of capitalist myths (1957). In his later essay, 'The Rhetoric of the Image' (1977a), Barthes seeks to demonstrate that images have a 'code' and hence a linguistic nature, by proposing that the advertising image has, in addition to a linguistic sign, a coded iconic sign and a non-coded iconic sign. Barthes' linguistic approach to culture has spread to a number of semiologists, as evident in the expressions "advertising language" (Vestergaard and Schrøder 1985: 38), "film language", "film grammar" and "poetry of cinema" (Wollen 1998: 78), the puzzling "language of objects" (Williamson 2002: 12) and "grammar of visual design" (Kress and van Leeuwen 2006). The reduction of nonverbal communication to verbal models, hence the commitment to glottocentrism, is openly declared by Bignell (1997: 6) in that "since language is the most fundamental and pervasive medium for human communication, semiotics takes the way that language works as the model for all other media of communication." Invoking this argument, Kress and van Leeuwen justify their choice of term 'grammar' by stating that "we need a term that can encompass oil painting as well as magazine layout, the comic strip as well as the scientific diagram" (2006: 3). In addition to formulating a general linguistic approach to culture, Barthes also spread linguistic jargon as analytical methods, and promoted the notions of 'paradigm' and 'syntagm' as the general organising principles for all systems of signs. This approach is evident for example in Fiske and Hartley's *Reading Television* (1978: 56-57) which posits that paradigmatic analysis in television programmes requires one to compare the effects of long shot with effects of close up while syntagmatic analysis requires the analyst to relate each shot to others in the sequence. The linguistic understanding of culture as exposed by these scholars is severely limited because as Sebeok showed (1988) Primary Modelling System (nonverbal

communication) is phylogenetically older than verbal communication, as such is not so simply reducible to syntagmatic and paradigmatic analysis. An alternative approach to analysis, as that proposed below, would posit 'culture as *communication*' rather than 'culture as language' or 'grammar'.

(b) The conflation of Barthesian semiology into Saussurean linguistics

The second fault of semiology concerns, as Cobley (2006a) notes, the way in which Saussure's *Cours de linguistique générale* (1916) is transmogrified in Barthes' *Éléments de sémiologie* (1964), and, consequently, the way in which Barthes' conception of the sign is almost unanimously mistaken for Saussure's by a number of commentators in Anglophone media and cultural studies (e.g. Fiske and Hartley 1978, Fiske 1982, Dyer 1988, Jhally 1990, Easthope 1991, Danesi 1995, Bignell 1997, Williamson 2002, Belsey 2002). Such a view pretends that cultural understanding can be reduced to a series of unproblematic links between 'things in the real world' and ideas. For this reason, the erroneous conflation of Saussurean linguistics with Barthesian semiology can be identified as the cause of the 'text-centrism' that pervades much of semiological analysis.

In the *Cours,* Saussure (1983: 66) defines the linguistic sign as a *psychological* entity. As he states "a linguistic sign is not a link between a thing and a name, but between a concept and a sound pattern." Notably, for Saussure both elements of the sign in fact are psychological entities. Hence "the sound pattern is not actually a sound; for sound is something physical. A sound pattern is the hearer's psychological impression of a sound, as given to him by the evidence of his senses" (Saussure 1983: 66). Saussure refers to 'sound image' and 'concept' respectively as *signifiant* and *signifié.* It has to be noted that Saussure specifies the psychological aspect of the *signifiant* because he is against the idea of "the sign as a mere correlation between antecedently given items" (Harris 2003 cited in Cobley 2006a: 359) such as that which would exist between a physical sound or the shape of a word and an idea. This is because such a conception would assume that ideas exist independently of words, but also it would lead one to assume that the link between a name and a thing is quite unproblematic (Saussure 1983: 65). However, this assumption that Saussure wanted to avoid is precisely what Barthes smuggles into sign theory in *Elements of Semiology.* Barthes (1977: 47, my italics) in fact presents a rather nebulous reading of Saussure's *signifiant* and *signifié* "the signifier can be related by a certain matter, words. Materiality of the signifier is not simply matter. Rather it is substance. Substance

can be immaterial, matter cannot. The substance of the signifier is always *material* (sounds, objects, images)." As Cobley notes (2001b: 158), such a reading is refracted through Barthes' reading of Hjelmslev (1970), and particularly in reference to the idea of plane of expression and plane of substance (Cobley 2006a: 359). In light of this, Barthes openly contradicts' Saussure view of the *signifiant* by explicitly declaring that the "signifier is a material mediator of the signified". So whereas for Saussure the linguistic sign was a psychological entity, for Barthes the sign becomes a *physical* entity that is objectively present in the text (Barthes 1977: 50). The consequences of this theoretical move are twofold: on one hand by turning the *signifiant* into an objective entity or a *material vehicle,* Barthes expands the realm of application of semiology from verbal signs to include nonverbal signs. (Cobley 2006a, 2007); on the other hand it inaugurates the text-centric character which pervades his semiological analyses and those of his commentators, that is, the search for immanent signifying properties of the text as if these were intrinsic to it and independent of its contexts of use.

In fact, as Cobley (2006a) notes, Barthes' version of the sign is taken on by scholars in media and cultural studies and presented unanimously as Saussurean. An accomplice to this is Baskin's 1959 English translation of Saussure's *Cours* which translated signifiant and signifié as *signifier* and *signified* thus giving "the impression to English natives that the signifiant was anything that did the work of signifying or, to put it another way, a sign – precisely the formulation that Saussure wanted to avoid" (Cobley 2006a: 360). Thus amongst commentators in media studies, Saussure's *signifiant* becomes "a physical form" (Fiske 1982: 41), something that "exists in the material world" (Bignell 1997: 11), a "material vehicle" (Dyer 1999: 118; Jhally 1990: 130), as for example the ink that comes off a pen onto one's finger (Cobley and Jansz 1997: 19) or a "written shape" (Belsey 2002: 36), "the physical part of the sign, the actual substance of which it is composed (sound waves, alphabet characters, hand movements, visual forms" (Danesi 1995: 25) and even worse, a "thing" (Williamson 2002: 18). Amongst the semiologists, it is only Kress and van Leeuwen 2006 who present a less text-centric view of signification by stating that "signifiers are *available* forms such as colour, perspective, line" (2006: 7), referring through their concept of availability to the fact that signs are activated by a specific individual in a specific context (2006: 9). Kress and van Leeuwen's contribution, inserting subjectivity in signification through contingency, allows one to identify the facts overlooked by Barthes' and his commentators' objectivist conception of signification, firstly that a sign is a sign *to someone* (Peirce 1955b), and secondly that a sign is a relation that includes the so-called objective

'organisation of signifiers' (representation) yet it does not solely consist of it (see Deely 2009b below).

(c) Excessive emphasis put on representation and code

In fact, the third fault of semiology concerns the bandying about of *representation*, a trend initiated (again) by Barthes in *Mythologies* (1957), and which has become a theoretical and analytical habit of semiology as a whole. The problem associated with this approach is that it privileges the role that representation plays in signification, even in its variant of representation through *code*, and generally neglects the pragmatic/subjective aspect of sign processes. For example Hall (1997: 21) claims that "the meaning is *not* in the object, person or thing, nor is it *in* the word... The meaning is *constructed by the system of representation*." One can immediately see that this approach privileges representation over other aspects of signification, as if construction of meaning excluded emotional, physiological and environmental constraints or its actual context of use. Hence one may argue that Hall's view tends to worry about the 'text in principle' rather than the 'text in practice.' Even the tedious ideological debate (cited by e.g. Fiske 1989 and Bignell 1997) about the active or passive status of readers or media audiences which was evidently conceived in the 1980s as a solution to the orthodoxy embedded in approaches to representation, ignores the fact that representation certainly influences the process of signification but it is very far from being the sole player in signification, or the only factor responsible for the construction of meaning. This chapter argues that such a process instead refers to organisms' capacity of building, subjectively, a *purely objective reality* (Deely 2009b; more on which below).

In *Mythologies* (1973a) Barthes introduces the concept of *myth*; that is, a collective representation of reality which in his view, is not a reflection of reality itself but a reflection of culture. In other words, myths are responsible for making 'culture' pass as 'nature' or for turning "the social, the cultural, the ideological, the historical into the 'natural'" (1977b: 165) For example, in discussing the myth of the Romans in films, Barthes states that "in Mankievicz's Julius Caesar, all the characters are wearing fringes. Some have them curly, some straggly, some tufted, some oily, all of them well combed, and the bald are not admitted, although there are plenty in Roman history" (Barthes 1973a: 26) In short, Barthes underlines the discrepancy between fiction (Romans with a fringe) and reality (Romans who must have suffered hair loss and thus no fringe). In 'Myth today', the final

theory-based essay of *Mythologies,* Barthes turns this amusing but simple observation into a complex academic argument. He does so by means of Saussure-inspired semiology, which according to Barthes enables myth to be broken into two semantic systems, a *connoted* system (where the signified is ideological) and a *denoted* system which through its apparent literalness, naturalises the class proposition (the ideology) contained in connotation (Barthes 1977b: 165). Barthes explains what he refers to as 'ideology':

> The starting point of these reflections was usually a feeling of impatience at the sight of 'naturalness' with which newspapers, art and common sense constantly dress up a reality which (...) is undoubtedly determined by history (...) I resented seeing Nature and History confused at every turn, and I wanted to track down, in the decorative display of what-goes-without-saying, the ideological abuse which, in my view, is hidden there (Barthes 1973a: 11).

According to this view, ideology is "what-goes-without-saying" something that appears real by means of its 'literalness', motivation or denotation, but that in truth is unnatural because "it is history which supplies its analogies to the form" (Barthes 1973c: 127). In other words, denotation allows 'bourgeois ideology' to "spread over everything and in so doing lose its name without risk" (1973c: 139). Hence denotation naturalises connotation and allows false, distorted representations of reality (e.g. the Romans in movies) to pass as true (the Romans in history). Even if Barthes claims that "myth hides nothing and flaunts nothing: it distorts; myth is neither a lie nor a confession: it is an inflection" (1973c: 129) one could still argue that through his work he constantly proposes the idea that the representation of reality as elicited by myths is *false*. Looking at this statement

> The (...) sign, the fringe of Roman-ness (...) reveals a degraded spectacle, which is equally afraid of simple reality and of total artifice. For although it is a good thing if a spectacle is created to make the world more explicit, it is both reprehensible and deceitful to *confuse* the sign with what is signified (Barthes 1973a: 27, my italics).

one can see that Barthes' worries that viewers of Mankievicz' s movie will inevitably confuse the false Romans with the fringe with the real Romans who may have not had the fringe, an anxiety which betrays his concern for the *falsity* of representation. One may argue in fact that through the concept of myth, Barthes takes complexity away from signification and turns it into a typical formal logic problem in which the analyst's job is to determine the True or False aspect of a final proposition (in this case, the cultural proposition elicited in representation). In so doing, Barthes reduces the whole process of signification solely to its representative aspect, a view that Cobley has dubbed as resting "at the surface level" of analysis (Cobley 2006b: 417) possibly because signification

amounts to more than just representation and does not explain why audiences/readers/human beings willingly and persistently allow themselves to 'get fooled' in watching movies which present false Romans or characters or settings that are equally fictitious. Hence by simply acknowledging rather than explaining the (false) statements embedded in representation, one could argue that Barthes' theory of myth is mostly descriptive and has little or no explanatory value.

This very fact has gone largely unnoticed by a number of Barthes' commentators who re-iterate Barthes' superficial approach to culture (resting on his un-Saussurean view of semiology as above) and who restrict the purpose of analysis to the 'unmasking' (that is, acknowledgement) of the false cultural propositions contained in myths, as suggested by Barthes' critical approach to semiology. For example, Goffman (1979: 27) implicitly refers to Barthes' nature-as-true and culture-as-false mythical categories when he states that "commercial pictures are in the main entirely posed, 'mere pictures', at best 'realistic'. But of course, the reality they presumably reflect distortedly is (...) artificial." Similarly, Vestergaard and Schrøder (1985) warn that advertisements are dangerous in that "the norm they propagate remains on a latent, 'natural' level, which means that the reader accepts the norm as unquestionable without subjecting it to conscious rational scrutiny" (1985: 143). These arguments recount both Barthes's idea of 'denotation' which makes 'connotation' appear natural or 'true', as well as the purely descriptive character of his theory which fails to explain why it is that readers may 'accept norms (if that is the case) as unquestionable'. Williamson (2002) goes as far as turning the superficiality of Barthes' approach into an overt analytical standpoint by stating that her purpose is in fact not to measure the influence of advertising, instead "I am simply analysing what can be seen in advertisements" (2002: 11). It is this approach to culture which overemphasises representation placing it above the other aspects of signification (e.g. social and biological context, where the social is a specific subset of the biological, more on this below) that makes semiology guilty of *text-centredness*[19], that is, overly concerned with the *text-in-principle* rather than the *text-in-practice*. Such a stake on signification stemming from a text-centric understanding of culture, does not just focus on the supposedly 'objective' features of text but also rests on Barthes' unfortunate conception of myth transforming

[19] This term is used by Cobley (2001a: 20) to qualify the type of critique that the philosopher Ricoeur lodges at Propp, Greimas and Levi Strauss for their attempts at 'dechronologising' narrative and reducing it to a series of paradigmatic functions. Essentially this may refer to the (structuralist) practice of conceiving texts in terms of structure alone instead of positing, at least, structure-in-context.

history into nature (1973c: 129) and thus on a concept of culture as an entity which is not only separated but also opposed to nature. Cultural analysis clearly needs to move away from such an unfortunate nature/culture opposition by means of a understanding of communication systems such as that proposed by Bateson's "pattern which connects all the living creatures" (2002 [1979]: 7) or by Sebeok and Danesi's extensionality principle which sees complex models (e.g. cultural models) as derivative of simpler ones (e.g. natural codes) (2000: 11). These views which see culture and nature as continuous to each other despite their differences in type, stems from a phylogenetic-homological understanding of systems (see below) which is clearly missing in semiology.

On the other hand, Kress and van Leeuwen mitigate Barthes' position and his commentators' attempt to turn semiosis into a True-False logic problem by underlining the role that the context of use of the text has on signification:

> A social semiotic theory of truth cannot claim to establish the absolute truth or untruth of representation. It can only show whether a given 'proposition' (visual, verbal or otherwise) is represented as true or not. From the point of view of social semiotics, truth is a construct of semiosis, and as such the truth of a particular social group arises from the values and beliefs of that group (Kress and van Leeuwen 2006: 156).

It is clear that by referring to a 'particular' social group, Kress and van Leeuwen conceive representation within specific cultural contexts, what they name the *social* aspect of semiosis. A cybernetic and biosemiotic view of semiosis (and information, as anticipated in Chapter 6 and expanded on below) could take a step further by not limiting itself to acknowledging the role of social context in validating a cultural proposition, but by evaluating the extent to which a semiotic model is *workable* for a subject set in social context. Such a context is in turn conceived in an evolutionary manner, and hence included within a larger *biological* (i.e. physiological and ecological) context.

Another text-centric approach to the study of culture in semiology is represented by the emphasis put on representation through *code*, an approach originating in Eco's *A Theory of Semiotics* (1976) and which has "become standard in the teaching of communications and media in English-speaking universities in the ensuing decades" through the work of Fiske, Bignell, Dyer etc. (Cobley 2012: 227). In the essay *Apertura, Informazione, Comunicazione* (2009 [1962]) Eco examines the code-based information theory embedded in Shannon and Weaver 1949's celebrated theory of communication because, as he states, he wants to measure the extent to which information theory models are applicable to aesthetics (Eco

2009: 96). However according to Eco, when envisaged within a semiological context, the information-theory's 'code' acquires the role of a "holistic phenomenon" (Cobley 2012: 227) which allows one to consider all the various links in the communication chain (source, transmitter, (technical) receiver, addressee channel, signal, noise, message), instead of looking only at source or message, as Barthesian approaches to culture do. (Eco 1986: 138) For example, in relation to a hypothetical situation in which Eco misinterprets a message in Morse code from his lover as "my husband is absent" instead of "my husband is here" and takes the wrong action of visiting his girlfriend, Eco (1986: 139) states "my [wrong] behaviour (with all the ensuing unpleasant consequences) is determined not by the form of the message or its contents according to the Emitting Source but by the code I am using." This observation has two implications: in Eco's code-based communication model the code that the *addressee* possesses is as important as that which the sender possesses (hence this observation becomes instrumental in giving importance to readership); and code in general acquires a privileged position in communication.

While Eco took care not to literally transpose information theory onto literature and aesthetics, so as to avoid reducing code to the sign-object referential function, a number of his contemporaries did not. Guiraud (1998 [1971]), in a Barthesian and thus un-Saussurean fashion, envisages code merely as a link between signifier and signified: "Codification is an agreement among the users of a sign: they recognise the relation between the signifier and the signified and respect it in practice" (1998: 25). Guiraud further argues that signification is codified (1998: 24), and identifies logic and poetics as codes. Though, ambiguously, his code-based semiology wipes away the cognitive constituent of emotions[20] when he states that "one could define emotion as an *incapacity* to understand: love, pain, surprise, fear etc., inhibit the intellect which is incapable of comprehending what is happening" (Guiraud 1998: 9, my italics). In a blander manner, Dyer (1982) puts forth a similar argument when she claims that "Codes make meaning possible. Codes and convention organise and release the meanings of a text in the process of viewing and reading" (1982: 116) and identifies code as the sole responsibility for the organisation of meaning, thus neglecting the motivational aspect of communication (that is, that undoubtedly one of the factors shaping the reception of a communication is one's particular inclination, experience, wish or desire in the past, present or future may be). In a similar but more problematic fashion,

[20] Paradoxically, (animal-focused) ethology has paid more attention than (human-focussed) semiology to the cognitive constituent of emotion, especially through the work of Konrad Lorenz (1971).

Bignell (1997) and Vestergaard and Schrøder (1985) encrypt semiology with the 'information transfer' concept of meaning, operating the literal transposition of mathematical models into aesthetics that was admonished by Eco. According to Bignell, meaning, like information is intrinsic to code since "the role of signs as members of code groupings means that many signs are heavily loaded with significance which comes from the code in which they are used." (1997: 10) The choice of the term 'loaded' indicates that Bignell's code-based semiology relies on an information transfer model as if meaning, like information bits, consisted of discrete units loaded by a technician who masters the codes into a message. Vestergaard and Schrøder are even less shy about this technical conception of meaning when they refer to "meaning transfer in advertising" (1985: 152).

In addition to such a naïve application of information theory to cultural communication, code-based semiotics is made faulty by its ethnocentric tendentiousness. For example, Fiske (1987: 4) replicates semiology's linguistic determinism in the form of code-determinism when he states that "the only way we can perceive and make sense of our reality is by the codes of our culture." Such a view not only reduces signification to decodification, but implies that the codes to be deciphered are exclusively cultural. On the other hand, in biosemiotics, theories such as von Uexküll's *Umwelt* (1940), Emmeche and Hoffmeyer's *Code Duality* (1991) and Sebeok's notion of *Primary Modelling System* (1988) have demonstrated that communication consists of natural 'codes' (nonverbal communication, all of which are difficult to figure as a fixed code). Human cultural codes rely on these codes. Thus, whether one believes that there are codes in nature and codes in culture, it still amounts to the same thing: that cultural codes are far from being the only repository for meaning in communications.

(d) Narrowing analysis towards 'unmasking' ideology

Glottocentrism, over-emphasis on both representation and code explains a fourth fallacy of semiology, that of *narrowing* analytical scope to the job of merely revealing ideology: that is, semiological analysis is limited to the unmasking of power relations inscribed in texts and ignores any other semiotic or informational relations that a text or a semiotic system can suggest. Barthes's idea of ideology as "what-goes-without-saying" in mythical representation and his critical yet anthropocentric and superficial analyses of culture have been widely adopted in Anglophone media theory (Cobley 2006a). The narrowing of semiology towards investigating ideology actually comprises two polarised approaches:

that of (1) the *denunciation* of ideology (through pious 'unmasking') and (2) the *justification* of ideology (through an orthodox concept of 'readership'). Approaches of type (1) which aim at unmasking the power relations hidden in representation have concerned literary texts (Barthes 1977c; Easthope 1991; Belsey 2002), popular culture in general (Hall 1980; Dyer 1982; Fiske 1989, 1990a) but also its specific forms of culture such as advertising (Goffman 1979; Jhally 1980; Vestergaard and Schrøder; Williamson 2002; Bignell 1997). Within a literary context, Barthes unmasks the myth of authorship by stating that "A text is made of multiple writings, drawn from many cultures (...) there is one place where this multiplicity is focussed, and that place is the reader, not (...) the author" (Barthes 1977c: 148). Belsey takes Barthes' unmasking approach further and nearly advocates conspiracy theory when she claims that representation (as a partial truth masked as coherence) is a strategy to reproduce the modes of production of capitalism (Belsey 2002: 53). In advertising, scholars reiterate Barthes' argument according to which ideology in representation passes as 'true'. Vestergaard and Schrøder claim that advertisements are ideological systems because they mediate dominant attitudes to history, nature, and so on, as if these false systems of ideas were instead universally true and valid (Vestergaard and Schrøder 1985: 152), whereas Williamson sees semiological analysis as instrumental in not "letting the 'ad' world distort the real world around the screen page" (Williamson 2002: 11). In visual communication, Kress and van Leeuwen bring a more neutral example of power relations being replayed through images/camera shots: "If a represented participant is seen from a high angle, then the relation between the interactive participant (...the viewer) and the represented participants is depicted as one in which the interactive participant has power over the represented participant..." (Kress and van Leeuwen 2006: 140).

A number of scholars also advocate the unmasking of the power relations hidden in representation through the help of Eco's notion of code. In this view, code would be the specific name for the representational conventions that re-iterate the power imbalance between producers and consumers of text. For example, in the context of popular culture, Hall argues that codes "are the means by which power and ideology are made to signify in particular discourses" (Hall 1980: 134). According to Dyer (1982: 135) "codes organise our understanding of the world in terms of 'dominant meaning patterns.'" Fiske (1987: 6) identifies one such 'dominant meaning pattern' which embeds a power relationship in the ideological code of patriarchy, that is, a representational convention by which women in television programmes are typically shown to lack knowledge. Similarly, in advertising,

codes are seen as instrumental to capitalism in that "consumption today is concerned with the 'systematic manipulation of signs' within the workings of a broader behavioural code" (Jhally 1980: 11) and because "'by nature ... [codes] are encouraging their readers to consume products, and consumption is one of the fundamental principles of contemporary culture, part of our dominant ideology" (Bignell 1997: 26).

Eco's notion of code, however, has also been central to those approaches of type (2) that aim at *justifying* ideology when this is conceived as a strategy that 'gives power back' to the readers of texts (instead of envisaging power as pertaining solely to industry text-producers). As anticipated earlier, through the idea that "the receiver transforms the signal into message, but this message is still empty form to which the Addressee can attribute various meanings depending of the Code he applies to it" (Eco 1986: 139), Eco privileges the codes of the addressee over those of the sender. Hence semiological contributions that built on this approach did not stop at uncovering the 'falsity of representation' but adopted an instrumental approach towards ideology-at-work-in-representation by underlining its 'constructive' or meaning-making function instead than its 'brainwashing' function. In the study of popular culture, Dyer (1982) and Fiske (1989), justify ideology as a means to conceive *readership* and *resistance.* Dyer notes the fundamental role of the individual reader in cultural signification in that "readers or spectators have actively to introduce cultural codes in order to interpret a sign by uniting signifier and signified."(Dyer 1982: 128) Fiske sees ideology as a repository for *cultural resistance* because by means of its excessiveness and obviousness, the popular text challenges the reader to constantly rewrite its own text in order to make sense of it. Thus ideology transforms the reader into a constituent of the active audience. As Fiske states, the 'vulgar' features of popular texts constitute the fertile raw resources out of which popular culture can be made (Fiske 1989: 114). This theoretical move which uses ideology as a device which harbours 'intelligent' reactions in readers, has allowed semiologists to level the playing field such that popular culture as an object is as worthy study as the texts that pertain to high culture. As McKee (2003: 105) explains, simply saying that popular culture is bad does not help to understand sense-making practices. In a similar, though reversed, fashion, in the literary context ideology allows scholars to 'downgrade' literary texts to the levels of popular texts (Easthope 1991; Belsey 2002) since both of them have ideology. For example, Easthope claims that "both literary and popular cultural texts operate through a system of signs, meanings arising from the organisation of the signifier, so both can be analysed in common terms" (Easthope 1991: 66). Similarly, Belsey argues that literature's sense-making

practices do not work very differently from those of advertising (2002: 46) and to support her claims recalls Althusser's view that literature is ideological in that it does not reflect reality but "all it can reflect is the order inscribed in particular discourses" (2002: 43).

However, what one can evince from these views is that by proposing a notion of readership that is intertwined with ideology yet also resistant to it, they ultimately rely on a very problematic notion of what ideology is. Such a 'problematic' approach is derived from the fact that 'ideology theory' as in Althusser's 'Ideology and ideological state apparatuses' (1971) has been borrowed without paying attention to some of its complexities. Approaches of type [1] which advocate the falsity of representation, fall victim to one problem in Althusser's statements, specifically that "Ideology represents the *imaginary* relationship of individuals to their real conditions of existence" (Althusser 1971 cited in McDonnell and Robins 1980: 165). Instead, as McDonnell and Robins convincingly contend, Althusser's very argument is vitiated by the idea of *falsity* implied in ideology, as they state:

> It reduces ideology to mere false consciousness. [...] Ideology is no false consciousness, because it duplicates a concrete reality, one that really does exist , one that imposes itself on the texture of everyday life. ... Nor is ideology, in this conception, immaterial, a mere epiphenomenon; it is an illusion, but one that is 'the most efficacious reality, the spell that holds the world bewitched' (Adorno)" (McDonnell and Robins 1980: 222).

Elsewhere, Althusser focuses on ideology as concrete reality but this statement of the importance of the 'imaginary' has been seized too readily by many who would use the concept of ideology.

In approaches of type (2), there is an exploitation of the 'falsity of ideology' as a positive factor in that "It is precisely the fictionality of the aesthetic text... that invites plural readings for it in a degree to which the referential text does not" (Easthope 1982: 129) and "by taking up film through the Althusserian concept of signifying practice... *Screen*... anticipated the widespread recognition that the reader should not be seen as 'a consumer, but as producer of the text'"(Easthope 1982: 126, citing Barthes). Indeed, Fiske argues (following Hall 1973) that when confronted with popular texts, which are supposedly high in ideological content, one can choose whether to produce "a preferred reading according to the dominant code", a "negotiated reading", or a "radically opposed reading" (Fiske 1990a: 187). In other words, Fiske argues that through the act of reading one can rebel against the repression exercised through ideology by (what Althusser calls) the ideological state apparatuses, in the very fact that readership implies 'subjectivity' and activity (rather

than passivity). However this view of the active reader can be deemed as an instance of wishful thinking in a faux Althusserian guise, and especially in view of his notion of the subject falling prey to ideology through *interpellation* (Althusser 1971: 162). Such an expression refers to an hypothetical situation in which, say, a policeman (representing the ideological state apparatus) shouts at a passer-by: "You, for whom I have shed this drop of my blood' /'Hey, you there!" The passer-by is then compelled to pay attention to, and reply, upon turning around: "Yes, it's me!" This vignette illustrates how the ideological state apparatus (the policeman) constitutes the subject, the individual whose identity (it's me! – self-recognition) has emerged at the same time in which the ideological act (the shout) was perpetrated. In fact, for Althusser' "ideology interpellates individuals as subjects" (Pêcheux 1982: 92) that is, ideology does not simply affect the subject, but *constitutes* the subject in the first place. As Pêcheux explains, interpellation

> ... designates, by the discrepancy in the formulation 'individual/subject', the paradox by which the subject is called into existence: indeed, the formulation carefully avoids presupposing the existence of the subject of whom the operation of interpellation is performed – it does not say: 'The subject is interpellated by Ideology'... In fact, what the thesis 'Ideology interpellates individual as subjects' designates is indeed that 'non-subject' is interpellated-*constituted* as subject by ideology (Pêcheux 1982: 106, my italics).

It follows then that, in Althusserian terms, the subject does not exist *prior* to ideology, but is constituted *by* it. In other words, ideology as the *lived* relationship to existence upon which Althusser insists, has a mythical starting point. Impinging on the same example, Fiske argues that one can 'resist' ideology in that "if you hear in the street a shout 'Hey You!', you can either turn in the belief that you are being addressed or you can ignore it... you thus reject the relationship implicit in the call" (Fiske 1990a: 175). However, conceiving the reader as a form of active audience that is active by the very means of being capable of resisting ideology is a view flawed from the start, because it presupposes that the subject exists and is as such (i.e. an 'active' reader) *before* its encounter with ideology. This is a contradiction, if indeed it is not the interested exploitation of an Althusserian loophole. In Althusserian terms, ideology cannot be resisted in that it is *constitutive*. That is, there is no such thing as an 'I' before the very call 'You', a perspective which puts a heavy burden on the workings of 'culture', 'nurture' and 'ideology' to sustain selfhood . Neglecting this fact amounts to a desire to take the most 'convenient' aspect of Althusser's Marxism (that authorities are repressive – the convenient aspect of this statement serving as a rationale for 'response', including 'reader response'), and neglecting the less convenient, that is, that

the human being's subjectivity is not as unconstrained as the politically-driven semiologist would like to think.

The grounding for a new form of cultural analysis

The implication of semiology's analytical scope being restricted to investigating ideology is that cultural studies posit power relations as the only cognitive system that frames human beings' meaning-making patterns. Such a politically-oriented disciplinary link is certainly one that is germane to the understanding of human cultural systems, but in semiology this disciplinary specialism has come at the cost of ignoring all the other interdisciplinary links that the study of culture may trigger. The *critical* (intended as human-political) function does not have to be the only scope of analysis since there are as many purposes of analysis as there are social systems: legal, scientific, artistic, religious, ethical; hence one may conclude that semiology's view of signification which privileges (human) power relationships over all the other semiotic relationships that texts may trigger, is a view that is certainly guilty of anthropocentrism but also one that severely limits the scientific purport of cultural analyses. Thus, a field such as 'British cultural studies' must broaden its analytical scope beyond that of investigating the power relationships 'hidden' in representation. Also, one may argue that even in the event of (political) criticism being the sole purpose of analysis, such a criticism needs to be carried on with better models than those offered by semiology, that is, within a semiotic 'proper' framework that is overall less *glottocentric, text-centric, nature-insulated* and *discipline-specific* than that proposed by Barthes and his commentators. In fact, as Barthes himself identifies in a reflection (that has often escaped his most slavish commentators) that he formulated 15 years after *Mythologies*, the scope of semiology must be expanded beyond the "pious show of unmasking of ideology" (Barthes 1973b: 9). This is because "Any student can and does denounce the bourgeois or petit-bourgeois character of form. Mythological doxa has been created. Denunciation, mystification has become itself discourse, stock phrases, cathechistic declaration" (Barthes 1977b: 166). Hence, Barthes continues, if "initially the aim was the destruction of myth. Now, [the aim is] the 'destruction of the sign'. 'Mythoclasm' is succeeded by 'semioclasm' which is much more far-reaching and pitched at a different level" (1977b: 167). In other words, Barthes invites semiologists to stop the activity of "critical decipherment" (1977b: 168) but to start to evaluate the scientific reach of semiological tools as a means for "accounting in detail for the mystification which transforms petit-bourgeois culture into a universal nature" (1973b: 9).

Cobley (2006: 371) explains the reasons for Barthes' shift of view on myth:

> Barthes' call for semioclasm came shortly after the formation of the International Association for Semiotic Studies in 1969, where semioticians such as Thomas A. Sebeok broadened the entire agenda of sign study by encouraging its application to the whole of life. Notwithstanding the experience of 1968, it cannot be a coincidence that Barthes moved away from mythoclasm at this point, even if he was not directly asking the really big questions that came to characterise international semiotics.

In other words, the IASS had a remit far more expansive than Barthes' (i.e. semiotics of 'everything') hence, Barthes changed his mind on 'myth'. As Cobley argues, this move was functional to Barthes' later "'retreat' into the text and writing" (2006a: 371), where he would continue advocating a hierarchy of readerly/writerly as an attack to realism. Although the current project does not espouse such a view in that in a seemingly opposite fashion it attempts to embrace a perspective which instead exposes 'the richness of realism', Barthes was right in at least on one instance, that is, that "semioclasm' as an "assault on the mechanics of meaning at the very level of the sign itself" (Cobley 2006a: 365) is an approach that must be an interdisciplinary one. As he states "Myth must be included in a general theory of language (...) and this theory, resting on the formulations of ethnology, psychoanalysis, semiology and ideological analysis must widen its object (...)" (Barthes 1977b: 169).

Thus in light of this statement in favour of interdisciplinary, one could argue for the necessity of envisaging 'semioclasm' within a general doctrine of signs as that elicited by C. S. Peirce. This is because, as argued below, Peirce' s semiotics pays justice to both the 'subjective' aspect of sign processes as well as their realist aspect, and in this sense it is an instance of "objective pragmatism" (Rescher 1995: 713).

Semiotics 'proper' and pragmatism

Responding to Barthes' invitation to carry on an interdisciplinary investigation of culture, and on the need to supersede the four faults of semiology as outlined above, this section provides a proposal for a new form of cultural analysis. This proposal is grounded a) in the *semeiotic* of Peirce as reworked by philosopher Deely, and b) in the cybernetic reading of biosemiotic theories as proposed in the body of this thesis (Chapter 3 to 5) and c) a transdisciplinary perspective, akin to that found in Brier's *cybersemiotics*, that envisages the integration of the semiotics and the biosemiotics-as-systems theory paradigms for the sake of a theoretical synthesis.

The grounding for a new form of cultural analysis must be conceived within a 'semiotic proper' perspective rather than a semiological one. As seen earlier, semiotics proper can be envisaged as the general doctrine of signs that has as its precursors the ancient Greek physicians, Poinsot, Locke, and Peirce. The difference between this older tradition of semiotics and 20th Century semiology is that 'semiotics proper' possesses a framework that, for the reasons that will be outlined below, accounts for the study of all signs, including verbal and nonverbal signs. In this respect, in proposing *Elements of Semiology* Barthes does try to account for nonverbal communication, but he has to distort Saussure for this purpose[21] while at the same time still promoting a type of analysis that is "susceptible to elucidation using broadly linguistic principles" (Cobley 2007: 45). Hence one may argue that since semiology has been perpetrated by linguistically-fixated thinkers such as Barthes, it can perhaps be deemed capable of effectively studying verbal communication, but not capable of accounting for nonverbal communication, since it does not possess nonverbal categories for this phenomenon. As shown, this fact has not been sufficiently taken into account by Barthes' commentators in Anglophone media studies. Hence in the attempt to provide an alternative to the semiological model (as already hinted at in Cobley 1996, and pursued in Cobley 2012b), one needs to outline the relevance of 'semiotics proper' for cultural analysis by (1) doing more justice than the semiologists did to Peirce's wider philosophical framework, and (2) by contextualising Peirce's semiotics within both a contemporary semiotics perspective such as that furnished by Deely, and (3) within a perspective grounded in biosemiotics-reworked-as-systems theory, as furnished by this thesis.

The 'semiotic proper' perspective analysed here is one that has been made relevant to the current historical time by the writings of Deely collected in *Realism for the 21st Century* (2009a). In *The Relation of Logic to Semiotics* (2009c [1981]), Deely traces the fundaments of Peirce's semiotics by underlining the difference between logic (upon which semiology implicitly relies) and semiotics. Quoting Fisch (1977: 36) he explains that:

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[21] Hence one can note that Barthes' view is inadequate from the point of view of Saussurean linguistics, but is at the same time too Saussurean or linguistically-fixate (e.g. resting on the bivalent principles as denotation/connotation, nature/culture, syntagm/paradigm) to the able to account for an effective study of communication systems of the living, which as Merrell put it, are fuzzy logical systems. As he states "This fuzziness reveals the need for a 'logic' of a broader scope than bivalent principles, although this more encompassing 'logic' must incorporate bivalent principles as a subset" (Merrell 2010: 122-123).

> (...) Peirce from the beginning conceived of logic as coming in its entirety within the scope of the general theory of signs (...) for a time in his fifties he distinguished a narrow and a broad sense of logic, in the latter of which it was coextensive with the general theory of signs (...) eventually he abandoned the narrow sense.

According to Peirce logic is only a narrow part of semiotics or, as Peirce originally put it, a subclass that worries specifically about "conditions of the truth of representation" (Peirce 1955b [1897–1903]: 99). Because any approach that relies on logic, even if implicitly, worries about the "conditions of the truth of representation", it is no surprise that semiologists have limited cultural analysis to investigating ideology, that is, the (obvious lack of) truthfulness of representations found in media texts. Instead, unlike logic in the narrow sense, Peirce's semiotics is underwritten by the *quasi-necessary* (Peirce 1955b: 98) logic of *abduction* (Peirce 1955a: 304) which does not solely worry about the truth conditions of a reasoning process (as in semantics) nor even just about its formal coherency (as in formal logic or syntactics), though it obviously include them as their subsets, but it is also concerned with function and context of communication (its workability in a context, as in Morris' pragmatics) but also its degree of realism (its accuracy). Indeed Peirce's semiotics is irreducible from his wider stance of *philosophical pragmatism*[22], a stance that promotes 'realism' and which Peirce himself renames as 'pragmaticism' (Peirce 1955e [1906]) to distinguish it from William James' (1907) subjective pragmatism[23]. Ensconcing Peirce's semiotics within the tradition (started by him) of philosophical pragmatism is vital in order to understand the essence of the difference between semiotics and semiology. However, to stress semiology's excessive reliance on logic more forcefully and to indicate how semiotics supersedes it, one has to define more clearly what Perceian pragmatism is, and how any definition can contribute towards novel guideline for cultural analysis.

In *The Essentials of Pragmatism* (1955d [1902-1905]) Peirce defines his philosophical stance as follows "What distinguishes [pragmaticism] from other species [of philosophy] is,

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[22] A fact that as underlined above, has gone unnoticed to semiologists.

[23] Rescher effectively describes the difference between Peirce's pragmaticism (realist pragmatism) and James' (subjective) pragmatism "There is a pragmatism of the right, a Peircean or objective pragmatism of 'What works impersonally'... . And there is a pragmatism of the left, a Jamesian or subjective pragmatism of 'What works for X' in proving efficient and effective for the realisation of a particular person's (or group's) wishes and desires. The objective pragmatists stand in the tradition of Peirce and include F. P. Ramsey, C. I. Lewis, Rudolf Carnap; the subjective pragmatists stand in the tradition of William James and include F. C. S. Schiller and Richard Rorty. (John Dewey straddles the fence by going for a social interpersonalism that stops short of impersonalism)" (Rescher 1995: 7127).

first, its retention of a *purified philosophy*; secondly, its full acceptance of the main body of our *instinctive belief*; and thirdly its strenuous insistence upon scholastic *realism*" (Peirce 1955d: 260, my italics). One may argue that the same cornerstones of Peircean pragmatism, must also remain in force for any semiotic perspective taken on communication, including of course, cultural communication. Hence the outlined philosophical cornerstones of pragmatism such as *Firstness, Secondness* and *Thirdness* (in the guise of a 'purified philosophy'), *abduction* (in the guise of 'instinctive belief'), and *biological type* (Deely 2009b) or *cybersemiotic* (Brier 2008) constraints (in the guise of 'realism') can help us formulate new guidelines for cultural analysis i.e. (a) substituting 'interpretation' for *modelling,* (b) substituting 'representation' for *purely objective reality, and* (c) substituting 'motivation' for *cybersemiotic* constraints. The justification for such a proposal is as follows.

Exchanging 'interpretation' for *modelling*

To delineate the grounding for a new form of cultural analysis one needs also to dispense with the concept of 'interpretation' in favour of the more precise concept of *modelling* (a mathematical term, utilised in the context of semiotics by Lotman 1967, Anderson and Merrell 1991, and revisited by Sebeok and Danesi 2000). This proposal is inspired by Morris who in his work proposed to dispense with the concept of 'meaning' because it was too unscientific (2010 [1946]: 171). In fact, 'modelling' implies a *structural* and *phylogenetic* outlook on systems that 'interpretation' does not possess, and as such it is more suited to the scientific-systematic study of communications.

In semiology, 'interpretation' has been conceived in a contradictory manner; that is, either deterministically or in an indeterminate manner, the former view figuring interpretation as an instance of "meaning transfer" (Vestergaard and Schrøder 1985), the latter view considering it as a rather shapeless free reading activity, as in Barthes's observation that there are as many texts (that can be extrapolated of a work) as there are readers (Barthes 1977b). The first view stems from the straightforward (naïve) application of Shannon and Weaver's mathematical communication model, which implies 'information transfer' in technological communication, to biological and human communication. The limits of the application of the information-transfer model to biological communication is a well hewn problem that has been effectively tackled in the sciences (for recent critiques see second order cyberneticians, as well as Brier 2008). But given its recurrence in semiology, one may

argue that it has not been tackled enough in the humanities. On the other hand, the problem regarding the 'limits of interpretation' as raised by the second view, is far from closed. That interpretation is not an unconstrained informational activity has been underlined by Jackson (1991) and by Eco (1992). According to Eco, the limits of interpretation lie in semiosis being a process constrained by a certain *ground* or a given context (2006 [1992]: 28), in other words, 'reality', whose "thought or opinion... must therefore belong to a community of knowers" (2006 [1992]: 40). Along the line of Eco's argument one may argue in favour of stressing the 'limits' of semiosis; however, in contrast to Eco's argument, in this thesis semiosis is conceived as encompassing all organic phenomena, hence such limits (even when these apply to culture) must include biological constraints. It is proposed that such an objective may be reached by substituting the term 'interpretation' with the term 'modelling'. This is because modelling, unlike interpretation, furnishes analysis with precise 'scientific' categories (transdisciplinarity, history, function), for the understanding of communication. These categories make possible the link between the philosophical aspect of Peirce's pragmatism (his philosophical categories) and this project's thesis 'biosemiotics-as-systems theory'.

The term 'modelling system' supersedes 'interpretation' on the grounds of precision because it argues more explicitly in favour of the *structural* aspect of signification, that is, that the activity of producing forms (modelling) relies on *patterns* of production that can cut across nature and culture (hence the transdisciplinary aspect of modelling). Because these patterns possess a 'structure', they can be considered 'systems' (i.e. a set of elements and their relations) or more specifically, 'modelling systems', identified by Lotman as "The structure of elements and of rules for combining them that is in a state of fixed analogy to the entire sphere of an object of knowledge [...]" (Lotman 1967 cited in Sebeok 1991b [1988]: 50). Owing to the notion of modelling system put forth in Tartu semiotics, Sebeok and Danesi (2000) distinguish between Primary, Secondary and Tertiary Modelling systems as a means to categorise instances of nonverbal communication, verbal (and by extension, technological) communication, *and* cultural communication. Sebeok and Danesi posited that the structural aspect of each modelling system can be investigated in terms of singularised, composite, cohesive and connective forms (2000: 20-43). Hence, by proposing at least twelve types of forms (or signs-systems), Sebeok and Danesi provide a framework that would allow an analyst to map (devise the structure of) instances of culture more precisely than the single linguistic sign proposed by Barthes, or the three sign types

(index, icon and symbol) proposed by the media-semiologists who tried to link Barthes' version of semiology with a surrogate of Peirce's semiotics.

Furthermore, as demonstrated in Chapter 5, biosemiotics reconfigured as systems theory posits that communication has to be understood not as the modelling of static systems but as the modelling of *homological* systems. According to this view the 'patterns' of production of forms (the conditions for communication) are to be situated in history. Hence the term 'modelling system' is superior to 'interpretation' also on the grounds of historical precision because it foregrounds the historical aspect of modelling (as also originally carried out by Lotman), and therefore argues more explicitly in favour of the phylogenetic and evolutionary aspect of communications. As Wendy Wheeler (2012) expressed once in a talk "nothing comes from nothing, patterns are repeated. Culture comes from nature." In other words, 'modelling' helps one to conceive communication as a continuous, evolutionary phenomenon that in being present in all living beings, links nature to culture. This is the view embedded in Sebeok and Danesi's Modelling Systems Theory (2000), whose extensionality (that is, fundamentally phylogenetic or historical) principle suggest that modelling systems are *derivative*, or phylogenetically connected to each other, i.e. the primary modelling system (nonverbal communication plus a sophisticated capacity for cognitive differentiation) is the precondition for secondary modelling system, whereas this latter (verbal communication) is the precondition for the tertiary modelling system (cultural communication). Hence, the framework proposed by Modelling Systems Theory does not only provide the tools for a structural-synchronic understanding of cultural history, but for an historical understanding, since each modelling system is logically connected to the other by means of historical derivation.

What is also peculiar about Sebeok and Danesi' s approach to modelling systems is that they identified that Primary, Secondary and Tertiary modelling systems correspond *grosso modo* to Peirce's Firstness, Secondness and Thirdness. De Waal (2001: 17,18) helpfully explains that Firstness is "any simple and positive quality of feeling", Secondness is "the object purely in virtue of it being opposed to, or connected with, another object", Thirdness "involves mediation". This definition allows one to graft onto cultural instances identified as primary, secondary or tertiary models Peirce's philosophical categories of knowledge: that is, *feelings, brute facts* or *laws.* One may deem this attempt at casting 'modelling' within the wider context of Peirce's philosophical categories of knowledge to be a much wider approach than that proposed by semiologists who reduce signification to

a *straightforward* act of 'interpretation of representation' (as exemplified by Vestergaard and Schrøder's 1985 expression of "meaning transfer") or to an *incommensurable* act of interpretation where tracing the historical character of communication is a futile enterprise as in Barthes (1977d: 160) "to try to find the 'sources', the 'influences' of a work, is to fall in with the myth of filiation; the citations which go to make up a text are anonymous, untraceable..." When biosemiotics is conceived as systems theory, the historical-phylogenetic aspects of cultural models and the way these map onto Peirce's categories need to be put at the centre of cultural analysis.

To account for these theoretical points into practice, one can argue that envisaging 'modelling systems' as other than 'straightforward' or 'incommensurable' intepretation is beneficial to cultural analysis as it allows the formulation of a blueprint for analysis. One could say that the structural-historical perspective opened up by 'modelling' allows an analyst to posit that in light of the continuity of systems, the *difference in kind* amongst systems has to be fundamentally envisaged within a *difference in degree*. That is, the phylogenetic aspect of modelling systems would allow the analyst to preliminary identify what Bateson would call *phylogenetic homology* that is, the "pattern which connects nature and culture." For example, if one was to analyse a digital media cultural phenomenon such as the rise and fall of a cyberpunk virtual community, the phylogenetic aspect of modelling systems theory would allow one to trace the community's participatory aspect to instances of biological self-organisation. Under this light, the difference between natural communities and cultural communities is primarily a *difference in degree*. But, also, the historical perspective taken on technology would allow one to conceive the *difference in degree* between old forms of technology and new technology in a manner that takes into consideration *remediation* (Bolter and Grusin 1999). In other words, that new media is old media *reframed*. However, as Anderson and Merrell put it (1991), the modelling of micro- and macro-evolution involves both continuity and discontinuity. However, because such a perspective privileges evolution over ontogenesis (Anderson 1992), then one may argue that discontinuity (e.g. technological novelty) can only be conceived within the wider framework of continuity (remediation). Hence the phylogenetic aspect of modelling systems would allow the analyst to also account for the *difference in kind* of the community in respect to pre-Internet cultural communities, to early-internet virtual communities (web 1.0, that is, Internet in the 1990s) and to contemporary web 2.0 virtual communities. So, understanding continuity does not exclude novelty. And it gives primacy to the former aspect of systems – in other words, difference in kind of systems (novelty) can only be

appreciated within a difference in degree (continuity). On the other hand, the structural aspect of modelling systems allows one to identify the different levels of (as in Peirce's categories) semiotic constraints: feelings, brute facts, laws. Each modelling system in fact works under these constraints. In the realm of culture these constraints could be understood as *emotions, technological framing* and *cultural conventions*, and they would constitute the levels of signification that sustain a community. By means of its grounding in biosemiotics this framework would also allow the analyst to map those instances of nonverbal communication, in addition to the verbal component, that contribute to shaping virtual communities, such as the *orienting* aspect of users' behaviour and, obviously, the collective aspect, grounded in self-organisation, that digital culture phenomena display when looked at structurally. So, the framework has a myriad practical applications for the social sciences.

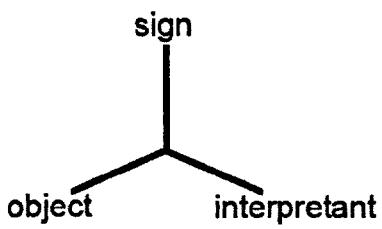
Dispensing of 'representation' in favour of *purely objective reality*

Now that the implications of the structural and historical aspect of modelling for cultural analysis have been raised, one needs to explore the implications of the *functional* aspect of modelling for analysis. This aspect is explored here in terms of the 'instinctive belief' or the *abductive* (see Chapter 5) part of pragmatism. It is argued that a pragmatic framework for cultural analysis needs to substitute the concept of 'representation' in favour of the more encompassing concept of *Purely objective reality* (Deely 2009b).This is because 'purely objective reality' implies a pragmatic understanding of signification that is not solely concerned with the 'conditions of truth of representation' (as semiologists do when attempting to uncover the 'falsity' of representation) and thus with the text-in-principle, but also with the 'workable' aspect of signification, even when this elaborates on (logically-speaking) false premises. As such, this view is more suited to the study of the texts-in-practice that characterise communication and is capable of accounting more fairly for the reasons why people 'enjoy' media texts, even the ones eliciting the most improbable or perhaps, morally problematic, representations of reality.

As shown, semiological approaches reduce signification to its representative aspect. However, by also conceiving representation, in turn, as 'false statements about reality', semiologists create a 'trap'-like situation from which the reader can never escape, i.e. readers can only absorb information about reality through representation, and representation is not 'true', hence signification merely consists in having false pictures of

reality. One can see how this thinking not only takes complexity (and pleasure!) away from signification but also relegates the status of semiotic information to that of a 'true' or 'false' formal logic problem. This ill-conceived practice implies that sign-analysis amounts to a simple exercise that consists in determining the false or true aspect of the cultural propositions (information) elicited in representation. Instead, to give a fairer picture of signification, one that rests on 'semiotics proper' rather than semiology, one must consider signification within the framework offered by Peirce' s triadic model of sign-process (1955b: 99) as reworked by Deely in the essays that make up *Realism for the 21st Century* (2009a). Specifically, it is argued that Deely's distinction between 'thing' and 'object' (1981) [24] and his notion of *purely objective reality* (2009b) constitute the grounding for a new form of cultural analysis in that, by relying on 'instinctive beliefs' which can at times be illusory but still efficient, it suggests that 'workability', in addition to 'accuracy', is an important feature of signification. This claim is justified as follows.

Let us therefore consider how Deely reconfigures objectivity. For the sake of simplicity, let us accept a 'traditional' notion of objectivity within the context of semantics, the field that studies the correspondence of the content of a proposition with reality. Following this view, an objective or *true* statement would be something whose content is coincident with reality, whereas a non-objective or *false* statement would be a statement whose content does not match reality. Deely reconfigures this notion through Peirce's triadic model of the sign, conceived as a unity emerging from the irreducible relations among *representamen (*or sign-vehicle), *object,* and *interpretant (*or meaningful reaction) (Peirce 1955b [1897–1903]).



[24] I have previously utilised this contribution from Deely has as a means to find a middle path between the formal and constructionist views of information that one can find in first order and second order cybernetics (see Cannizzaro 2012a). The reason why Deely's contribution is also used in this section is that his 'thing' and 'object' ontology could prove to be a solution for all those debates which end up discussing subjectivity or objectivity in terms of the true-false logical dichotomy, as found in semiology.

Fig. 1 Peirce's triadic sign model

As illustrated in Fig. 1[25], Peirce's definition of the sign holds that "a sign, or *representamen*, is something which stands to somebody for something in some respect of capacity" (1955b: 99). To introduce 'objectivity' in this model, Deely brings in Peirce' s example of the thermometer whose mercury line reacts to an increase in warmth in a room and rises (2006: 31). When considered by itself, the rise of mercury brought about by the increase of ambient warmth is a cause-effect dyadic interaction. However, when somebody or thing is there to register the rise of mercury, there is a triadic (or semiotic) interaction of sign, object and interpretant. Thus, when semiosis takes place, or, when a dyadic interaction enters some field of experience, the warmth of the environment from being a *physical* thing, becomes the *known* thing, or a personal element of experience or *object;* the *rise of mercury in the thermometer* becomes a *'sign'* of the warmth of the environment; the *increase of ambient temperature* becomes the 'interpretant' of the rise of mercury interacting with the environment-object. What is really important here is the distinction that Deely makes between 'thing' and 'object'. According to this distinction, a thing is that which exists beside being known; it constitutes 'mind-independent reality' and reflects a physical situation. In Peirce' s example of the thermometer, the 'thing' is the state of the thermometer "prior to being read.. involved only in dyadic interaction" (Deely 2006: 31). On the other hand, when an organism comes across a thing, an informed 'object' is generated. Objects amount to 'mind-dependent reality'. In explaining what is the 'object', Deely (2006: 31, my emphasis) states that

> on being read [cf. the thermometer] a third factor enters in, the factor of interpretation. The thermometer on being seen may not be recognised as a thermometer: in that case, besides being a subject of physical interactions, that is to say, a thing, it becomes also a cognised or known thing, and element of experience or *object.*

An object is therefore defined as that which is *known* or *seen* at the very basic level of experience, without necessarily having been recognised or named. Thus *experience* is, at roots, what distinguishes an object from a thing. One could also say that 'objective' means 'experienced'.

[25] This figure and the next figures depicting Deely's ontology being grafted onto Peirce's triadic model of the sign, follow the pictorial convention set by Floyd Merrell, who effectively illustrates Peirce's triadic model by means of a 'tripod' (Merrell 2010).

Because an interpretative judgement – the process of forming an interpretant – may be based on a 'thing' or merely on an 'object', one can characterise the *quasi-necessary* nature of the interpretant, that is, "a more developed sign" (Peirce 1955b: 99). This is because the rise of mercury in the thermometer (the sign) signifies a rise in ambient temperature (interpretant) in any case, whether the thermometer gives a correct reading (or points to a thing, an actual or physical state of a situation) or is instead malfunctioning and gives an incorrect reading (or points to an object, an element of experience that however does not correspond to physical reality). In the latter case, the interpretant is based on error. Therefore, as Fig. 2 and 3 shows, there can be two cases that describe an interpretant:

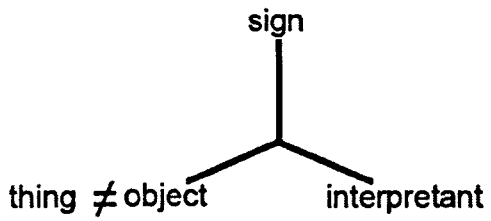


Figure 2. The interpretant is objective but *not* physical

The first case (Fig. 2) is a situation in which a generated judgement or an interpretant is objective *but not* physically true, or directly capturing a 'thing'. The reason being that the object upon which it is based does not correspond to a thing or the actual state of affairs of the environment. The second case (Fig. 3) is a situation in which an interpretant is objective *and* physically true, that is, when the object upon which it is based *does* correspond to a physical thing.

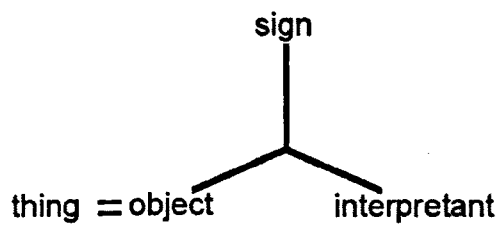


Fig 3. The interpretant is objective *and* physical

Here, the interpretation of a dyadic interaction or an event is accurate and relates to what has actually taken place. As Peirce states, "*some* general objects are real" (Peirce 1955d: 264).

Hence, given the thing/object distinction, one can see that an interpretant can rest on a true premise (when the object corresponds to a thing) or on a false premise (when the object deviates from a physical situation). In other words, in a 'semiotic argument' a truth condition may not be satisfied for a number of reasons (the loss of accuracy of the symmetry between thing-object) but an interpretant (arising as a relation between sign and thing-that-becomes-object) will still form. The semiotic process that gives rise to an interpretant is grounded in abduction or the inferential process whereby one forms hypotheses about the state of reality that can be true, but also false, in other words, can have different levels of accuracy (see Chapter 6). What is relevant of abduction to this discussion is that whatever the 'accuracy' state of the hypothesis, by means of coming alive, the interpretant (brought about by abduction) will always constitute an element of experience, hence will still be (semiotically) legitimate or *valid*. In fact, as Peirce states "... in every fallacy, therefore, possible to the mind of man, the procedure of the mind conforms to the formula of valid inference" (Peirce 1955c: 231-232). Hence, whatever the values of the premises, in semiotics *an interpretant is always objective,* or experienced, and thus, in a sense, 'real'. This 'experienced' reality Deely (2009b: 342–344) calls *Purely objective reality.*

More specifically, Deely argues that "Fully actual objectivity arises only when and in the physical interaction of two or more physical substances one at least of the interactants is an animal (...)"(2009b: 343), in other words he stresses the central role of animal experience in constituting 'purely objective reality'. Therefore because of its embodiment within experience, an interpretant always 'makes sense' and always provides a *workable* picture of reality. The interpretant has to be considered in light of its 'workability' because, as Peirce states, "not only may generals [Deely's object] be real, but they may also be *physically efficient*, not in every metaphysical sense, but in the common sense acception in which human purposes are physically efficient" (Peirce 1955d: 264). For example, it does not matter that zombies do not exist. One can still 'experience' them through a movie, establish a meaningful (objective) relation with the clearly 'false' zombie-object and then be afraid (interpretant) of zombies as if they were a real thing. That is, the zombie-reality that one has formed is a 'workable' (purely objective) picture of reality, despite its absurdity (or low degree of 'accuracy'). Moreover, as Sebeok (cited in Cobley 2010d: 3) put it "it makes sense for everyone why Sebeok's description of semiotics was not 'the study of signs' but 'the study of the difference between illusion and reality"[26]. Thanks to Deely's thing/object distinction, one may argue that a text 'works' even when it is based on false or

[26] Personal email communication.

fictitious representation of reality. This is because "a fictitious relation is not real but is still a relation" (Deely 2009b: 336), and "relations depend upon a fundament, and this fundament is a modification of subjectivity" (Deely 2009b: 339). The argument granting semiotic legitimacy to the objective/fictive reality that a living being creates through the experience of semiosis can be supported also by Peirce's (1955d: 268, my italics) provocative statement that:

> The two words *real* and *fictive* bear no signification whatever except as marks of *good* and *bad.* But the truth is that what they call bad or fictitious, or subjective, the intellectual part of our knowledge, comprises all that is *valuable* on its own account, while what they mark as good, or real, or objective, is nothing but the pretty vessel that carries the precious thought.

Here Peirce clearly suggests that what is subjective or fictitious is valuable, but he also seems to suggest that what appears real or objective simply because it has been 'verified' or 'adjusted' (as semiologists would attempt to do of representations) is not enough to account for what becomes 'relevant' to a subject in signification

The *functional* (intended as abductive-adaptive) aspect of purely objective reality, even in the event of this being 'illusory' or resting on false premises (e.g. ideology), is the reason why it is not enough to look, as semiology does, at the 'accuracy' of signification – conceived, hence, solely as representation – that is, at the *text-in-principle*. This view does not take into account that *all* the reactions of man as a semiotic being to reality are 'workable', in that they are subject to a pragmatic process (abduction at work in a context). It is argued that a view that, instead, emphasises the pragmatic dimension of signification, as that proposed here, is more suitable for investigating the *text-in-practice*. Such a view would imply that by means of their potential to generate an interpretant, semiotic relations are involved with changes in subjectivity, as Deely (2009b: 339) puts it "relations depend upon a fundament, and this fundament is a modification of subjectivity". Perhaps this suggests that reactions to texts forcefully constitute a human being's purely objective reality well *before* the truthfulness of such texts is put under scrutiny by the subject itself.

This fact can be illustrated by the following example. I have shown for a few years in class during a 'reading media texts' workshop, a short Walt Disney motion picture movie called *Der Führer's Face* (USA, 1942). This clips see Donald Duck having a nightmare in which he is in Nazi Germany and forced, with other people, to work "48 hours a day for the Führer" in a factory, producing bullets, taking vacations from work by enjoying an Alps poster for a

few seconds, and eventually collapsing through overwork. The clip was shown 1943 in theatres but it was "released on the 'Disney Treasures on the front lines' DVD for the first time since 1942" (IMDB 2012). One can assume that the clip has fallen out of general circulation after its original theatrical release because propaganda movies of this kind, which identified a clear enemy, were not needed after the war. Given its American-propagandist context and its presentation of America's enemies through grotesque racial caricatures of Germans, Italians and Japanese, this clip may appear problematic for today's audience. Interestingly, students, when asked whether they would allow or deny access to this movie on public broadcast media *today*, gave mixed replies, mostly agreeing that the content of this media text is 'racist', and some arguing that it should be banned for good, even from YouTube. However, such an orthodox thought does not explain how it is that during projection, the 'racist' motion picture has triggered continuous laughter and a sense of unalloyed delight on the side of the students that one would hardly ever obtain in class upon showing more 'orthodox' media content. So, this example brutally suggests that, in signification, emotions come first (Peirce's Firstness), brute facts or the material that consolidates the emotions come second (Secondness), and logical thought comes after (Thirdness). This is in clear contrast with Barthes who, in *The Rhetoric of the Image* (1977a), argues that connotation (so-called 'cultural factors') comes first, and then at a second remove, the audience works out denotation which then 'naturalizes' the connotation. One could say, in fact, that Barthes uses connotation to contain both Firstness (emotion) and Thirdness (culture) responses, with denotation as the brute facts of Secondness. In effect, Barthes conflates the cultural factors with the 'pre-cultural' factors', and in so doing he waters down the importance of emotions for signification by simply collapsing them into cultural connotations. This is possibly the reason why attempts to account for signification in semiology have started from representation (the text in principle), rather than starting with emotions (the text in practice). However, as Cobley (2010f: 24) suggests, "research into specific instances of semiosis thus needs to be underpinned by a general theory of semiosis which figures motivation and interest in any living objects under investigation and in the living beings carrying out the investigation." This reflection and the above example suggest that a new form of semiotic analysis may need to take into account emotions *before* focusing on (the falsity of) representation, or at least acknowledge the role of emotions prior to and separate, as well as within, representation.

The narrowness of semiological approaches to signification is the reason why Cobley argues that "what contemporary semiotics demonstrates, bluntly, is that interventions for change

at the level of discourse alone are the equivalent of a gnat biting an elephant." (Cobley 2007: 47) In this respect, cultural analysts' attempts at providing fairer, less racist, less homophobic media representation (McKee 2003) certainly constitute an honourable intent, but it remains one that rests on the narrowly-conceived conception of signification (the text in principle) hence it is at risk of being an instance of wishful thinking rather than a theoretically-sound intervention. A more theory-wise approach would acknowledge, rather than dismiss 'as wrong', what is 'valuable' or 'workable' for the readers of media representations, even in the very likely event that what is 'workable' may be 'false' or inaccurate, logically speaking. In other words, if one wants to investigate tangible (and not wishful) 'changes in subjectivity' as Deely puts it, or *the text in practice*, one must instead start with the 'purely objective reality' of a subject, that is, the merely objective or the 'logically-illegitimate but semiotically-valid' reactions of subjects to texts. This is tantamount to taking seriously the reaction of laughter in response to stereotypical or racist representations. In analytical practice, rather than limiting the analytical scope to acknowledging the truthful aspect of representation and acting on representation alone, a cultural analyst must look at the *whole* text-subject interaction by looking at how emotions arise in this interactions *before* analysis of the content of text alone is put forward. In other words, an analyst must start with emotions (firstness) considered as *hypothetical conclusions* of an abduction, and then, if one wants to explain how the overall interaction works, 'test' these, that is, trace them back to, representation (thirdness). Let us not forget that as Peirce states that "The only justification of an inference from signs is that the conclusion explains the facts." (1955c: 229) Hence the best way to explain the facts – i.e. the text-organism interaction – is by starting from its conclusion, even in the event that such a conclusion consists in *emotions*. This back-to-front approach might seem counter-intuitive (especially to a semiologist). Why would it not? To answer this, let us turn to why we migh favour this trajectory of thinking.

Recasting 'motivation' as *cybersemiotic* constraints

Along the line of Cobley's argument according to which "semioethics requires a replacement of the overvaluation of the optimism of the will with a more penetrative pessimism of the intellect... [that is] theoretical anti-humanism" (2007: 60), it is argued that a new form of cultural analysis must abandon the concept of 'motivation' in favour of the more rigorous concept of *'cybersemiotic'* constraints. This original approach is so because 'motivation' implies that the only constraint to semiotic relations is free will (effectively:

none), whereas one can instead argued that the information constructed through modelling is constrained by what Deely calls 'the biological type' (Deely 2009b: 343), which in turn one may name following Brier (2008) as *cybersemiotic* constraints. The relevance of cybersemiotic constraints for the analysis of culture is that they allow the analyst to envisage *physiological* and *ecological* contexts in addition to social, historical and intertextual contexts already identified as framing cultural understanding. This enlarged strategy suggests a way out of the nature/culture divide that has characterised semiological theory and analyses.

As has been seen, abductive logic, or semiotics, does not just concern itself with the truth conditions of a reasoning process (as in semantics) nor even just about its formal coherency (as in formal logic or syntactics), but is also concerned also about its function, or its place in a *context* (the pragmatic side of reasoning). However, what is context? Elsewhere (Cannizzaro 2012b) I have referred to context through Kress' notion of *motivation* (1993); however, in a biosemiotics *as* systems theory perspective one should refer to context not as 'motivation' but as *cybernetic constraints*. To argue in favour of this switchover, let us identify the reasons that vitiate Kress' notion of context.

Kress's argument takes a position on a long-standing debate in semiology on the nature of the relation between signifier and signified. Saussure (1983 [1916]) in fact argued that within the context of *la langue*, such a relation is 'arbitrary', whereas Benveniste (1970 [1949]) demonstrated that it is 'necessary'. Semiologists have typically taken a position that mediates between the two sides of the debate. For example, by means of reference to Peirce' semiotics, Fiske (1990b: 46) explains that Saussure's followers recognised that the physical form of the sign [signifier]... and its associated mental concept [signified]... can be related in an *iconic* or *arbitrary* way. Coupled to this simplistic solution to the necessary-arbitrary linguistic debate, Kress argues against the arbitrariness of sign relations altogether in favour of necessity, which he calls 'motivation', by bringing the example of a three and a half year old child who drew seven uneven, ugly circles of different sizes on a piece of paper and said "this is a car". Kress argues that the child's drawing, taken as sign, has been 'motivated' by the object he observed and by his context of observation, that is, "his place in the world, physically, cognitively, socially, culturally, conceptually." (1993: 72) However, as Cobley shows, such a *sociosemiotic* position is ill-conceived because it suggests that "the relations of motivation between signs and their users is supposedly subject to an act of will" (Cobley 2007: 51). In other words the term 'motivation' may dangerously support "the

humanist imperative in respect of signs... [which] re-casts motivation as an entirely voluntarist affair." (2007: 51) Instead, as Cobley underlines, although "Althusser does suggest that humanism has its uses... he is absolutely forthright about the need for absolute anti-humanism in theoretical work of the kind semioethics might be taken to be." (2007: 52) Hence, although I personally have used this (Cannizzaro 2012b) to refer to context in an anti-humanist sense, I also wish to argue for the necessity of substituting it for a less anthropomorphic notion of context, conceived broadly as the perspective suggested by Brier' *s cybersemiotics* (2008) and specifically by this thesis' cybernetic understanding of biosemiotic information.

Before discussing the constraining aspect of cybersemiotic information, one has to characterise the *realist* stance of such a concept as well as its *biological* stance. This is because when considered within Perceian semiotics, the two stances – realism and biological knowledge – are mutually inclusive. Peirce's 'scholastic realism' (as adumbrated above) consists in conceiving that there is a reality that is independent of human and animal experience of it. As he states, the sense in which the pragmaticist uses the world 'real' is "that is real which has such and such characters, whether anybody thinks to have those characters or not." (Peirce 1955d: 264) Indeed, "The usefulness of some signs... consists in their being connected with the very thing they signify" (Peirce 1955c: 234). Hence, a 'workable' purely objective reality, by means of being formed by sign-relations (and abduction), is realist, i.e. constrained by reality. In this picture, 'abduction' can be a tricky term because it allows one to argue that a purely objective reality results from the emergence of feelings. However such feelings are not to be conceived as the result of free will but as a (complex) reflection of *reality*. As Peirce argues "so far as the sensation is a mere feeling of a particular sort, it is determined only by an inexplicable, occult power; and so far, it is not a representation, but only the *material quality* of a representation..." (Peirce 1995c: 238, my italics). This passage seems to suggest that emotional experience is 'qualified' by there being a world out there. In fact "Since a sign is not identical with the thing signified, but differs from the latter in some respects, it must plainly have some characters which belong to it in itself, and have nothing to do with its representative function. These I call the material qualities of the sign" (1955c: 234). Thus, far from being solely the result of will, emotions are constrained by the reality that they reflect and whose material quality they embody.

Once the realist aspect of abductive logic (or semiosis) is clarified, one can elaborate more precisely of Deely's purely objective reality. As Deely (2009b: 343, my italics) states:

> the interaction [of two or more physical substances] partially specifies and determines the awareness of the animal (*species impressa*) semiosically to form and construct a further awareness of its own (*species expressa*) transforming the bare physical into an objective world with which the animal can and must deal according to its *biological* type.

In other words, far from being an unconstrained act of will, the formation of an 'interpretant' (whether this is based on a 'thing' or on an 'object') is always constrained by the biological embodiment and situatedness of semiotic experience. One may argue that the animal's biological type (its sensorial availability and ecological niche) is fundamental to conceive of an interpretant. This fact is particularly evident in the case of animals possessing malfunctioning sensorial organs which allow the formation of an interpretant which is based on an 'object' that diverges only partially from a 'thing', the formation of an interpretant that 'makes sense' (or is workable) yet is not entirely accurate. For example, people with mild to moderate hearing impairments hear distorted sounds, not sounds as 'they really are'; however, when they wear hearing aids for the first time and experience the 'sounds as they really are', these will sound 'loud', that is, distorted. The same is valid for the common sensorial distortion that can occur within sight. Wearing a new pair of glasses commonly gives the feeling of a distorted perception, for example the floor may look much higher or curvier than it 'really' is. What is striking about natural sensorial distortion is that, when corrected with artificial devices, the 'real' thing – i.e. sounds as correctly heard through hearing aids, or the floor as correctly seen through new spectacles - appears 'false'. That is, for a period of time, an accurate view of the environment makes less sense than the habitual, distorted and merely objective view (where the object of experience does not fully correspond to a thing) that one can normally have of it. In other words, the organism's purely objective reality appears real or natural even when this is (totally or partially) illusory. This is the result of the fact that an organism's 'biological type' is such an integral, irreducible and indivisible part of the construction of one's purely objective reality that is trusted (on the basis of feeling) and taken as workable even when this is not fully accurate. Hence, it would seem fatuous to dismiss the study of physiological limits, or ecological limits in culture. Deely's reminder of the framing impact that the 'biological type' has in the process of building a purely objective reality suggests that if one wishes to tackle more comprehensively the complexity which underlies signification, including, of course, the 'reading of media texts', one needs to envisage in addition to

emotion, also *physiology* and *ecology* as the legitimate contextual constraints in which culture operates.

Such contextual constraints can be dubbed 'cybersemiotic' because they broadly correspond to Brier's notion of *cybersemiotic information*, a perspective which holds that an organism's individual point of view is created by "bodily interactions with environment and creation of a signification sphere". (Brier 2008: 392) Both notions of cybersemiotic 'information' and cybersemiotic 'constraints' could be aligned on the basis of their insistence on a contextual understanding of information that must include both the semiotic and the cybernetic aspect of modelling. However, context is here referred to 'constraint' rather than 'information' because the present chapter seeks to solve a problem within the humanities, the latter of which, as Cobley argues, have tended to overstress agency (2010b: 241) and have hence been more in need of a theorisation of constraints than the first person experience that Brier's 'cybernetic information' stresses. In light of this elucidation, one may argue that purely objective reality is framed by both semiotic constraints or (1) *abduction,* by cybernetic constraints or (2) *environmental* constraints, and (3) *physiological* constraints, (4) theories of *error*/distortion, but also by (5) a theory of the *observer* which is applicable to all these levels of constraint. Much has already been said on (1) abduction in Chapter 6, hence I will limit this section to talking about its functional aspect in terms of past causes (memory) and final causes (purpose).

On the one hand, (1) emotions (through abduction) frame one's purely objective reality by means of having aided the recognition of a thing as an object *in the past*, that is, by means of *previous experience*. Hence the 'collection of previous emotions' that aids the recognition of something as relevant, or as a piece of information, can be explained in reference to Juri Lotman's amusing illustration of *common memory.* Lotman recollects that a lecture by the mathematician P. L. Chebyshev on the subject of the mathematical problem of cutting the cloth was attended by an unexpected audience consisting of tailors, modistes and fashionable young ladies, who all fled after the lecturer's opening words: "Let's suppose for simplicity's sake that the human body is spherical". Lotman (2001d: 63) explicates through this example that "The text [the lecture] 'selected' its own audience creating it in its own image and likeness. Communication with another person is only possible if there is some degree of common memory." Hence one may argue that an aspect of reality becomes relevant to a living system only when the system itself has already a model of that reality stored in the form of emotion within a wider web of other emotions,

called by Lotman 'common memory'. In this way, common memory becomes the *antecedent cause* or the antecedent constraint of semiotic information. On the other hand, it is also *future causes*, or emotions triggered in the present by future objectives that constitute the emotional context of purely objective reality. As Kull, Deacon, Emmeche, Hoffmeyer and Stjernfelt affirm "teleological processes that are specially organised with respect to specific ends or referents are unique to living systems" (2009: 168), hence teleology is a defining feature of semiosis, and deeply shapes an organism' s purely objective reality. This view is supported by the fact that Sebeok (1979f: 13) himself declared that "the ideal of semiotic analysis is to combine causal with functional [teleological] explanation – to show how sign form interrelates dynamically with sign function." Also, to account for emotional constraints, feelings need to be theorised in light of second order cybernetic theory of the observer, and thus as being present in both the *observed* system and the *observing* system.

To use Deely's terminology, a personal world view would also be constrained by 'thing-availability' or (2) environmental framing. Simply put, one cannot form a model of something if there is not a 'something.' Hence a biosemiotic, integrative conception of information should therefore take into account both Deely's ontological notion of 'thing', Peirce's realism as well as the cybernetic notion of *structural coupling* (Maturana and Varela 1980, Varela 1991). Also, as I have spoken of eye and ear impairments, a purely objective reality is constrained by physiological availability (3). One may argue that when Sebeok (1988) brought to the forefront Jakob von Uexküll's concept of *Umwelt* or sensorial world, he wanted to underline the fundamental role that sensorial framing, or the inner anatomical structure of the species itself plus the kind of innate modelling capability it possesses, has in shaping the organism's personal world view. Indeed, Sebeok was also aware that sensorial framing does not just apply to the observed system, but also to the observing system (1978), hence both environmental and physiological framing may need to be included due to the constraints of the context of observation.

Through his concept of 'object' Deely reminds us that our view of the world may be objective (known) but deviant from a physical situation rather than coincident with it (2006: 42) and in so doing he hints at the role of error (4) in signification. Error "may help to make the third factor [the interpretant] evident, but removal of error does not at all take the third factor away" (2006: 45) The proof is that an organism is still capable of building a picture of reality that 'makes sense' even when this is not accurate. It has to be

remembered here that 'error' does not necessarily have, although it does not exclude, a negative valence as it constitutes the basis for learning. In fact, as essay-marking experience commonly shows, students aware of their own disabilities and that are likely to put three times the effort into their coursework than their able classmates, end up performing better than the class average. Thus 'error' needs to be considered on the basis of both its disabling and enabling capability, which, to a large extent, may be considered as two sides of the same coin and as the root to creativity as problem-solving and adaptation. It follows that any attempt to further delineate a biosemiotic concept of information needs to investigate what is valuable for the organism and take into account both general theories of error (Wilden 1980, Serres 1982, Sebeok 1991c) but also specific theories of error, especially within the context of sensory disabilities as these may shed light on the working modes of sensorial framing in general and how this sustains the modelling of culture. Lastly, a biosemiotic concept for information cannot ignore Second Order Cybernetics' (von Foerster 1973, Maturana and Varela 1980, Luhmann 1986) explicit efforts to insert (5) a theory of the observer within any theory of observation, thus within science in general. As Cobley (2010a: 2045) notes in fact, "the future of research in the sphere of biosemiotics will be enhanced by a greater understanding of 'observership'". Hence all levels of the contextual constraints, including the emotional, environmental-physiological and error-based constraints, have to also be envisaged within the context of observership.

Conclusion

The investigation of the fallacies of semiology' have unhearted the framework for analysis that much cultural investigations have been based on is *glottocentric, text-centric, nature-insulated* and *discipline-specific.* In particular, many semiological efforts in cultural studies have focussed on 'investigating' ideology, but they have done so through the inadequate framework of signification conceived merely as representation. Hence it is argued that even when (humanist) criticism is the sole purpose of analysis, such a criticism needs to be carried on within a more scientifically and philosophically sound framework than that offered by semiology. As proposed, such a framework must be an interdisciplinary one, and particularly one that stems from an understanding of biosemiotics from the enhanced point of view of systems theory and cybernetics, as proposed in the body of this thesis.

As shown, grounding cultural analysis in Peircean pragmatism (and specifically in philosophy, abduction and realism) and in 'Biosemiotics *as* Systems Theory' rather than

semiology allows one to formulate new guidelines for cultural analysis. It replaces 'interpretation' with *modelling,* dispenses with 'representation' in favour of *purely objective reality,* and recasts 'motivation' as *cybersemiotic* constraints.

Modelling can supersede interpretation on the basis of its higher potential for the scientific-systematic study of communications, potential which is due to its grounding in a *structural* and *phylogenetic* outlook on systems as in Sebeok and Danesi 2000 and in Peirce's philosophy. In cultural analysis, 'modelling' opens up a structural-historical perspective on systems that allows one to envisage the *difference in kind* within a *difference in degree* of communication used by species, a perspective which would favour technological remediation over a revolutionary view of technology.

Purely objective reality can supersede 'representation' in that, by emphasising the functional aspect of signification (grounded in 'instinctive belief' or *abduction*), it goes beyond the mere account of the 'conditions of truth of representation', and can account more fairly for the *text-in-practice,* as opposed to the *text in principle* (the concept which characterises semiological approaches to culture). In cultural analysis, 'purely objective reality' implies that one needs to take into account the emotions triggered by the text since, in the reading process, they invariably occur *before* any investigation of the ideological aspect of the representation contained in the text. Arguably, this view is capable of accounting more fairly for the reasons why people 'enjoy' media texts, even the ones eliciting the most improbable or morally problematic representations of reality.

Cybersemiotic constraints can supersede 'motivation' on the ground of providing an alternative to the use of anthropocentrism models in the analysis of cultural communication. 'Cybersemiotic constraints' constitute a proposal for a non-humanist conception of cultural analysis by positing that a cultural analyst in addition to the study of the already acknowledged historical, social and intertextual context, must explicitly include the study of the emotional, as well as biological (intended as physiological and ecological) and observational context in the investigation of the cultural text-in-practice. Such a proposal, far from eliminating the human dimension of culture, reconfigures it in terms of its (phylogenetically) older and (transdisciplinary) wider biological dimension. Envisaging cultural context in terms of cybersemiotic constraints is a perspective that suggests a way out of the nature/culture divide that was so glibly advocated by Barthes. As Sebeok

repeatedly pointed out, the idea of a split between nature and culture is absurd, simply because the former is merely a small compartment of the latter (Cobley 2007: 59).

CHAPTER 8

Conclusion

This concluding chapter summarises the findings of this project, outlines some of the issues that the project reveals but which it cannot explore due to reasons of space, and suggests avenues for future research that the project opens up for scholars of biosemiotics, systems theory and semiotics.

Summary

The findings of this project are summarised in this order:

- A philosophical PhD needs to have a theoretical investigation as its object and an 'intervention' in theoretical debates, with an awareness of the perils of ideology, as its aims.
- An interdisciplinary project, such as this one, benefits from the comparative-historical perspective offered by *Deely's* 'archaeology of concepts' (1981).
- The project has investigated biosemiotics in terms of systems theory. Background research shows that biosemiotics and cybernetics-systems theory are broadly relevant to each other in respect to contributions on modelling and information. Such relevance is evident in the common interest in dynamic systems and metalanguage, and in the common difficulty in characterising information. This finding justifies the need for further analysis of the common disciplinary ground of the two fields.
- Analysis modelled upon Bertalanffy's idea of *isomorphism* (1945) shows that the isomorphic models shared by biosemiotics and systems theory are 'transdisciplinarity', 'history' and 'function'. These can also be considered as categories of systems thinking. Further analysis modelled upon Deely's 'archaeology of concepts' shows that such isomorphism is historically determined i.e. that these categories have been inherited by biosemiotics from cybernetics through the historical link that cybernetics bears with 'Soviet' semiotics and early 20th century theoretical biology.
- Analysis modelled upon Althusser's idea of *uneven development* (1965) demonstrates that there is a discrepancy of models between biosemiotics and systems theory in respect to *information.* Information is orientated towards

abduction in biosemiotics, and geared towards deduction in systems theory. Such a difference constitutes the 'difference in type' between the biosemiotic and the systems theory paradigms; however, this fact has to be articulated within a historical perspective, hence within a view that privileges the 'difference in degree' between biosemiotics and systems theory.

- This thesis – 'Biosemiotics *as* Systems Theory' – provides the grounding for a *new* form of cultural analysis. Particularly, it suggests an interdisciplinary framework (as a means to transcend the four faults of semiology) for the analysis of culture that unfolds along the following guidelines: substituting 'interpretation' with *modelling,* dispensing of 'representation' in favour of *purely objective reality,* and recasting 'motivation' in terms of *cybersemiotic* constraints.

Theoretical work for a PhD is often an accompaniment to a detailed description of the approach in a thesis. Such work exists in lieu of the 'methodology' that would be found in an empirical project. Chapter 2 presents such a description in relation to the pursuit of analytical rigour. The justification for this theoretical approach was inspired by the theoretical work of Althusser who, in the introduction to *Pour Marx* (Althusser 1965), provided a strong model for the defence of philosophical methods in academic argumentation. Here, he argued for the necessity of work which has theoretical investigations as its object and, as its aims, 'intervention' in theoretical debates that are at risk of being ideological. These are the guidelines that have been followed in full in this project - the theoretical investigation of biosemiotics was its objective, plus an 'intervention' into the fundamentally ideological state of cultural theory was its final aim.

Deely' s 'archaeology of concepts' (1981), consisting in "the uncovering of the layers by which concepts ultimately taken for granted in some specific population acquired their illuminative power for human culture" (2009c [1981]: 145), extended the extant understanding of biosemiotics from the enhanced vantage point of the history of cybernetics. Yet, of course, this framework also required a clarification of *history,* ultimately drawn from Althusser's idea of *uneven development* and/or contradictions (Althusser 2005[1965]: 97). If 'biosemiotics is an *uneven* development of systems theory' as this thesis has held, then the comparative perspective opened up by the 'archaeology of concepts', prompted the organisation of interdisciplinary material through Bertalanffy's transdisciplinary notion of *isomorphic model* (Bertalanffy 1973c [1945]: 89).

In pursuing the thesis that biosemiotics is an uneven development of modern systems theory, this project has presented a review, divided into two parts, of the key contributions that pertain to the field of biosemiotics (Chapters 3) and to the field of systems theory and cybernetics (Chapter 4). These reviews have been performed separately in order to identify preliminary areas of overlap between the two fields, so that it is only their findings that are subsequently compared and contextualised where needed, in the analytical chapters that follow (Chapter 5 and 6).

The review of biosemiotics' literature was theme-based around the concepts of *modelling* and *information* as 'paradigmatic features' of biosemiotics which are implicitly relevant to systems theory. It has been seen that the contributions on 'modelling' that are examined – von Uexküll's *Umwelt* (1940), Lotman's *modelling systems* (1967) and *semiosphere* (1990), Sebeok's *primary modelling system* (1988), and Sebeok and Danesi' s *Modelling Systems Theory* (2000) - introduce in biosemiotics the notion of 'space'. Such an expression implies the categories of 'system' and 'change' or the quest for *dynamic systems* in biosemiotics. This impetus, as has been demonstrated, is similar (hence broadly relevant) to cybernetics-systems theory's quest for homology. On the other hand, contributions on 'information' in biosemiotics have been grouped according to the views of those scholars who emphasised (1) information's control function (Sebeok 1991c; Sharov 1992, 2010), or (2) information's indeterminacy (Sebeok 1978; Hoffmeyer 1996a, 2008a; Brier 2008). The identification of this discrepancy has laid the ground for the comparison of these positions with seemingly similar contradicting conceptualisations of information as also found in cybernetics.

The second part of the literature review comprised sources in cybernetics and systems theory. This review took place in a historical frame so as to underline, in a non-stereotypical fashion, the evolution of cybernetics' core theoretical models from proto-cybernetics through first and Second Order Cybernetics to systems theory. The account identified a number of theoretical developments in cybernetics which in light of their general relevance to biosemiotics are argued to represent the historical precursors to the biosemiotic project. These include proto-cybernetics' *mathematical homology* and *function* (Wiener 1909; Thompson 1917; von Uexküll' 1940), early cybernetics' *multi-* and *transdisciplinary* approaches (Rosenblueth, Wiener and Bigelow 1943; von Neumann 1948; Shannon and Weaver's 1949; Wiener 1948, 1951), First Order Cybernetics' adumbrating of *General System Theory* (Boulding 1956; Bertalanffy 1968 [1939-1967]) and *biocybernetics* (Bertalanffy 1940; Ashby 1956; Pask 1961; Bateson 1967, 1970, 1972, 1979; Lovelock 1979),

Second Order Cybernetics' *constructivism* (von Foerster 1973; Maturana and Varela 1980; Luhmann 1990), the concept of autopoiesis (Maturana and Varela 1980, Luhman 1986) *social systems theory* (Luhmann 1995a) and theories of *error* (Wilden 1980; Jantsch 1980; Serres 1980). This part of the review demonstrated that biosemiotics originated as an uneven development of systems theory in a similar manner to that in which systems theory is shown to originate as an uneven development of cybernetics. In particular, it is proved that (Second Order Cybernetics) systems theory encounters a contradiction in the conceptualisation of information (understood as either in pragmatist or constructivist fashion), the occurrence of which constitutes fertile ground for the emergence of biosemiotics as a new 'interdisciplinary scientific project' as launched by Sebeok (1977a) and accelerated by Hoffmeyer (2008a: 3).

Both the reviews of biosemiotics and cybernetics-systems theory foreshadowed the idea that contributions on modelling and information in both fields bear a *general* degree of relevance to each other and thus *broadly* describe the area of disciplinary overlap between the two fields. This finding justified the need for a more detailed cross-comparison of these concepts.

Analysis revealed two broad classes of results (1) that biosemiotics and systems theory are *isomorphic* to each other (*sensu* Bertalanffy) in terms of *transdisciplinarity, history* and *function* and that such a disciplinary overlap is an instance of historical causation (Chapter 5); (2) that since historical determination implies uneven developments (*sensu* Althusser) there is also a considerable degree of discrepancy between biosemiotics and systems theory which is identifiable in respect to information (Chapter 6).

The first group of results thus concerns the models which biosemiotics and cybernetics-systems theory have in common. The first, as we have seen, is transdisciplinarity. Their adoption of *systems thinking,* which is evident in in Sebeok and Danesi's *Modelling Systems Theory* (2000), Lotman's *Semiosphere* (1990), Bertalanffy's *General System Theory* (1968) and Luhmann's *General Theory of Social Systems* (1995) is transdisciplinary in that it suggests that one may focus on the organisational (relational) aspects of different phenomena rather than their material (summative) aspects. It has been argued that such an impetus towards systems thinking in biosemiotics is a case of historical inheritance from cybernetics. Historical evidence was accounted in my exposition of cybernetics' early 'ideological' influence on 'Soviet' semiotics (as in Lucid 1977), which in turn furnishes the

basics for Sebeok's conceptions of primary modelling system (1988), and thus for conceptions of biosemiotic modelling as a whole.

The second model that biosemiotics and cybernetics have in common is *history*. Biosemiotics' instances of 'historical systems thinking' (Hoffmeyer and Emmeche 1991; Sebeok 1988; Anderson and Merrell 1991) have been shown to rely on an *evolutionary* conception of systems, undoubtedly inherited from evolutionary theory in biology. Such an impetus coincides with biosemiotics' quest for *phylogenetic homology*. On the other hand, contributions in cybernetics which investigate 'change' in systems mainly rely on a model of *development* (von Uexküll 1940; Rosenblueth *et al.* 1943; Ashby 1956; Lovelock 1979). Hence these contributions appear to merely put forth a quest in favour of *logical homology*. However Bertalanffy's theory of the organism as an open system (1940), grounded in a historical concept of entropy (Prigogine and Stengers 1984) and hence evolution in a irreversible thermodynamics sense, demonstrated a common interest in historical or dynamical systems. As I showed, Prigogine and Stenger's work on irreversible thermodynamics (1984) thus influenced Lotman's historical model of culture (*semiosphere*), which in turn furnishes the 'sphere' metaphor that is so much in use in biosemiotic theory (Hoffmeyer 1996a; Kull 1998: Brier 2007).

The third model that biosemiotics and cybernetics have been shown to share is *function*. Biological accounts of biosemiotics (Kull *et al.* 2009; Emmeche 2002; Stjernfelt 2002; Hoffmeyer 2008a) explore biological function in terms of *final cause* or Deely's *vis a prospecto* (2010), a view that tends to emphasise the indeterminacy aspect of function, similarly to those accounts (as outlined in the literature review). These contributions emphasise information's indeterminacy. On the other hand, 'cultural' accounts of biosemiotics (Sebeok 1979f, 1988), as was seen, emphasise both *initial causes* (or the anchoring aspect of nonverbal language for culture) but also the final cause as embodied in human culture and possibly in animal aesthetic behaviour. It has been argued that such a more balanced account of function on the side of cultural semiotics is due to biosemiotics' heritage in cybernetics. Historical evidence was offered with reference to the proto-cybernetic argumentation on a notion of function (Thompson 1917; von Uexküll 1940) that disregards antecedent causes (constraining function) or final causes (purposive but open-ended regulative function) as mutually exclusive, which is the grounding framework of Sebeok's attempt to do justice to both the initial cause and final cause of dynamical aesthetic systems (1979f).

The second group of results concerned the models which biosemiotics and cybernetics-systems theory do not have in common. This amounted to a profoundly different or uneven (*sensu* Althusser) qualification of the notion of *information*. In this group of results, both fields conceive of information in polarised terms: biosemiotics posits that information is either determinate or indeterminate, whereas cybernetics-systems theory posits that information is either objective or subjective. These internal contradictions notwithstanding, it has been argued that each field bears a subject-specific 'bias' towards information which is identifiable in the respective presence or non-presence in their framework of *abduction* i.e. the hypothetical reasoning involved in semiosis (Peirce 1955a [1903]: 304).

Information in biosemiotics is orientated to abduction – *observership* (Sebeok 1978), *semiotic niche* (Hoffmeyer 2008a: 183) and *rependium* (Relentlow in Brier 2008: 167) – and has been shown to be aligned with modelling strategies identifiable with logic conceived in a broad sense as coextensive with Peirce's *general theory* of signs. Information in cybernetics-systems theory is geared towards deduction – *generic thinking* (von Neumann 1948), logical theory of biological survival (Ashby 1956) and *observership* (Luhmann 1990; von Foerster 1973, 1979) through the logico-mathematical concept of *distinction* by Spencer Brown (1969) – and has been shown as aligned with a modelling strategy more closely identifiable with logic conceived in the narrow sense as an analytical *method* within the mathematical sciences. Such an affiliation was shown to be the case even in those instances in which it attempts to mitigate the 'objectivism' of information by means of observership. As has been seen, in general, biosemiotics relies on phylogenetic homology whereas cybernetics relies more on logical homology. Hence despite strict similarities in the modelling strategies that both biosemiotics and systems theory possess (in terms of transdisciplinarity, history and function), e.g. their 'difference in degree', this thesis has revealed that the differing in their take on information amounts also to a 'difference in type'.

While this thesis, 'Biosemiotics *as* Systems Theory', has implications for understanding each of the fields involved, it has also challenged 'cultural semiotics', particularly for the semiological version of it as put forth in Anglophone media and cultural studies (Chapter 7). Semiology has been 'incriminated' for its perpetration of four major faults in analysis, namely:

1. the *pars pro toto* fallacy,

2. *conflating* Barthes' semiology into Saussure's,
3. overemphasising *representation*, and
4. *narrowing* analysis' scope to the task of 'unmasking' ideology.

A survey of these faults has demonstrated that the framework for analysis suggested by semiology is *glottocentric, text-centric, nature-insulated* and *discipline-specific.* By force of its interdisciplinarity, this thesis provides the grounding for a new form of cultural analysis that makes semiology more redundant.

Specifically, this thesis' findings concerning 'modelling' and 'information' suggest new guidelines for cultural analysis. These consist in substituting 'interpretation' with *modelling,* exchanging 'representation' for *purely objective reality,* and reframing 'motivation' with *cybersemiotic* constraints. 'Modelling' understood as phylogenetic homology (structural, historical, functional outlook on systems), facilitates a systematic study of communication that acknowledges the link between nature and culture by suggesting that *differences in kind* are a special subset of *differences in degree* across systems. Also, by resting on Peircean pragmaticism (philosophy, abduction and realism), Deely's 'Purely Objective Reality' (2010) accounts more fairly for the *text-in-practice*, hence for the reasons why people 'enjoy' media texts. Finally, 'cybersemiotic' constraints, inspired by Brier's *cybersemiotic information* but differentiated from it by means of a higher emphasis put on constraints, contribute to the investigation of the *text-in-practice* by nuancing a theorisation of emotional, biological (intended as physiological and ecological) and observational contexts in the investigation of culture. These guidelines constitute a proposal for a non-anthropocentric analysis of communicational devices in culture.

Problems raised

The process of research has uncovered three issues that are relevant to this thesis, but that for reasons of limited space cannot be fully explored within the current project.

1. As argued in Chapter 5, the acknowledgment of the link between biosemiotics, systems theory, the Prague school of semiotics (Salthe) and Tartu-Moscow semiotics (Lotman) is not without problems as it leaves open a question concerning the extent in which all these theories are underwritten by a hierarchical concept of system. While Salthe (1985), Lotman (1967, 1990) and Evan-Zohar (1986), this latter explicitly draws from the historical-systems theory of Lotman) clearly state

that the organisational pattern of systems is hierarchical, Luhmann (1995c: 19) clearly states that "one must distinguish conceptually between differentiation and hierarchisation on the level of the general theory of social systems. Hierarchisation is then a specific case of differentiation". Specifically, Luhmann openly invokes the system/environment distinction as a means to supersede the parts-to-whole hierarchy, which is instead openly advocated in Salthe. The issue at stake here clearly concerns the implications of the systems-environment distinction in relation to hierarchy, an issue that perhaps would require a more thorough comparison of concepts of hierarchy across Luhmann's systems theory and Lotman's systems theory.

2. The argument detecting the 'bias' of information in cybernetics-systems theory (as in Chapter 6) required a firm stand to be taken in relation to either deduction or abduction. By means of the comparison of Peirce's *Firstness* (1955b: 104) to Spencer Brown's "desire to distinguish" (1972: 69), the latter's notion of *observership* (1972) appears biased towards deduction. However, this acknowledgement was dictated by the line of argument put forth in that chapter and by a stronger adhesion to Peirce's 'empiricism' rather than Spencer Brown's *a priori* theory of knowledge, though certainly not by a desire to dismiss Spencer Brown's work altogether. Indeed, since it is significant that Peirce's and Spencer Brown's work have consequences in terms of subjectivity in their respective fields of application (biosemiotics for Peirce, cybernetics for Spencer Brown), it may be worthwhile to continue a mapping of the systems of knowledge they propose in order to investigate the real extent to which the two projects are mutually exclusive. Further work might, perhaps, underline with precision not only the differences between the two views (as this thesis does) but also the similarities.

3. In Chapter 7 I emphasised how semiologists rely on a very problematic notion of ideology, one that has been borrowed from Althusser (1971) without paying full attention to its complexity. I also stated that 'ideology' is a topic that deserves full treatment in respect to biosemiotics in a different project. Hence the working of ideology qualifies as one of the key issues that is raised but cannot be finalised by this thesis. Althusser argues that a human becomes a subject by being interpellated by ideological state apparatuses (ISAs) through ideology (Althusser 1971; cf.

Pêcheux 1981), or, in other words, he argues that there is no subject before experience. Similarly, what was gathered out of Deely's 'thing and object' distinction (2006) is that there is neither no 'object' prior to experience, but there are things. Hence what one is left to wonder is whether Althusser's understanding of the human aligns with Deely's notion of 'thing', or perhaps, if the subject is not a specific subset of 'thingness'. This acknowledgement prompts the immediate question of the workings of Deely's ontology if this was mapped against Althusser's theory of the (ideological) subject, a topic that is highly relevant to biosemiotics but also out of the strict remit of this project.

Avenues for future research

The project also suggests of avenues for future research within four broad areas:

a) research methods,

b) biosemiotics,

c) systems theory, and

d) semiotics.

The philosophical approach used in this thesis, from Chapter 2 onwards and largely based on Deely's 'archaeology of concepts', promises to open an avenue for exploration in the area of research methods within the humanities and the theoretical sciences. The 'Deely Method', as it could be called, suggests that a useful way of investigating a broad research area is by means of interdisciplinary mapping, or figuring one field in terms of another as has been seen in this thesis. The far-ranging scope of this approach may suggest a response to the typical research guidelines that are given to students according to which they have to narrow down their field of action as soon as possible or they risk becoming lost in details. Instead the 'Deely Method' may demonstrate that 'ambitious' research projects which deal with a range of disciplinary material are, in effect, feasible provided that the researcher is equipped with a systematic method that facilitates the organisation of such material. Indeed, by means of its comparative and historical perspective, the 'Deely Method' can be considered a valuable tool that facilitates 'organisation' and allows one to systematically define 'goals and methods' as the research progresses and new material accumulates. Additionally, the application of the 'Deely Method' in this thesis hints at the

fact that grounding an investigation in its historicity may help in precisely identifying the gap in research to be addressed. In this respect, the 'archaeology of concepts' could become a 'qualititave method' for the humanities or the theoretical sciences regularly taught in research methods courses, and its effectiveness could be further tested by means of application to other projects.

The execution of the current project may also serve as a defence of the transdisciplinary perspective opened up by Bertalanffy's General System Theory. He posits that phenomena can be investigated in terms of their organisational state. General System Theory, in fact, suggests that transdisciplinarity allows analysts to "make comparisons, and thus further analysis across different entities possible" (Luhmann 1995b: 2). Therefore, as a 'defence' against the critiques that General System Theory is "inconclusive" (Lilienfield 1978) or "vague" (Sebeok 1977a: 185), perhaps the application of the transdisciplinary view embedded in GST to the comparative investigation of biosemiotics and cybernetics-systems theory suggests that such a perspective facilitates the identification of *similarities* across different fields (interdisciplinarity) while also aiding the identification of fundamental *differences* across these fields. In so doing GST suggests further avenues for analysis. The approach to the argument adopted in this thesis, which investigates similarities while keeping an eye on differences between biosemiotics and systems theory, is a direct application of this principle and perhaps demonstrates its usefulness for scholars with an interest in the implementation of systems theory.

Moreover, while this discussion of the relation of systems theory for biosemiotics has demonstrated that such a thesis has an impact on practices of cultural analysis, this thesis may also bear implications for biosemiotics, and further implications for semiotics itself. In respect to biosemiotics, it is argued that biosemiotic modelling strategies are identifiable with logic conceived as semiotics. Hence, one may argue that such strategies are more suited for the study of living systems than those presented by systems theory. Such 'suitability' is evident in biosemiotics' more pronounced reliance on *abduction*. This 'reliance' consists in abduction being relevant not only to scientific discovery but to biological learning in general. However the relevance of abduction for biosemiotics could be expanded further, since it is only Sebeok's, amongst the scholarly work examined in this thesis, which not only mentions abduction but also gives evidence of its working in more than one place. Hence, in order to claim the 'superiority' of its own method for the study

of living systems over cybernetics-systems theory in full, biosemiotics may need to incorporate theorisations of abduction more explicitly into its paradigm.

In respect to semiotics, the framework suggested by the reworking of 'Biosemiotics *as* Systems Theory' is one which foregrounds a non-anthropocentric perspective on culture. This has ramifications for the systemicity and rigour offered by the analytical tools of modelling, purely objective reality (which implies abduction and realism) and cybersemiotic *constraints*. These tools are particularly resourceful for the humanities which tend to indulge in an indiscriminate ideology of free will or unfettered agency as an unconstrained process of subject formation. Such an ideological tendency is perhaps most evident in the positions advocating the supremacy of 'readership' present in semiological or semiology-inspired work. However, this emphasis put on readership:

1) is in clear contradiction with the overemphasis that semiology puts on representation (which implies instead that there are 'things' in media texts that are directly passed on to passive audiences – if the reader was so active, why would representation matter more, to a semiologist, than the reader's *feelings*?);

2) can be considered as an ideological argument all the way through in light of its distortion of Althusser's 'repressive' theory of ideology into a 'liberating' theory of ideology.

So perhaps the invitation to consider both the *emotions* and *constraints* of 'readership' is one that promotes the role of the 'semiotic animal', or the organism over the role of the reader. This realisation implies that Barthes' agentive prescriptive statement on the desirability of readership over authorship, which reads "The birth of the reader must be at the cost of the death of the author" (Barthes 1977c: 148) can be nicely transfigured in biosemiotic terms as "The birth of the organism must be at the cost of the death of the reader."

'Biosemiotics *as* Systems Theory', ultimately, has not just been a thesis but a method. It has revealed much that biosemiotics – still, to some extent, in nascent form – has left unconsidered: the strength of the principle of abduction, in particular. It has also illuminated the continuing relevance of systems theory, especially in relation to information and observership. The further work of the major paradigm shift that biosemiotics represents, will be extensive and varied. Yet, this thesis has hopefully made

clear that the transdisciplinary reach of biosemiotics will be felt most strongly through *modelling, purely objective reality,* and *cybersemiotic* constraints.

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