The Forms of Meaning

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Modeling Systems Theory and Semiotic Analysis

by
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Preface

One of the traits that distinguishes human beings from other species is an instinctive ability to make sophisticated, ingenious, resourceful *models*. Model-making typifies all aspects of human intellectual and social life. Before building a house, a constructor will make a miniature model of it and/or sketch out its structural features with the technique of blueprinting. An explorer will draft a map of the terrain s/he anticipates traversing. A scientist will draw a diagram of atoms and subatomic particles in order to get a "mental look" at their physical behavior. Miniature models, blueprints, maps, diagrams, and the like are so common that one hardly ever takes notice of their importance to human life; and even more rarely does one ever consider their *raison d'être* in the human species. Model-making constitutes a truly astonishing evolutionary attainment, without which it would be virtually impossible for modern humans to carry out their daily life routines. All this suggests the presence of a *modeling instinct* that is to human mental and social life what the physical instincts are to human biological life. Now, what is even more remarkable is that *modeling instincts* are observable in other species, as the relevant literature in biology and ethology has amply documented. The intriguing question that such deliberations invariably raise is the following one: *What is the function of modeling in life forms?* This question begs, in turn, a whole series of related ones: *How is human modeling similar to, or different from, modeling systems in other species? What is the relation between modeling and knowing?*

The purpose of this book is to present and describe a methodological framework that can be used to seek answers to questions such as these—a framework developed on the basis of the work that has been conducted in the field of inquiry known as *biosemiotics*. This is a movement within *semiotics* aiming to study the manifestation of modeling behaviors in and across all life forms. The framework is called *modeling systems theory* (MST), developed by one of the authors of this book—Thomas A. Sebeok—over a lifetime of research on the interface between the biological and the semiotic sciences (see, for instance, Sebeok 1994). This book is intended to be both a synthetic overview of MST and a compendium of illustrations

showing how it can inform and potentially expand the method of inquiry in both semiotics and biology. Our principal goal is to distill from MST the main implications that we perceive it has for investigative practices in those sciences. Thus, we have written this book in an accessible "textbook" style, so that the reader can get a nontechnical, yet comprehensive, look at what MST is essentially all about.

This book is the result of a collaborative effort on two counts. First, it is the product of the research and ideas of the primary author, Thomas A. Sebeok, and of the practical implications that these have had for the secondary author, Marcel Danesi, in the courses he has been teaching in semiotic theory at the University of Toronto. Second, its specific layout and its contents have been guided by the many suggestions and commentaries that both colleagues and students, at Indiana University and the University of Toronto, have passed on to each author over the years. We sincerely hope that this book will reflect what they have told us would be most useful to them. This book can be used as a reference manual by semioticians interested in MST and by students taking advanced courses in semiotics, communication theory, media studies, biology, linguistics, or culture studies. We have composed it so that a broad readership can appreciate the fascinating and vital work going on in this relatively unknown area of inquiry, most of which is often too technical for general consumption. Each chapter contains numerous practical exemplifications and insights into the potential applications of MST to the study of cross-species modeling. Nevertheless, the writing is not so diluted as to make it an overly simplified treatment. Some effort to understand the contents of each chapter on the part of the reader will be required. The more technical parts might entail several rereadings.

Since the focus of this book is practical, the critical apparatus of references to the technical literature is kept to a minimum. For the sake of comprehensiveness, we have appended an extensive bibliography of works upon which the MST framework has been built at the back. A convenient glossary of technical terms is also included.

Contents

Chapter I
Models and semiotic theory

I can't work without a model. I won't say I turn my back on nature ruthlessly in order to turn a study into a picture, arranging the colors, enlarging and simplifying; but in the matter of form I am too afraid of departing from the possible and the true.

Vincent Van Gogh (1853–1890)

1. Introductory remarks

A striking feature of human cognitive and social activities is the fact that they are mediated by the innumerable *forms of meaning* created and conveyed by the words, drawings, artifacts and other *models* of the world that people make and use routinely. The world of human beings is a de facto world of *meaning-bearing forms*. The systematic study of these forms comes under the rubric of *semiotics*, defined commonly as the "science of signs".

Modeling is the innate ability to produce *forms* to stand for objects, events, feelings, actions, situations, and ideas perceived to have some meaning, purpose, or useful function. The form may be imagined, in which case it is called a *mental image*, or it may be something externalized, in which case it is called a *representation.* Semiotic research has identified four basic types of forms: (1) *signs* (words, gestures, etc.); (2) *texts* (stories, theories, etc.); (3) *codes* (language, music, etc.); and (4) *figural assemblages* (metaphors, metonyms, etc.). In this opening chapter, we will describe and illustrate each of these types, recasting their traditional conceptions in terms of an approach to semiotics known as *modeling systems theory* (MST). These "recastings" constitute the basic elements of a methodological framework, called *Systems Analysis* (SA), that can be applied to the study of modeling phenomena across species. The goal of SA is, in fact, to make the systematic study of cross-species modeling a practicable goal.

1.1 Models

What is a *model*? Although a model is easily recognizable as such, it is something that virtually defies a formal definition. As the philosopher Max Black pointed out in his classic (1962) study of modeling in science, the term *model* has as many definitions as it has uses. For the present purposes, a *model* can be defined as a *form* that has been imagined or made externally (through some physical medium) to stand for an object, event, feeling, etc., known as a *referent*, or for a class of similar (or related) objects, events, feelings, etc., known as a *referential domain*. An imagined form can be called, simply, a *mental form*; a form made externally to stand for a referent can be called an *externalized form*.

A toy model of a house, made with a set of plastic building blocks, is a perfect example of what constitutes a model. Clearly, it is an *externalized form*, since it has been constructed to *represent* the physical *form* of a real-world house–i.e., "present it again" in terms of the blocks. The house is the *referent* of this model. Needless to say, the degree of structural fidelity between the toy model and the actual house it attempts to duplicate will vary according to the specific abilities of the model-maker, the number and kinds of blocks available, and the degree of reproducibility of the house–if the house to be modeled has many architectural details, for example, then it is much harder to reproduce its form faithfully in the toy model.

Models serve many functions in human life. They allow people to recognize patterns in things; they act as predictive guides or plans for taking actions; they serve as exemplars of specific kinds of phenomena; and the list could go on and on. As mentioned, the science which studies models and their functions is semiotics. For the sake of historical accuracy, it should be mentioned that semiotics was founded as a branch of medicine in the ancient world. In fact, in its oldest usage, the term *semeiotics* was coined by Hippocrates (460?-377? BC), the founder of Western medicine, to designate the study of particular types of *forms*–bodily symptoms. Symptoms are, in effect, forms produced by Nature's own modeling systems, designed to alert an organism to the presence of altered states in its body. The particular forms that symptoms assume in a specific species provide vital clues to the probable source and etiology of such states.

A symptom is an example of an *externalized natural form*, i.e., a form produced by Nature. Words and symbols, on the other hand, are *externalized artificial forms*, i.e., forms made intentionally by human beings to represent something. There are four general types of artificial forms that humans are capable of producing: *singularized, composite, cohesive*, and *connective*.

In traditional semiotic theory *singularized forms* are called *signs*. In an MST framework, a sign can be defined, more precisely, as a form that has been made specifically to represent a singular (unitary) referent or referential domain. Singularized forms can be verbal or nonverbal. The English word *cat*, or the Spanish word *gato*, for example, are verbal singularized forms standing for the referent [carnivorous mammal with a tail, whiskers, and retractile claws]; figure 1 (below) is their nonverbal (visual) equivalent. (In this book, square brackets are used to enclose forms, referents, and features of various kinds). Now, a description of the same referent as *a popular household pet that is useful for killing mice and rats* constitutes, clearly, a different kind of form. This is known traditionally as a descriptive *text*. In MST, a text can be defined, more specifically, as a *composite form*; i.e., as a form that has been made to represent various referents–[household pet], [mice], etc.–in a composite (combinatory) manner. Classifying a *cat* in the same category as a *tiger, lion, jaguar, leopard, cheetah,* etc. exemplifies another type of modeling strategy–namely, the tendency to *codify* types of forms in some *cohesive* fashion. In MST, a code can be defined as a system that allows for the representation of referents perceived to share common traits–e.g., [cat], [tiger], [lion], [jaguar], etc. (= the feline code). Codes consist of interacting elements, forming a *cohesive* whole, which can be deployed to represent types of phenomena in specific ways. Finally, the use of the word *cat* in an expression like "Alexander is a cool *cat*" is the result of a fourth type of modeling strategy, known traditionally as *metaphorical.* In this book, the term *connective form* is preferred instead, because a metaphor is a form which results, in effect, from the linkage of different types of referents (or referential domains): e.g., a human referent, [Alexander], with a feline referent, [cat].

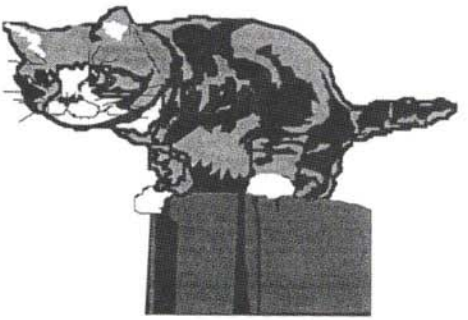

Figure 1. Nonverbal (visual) form standing for [carnivorous mammal with a tail, whiskers, and retractile claws]

Consider the toy house analogy again. Modeling a [house] with building blocks produces, in effect, a singularized form. However, if the construction were made to include pieces representing a surrounding lawn, fence, and road, then the model would exhibit a composite form. Now, if the same set of blocks could be used not only for making a specific kind of house form, but other habitation forms as well (a hut, a cabin, etc.), then that set of blocks would constitute a cohesive system, since it would allow for the modeling of different types of abodes. Lastly, if the set of building blocks designed for making model houses were augmented by a set of different kinds of building blocks–say, blocks designed for making model vehicles–then various new models could be envisaged: e.g., a mobile home, a house trailer, etc. These are connective forms, resulting from the linkage of different kinds of building blocks.

These four types of modeling strategies are not mutually exclusive. Indeed, they are highly interdependent–signs go into the make-up of texts which, in turn, are dependent upon the elements that codes make available. As an analogy, consider another type of toy–the jigsaw puzzle. In this puzzle, the following parallels can be made:

- *singularized form* = single piece of the puzzle
- *composite form* = the picture that results when the pieces have been assembled in the required manner
- *cohesive form* = the jigsaw puzzle itself as different from, say, a chess game

- *connective form* = any linkage made between the pieces of the jigsaw puzzle and those of chess

The last analogue is purely illustrative. Unlike the new forms resulting from metaphorical connections, a jigsaw puzzle piece linked with a chess piece in some way does not generate a new puzzle form.

The different artificial forms that characterize human representation are shown in figure 2:

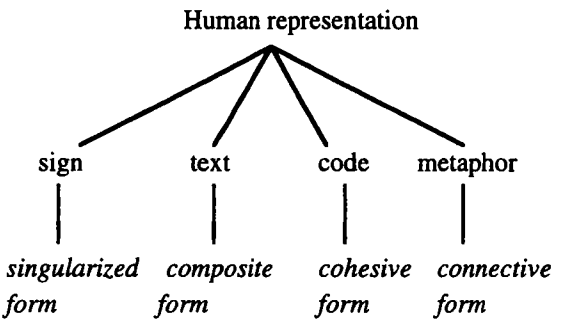

Figure 2. Types of forms characterizing human representation

1.1.1 Modeling, semiosis, and representation

The ability to make models is, actually, a derivative of *semiosis*, defined simply as the capacity of a species to produce and comprehend the specific types of models it requires for processing and codifying perceptual input in its own way. Semiosis is a capacity of all life forms; representation, on the other hand, is a unique capacity of the human species, which develops during the neonate and childhood periods. When an infant comes into contact with a new object, h/er instinctive reaction is to explore it with the *senses*, i.e., to handle it, taste it, smell it, listen to any sounds it makes, and visually observe its features. This exploratory phase of knowing the object constitutes a *sensory modeling* stage. The resulting internal model (mental image) allows the infant to *recognize* the same object subsequently without having, each time, to examine it over again "from scratch" with h/er sensory system (although the infant often will examine its

physical qualities for various other reasons). Now, as the infant grows, s/he starts to engage more and more in semiosic behavior that replaces this sensory phase; i.e., s/he starts pointing to the object and/or imitating the sounds it makes, rather than just handling it, tasting it, etc. These imitations and indications are the child's first attempts at *representing* the world in purely human terms (Morris 1938, 1946). Thereafter, the child's repertoire of *representational* activities increases dramatically, as s/he learns more and more how to refer to the world through the singularized, composite, cohesive, and connective modeling resources to which s/he is exposed in cultural context.

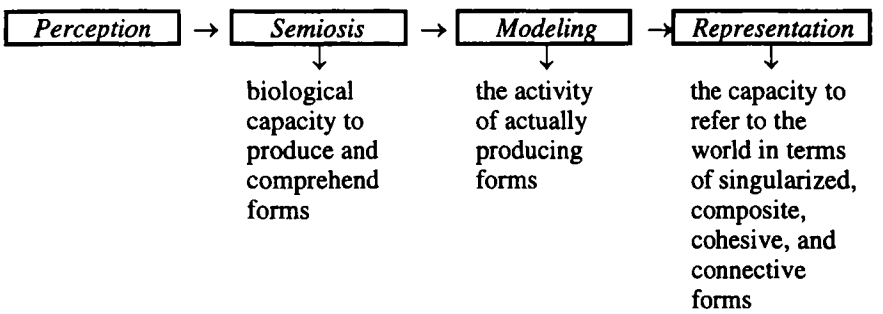

Figure 3. Relation among semiosis, modeling, and representation

1.1.2 Concepts

Representation reveals how the human brain carries out its work of transforming *sensory knowing* into *conceptual knowing*. Concepts are mental forms. There are two basic types of concepts–concrete and abstract. A *concrete concept* is a mental form whose external referent is demonstrable and observable in a direct way, whereas an *abstract concept* is a mental form whose external referent cannot be demonstrated or observed directly. So, for example, the word *car* stands for a concrete concept because its referent, [a self-propelled land vehicle, powered by an internal-combustion engine], can easily be demonstrated or observed in the physical world. The word *love*, on the other hand, represents an abstract concept because, although [love] exists as an emotional phenomenon, it cannot be demonstrated

or observed directly, i.e., the emotion itself cannot be conceptualized apart from the behaviors, states of mind, etc. that it produces.

Concepts are formed in one of three general ways. The first is by *induction*. Induction is the process of deriving a concept from particular facts of instances. For example, a child who has not yet formed the concept of a [cat] might notice that certain types of animals s/he has encountered have whiskers. This feature would lead the child to induce that *any* such animal is imaginable (and thus representable) as a creature [with whiskers]. The second way in which humans form concepts is by *deduction*, the opposite of induction. For instance, a child who has formed the concept of [cat] would be able to deduce whether a specific mammal which s/he encounters for the first time is a [cat] or not by observing if it fits the general form of a [cat] in h/er mind. Finally, concepts are formed through *abduction*. For the present purposes, this can be defined simply as the process by which a new concept is derived on the basis of an existing concept which is perceived intuitively as having something in common with it. Abduction constitutes "best guess inferencing". A classic example of abductive reasoning is provided by the annals of science. The English physicist Ernest Rutherford (1871-1937) proposed a theory of atomic structure whereby he guessed that the inside of an atom had the structure of an infinitesimal solar system, with electrons behaving like little planets orbiting around an atomic nucleus. Rutherford's model of atomic structure was, in effect, an abduction as to what the inside of an atom looked like.

The distinction between concrete and abstract concept-formation is, needless to say, a convenient one. In actual fact, there are many degrees of concreteness and abstraction in conceptualization that are influenced by various kinds of psychological and social factors (Leech 1981: 9-23). Suffice it to say here that most of the raw, unorganized information that comes from seeing, hearing, and the other senses is organized into useful *concepts* by representational forms that have been arrived at through induction, deduction, or abduction. Moreover, it is now evident that the type of conceptualization process enlisted depends on the kind of form that the human mind seeks to extract from a specific situation. Often, all three processes–induction, deduction, abduction–are involved in a complementary fashion.

Since concepts are mental forms, it follows that the *form* that *knowledge* assumes depends on the type of *modeling* used. To see why this is necessarily so, consider the following anecdotal rendition of the notion of *indeterminacy* in physics formulated by Werner Heisenberg (1901-1976). Suppose that a scientist reared and trained in New York observes a physical event that s/he has never seen before. Curious about what it is, s/he takes out a notebook and writes down h/er observations in American English. At the instant that the American scientist observes the event, another scientist, reared and trained in the Philippines who speaks only the indigenous Tagalog language, also sees the same event. The Philippine scientist similarly takes out a notebook and writes down h/er own observations in Tagalog. Now, the question is: *To what extent will the contents of the observations, as written in the two notebooks, coincide?* The answer, of course, is that the two sets of observations will not coincide completely. The reason for this is not due, clearly, to the nature of the event, but rather to the fact that the observers were different people, and that the representational systems used (English vs. Tagalog) provided each scientist with different verbal forms for characterizing the event. So, as Heisenberg aptly suggested, the true nature of the event is indeterminable, although it can be investigated further, paradoxically, on the basis of the notes taken by the two scientists. Those notes are the de facto *models* that the scientists made of the event, both of which can be used to conceptualize the event, albeit *from different representational perspectives.*

1.1.3 Forms of meaning

The psychologist C. K. Ogden and the literary critic I. A. Richards argued in their classic 1923 work, titled appropriately *The Meaning of Meaning*, that it is impossible to define the notion of *meaning*. To the best of our knowledge, no significant progress has been made since in defining this term with any degree of accuracy. For the present purposes, it is sufficient to equate *meaning* with the particular *concept* elicited by a specific *representational form.* In traditional sign theory, the former is called the *signified*, and the latter, the *signifier.*

Human representation, as Ogden and Richards further observed, is a highly variable process. Like the indeterminacy involved in understanding natural phenomena, so too the exact nature of a *signified* is indeterminable in any objective sense, because its interpretation is shaped by situation, context, historical processes, and various other factors external to semiosis.

Semiotic theory has identified three main kinds of signifieds that representational forms encompass: *denotata, connotata*, and *annotata*. A *denotatum* is the initial referent (or referential domain) captured by a form. The process of representation in this case is called *denotation*. The denotatum of the word *house*, for example, elicits a singularized referent, namely [structure for human habitation]. Now, in human representational behavior, denotata can be extended freely to encompass other kinds of referents or referential domains, known as *connotata*, that appear to have something in common with them. This extensional process is known as *connotation*. For example, the meaning of *house* as a [structure for human habitation] can be extended to encompass connotata such as [audience], as in "The *house* roared with laughter"; and [legislative assembly], as in "The *house* is in session now". The salient characteristic of such connotata is that they extend the form of the initial referent–e.g., [structure for human habitation]–by implication: audiences and legislative assemblies do indeed imply [structures] of special kinds that [humans] can be said to [inhabit (occupy)] in some specific way. Texts and codes can likewise be extended freely to encompass an infinitude of connotata. Dress codes, for example, are regularly designed to evoke diverse social and/or group-specific connotata. Finally, the meaning of any form is influenced by subjective and/or group-specific interpretive *annotata*: e.g., the word *house* elicits subjective meanings that will vary according to an individual's or specific group's perception of [structures for human habitation]. An *annotatum* can be defined simply as the interpolation or assignment of a subjective and/or social meaning to a form (sign, text, etc.).

1.2 Modeling systems

The types of forms discussed above are the end-results of representational activities undergirded by three different, but interrelated,

modeling systems present in the human brain, corresponding *grosso modo* to what Charles Peirce (1839-1914) called *firstness*, *secondness*, and *thirdness*. The child's earliest strategy for knowing an object with h/er senses is, in fact, a *firstness* strategy (see above §1.1.1). The modeling system that underlies firstness forms of representation is the *primary modeling system* (PMS). The PMS can be defined as the instinctive ability to model the *sensory* or *perceptual* properties of referents. The child's subsequent attempts to refer to the object through vocal imitation and/or manual indication constitute a *secondness* knowing strategy. The modeling system that guides these attempts is the *secondary modeling system* (SMS). The SMS can be defined as the capacity to refer to objects with *extended* primary forms and with indexical (indicational) forms. Finally, in learning to use a culture-specific name to refer to an object, the child is engaging in a *thirdness* form of knowing. H/er ability to do so is dependent upon the *tertiary modeling system* (TMS), which can be defined as the capacity to acquire and utilize the symbolic resources of culture-specific abstract systems of representation.

These three systems can be characterized succinctly in developmental terms as follows:

- *Primary Modeling System* (PMS) = the system that predisposes the human infant to engage in sense-based forms of modeling.
- *Secondary Modeling System* (SMS) = the system that subsequently impels the child to engage in extensional and indexical forms of modeling.
- *Tertiary Modeling System* (TMS) = the system that allows the maturing child to engage in highly abstract (symbol-based) forms of modeling.

1.2.1 Modeling systems theory

Although modeling systems theory (MST) has roots in the work of various twentieth-century structuralist semioticians, it has never really blossomed forth as a comprehensive theoretical and methodological framework for general use in theoretical semiotics (e.g., Sebeok 1994). The elemental axiom, around which we have fashioned

our own framework for MST in this book, is the conception that all representational phenomena can be grouped into four broad types– singularized, composite, cohesive, connective. From this axiom six principles follow:

- Representation is the end-result of modeling (the *modeling principle*).
- Knowledge is indistinguishable from how it is represented (the *representational principle*).
- Modeling unfolds on three levels or dimensions, of which iconicity and indexicality (see below §1.3.2) are prior developmentally and cognitively to symbolicity (§1.3.2) (the *dimensionality principle*).
- Complex (abstract) models are derivatives of simpler (more concrete) ones (the *extensionality principle*).
- Models and their meanings are interconnected to each other (the *interconnectedness principle*).
- All models display the same pattern of structural properties (the *structuralist principle*).

Needless to say, we cannot go here into the many interesting philosophical problems related to what is knowledge. The *representational principle* implies simply that in order for something to be known and remembered, it must be assigned some representational form. The *modeling principle* asserts that modeling is the activity that underlies representation. The *dimensionality principle* maintains that there are three dimensions or systems involved in modeling– primary (iconicity), secondary (indexicality and extensionality), and tertiary (symbolicity). The *extensionality principle* posits that abstract forms are derivatives of more concrete, sense-based forms. The *interconnectedness principle* asserts that a specific form is interconnected to other forms (words to gestures, diagrams to metaphors, etc.). The *structuralist principle* claims that certain elemental structural properties characterize all modeling systems and forms. These are: *paradigmaticity, syntagmaticity, analogy, synchronicity, diachronicity,* and *signification.*

1.2.2 Structural properties

Paradigmaticity is a minimal differentiation property. To speakers of English, the two words *pin* and *bin* are kept distinct by a perceptible auditory difference in their initial sounds. This differentiation feature of sound systems is known in linguistics as *phonemic opposition*. Similarly, in classical Western music, a major chord is perceivable as distinct from a minor chord in the same key by virtue of a half tone difference in the middle tone of the chord. As such examples show, paradigmaticity is definable as the property of forms whereby some minimal feature is sufficient to keep them differentiated from all other forms of the same kind.

Syntagmaticity is a combinatory property. Forms such as *tpin, tpill, tpit,* and *tpeak*, for instance, would not be legitimate words in English because the initial sequence /tp/ + [vowel] is not characteristic of English word-formation, whereas words beginning with /sp/ + [vowel] would: *spin, spill, spit, speak*. This combinatory feature of words is called *syllable structure*. Similarly, a major chord is recognizable as such only if the three tones are combined in a specific way: [tonic] + [median] + [dominant]. Syntagmaticity is definable as the property whereby the components of a form are combinable in some specifiable way.

Analogy is an equivalence property, by which one type of form can be replaced by another that is perceived as being comparable to it. The English word *cat* is analogous to the Spanish word *gato*; European playing cards can replace American cards if an analogy is made between European and American suits; Roman numerals can replace Arabic numerals through simple conversion; and so on.

Synchronicity refers to the fact that forms are constructed at a given point in time for some particular purpose or function; and *diachronicity* to the fact that they are subject to change over time. The change that a form undergoes is not random, but rather, governed by both structural tendencies characterizing the code to which it belongs and external contextual (social, situational, etc.) influences. As an example, consider the word *occhio* 'eye' in Italian. The original form of this word was Latin *oculus*. Over time it became *oclu* (as various philological sources attest), and then *occhio*. These changes in physical form, however, did not come about haphazardly.

The elimination of the middle vowel of *oculus (oclus)* and the subsequent change of *cl* to *cchi* (phonetically [kky]) were structural tendencies within the late (Vulgar) Latin phonemic system.

Finally, *signification*, refers to the relation that is established between a form and its meaning. It is, more strictly, the relation that holds between the physical make-up of the form itself, the *signifier*, and the *referent* or *referential domain* to which it calls attention, namely the *signified*. As we saw above, there are three kinds of signification processes (§1.1.3)–denotation, connotation, and annotation.

The structural properties of forms are summarized below in table 1:

Table 1. Structural properties of forms

Property	Features/Functions/Manifestations
paradigmaticity	differentiation, recognizability
syntagmaticity	combination, arrangement
analogy	equivalence, replacement
synchronicity	structure and meaning of a form at a specific point in time
diachronicity	change in the structure and/or meaning of a form over time
signification	denotation, connotation, annotation

1.2.3 Biosemiotics

The modern-day practice of semiotics traces its origins to the writings of two scholars at the threshold of the twentieth century–the Swiss linguist Ferdinand de Saussure (1857-1913) and the American philosopher Charles S. Peirce (1839-1914). As an autonomous field of inquiry, it was expanded and developed throughout the twentieth century by Charles Morris, Roland Barthes, Louis Hjelmslev, Roman Jakobson, A. J. Greimas, Claude Lévi-Strauss, Juri Lotman, Thomas A. Sebeok, and Umberto Eco, to mention but a few.

As mentioned above (§1.1), in its oldest usage, the term *semeiotics* was coined by Hippocrates to alert medical practitioners to the value of knowing how to decipher bodily symptoms in order to carry out accurate diagnoses and formulate suitable prognoses of dis-

eases. The study of *sema* 'signs' became the prerogative of philosophers around the time of Aristotle (384-322 BC) and the Stoic philosophers who were, in fact, among the first to take on the task of investigating word-signs in non-medical terms, characterizing them in terms of three dimensions: (1) the physical word itself (e.g., the sounds that make up the word *blue*); (2) the *referent* to which it calls attention (a certain category of color); (3) its evocation of a *meaning* (what the color entails psychologically and socially).

The next major step forward in the study of forms was the one taken by St. Augustine (354-430 AD). This philosopher and religious thinker was among the first to distinguish clearly between *natural* and *conventional* (artificial) forms, and to espouse the view that there was an inbuilt *interpretive* component to the whole process of representation–a view that was consistent with the hermeneutic tradition established by Clement of Alexandria (150?-215? AD), the Greek theologian and early Father of the Church.

John Locke (1632-1704), the English philosopher who set out the principles of empiricism, introduced the formal study of signs into philosophy in his *Essay Concerning Human Understanding* (1690), anticipating that it would allow philosophers to understand the intrinsic relation between representation and knowledge. But the task he laid out remained in virtual disregard until the writings of Saussure and Peirce. It is the work of the latter two which contains the foundational concepts for circumscribing an autonomous field of semiotic inquiry, aiming to study signs as elements related to each other systematically, rather than as isolated, material things in themselves. The key concept in semiotics is, in fact, that no single form can bear meaning unless it enters into systematic connections with other forms. These connections are traditionally considered to be binary in nature. Recall from above (§1.2.2) that the words *pin* and *bin* are kept distinct by a perceptible auditory difference in their initial sounds. This paradigmatic feature is the result, in effect, of a *binary opposition* between initial /p/ and /b/: the former is a voiceless consonant (produced without the vibration of the vocal cords); the latter a corresponding voiced consonant (produced with the vibration of the vocal cords). The physical feature [vibration of the cords], more commonly designated as [voice], is either present [+] or absent [-] in the constitution of a sound. Structurally, [±voice] is a binary phonetic

feature that keeps various sounds distinct. The initial sounds in *pin* and in *bin* are two such sounds: /p/ is articulated as [-voice] and /b/ as [+voice].

MST is one of the fruits of an evolutionary branch of semiotics that has come to be called *biosemiotics* (e.g., Sebeok and Umiker-Sebeok 1992; Hoffmeyer 1996). The aim of biosemiotics is to extend the notions of general semiotics to encompass the study of semiosis and modeling in all species. The premise which guides biosemiotics is, in fact, that the forms produced by a specific species are constrained by the *modeling system(s)* which has evolved from its anatomical constitution. The aim of biosemiotics is to study not only the species belonging to one of the five kingdoms, Monera, Protoctista, Animalia, Plantae, and Fungi, but also to their hierarchically developed component parts, beginning with the cell, the minimal semiosic unit, estimated to consist of about fifty genes, or about one thousand billion (10^{12}) intricately organized atoms. Viruses are omitted from the biosemiotic purview because they are neither cells nor aggregations of cells.

Human bodies are assemblages of about one hundred thousand billion (10^{14}) cells, interconnected by an incessant flux of vital nerve signals. The origin of nucleated cells lies in a "semiosic collaboration" among single cells, which evolved less than one billion years after the formation of Earth. Simple cells likely fused at a certain point in time to form the complex assemblages of cells composing each living being. These assemblages constitute organs, which, in turn, constitute organisms, and which, in their turn, lead to the constitution of social systems (interacting organisms) of ever increasing complexity. The genetic code, of course, governs the exchange of signals on the cellular level; hormones and neurotransmitters mediate among organs and between one another (the immune defense system and the central nervous system are interconnected by a dense flow of two-way signal traffic); and a variety of signals conjoin organisms into a network of relations with each other as well as with the environment which sustains them.

In a phrase, the target of biosemiotics is the semiosic behavior of all living things. The main branches of biosemiotics are *phytosemiotics*, the study of semiosis in flora (Krampen 1981),

zoosemiotics, the study of semiosis in fauna (e.g., Sebeok 1963, 1972a), and *anthroposemiotics*, the study of semiosis in humans:

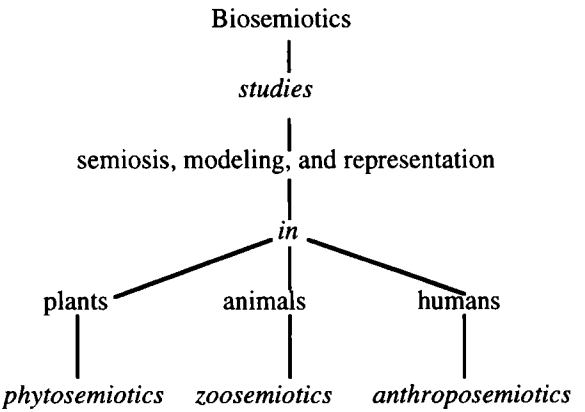

Figure 4. Branches of biosemiotics

In general, the method of inquiry in zoosemiotics is differentiated according to whether the animal is a herbivore or a predator, since the nutritional mode of the animal species shapes the features of its modeling system. The study of anthroposemiosis requires special treatment because the most distinctive trait of human semiosis is that it permits both nonverbal–demonstrably derived from its primate ancestry–and uniquely verbal modeling. The study of verbal modeling behavior constitutes the subject matter of the most advanced and highly formalized branch of semiotics, *general linguistics*.

Semiosis occurs at a molecular and chemical level first and is, thus, regulated by the genetic code, by humoral as well as cell-mediated immune reactions, and by the large number of peptides present in the central nervous system, functioning as neurotransmitters. The olfactory and gustatory senses are likewise "semiochemical". Even in vision, the impact of photons on the retina differentially affects the capacity of the pigment rhodopsin, which fills the ocular rods to absorb light of different wavelengths. Acoustic vibrations and tactile impulses delivered via the thermal senses are also transformed into electrochemical signals. Such signaling systems are routinely linked by several channels simultaneously or in parallel–a linkage that introduces a degree of redundancy, by virtue