Meaning in the Age of Big Data

ABSTRACT

The most fascinating semiotic applications of recent years came not from semioticians, but from those who practice semiotics without knowing they do so (what I call the Monsieur Jourdain syndrome). Military and surveillance applications, genome sequencing, and the practice of phenotyping are immediate examples. The entire domain of digital computation, now settled in the Big Data paradigm, provides further proof of this state of affairs. After everything was turned into a matter of gamification, it is now an exercise in data acquisition (as much as possible) and processing at a scale never before imagined. The argument made in this study is that semiotic awareness could give to science and technology, in the forefront of human activity today, a sense of direction. Moreover, meaning, which is the subject matter of semiotics, would ground the impressive achievements we are experiencing within a context of checks-and-balances. In the absence of such a critical context, the *promising* can easily become the *menacing*. To help avoid digital dystopia, semiotics itself will have to change.

Keywords: language, meaning, big data, representation, semiosis, narration, story

1. Preliminaries

Language interaction is the most definitory activity of the self-constitution of the species *homo sapiens*. Self-constitution—i.e., the making of ourselves through the activity in which we are involved (Nadin [1997])—takes place at all levels of life—in animals and even plants. However, the making and remaking of the human being under circumstances involving language associate the process of self-constitution with awareness. While it is true that a bacterium swimming upstream in a glucose gradient marks the beginning of goal-directed intentionality [Sowa 2017], it is only through language that purposiveness—a particular expression of anticipation—becomes possible, and indeed necessary [Brentano 1874; Margulis 1995]. Of course, language-based human interaction is only one among the many sign systems through which self-constitution takes place. It became the focus of inquiry (philosophical, scientific, aesthetic, social, etc.) since all other forms of expression (images, sounds, odors, etc.) are, so to say, *more natural*, that is, they appear as extensions of the senses. Language conjures the association with thinking, and as such it is present even in sign processes transcending language. The abstraction of mathematical or chemical formulae invites a language of explanations: what we would call *decoding*. Images, sounds, textures, rhythms, and whatever else are never language-free. Therefore, a re-examination of conceptions of language—the classic path from Aristotle to the computational theories of our days—is almost inevitable.

Today's ontology engineering, i.e., translating language into computable specifications of everything (for example, "Siri, what's the time?" new medical treatments, new materials, new forms of transactions) is nothing but the expression of how we can tame language so that machines (of today or of tomorrow) can "understand" what we want. Ideally, such machines would think the way we do. With this subject, we are moving from "What is X?" (any subject,

such as what is matter, or sex, or justice) to how we make new entities, how we think, how we evaluate thinking.

Wittgenstein is laughing louder than ever (at least in spirit). In rejecting the *name theory of language* (associated with Socrates), he knew that words do not correspond to things. (By the way, Eco was a follower of Wittgenstein in this sense.) Although not a semiotician himself, Wittgenstein wrote in *Philosophical Investigations* (PI) what everyone active in semiotics should learn by heart: *Every sign by itself seems dead. What gives it life? In use, it lives* [Wittgenstein 1953]. In *On Interpretation*, Aristotle distinguished between *sêmeion*—natural sign, such as a symptom of disease—and *symbolon*—"casting together," adopted by convention, shared. But he remained pretty much captive to the idea that signs—and, by extension, words—correspond to objects, "same for everyone, and so are the objects of which they are likeness" [Aristotle, 350 BCE; see also Dewart 2016]. With Wittgenstein, we experience a change in perspective: signs, and especially language, which was his focus, are associated with tools. This translates as: language is associated with activities. This is exactly what ontology engineering means in our days: specify an object or process, and program the computer to produce it or recognize it. Make it even actionable: when risk is identified, a process affected by risk can be avoided or triggered. In Wittgenstein's words:

> Think of the tools in a toolbox: there is a hammer, pliers, a saw, a screwdriver, a rule, a glue-pot, nails and screws. The functions of words are as diverse as the functions of these objects [PI, 11]

(Of course, the toolbox is now expressed virtually in one program or several, or in the ubiquitous apps.) It is no surprise then that Stuart Kauffmann [2011] adopts the screwdriver: his focus is on relational features (a subject I shall revisit in this study). He knows that no computer process can capture all functions of objects, as we use them, some according to their purpose, others according to purposes we make up. (Kauffman's take on the screwdriver is actually about the limits of algorithmic computation.)

But let's stay focused. What this study proclaims is the need to *rethink the foundations of semiotics*. In concrete terms: the sign as the knowledge domain of semiotics explains why semiotics entraps itself, as a discipline, in a dead-end street where all that can be expected from it are reflections in a house of mirrors, all showing the same image from many viewpoints, but none suggesting the path out of this self-delusional condition. Peirce—to whom we owe the modern foundation of semiotics—was aware of the danger of focusing on the sign. The interpretant, as part of the sign definition (uniting object, representamen, and interpretant) was meant to give a dynamic dimension to sign-based activities. But the notion of semiosis remained undefined; its nature as process was mostly ascertained, but not endorsed with an operational function. In a dictation for Schlick (December, 1932), Wittgenstein gave a convincing argument for the need, and indeed possibility, to transcend the sign as label, and word as name theory: "…if I were asked what knowledge is, I would enumerate instances of knowledge and add the words 'and similar things'." [Wittgenstein and Waisman 2003]. For describing the dynamics, how various instances of something (such as what is knowledge, what is life, what is justice) complete each other, he chose the metaphor of the game. Of course, there were no video or computer games to refer to (and even less to predict), but rather "board games, card games, bull-games, athletic-games" in which he discerned "similarities, affinities, like for family—build, features, color of eyes, gait, temperament…." Any choice is different, and any attempt at a new

foundation is based on the narration of describing the life of signs, and thus of language characterized by their use. Narration is the record of the actions. With the risk of getting ahead of myself, I shall state here that the interpretation aspect in my conception of semiotics is expressed in stories associated with a narration: examine the record and interpret it (but I shall eventually return to this).

To take a sign out of context, i.e., out of the pragmatics in which it participates, is in my view not different from taking a pawn from the chessboard and asking someone who does not play the game what it is. Wittgenstein got it right: outside of the game of chess, the pawn is, for those not familiar with the game, a piece of wood, or metal, or plastic, a dead symbol. In my view, outside of the narration represented by the game (sequence of moves leading to the game's outcome), neither the pawn nor any other figure, not even the chessboard or the game itself, makes sense. Their meaning—the actual object of semiotics—is in the narration: the game played by the rules shared by those involved. The stories of particular games—e.g., Big Blue beating Kasparov, or some champion beaten by a less known player—are interpretations. Deep Learning (in some embodiment of algorithmic AI, such as AlphaGo beating Fan Hui, the champion at Go) are interpretations with an open-ended semiosis. By the way: Kasparov knows what a pawn is; Big Blue does not. Fan Hui knows what Go means, AlphaGo does not. The game was reduced to permutations within a large space of possibilities, and the winner is not intelligence but computational brute force! Kasparov as a winner, or Fan Hui as a winner would have enjoyed the meaning of the game; on the machine side, the engineers enjoy the success of computer performance, expressed in numbers (Big Data at work).

Having sketched here in the Preliminaries the path to the outcome of the study, I will revisit arguments leading to my attempt at a new foundation of semiotics.

2. Culture as Sign System

The foundation of semiotics around the notion of the sign (shortly mentioned in the Preliminaries) explains its accomplishments. But it also suggests an answer to the question of what led to the failure of the discipline to become the backbone of modern sciences and humanities; or, alternatively, to ascertain its own pragmatic relevance. Indeed, not living up to its possibilities affected not just its own credibility as a specific knowledge domain, but also my claim that it might act as a useful participant in other endeavors. Relevant is the fact that the sciences and the humanities are becoming more and more fragmented in the absence of an integrating coherent semiotic theory. The necessity of such a theory is also highlighted by the extreme focus on quantitative aspects of reality, to the detriment of understanding qualitative aspects, in particular, the meaning of change. Physics, and even chemistry, economics, cognitive science, etc., without mathematics are not a conceivable alternative. But few scientists realize that only when semiotics might acquire the same degree of necessity will conditions be created for complementing the obsession with depth (specialized knowledge) with an understanding of breadth, corresponding to an integrated view of the world.

Many attempts have been made to write a history (or histories) of semiotics: biographies of semioticians, history of semantics, history of symptomatology, anthologies of texts relevant to semiotics, and the like. Few would argue against the perception that we have much better histories of semiotics (and semioticians) than contributions to semiotics as such. What can be learned from the ambitious projects of the past is that semiotic concerns can be identified along the entire history of human activity. In trying to define *The Subject of Semiotics*, Kaja Silverman [1984] correctly identifies authors (in particular, Eco [1976], as well as Lotman [1990]) who

considered culture as the subject matter of semiotics. Roland Posner (in "Basic Tasks of Cultural Semiotics" [2004]) correctly noticed that Cassirer [1923-1929] (to whose work we shall return) analyzed sign systems in culture, but also cultures as sign systems. Ana Maria Lorusso [2015], writing in the series *Semiotics and Popular Culture* (edited by Marcel Danesi) advanced a cultural perspective. Initially, semiotic activity was difficult to distinguish from actions and activities related to survival. Over time, semiotic concerns (especially related to language) constituted a distinct awareness of what is needed to succeed in what we do and, furthermore, to be successful.

The aim being the grounding of semiotics, we will examine the variety of angles from which knowledge was defined from its domain. In parallel to the criticism of conceptions that have led to the unsatisfactory condition of semiotics in our time, we will submit a hypothesis regarding a foundation different from that resulting from an agenda of inquiry limited to the sign. Finally, we will argue that the semiotics of semiotics (embodied in, for instance, the organization dedicated to its further development) deserves more attention, given the significance of "organized labor" to the success of the endeavor. Evidently the American Academy of Arts and Sciences will continue to celebrate accomplishments in domains such as mathematics, physics, computer science, etc., but, so far, not semiotics, whose contributions to society are more difficult to assess. While the grounding of semiotics in the dynamics of phenomena characteristic of a threshold of complexity associated with the living (Figure 1) will be ascertained, the more elaborate grounding in anticipation, is a subject beyond our aims here (see Nadin [2012]).

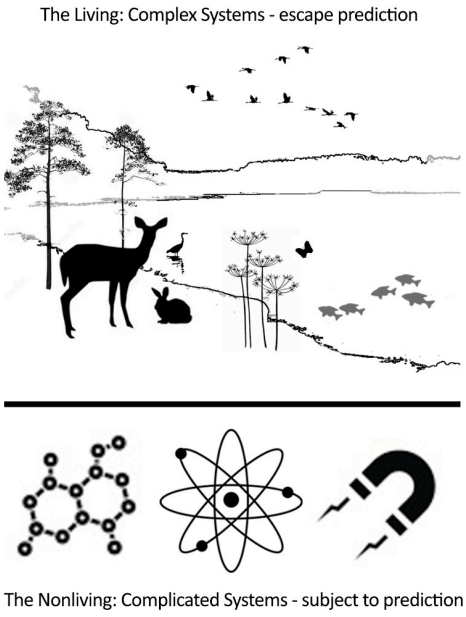


Figure 1. Semiotics at the threshold of complexity defining the living

3. Zoon Semiotikon

Paul Mongré (in 1897) knew more semiotics than Charles Morris (in 1938). Let me explain this statement. We don't really need an agreement on what the subject of semiotics is, or what a sign is, in order to realize that the underlying element of any human interaction, as well as interaction with the world, is semiotic in nature. Interaction takes place through an intermediary. Signs or not, semiotics is about the *in-between*, about *mediation*, about guessing what others do, how nature will behave. Even two human beings touching each other is more than the physical act. In addition to the immediate, material, energetic aspect, the gesture entails a sense of duration, immaterial suggestions, something that eventually will give it meaning. It is a selection (who/what is touched) in a given situation (context). And it prompts a continuation.

But there is more to this preliminary observation. Just as a detail, the following observation comes from brain imaging science: The three most developed active brain regions—one in the prefrontal cortex, one in the parietal and temporal cortices are specifically dedicated to the task of understanding the goings-on of other people's minds [Mitchell, De Houwer, Lovibond 2009]. This in itself suggests semiotic activity related to anticipation. Actions, our own and of others, are "internalized," i.e., understood and represented in terms of what neurobiology calls *mental states*. So are intentions. In this respect, Gallese [2001, 2009] wrote about mind-reading and associated this faculty with mirror neurons. From this perspective, the semiotics of intentions, desires, and beliefs no longer relies on signs, but on representations embodied in cognitive states.

It would be presumptuous, to say the least, to rehash here the detailed account of how the human species defined itself, in its own making, through the qualifier *zoon semiotikon* (Nadin, [1997, pp. 197, 226, 532, 805]), i.e., semiotic animal. Felix Hausdorff, concerned that his reputation as a mathematician would suffer, published, under the pseudonym Paul Mongré, a text entitled *Sant' Ilario. Thoughts from Zarathustra's Landscape* [1897]. A short quote illustrates the idea:

> The human being is a semiotic animal; his humanness consists of the fact that instead of a natural expression of his needs and gratification, he acquired a conventional, symbolic language that is understandable only through the intermediary of signs. He pays in nominal values, in paper, while the animal in real, direct values […] The animal acts in *Yes* and *No*. The human being says *Yes* and *No* and thus attains his happiness or unhappiness abstractly and bathetically. *Ratio* and *oratio* are a tremendous simplification of life. . . . (p.7). [Translation mine].

Through semiotic means, grounded in anticipatory processes (attainment of happiness, for instance), individuals aggregate physical and cognitive capabilities in their effort. Indeed, group efforts make possible accomplishments that the individual could not obtain.

Obviously, this perspective is much more comprehensive than the foundation of semiotics on the confusing notion of the sign. In what I described, there is no sign to identify, rather a process of understanding, of reciprocal "reading" and "interpreting." The decisive aspect is the process; the representation is the unfolding of the process defining cognitive states. This view has the added advantage of explaining, though indirectly, the major cause why semiotics as the discipline of signs continues to remain more a promise than the "universal science" that Morris [1938] chose to qualify it. A discipline dependent upon a concept (on which no agreement is

possible) is much less productive than a discipline associated with activities: What do semioticians do?

4. Knowledge is a Construct

Wittgenstein's views on knowledge led to the understanding of language as a tool for knowledge acquisition. We have access to a large body of shared knowledge on the evolution of humankind, in particular on the role of various forms of interaction among individuals and within communities. The entire history of science and technology is part of this body of shared knowledge. Also documented is the interaction between the human being and the rest of the world. This knowledge is available for persons seeking an understanding of semiotics in connection to practical activities—where the sign lives. This is not different from the situation of mathematics. Let us recall only that geometry originates in activities related to sharing space, and eventually to laying claim to portions of the surroundings, to ownership and exchange, to production and market processes. There are no triangles in the world, as there are no numbers in the world, or lines. To measure a surface, i.e., to introduce a scale, is related to practical tasks. Such tasks become more creative as improved means for qualifying the characteristics of the area are conceived and deployed. To measure is to facilitate the substitution of the real (the measured entity) with the measurement, i.e., representation of what is measured. To travel, to orient oneself, to navigate are all "children of geometry," extended from the immediacy of one's place to its representation. This is where semiotics shows up. The experiences of watching stars and of observing repetitive patterns in the environment translate into constructs, which are integrated in patterns of activity. Rosen took note of "shepherds [who] idly trace out a scorpion in the stars..." (the subject of interest being "relations among components"). He also brought up the issue of observation: "Early man . . . could see the rotation of the Earth every evening just by watching the sky" (Rosen [1985, p. 201]). In the spirit of Hausdorff's definition of the semiotic animal, Rosen's suggestion is that inference from observations to comprehension is not automatic: An early observer "could not understand what he was seeing," as "we have been unable to understand what every organism is telling us," [p. 201]. The "language" in which phenomena (astronomic or biological) "talk" to the human being is that of semiotics; the human being constructs its "vocabulary" and "grammar." This applies to our entire knowledge, from the most concrete to the most abstract.

Mathematics, in its more comprehensive condition as an expression of abstract knowledge, is a view of the world as it changes. It is expressed in descriptions such as points, lines, and intersections; in formal entities, such as circle, square, volume, etc. It is expressed numerically, e.g., in proportions, which means analytically, through observations of how things change or remain the same over time. It can as well be expressed synthetically, that is, how we would like to change what is given into something else that we can describe as a goal (using numbers, drawings, diagrams, etc.).

5. To Understand the World

Informed by mathematics, we gain an intuitive understanding of how humans, in making themselves, also make their comprehension of the world part of their own reality. The perspective from which we observe reality is itself definitory for what we "see" and "hear," for our perceptions, and for our reasoning. This should help in realizing that the foundation of

semiotics is, in the final analysis, a matter of the angle from which we examine its relevance. The hypothesis we shall address is that the definition upon the ill-defined notion of the sign is the major reason why semiotics remains more a promise than an effective theory. The failure of semiotics is semiotic: the representation of its object of inquiry through the entity called *sign* is relatively deceptive. It is as though someone were to establish mathematics around the notion of the number, or the notion of an integral, or the notion of sets. Indeed, there have been mathematicians who try to do just that; but in our days, those attempts are at best documented in the fact that there is number theory (with exceptional accomplishments), integral calculus, and set theory (actually more than one). But none defines mathematics and its goals. They illustrate various mathematical perspectives and document the multi-facetedness of human abstract thinking.

If we focus on the sign, we can at most define a subset of semiotics: sign theory, around classical definitions (as those of Saussure, Peirce, Hjelmslev, for example). But semiotics as such is more than these; and it is something else. Interaction being the definitory characteristic of the living, and semiotics its underlying condition, we could identify as subfields of interest the variety of forms of interaction, or even the variety of semiotic means through which interactions take place. Alternatively, to make interactions the subject of semiotics (as Sadowski attempted [2010]) will also not do because interactions are means towards a goal. *Goals* define activities. Activities integrate actions. Actions are associated with representations.

What is semiotics?" not unlike "What is mathematics?" or for that matter "What is chemistry, biology, or philosophy?" are abbreviated inquiries. In order to define something, we actually differentiate. Semiotics is not mathematics. It does not advance a view of the world, but it provides mathematics with some of what it needs to arrive at a view of the world—with a language. Mathematicians do not operate on pieces of land, or on stones (which mathematics might describe in terms of their characteristics), or on brains, on cells, etc. They produce and operate on *representations*, on semiotic entities conjured by the need to replace the real with a description. The *goal* of the mathematicians' activity, involving thinking, intuition, sensory and motoric characteristics, emotions, etc., is abstraction. Their *activity* focuses on very concrete semiotic entities that define a specific language: topology, algebra, category theory, etc.

Among many others, Nietzsche [1975, p. 3]) observed that "Our writing tools are also working, forming our thoughts." As we program the world, we reprogram ourselves: Taylor's assembly line "reprogrammed" the worker; so do word and image processing programs; so do political programs, and the programs assumed by organizations and publications.

6. To Represent is to Present Again

To represent is one of the fundamental forms of human activity. *To express* is another such form. The fact that there might be a connection between how something (e.g., pain) is expressed (through a scream) and what it expresses is a late realization in a domain eventually defined as cognition. The relation between what (surprise, for example, can also lead to a scream) is expressed and how expression (wide-open eyes) becomes representation is yet another cognitive step. Furthermore, there is a relation between what is represented (e.g., fear) and the means of representation, which can vary from moving away from the cause of the fear to descriptions in words, images, etc. Moreover, to represent is to present one's self—as a living entity interacting with other living entities (individuals, as well as whatever else a person or person interact

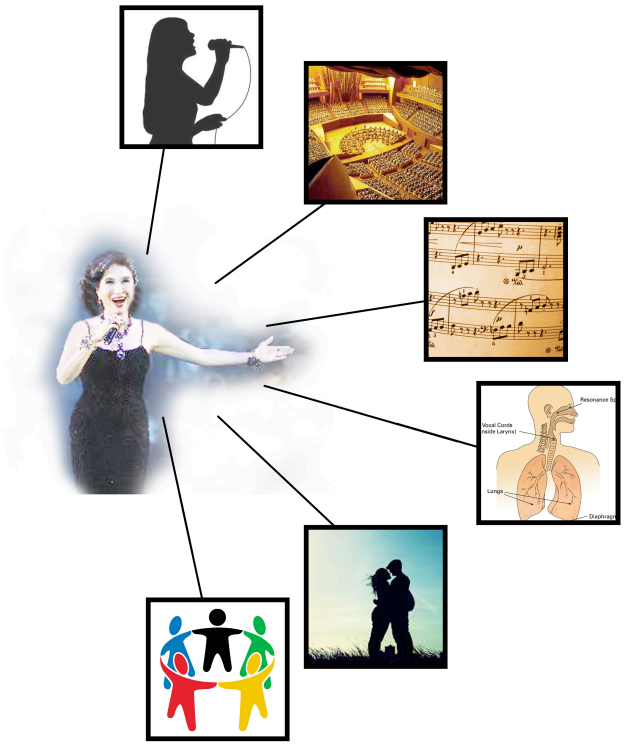


Figure 2. The subset of possible partial representations (musical score, drawing, video or film associated with melody, metaphor, visualization, etc.) complete the descriptions. Representations are always an open ended selection, from which representations of representations etc. can be also generated.

with)—as an identity subject to generalizations and abstractions. There are signs (usually called *symbols*, cf. Cassirer [1923-1929]) in mathematics, chemistry, and physics; more symbols are to be found in genetics, computer science, and artificial intelligence. But in these knowledge domains, they are not present as semiotic entities—i.e., as relevant to our understanding of interaction—but rather as convenient representations (of mathematical, chemical, or physical aspects), as formal entities, as means for purposes other than the acquisition and dissemination of semiotic knowledge. They are condensed representations. The integral sign ∫ stands for a limit of sums. It represents the operation (e.g., calculate an area, a volume). Let us recall Lewis Mumford's observations: No computer can make a new symbol out of its own resources," [1967, p. 29].

The abbreviated inquiries invoked earlier—What is semiotics? What is mathematics? What is chemistry?—are relevant because behind them are explicit questions: What, i.e., which specific form of human activity, do they stand for? What do they mediate? What semiotics, or mathematics, or chemistry stands for means: What are their specific pragmatic justifications? What can you do with them? Moreover, while mathematics does not depend upon other sciences, can the same be said about semiotics?

If we could aggregate all representations (Figure 2) we would still not capture reality in its infinite level of detail; nor could we capture dynamics. The living unfolds beyond our epistemological boundaries. We are part of it and therefore every representation will contain the observed and the observer. The infinite recursivity of our observations explains why the phase

space of the living is variable: with each new observation, the state of the observer and of the observed change. This is unavoidable. Considering the sequence of observations, translated into representations, we can say that the narrative of observation is by necessity incomplete.

The representation of different parts of the human body in the primary somatosensory cortex is a very clear example of the role of semiotic processes. Those representations change as the individual's activity changes. They facilitate preparation for future activities; they predate decisions and activities. They are in anticipation of change. The semiotics of the process is pragmatically driven. Let's recall Wittgenstein's observation on language as part of an activity. The narrative of life integrates semiotic representation. Think about the fascination with text messaging and how the fingers involved are represented in the cortex. The fact that text messaging affects driving (and leads to accidents) is only the next sequence in the narrative of living language. Semiotics understood in this vein returns knowledge regarding how technology empowers us, as it reshapes our cognitive condition at the same time.

7. Once More About Knowledge

Wittgenstein took note of the fact that language is deceptive. His view was that philosophical problems (and for that matter problems in general) arise from our language—the games we play—not in the world. His world—World War II is the broad context—is, for all practical purposes, not fundamentally different from ours (a continuous state of war, reflecting the competitive nature of capitalism). Migration (the millions seeking a new life away from war, misery, intolerance, terrorism, etc.), political instability, and climate change concerns are expressed in our language—i.e., in the deceptive semiotics of the media—at a scale different from that of reality. Words never corresponded to things; they only re-presented them, and even in this re-presentation they lie. "Semiotics is concerned with everything that can be taken as a sign. […] Semiotics is in principle the discipline studying everything which can be used in order to lie. [Eco 2017, p. 68]. However, the plans for building a dam, the design of a hammer or of a car carries knowledge that makes the real (dam, hammer, car, etc.) possible. This prompts the question of whether what we call *knowledge*—shared understanding of everything pertaining to life—is peculiar to semiotics as it is to the making of things. The idea that narration is what semiotics is about—i.e., the sequences of actions leading to conceiving what will become a dam, a hammer, a car, is no longer an abstract representation, but a concrete instantiation: we are what we do. The story is the outcome and its interpretations in use.

The reference is always the human being animated by the practical need to know in order to succeed, or at least to improve efficiency of effort under specific circumstances (context). Thus, "What is semiotics?" translates as "What defines and distinguishes human interactions from all other known forms of interaction?" Indeed, the interaction of chemical elements (i.e., chemical reaction) is different from that of two individuals. Obviously, some chemistry is involved; however, the interaction characteristic of the living is not reducible to chemistry. "Mind reading" is not *abracadabra*; it is not picking up some mysterious or real waves (electro or whatever); it is not second-guessing the biochemistry of neuronal processes. It is modeling in one's own mind what others are planning, what goals they set for themselves. In some way, this involves adaptive percept-action processes [Morris and Ward (eds.) 2005; Pinegger, Hiebel, Wriessnegger, Müller-Putz 2017].

Physical interaction at the atomic level is quite different from that at the molecular and macroscopic levels, and even more different at the scale of the universe. As exciting as it is in its

variety and precision, the physical interaction of masses (as in Newton's laws of mechanics) does not explain aggregation, e.g., the behavior of crowds, or the "wisdom of crowds." In the end, "What is semiotics?" means not so much to define its concepts (sign, sign processes, meaning, expression, etc.) as it means to address the question of whether whatever semiotics is, does it correspond to all there is, or only to a well-defined aspect of reality. Neither mathematics, nor chemistry, nor any other knowledge domain encompass all there is. One specific knowledge domain is not reducible to others. If the same holds true for semiotics, the specific knowledge domain would have to correspond to a well-defined aspect of reality. It is obvious, but worth repeating, that semiotics (not unlike mathematics, chemistry, physics, etc.) is a human product, a construct subject to our own evaluation of its significance.

Before there was mathematics, or chemistry, or physics, there was an activity through which individuals did something (e.g., kept records using knots, used a lever, mixed substances with the aim of making new ones,). In this activity, they constituted themselves as mathematicians, physicists, or chemists; and were recognized as such by others (even before there was a label for activities qualifying, in retrospect, as mathematics, physics, chemistry, etc.). In retrospect, we label such activities as semiotic: this is the narration of semiotics itself.

Returning to mathematics: Is the integrating view of the world it facilitates exclusively a human-generated representation of gnoseological intent and finality? Or can we identify a mathematics of plants or animals, of physical processes (such as lightning, earthquakes, the formation of snowflakes)? Does nature "make" mathematics? The fact that mathematics describes the "geometry" of plants, the movement of fish in water, and volcanic activity cannot be automatically translated as "plants are geometricians," or "fish are analysis experts," or "volcanoes are topologists." Rather, watching reality through the lenses of mathematics, we identify characteristics that can be described in a language (or several) that applies not to one specific flower or leaf, not to one specific fish or school of fish, not to one volcano, but to all activity, regardless where it takes place. The generality of mathematical descriptions, moreover mathematical abstraction, is what defines the outcome of the activity through which some individuals identify themselves as mathematicians (professional or amateur).

For the sake of clarity: Nature does not make mathematics, as it does not make semiotics. Anthropomorphism is convenient—"the language of plants," the "symbols of nature"—but confusing. Only with awareness of the activity is it epistemologically legitimized. There are no signs of nature, or semiotic processes of nature; there are human-constructed models for understanding nature. The same applies to machines: there is no semiotics in the functioning of a machine. It is made of parts assembled in such a way that it turns an input into a desired (or not) output. The human being projects semiotics into interaction with machines. Of course, there are signals, best expressed through values defining the physical process (e.g., electrons traveling along circuits). But to confuse signal—physical level—and sign—semiotic level—means to make semiotics irrelevant. Too many well-intended researchers operate in the space of ill-defined entities.

8. The Identity of the Semiotician

No doubt, identity is a concept anchored in Saussure's semiology. But here we pose a different question: Is there some generality, or level of abstraction, that can define the identity of a semiotician? Again, Wittgenstein would answer in the negative. Or are we all, regardless of what we do, semioticians (or *sémiologues*?), given that interaction, characteristic of all the living,

cannot be avoided. Moreover, given that we all indulge in representations and act upon representations, does this not qualify us as semioticians? Given that we all interpret everything—regardless of the adequacy of our interpretations—does this make us all semioticians? The entire domain of the living, not only that of human existence, is one of expression and interaction that seems to embody semiotics in action. Mental states are associated with neuronal activity. The physics and biochemistry, and the thermodynamics for this activity form one aspect. The other aspect is the understanding of each instance of the process, of the aggregate state to which it leads. However, there is a distinction between the activity and awareness of its taking place, of its consequences. Based on knowledge from different disciplines (biology, genetics, neuroscience, etc.), the following statement can be made: Semiotics at the genetic level, semiotics at the molecular level, and semiotics at the cell level, in association with information processes, are prerequisites for the viability of the living as such. Furthermore, it can be ascertained that bottom-up and top-down semiotic processes define life as semiosis, in parallel to its definition as information, i.e., energy related process (going back to the laws of thermodynamics) [Nadin 2010]. Awareness of semiotic processes is not characteristic of genes or molecules; neither is information awareness located where information processes take place. Awareness (of semiotics, or of information processes) corresponds to the meta-level, not to the object level.

What can we learn about semiotics—assuming that semiotics is a legitimate form of knowledge—by examining the world? First and foremost, that interaction, as a characteristic of the living, is extremely rich, and ubiquitous. Second, and not least important, life being change, interactions not only trigger change, but they themselves are subject to change. Observation yields evidence that some interactions seem more patterned than others (and accordingly predictable). Take the interaction between a newborn (human, animal) and parent. There is a definite pattern of nurturing and protection—although there are also cases of filial cannibalism (eating one's young, as do some fish, bank voles, house finches, polar bears). These patterns correspond to representations of the present and future, i.e., they are connected to anticipatory processes (underlying evolution). Or take sexual interactions (a long gamut, extended well beyond evolutionary advantage in the life of human beings); or interactions between the living and the dying. The epistemological condition of semiotics derives from the fact that life would continue even if there were no semioticians to ever observe it and report on what they "see" as they focus on interactions, or on the constructs we call sign processes. The existence of life, or the making of life, does not depend on adding semiotic ingredients to the combination of whatever might be necessary to make it. For that matter, it does not depend on adding mathematics or physics or chemistry to the formula. The awareness resulting from a semiotic perspective leads to the acknowledgment of such phenomena as living expression. Indeed, in the absence of representations, life would cease.

9. Engineering Interactions

But things are not as simple as a cookbook for life. The mathematics for the cookbook (also known as *algorithm*) is important in defining quantities and sequences in time (first bring water to a boil, add ingredients in a certain order, simmer). The semiotics is relevant not so much for cooking for oneself, but in supporting preparation of the meal for others. This is what representations do as they are passed along in the organism. Cells "work" for each other; a cell's state depends on the states of the adjacent or remote cells. (This is what inspired Conway's

"Game of Life" [1970]. The organism is the expression of all that is needed in terms of means of interaction—semiotic and informational—to make possible an aggregated whole of a nature different from that of its components. It is on account of complexity that this aggregation takes place and lasts as long as what we call *life*.

Expressed differently, semiotics is relevant for "engineering" interactions: recipes are the "shorthand" of cooking. They carry explicit instructions and implicit rules, that is, assumptions of shared experiences. Semiotics embodies the sharing, but does not substitute for the experience. The informational level corresponds to "fueling" the process, providing the energy. Taken literally, even the simplest recipe is disappointing. There is always something expected from those who will try it out. No recipe is or can be complete (in the same manner in which the use of a screwdriver presents an open-ended list of possibilities). The possibility to discover on your own what cannot be encapsulated in words, numbers, procedures, or images opens up the process of self-discovery. In this sense, semiotics is relevant for dealing with the question of what the future will bring: you mixed egg yolk and oil, and instead of getting mayonnaise, the ingredients start to separate. What now? At the level of the living, life, not mayonnaise, is continuously made. At the end of the life cycle, the ingredients separate, the semiotics disappears, information degrades. Semiotics encodes in generating representations, and decodes in interpreting representations. These are distinct practical functions otherwise inconceivable. *Encode* means as much as semiotic operations performed on representations. *Decode* means the reverse, but without the guarantee that the encoded will be retrieved. Quite often, we find a different "encoded" reality: semiotic processes are non-deterministic.

10. Why Do We Still Ignore Windelband?

The narrative of philosophy, or that of a science for that matter, can be compressed into a time series of names—authors who contributed ideas that made a difference. Another narrative could be that of names dropped, names forgotten or ignored, which can mean many things: ideas significant once upon a time are less (or not at all) meaningful; ideas associated with one name or several were taken over by others, further developed, the original contributors forgotten. Or, even, that we are still not able (or willing) to accept viewpoints not aligned with the paradigm in place [Kuhn 1962], which is another way of saying not accepted by those in "power." (Science itself is, as Lakatos [1970] argued, a power game.) In this section I shall focus on a precise example, with the hope that semioticians will take note of a contribution pertinent to their work.

It comes as no surprise to anyone that interactions can be mathematically (or genetically) described. But mathematical descriptions (or genetic, as well) can only incompletely characterize them. More precisely: the mathematics of interactions is, after all, the description of assumed or proven laws of interaction. In this respect, law is a repetitive pattern. Physical phenomena are acceptably described in mathematical descriptions called *laws*. This is what Windelband [1894]—the name left out of the narrative I discuss—defined as the *nomothetic* (derived from *nomothé* in Plato's *Cratylus,* 360 BCE). The same cannot be said of living interactions, even if we acknowledge repetitive patterns. No living entity is identical with another. The living is infinitely diverse. Therefore, semiotics could qualify as the attempt to acknowledge diversity unfolding over time as the background for meaning, not for scientific truth. This is what Windelband defined as the *idiographic*. Remember the primitive man watching the sky and not knowing the "truth" he was seeing (Earth's rotation). Organisms, while not devoid of truth

(corresponding to their materiality) are rather expressions of meaning. Representations can be meaningful or meaningless. They are perceived as one or the other in a given context.

With meaning as its focus, semiotics will not be in the position to say what is needed to make something—as chemistry and physics do, with the help of mathematics—but rather to identify what meaning it might have in the infinite sequence of interactions in which representations will be involved. This applies to making rudimentary tools, simple machines, computer programs, or artificial or synthetic entities. Semiotic knowledge is about *meaning as process*. And this implies that changing a machine is very different from changing the brain. Inadequate semiotics led to the metaphor of "hardwired" functions in the brain. There is no such thing. The brain adapts. Activities change our mind: we become what we think, what we do. We are our semiotics.

11. The Meaning of Interactions

The fact that signs—better yet, representations—are involved in interactions is an observation that needs no further argument. Being entities that stand for other entities, signs might be considered as agents of interaction. Evidently, with the notion of agency we introduce the expectation of signs as no longer "containers" of representation, but rather as intelligent entities interacting with each other, self-reproducing as the context requires. Consequently, one might be inclined to see interaction processes mirrored into sign processes (i.e., what Peirce named *semiosis*). But interactions are more than sign processes. Better yet: sign processes describe only the meaning of interactions, but not the energy processes undergirding them. This needs elaboration since the question arises: What does "ONLY the meaning of interactions" mean? Is something missing?

11.1 A rejected distinction revisited

To describe interactions pertinent to non-living matter (the physical) is way easier than to describe interactions in the living, or among living entities. For such descriptions we rely on the physics of phenomena—different at the nano-level in comparison to the scale of reality or to the cosmic scale. Quantum mechanics contributed details to our understanding of physical interactions (for instance, in bringing to light the entanglements of phenomena at the quantum level of matter). Focusing on signs caused semiotics to miss its broader claim to legitimacy: to provide not only descriptions of the meaning of interactions, but also knowledge regarding the meaning of the outcome of interactions, the future. When the outcome can be derived from scientific laws, we infer from the past to the future. Statistical distribution and associated probabilities describe the level of our understanding of all that is needed for physical entities to change. When the outcome is as unique as the living interaction itself, we first need to acknowledge that the living is driven by goals—which is not the case with the physical, where, at best, we recognize attractors: the "teleology" of dynamic systems. Therefore, we infer not only from the past, but also from the future, as projection of the goals, or understandings of goals pursued by others. Possibilities describe the level of our understanding of what is necessary for living entities to change, i.e., to adapt to change. This is the domain of anticipation, from which semiotics ultimately originates. (In addition to my arguments, Nadin [1991] on this subject, see Emmeche, Kull, Sternfelt [2002]; Hoffmeyer [2008]; Kull, Deacon, Emmeche, Hoffmeyer, Sternfelt [2009]). Therefore, semiotics should be more than the repository of meaning associated with interaction components.

As information theory—based on the encompassing view that all there is, is subject to energy change—emerged (Shannon and Weaver [1949]), it took away from semiotics even the appearance of legitimacy. Why bother with semiotics, with sign processes, in particular (and all that terminology pertinent to sign typology), when you can focus on energy? Energy is observable, measurable, easy to use in describing information processes understood as the prerequisite for communication. Information is more adequate than semiotics for conceiving new communication processes, which, incidentally, were also iterative processes. But there is also a plus side to what Shannon suggested: information theory made it so much more clear than any speculative approach that semiotics should focus on meaning and significance rather than on truth.

Over time, semiotics attracted not only praise, but also heavy criticism (our own will be formulated in a later section). In general, lack of empirical evidence for some interpretations remains an issue. The obscurity of the jargon turned semiotics into an elitist endeavor. Structuralist semiotics (still dominant) fully evades questions of semiotic synthesis and the interpretant process. Too often, semiotics settled on synchronic aspects, a-historic at best (only Marxist semioticians take historicity seriously, but at times to the detriment of understanding semiotic structures). Closer to our time, semiotics has been criticized for turning everything into a sign, such semioticians forgetting that if everything is a sign, nothing is a sign. In one of his famous letters to Lady Welby, Peirce writes:

> It has never been in my power to study anything—mathematics, chemistry, comparative anatomy, psychology, phonetics, economics, the history of science, whist, men and women, wine, metrology—except as a study of semiotics (Peirce, [1953, p. 32]).

The message here is that semiotics is inclusive, and that it should not be arbitrarily fragmented. Peirce does not bring up a semiotics of mathematics, chemistry, comparative anatomy, etc. because it is nonsensical to dilute the "study of semiotics" into partial semiotics. Nobody who understands logic would advance sub-disciplines such as "logic of feminism," "logic of genetics," "logic of politic," etc. Those who lobby for all kinds of sub-semiotics deny semiotics its comprehensive perspective.

Parallel to this recognition is the need to assess meaning in such a manner that it becomes relevant to human activity. So far, methods have been developed for the experimental sciences: those based on proof, i.e., the expectation of confirmation and generalization. But there is nothing similar in respect to meaning, not even the realization that generalization is not possible; or that semiotic knowledge is not subject to proof, rather to an inquiry of its singularity. The *nomothetic* comprises positivism; the *idiographic* is the foundation of the constructivist understanding of the world (Piaget [1955]; von Foerster [1981]).

11.2 The falsifiable

Mathematicians would claim that their proofs are absolute. Indeed, they make the criterion of falsifiability (Popper [1934]) one of their methods: Let's assume, *ad absurdum*, that parallels meet. If they do, then what? No scientific ascertainment can be proven to the same level of certainty as the mathematical, because it is a projection of the mind. By extension, this applies to computer science and its many related developments, in the sense that automated mathematics is

still mathematics. (Mathematicians themselves realize that in the future, mathematical proofs will be based on computation.) Science lives from observation; it involves experiment and justifies itself through the outcome. If the experiment fails, the science subject to testing fails. That particular observation is not absolute in every respect. Let us name some conditions that affect the outcome of experiments: selection (what is observed, what is ignored); evaluation (degrees of error); expression (how we turn the observation, i.e., data, into knowledge).

Experiments are always reductions. To reproduce an experiment is to confirm the reduction, not exactly the claim of broader knowledge. The outcome might be disappointing in respect to the goal pursued: for example, the various drugs that have failed after being tested and approved. But the outcome might, as well, prove significant in respect to other goals. Drugs that are dangerous in some cases prove useful in treating different ailments: thalidomide for arthritic inflammations, mouth and throat sores in HIV patients; botox for treating constricted muscles. Failed scientific proofs (Deutsch [2012]) prompt many fundamental reassessments. Compare the scientific theory of action at distance before Newton and after Newton's foundations of physics; compare Newton's view to Einstein's; and compare Einstein's science to quantum entanglement. Compare the views of biology prior to the theory of evolution, or to the discovery of the genetic code. Given the epistemological condition of mathematics, new evidence is not presented in the jargon of mathematics. A new mathematical concept or theorem is evidence. Probably more than science, mathematics is art. It is idiographic, not nomothetic knowledge. As we know from Turing and Gödel, it cannot be derived through machine operations (Hilbert's challenge). If there is a cause for mathematics, it is the never-ending questioning of the world appropriated by the mind at the most concrete level: its representation. The outcome is abstraction. This is what informed Hausdorff as he described human nature. There is, of course, right and wrong in mathematics, as there is right and wrong in art. But neither a Beethoven symphony nor Fermat's conjecture (proven or not) is meant as a hypothesis to be experimentally confirmed. Each has an identity, i.e., a semiotic condition. Each establishes its own reality, and allows for further elaborations. Not to have heard Beethoven's symphonies or not to have understood Fermat's law does not cause bridges to collapse or airplanes to miss their destinations.

11.3 The art of mathematics and the art of healing

By its nature, semiotics is not a discipline of proofs. Not even Peirce, obsessed with establishing semiotics as a logic of vagueness (Nadin [1980] [1983]) produced proofs. In physics, the same cause is associated with the same effect (in a given context). Take the example of thalidomide, first used as a sedative, which led to birth defects ("thalidomide babies") when pregnant women took it. Now consider the reverse: the medicine is used for alleviating painful skin conditions and several types of cancer. The semiotics behind symptomatology concerns the ambiguous nature of disease in the living. The ambiguity of disease is reflected in the ambiguity of representations associated with disease. Better doctors are still "artists," which is not the case with software programs that analyze test results. Diagnosis is semiotics, i.e., representation and interpretation of symptoms, that is both art and science. Machine diagnosis is information processing at work. Human diagnosis is the unity of information and meaning.

When mathematicians, or logicians, translate semiotic considerations into mathematical descriptions, they do not prove the semiotics, but the mathematics used. For example, Marty [1990] provided the proof that, based on Peirce's definition of the sign and his categories, there can indeed be only ten classes of complete signs. But this brilliant proof was a contribution to the

mathematics of category theory. Goguen's brilliant algebraic semiotics [1999] is in the same situation. "In this setting [i.e., user interface considered as representation, our note], representations appear as mappings, or morphisms . . . which should preserve as much structure as possible."

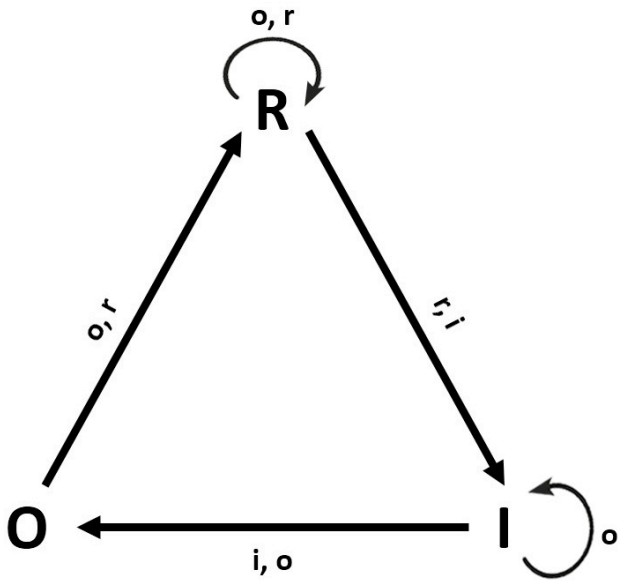


Figure 3. Sign and fuzzy automata. In this case, a Nerode automaton for S = *f* (O,R,I,o,i)

My own attempts at proving that signs relationally defined as fuzzy automata (Nadin [1977], Figure 3) are more a contribution to automata theory than to semiotics. No semiotician ever cared about these attempts; none took such proofs to mean anything in examining signs in action or in understanding semiotics. For their art, which is the art of semiotic interpretation, the mathematical proof is of no relevance. The same holds true for the classes of signs. There are no such signs as *icons*, *symbols*, or *indexes*. These are types of representation. But to deal with the ten classes that Peirce advanced is cumbersome, to say the least. To deal with the 66 classes of signs corresponding to his triadic-trichotomic view is even more arcane.

11.4 Acceptance

This extended preliminary discussion deals with how we might define a foundation of semiotics not around a formal concept—i.e., the sign. Since the concept is subject to so many different interpretations, none more justifiable than another, we need to avoid it. The goal is to make the reader aware of why even the most enthusiastic semioticians end up questioning the legitimacy of their pursuit. Before further elaborating on my own foundational statement for semiotics—this text is only an introduction to it—I shall proceed with a survey of the semiotic scene. This should produce arguments pertinent to the entire endeavor. I derive no pleasure from reporting on the brilliant failure of a discipline to which I remain faithful. Let's be clear: it is not because semioticians (of all stripe) come from different perspectives, and use different definitions, that semiotics does not emerge as a coherent approach. Rather, because it does not yet have a well-defined correlate in reality, in respect to which one could infer from its statements to their

legitimacy and significance. Only because we can practice semiotics, or put on the hat that qualifies someone as semiotician (professor or not), does not justify semiotics as something more than quackery. Can semiotics have a defined correlate in reality? Can it transcend the speculative condition that made it into a discourse of convenience spiked with technical terminology? (Jack Solomon [1988] argued that its own principles disqualify it from having universal validity.)

Everyone in the more affluent part of the world knows that society can afford supporting the unemployed, or helping people without insurance, or providing for self-proclaimed artists. But this by-product of prosperity, and the general trend to support everything and anything, cannot justify semiotics more than the obsession with gold once justified alchemy, or the obsession with cheap oil justifies wars in our time. In order to earn its legitimacy, semiotics (i.e., semioticians) must define itself in relation to a compelling aspect of the living, something in whose absence life itself—at least in the form we experience it—would not be possible. If this sounds like a very high-order test of validity, those readers not willing to take it are free to remain insignificant, whether they call themselves semioticians or something else. With the demotion of Aristotelian inspired *vitalism*, life was declared to be like everything else. As our science evolved, the "knowledge chickens" came home to roost: We pay an epistemologically unbearable price for having adopted the machine as the general prototype of reality. The semiotic animal is not reducible to a machine (even though signs, in Peirce's definition, are reducible to fuzzy automata; cf. Figure 3).

12. Groucho Marx as Semiotician

The reader who still opens any of today's publications on semiotics—journals, proceedings, even books—often has cause to wonder: Is semiotics an exercise in futility? Authors of articles, conference papers, books, and other publications will probably present arguments such as:

- there is a peer-review process in place that legitimizes their efforts;
- the situation in semiotics is not different from that in any other knowledge domain;
- there are no evaluation criteria to help distinguish the "wheat" from the "chaff." In the democratic model of science (semiotics and other fields), "Anything goes."

Each argument deserves attention. But first an observation (which might not seem related to the subject): The quality of education and research in general seems to diminish as more money is spent for them. Stated differently: The gap between excellence—yes, excellence still exists—and mediocrity is widening. By contamination, mediocrity threatens to set a *very* low common denominator. Pretty soon, a Ph.D. will be as common (and insignificant) as membership in those clubs that Groucho Marx refused to join because they would have him. However, this is not the place to address the way in which expectations of higher efficiency (Nadin [1997]), characteristic of our current state of civilization, translate into the politics and economics and education of mediocrity. A different aspect is worthy of discussion here: Some disciplines are focused on relevant aspects of science, humanities, and current technology. They define vectors of societal interest. It does not take too much effort to identify the life sciences as a field in the forefront of research and education; or, for better or worse, computer science, in its variety of directions. Nanotechnology is yet another such field. It originated in physics (which, in its classic form, became less relevant) only in order to ascertain its own reason for being well beyond anyone's expectations. Some readers might recall the time when scientists (Smalley [2001]) claimed that nanotechnology would not work, despite the scientific enthusiasm of the majority of scientists in

the field[1]. In the meanwhile, nanotechnology has prompted spectacular developments that effected change in medicine and led to the conception of new materials and processes. Computer science met nanotechnology at the moment Moore's law, promising the doubling of computer performance every eighteen months, reached its physical limits.

Besides semiotics, many other disciplines (including traditional philosophy) live merely in the cultural discourse of the day, or in the past. More precisely, they live in a parasitic state, justifying themselves through arcane requirements, such as the famous American declaration, "We need to give students a liberal arts education" (a domain in which semiotics is often based). They do not even understand what *liberal arts* or *humanities* means today: using Twitter and the iPhone, or reading the Constitution? Being on social media or reading the "Great Books"? These are questions of a semiotic nature.

12.1 The past is reified in institutions

Semiotics as it is practiced, even by dedicated scholars, certainly does not qualify as groundbreaking, no matter how generous we want to be. Rather, it illustrates what happens to a discipline in which its practitioners, most of them in search of an academic identity—a placeholder of sorts—regurgitate good and bad from a past of promise and hopes never realized. What strikes the reader is the feeling that semiotics deals more with its own questions than with questions relevant to today's world. Even when some subjects of current interest come up—such as the self-defined niche of biosemiotics (cf. Uexküll [1934/2010]; Barbieri [2007]; Favareau [2009])—they are more a pretext for revisiting obscure terminology or for resuscitating theories dead on arrival. Congresses, the major public event of a society formed around a discipline, are the occasion for defining the state of the art in a particular knowledge domain. The ten international congresses on semiotics held so far make up a revealing story of how the enthusiastic beginnings of modern semiotics slowly but surely morphed into a never-ending funeral. There is a dead body carried in that casket—semiotics—and there are endless speeches about its greatness. Like all institutions, the International Association is more concerned with its own perpetuation than with the growth and quality of the discipline it is supposed to represent.

The founding members of the IASS (Greimas, Jakobson, Kristeva, Beneviste, Sebeok) had in mind the promotion of semiotic research in a scientific "esprit": "…promouvoir les recherches sémiotiques dans un esprit scientifique." (French dominated at that time.) This important function is specifically mentioned on the IASS website. Even in its so-called new form, the website, seen from the perspective of semiotics, is a rather telling example of how limited the contribution of semiotics is in providing new means and methods of communication and interaction. An inadequate website is not yet proof of the inadequacy of the current contributions to semiotics. It is a symptom, though. In the spirit of the dedication to a scientific agenda, Eco, Solomon Marcus, Pelc, Segré—to name a few—contributed to a better reputation of semiotic research. They, and a few others (e.g., Deledalle [1997/2001], Marty [1990], Bouissac [1977], Nöth [1985/1995]), and the followers of the Stuttgart School) succeeded in producing works worthy of respect. In the present, very few distinctive centers of semiotic research can be

[1] "How soon will we see the nanometer-scale robots envisaged by K. Eric Drexler and other molecular nanotechologists? The simple answer is never."

identified. One is located at the University of Toronto[2]; the other at the University of Tartu, Estonia[3]. They deserve recognition beyond the lines I dedicate to them in this study.

But a closer look at what continues to be produced under the guise of semiotics, all over the world, leads to the realization that the initial optimism of the "founders" was either groundless, or did not reflect the potential of the many self-proclaimed semioticians. On behalf of the first congress (Milan 1974), Umberto Eco [1975] wrote (in the Preface to the *Proceedings*) about a "fundamental" and an "archeological" task. The first would be the justification for the existence of semiotics; the second, to derive from its past a unified methodology and, if possible, a unified objective. Very little has been clarified regarding the initial existential questions: What justifies the existence of semiotics? What are its objectives? What is its methodology? The only significant aspect is that, despite their irrelevance, events such as congresses (and publication of the associated *Proceedings*) continue to take place! In keeping with the mercantile spirit of the time, the International Association for Semiotic Studies even came up with a scheme for a congress franchise.

Obviously, the statements made above require substantiation. Some of those persons alluded to might suspect the settling of some score (there is nothing to settle since there is no score to keep). Others might suspect a generational conflict, or even an attempt to idealize the past (the romantic notion of "heroic beginnings"). Obviously, such possible interpretations cannot be avoided. Nevertheless, the issue brought up—lack of significance—and the motivation—the reason for addressing it as a subject worthy of attention—are quite distinct. Therefore, I shall proceed in three directions:

(1) a short presentation of today's major themes in the humanities, the sciences, and technology;
(2) a short historic account of developments in semiotics;
(3) a methodological perspective.

The intention is not to cast aspersion upon work produced in the field in recent, and less than recent, years, but rather, to show that this is probably the time of the most interesting (i.e., rewarding) subjects for semiotics. This is the time of new opportunity for semiotics to make its case as a viable discipline and to confirm its necessity. I do not write here delayed reviews of the many articles I indirectly refer to; neither do I write letters of evaluation for one or another author. To watch some presentations under the heading "Semiotics" on YouTube, or similar media, is embarrassing. But mediocrity in this case is not so much congenial to the subject as it is an expression of mediocrity as the new standard of acceptance on social media, and intellectual endeavor in general. To stimulate a discussion on the sad state of semiotics today is, to a great extent justified by the realization that defining semiotics in a manner counter-productive to its development explains its shortcomings.

Why is semiotics, with very few exceptions, in a lamentable condition today? This is a valid interrogation, similar to one articulated regarding physics after the obsession with nuclear energy. Or, for that matter, why medicine, practiced as a reactive endeavor, is failing society. Concerning the "Why?" of the position I take: The attempt to redefine the foundation of

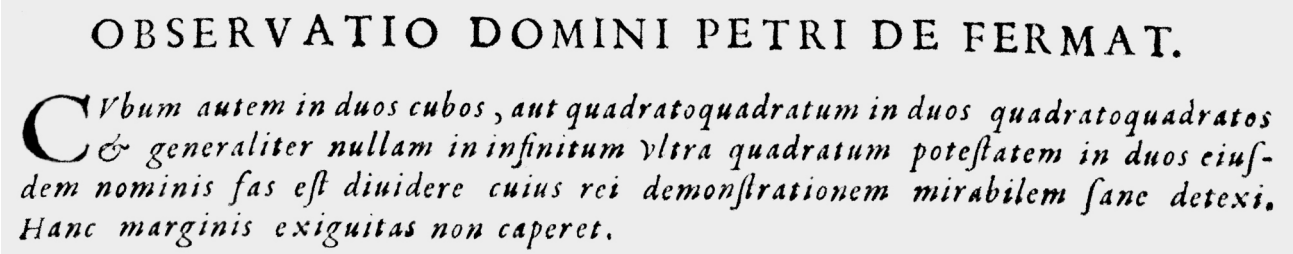
[2] Semiotics and Communication Studies, Victoria College; the Toronto Semiotic Circle (founded in 1973) is still active. An International Summer Institute for Semiotic and Structural Studies takes place regularly.
[3] The Kaunas University of Technology hosts an International Semiotics Institute; there is also an online Semiotics Institute.

semiotics is intended as an invitation to everyone dedicated to the subject, not to its occasional visitors. I do not promise miraculous solutions. This study is an expression of the love and passion I have for semiotics, and of the conviction that it can deliver more than fancy phrasings. The fact that it comes from an "outsider" (i.e., a semiotician who remains unaffiliated) should not be seen as an attack against the semiotic establishment. I've no ax to grind (and no time to do so), and aspire to no glory and to no office (national or international).

12.2 The broader perspective

The Human Genome Project (HGP)—an impressive undertaking that made powerful sequencing tools available—is seen by some as a huge success, and by no few others as a miserable failure—an example of "spin science," as it was recently labeled (Chu, Grundy, Bero [2017]. To indulge in a discussion of the argument could easily fill pages of books. What does not, however, require the same attention to detail and does not lead to shallow judgments ("Did it or did it not live up to the promises made?") is the realization that there is no such thing as a unique semiotics underlying genetics. The four letters of the genetic code are involved in an open-ended narration, different from person to person. Wittgenstein, again, would have identified instances of genetic expression and warned us that, "there is no shared constituent to be discovered" (cf. the Schlick dictation cited above). How many semioticians involved themselves in the project? (I do not ask how many were invited—the answer is None!) How many, after the HGR, took it upon themselves to decipher information made available (AAAS [2001])? Besides the rhetoric of the question, there is the reality of the fact that semioticians prefer to discuss terminology, compare their preferred authors (Peirce, Saussure, Eco, Barthes, Lotman, etc.), discuss movies and feminism, interpret religious or other codes—but do not acquire the knowledge needed to competently discuss the meaning of DNA, the semiosis of RNA, the individual genetic code, and similar subjects.

The most captivating mathematics (a subject I place in the humanities), the most brilliant attempts to understand language, the most dedicated effort to understand the human condition—these are themes impossible to even conceive of without acknowledging their semiotic condition. Take again the attempt to prove Fermat's Theorem. Fundamentally, the approach extends deep into the notion of representation. The very elaborate mathematical apparatus, at a level of abstraction that mathematics never reached before, makes the whole enterprise semiotically very relevant. The entire discussion that accompanied the presentation of the proof, expressions of doubt, commentaries, and attempts to explain the proof are *par excellence* all subjects for semiotics. The subject is interpretation, the "bread and butter" of semiotics, its *raison d'être*. A question that begs the attention of semioticians is, "How far from the initial mathematical statement (Fermat's Theorem) can the proof take place?" That is, how far can the representation of representation of representation, and so on extend the semiotic process before it becomes incoherent or incomprehensible?


OBSERVATIO DOMINI PETRI DE FERMAT.

CVbum autem in duos cubos, aut quadratoquadratum in duos quadratoquadratos & generaliter nullam in infinitum vltra quadratum poteſtatem in duos eiuſdem nominis fas eſt diuidere cuius rei demonſtrationem mirabilem ſane detexi. Hanc marginis exiguitas non caperet.

Figure 4. Fermat's Theorem in Latin

Fermat's short message in Latin ("Cubem autem in duos cubos, etc." Figure 4) on his copy of a translation of Diophantus' *Arithmetica* (3rd century CE) is a theorem represented in words, i.e., in a "natural" language. It is relatively easy to interpret. Later (1637), this theorem was "translated" into mathematical formulae. Fermat's Last Theorem states that no nontrivial integer solutions exist for the equation:

$$a^n + b^n = c^n$$

if n is an integer greater than 2.

One did not need to know Latin but had to be familiar with mathematical symbols in order to understand the equation (and even use it for some examples). Computation changed the way mathematicians (but not only) think. Therefore, mathematicians say that in order to prove Fermat's Theorem, they would have to prove a conjecture (the Taniyama-Shimura Conjecture) that deals with elliptic curves. Understanding the conjecture implies highly specialized knowledge. Wiles [1995] submitted a brilliant piece of mathematics as proof, and further worked on details once some colleagues challenged his results. Chances are that no other discipline besides semiotics can assist in giving meaning to the effort. Now it's time to explain this assertion.

Semiotics is, of course, a knowledge domain different from mathematics. Within its knowledge domain, the mathematical question and the proof concern Peirce's *interpretant process*. Fermat's description in Latin was unequivocal; the translation into mathematical symbolism is also unambiguous. The mathematical proof, however, is so far removed from the simplicity of the Theorem that one can question the semiosis: from simple to exceedingly complicated. Under which circumstances is such a semiosis (i.e., epistemology) justified? This goes well beyond Fermat; it transcends mathematics. It becomes an issue of relevance because many semiotically based activities (such as genetics, visualizations, virtual reality, ALife, synthetic life) pertinent to the acquisition of knowledge in our age tend to evolve into complicated operations not always directly connected to what is represented. The HGP mentioned above is another example of the same. This is an issue of meta-knowledge. If knowledge acquisition, expression, and communication are indeed semiotically based, then this would be the moment to produce a semiotic foundation for meta-knowledge.

Would Peirce, given his very broad horizon, have missed the opportunity to approach the subject? I doubt it. By the way: as Einstein produced his ground-breaking theory, Cassirer found it appropriate to offer an interpretation informed by his semiotics [1921][4]. In other words, there

[4] "We make 'inner fictions or symbols' of outward objects, and these symbols are so constituted that the necessary consequences of the images are always images of the necessary consequences of the imaged objects."

is proof that semiotics can do better than indulge in useless speculative language games, as it does in our time.

What I suggest is that specialization—such as in the mathematics required to produce the proof, or the mathematics that Einstein mastered, or the genetics needed for evaluating the HGP—is a necessary condition for the progress of science. But not sufficient! Specialists—and there are more and more of them—ought to relate their discoveries to other fields, to build bridges. For this they need semiotics as an integral part of their way of thinking, as a technique of expression, and as a communication guide.

We are experiencing various attempts to integrate computation, genetics, anthropology, philosophy, and more into understanding how language emerged and diversified. Never before has language—in its general sense, not only as the language we speak—been as central to research as it is today. Hausdorff, the mathematician who understood the semiotic nature of the human being, anticipated this; that is, he acted according to this understanding. And since semiotics has, more often than not, been understood as the semiotics of language (in this sense, Saussure succeeded with his semiology), it would be only natural to expect semioticians of all stripes to get involved in it. Genetics is, in fact, the study of DNA "expression," of a particular kind of language defining the narrative and the associated stories that make up the "texts" and "books" of life. Or, as I shall argue, the narrative and the associated stories defining the unfolding of life over time. "Sentences" of a genetic nature identify not only criminals in a court of law, but also genetic mechanisms related to our health. Would Saussure have missed the chance to collaborate with researchers who uncover the first "language genes"? Would Hjelmslev? No one expects semioticians to clarify the relation between brain activity and language. Brain imaging opened access to cerebral activity. But language is not necessarily housed in the brain, or only in the brain; it extends to the entire body, always engaged when we express ourselves through language. Natural language is the most ubiquitous medium of interaction. It is involved in knowledge acquisition, in its expression, communication, and validation. Semiotics, if founded not around the sign concept—quite counter-intuitive when it comes to language (to the sign in the alphabet, the word, the sentence)—but with the understanding of the interactions that languages make possible, would contribute more than descriptions, usually of no consequence to anyone, and *post facto* explanations. That is why I am trying to suggest a foundation in the narrative, the timeline of everything we do.

12.3 "Living mirrors of the universe"

The monkey that Nicolelis [2001] used in order to "download" the thinking that goes on when games are played does not qualify as an example for using language. The monkey initially acted upon the joystick in order to score. But once it noticed that the signals associated with its actions—for instance, with what it wanted to do—it chose the economy and speed of motoric expression. Are downloaded streams of data describing brain processes made up of signs? Since everything can be interpreted as a sign, to dismiss such data as being only representative of the physics and chemistry of the monkey's brain activity would be as preposterous as making reference to "prove" spirituality. What such streams of data are is relatively clear: representations of quantitative processes, of measurements. However, the monkey is pursuing a goal associated with the classic reward mechanism, the banana in this case. (Talk about stereotypes in science!) Therefore, intentionality—recall the bacterium swimming upstream and Margolis—cannot be

ignored. Once we associate data and meaning (as Wheeler[5] suggested, cf. Nadin [2011]), we have access to information. The semiotics is implicit in the observation that thinking and acting upon representations can be connected. In a different context (Nadin [2016]), I proved that the entire body is the brain. This applies to the human being as it applies to the Nicolelis monkey. The sensorial and the cognitive are associated. Motoric expression is not an execution of commands, but rather an expression of the holistic nature of the process. Moreover, the monkey condition is not equivalent to what we call the human condition. Humans play entire games of chess (or any other game) in their minds, not by necessarily moving pieces on a chessboard. For them, the pawn does not have to be on the chessboard in order to be identified as constitutive of the game.

As speculative as the notion of the human condition is, we have finally arrived at the juncture where very good models of the human condition, understood in its dynamics, can be conceived, constructed, and tested. The underlying element here is actually what Hausdorff defined as the *zoon semiotikon*, and what Cassirer defined as *animal symbolicum*. Hausdorff, a distinguished mathematician, could have defined the human being as "mathematical animal," but to him the qualifier *semiotic* meant a more general, more encompassing level. Cassirer was a philosopher; to him, generating symbols seemed more relevant than generating new philosophies. Before Hausdorff, and before Cassirer, many other scholars in the humanities considered the qualifier "semiotic" as co-extensive of being human. (Some extended it to animals, as well.) Leibniz, with his *miroirs vivants de l'universe*, inspired Cassirer's definition of the symbol and his attempt to define the human condition in semiotic terms. Locke [1690] found a place for semiotics in a precise domain, i.e., the ways and means whereby the knowledge … is attained and communicated. His definition:

> Nor is there anything to be relied upon in Physick, but an exact knowledge of medicinal physiology (founded on observation, not principles), semeiotics, method of curing, and tried (not excogitated, not commanding) medicines.

The active role of the Russian and Czech semioticians in explaining the role of language in the making of humankind, and Roland Barthes' subtle analysis of language and culture, are convincing arguments that would not have failed to be in the forefront of the semiotic research associated with the current attempts to define the human condition. (For more on the subject, see Nadin [1986, p. 163] and [2014].)

The subject ought to be understood as broadly as possible. This means that within the realm of the living, there is a whole gamut—from the mono-cell to *homo faber*—of representations to consider. Is there anything that qualifies as semiotically relevant across the various forms of the living? Interaction is probably the most obvious aspect. At a closer look, the making of the living consists of integrated interactions—from the level of the cell to that of organisms and among them (not to say their interaction with the world, living or not). At all these levels, representations are exchanged. Interactions transcend unidirectional processes—which are the expression of causality. Therefore, semiotic processes appear as a characteristic of the whole (organism) in an integrated world, but also as one among organisms (same or different). For

[5] Famous as a physicist, John Archibald Wheeler insisted on the meaning of information (see Davies, 2004, pp. 8-10). Davies, C. W. P. (2004). John Archibald Wheeler and the clash of ideas. In J. D. Barrow, C. W. P. Davies, & C. L. Harper (Eds.), Science and ultimate reality (pp. 3-24). London: Cambridge University Press.

reasons of illustrating this idea, I will make reference to the interactions involving the human microbiome (i.e., microbes or microorganisms that inhabit part of the human body). To understand all of this, semioticians are not invited to become biologists, rather to engage biological knowledge (acquired in specific experiments) in order to generalize the notion of semiotic process. That which lives is defined not only by the physics, chemistry, or energy of the process, but also by the various representations exchanged and the ability to interpret them. The living is the domain of meaning. There was interactivity in every previous stage of evolution. Interactivity involving the living implied interpretation—the outcome depended on it—but never at the scale at which society makes semiotic-based interactions its major form of activity. Society also hopes to have the guidance of science, in particular semiotics, in giving meaning to such semiotic processes. The availability of such guidance will help avoid costly consequences—such as those experienced in recent years: terrorism, technological errors, speculation, etc. Medicare fails when data substitutes for meaning. The aging of humankind is probably even more consequential in this sense. Success and failure depend upon interpretation. Machines are better at processing data, but not really better than humans at interpreting it. They can handle way more quantitative descriptions than can the people who build them. But quantity does not automatically lead to improved comprehension in a changing context. Machines are cursed to be blind and deaf to meaning.

The major themes in the sciences beg no less for the contribution of semiotics. Computation is, for all practical purposes, semiotics at work, at a syntactic level, in communication with what is called information processing. Artificial intelligence, in its many flavors, cannot be conceived without integrating semiotic concepts in its concrete implementations. Learning, deep or not, implies considerations that transcend the quantitative. To emulate (a player of chess or of Go, a composer, or a painter) implies descriptions at a level of detail that cries out for more forms of qualitative distinctions. Why one option, from among a huge number ("brute force" in action), is better than others can be "learned" through "training" (in this case, of deep neural networks). That probability considerations dominate is normal: no new question is formulated, the past informs the future. For authentic creative endeavors, probability will have to be complemented by possibility (the possible future); reaction will have to make way for anticipation. The new forms of computation—genetic, quantum, DNA, etc.—are all forms of processes with a semiotic component. More specifically: No information process (e.g., computer, sensor-based information harvesting, intelligent agents-based activities) is possible without representation. Representation is the definitory subject of semiotics (in awareness of it, or in total disregard of it). While electrons move through circuits, and while logic is emulated in hardware (circuits performing logical operations), operations on representations are the prerequisite for any information processing. Unfortunately, the variety of representations (for which Peirce delivered the types, i.e., indexical, iconic, symbolic) and their specific dynamics are superficially understood, if at all (Sowa [2017]). The focus should be on the living—a distinction which the academic world still resists—and on human activity in general. This would make possible the semiotic processes implicit in mechanisms of life. Major research directions—cells or membrane biochemistry, for example—show that we are getting better at understanding the object level and in describing the associated representational level. To realize the unity between the focus on data and the semiotic focus on meaning is a major scientific challenge. It will not happen by itself. Institutionalized science always resists new viewpoints.

For the sake of clarity: Representation is not reducible to the entity we call *sign*, regardless of how it is defined. Signs are media for representation, like letters in the alphabet are media for

words, sentences, texts. The process we call *representation* cannot be reduced to one or several signs (Figure 2). Pursuing the parallel mentioned earlier (mathematics, chemistry, biology, etc. and semiotics), we arrive at the realization that the definition of semiotics based on the sign is at least as unsatisfactory as a definition of mathematics would be if it were based on numbers alone, or of chemistry based on elements, or of biology based on cells, or of linguistics based on the alphabet. Representation would have to be further defined as a process, uniting information (measurable) and meaning (result of interpretation). It is in this condition that representation proves to be significant for the understanding of the living, of mathematics (a specific form of human activity), of science, of the arts, of communication, and of interaction. Despite this peculiarity, semioticians are so removed from the major scientific and humanistic themes of the day that they don't even know that this is their greatest chance—ever! The entire stem cell debate could have taken a different path had competent semioticians contributed to an understanding of stem cell "semiosis" and the relation to the broader issues of creativity.

13. Languages of Interaction

I will finish this compressed exposition by stating that technology is shaped by questions that, at first glance, impress as being semiotic in nature. Technological artifacts of all kind—from games to virtual reality labs in which new materials are conceived—rely on various types of semiotic entities, on representations in the first places, and their interpretation. They make sense, and can become a relevant subject of inquiry, only as new "languages of interaction." The global scale of life makes an integrative approach necessary, but not in the sense of the economy of profits at a scale never before experienced. Globality was discussed at one of the semiotic congresses, or in previous meetings (*Signs of the World*, Lyon, 2004, where "interculturality and globalization" were the convenient slogans of the semiotics community). Nevertheless, semioticians rather take a passive role instead of advancing a critical position. In our extremely controversial time, there is a need for semiotics based on acknowledging diversity, while simultaneously providing means of expression, communication, and signification that pertain to the new scale of human activity. The social dimension of semiotics, specifically brought up by Saussure could be reached by working out evaluation criteria. Opportunistic semiotics (on the bandwagon of many causes) is impotent. Creative ideas for addressing the increased abuse of the public (fake news, fake movements, then never-ending surveillance of the individual, etc.) are yet to be affirmed. The GPS facility, accessible world wide, was the first major embodiment of semiotics in action. I do not, of course, expect semioticians to start writing articles on what kind of a sign a GPS indicator is, but rather to contribute semiotic concepts that will make the language of the system so much easier to understand and use. Monitoring, regardless of purpose, is a form of limiting privacy; assisting, when desired, is helpful. When and if semiotics partakes in the process, GPS data will seamlessly integrate in what we do—drive, visit new places, connect to others, for example. That is, when it becomes part of our language, semiotics could support a concrete accomplishment. Hopefully, semioticians will be able to understand this opportunity.

On this note, a simple observation: Brain imaging revealed that taxi drivers in some of the big cities (London was the first address researched), difficult to navigate, developed in the process measurable new faculties. Of course, these are semiotic in nature: Understanding of representations and the ability to match goals and means (a request such as "Get me to Piccadilly in the shortest time," involves quite a number of parameters). The emergence of GPS-based

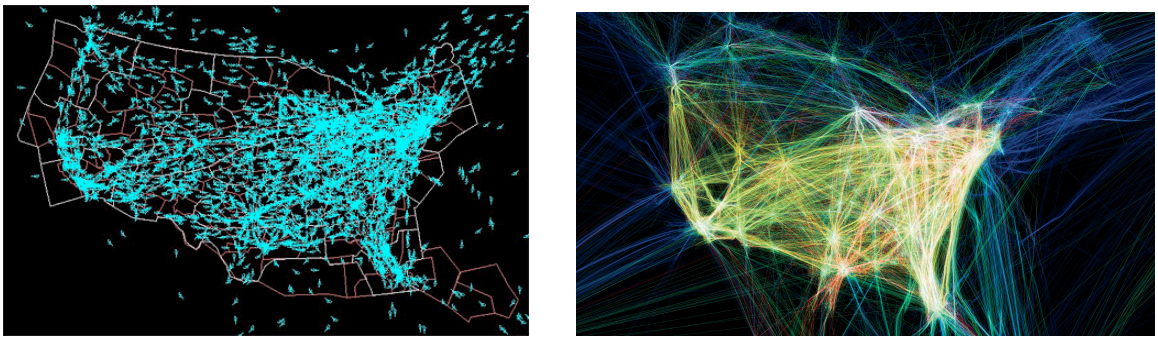


Figure 5. Air traffic paths and flight patterns

navigation might lead to the loss of those faculties. Semioticians should be aware of the fact that the world before maps and the world after maps became available are very different realities. This example is only illustrative of the formative power of our representations (Figure 5).

As technology further evolves, more and more automated systems guide our navigation—in libraries, on the worldwide web, in air travel, on high-speed trains, on highways and toll roads, utilization of drones, etc. Aaron Koblin [2008-2015] documented this process in visualizations of extreme semiotic significance. So did Albert-László Barabási. If Within (the name of Koblin's company) where Koblin develops virtual stories, had been the invention of semioticians, I could define today's state of semiotics as excellent. But it was not. Neither was the work of Barabási and his group inspired by semiotics, but by networks. And if the Worldwide Web, through which many publications (including a few of semiotic interest) are presented, had involved the least participation of semiotics, we would have had a Web that is not syntactically driven. The inventor of the Web (Tim Berners-Lee [1998], awarded with knighthood for his work) is still dreaming of a semantic stage (although what ontology engineers deliver seems to satisfy his criteria). Many people work on this project, in particular the ontology engineers, who provided computers with machine-readable encyclopedias. (For me, personally, only a pragmatically driven Web makes real sense. But this is a different subject.) While the GPS actually changes the nature of our relation to space, and indirectly to time, its semiotics is a legitimate question waiting to be addressed because it involves a new semiotic condition for the human being. The military purpose of the orientation system is spectacularly transcended by rich semioses that, strangely enough, emerged without any input from semioticians. The autonomous car (the new obsession among technologists) is actually a semiotic integrated device: make sense of the world as you move from one location to another, and exchange data with similar devices. If today semiotics were to contribute to a semantic Web, we would avoid the many errors that have affected the growth of the Web into the monster it is now. But ontology engineers and semioticians don't work together. We find data on the Web, to the extent of overwhelming the user, but we do not really find information, and almost never meaning. If this is not a challenging semiotic project, then I don't know of any. At the drawing board for autonomous cars, ships, airplanes, etc., semioticians should have a say—if their semiotic competence were up to the task.

Some years ago, I acknowledged semiotics at work in the activity of Luc Steels, Stevan Harnad, and Juyan Weng. João Queiroz, and Angelo Loula, and especially in the work of Sieckenius de Souza's semiotic engineering work (Nadin [2017]. And yes, in the AI domain, resuscitated by neural networks-based deep learning applications, there is a definite awareness of the semiotic component of intelligence. Tony Belpaeme (Professor of Cognitive Systems and

Robotics) and Angelo Cangelosi (Professor in Artificial Intelligence and Cognition) come to mind in this vein. Few, if any semioticians made the effort to understand the semiotics of machine learning (ML) or the semiotics of neural network training. Therefore, they could not even serve as dialog partners to the mathematically focused community of deep learning researchers. But the work of such researchers is not presented at semiotics meetings and congresses or in the regular semiotics publications.

Obviously, this short account is not exhaustive, and it is less systematic than it would be in a different context. The intention is only to suggest that semiotics has a very fertile ground to cultivate, if semioticians care to work at it, or if professionals from other disciplines pay more attention to semiotics. It is not too late! In a different context (Nadin [2005[), I brought up *The Semiotic Engineering of Human-Computer Interaction*, a book written by a computer science professor (trained as a linguist), Clarisse Sieckenius de Souza [2005], who "spread" the semiotic word in the HCI community. We have here an example of an applied understanding of semiotics informed by the desire to advance issues of interaction—to make it into a foundation for new forms of engineering. It is modest proof, if anyone needed more proof, that so much can be done, provided that semiotics competence guides the effort. Aware of this characterization of her book (which semioticians managed to ignore), she recently wrote to me by e-mail:

> Having studied semiotics does make a difference […] I have the impression…that HCI professionals and students educated in North America tend to have a "What is in it for me?" approach. […] As you know, the answer is, "a whole new world," but it will take a lot of critical thinking to get it.

She was not sure that making her thoughts public would help.

14. Pragmatic Relevance

Semiotic awareness, such as expressed in biosemiotics or even semiotic engineering, has led to more than one attempt to define its knowledge domain and its specific methods. Still, so it seems, each start was relatively short-lived. The generically defined "ancient times" had such a start, with works such as Plato's *Sophistes* (360 BCE), Aristotles' *Poetica* (350 BCE), and the Stoics, mentioned in almost every account of history. It is worth mentioning that Sextus Empiricus (in *Adversus Mathematicos*, VIII) made the distinction between what is signified, what signifies, and the object. Early attempts to understand semiotics are focused on the verb *to introduce* something. The object and the signifier are material; the signified (*lekton*) is not, but it can only be right (adequate) or not (inadequate). Indian Buddhism and Brahmanism, the Christian infatuation with signs (St. Augustine's *De Doctrina Cristiana*, 397 CE, and St. Anselm's *Monologion*, 1075-1076), and Avicenna's explorations in medicine and theology remain documentary repositories of the many questions posed by two very simple questions: How can something in the world be "duplicated" in the mind? The duplication suggests that the question is not about signs (standing for some thing), but about re-presentation. Moreover, once we think about it (the reality duplicated in the mind), can we know it, or assume that what we know corresponds to reality? Or does knowing actually involve a practical activity with a desired outcome?

Edward O. Wilson [1984] came up with a provocative statement of significance not only to semiotics: "Scientists do not discover in order to know, they know in order to discover." The

inversion of purpose (the causality) points to opportunity. Reading classical texts (such as those mentioned above)—and very few semioticians care to do that—reveals that the sign was only the trigger of the interactions it made possible, not associated with their meaning, and even less with their significance. From the beginning, the fascination was with semiotic knowledge: what we learn from observing interactions, and how these are subject to betterment. It is not the history that is important here, but rather the attempt to understand the need for semiotics—if a need indeed exists. The premise guiding this effort is *pragmatic relevance*: If semiotics does not make a difference, as mathematics, chemistry, and physics do, why bother with it? After the rather modest beginning of semiotic inquiry (within the broader questions of philosophy), interest in formulating semiotic interrogations diminished. However, the still controversial "Middle Ages" were yet another start. The works of Roscelin (representative of extreme nominalism); Guillaume de Champeaux (who maintained that universals exist independent of names), and Abélard (on logic) stand as examples for the enthusiasm of those seeking in semiotics answers to the many challenges of those times. Let's be clear: The fundamental opposition between nominalism and realism is a test case. If things are only names, semiotics would be in charge of the world. If, alternatively, the world, in its manifold materiality, were to look at names and call them a poor attempt at describing it, semiotics would be useless. Jean de Salisbury (*Metalogicon*) suggested that abstractions are not related to signs and take the role of names and naming. It is a fascinating journey to read Occam, William of Shyreswood, Lambert d'Auxerre, and Roger Bacon, first and foremost because their questions, extended to the domain of rationality, will inspire the third attempt at restarting semiotics in the classical age. To put it succinctly, it was not much more successful than the previous beginning. Hobbes (*Leviathan*, 1651) the *Logique de Port Royal*, (or *The Art of Thinking*, 1662) John Locke (the forms of reasoning and *The Division of Sciences*, 1690), and foremost, Leibniz (symbolic and mathematical thought, 1672-1696) are precursors of the modern rebirth associated with Saussure and Peirce and the already mentioned biosemiotics and semiotic engineering.

Important, even for those disinclined to seek guidance in works of the past, is the distinction between language associated with convention or law (*nomoi*)—such as programming languages—or with nature (*phusei*)—such as the genetic code. Nobody expects today's semioticians to become historians. But in the absence of a broader understanding of their concepts, semioticians will continue to explore, blindfolded, new continents (of thought and action). I do not doubt that Saussure and Peirce are valid references, but I suggest that Hermann Paul's [1880] *diachrony* is far more conducive to understanding the specific dynamics of languages. This is only one example. Nikolai Sergeyevitch Troubetzkoy [1939] might be another, as is Louis Hjelmslev. Even Uxeküll deserves better.

14.1 Opportunism testifies to shallowness

The modern rebirth of semiotics eventually legitimized what others were doing within their respective disciplines: philologists, structuralists, scholars in literary theory, and morphology. Many fascinating ideas were advanced, and it seemed that a promising new age had begun. But the effort had one major weakness: it remained focused on the sign. Once the new territory of semiotics was defined—mainly by connecting it to Peirce's semiotics—many moved into it, while actually continuing to do what they had always done: interpretations of art and literature, with the help of scientific-sounding terminology. This is not unusual. The most recent example is the morphing of mathematicians and physicists into computer scientists. It took a while until the

"new science" (if "new" can be justified in having Leibniz as the final reference) settled into its "language" and "methods." But in the case of semiotics, those who ran over the border and sought "political asylum" in the "free country" of semiotics actually remain faithful ("captive" would be a more accurate descriptor) to their old questions and methods. The new terminology was not revealing, but obstructive.

Semiotics at a rather superficial level became the stage for literary critics, art historians, confused structuralists, and even for some linguists, mathematicians, and sociologists; even some philosophers ventured on the stage. Before long, we had the semiotics of feminism, multiculturalism, human rights, sexuality, food, and even the semiotics of wine; we had gay, lesbian and transgender semiotics, environmental semiotics, and even climate change or sustainability semiotics. *But no semiotics*! Semiotics in this form became a critical discourse of convenience for everything opportunistic. Instead of a rigorous dedication to meaning, these semiotic exercises mimicked everything that the sciences had already provided. Philosophy, in its classical form (i.e., as a speculative endeavor), could have performed the same without the heavy terminology that alienated even those who were convinced that semiotics was a legitimate endeavor. While all the subjects—and there are way more than what is listed—are, of course, relevant within the broader context of culture and civilization, the qualifier *semiotic* at most justified the opportunistic take around the sign as identifier, but did not essentially contribute anything constructive. Jokes about semiotics ("Is it the half of *otics*?") replaced jokes about weather forecasters and statisticians.

15. Language and Semiotics

While semiotics realized early on that language is the most complex sign system, the semiotic investigation into language was not really productive. I brought up Wittgenstein's views, especially the realization that philosophical problems are in language, not in the world, because more than the celebrated semioticians of language, he grounded language in human activity. To repeat: my main criticism of the semiotics of language concerns the abdication to the notion that semiotics is about the sign. That "language is the most complex sign system," as stated above, was helpful in enlisting language competence—of linguists, grammarians, anthropologists, etc.—but also limiting. Moreover, it confirmed a logocratic view—language as dominant—to the detriment of other forms of expression and communication. This ideology went unchallenged until Peirce, and later Cassirer, each in his own way realized that a variety of semiotic processes complement the semiotics of language. From a different perspective, Roland Barthes thematized the totalitarian nature of language within culture. Within his views, totalitarian regimes rely upon the authority of language in order to consolidate their power. Even the sciences (physics, mathematics, chemistry, etc.) can at times consolidate their "power" through the "languages" they cultivate, to the detriment of alternative understandings in their object domain. Computer science and genetics (the language of gene expression) fully illustrate this thought.

Attempts were made within semiotics to challenge the logocratic model. For instance, some scholars, in the tradition of Locke, tried to advance semiotic notions connected to human activity; others (inspired by Jakob von Uexküll, as author of theoretical biology [1934/2010]) reached beyond the human being into the larger domain of nature. But within semiotics itself, dominated by scholars who fled language studies, such attempts were at best tolerated, but never taken as a scientific challenge. If, finally, semiotics could in our days free itself from the obsession with sign-based language as object of its inquiry, it could make the progress everyone

expected. A meaningful dialog among those who acknowledge images, sounds, smell, and tactility as relevant to interactions would certainly benefit semiotics. The fact that a musical score is much more than a string of notes (the syntax) is an almost trivial observation. That the score is, in the sense I suggest for a new foundation of semiotics, a narration invites a different understanding of semiotic processes. Indeed, from the narration to the stories it makes possible—the variety of interpretations, of performances, of meanings—the semiosis transcends that associated with signs. The dynamic dimension gives meaning to the semiotic approach. Similar reflections can be suggested for the narration embodied in images—regardless of whether they are realistic or abstract, photographs, typographic, video, mixed media—or for that matter associated with the sense of taste. A recipe is the "score" for the food which will be eventually prepared, cooked, eaten, enjoyed. Logocratic semiotics is simply incapable of effectively capturing the meaning on non-linguistic semiotic processes. Sign-based semiotics does not capture the meaning of the narration of the activity through which signs come to life.

Even though I have made some historical references, I'm not trying to rewrite the history of semiotics (in which very convincing work was already done). I am not even trying to associate moments in history with the currency of a particular subject. We are not short of histories as we are short of better semiotics. What I attempt here is to point to a development that explains the linguistic bent of even some of the best works produced at the end of the last century. The brilliant literary accomplishments of the French School, as well as the powerful arguments of the Vienna School, of the Russian-Prague formalists and the Soviet school, and even the German and American elaborations of the 1980s and 1990s are pretty much driven by the same implicit understanding that natural language is paradigmatic. A sign-focused semiotics further consolidated this position, instead of questioning it. We will not be able to escape the deadly embrace of this limited understanding unless and until semioticians establish a fresh perspective.

They should at least acknowledge that language is not always language. This is important because languages are structurally different, we miss the opportunity to take advantage of the characteristics of other cultures. (We have even generalized from the Indo-European languages to the new language of programming.) Moreover, we have generalized from Indo-European languages to images, sounds, and other expressive means, although their semiotic conditions are different. If the logocratic model is problematic in the first place, it becomes even more so when it generalizes on account of a particular language experience instead of integrating as many as possible (corresponding to the richness of human activities unfolding in various contexts). However, at the periphery—i.e., exactly that part of the world that was ignored by Western semiotics—semiotic awareness "outside the box" has developed quite convincingly and semiotics gained in significance. Of course, the periphery was "colonized;" English is the *lingua franca*, and semiotics was imported like so many Western-based intellectual endeavors. But recently, awareness of language and logic characteristics of practical experiences not reducible to those of Western civilization started to inform alternative understandings.

Just as an example: French, typical of Western language and logic, and Japanese, of a very different language and logic, are difficult to reconcile. (To elaborate extends beyond the scope of this text. See Nadin [1997, pp. 168-169, 214, 325]). And so is the phonetic writing of many western languages different from the synthetic Korean alphabet and from the Chinese. Within the space of examples promised, there is one example of the compression of writing (Figure 6):

Figure 6. From iconic representation to Chinese ideograms (cf. Dongguo [2008])

But the semiotic process is even more evident in respect to artifacts of more recent date. For example, the word *thermos* in Korean (Figure 7):

水 + 囚 + 皿 = 溫

물 수 + 가둘 수 + 그릇 명 = 따뜻할 온

Water + Imprison + Plate = Warmth

Figure 7. Korean "shorthand for the word *thermos*

Of course, the narration of the function of this industrial product is broader: how does the thermos work? In Chinese, the narration is more conspicuous: water is imprisoned and attached to a plate, and thus kept warm. The Korean narration is compressed, the English (dictionary definition): a container that keeps a drink or other fluid hot or cold by means of a double wall enclosing a vacuum.

Along the line of the argument for the formative role that narration plays, I could have used the evolution of number representation: from the fingers and toes to the more compressed notation of Arabic numerals. Writing the word for each number exceeding a certain scale is, obviously, less efficient than the mathematical notation: one million seven hundred thirty-eight thousand five hundred six vs. 1,738,506. The compression can go even further.

Quite interesting semiotics is practiced today in China, eager to embrace all sciences; in Korea, the world center of digital interaction; in Japan, which capitalized on semiotics more than any other economy; and in India. The latter is the recipient of most of Western outsourcing, which is often semiotic work by the way: translations, word processing, scanning, record keeping, programming, etc. While the sign is not discarded, the focus of such a work is rather on broader semiotic entities (text, narrative, game, etc.). This suggests, indirectly, an interest in issues of representation, which are not affected by differences in languages and the associated differences in logic (from the 2-valued Aristotelian logic to the Oriental multi-valued logical systems).

If only Baumgarten's sketchy semiotics, which is part of his attempt to provide a foundation for aesthetics (*Aesthetica* [1750]), were to be considered, semioticians would at least, instead of generalizing from the language-defined sign, seek a broader understanding of the sign as such, as

Peirce attempted. Such an understanding will in the end have to translate into the most important dimension of the sciences: predictive power. Humankind is pretty advanced in the predictive aspects of the physical world. Nevertheless, we are still at a loss in regard to predictive aspects of living processes—medical diagnostic and treatment come first to mind. Let it be pointed out here that the logographic-driven semiotics focused on the sign could at best deliver explanations for semiotic processes concluded (e.g., characteristic of the physical reality). Analytical performance characterizes this attempt. But even in the best of cases, it could not serve as knowledge on whose basis future semiotic processes could be envisaged or, for that matter, designed, tested, and validated as means to support human activity. A semiotics running after, instead of leading to, desired semiotic processes cannot serve as a bridge among sciences, and even less as an innovative field of human activity.

These lines are only an indirect argument in favor of more semiotics of the visual or of multimedia, of learning from the differences in various languages, and of discovering the underlying shared elements of such languages. Whether we like it or not, language ceased being the dominant means of knowledge acquisition, just as it ceased being the exclusive means of knowledge dissemination (Again, Nadin [1997]. Representations in expressions other than in language—computer models and simulations, for instance—are the rule, not the exception. Moreover, representation, in its broad sense, shapes human interaction to the extent that it renders the semiotics of natural language an exercise in speculative rhetoric.

The fact that means of representation are simultaneously constitutive of our own thinking and acting is not yet reflected in the semiotic elaborations of our time. Some researchers, unfortunately ignoring each other, rushed to establish a computational semiotics, and even cognitive semiotics, not realizing that the fashionable qualifiers "computational" and "cognitive" mean, after all, a semiotics of semiotics. What semiotics does not need is a new way of packaging the worn-out speculations resulting from the ceremonial of an old-fashioned dance around the sign—the elusive princess at a ball where everyone seems blessed with eternal oblivion.

Since computational semiotics was mentioned (cf. Stephan [1996]; Rieger [1997] [2003]; Gudwin and Queiroz [2005]), it is appropriate to ask whether such a discipline is possible. Computers, in the form used in our days (i.e., Turing machines performing algorithmic operations), are syntactic engines. Without a semantic dimension, and furthermore without a pragmatic opening, they are limited to a language of two letters and a very constricting logic (Boolean). The semiotics of this language is very limited. However, the broad agreement that knowledge is expressed more and more in computational form could translate into a well-defined goal: express semiotic knowledge computationally. Of course, we are referring here to the meta-level. As such, the goal deserves attention because even though deterministic machines are inadequate for capturing nondeterministic processes, we can work towards conceiving new forms of processing that either mimic the living—such as neuronal networks or membrane computing—or even integrate the living (hybrid computation). Computational semiotics—making reference to Dmitri Pospelov and Eugene Pendergraft, to James Albus, to "language games" (behind which Wittgenstein is suspected), to Luis Rocha and Cliff Joslyn, and even to Leonid Perlovsky and his intelligent target tracker—is more than looking for justification for AI research, or for some computer-based terminology associated with signs. It would be encouraging to engage those interested in foundational aspects of semiotics in a computational effort. One possible result could be a semiotic engine conceived as a procedure for generating representations and for supporting interpretation processes.

16. The Semiotic Method

The possibility of a semiotic engine brings up the third and last aspect I listed above: What defines the semiotic method? Our concepts, whether semiotic or not, are a projection of our own reality: who we are, what we are made of, how we change, how we interact. The world in which we live embodies matter in an infinite variety of expression. Its dynamics results from energy-related processes, themselves of infinite variety. There is change, including our own; there is the rate of change, testifying to an acceleration related to improved performance, but not necessarily to better understanding of what and why we do what we do. There is also failure. The Internet exemplifies this suggestively: more possibilities, more liabilities. For the new freedom (access to data, communication, social media, etc.), we pay with a sense of vulnerability that undermines not only individual integrity, but even the foundation of democracy. "The Internet, our greatest tool of emancipation, has been transformed into the most dangerous facilitator of totalitarianism we have ever seen," (Assange [2012, p. 1]). The broader the scale of human endeavors, the bigger the scale at which we experience failure. For all practical purposes, a powerful earthquake and a massive tsunami are of a scale comparable to a nuclear power plant breakdown (and its many consequences). And there is the human being: *We are what we do* defines the living, including the human being. We are currently experiencing the computational condition of research and activity: a growing number of possibilities, immense risk. The computational extension of our reality opens new horizons; it also affects the nature of human existence, undermining the known in favor of possibilities that might erode the viability of the human species. Or, alternatively, increase it.

Among other things, humans observe nature (while being part of it) more through the deployment of computational means. And they attempt to change the world according to needs they have, desires they form, goals they express, capabilities they acquire. In this encompassing process of the human being's continuous self-making, humans are semiotic animals able to operate not only on what is available (from stones, tree branches, edible vegetation, to swiftly running rivers and combustible matter), but also on representations of what the world actually is. Computation is representation driven—and generates more representations. This ability is acquired, tested, and continuously changing. To operate on representations is to transcend the immediate, the present. Only the *zoon semiotikon* (and similarly the *animal symbolicum*) has an awareness of the future in the sense that they can affect the dynamics of existence. Only through the intermediary of semiotic processes of representation do human beings free themselves from the immediate—but at the price of mortgaging their own future. Only awareness of meaning can inform a course of action that will bring opportunity and risk into some balance.

17. The Game of Life

Although it has the power of a Turing machine, Conway's cellular automaton is not algorithmic: the "game" evolves only on account of its initial state (Figure 8). The initial patterns—living organisms on a checkerboard—is changed by using Conway's rules (for birth, death, survival). Here they are: every living cell adjacent to two or three neighboring living cells survives; if the number of adjacent cells with four neighbors dies (overpopulation), a single neighboring living cell dies from isolation. Each empty cell adjacent to *exactly* (i.e., no more and no less) three neighbors is a birth cell. What does this mathematical game have to do with semiotics? As an

undecidable entity—i.e., it cannot be fully and consistently described—it is a representation of change and self-configuration. It is, of course, not a sign, but rather, as it is played, a narration resulting in visual patterns.

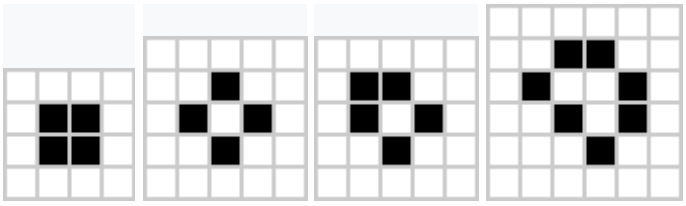


Figure 8. Visual patterns in the Game of Life

The life of the narrative is its interpretation—in stories. These are the outcome of the dynamics of the game of life. But we are again a bit ahead of ourselves. Let's step back to representation.

Representation is the prerequisite for natural or artificial reproduction (simulated in Conway's game). The sperm and the egg to be fertilized are embodied representations of the particular male and female. The stem cell, unfolding under complex anticipatory dynamics, is part of the process. Computer programs "translate" algorithms—describing a course of action for reaching a well-defined goal—into operations on representations. Computer viruses, probably more than other successful programs, illustrate artificial reproduction as it results from a dynamics associated with pre-defined operations. The reverse engineered Stuxnet—the virus deployed by secret services to control friend and foe (Iran, at that time)—is a good introduction to the subject. Many other stealth programs are at work at spying on those connected to the Internet: for commercial purposes, for political reasons, for criminal activities. (If you are on Facebook, for example, you are spied on: each click is recorded and meaning is extracted.) Adaptive characteristics of the living and adaptive mechanisms in the world of machines, as different as they are, correspond to two different modalities for generating representations appropriate to changing contexts of existence or functioning. In adapting, the living experiences information processes, corresponding to energy- and matter-related phenomena, and semiotic processes, corresponding to meaning, and embodied in the narrative of life and its many associated stories.

Space and time are constitutive representations characteristic of our epistemological focus (we want to know). Consequently, it is epistemologically suicidal not to realize that concepts, which are representations, help to both describe and constitute the world. We perceive the world empowered (when not blinded) by our thinking and supported (when not handicapped) by artificially extended perceptions. We "see" today much, much more than what we see (just think about the "invisible" micro-level of matter, or the phenomena in the universe in which we exist); we "hear" today much more than what our ears bring to us. But in the end, we never escape the epistemological circularity of our perspectives. This applies to mathematics as it does to semiotics. For people focused on a sign-centered semiotics, a sign definition is as adequate as we can make it adequate. But it is a construct, always subject to questioning, as Sadowski [2010] recently questioned Peirce's definition, or as I (Nadin [1983]) questioned Saussure's definition (notwithstanding the relevance of his linguistic contributions, cf. Bouissac, [2010]). Something else is at stake: not the adequacy of sign-based semiotic concepts, but the ability to support, to guide practical experiences. The first integrated VLSI (i.e., integrated circuits), celebrated as one of the major accomplishments in the technology of the last 50 years, was a project in applied

physics. Today, we integrate billions of transistors in a chip, or achieve technological performance in myriad ways, Physics and awareness of the characteristics of the living fuse into a new perspective. Deeper and deeper neural networks, i.e., mathematical constructs mimicking the real neuron (infinitely diverse) afford learning patterns that imitate human training. But after all is said and done, the entire effort is focused on *representations*—of arithmetic, calculus, geometry, physics, etc. No doubt, the chip remains a magnificent outcome of mathematics, physics, chemistry, and technology, i.e., engineering. The artificial neuron is yet another example in the same league. But what is "condensed" on the chip or on the artificial neuron is knowledge—representations, not signs, expressed in digital form. Ultimately, this knowledge is a representation of all we know about arithmetic, calculus, geometry, etc., of what we know about graphics, color, form, shape, etc. The most recent (and probably soon-to-be improved upon) computational "winner" of the Go game (against the world champion) owns the past of all Go games but could not come up with a new game. In video games, the victory of information processing (implementation of the binocular parallax) is associated with a semiotic accomplishment: the meaning of 3D in situations of search, hiding, and exploring realistic representations of landscapes, etc. Machines playing against machines is the new form of gladiatorial combat: no more blood and death, but a lot of resources. An AI program can reverse engineer the game engine used in making the game! Playing hide-and-go-seek involves our individual characteristics, our *ad hoc* knowledge pertinent to hiding and seeking. Playing an MMOG (massively multi-player online game) involves embodied knowledge. If this knowledge reflects the reductionist-deterministic view of the world, the game will be a good simulation of this perspective—but not a new perspective of our own being, of our condition as semiotic animals. This is a world of action-reaction. Playing with others, located around the world, via the medium of the game recovers anticipation. This is a victory for semiotics, even if semioticians have to date missed the meaning of such innovative applications.

18. *Monsieur Jourdain* Did Not Know He Was Speaking Prose

Figure 9. *The Bourgeois Gentleman* (Molière)

Monsieur Jourdain: And this, the way I speak. What name would be applied to...?
Philosophy Master: The way you speak?
Monsieur Jourdain: Yes.
Philosophy Master: Prose
Monsieur Jourdain: It's prose. Well, what doyou know about that! These forty years now, I've been speaking in prose without knowing it.

But what are semioticians doing while the world changes drastically and a new human being emerges? The old soup of psychoanalytic extraction is warmed up again and again; literary criticism is disguised as semiotic analysis; structuralist considerations are rewritten in semiotic jargon; linguistic terminology is made to appear semiotic. To forever analyze popular culture

(after Barthes and Eco exhausted the theme), film, music, new media, and video games might lead to texts published by editors as clueless as the writers, but not to the knowledge that society has the legitimate right to expect from semiotics. Books on the semiotics of games will never replace the experience of the game itself, or of conceiving the game. One alternative, among many possible, could be the opening of a "Story Lab" where semiotics can be practiced in generating new stories, corresponding to the fast dynamics of the present, instead of continuing the impotent discourse on narrativity (without understanding the difference between narration and story). No less exciting is the goal of providing semiotic methods for the human interactions of the future, not just attempts to explain what these interactions were. (Useless analytical exercises in semiotics have already perverted the field and damaged its reputation!)

Have I given the impression that conditions were ideal in the "good old days" of the semiotic revival of the early 1970s (or earlier)? I hope not. Have I incited a conflict between succeeding generations of semioticians? Probably, in the sense that I still hold to the notion (Peircean, by the way) that without an ethics of terminology, each of us will be talking about something (the sign, let's say) and understanding something else. The best example of this is the use of the word *sign*, and the tendency to substitute *symbol* for *sign* (or *vice versa*). Those falling for YouTube elaborations on semiotics would be well advised to undergo some form of decontamination or some training in the ethics of terminology. For this ethics to emerge, we also need an encompassing semiotic culture: more people who read primary sources, not approximate derivations, and more people with *original* ideas who actually read what has already been written on a topic—and give credit where credit is due. Yes, there was more scholarship before, despite the absence of Google or Wikipedia—sources of generalized mediocrity, which some believe substitute for true research effort. Without the realization of the need for scholarship, well-intended newcomers will rediscover "continents" that were already explored, and consequently miss their chance to contribute fresh thoughts.

Mediocrity corresponds to a new semiotic condition of the human being. Within shorter cycles of change, and under the inescapable pressure of faster dynamics, there is no room left for depth. Humankind is shaping itself as a species of shallow enterprise, an existence focused on breadth not depth, contributing spectacularly to its own end (within a perspective of time that makes the end still far away). I know of "distinguished professors" (their official, but not earned, title) who cannot distinguish between semiology and semiotics, between meaning and significance, between data and information, and who cannot even pronounce "Peirce" and "Saussure" correctly. But they don't shy away from disseminating their ignorance to young people who trust them by virtue of their institutional identity. Authority built on language games ends up as academic charlatanism.

In various attempts at making up "specialized" semiotics—of music, law, sex, and so on and so on—mostly left in some state of indeterminacy, well-intentioned authors decided to use the concept of the sign in order to deal with particular objects of their interest. Obviously, someone can take a ruler to measure how long a carrot is, or how short a mouse's nose. Appropriateness of perspective, and thus of qualifiers for a certain action or tool, is a methodological prerequisite for any scientific endeavor. Philosophy is not measured in gallons; a work of art is not reducible to the number of knots in the canvas; music is not the map of sound frequencies. The sign, well- or ill-defined, can be the identifier of choice for pragmatic reasons: How well does the STOP sign perform its function? (Keep in mind: when the car is fully automated, i.e., the driverless, autonomous vehicle, the sign as such becomes obsolete.) How appropriate are the various components of a sign such as a logo in a corporate identity "language"? (But when the life of a

corporation is no longer than the life of its only product, identity is consumed.) Why is a certain selection made (color, shape, rhythm) in the attempt to establish conventions for communication purposes, or within a culture? (Such choices will change as fast as anything does in our time.)

Semiotics is not reducible to signs, or to the formal relation among signs (what is called *syntax*). Those who do not realize this irreducibility might at times generalize in a manner not beneficial to semiotics. The best example is that of semioticians forcing their contrived terminology on hot domains of knowledge. *Biosemiotics* (Barbieri [2007]) is such a domain; and many self-delusional attempts have been made to find semiotics in biology, instead of first asking the question of how semiotics might be relevant to advancing biology. Biological processes consist of both informational and semiotic processes: they are narrations This could be important to semioticians, but only after they find out what this means. However, more important than the syntax of life is life itself, a narration that encompasses semiotics and pragmatics. Its deviations in stories (disease, accident, birth and death, etc.) are far more conducive to knowledge than inventories of signs.

Kull and Velmezova [2014] honored by assessment:

> The day when scholars and students of semiotics become the hottest commodity in the labor market and are traded like neurosurgeons, high-performance programmers, footballs players, movie stars, or animators, we will all know that semiotics finally made it. Currently, semiotics is of marginal interest, at most, in academia. Nobody hires semioticians. I am convinced that this can change. But for this change to come about, everyone involved in semiotics will have to think in a different way, to redefine their goals. Semioticians need the patience and dedication necessary for working on foundational aspects, starting with defining the specific domain knowledge and the appropriate methodology. And they need to define a research agenda for semiotics above and beyond the speculative.

As a dedicated scholar of the respectable Tartu School (usually identified with Lotman), Kalevi Kull might have decided to quote these words because he belongs to those who candidly wish that semiotics will do better than it now does.

ACKNOWLEDGMENTS

Dr. Marcel Danesi saw value in my attempt at reassessing the foundations of semiotics and invited me to pursue the matter further. This encouraged me to revisit the main ideas formerly articulated as hypotheses. The initial text prompted Umberto Eco's endorsement and a lively discussion in Tartu with Kalevi Kull and Stuart Kauffman (Tartu Summer School of Semiotics, August 17-20, 2015). Dean Anne Balsamo, responding to suggestions from graduate students and PhD candidates at the ATEC Program (Art, Technology, Emerging Communication) at the University of Texas at Dallas, twisted my arm in requesting a class in semiotics. After 34 years of absence from teaching semiotics, I designed a curriculum that extends from the past of semiotics to ontology engineering, machine learning (including the new Deep Learning applications), biosemiotics. It is a test for my new foundation for semiotics. Of course, I am indebted to all those I interacted with on this captivating question.

Gratitude is expressed to Dr. Asma Naz for her contribution to many matters regarding this study. Joyce Hong is a patient assistant trying to keep up with a very demanding job in the antÉ Lab. Elvira Nadin provided invaluable research in support of my attempt to provide a broad context. I would like to express my gratitude also to the antÉ—Institute for Research in Anticipatory Systems, The University of Texas at Dallas, and to the Hanse Wissenschaftskolleg (Hanse Institute for Advanced Studies), Delmenhorst, Germany, for supporting the research that made this article possible.

References

American Association for the Advancement of Science (2001) Special Issue: *The Human Genome*. *Science*, 291:5507, 16 February. http://science.sciencemag.org/content/291/5507.

Aristotle (350 BCE) *On Interpretation*, 1.16a 4-9 (Edgehill, E.M., trans.) *Peri Hermeneias* (second text of Aristotles' Organon, known by its Latin title *De Interpretatione*. See also http://classics.mit.edu/Aristotle/interpretation.html.

Assange, J. (2012) *Cypherpunks: Freedom and the Future of the Internet*. New York: OR Books.

Barbieri, M. (Ed.) (2007) *Introduction to Biosemiotics. The New Biological Synthesis*. Heidelberg: Springer.

Baumgarten, A.G. (1750). *Aesthetica*. Frankfurt-an-der-Oder: Impens. I.C. Kley.

Berners-Lee, T. (1998) *Semantic Web Roadmap*. Retrieved on March 31, 2011 from http://www.w3.org/DesignIssues/Semantic.html.

Bouissac, P. (1977) *Circus and Culture: A Semiotic Approach* (Advances in Semiotics). Bloomington: Indiana University Press.

Bouissac, P. (2010). *Saussure. A Guide for the Perplexed*. New York/ London: Continuum International Publishing.

Brentano, F. (1874) Von empirische Standpunkt, *Psychologie* (2 Volumes). Leipzig: Von Duncker & Humblot.

Cassirer, E. (1921) Zur Einstein'sche Relativitätstheorie. Berlin. *Substance and Function and Einstein's Theory of Relativity* (W.C. Swabey and M.C. Swabey, Trans.). Chicago/London: Open Court Publishing Co., 1923, 351-445.

Cassirer, E. (1923-1929). *Philosophy of Symbolic Forms* (R. Manheim, Trans.) New Haven: Yale University Press, 1955.

Chu, K., Grundy, Q., Bero, L. (2017) "Spin" in published biomedical literature. A methodological system review, *PLOS Biology*, 15:9, September. http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.2002173.

Conway, J.H. (1970) See: *Gardner, M. (October 1970) Mathematical Games – The fantastic combinations of John Conway's new solitaire game "life". Scientific American, 223 pp. 120-123.*
See also: http://rosettacode.org/wiki/Conway%27s_Game_of_Life.

Deledalle, G. (1979) *Théorie et pratique du signe: Introduction à la sémiotique de Charles S. Peirce*. Paris: Payot. Published in English, 2001. *Charles S. Peirce's Philosophy of Signs: Essays in Comparative Semiotics* (Advances in Semiotics). Bloomington: Indiana University Press.

Deutsch, D. (2012) *The Beginning of Infinity*. New York: Penguin Books.

Dewart, L. (2016) *Hume's Challenge and the Renewal of Modern Philosophy*. BookBaby Publishers.

Dingguo, S. (2008) *The Wisdom of Chinese Characters* (English Edition). Beiging: Beiging Language and Culture University.

Eco, U. (1975). Preface. In S. Chapman, U. Eco, J-M. Klinkenberg (Eds.), *A Semiotic Landscape/Panorama Sémiotique*, The Hague: Mouton..

Eco, U. (1976). *A Theory of Semiotics*. (Advances in Semiotics). Bloomington: Indiana University Press.

Eco, U. (2017) *The Philosophy of Umberto Eco*. In: Beardsworth, S. and Randall, E.A. (Eds.) Chicago: Open Court Publishing.

Emmeche, C., Kull, K., Sternfelt, F. (2002) *Reading Hoffmeyer, rethinking Biology.* Tartu Semiotics Library 3, Tartu: Tartu University Press.

Favareau, D. (2009) *Essential Readings in Biosemiotics: Anthology and Commentary*. (Biosemiotics, 3) Dordrecht/Heidelberg/London/New York: Springer.

Foerster, H. von (1981) *Observing Systems*. Seaside, California: Intersystems Publications.

Gallese, V. (2001) The "Shared Manifold" Hypothesis. From Mirror Neurons to Empathy, *Journal of Consciousness Studies*, 8, pp. 5-7, 33.

Gallese, V. (2009) Mirror Neurons, Embodied Simulation, and the Neural Basis of Social Identification, *Psychoanalytic Dialogues*, 19, pp. 519-536. London: Routledge.

Goguen, J. (1999) An Introduction to Algebraic Semiotics, with Application to User Interface Design. In C.L. Nehaniv (Ed.), *Computation for Metaphors, Analogy, and Agents* (Lecture Notes in Computer Science 1562), Berlin/Heidelberg/New York: Springer, pp. 242-291.

Gudwin, R., Queiroz, J. (2005) Towards an Introduction to Computational Semiotics, *Proceedings of the 2005 IEEE International Conference on Integration of Knowledge Intensive Multi-Agent Systems* – KIMAS'05, 18-21 April 2005, Waltham, MA, USA, pp. 393-398.

Hoffmeyer, J. (Ed.) (2008) *A Legacy for Living Systems. Gregory Bateson as Precursor to Biosemiotics.* Berlin/Heidelberg/New York: Springer.

Kauffman, S. (2011) There Are More Uses For A Screwdriver Than You Can Calculate. http://www.wbur.org/npr/135113346/there-are-more-uses-for-a-screwdriver-than-you-can-calculate.

Koblin, A. (2008-2015). *Aaron Koblin Website: Information*. Retrieved on April 1, 2017 from http://www.aaronkoblin.com/info.html

Kuhn, T.S. (1962) *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Kull, K., Deacon, T., Emmeche, C., Hoffmeyer, F., Sternfelt, F. (2009) Theses on Biosemiotics: Prolegomena to a Theoretical Biology. *Biological Theory*, June, 4:2, pp. 167-173.

Kull, K., Velmezova, E.(2014) What is the main challenge for contemporary semiotics? *Sign Systems Studies*, 42:4, pp. 530-548.

Lakatos, I. (1970). Criticism and the Methodology of Scientific Research Programmes. *Proceedings of the Aristotelian Society*, New Series, Vol, 69 (1968–1969), pp. 149-186.

Locke, J. (1690) Of the Division of the Sciences, *An Essay Concerning Human Understanding*, Chapt. XXI, Book 4.

Lorusso, A.M. (2015) *Cultural Semiotics*. London: Palgrave Macmillan.

Lotman, J.M. (1990) *Universe of the Mind: A Semiotic Theory of Culture*. (A. Shukman, Trans.) Bloomington: Indiana University Press.

Margulis, L. (1995) Gaia Is A Tough Bitch. In: Brockman, J. (Ed.) *The Third Culture: Beyond the Scientific Revolution*. New York: Simon and Schuster. See also https://www.edge.org/conversation/lynn_margulis-chapter-7-gaia-is-a-tough-bitch http.

Marty, R. (1990) *L' Algèbre des Signes: Essai de Sémiotique Scientifique d'après Charles Sanders Peirce* (Foundations of Semiotics, 24). Amsterdam: J. Benjamins Publishing Co.

Mitchell, C.J., De Houwer, J. Lovibond, P.F. (2009) The propositional nature of human associative learning. *Behavioral and Brain Sciences*, 32:2, 183-198, doi: 10.1017/S0140525X09000855.

Mongré, P. (F. Hausdorff) (1897). *Sant' Ilario. Thoughts from Zarathustra's Landscape*. Leipzig: C.G. Nauman.

Morris, C.W. (1938). *Foundation of the Theory of Signs* (1st edition). Chicago: University of Chicago Press.

Morris, R and Ward, G. (Eds.) (2005) *The Cognitive Psychology of Planning*. London: Psychology Press.

Mumford, L. (1967) *The Myth of the Machine: Technics and Human Development*. New York: Harcourt, Brace, Jovanovich.

Nadin, M. (1977) Sign and fuzzy automata, *Semiosis,* 1:5.

Nadin, M. (1980) The logic of vagueness and the category of synechism, *The Monist,* 63:3, pp. 351-363.

Nadin, M (1983) The logic of vagueness and the category of synechism. In: Freeman, E. (Ed.), *The Relevance of Charles Peirce*. La Salle: The Monist Library of Philosophy, pp. 154-166.

Nadin, M. (1986) Pragmatics in the semiotic framework. In: Stachowiak, H. (Ed.), *Pragmatik,* II The rise of pragmatic thought in the l9th and 20th centuries Hamburg: Felix Meiner Verlag, pp. 148-170.

Nadin, M. (1991) *Mind—Anticipation and Chaos*. (In the series: Milestones in Research and Discovery). Stuttgart/Zurich: Belser.

Nadin, M. (1997) *The Civilization of Illiteracy*. Dresden: Dresden University Press.

Nadin, M. (2005). E-mail exchange with Clarisse Sieckenius de Souza.

Nadin, M. (2010) Anticipation and dynamics: Rosen's anticipation in the perspective of time. *International Journal of General Systems* (Special issue on Anticipation, with an Introduction by G. Klir). London: Taylor and Francis, 39:1, pp. 3-33.

Nadin, M. (2011) Information and Semiotic Processes. The Semiotics of Computation, *Cybernetics and Human Knowing*, 18:1-2, pp. 153-175.

Nadin. M. (2012) Reassessing the Foundations of Semiotics: Preliminaries. International Journal of Signs and Semiotic Systems, 2:1, pp. 43-75.

Nadin, M. (2014) Semiotics Is Fundamental Science. In: Jennex, M. (Ed.) *Knowledge Discovery, Transfer, and Management in the Information Age*. Hershey PA: IGI Global, pp. 76-125.

Nadin, M. (2016) Anticipation and the Brain, *Anticipation and Medicine*. Cham, Switzerland: Springer International Publishers, pp. 147-175

Nadin, M. (2017) Semiotic Engineering – An Opportunity or an Opportunity Missed, *Conversations Around Semiotic Engineering*. Berlin: Springer International, 2017, pp. 41-63.

Nicolelis, M.A.L., Shuler, M. (2001) Thalamocortical and corticocortical interactions in the somatosensory system. In: Nicolelis, M.A.L (Ed.) *Advances in Neural Population Coding. Progress in Brain Research*, 130, pp. 89-110. Amsterdam: Elsevier Science.

Nietzsche, F. (1975) In: Colli, G. and Montinari, M. (Eds.) *Kritische Gesamtausgabe Briefwechsel*. Berlin: Walter de Gruyter.

Nöth, W. (1985). *Handbuch der Semiotik*. Stuttgart: Metzler. Published in English (1995). *Handbook of Semiotics* (Advances in Semiotics). Bloomington: University of Indiana Press.

Paul, H. (1880) *Prinzipien der Sprachgeschichte*. Halle: Max Niemeyer (1st ed.). Published in English as *Principles of the History of Language* (H.A. Strong, Trans.). College Park: McGroth Publishing Company, 1970.

Peirce, C.S. (1953) *Letters to Lady Welby* (Lieb, I.C., Ed.). New Haven CT: Whitlock.

Piaget, J. (1955) *The Child's Construction of Reality*. London: Routledge and Kegan Paul.

Pinegger, A., Hiebel, H., Wriessnegger, S.C., Müller-Putz, G.R. (2017) Composing only by thought: Novel application of the P300 brain-computer interface. *PLoS*, September 6, 12:9 https://www.ncbi.nlm.nih.gov/pubmed/28877175. doi: 10.1371/journal.pone.0181584.

Plato (360 BCE) *Cratylus*. (B. Jowett, Trans.). Retrieved on April 10, 2011 from, http://classics.mit.edu/Plato/cratylus.html

Popper, K.R. (1934) *Logik der Forschung*. Vienna: Mohr Siebeck. Published 1959 in English as *The Logic of Scientific Discovery*, London: Routledge.

Posner, R. (2004) Basic Tasks of Cultural Semiotics. In: Witham, G. and Wallmannsberger, J., (eds.) *Signs of Power – Power of Signs. Essays in Honor of Jeff Bernard*. Vienna: INST, pp. 56-89.

Rieger, B.B. (1997) Computational Semiotics and Fuzzy Linguistics. On Meaning Constitution and Soft Categories. In: Meystel, A. (Ed.), *A Learning Perspective. International Conference on Intelligent Systems and Semiotics* (ISAS-97), Washington DC: NIST Special Publication, 918, pp. 541-551.

Rieger, B.B. (2003) Semiotic Cognitive Information Processing: Learning to Understand Discourse. A Systemic Model of Meaning Constitution. In: Kühn, R., *et al.* (Eds.) *Adaptivity and Learning. An Interdisciplinary Debate*. Berlin/Heidelberg/New York: Springer, pp. 347-403.

Rosen, R. (1985) Organisms as Causality Systems which are not Machines: An Essay on the Nature of Complexity. In: Rosen, R. (Ed.) *Rosen: Theoretical Biology and Complexity*. Orlando/New York/London: Academic Press, pp. 165-203.

Sadowski, P. (2010) *Towards systems semiotics: Some remarks and (hopefully useful) definitions*. http://www.semioticon.com/semiotix/2010/03/towards-systems-semiotics-some-remarks-and-hopefully-useful-definitions/.

Shannon, C.E., Weaver, W. (1949) *The Mathematical Theory of Communication*. Urbana/Chicago/London: University of Illinois Press.

Sieckenius de Souza, Clarissa (2005. *The Semiotic Engineering of Human-Computer Interaction*. Cambridge MA: MIT Press.

Silverman, K. (1984) *The Subject of Semiotics*. Cambridge: Oxford University Press (reprint edition).

Smalley, R.E. (2001) Of Chemistry, Love and Nanobots (Nanofallacies), *Scientific American*, September 2001, pp. 76-77.

Solomon, J.F. (1988) *The Signs of Our Time. Semiotics: the Hidden Messages of Environments, Objects, and Cultural Images*. New York: St Martin's Press.

Sowa, J. (2017) The Virtual Reality of the Mind. http://222.jfsowa.com/talks/vrmind.pdf.

Stephan, P. (1996) Auf dem Weg zu Computational Semiotics. In: Dotzler, D (Ed.) *Computer als Faszination*, Frankfurt: CAF Verlag, p. 209.

Trubetzkoy, N.S. (1939) Grundzüge der Phonologie, Traveaux du Cercle Linguistique du Prague 7. (Principles of Phonology, Baltaxe, C. trans., Berkeley, CA: University of California Press, 1969).

Uxeküll, J. von (1934) *Streifzüge durch die Umwelt von Tieren und Menschen*. Berlin: Julius Springer Verlag. English translation, 2010, (O'Niell, J.D., trans.) *A Foray into the Worlds of Animals and Humans*. Minneapolis/London: University of Minneapolis Press. Published together with a translation of Uxeküll's (1940) *Bedutungslehre* as *A Theory of Meaning*.

Wiles, A. (1995) Modular elliptic curves and Fermat's Last Theorem, *Annals of Mathematics*, 141:3, pp. 443-551. (Also available in pdf.)

Wilson, E.O. (1984) *Biophilia: The Human Bond with Other Species*. Cambridge: Harvard University Press.

Windelband, W. (1894) Geschicthte und Naturwissenschaft, *Präludien. Aufsätze und Reden zur Philosophie und ihrer Geschichte*. Tubingen: J.C.B. Mohr, pp. 136-160. (History and Natural Science. Speech of the Rector of the University of Strassburg).

Wittgenstein, L. (1953) *Philosophical Investigations* (Anscombe, G.E.M., trans.) London: Basil Blackwell.

Wittgenstein, L. (2003) Diktat fur Schlick (Moritz Schlick, Dec. 1932) *The Voices of Wittgenstein: the Vienna Circle: Ludwig Wittgenstein and Friedrich Waisman.* London: Routledge.