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Introductory Chapter: Semiotic Hauntologies of Ghosts and Machines

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1. Introduction

Semiotics has a long tradition as the science of signs, signification and meaning-making. Four traditions have contributed to Western semiotics: semantics (including the philosophy of language), logic, rhetoric and hermeneutics. However, both John Deely and Umberto Eco [1, 2] have claimed the need to re-read the history of philosophy, and maybe of other disciplines, from a semiotic point of view. This volume shows that there are many other fields contributing to make semiotics an interdisciplinary arena and an ever-growing field of interest.

In the Western world, the first semiotic incursions can be traced back to the Greeks. Before contemporary semioticians raised the question of the powerful action and “affordances” of signs (see below for this concept), there were phenomena considered “significant” in three main contexts: poetics (and linguistics), logic (and philosophy) and medicine. This introductory paper shows how knowledges from the past haunt the present and future of semiotics in various ways. The reflection functions as a catalyst to connect the diverse papers collected in this volume, contributing to point out the contemporary relevance of semiotics and its interdisciplinary applications.

The subtitle “of ghosts and machines” refers to a phrase used by Oxford professor of philosophy Gilbert Ryle (1900–1976) to capture the Cartesian idea of a soul/mind within the body/machine, which he employed to criticize materialist theories that reduce mental activity to physical reality. The phrase was later popularized by Hungarian-British journalist Arthur Koestler (1905–1983) who borrowed it for his 1967 book *The Ghost in the Machine*, where his central concern was the controversy over auto-replicative forms of intelligence in the human brain. The phrase has acquired new meanings in artificial intelligence. It was used by Arthur

C. Clarke in his (1982) novel *2010: Odyssey Two*, by Stephen King in his 1991 serial novel *The Dark Tower*, and more recently, by Japanese artist Masamune Shirow for his manga *Ghost in the Shell* and its movie adaptations. The evolution of the topic shows concern over the possibility of cyber-brains and the symbiosis of the human and the machine, throwing light on some key aspects of the contemporary debate on semiotics.

Indeed, cybernetic advance is so rapid that there is already software that tracks the electrical activity of human nervous systems, collecting patterns of thoughts and emotions in order to map entire human life experiences, turning them into searchable data (i.e., the British Telecom “Soul Catcher” computer chip). In the move towards “Silicon Souls”, research on biomechanics developed at MIT lab (<http://biomech.media.mit.edu/>) will allow a new generation of prosthesis by means of a dynamic socket that maps nerve and muscle movements in the amputee’s body. These prostheses are extensions of the body as much as of the mind, since they map machine algorithms upon artificial limbs. All these contemporary immersive technologies explore the imbrication of digital simulations with body schemata. Furthermore, in the race to connect the world, the InterPlaNet (IPN) initiative launched by NASA in 1998 offers a computer networking protocol designed to operate at interplanetary distances (<http://ipnsig.org/>), not just “connecting people”, but connecting galaxies.

Let me turn for a minute to the etymology of the word “ghost”. According to the Oxford English Dictionary, the term originates in Proto-Germanic *Gaisto-z*, which in Old English became *gāst* and *gāest* (*Exeter Book*) and *Geist* in German, meaning “breath”, in the sense of disembodied spirit of a dead person that inhabits a body and might be good or bad. It later acquired religious and psychological overtones as “psyche”, “soul” and “vital principle”. According to Sir James Frazer, the “ghost” is a sort of creature that animates the body, escaping it temporarily during sleep and permanently in death: death being the permanent absence of the soul, he explains in *The Golden Bough*. The similarities with Proto-Indo-European **ǵʰeysd-*, **ǵʰisd-* (“anger, agitation”), **ǵʰyis-* (“bewildered, frightened”) and **ǵʰey-* (“to propel, move, spin”) should also to be noted.

Alongside “ghost”, the Greek term *phántasma* originally meant to “make visible” or “bring to light”, and it is related to contemporary terms such as “appearance”, “image”, “phantom” or “fantasy”, all of which entered Western languages through Latin. As in the case of “ghost”, it came to mean “soul” and “spirit”, maintaining a religious significance as in the Bible (i.e., “the Holy Ghost”; in Latin *Spiritus Sanctus*).

Continuing our incursion on etymological roots, the origin of the term semiotics shows interesting parallels that make obvious the human desire to transcend death through memory and representation, that is, the use of signs that try to make present that which is absent. In Jacques Derrida’s terms, “logocentrism” would be a characteristic pattern of the Western world. He also used the term “hauntology” in his 1993 book *Spectres of Marx*, following a reference to “spectre” made by Marx himself in his *The Communist Manifesto* [3]. Derrida also echoes Shakespeare’s *Hamlet* in order to explain that re-presentation is a form of making present an absent past by means of different sets of signs. He argues that the attempt to isolate social (history) or individual identity is always futile because it is “always already” (he uses this term to capture the idea of the past living in the present) dependent of semiotic systems

where meaning is deferred, subject to interpreting actions. According to Derrida, the sign/signifier can never capture the object/signified in its totality because we are not talking of essences but of complex processes that encompass many dimensions, as well as various forms of temporality.

Indeed, the haunting figure of the ghost sign, simultaneously absent and present, dead and alive, was always already there in the etymology of the term semiotics. The Greek noun *sêma* appears in ancient texts (i.e., Homer and Hesiod) with the sense “tomb/burial ground” as well as with the meaning of natural or conventional signal. After the sixth century BCE, the term *semêion*, which originates from *sêma*, was commonly used by Aeschylus, Aesop, Hecataeus of Miletus, Anaxagoras or Cleostratus, and it comes to mean “symbol” and “sign of a god” as well as “indication” and “proof”. It coexists with *tékmor*, found in *The Iliad* with the meaning of “proof” and eventually “sign” and “indication” (*Iliad*, I, 526; VII, 30; IX, 48; IX, 418; IX, 685; XIII, 20; cited in Castañares 2012) [4]. According to Detienne and Vernant, these terms were also used in fortune telling, astronomy and navigation, referring to signals coming from the gods and alluding to cunning knowledge associated with the goddess Metis (pp. 168–169) [5].

The term *tékmor* evolved towards *techné* in the context of medicine during the fifth century BCE and the beginning of the fourth, when Hippocrates’ disciples compiled the chief treatises of the *Corpus Hippocraticum*. According to these treatises, doctors were able to identify a specific type of signs (*semêia*) through which they were able to conclude the health or illness of individuals. The medical method of establishing conjectures (*tekmaíresthai*) for diagnosis departed from the analogical deductive procedure used in philosophy and which rested on the notion of *phýsis* as a cosmos (a whole finished reality, arranged by laws that were replicated at the human microcosmic level). Hippocratic medicine described inferential semiotics when it explained how *semêia* moves beyond mere conjecture to become *semêion* and gain the sense of proof (*tekmeríaon*) [4].

Aristotle’s contribution to semiotics had already clarified that signs are demonstrative propositions that might (or might not) acquire meaning to someone. Beyond causality relations, statements can constitute the premises of a syllogism and, as such, they can become conventional cultural signs whose paradigm is the “word”. However, they may also lack a specific name (*anónimon*) and therefore be refutable (*Rhetoric* I, 2, 1357 a 34 ff.). For instance, the fact that Socrates was wise and just is a (*anonymous*) sign that wise men are just (1357b pp. 11–13) [6]. Although in his *Poetics* (1456 b 20–21), Aristotle’s attempts to define various terms related to the field of logic and semiotics, a clearer allusion appears in *Perihermenias* or *De interpretatione*, where he puts forth the explicit opposition between words and things (*lógos* and *ón*), already prefigured in Plato. One of the fragments presents an early description of triadic semiotics (Deely p. 76) [7].

“Now spoken sounds (*ta en têi phonêi*) are symbols (*sýmbola*) of affections (*pathématon*) in the soul, and written marks (*ta graphómēna*) symbols of spoken sounds. And just as written marks are not the same for all men, neither are spoken sounds. But what these are in the first place signs (*semêia prótos*) of – affections of the soul – are the same for all; and what these affections are likenesses (*omoíomata*) of – actual things (*prágmata*) – are also the same.” (*De interpretatione* 16a 3–8) [7].

After the death of Alexander the Great in 323 BCE and the emergence of the Roman Empire, Greek civilization entered the Hellenistic Age, a period marked by battles and territorial shifts which lasted until the Roman conquest of Ptolemaic Egypt in the first century BCE. Many sources were lost during this period, either because of war or because of lack of interest in scribal preservation.

In the second century CE, Claudius Galenus synthesized Hippocratic medicine and the philosophical thoughts of Plato and Aristotle to include the advancement of technology into the inferential process of medical diagnosis (*diagnostikón meros tes technes*), coining the term *semeiosis*.

In the 1750s, a series of excavations that took place at Herculaneum (an ancient Roman town located at the skirts of Mount Vesuvius and covered with debris after the 79 CE eruption) unveiled a great collection papyrus.¹ Among these, there was a treatise by Epicurean philosopher Philodemus of Gadara (c. 100–35 BCE) probably entitled *Perì semeîon kai semeiôseon* (*On Signs and Sign Inferences*), known now by its abbreviated title, *De Signis*. The treatise contains a variation of the term *semeiôseos*, from which C.S. Peirce would derive *semiosis* [8, 9]. As in Aristotle, for Philodemus, common signs cannot be taken as valid inferential premises, as can particular or necessary signs (*anankastikón*). The treatise preserves the controversy on the validity of sign inference which took place between Epicureans and Stoics in order to establish the type of “proof” to determine the difference between signs. While the Stoics defended deductive inferences established from *a priori* principles, the Epicureans trusted empirical inductive testing.

Greek reflections on the nature and purpose of sign systems and their relations to different types of knowledge has continued to “haunt” Western thought for centuries. Thus, scholasticism and medieval semiotics developed within theology and the trivium of the three liberal arts, concerned primarily with textual exegesis and hermeneutics: grammar, dialectic (logic) and rhetoric. During this period, realist and nominalist positions debated over the existence (or not) of universals. A proponent of nominalism, William of Ockham (1285–1349) considered universals to be signs without an existence of their own, but standing for individual objects. Conceptualism, held by Peter Abelard (1079–1142), Albert the Great (1200–1280) and Thomas Aquinas (1225–1274), was accepted as a synthesis of the two positions, with universals are also mind-dependent but formed by similarities with real things of a common form.

A new era of interest and research on the nature of signs began in the ages of rationalism and British empiricism. The period showed a shift from analogic reasoning towards the expression of knowledge as both analytic and referential practice, where representation stems in the observer’s perceiving/thinking mind (subject of enunciation) and gradually shifts to a more abstract mode, where the word/sign and the phenomenon/matter are brought to coincide in the act of mimetic representation. This move was also associated with an epistemological shift: from the perceiving subject to the observed empirical object (experiment) [10]. The use

¹<http://www.herculaneum.ox.ac.uk/http://163.1.169.40/cgi-bin/library?e=d-000-00---0PHerc--00-0-0--0prompt-10---4-----0-11--1-en-50---20-about---00031-001-1-0utfZz-8-00&a=d&c=PHerc&cl=CL5.1>

of optic technologies and lenses employed in instruments such as the telescope, developed by Johannes Kepler (1571–1630) and Galileo Galilei (1564–1642), enabled this viewing transition, just as the screens of computers, tablets and smart phones open contemporary worlds to the virtual cyber-sphere.

In spite of Galileo's innovative engineering, his methods were based largely on the theories of analogy, proportion and inverse proportion, passed, on by the Italian mathematician Leonardo Fibonacci of Pisa (1175–1250) as well as the Egyptian-Greek architect known as Euclid (c. 300 BCE). A new translation of his book of *Elements* was published in 1543, only some 20 years before Galileo's birth. It had the advantage of coming from a Latin version based on an earlier Greek source, rather than via Arabic translations. I bring to the fore these issues of translation and the differences in symbolic representation because the late 1500s and early 1600s mark the expansion of Gutenberg printing press as well as the rupture of the ancient unity between calculation, natural philosophy and alphabetic writing [11].

The ensuing separation continued to pose the problem in philosophical debates between demonstrative and dialectical reasoning, as scholars tried to explain how singular items of experience were part of universal knowledge, a problem explored by Gottfried Wilhelm Leibniz (1646–1716). Mathematician and author of *Alice Adventures in Wonderland*, Charles Lutwidge Dodgson, better known as Lewis Carroll, confronted the problem in his *Tangled Tales*. In *Principles of Mathematics* (1901), Bertrand Russell continued to face a similar challenge: Whether the class of all classes [now called 'sets'] is or is not a member of itself [12, 13].

The analytico-referential form of reasoning developed after René Descartes (1596–1650) tried to explain the connection between the physical body, much like a machine, separated from the "spirit" or "soul" that animated the mind. In *The Description of the Human Body*, he argued that the mind regulates the body through the pineal gland, which he considered the "seat of the soul". His idea of innate human knowledge led John Locke (1632–1704) to combat Cartesian deduction with inductive empiricism. Limitations arose in both cases, as knowledge was treated as an object, thus creating a boundary between the liminal being, of which one is conscious, and the ineffable being (the sublime) for which there was no articulation (Reiss p. 39) [10].

The semiotics of George Berkeley (1685–1753) maintained that words do not always stand for ideas and that they have other functions such as referring to passions. Johann Gottfried Herder (1744–1803) sustained that human cognitive capacity only has access to the exterior marks of things (signs) and that these do not express the things themselves, only their names. Immanuel Kant (1724–1804) *Critique of Pure Reason* (1781) postulated basic conceptual categories of human thought as *a priori* tools for making sense of the world. To Kant, these categories exist independently of human experience; the image (*Bild*) was a category of perception, while *a priori* concepts formed part of 'pure reason'. This topic was also explored by Gotthold Ephraim Lessing (1729–1781) in his work *Laocoon*, a prominent example of the study of iconicity in the arts. A precursor of the studies on iconicity was Giambattista Vico (1668–1744), whose philosophy was also influential upon Friedrich Wilhelm Schelling (1775–1854) or Novalis (1772–1801), and Georg Wilhelm Friedrich Hegel (1770–1831) and, more specifically, Bernard Bolzano (1781–1848) continued to develop a pragmatic dimension of semiosis by

exploring different types of signs from the point of view of perception (visual and auditory signs, gestural and verbal signs).

In the twentieth century, the study of semiotics takes a definite impulse. Victoria Lady Welby (1837–1912) has been recently acknowledged an important female precursor. In *Philosophical Investigations*, Edmund Husserl (1859–1938) developed a phenomenological theory of signs and meaning which explored the phenomenon of awareness and attention. Husserl argued that some phenomena are not immediately perceived in themselves. Such assertion already implied a gap between the objects as sign (signifier) and as thing (signified). Under the impetus of Ferdinand de Saussure (1857–1913), Louis Trolle Hjelmslev (1899–1965) and Algirdas Julien Greimas (1917–1992), the European structural approach relied on the supremacy of discourse and emphasized the dyadic correspondence between the material sign (signifier) and its referent (signified). It was later criticized under poststructural and deconstructive criticism (i.e., Derrida above). The North-American triadic approach, developed by Harvard pragmatist Charles Sanders Peirce (1839–1914) and Charles William Morris (1901–1979), as well as Italian semiotician Umberto Eco (1932–2016), went beyond the scholastic conception of reference *aliquid stat pro aliquo* and placed attention on the role of the user in the process of sense-making and interpreting, establishing three semiotic moments of reference: the material sign vehicle, the object it refers to, and the decoding “interpretant”. Peircean semiotics, as both metaphysics and epistemology, reconfigures any simple binary distinction between phenomena (sensation, perception) and noumena (unmediated referent or event that exists without sense or perception) as an irreducible triadic relationship [14].

In the years of expansion of Claude Shannon’s information theory, Eco insisted in distinguishing between a semiotics of communication, multidimensional, always intentional and based on a shared code by transmitter and receiver, and a semiotics of meaning which only required an intelligent consciousness at the reception pole, not requiring a transmitter that would transmit signs and signals willingly. Likewise, the members of the Palo Alto “Invisible College” who came from various fields but mainly from anthropology, sociology and psychology (i.e., Gregory Bateson 1904–1980, Paul Watzlawick 1921–2007 and Erving Goffman 1922–1982, among others) confronted the mathematical theory of information systems and defended the social aspects of human communication as a matrix that encompasses all human activities, a permanent social process that integrates intentional behaviour, with orchestral forms of verbal and non-verbal communication (i.e., kinesthetics, proxemics, etc.; Matterart pp. 51–54) [15]. This interest for the intentional aspects of communication gradually gave way to the theory of affordances [16].

Anthropologist Marcel Danesi, editor of the world’s leading journal “*Semiotica*”, sees semiotics as an interdisciplinary Web, following his mentor and collaborator Thomas Sebeok (1920–2001). This “Semiotic Web” provides the interconnectivity of sign systems not just in the milieu of cultural representations but also in nature, embracing recent cybernetic theories of embodiment and performance coming from biosemiotics and the neurosciences. In Sebeok’s view, the term “semiology” only captured the anthropocentric part of the discipline [17]. Sebeok’s ideas coincided with the development of cybernetics, defined by Norbert Wiener in 1948 as the scientific study of control and communication in the animal and the machine. The term “cybernetic” comes from Greek *kybernetike* meaning “governance” as well as “steering” (in

navigation). Metaphors of navigation are frequently used when referring to moving within the encrypted codes of the World Wide Web. In contemporary Data Mining, semiotic modelling is used to map concepts into measurable variables through specific diagnostic criteria, and establish their specificity in relation to contextual interpretation. For instance, Sebeok's and Danesi's modelling systems theory (MST) distinguishes representations that include a singularized (sign), a composite (text) or cohesive form (code) [18, 19].

Ronald Stamper, a British pioneer in the field of semiotics as applied to informational systems, also stresses the importance of "signs" as fundamental units in computer science. Stamper incorporated Speech Act theory (i.e., Austin and Searle) in his *Organizational Semiotics methodology*. Methods for Eliciting, Analysing and Specifying Users' Requirements (MEASUR) is used to incorporate technical and social aspects of communication in data mining models corresponding to three fundamental domains: application domain (i.e., medicine), the computational domain (where mathematical codes correspond to concepts in the application domain), and the implementation or "empirical" domain (physical properties of sign and signal transmission and storage). This last aspect was added by Stamper to the traditional semiotic division of syntactic, semantic and pragmatic concerns, including a "social" level for shared understanding above the level of pragmatics [20].

Since the 1990s, with the advent of the digital revolution, the discussion has shifted towards the inclusion of tools and machines in human lives, and how new technologies might impact meaning making and operate as semiotic instruments, embodying the ghost in the machine. Contemporary trends in semiotics explore interactions between living systems, organisms and their environments, following the pioneering work of Jacob Von Uexküll (1864–1944). These approaches have culminated in perception-action (sensory-motor integration-mirror neuron structures) approach, which stresses the role of observers/users around the concept of "affordance" (experience from previous interactions with the world) and the active task-oriented sense-making anticipated by Gibson [16]. Instead of conceiving living systems in terms of their reactions to external stimuli, in these approaches, it is important to pay attention to their constructed internal model of the world and the relation between sensing, desiring and acting. Interestingly, Marx's spectre licks behind the theory of affordances as it can be seen in the following passage.

"Since the relative form of value of a commodity—the linen, for example— expresses the value of that commodity, as being something wholly different from its substance and properties, as being, for instance, coat-like, we see that this expression itself indicates that some social relation lies at the bottom of it. With the equivalent form it is just the contrary. The very essence of this form is that the material commodity itself—the coat—just as it is, expresses value, and is endowed with the form of value by Nature itself. Of course this holds good only so long as the value relation exists, in which the coat stands in the position of equivalent to the linen. Since, however, the properties of a thing are not the result of its relations to other things, but only manifest themselves in such relations, the coat seems to be endowed with its equivalent form, its property of being directly exchangeable, just as much by Nature as it is endowed with the property of being heavy, or the capacity to keep us warm" (p. 66) [21].

Another spectre is that of Aristotle, who struggled to define the affordances of knowledge, truth and the "soul" in his *Nicomachean Ethics* (Book VI, Ch. 3). He spoke of *epistēmē* (1139 b 18–36)

or universal knowledge, shared, circulated and preserved in cultural memory and heritage; *techne* (*Nicomachean Ethics* 1140 a 1–23), skills or capacities to accomplish tasks that operate on variable spheres, and related in chapter 4 to a trained capacity to create through reason (*logos*); and, in other words, knowledge of specific principles and patterns, and frequently translated as “craft” or “art” in its meaning of systematic use of organizational know-how or codified knowledge oriented towards intelligent human action. And finally, he also defined *phronesis* (*Nicomachean Ethics* 1140 a 24–1140 b 12) as a sort of practical wisdom and idiosyncratic knowledge that comes from life experiences as a result of trial and error; to some extent, it is intuitive and cannot be shared. Aristotle distinguished *phronesis* from *sophia* (theoretical wisdom, which involves epistemic reasoning) and held that these types of knowledge corresponded to three basic human activities: *theoria* (thinking), aimed at universal knowledge and truth, *poïesis* (making), whose end goal is production, and *praxis*, the objective of which is doing or action [6].

In recent discussions of Aristotle’s *Rhetoric*, such as the collection edited by Alan G. Gross and Arthur E. Walzer (2000), *phronesis* is discussed in relation to an older quality, *metis* or conjectural intelligence, personal mode of knowledge encapsulated in practice, and popular in the Mycenae civilization, and attributed to figures such as Prometheus and Odysseus/Ulysses, the paragon of craftiness and cunning [22]. Drawing on work by Detienne and Vernant, *metis* has been found to exemplify an earlier form of world knowledge prior to the development of the synthesis of Platonist and Aristotelian models [5]. Carolyn R. Miller writes that this “conjectural worldview concerns the individual case, rather than universal knowledge, probability rather than certainty, qualitative rather than cumulative or quantifiable information, and inferential rather than deductive thought” (p. 138) [23].

Thus, rapidly shifting and disconcerting apprehensions of reality require both conjectural knowledge (*metis*) and practical intelligence (*techne*) targeted at concrete decisions. Some scholars (notably Stephen Gaukroger) have noted that when knowledge shifts occur, and a new cluster of concepts emerge. In the case discussed, the notion of *epistēmē* took over *metis* (p. 42) [24]. In the introduction to the thematic issue of the journal *Icono* 14, “Technopoïesis: Transmedia Mythologisation and the Unity of Knowledge” (2017), co-authored with Henry Sussman, we attempted to show, following Foucault’s *L’Archéologie du Savoir* or Timothy Reiss among others [25, 26], the co-existence and shifting of different *epistēmēs* as power-knowledge systems, visible for instance in the transition that took place in the late medieval and early Renaissance Europe with the combination of Neo-Platonism and Aristotelianism [27].

In his contribution to the *International Handbook of Semiotics* (2015), Deely traced back to Aristotle the premodern background of the semiotic triangle and explained how translations overlooked certain expressions referring to a kind of collective consciousness (a hauntology?) prior to the development of individual self-awareness:

“In terms of the (lost) terminology, the *passiones animae* or “passions of the soul” are the forms of specification (*species impressae*) for developing thought which have their origin in the action of sensible things upon the senses, as these stimuli are *further* developed or shaped by the active interpretative response of the internal sense of memory, imagination, and estimation that together, or “collectively” constitute, on the side of animal Innenwelt, the foundations or basis (*species expressae*, or “phantasms”) for the relations to the environment constituting the animal’s objective world, the Umwelt” (p. 67).

As John Derbyshire's contribution to *The Spectator* (June 5, 2014), "Chasing down the Ghost in the Machine" shows the controversy on the seat of consciousness remains [28]. Writing also in 2014, semiotician Paul Copley emphasizes the role of biosemiotics in challenging the mechanist worldview and placing consciousness in relation to nature and in a continuum with plant-animal existence. To Copley, biosemiotics also serves to question the role of agency as inherently human and shows that different forms of agency can be found at very lower biological levels in the most rudimentary of organisms [29].

Introduced by Jakob von Uexküll (1936, 1937), the idea of *Umwelt* is pivotal in biosemiotics. For some scholars, it is the 'world' of signs which an animal *creates/inhabits* according to its sensorium. According to Sebeok, the *Umwelt* can be understood as a 'model' that allows an organism to survive (avoid predation, seek out comfort and nourishment, reproduce etc.) [30]. The perception-action shift has placed semiotics at the centre of phenomenal apprehension, and meaning making as a subjective mapping-function of (*interpreter*) intentionality and action-oriented survival. The object is also invested with perceptual-effector potentialities that capture interpretive action and reflect human desires [27].

The emphasis on performative models that stress the 'actant/agent/user' is also visible in relation to the tools and machines we use. Since the publication of Philip Johnson-Laird's theory of Mental Models, [31] there has been much discussion and use of the theory of "affordances" and mental models in human-computer interaction and usability, as shown in several paper in this volume, which address the debate between the compatibility of mental models and formal rules of inferential logic. In recent years, software tools capable of capturing and analysing the structural and functional properties of mental models are being designed [32]. The study of semiotics and the concept of "affordance" is relevant to these fields with regards to the semantic and pragmatic possibilities of task-oriented sense-making approaches, conceived in terms of their constructed internal model (*Innenwelt*-eventually *Umwelt* in biosemiotics), as applied to very different fields such as Psychology, Linguistics, Philosophy of Language or Computer Programming. The application of the concept of "affordance" in the context of human-machine interaction in Donald Norman's *The Design of Everyday Things* (1988) opened semiotics to areas involved in user-centred-design, manipulation interfaces, cognitive engineering, modelling systems, organizational semiotics, and so on, some of which are addressed in this volume. The complex relation of distinctive semiotic affordances (potentials and constraints for making meaning) intention, and intermedial variability, alongside questions of social usability in particular contexts, have caused the category of design to move into the foreground of attention in semiotics [33].

Since the 1990s, the widespread use of computer systems has contributed to the development of systemic approaches that contemplate knowledge as made of various (fractal) levels of communication structures; dynamic open systems with permeable interdisciplinary borders which include ideological, political, economic and axiological structures. Very importantly, because all human actions are increasingly performed by means of digital instruments, the changes point in the direction of a huge shift in the ontology of symbolization, involving the foundation of design, development, and evaluation of visualization systems from a semiotic perspective. Thus, the present volume includes various papers on Organisational Semiotics (OS) in Building Information Modelling (BIM), and Functional Requirements Classification Models and Operational Approaches to Conceptual Understanding.

Immersed as we are in the digital revolution, the pedagogic significance of images cannot be underestimated. The corpus of learning resources relies more and more on graphics, charts and icons than it ever did before. Once the amount of content in the World Wide Web has reached saturation levels, design practices are oriented towards the transformation of content and its replication (re-mediation/transmediation) in various semiotic multimodal formats. The image is possibly the most prominent one. Different gains and losses take place when the actions involved in using an artefact are captured onto an image, as it may happen in the context of teaching technological subjects such as physics or mathematics. Debates on the effects of these changes upon representation, and their impact on learning practices have ranged from views on the catastrophe of image-dominance for literary and cognition, to expressions of enthusiasm and attempts to elucidate the effects of the distinctive semiotic affordances (potentials and constraints for making meaning) amid diverse media formats. As pointed out above, the foregrounding of 'design' as a crucial semiotic category, also implies a conceptual shift from the idea of learning competences (in relation to specific educational practices conceived in terms of understanding and following particular conventions) to a focus on agency at both ends of the semiotic chain. Thus, various papers in the volume develop the topic of science education, conceptual change and teaching methods and approaches.

As a conclusion, this introduction has provided a framework for the papers included in this collection. A common thread is the delimitation of interdisciplinary borders at the material level of physical reality as well as in their semio-cognitive and cultural implications. Semiotics continues to provide a framework for emerging knowledge traditions, extending its limits to the non-human realm of biosemiotics and cybernetics, without completely disregarding the hauntings of the past. As body schema expands to its non-human and posthuman dimensions, we need to keep chasing the ghost in the machine.

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