How do we reason when using computers? How programmable are we?

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Abstract—**This article is the presentation of a semiotic study of the interpretation of signs by computer users. The main effort is put on finding how, under given conditions, the interpretation process is determinate to an extent where the user becomes programmable. This case study focuses on a user's first contact with a computer illustrated by the out-of-the-box configuration procedure of the Apple® iMac TM[1]. The triadic conception of signs proposed by C. S. Peirce and their classification in ten categories serves as the basis of this approach. The hierarchy of the cenopytharogean categories[2] combined with the internal relations of determination inside the triadic sign lead to a configuration of the ten classes of signs in an lattice structure [Marty, 1990, p. 167-183]. By taking into account the classes communicated to the user, and by considering their position in the lattice, one can arguably predict the reasoning path of the user.**

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INTRODUCTION

"These are the days of miracle and wonder (...) Staccato signals of constant information[3]" — we have entered the Information Age. In societies where information proliferates, the most valuable currency is *information knowledge.* Consequently, a more modern definition of literacy would be: "an effective use of information systems and resources". By "effective use", it is not only meant the ability to process information rapidly, but also the faculty to comprehend and interpret it. While computers may solve the issue of processing ever-growing volumes of information, this leaves the task of interpreting it to the individual. Ironically, making programs more "intelligent" only offers a short-term solution; while empowering the user by alleviating their task, it also slowly contributes to stifling their knowledge by making it obsolete. Because one counts knowledge as a commodity, one expresses the dialectical tensions[4] in expert-run Information Society in terms of knowledge gap between the main actors, which eventually raises the question of how communication operates between those who possess information knowledge and those who do not. It is clear that the level of knowledge of the information that an individual can attain depends in the first place on the level of knowledge already gathered and in the second place on the value of the incoming information, whether or not it contributes to more general and complete representations. Conversely, a systematic lack of valuable information contributes to empirical knowledge which, although often adequate in many situations, can lead to false beliefs, laziness, presumption and dogmatism[Dewey, 1910, "Empirical and Scientific Thinking" p.145-156]. In a sense, every individual, especially in front of a computer, is manipulable which poses the question: "*how do we reason when using computers and how programmable are we?*"

Interest in how information is communicated and interpreted has been the subject of inquiry of semiotics, the study of signs and sign phenomena. Precursors are Ferdinand de Saussure initiator of the structuralist European tradition and American philosopher C.S. Peirce whose theories rely heavily on logic and pragmatism. Because of the inadequacy of saussurean models to integrate perception theory and the genesis of signification within the framework of the theory, or rather said because instead the peircean model is perfectly adequate for it, our approach to the present question will be carried out in accordance with the works of C.S. Peirce, in an attempt to apply semiotic theory to computers.

In the first section of this paper we will focus on reformulating the problem from a pragmatic and semiotic perspective, which will lead us to introduce a series of terms and concepts specific to peircean semiotics. In the second section of this paper, we will explicitly define those terms for the sake of clarity. In a third section, to illustrate our claims, a case study will be presented that focuses on the configuration procedure of the Apple iMac TM computer as performed by first-time users. Finally, by progressively moving away from this particular example, we will put forth a generalization applicable to other cases.

SEMIOTICS AND COMPUTERS

In this section, we will reconsider the question of programmability from the perspective of pragmatism and reformulate the issue in semiotic terms.

In an article entitled "*How to Make Our Ideas Clear,*" [Peirce, 1935] C.S. Peirce argues that our beliefs are rules

[1] "Apple" and "iMac" are registered trademarks of Apple Computer, Inc.
[2] term invented by Peirce to refer to the categories of modes of being (Firstness, Secondness, Thirdness) see section II.
[3] *The Boy in the Bubble.* Graceland. Paul Simon (1986)
[4] tensions due to an inherent contradictory aspect of things.

for action; the meaning of a thought is defined by the action it is fitted to lead to. From that perspective, the question "*how do we reason when using computer?*" can be restated as "*what conduct does our experience with a computer lead us to produce?*"

In the same article, he writes:

> "Thought in action has for its only possible motive the attainment of thought at rest; and whatever does not refer to belief is no part of the thought itself." (CP 5.396)[5]

To Peirce, "the action of thought is excited by the irritation of doubt" (CP 5.394) and we think in order to attain the state of rest that accompanies states of belief.

Then he asks the question "*and what, then, is belief?*" (CP 5.397)

> "First, it is something that we are aware of; second, it appeases the irritation of doubt; and, third, it involves the establishment in our nature of a rule of action, or, say for short, a habit" (CP5.397)

and later:

> " The essence of belief is the establishment of a habit; and different beliefs are distinguished by the different modes of action to which they give rise." (CP 5.398)

The question now becomes: "*what changes in conduct does our experience with computers lead us to produce?*". Practically speaking, if nothing in our experience with computers is any different from our everyday experience with objects of the analog world, then our conception of the digital world is not any different from our conception of the analog world. Put simply, if our actions are the same in both cases then our conception of the digital is false. It is false because we believe that established habits in the analog world need not be modified, when obviously there is a discontinuity between the two worlds.

Representation - analog/digital

In order to understand that there is a discontinuity, it is first necessary to divorce the thing that represents from the thing represented. The task can be challenging in the realm of computers to discern between the real and the simulation of the real — as Jean Baudrillard notes — when representations of things come to replace the things being represented by masking reality or the absence of reality[Baudrillard, 1984]. It is nevertheless the starting point of semiotics to separate the signifier from the signified ("the word is not the thing"), but it is not enough. To avoid falling into "semioclasty" — a term coined by Roland Barthes to denote the practice of breaking signs apart "to criticize and denounce the ideologies that insinuate themselves into codes, adhere to them and invest themselves with a sort of constrictive necessity"[Gritti, 1975][6] — one should understand that signs do not pretend to *simulate* or create an illusion of the real but instead, by involvement of the user's experience, they *refer* to it: by means of indices they direct the attention to the object of the representation, and by means of icons they afford information about it [Marty, 1993, "Qu'est-ce que l'illusion référentielle?" p. 82].

After drawing a distinction between the sign that represents and the object being represented, we need to introduce a third element which is precisely the connection between them. Because a given sign may well appear in different contexts it can naturally be associated with different objects. Let us term the object being associated to a given sign in an analog experience the *analog object* and the object that would be associated to the same sign in a digital experience the *digital object.* There is no necessity to draw a distinction between analog and digital signs because one would shift focus from the mode of representation of information to the historical nature of a medium that is being used to convey the information. Unlike Marshall McLuhan we do not believe that "the medium is the message" as catchy as it may sound, which is tantamount to saying that "the word is the thing". Let us instead concur with Peirce that the medium participates in the message ("I use the word "Sign" in the widest sense for any medium for the communication or extension of a Form (or feature)" [Hardwick, 1977, 1906 p.196]; therefore characterizing the medium is insufficient to characterize the nature of the message it carries. Quoting G. Bateson on code-duality:

> "The difference between digital and analogic modes of communication may perhaps be made clear by thinking of an English-speaking mathematician confronted with a paper by a Japanese colleague. He gazes uncomprehendingly at the Japanese ideographs, but he is able to partly understand the Cartesian graphs in the Japanese publication. The ideographs, though they may originally have been analogic pictures, are now purely digital; the cartesian graphs are analogic."[Bateson, 1972, p. 373]

which is to say that the same medium serves to carry both analog and digital information, forcing us to reconsider the all too simplistic dichotomy based on the nature of the medium. What distinguishes then analog from digital representation if not the medium? In order to answer the question one is forced to take into consideration the context of the message.

Peirce introduced the notion of *commens*, which "consists of all that is, and must be, well understood between utterer and interpreter, at the outset, in order that the sign in question should fulfill its function." In short, the relation that the sign entertains with its object — be it termed digital or analog — is the universal expression of historical institutionalized correspondences established inside a community rather than the characteristics of a medium. Strictly speaking, there is no such thing as a genuine digital medium.

The central aspect of representation be it analog or digital lies therefore in the type of relation established between a sign and its object in a given context.

[5] "CP" stands for "The Collected Papers of Charles Sanders Peirce" ([Peirce, 1935]and [Peirce, 1958]), the numbers are the edition volume and the paragraph number.

[6] as cited from [Genosko, 1997, Lecture Five]

The sign-object relation, Peirce and Saussure.

Comparisons between Saussure's and Peirce's models are outside the scope of this article[7], but it is nonetheless important to point out why one chooses one model over another.

The connection between the sign and that which the sign refers to, its "signification", exists for Saussure in the context of a system, a coherent semiotic structure in which all elements are mental objects. The meaning of a sign depends on its place in the system and the sign's relationships, which may well mirror relations between objects of the 'exterior world', but in any case the genesis of these phenomena is not taken in charge by the saussurean model.

However for Peirce, the meaning of a sign is not prescribed according to its place in the structure of a system but is continuously being redefined during its interactions with the members of the community, in a pragmatic depending on the way in which it is used. Indeed, both the sign and the object have an existence and are connected together in an abstract an universal way in the 'exterior world', i.e. in the community, as well as in the interior world of the individual as the actualization of the social norms and institutions of the community. For that reason, the sign is not, as with Saussure, *a priori* linked to its object by the action of external forces. The saussurean model does not have that dynamic and the plasticity of the peircean model.

In our case, and more generally when considering computer-human interactions, it seems preferable to consider the sign-object relation as not being *a priori* given, as instead constantly being redefined by the action of dialectic forces and tensions within computerized societies. Hence the difficulty to treat computer semiotics from a structuralist approach that lack the plasticity of the triadic model. For those reasons, the peircean sign model is strongly advocated here and we refer to it only in the rest of this article.

The question of programmability

Studying the act of reasoning among computer users comes down to characterizing the inferential process of the *interpretant* thought that connects the sign to its object. The inference starts at the instant of the perception of the sign by the user and ends when the object is present to their mind. An interpretant is the effect that a sign produces on a mind which can be a feeling, an action, another sign or simply put whatever the user is led to perform in order to grasp the meaning of a sign. The question of the user's programmability that is under investigation concerns us primarily with the factors that contribute to impose or strongly suggest interpretants.

[7] for an account of it the reader is referred to [Deledalle, 1979, p. 29-49] or [Marty, 1990, p. 65-73]

The production of interpretants, also known as *semiosis*[8], leading to the co-existence of a sign, an object and an interpretant in a triadic relation, is a dynamic process autonomous and self-governing:

> "It is implicit in regarding semiosis as the production of the interpretant by the sign itself that signs are not regarded as being governed by rules in the sense of "falling under" them. The idea is rather that the disposition or power of the sign to generate an interpretant is the rule, which thus does not stand over and above the sign, as it were, but is rather an immanent principle therein. This is the basis for characterizing semiosis processes as autonomous or self-governing."[Ransdell, 1992, p. 44]

We will see later that the "power of the sign" is in fact the expression of the power of the sign's institution. Still, predictability in the production of interpretants, if there is, and programmability cannot be taken for synonyms. For instance, even if the conclusion of a deductive process is imposed to a sensible mind and therefore is in that sense predictable, nothing implies that the mind has been programmed to reach that conclusion. To program a person is to predetermine their thinking, behavior, or operations as if by computer programming, which differs from an act of mere prediction which falls short when it comes to predicting free associations of ideas. But one can achieve to predetermine someone's thinking by carefully organizing the elements of signification of a message into a structure, which in a given communicational context contributes to the institution of the message. It is rather the selection of these elements of the sign according to the effects that they are known to have in given contexts of interpretation that makes programmability possible. One can only address the question by searching for determining factors inside institutionalized sign-object relations. One may argue that autonomy and free will keep the individual from being manipulated. It is true, to a certain extent, provided that they understand the mechanisms involved in the process.

Perception theory and semiosis

Before describing in more details the nature of the relation between the sign and the object it seems natural to give an account of the phenomenology of the sign and of the object, i.e. the study of the form that they take when they are present to the mind. In Peirce's terms this consists in doing their 'phaneroscopy', the study of "the collective total of all that is in any or in any sense, present to the mind, quite regardless of whether it corresponds to the real thing or not" (CP 1.284). The formalization of those concepts done by R. Marty (in [Marty, 1990] and [Marty, 2000]) allows considering phenomenology from an algebraic perspective.

The perception of an object comprises the juxtaposition of a percept and a perceptual judgment. Peirce invented the term 'percipuum' to summarizes in one word the two

[8] "But by "semiosis" I mean [...] an action, or influence which is, or involves, co-operation of three subjects, such as a sign its object and its interpretant, this tri-relative influence not being in any way resolvable into action between pairs." (CP. 5.484)

aspects that the act of perception involves. The percept corresponds to the effect of stimuli (or “qualities of feeling”) which are visual, auditory, olfactory (...) sensations in raw form, and a perceptual judgment is the selection of these percepts and the interrelations between them so as to create arrangements between them called relational structures.

On a personal scale, all perceptual judgments made by an individual on an object have a common origin linking every experience that the individual has had of the object, constituting the particular form of that object for that individual.

On an even larger scale, the essence of the object, called its *’eidetic*[9] structure’ corresponds on the level of a community to a unique universal structure present in the perception of the object for every subject of the community. The hypothesis made by R.Marty that allows formalization of phenomenology is that "*an object is present to a mind if and only if this mind forms its eidetic structure*"[Marty, 1990, Ch. I and p. 110] and [Marty, 2000].

Practically it means that for an object to be present to the mind, the mind has to reconstruct its entire eidetic structure in some way or another through an inferential process initiated from available elements of perception and from memorized experiences. This is precisely what representation phenomena presuppose: an object present to the realm of perception (the sign) stands for an object which is absent, which is possible because their eidetic structures are preconnected by the existence of institutionalized correspondences inside a community that the individual as a member of the community is aware of . The perceptual judgment consists then in recognizing among the various forms of relations connecting qualities of feeling of the sign, the characteristic forms of relations involved in institutionalized correspondences, so as to entirely reconstruct the eidetic structure of the object through a series of inferences (see fig. 1, adapted from [Marty, 1990, fig.10 p.62])

The categorization of signs into classes is a formal outline of this inferential process also referred to as *semiosis*, consists in logically analyzing the action of the sign. It is done by describing the evolution of the structure that serves as the medium for the communication of a *form* present at every stage of the process, transmitted from the object to the sign and determining by mediation the interpretant to connect the sign to the object. This corresponds to Peirce’s definition in:

> “I use the word "Sign" in the widest sense for any medium for the communication or extension of a Form (or feature). Being medium, it is determined by something, called its Object, and determines something, called its Interpretant or Interpretand.” [Hardwick, 1977, 1906 p.196]

Of course, the form in question should not to be taken in the sense of a physical object, but as a form of relations connecting qualities of feeling, preserved and expanded through the various moments of the semiotic process. This form is present simultaneously in the eidetic structure of the object in the form of the immediate object, as well as in the sign in the form of what Peirce also called the *ground* of the sign[10], and finally present in the interpretant at the term of the inferential process. The totality of the object present to mind when all individual semioses have been completed is logically assembled by the doing the product[11] of the dynamic objects individually obtained, which leads to noting the existence of several classes of signs inside the same semiotic process, which as will be seen later are hierarchized in the structure of a lattice (see fig.5, p.13).

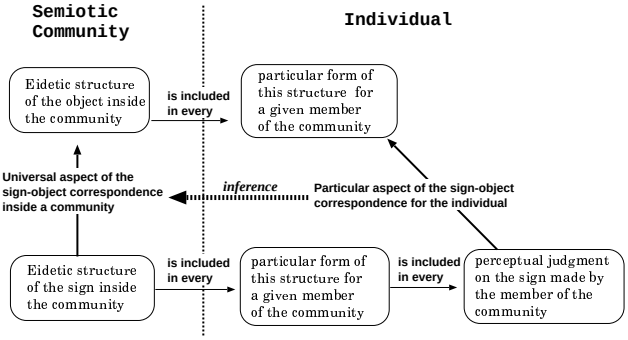

Fig. 1. Inferential process of reconstruction of the eidetic structure of the object

The role of institutions

How do institutions influence the individual? The abstract aspect of an institution is expressed in the universality of the sign-object relation among the members of a community and the dated correspondences between the eidetic structures of the object and the sign on the scale of a semiotic community that every member has learned. These correspondences are reactivated when the sign is perceived, and the inferential process in which they take part is governed by habits and passes merely unnoticed until an element of the sign cannot be accounted for under the dated circumstances of the institutionalized context of interpretation. This corresponds to the phase of doubt in "*The Fixation of Belief*" [Peirce, 1935]. To eliminate the doubt the individual must reach a state of belief again.

In order to do this, the institutionalized sign-object relation must be modified in order to integrate all singular aspects of the sign that remain unexplained. Every new correspondence made by an individual between the particular structures of the object and the sign is ready to form a valid correspondence between their eidetic structures, which means that individuals can change institutions

[9] From Greek *eidos* : shape, form. An essential structure prior to and determining any concrete experience. (cf. Husserl)

[10] in CP 2.228 : “... The sign stands for something, its object. It stands for that object, not in all respects, but in reference to a sort of idea, which I have sometimes called the ground of the representamen”

[11] [explain product of semiotic diagrams ...]

if the community accepts the changes done by them on the sign-object relations.

The interpretation process is governed by the habits of each individual to associate an object to a given sign depending on the context in which the sign is perceived; on a social scale we would speak of *habitus*[12] , which the habits of the individual are a particularity of. That which Peirce calls the immediate object corresponds to the object immediately associated to the sign, i.e. the characteristic part which is institutionalized ("the Object as the Sign represents it" (CP 8.343) or "the Object within the Sign"), as opposed to the dynamic object — the real object — that is mediate ("the Object outside the Sign"), obtained by inference as semiosis unfolds and which the immediate object hints at. Can this process actually be programmed? Not if we consider the entire process because it is highly subjective. Peirce wrote that "a sign should leave its interpreter to supply a part of its meaning (CP 5.448)" and:

> "We must distinguish between the Immediate Object, —i.e., the Object as represented in the Sign, — and the Real [...], say rather the Dynamical Object, which from the nature of things, the Sign cannot express, which it can only indicate and leave the interpreter to find out by collateral experience." [Peirce, 1998, "Excerpts from Letters to William James", p.498]

There is however in the sign-object relation a correspondence essentially objective: the one that is institutionalized, universally present in a community usually referred to as social habit or *habitus*. To avoid any sort of psychologism it is this objective correspondence, because of its universal acceptance, that we must consider in the first place as a condition for programmability.

The question "*how programmable are we?*" can be rephrased as "*how far can our habits of the analog be transposed into the digital without us seeing the necessity to adapt ?*". Not seeing the necessity to adapt implies that, in the process of interpretation, the digital object is reconstructed only by transposing the analog into the digital, i.e. the institutionalized sign-object correspondence in the analog world is actually capable of functioning as a valid correspondence connecting the same sign to the digital object. For this to be possible, the eidetic structure of the analog object must be insertable into the eidetic structure of the digital object, at least to a certain extent, so as to create a referential illusion. Under those circumstances, the user's experience of the digital object is virtually identical to interacting with the corresponding analog object that immediately comes to mind. There is no surprising fact to account for, no doubt occurs, therefore no move is needed to build new beliefs.

Albeit little there is still a gap however, therefore the object ultimately conceived should be called instead "pseudo-analog" in order to describe its capacity to be taken for an analog object to a certain extent, in virtue of some characteristics which will later be investigated. It is nowadays a reality however that a lot of effort is being put into reducing this gap, either by attempting to make programs more intelligent, more "human-like" or by increasing the level of realism in computer interfaces. By anticipating the short-term future, one can make a safe assumption that in a few years' time the gap will be made so little as to consider it negligible. With this hypothesis in mind we will consider the dynamic object to be the same as the immediate object, for an average user at least for whom there is no reason to distinguish between the analog and the digital object.

[12] A **habitus**: "the product of internalization of the principles of a cultural arbitrary capable of perpetuating itself after pedagogic action has ceased and thereby of perpetuating in pratices the principles of the internalized arbitrary." [Bourdieu and Passeron, 1990, "Foundations of a theory of symbolic violence"p.31]

Summary

We have now reformulated the original question "*how do we reason when using computers and how programmable are we ?*"" as:

"What changes in conduct does our experience with computers lead us to produce and how far can our habits of the analog be transposed into the digital without us seeing the necessity to adapt ?"

Problematics are now more clearly defined: the issue is of "bridging the gap" between the analog and the digital. We are set to demonstrate that the limitations are not technical but representational.

But in order to answer the question it is necessary to dig deeper into Peirce's semiotics and introduce the modes of being of objects present to the mind, and the classification of signs...

PEIRCE'S SIGN MODEL - THE TEN CLASSES OF SIGNS

In this section, we go through important notions in Peirce's semiotics, much too succinctly to give any nearly comprehensive view of them, but fairly enough to clearly state the premisses before proposing an answer to the present issue.

The problematics of the transposition of the analog into the digital are to be understood from the standpoint of the user, as a question of representation, not as a survey of digitization techniques. There lies a major difficulty: we have to treat subjective phenomena occurring in the mind of an individual, and somehow make them objective by extracting them from the context of the experience. All that is in the broad sense present to the consciousness is what Peirce called by the term 'phaneron' ("the collective total of all that is in any or in any sense, present to the mind, quite regardless of whether it corresponds to the real thing or not" CP 1.284). Phaneroscopy, the decomposition of the phaneron into formal elements is a logical analysis of the relational structures associated to mental objects which leads to a categorization of phenomena on the basis of their form or structure.

"We are to consider what forms are possible, rather than what kinds are possible, because it is universally admitted, in all sorts of inquiries, that the most important divisions are the dividions according to form, and not according to qualities of matter, in case division according to form is possible at all." [Peirce, 1998, "The Basis of Pragmaticism in Phaneroscopy", p.362]

Phaneroscopy

The phaneron itself only exists insofar as it is a collective total present to the mind at the time of the experience, and it must therefore be considered in the context of the subjective and particular experience of the individual, but the forms embodied in the phaneron are universal, they exist independently of any individual, since they are objectified structures extracted from actual experiences, through an act of mental separation or 'prescision[13]'. They are after all only mathematical objects, abstract in the same manner as a circle needs not be drawn on paper in order to exist.

These *forms* exist independently of the mind. They are found for example in the eidetic structures of objects of the exterior world as disembodied forms of relations which become actual when the mind forms their structure, i.e. when qualities of feeling produced by stimuli of exterior objects or being recalled from earlier experiences are connected in a perceptual judgment so as to form the structure in question. This explains how a sign from the exterior world can cause what Peirce, when referring to the interpretant, expressed as the "determination of a mind".

Reduction of phanerons

While the substance of the phaneron is so to speak the mind itself, the form of the phaneron is that of the relational structures of perception mentioned earlier. According to the "reduction thesis", a relational structure of more than three elements is always reducible to some combination of triads, dyads and monads, as empirically claimed by Peirce and proved in [Marty, 1990, p. 94-105] (see fig.2 as adapted from [Marty, 1990, fig.20 p.112] and [Peirce, 1976, "The categories" p.306]). Consequently every phaneron comes down by analysis to a combination of three indecomposable elements falling under what Peirce called cenopythagorean categories including tertians (for the category of the triads), secundans (for the category of the dyads), and primans (for the category of the monads).

No dyads can be combined so as to form a triad, and no combination of monads can form a dyad or a triad, so that the primans, secundans and tertians are the indecomposable elements of the phaneron.

Concerning the primans :

[13]Term introduced by Peirce in "On a New List of Categories" (1868): "The terms "prescision" and "abstraction," which were formerly applied to every kind of separation, are now limited, not merely to mental separation, but to that which arises from attention to one element and neglect of the other" (CP 1.549)

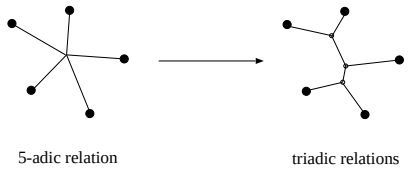

Fig. 2. Decomposition of elements of the phaneron into a combination of indecomposable elements

"... there is no a priori reason why there should not be indecomposable elements of the phaneron which are what they are regardless of anything else, each complete in itself; provided, of course, that they be capable of composition. We will call these and all that particularly relates to them Priman. Indeed, it is almost inevitable that there should be such, since there will be compound concepts which do not refer to anything, and it will generally be possible to abstract from the internal construction that makes them compound, whereupon they become indecomposable elements." (CP 1.295)

the secundans :

"In secundo, there is no a priori reason why there should not be indecomposable elements which are what they are relatively to a second but independently of any third. Such, for example, is the idea of otherness. We will call such ideas and all that is marked by them Secundan (i.e., dependent on a second)." (CP 1.296)

and the tertians :

"In tertio there is no a priori reason why there should not be indecomposable elements which are what they are relatively to a second and a third, regardless of any fourth. Such, for example, is the idea of composition. We will call everything marked by being a third or medium of connection, between a first and second anything, tertian." (CP 1.297)

"We find then a priori that there are three categories of undecomposable elements to be expected in the phaneron: those which are simply positive totals, those which involve dependence but not combination, those which involve combination." (CP 1.299)

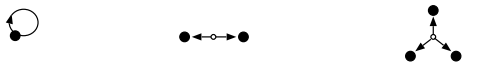

Fig. 3. Indecomposable elements of the phaneron

In the diagram of fig. 3, the dots represent "qualities of feeling" either experienced at the instant of perception or remembered from earlier experiences:

"Among phanerons there are certain qualities of feeling, such as the color of magenta, the odor of attar, the sound of a railway whistle, the taste of quinine, the quality of the emotion upon contemplating a fine mathematical demonstration, the quality of feeling of love, etc." (CP 1.304)

The arrows represent the primans, secundans and tertians of the phanerons. Roughly speaking, the monad is the form of relation of qualities (for ex: sensations of colors, sounds ...), the dyad the form of relation of actual facts and existents and the triad the form of relation of mediation, regulation and general laws.

A substantial aspect in the categorization of indecomposable elements of the phaneron is that the categories are governed by relations of presupposition, that any tertian presupposes at least a secundan, that any secundan presupposes at least a priman, and consequently that any tertian presupposes at least a priman.

To summarize , the decomposition of any phaneron into combinations of the elementary forms: tertians, secundans and primans makes it possible from a phenomenological perspective to perform the phaneroscopy of any collective total of objects present to the mind, and amongst other things of the three instances of the sign itself (sign-object-interpretant).

Modes of being

Should we consider only distributions of objects present to the mind without examining the possibilities of connections between those objects, nothing would we learn about the nature of their being. As Peirce put it "as long as things do not act upon one another there is no sense or meaning in saying that they have any being, unless it be that they are such in themselves that they may perhaps come into relation with others (CP 1.25)". An analysis of the modes of connection of the elements of phanerons is for that reason of foremost interest here. The task is made easier by considering the types of relations that *indecomposable elements* of objects present to the mind can take part in, which in the extension of the concept is referred to as their modes of being. Generally speaking, the mode of being of something — be it an idea or an existent — is a categorization of the capacity of its form to be in connection with other forms, independently of the individual in the sense that modes of being are objectively extractable from the experience while in the same time they only take form by being subjectively experienced. There are only three modes of being also called cenopythagorean categories deduced from the classification of elements of the phaneron. They are termed Firstness, Secondness and Thirdness.

In our case, we are interested in the connective possibilities of elements of the phaneron not in general but in the context of a signification process, that is to say that we are speaking, after taking into consideration the relations of determination inside the triadic sign, about the mode of being of the object in relation with the sign or the mode of being of the sign in relation with the interpretant or the mode of being the object in relation with the interpretant. In this situation, a priman can be connected with another priman (aka. Firstness), a secundan can be connected with either another secundan (aka. Authentic Secondness) or two primans (aka. Degenerate Secondness), and a tertian can be connected with either another tertian (aka. Authentic Thirdness), to a secundan and a priman (aka. Degenerate Thirdness at the first degree) or to three primans (aka. Degenerate Thirdness at the second degree).

- Firstness

Peirce defined Firstness as: "Firstness is the mode of being which consists in its subject's being positively such as it is regardless of aught else." (CP 1.25). Since, in Firstness the active element of an object present to the mind in its relation with other objects is a priman (the form of relation of qualities), Firstness is the mode of being where qualities of feeling are identified by recognizing in the conception of the object the form of relation associated with qualities, i.e. the monad. For instance in the perception of the color red, the quality of feeling of red, present in the perceptual configuration of a red object — be it internal or external — can be associated with the idea of blood, which is possible because the mind recognizes in both the perception of red and the idea of blood, the qualities consistent with the monad, i.e. the form of relation of things existing only by being in relation with themselves independently of anything else. The idea of redness connecting the perception of red to the idea of blood is the role of the interpretant in the representation of blood by the color red.

- Secondness

Secondness is explained within the concepts of action and reaction, "a mutual action between two things regardless of any sort of third or medium, and in particular regardless of any law of action" (CP 1.322)

In Secondness, the active element of an object present to the mind in its relation with other objects is a secundan (the form of relation of actual existents and facts). Secondness is the mode of being where two qualities of feeling are identified as being connected by recognizing in the conception of the object the form of relation associated with actual existents and facts, i.e. the dyad.

There are two ways in which facts can be represented depending on the object being in a relation of Authentic or Degenerate Secondness with the sign, i.e. depending on the nature of the relation between their respective phanerons being a real relation or a relation of reason.

- Authentic Secondness

If the dyad is present as such in the configuration of the object, in which case the correspondence exists independently of the mind because the dyad is "already given", then there is what Peirce calls a *real relation* involving "external seconds, which are constituted by external fact, and are true actions of one thing upon another" (CP 2.365), and the mode of being is Authentic Secondness. Peirce gave as an example the proposition *"Cain killed Abel"* :

> "A real relation subsists in virtue of a fact which would be totally impossible were either of the related objects destroyed; (...) the fact that Cain killed Abel cannot be stated as a mere aggregate of two facts, one concerning Cain and the other concerning Abel" (CP 2.365)

In that case, the dyad present in the conception of the action of Cain upon Abel, summarized in the fact that Cain killed

Abel, is *de facto* present in the sign, which renders the nature of the relation between the sign and the object existential and as a result of this, the sign compulsively draws the attention towards the object. In this example secondness is the mode of being of the object as it is represented in the sing, and while the dyad (Cain - Abel) is present in the sign as it is present in the object, there is no guarantee that it is actually communicated further to the interpretant. In that case, which would be a case of phenomenological entropy the mind would not become aware of the action of Cain upon Abel, while being conscious of their respective presence as qualities of feeling, i.e. as an idea of Cain and an idea of Abel, but not an idea of one killing one another.

- Degenerate Secondness

Now, if the dyad is not *de facto* given, but is formed, with the intervention of the mind, by a *relation of reason* that connects into a dyad two qualities of feeling originating from either the same or different perceptual configurations, then the mode of being is termed Degenerate Secondness. Peirce gave the following illustrating example :

> "a relation of reason subsists in virtue of two facts, one only of which would disappear on the annihilation of either of the relates (...) Rumford and Franklin resembled each other by virtue of being both Americans; but either would have been just as much an American if the other had never lived" (CP 2.365)

In that case, Rumford and Franklin are connected together when we think about the object of the sentence *"Rumford and Franklin are Americans"*, i.e. when we picture ourselves Rumford and Franklin both being American, but the connection drawn between them exists only by virtue of them sharing the common trait or being Americans, and nothing else, therefore the relation bears nothing existential. This is a diagrammatic form of representation.

- Thirdness

Thirdness is the "mode of being, which consists in the fact that future facts of Secondness will take on a determinate general character" (CP 1.26)

In Thirdness, the active element of an object present to the mind in its relation with other objects is a tertian (the form of relation of general laws and regularities). Thirdness is the mode of being where three qualities of feeling are identified as being connected — one of them connecting the two others — by recognizing in the conception of the object the form of relation associated with general laws and regularities, i.e. the triad.

- Authentic Thirdness

In the case of Authentic Thirdness, the triad is present as such in the conception of the object and the relation existing between the three qualities of feeling is forced to the mind by the force of institutions, i.e. no intervention of the mind is required in order to form the relations. It is the case of all symbolic representations of an object by another. For instance the logotype of Apple with its characteristic shape of an apple bitten off in the corner stands as a symbolic representation of the company itself, their products, their culture ... The quality of feeling uniting the physical logotype of the company with the existing products of the company via a sort of "appleness" together forming a triad of three elements present to the mind as one as soon as one thinks about either one of them. This triad is present in the sign because it is present as such in the object, with the difference that in the object it is idea of the logotype, the idea of the company and their products and the idea relating the two (that "appleness") that together form the triad. This explains how the physical aspect of a company's logotype can be modified and simplified within certain limits without ever ceasing to be associated with the same company.

- Degenerate Thirdness in the first degree

Degenerate Thirdness in the first degree, is a mode of being similar to Authentic Thirdness with the difference that the triad is not in the sign because it is in the object but the triad is formed through intervention of the mind by bringing together the quality of feeling of a dyad — a fact, the real action of one thing upon another —, an a quality of feeling being the idea of a relation between the thing that is acting and the thing being acted upon, but a relation of reason only:

> "Among thirds, there are two degrees of degeneracy. The first is where there is in the fact itself no Thirdness or mediation, but where there is true duality; (...). Consider, first, the thirds degenerate in the first degree. A pin fastens two things together by sticking through one and also through the other: either might be annihilated, and the pin would continue to stick through the one which remained. A mixture brings its ingredients together by containing each. We may term these accidental thirds." (CP 1.366)

Or in this illustration by Peirce :

> "How did I slay thy son?" asked the merchant, and the jinnee replied, "When thou threwest away the date-stone, it smote my son, who was passing at the time, on the breast, and he died forthright." Here there were two independent facts, first that the merchant threw away the date-stone, and second that the date-stone struck and killed the jinnee's son. Had it been aimed at him, the case would have been different; for then there would have been a relation of aiming which would have connected together the aimer, the thing aimed, and the object aimed at, in one fact. (CP 1.366)

for someone witnessing the scene, the action of the jinnee on the merchant's son may have seemed to be premeditated. Had it actually been the case there would have been a real mediation in the intentions of the Jinnee to connect the Jinnee and the merchant's son in the act of a murder, but since the action was accidental and therefore not premeditated on the part of the Jinnee, it is a case of accidental thirdness. Since in any case there is the action of one thing upon another, Degenerate Thirdness in the first degree presupposes Authentic Secondness.

- Degenerate Thirdness in the second degree

In Degenerate Thirdness in the second degree there is not even the action of one thing upon another. A triad is formed by bringing together the qualities of feeling of three things that would otherwise not be related to each other, was it not by relations of reason:

> We now come to thirds degenerate in the second degree. The dramatist Marlowe had something of that character of diction in which Shakespeare and Bacon agree. (...) The relations of reason which go to the formation of such a triple relation need not be all resemblances. Washington was eminently free from the faults in which most great soldiers resemble one another. A centaur is a mixture of a man and a horse. Philadelphia lies between New York and Washington. Such thirds may be called intermediate thirds or thirds of comparison. (CP 1.367)

This mode of representation is that of the metaphor. It is clear that the sign "Philadelphia" does not physically *lie between* the signs "New York" and "Washington" although it is easy to conceive the existence of a triad by representing the position of the cities on a map and by linking the idea of a dot (Philadelphia) to the idea of a segment [(New York) - (Washington)] via the idea that "a dot can belong to a segment", the object of the sentence. It is the transposition of this triad into the sign, or the idea that the triad found in the object can simultaneously be found in the sign, after which the proposition makes sense. Degenerate Thirdness in the second degree presupposes degenerate Secondness, which appears in the parallelism of the transposition of the dyadic relation: *(–) belongs to the segment (–)* from the object to the sign.

In summary, the connective capacity of an object to form correspondences with other objects is called its mode of being. Firstness is the mode of being of qualities, Secondness of existents and facts, and Thirdness the mode of being of general laws and concepts. Thirdness has two levels of degeneracy and Secondness has one level of degeneracy. The categories are ordered, Thirdness presupposes Secondness and Secondness presupposes Firstness, in other words concepts and laws govern existents and facts which in turn are required to incorporate qualities in order to exist.

Semiotic and classification of signs

By taking an abstractive stance back and letting the mind become its own spectator, by mentally differentiating in semiotic phenomena the different instances of signification, i.e. the things representing, the things being represented and the mechanisms through which the things that represent are put in relation with the things represented, and after considering the collective totality of objects that each of these three instances consist of, it is possible to formally associate a phaneron to each of these totalities. Indeed, in a given phenomenon one can differentiate between the presence to the mind of the things that are representing, i.e. the signs, and the presence to the mind of the objects that are being represented. Beside that, the mechanisms through which, in the representation of one thing by another, a totality of objects is substituted with another, require in order to be correctly analyzed at least a good understanding of social norms and conventions and the cultural signification of objects in society. Nonetheless, the presence to the mind of these connections in the form of a field of interpretants constitute a third phaneron. It is by logical analysis those three instances can be extracted from a given phenomenon. Now matter how isolated they may appear to be, their coexistence inside a same phenomenon is necessary for the global signification of the phenomenon.

Any phenomenon of representation can therefore be semiotically analyzed as a cooperation of three semiotic phenomena:

- a perceptual configuration of objects (signs) available to the senses as qualities of feeling that are either directly experienced or remembered from earlier experiences, whose function is to represent something else,

- the "something else" (called objects), absent from the realm of perception, but available through a series of inferences by reconstruction of their eidetic structures,

- the particular effect (an interpretant in a field of interpretants) caused by the perception of the sign on a individual who has learned universal forms of correspondences, the meaning of signs, a characteristic aspect of institutions in a given semiotic community.

It is on this basis that an objective method for the classification of phenomena is made possible, by formally mixing phaneroscopy and semiotics, which would virtually be impossible should any phaneron not be expressible after reduction as a combination of elementary forms. What are then globally referred to as "the sign", "the object" and "the interpretant" in a phenomenon are the respective recombination of all the elements individually identified as contributing to the overall signification of the phenomenon, i.e. respectively a totality of signs, a totality of objects that signs refer to, and all the means by which the signs refer to the objects. Each of these elements of signification analyzed as constituents of a semiotic phenomenon are associated with one or several classes of signs — a correspondence not defined once and for all but characteristic at a given time in history of the social signification of those signs in a system of codes, and of the actual action that they have on a mind.

Classes of signs

In CP 2.243 Peirce divides signs into classes according to the following scheme based on the modes of being of the different components of the sign:

> "Signs are divisible by three trichotomies; first, according as the sign in itself is a mere quality, is an actual existent, or is a general law; secondly, according as the relation of the sign to its object[14] consists in the

[14] the dynamic object

sign's having some character in itself, or in some existential relation to that object, or in its relation to an interpretant; thirdly, according as its Interpretant[15] represents it as a sign of possibility or as a sign of fact or a sign of reason." (CP 2.243)

Since the structures of the object and of the interpretant are in continuous expansion, it is required that a reference be set. The reference is taken at the term of the semiosis when those structures have sufficiently stabilized. It is therefore understood that the object is the dynamic object and the interpretant the final interpretant.

- First trichotomy

"According to the first division, a Sign may be termed a Qualisign, a Sinsign, or a Legisign". (CP 2.244).

The first division deals with the nature of the "sign in itself", or in other terms the mode of being in which the effective element of the sign takes part. These active elements of the sign in a semiotic phenomenon can either be a quality in the form of a monad (the mode of being of the sign is Firstness), an actual existent in the form of a dyad or two monads involved in a correspondence with another dyad (the mode of being of the sign is Secondness with various degrees of degeneracy), or a general law, an association of general ideas, in the form of either a triad, or three monads, or the combination of a dyad and a monad involved in a correspondence with another triad (the mode of being of the sign is Thirdness with various degrees of degeneracy). These signs are respectively called qualisigns, sinsigns and legisigns:

"a sign is either of the nature of an appearance, when I call it a qualisign or secondly, it is an individual object or event, when I call it a sinsign (the syllable sin being the first syllable of semel, simul, singular, etc.); or thirdly, it is of the nature of a general type, when I call it a legisign" (8.334).

Since a legisign is a law and not an existent, it can only signify through one of its instances that are particular sinsigns called Replicas of the legisign:

"Each single instance of it [legisign] is a Replica. The Replica is a Sinsign. Thus, every Legisign requires Sinsigns. But these are not ordsinary Sinsigns, such as are peculiar occurrences that are regarded as significant. Nor would the Replica be significant if it were not for the law which renders it so." (CP 2.246)

Similarly, a sinsign involves one or several qualisigns which are the qualities that the sinsign embodies.

- Second trichotomy

"According to the second trichotomy, a Sign may be termed an Icon, an Index, or a Symbol." (CP 2.247)

The second division concerns the sign-object relation or rather said the mode of being of the object in its relation to the sign, which essentially is an answer to the question "*how does the sign represent its object?*". One refers here to the universal aspect of the relation between the eidetic structures of the sign and of the object as it is institutionalized inside a community. The mode of being of the object in relation to the sign is obviously of the same nature as the mode of being of the sign itself. When, in the first trichotomy, one considered the general categories of Firstness, Secondness or Thirdness that the sign belonged to, clearly this was done with reference to any possible object and none in particular. For instance if three primans were to be the effective elements of the sign, by taking their mode of being individually one would haved categorized them in the category of Firstness, but since it is understood that the three primans of the sign are together involved at least in a correspondence with a tertian, the mode of being of the sign is a degenerate or "accidental" form of Thirdness, otherwise one would have considered the primans separately from the beginning as the effective elements of three separate signs. For that matter, the distinction between the first and the second trichotomy will be made on the basis of the degree of authenticity or degeneracy of the mode of being of the object in relation to the sign. This yields three possible configurations divided into icons, indices and symbols:

"Genuine form of the representamen[16] is the symbol. First and second degenerate forms are the index and icon respectively." (MS 307. Lecture III A. MS., notebook, G-1903-1.)

i) icons

"An Icon is a sign which refers to the Object that it denotes merely by virtue of characters of its own, and which it possesses, just the same, whether any such Object actually exists or not." (CP 2.247)

For the sign to refer to the object only by virtue of qualities in common between the sign and the object, the mode of being of the object in relation to the sign must consist either in Firstness (aka. image or qualisign), Degenerate Secondness[17] (aka. diagram or iconic sinsign) or Degenerate Thirdness[18] in the third degree (aka metaphor or iconic legisign)

Which Peirce develops in :

"Hypoicons may be roughly divided according to the mode of Firstness of which they partake. Those which partake of simple qualities, or First Firstnesses, are images; those which represent the relations, mainly dyadic, or so regarded, of the parts of one thing by analogous relations in their own parts, are diagrams; those which represent the representative character of a representamen by representing a parallelism in something else, are metaphors." (CP 2.277)

Examples of images, diagrams and metaphors were given earlier in the description of the modes of being of objects and in particular the sections on respectively Firstness, Degenerate Secondness and Degenerate Thirdness in the second degree.

[15] the final interpretant

[16] sign and *representatem* are synonymous

[17] or equivalently "*Firstness* of Secondness" seen from the sign's perspective.

[18] or equivalently "*Firstness* of thirdness" seen from the sign's perspective

ii) indices

"An Index is a sign which refers to the Object that it denotes by virtue of being really affected by that Object." (CP 2.248)

which implies that a dyad in the sign must be in correspondence with a dyad in the object on the basis of a real relation. Consequently, the mode of being of the object in relation to the sign consists either in Authentic Secondness (aka. authentic index or indexical sinsign) or Degenerate Thirdness in the first degree (aka. degenerate index or indexical legisign) in which case the dyad which the triad in the object presupposes is put in correspondence with a dyad in the sign, as explained by Peirce in:

"An Index or Seme ({sema}) is a Representamen whose Representative character consists in its being an individual second. If the Secondness is an existential relation, the Index is genuine. If the Secondness is a reference, the Index is degenerate." (CP 2.283)

The action of an index is to direct the attention towards the object represented since the dyad is present in the sign such as it is in the object. As Secondness presupposes Firstness, an index presupposes at least one icon.

Examples of indices were given earlier in the section on Authentic Secondness (genuine indices), and in the section on Degenerate Thirdness in the first degree (degenerate indices).

iii) symbols

Finally:

"A Symbol is a sign which refers to the Object that it denotes by virtue of a law, usually an association of general ideas, which operates to cause the Symbol to be interpreted as referring to that Object" (CP 2.249).

A symbol is therefore a legisign. The law or general association of ideas governs existents and facts that are conventionally associated with the object being referred to on the basis of a habit. Different from the icon in which the connection exists on the basis of an idea of qualities in common only through a resemblance, or likeness between the sign and the object, and different from the index in which the connection between the sign and the object exists by virtue of the presence a real relation between the two, the connection in the case of the symbol requires in order to be effective that the mind should act as the mediator between the sign and the object urged by the force of a convention. Since conventions exist independently of any particular interpreter, the immediate object of a symbolic sign must be of the type of a law, and therefore be a tertian:

A Symbol is a law, or regularity of the indefinite future. Its Interpretant must be of the same description; and so must be also the complete immediate Object, or meaning. (CP 2.293)

and since the immediate object is included in the sign, it implies that the sign also is a tertian, therefore the mode of being of the object in relation to the sign is Authentic Thirdness. Since Authentic Thirdness presupposes Authentic Secondness, a symbol necessarily "contains" an index that indicates the subject denoted, it also contains an icon in order to signify a character of the object denoted.

Examples of a symbol were given in the section on Authentic Thirdness.

- Third trichotomy

"According to the third trichotomy, a Sign may be termed a Rheme, a Dicisign or Dicent Sign (that is, a proposition or quasi-proposition), or an Argument." (CP 2.250)

The third division applies to the extent to which the interpretant actually understands the relation between the sign and the object, the way in which the sign, and *a fortiori* the relation between the sign and the object, is presented to its interpretant. It is the particular form taken by the correspondence in the mind of the individual after the reactivation caused by the perception of the sign and when the inferential process of reconstruction of this correspondence has been partially or totally completed. In other terms, this third division deals with the mode of being of the object in its relation to the interpretant. There is no guarantee however that the relation formed between the object and the interpretant will in an authentic way be of the same nature as the universal form of relation existing between the sign and the object. Indeed only a degenerate form of it may actually be reached at the term of the inquiry, in that case it is only a substructure of the eidetic structure of the object will be formed by the mind, instead of its entire structure.

i) rhematic signs

"A Rheme is a Sign which, for its Interpretant, is a Sign of qualitative Possibility, that is, is understood as representing such and such a kind of possible Object. Any Rheme, perhaps, will afford some information; but it is not interpreted as doing so." (CP 2.250)

"A rheme is defined as a sign which is represented in its signified interpretant[19] as if it were a character or mark (or as being so)" (CP 8.337)

In a rhematic sign some primans of the object only, possibly the ones involved in either a secundan or a tertian of the object, are communicated to the interpretant. In consequence the only type of information afforded about the nature of the object is some of the qualities or characters of the object, but without any indication on facts pertaining to these qualities. The mode of being of the object in relation to the interpretant is either Firstness, degenerate Secondness or degenerate Thirdness in the second degree. All icons are rhematic signs.

ii) dicent signs

"A Dicent Sign is a Sign, which, for its Interpretant, is a Sign of actual existence." (CP 2.251)

"I define a dicent as a sign represented in its signified interpretant as if it were in a Real Relation to its Object. (Or as being so, if it is asserted.)" (CP 8.337)

A dicisign, or dicent[20] sign affords "real" information of an actual fact concerning the object because a secundan of

[19] final interpretant.

[20] From Latin: "that says"

the object is transferred into the interpretant as is, the latter being *informed* literally of a dyadic relation present in the object.

Examples of dicent signs are all sorts of propositions (linguistic or not). They connect existents and facts concerning those existents to general concepts.

"A proposition as I use that term, is a dicent symbol. A dicent is not an assertion, but is a sign capable of being asserted. But an assertion is a dicent."(CP 8.337)

In the particular case of linguistic propositions, for instance "Franklin and Rumford are Americans" one can isolate existents ("Franklin" "Rumford" "Americans") and a fact concerning those existents (the verb "to be" as "belonging to"). In any case, the effect of the dicent sign is to cause all concepts and individuals involved in the proposition to be interpreted as being in *real relations*, no matter if the proposition is asserted or not. Peirce writes that a dicent sign is a sign whose interpretant represents it as an index of its object [Peirce, 1998, "Sundry Logical Conceptions", p.277].

But while the index in itself affords no information about the nature of what is being represented since it only indicates that the things being represented are connected, a dicisign besides being an index will involve an icon to represent the information that it cannot convey by itself.

The mode of being of the object in relation to the interpretant consists therefore in either Authentic Secondness or Degenerate Thirdness in the first degree.

iii) argument

"An Argument is a sign whose interpretant represents its object as being an ulterior sign through a law, namely, the law that the passage from all such premisses to such conclusions tends to the truth. Manifestly, then, its object must be general; that is, the Argument must be a Symbol. As a Symbol it must, further, be a Legisign. Its Replica is a Dicent Sinsign." (CP 2.263)

A typical argument consists of several propositions called the premiss and the conclusion, and a law that logically connects them, this law consisting in a rule of implication, or a tautology ... For example, the statement "if A then B" is not strictly speaking an argument because it is an existent and an argument is, like all symbols, an *ens rationis*[21], a law that governs existents. Because this statement causes the mind to conceive that the truth of B is depending on the truth of A through the intervention of a given rule (here a rule of implication), the object is looked upon as being a genuine triad, and that aspect only constitutes an argument.

The mode of being of the object in relation to the interpretant consists therefore in Authentic Thirdness.

[21] as opposed to a concrete thing : an abstraction, its being depending on the truth of something.

Ten classes and the lattice of classes of signs

We can now list all the classes of signs that can logically be deduced first by selecting the mode of being of the object in relation to the sign (O – S) and then by running through all possible modes of being of the object in relation to the interpretant (O – I). O – S being given, O – I can only be an identical or a degenerate form of O – S. Let us write, for the sake of being succinct, "1 $\rightarrow$ 1" for "Firstness", "2 $\rightarrow$ 2" for "Authentic Secondness", "2 $\rightarrow$ (1,1)" for "Degenerate Secondness", "3 $\rightarrow$ 3" for "Authentic Thirdness", "3 $\rightarrow$ (2,1)" for "degenerate Thirdness in the first degree" and "3 $\rightarrow$ (1,1,1)" for "Degenerate Thirdness in the second degree".

O – S	O – I	Class
3 $\rightarrow$ 3	3 $\rightarrow$ 3	Argument
3 $\rightarrow$ 3	3 $\rightarrow$ (2,1)	Dicent Symbol
3 $\rightarrow$ 3	3 $\rightarrow$ (1,1,1)	Rhematic Symbol
3 $\rightarrow$ (2,1)	3 $\rightarrow$ (2,1)	Dicent Indexical Legisign
3 $\rightarrow$ (2,1)	3 $\rightarrow$ (1,1,1)	Rhematic Indexical Legisign
3 $\rightarrow$ (1,1,1)	3 $\rightarrow$ (1,1,1)	Iconic Legisign
2 $\rightarrow$ 2	2 $\rightarrow$ 2	Dicent Sinsign
2 $\rightarrow$ 2	2 $\rightarrow$ (1,1)	Rhematic Indexical Sinsign
2 $\rightarrow$ (1,1)	2 $\rightarrow$ (1,1)	Iconic Sinsign
1 $\rightarrow$ 1	1 $\rightarrow$ 1	Qualisign

It is easy to deduce from this table the forms of relation found at each stage of the semiotic process in O, S and I. For example the object of a rhematic indexical legisign is a tertian, the sign is a combination of a secundan and a priman, and the interpretant consists of three primans. The tertian of the object is in correspondence with the combination of a secundan and a priman of the sign. The secundan is transferred from the object to the sign as the secundan that the tertian presupposes, and the same tertian is in correspondence with a combination of three primans in the interpretant (see fig.4 as adapted from [Marty, 1990, fig.88 p.250]):

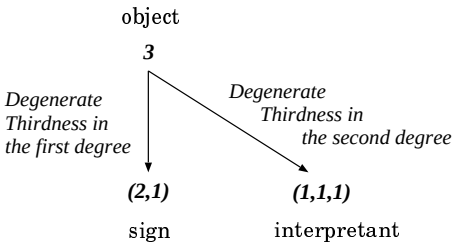

Fig. 4. Example : rhematic indexical legisign

Finally, as rigorously demonstrated in [Marty, 1990, p94-105] the logical relations of presupposition between the cenopythagorean categories (Firstness, Secondness, Thirdness and their degenerate variants) applied to the relations

of determination in the triadic sign lead to a configuration of the ten classes of signs in a lattice represented in the diagram of fig.5 as adapted from [Marty, 1990, fig.52 p.171]. The arrows linking the classes signify which classes are "contained" (in the sense of being presupposed) by a given class.

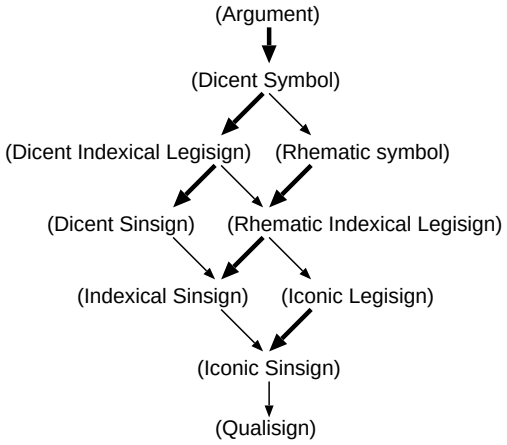

Fig. 5. Lattice of the ten classes of signs

For example, a Dicent Indexical Legisign involves at least a Dicent Sinsign (the Replica), a Rhematic Indexical Legisign (to denote the subject of that information), an Iconic Legisign (to signify the information), which also involve an Indexical sinsign, an Iconic Sinsign, and a Qualisign.

"A Dicent Indexical Legisign [...] is any general type or law, however established, which requires each instance of it to be really affected by its Object in such a manner as to furnish definite information concerning that Object. It must involve an Iconic Legisign to signify the information and a Rhematic Indexical Legisign to denote the subject of that information. Each Replica of it will be a Dicent Sinsign of a peculiar kind." (CP 2.260)

The configuration of the classes in a lattice offers a better understanding of semiotic phenomena because the complexity of the relation between the parts and the whole is taken into account, by integrating inside a global structure the contribution of each element in the signification process and all interrelations between these elements, instead of just considering them individually.

Summary

An analysis of semiotic phenomena of representation leads to consider three phenomena simultaneously present to the mind: the sign that represents, the object that is represented and the interpretant which connects them. All phenomena (or phanerons) — and *a fortiori* the sign, object and interpretant — are decomposable into combinations of elementary forms of relations functioning like 1, 2, 3-place predicates, called respectively primans, secundans and tertians which are the indecomposable elements that connect the qualities of feeling of phaneron. The categorization of signs into classes is done by considering the action that these elementary forms, taken in their contribution to the overall signification of a phenomena, have on the mind. The result of their action is characterized by their capacity to enter into relation with one another, aka. their mode of being. There are only three categories called Firstness, Secondness and Thirdness into which elements of the phaneron can take part. Firstness is the category of qualities as possible forms, Secondness the category of things that act upon each other, i.e. existents and the facts concerning these existents, and Thirdness is the category of general laws and concepts that governs existents and fact. The classes thus obtained are partially ordered in a lattice structure by relations of presupposition.
We can now begin with the case study.

CASE STUDY

The object of the study is the configuration procedure that the user has to go through in order to connect to the Internet by selecting various settings during the installation of Apple's iMac TM. The installation program, run only once the very first time that the machine is turned on, displays a series of screens, each of them constituting a step in the procedure. In order to move from one screen to another the user is required to enter information about the system, the country, the type of Internet connection, etc ...

For the sake of being succinct, our study will focus on one of those screens only, i.e. the one that the user is required to interact with at the very outset of the procedure (see figure 6, p. 14). In order to carry a thorough analysis, one should in fact consider each screen in its singularity and include its contribution to the overall signification of message. But we can roughly say that the vast majority of screens is composed of a singular object: the user's computer, using a mode of representation that will later be made more explicit, being displayed in a relation of proximity to a series of attributes entered by the user and applying to that object. Therefore, since a pattern is emerging and repeating itself substantially in the same manner, our approximation will consist in studying one specific screen only, chosen as representative of rest of the procedure

Method of analysis

The semiotic analysis done on this example of a software configuration aims to discover the mechanisms that are operative behind the message itself. The construction of meaning done by the user is better understood by sorting out the classes of signs into the lattice structure. Therefore to start with, the method will consist in identifying all signifying elements, i.e. all signs contained in the message, directly observable, either external or internal that in the context of interpretation refer to something else than themselves. Doing their phaneroscopy comes down to extracting their indecomposable elements. They consist of either

primans for the qualities, secundans for the existents and facts, or tertians for concepts and general laws. The following step will be to determine their respective objects, the modes of being of these objects in relation to the signs, and of their relation to interpretants, which requires taking into consideration the actual context of interpretation of the message.

As mentioned earlier, the institutionalized meaning of signs in society, the so-called codes and norms are expressed in the form of correspondences between the eidetic structures of the signs and their objects. The universal aspect of this correspondence is characteristic of the historical and sociological parameters on the level of a community, the other aspect is the particularity of that correspondence for a given individual belonging to that community. Since no other than the mind itself constitutes the cradle of birth of such phenomena, phaneroscopy because it is“ supported by the direct observation of phanerons (CP 2.286)” cannot be carried out otherwise than empirically. But both aspects although subjective in nature become objective realities as soon as they are experienced and described.

Contextual interpretation

That leads us to formulate two remarks that will be of importance for the rest of this study. Firstly, we will place ourself in a context of interpretation corresponding to the social and historical state of today’s society: a society used to dealing with traditional analog objects and relatively new to digital forms of representations. This first aspect is the social dimension, the universality of the correspondence between the sign and the object. Secondly, the interpreter of the message will be considered as an average user for whom the computer is equivalent to a “black box”, in other words a user relatively familiar with computers but not sufficiently in order to be aware of any of the mechanisms at work behind the interface. This second aspect is the particularity of the aforementioned correspondence for the individual that perceives the sign.

Our fundamental hypothesis will be to suppose that the habits and norms in force within the “analog world” are the primary forms of correspondences known to the user, in other terms, what is referred to as “the analog object” is no other than Peirce’s immediate object.

Elements of signification

Let us begin with a rapid overview of the screen that is the object of the study.

As shown on figure 6, the message is composed of both linguistic and pictorial elements. Pictorial elements are the photograph image of an iMac(TM) computer on the left-side area of the screen turned in the direction of a fill-in entry form. A round-shaped translucent push-button reading

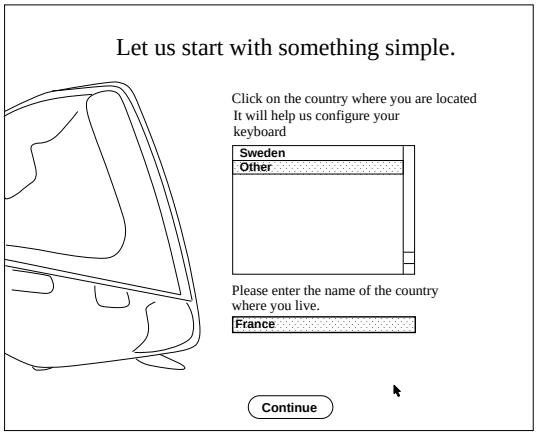

Fig. 6. Case study: screen interface of the configuration program

“Continue”[22] appears underneath. The linguistic elements consist of a main header (“Let us start with something simple[23].”), and various propositions (“Click on the country where you are located[24].” , “It will help us configure you keyboard.[25]” , “Please enter the name of the country where you live[26]”). If the user wishes to select a country other than the default one, they are required to click on the option “Other”, and manually enter the information.

The elements cited above are the most obvious signs of the message. They all stand for something else than themselves as it will now be developed further, but we must also take into consideration all objects that are presumingly present in the immediate environment of the user, i.e. the computer itself and all peripherals (mouse, keyboard, screen ...) as potential elements of signification.

Let us begin with visual elements pertaining to the computer itself.

a) The picture of the computer

Although not represented on the diagram of figure 6 (it must be remember that a diagram already is a representation), the elements of signification categorized as primans are the characteristic translucent colors of both the computer on the left and of the push button in the bottom center, the gentle aspect of their curves, the idea of transparency found across elements of the screen and on the actual computer and peripherals. The sense of unity produced involves a qualisign, i.e. a sign whose quality calls to mind other objects sharing the same qualities:

> A Qualisign is a quality which is a Sign. It cannot actually act as a sign until it is embodied; but the embodiment has nothing to do with its character as a sign. (CP 2.244)

[22] Since the language used in the original installation procedure is Swedish in our case, these are translations.
[23] Swedish : “Vi börjar med något enkelt”
[24] Swedish: “Klicka på det land där du befinner dig.”
[25] Swedish: “Det hjälper oss att koppla in ditt tangentbord.”
[26] Swedish: “Skriv namnet på det land där du befinner dig.”

What is referred to as “the look-and-feel” of the interface goes beyond the screen image and is applied to the rest of the computer. The qualisign is thus embodied in various objects called iconic sinsigns:

> An Iconic Sinsign (...) is any object of experience in so far as some quality of it makes it determine the idea of an object. (...) It will embody a Qualisign. (CP 2.255)

These objects consist of all existents embodying the same quality of translucence and curviness, e.g. the keyboard, the mouse, the power cable ... as the elements of the screen interface.

Chances are that beyond the idea of a mere resemblance between these elements, the characteristic look-and-feel slowly but surely contributes to institutionalizing a correspondence in the mind of the user connecting the quality of translucence to the entire gamut of products, and to an even greater extent if the correspondence is advertised. This kind of association is done not by convention but through a law called a legisign that requires each of its instances to embody that very quality :

> An Iconic Legisign (...) is any general law or type, in so far as it requires each instance of it to embody a definite quality which renders it fit to call up in the mind the idea of a like object. (..) Being a Legisign, its mode of being is that of governing single Replicas, each of which will be an Iconic Sinsign of a peculiar kind.(CP 2.258)

In short, these are the main primans involved in various type of iconic signs, more specifically in either qualisigns, or in iconic sinsigns such as existents like the computer itself, the rest of the peripherals and all elements of its interface that embody these qualities. Finally the same primans are involved in an iconic legisign or a law, usually referred to as “design guidelines”, prescribing the qualities found in all instances of the law, i.e in all existents, that will at the moment of perception naturally cause them to be associated with Apple’s products.

Now we may ask ourselves “what function does the image of the computer on the screen actually fulfill?”. Although obviously being the iconic representation of an iMac computer, the image does not merely fulfill a decorative function but also serves as an indication that the computer shown on screen stands for the one being configured. Indeed, their colors may differ, but since translucence and a form of curviness only are the determining aspects of the design, all objects sharing those qualities will naturally be fit to become instances of the iconic legisign. In any case, this picture on the screen depicting an iMac is an index of the real one displaying its own image (see figure 7). A relation of Authentic Secondness exists therefore between the sign and its object. In this particular case, the medium carrying the sign happens at the same time to be the very object denoted. The picture is therefore an indexical sinsign, rhematic in the sense that it draws attention towards its object denoted without affording any sort of information about it, not even its color :

> A Rhematic Indexical Sinsign (...) is any object of direct experience so far as it directs attention to an Object by which its presence is caused. It necessarily involves an Iconic Sinsign of a peculiar kind, yet is quite different since it brings the attention of the interpreter to the very Object denoted. (CP 2.256)

The “iconic sinsign of a particular kind” is of course the picture itself.

Now since every step of the configuration procedure tends to repeat in a consistent way the same pattern consisting in the picture of an iMac computer serving as an index of the actual computer, the result is that a regularity appears to the mind and a law is promulgated as a sign. This law is a rhematic indexical legisign, all of its instances or replicas are the rhematic indexical sinsigns :

> A Rhematic Indexical Legisign (...) is any general type or law, however established, which requires each instance of it to be really affected by its Object in such a manner as merely to draw attention to that Object. Each Replica of it will be a Rhematic Indexical Sinsign of a peculiar kind. (CP 2.259)

This example illustrates the importance in computer-user interfaces of visual consistency.

The analysis so far has led us to account for the presence on the left side of the screen of the computer picture. It directs the attention to the actual computer being configured. Eventually, the entire setup including all the peripherals (the mouse, keyboard, modem ...) is represented only by showing a part of it, which constitutes a visual synecdoche[27]. The result is that the perception of the picture of the computer causes the user to have present to the mind a representation of their own computer.

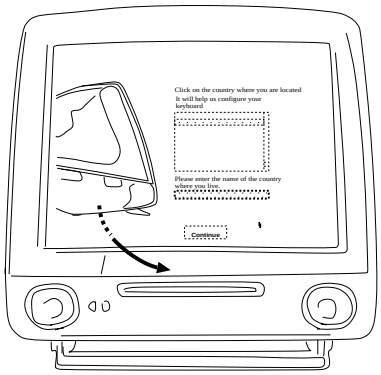

Fig. 7. Case study: visual synecdoche

We can now move on to the analysis of the rest of the screen, and focus on the fill-in form.

b) The fill-in form

Displayed on the right side of the screen, the form consists of a list box falling under the header “Click on the country where you are located.” and a second text entry field under the header “Please enter the name of the country where you live”. We will for the time being ignore the

[27] Rhetorical figure in which a part represents the whole.

linguistic content of the message and only retain the visual arrangement of text lines from a graphic viewpoint.

This compound of textual and graphic elements constitutes in itself the prototype of an administrative form, a printed type of document with blank spaces for insertion of the requested information, a concept borrowed from the analog world and necessarily known to the user. Physical fill-in forms in pixels or on paper are particular diagrams, the replicas of an iconic legisign. They are particular in the sense that in order to fall under the concept of an administrative form, they are required to meet the requirements of a law, an iconic legisign that prescribes the qualities that must be present in each of these instances for them to be interpreted as such. Because the form displayed on screen is an extension of the concept of an administrative form, the user is supposed from the beginning to know how to interact with it, by integrating its eidetic structure into the structure of previously memorized experiences involving the use of administrative forms. The transposition from the analog to the digital is done by substituting the digital form present on the screen with the idea of its paper version through the use of a metaphor, i.e. an iconic legisign.

In brief, the perception of the fill-in form on the screen causes for the presence to the mind of the user of a more general diagram called an iconic legisign under which all replicas both analog of the digital are falling. The correspondence between the digital and the analog is further expanded through an inference by analogy.

> "Analogy is the inference that a not very large collection of objects which agree in various respects may very likely agree in another respect." (CP 1.69)

The objects that "agree in various aspects" are the analog and the digital extensions of the concept. Both are present to the mind simultaneously as elements of the same phenomenon. The digital object is present through a direct observation of the screen, and the analog object is present because its eidetic structure, that of a typical fill-in form, is included in the eidetic structure of the digital object on the screen.

The rule of the inference by analogy consists then in expanding the eidetic structure of the digital object, first by incorporating the analog object, or rather its own eidetic structure into a larger one known from memorized experiences, and secondly by drawing correspondences in parallel between the newly formed expansions of respective structures. In the process, a writing pen is associated to the paper-based fill-in form while the keyboard is naturally associated to the digital variant of the paper form, i.e. the fill-in form on the screen. The compound comprising the structures of the keyboard and of the digital form is thus analogous in some respects to the compound formed by the structures of the pen and of the paper form in the analog world (see figure 8).

So far is the connection still hypothetical, based simply on an analogy and needs therefore be asserted by testing

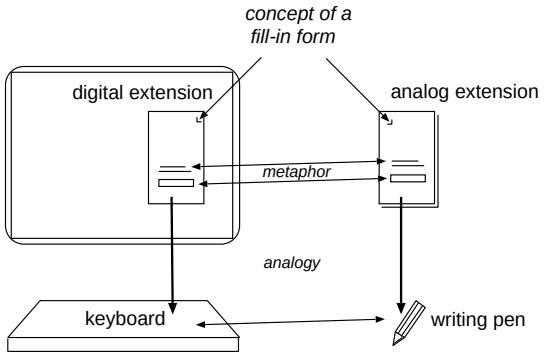

Fig. 8. Case study: metaphor and inference by analogy

its implications. For that matter, the user is required to ascertain that the dyad (keyboard / digital form) obtained from the dyad (pen / analog form) does not solely rely on a mental construct of his, a pure relation of reason, but that the relation is based instead on an external fact. This is simply done by typing character at the keyboard and by controlling that the result of the typing simultaneously appears in the fill-in form on-screen. In pragmatic wording, the user's belief of the validity of the analogy has created a rule for their actions.

Once the characters typed on the keyboard have appeared on-screen, the analogy is considered a valid inference and the metaphor of the paper fill-in form is retained. In the meantime, the aspect of secondness in the relation is given a character of authenticity, and as a consequence the digital object on-screen, beside being an iconic representation of its analog equivalent also is an indexical representation of it, more precisely an indexical sinsign, rhematic in the sense that no information is afforded on the very content of the form itself.

The characteristic pattern of interaction between the keyboard and the screen contributes to establishing in the mind of the user a rhematic indexical legisign that summarizes the entire analogy. The effect seen of the keyboard on the form on-screen is taken for granted by the user and the process of inquiry already carried out during the inference by analogy need not be rerun each time because its outcome already is included in each of the instances of the rhematic indexical legisign. Here again, a high level of consistency in the user interface must be preserved from one screen to another for the legisign to continue to operate.

But the fact itself is part of the more general concept of giving information that involves the idea of a mediation between parties, which the fact of filling in a form would be unfit to represent alone, was it not for the idea that it is institutionalized as such. The existing fill-in form therefore has the wider function of calling up an image producing a general concept, which the rhematic indexical legisign by directing the attention towards a fact, the action of the keyboard on the fill-in form represented by the action of a pen

on a paper form, could not fulfill. This type of sign is called a rhematic symbol (legisign):

> A Rhematic Symbol or Symbolic Rheme (...) is a sign connected with its Object by an association of general ideas in such a way that its Replica calls up an image in the mind which image, owing to certain habits or dispositions of that mind, tends to produce a general concept, and the Replica is interpreted as a Sign of an Object that is an instance of that concept (CP 2.261)

The replicas of a rhematic symbol also are rhematic indexical sinsigns but of a different kind than the replicas of the rhematic indexical legisign:

> Its Replica, however, is a Rhematic Indexical Sinsign of a peculiar kind, in that the image it suggests to the mind acts upon a Symbol already in that mind to give rise to a General Concept. In this it differs from other Rhematic Indexical Sinsigns, including those which are Replicas of Rhematic Indexical Legisigns. (CP 2.261)

In summary, the function of the form on the right side of the screen is to communicate the idea that the computer to a certain extent takes in information in the same way as an administrative office would, by way of filling in a form. It belongs to the class of the rhematic symbol.

The last part of the analysis consists in explicating the nature of the correspondence between the picture of the computer on the left and the fill-in form on the right.

c) Correspondence between the computer picture and the fill-in form.

The analysis so far has led us to identify a rhematic indexical legisign and a rhematic symbol involved in the representations of a computer and of a fill-in form. We have treated them as isolated elements; we must now find out how they are connected. According to the lattice of the classes of signs (see figure 5) the connection can be made by incorporating the rhematic indexical legisign and the rhematic symbol in the superior classes of the dicent symbol and of the argument. By taking a closer look at the screen (see figure 6) we can see that this is precisely what the propositions “Please enter the name of the country where you live ” and “It will help us configure you keyboard” manage to achieve, by informing the user on how the various graphical elements are logically organized. This is taken in charge by a type of argument which can be rewritten as:

- Rule of the premiss: *If you enter the name of your country then your keyboard will be configured.*
- Case of the premiss: *you enter the name of your country*
- Conclusion: *your keyboard will be configured*

One recognizes here a deductive form of argument composed of three propositions:

if p then q
p
---
q

All propositions are dicent symbols; and while they are composed here of linguistic signs mostly, they could as well have been represented graphically as pictograms. For example the proposition “Please enter the name of the country where you live” is equivalently represented by displaying the pictures of the flag of different countries.

A dicent symbol necessarily contains one or several rhematic symbols to signify the general concepts involved in the proposition:

> “Like the Dicent Sinsign it [the Dicent Symbol] is composite inasmuch as it necessarily involves a Rhematic Symbol (...) to express its information and a Rhematic Indexical Legisign to indicate the subject of that information.” (CP 2.262)

In the propositions above, rhematic symbols referring to existents are the concept of a keyboard and the concept of a country; those associated with facts are the concept of entering information which is precisely the rhematic symbol identified earlier in the analysis of the fill-in form, and the concept of configuring something.

Any proposition, be it linguistic or not, requires, to express the way in which, like in a diagram, the concepts are organized, the presence of an iconic legisign. The concept of configuring something, for example, besides being involved in a linguistic proposition, also is communicated through a visual proposition. It is constructed with an iconic legisign signifying that objects placed next to each other are likely to interact, by displaying in a diagrammatical way the picture of a computer next to a fill-in form. The interpretation is that the object represented by the fill-in form is connected with the object represented by the picture of the computer in some way of another, i.e. the idea of entering information is to be connected with the idea of the computer itself, including all the peripherals and the keyboard.

Summary

The diagram of figure 9 shows a summary of the signification process as analyzed so far.

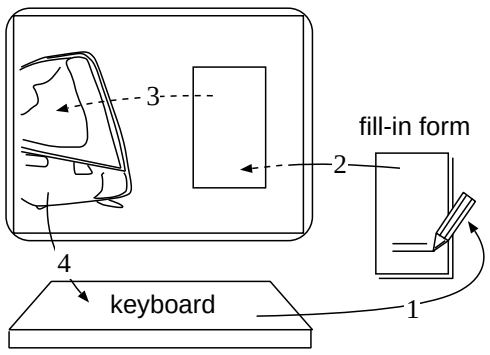

Fig. 9. Case study: summary of the entire significtion process

The connection between the picture of the computer and the actual keyboard corresponds to the arrow (4) studied in

a); it is a rhematic indexical legisign. The arrows (1) and (2) correspond to the metaphor of the administrative fill-in form which by analogy refers to the concept of giving information analyzed in b); we have categorized this sign in the class of the rhematic symbol. Finally the connection represented by the arrow (3) which summarized in a sense the entire process was studied in c); it is an argument.

Further analysis

By looking at the entire process, we see that the keyboard is involved in two different phenomena. First, as an element of perception, an existent in the immediate environment of the user, it is the sign of the imaginary writing pen associated by analogy with the object of the digital fill-in form; secondly it is found among the objects denoted by the picture of the computer through a visual synecdoche, present to the mind in both aspects and by different means. Paradoxically enough, the tool supposed to be used in order to configure the keyboard is the keyboard itself. One cannot help but think about M.C. Escher's "Drawing Hands" (see fig 10) and the perplexity caused by the idea of a self-contained system. Similarly here one is forced to accept the deceptive idea of a keyboard configuring itself. In the same way as the hand constructs itself in a conceptual self-reference so as to form a unique object, the reality constructed in the mind of the user does not differentiate between the digital and the analog object. If the hand emerging from the paper were the analog object, the digital object would be the sleeve that the hand is drawing inseparable from the rest of the hand. The reality known to the user does not stem from some intrinsic properties of the elements of a phenomenon but from the interrelations experienced between these elements. While in the analog world we are used to encounter these objects in relatively stable contexts which leads to consider their relations with other objects as intrinsic features of theirs, in the digital world their role can be constantly redefined. It is possible by employing analogies, metaphors, metonymies, paradoxes and all sorts of rhetorical stratagems to define any type of interrelational configuration of elements of a phenomenon and control the reality of the user.

In the particular paradoxical case of a keyboard configuring itself, which as a proposition can be expressed as "the keyboard configures the keyboard" similar to "Caïn kills Abel", the two terms are connected by a relation considered real by the user; the effect of the dicent symbol is indeed to connect the two terms in an existential relation. One has to remember that the first term of the proposition (the subject of the predicate) is an element of a phenomenon referring to something else than itself via the institution of the administrative form supposedly known to the individual, while the second term of the proposition (the object of the predicate) is an element of a phenomenon being referred to by visual synecdoche. The paradox, rooted in self-reference,

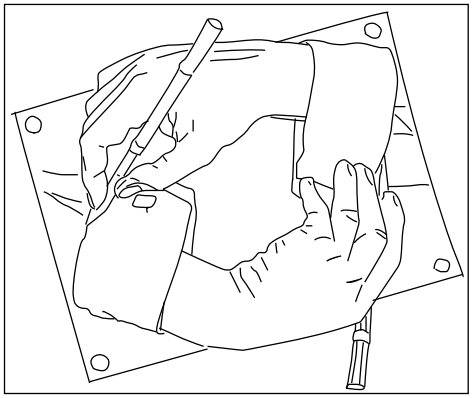

Fig. 10. diagram of Escher's Lithograph "Drawing Hands" (1948)

arises from the false assumption that it is the same 'keyboard' present in both phenomena, which is understandable because in the mind of the user all these phenomena are intertwined that they become indiscernible, and the distinctions that we have made earlier were obtained at the term of the semiotic analysis which no user is supposed to carry out. Strangely enough then, all conditions are met for the user to notice that there is a paradox.

Why do they fail to see it? The answer lies in that the construction of meaning is done here on a closed, formal system where objects refer to other objects inside the system only. The word 'configure' does not inform the user on anything else than merely indicating than one object is acting upon another, without actually mentioning what this action consists in and what it implies. The relative voidness of the word 'configure' therefore removes the paradox, and the entire configuration procedure is formally correct. But if informal elements were to be introduced, for example by displaying different keyboard layouts and introducing the concept of remapping keys then the paradox would become apparent. The entire procedure relies on the assumption that the user is unfamiliar with such concepts. Although reasoning correctly, they fail to see the artifice by lack of the valuable piece of information that would have forced them to reconsider the validity of the entire system. Unfortunately this precious kind of information is often referred to as 'computer technicalities' precisely by those who fail to acknowledge its value and happily fall for the trick.

GENERALIZATION

Manipulation or programmability are observable practically in the actions performed by the user, because these are the practical consequences of the conception that they have of the digital objects presented before them. But if some actions were to reveal a misconception of the object, they would necessarily be judged in relation to some other actions believed to be more adapted to the situation — a method of investigation difficult to defend because of the arbitrariness that defining a system of reference necessarily

implies. Therefore our fundamental hypothesis has consisted in admitting that digital and analog objects cannot in all respects be of the same essence, that their conception in respective contexts must differ at least in some aspects, and that consequently the actions performed on digital objects should in one way or another reflect those differences in conceptions.

As existents, these objects are governed by the rules and conventions characteristic of the various institutions that they belong to. In fact, the same existing object may be considered as the extension of a digital or analog concept, and conversely a same concept may have extensions in digital or analog contexts. In the case of our present analysis, a concept institutionalized in an analog context is being transposed into a digital context (see fig. 8), which contributes in the long run to its institutionalization in the digital world as well. All that is required is that existing digital objects should carry in their structure the structure of the corresponding analog object, at least the aspects characteristic of their institution in the analog world. The transposition from analog to digital occurs without modification of the (analog) institution by transposing into the signs present in digital contexts the characteristic aspects concerned by the legisigns of the analog institution.

Remember that we have defined the analog object as the object associated to a given sign in an analog context and the digital object as the object associated to a sign in a digital context. Using the same notations as in [Marty, 1990, "Fibres sémiotiques et champs d'interprétants" p.310-316] we have a class C_S (= $\{(S,O_j)\}_{j\in J}$) of all possible objects associated inside a community to a given sign S depending on the context. $\{(S,O_{analog}); (S,O_{digital})\}$ is the subclass of C_S that we will retain here that forms a simplified semiocultural field where the pairs (S,O_{analog}) and $(S,O_{digital})$ are the associations made inside the community between a given sign and its object in respective analog and digital contexts (see fig. 11.)

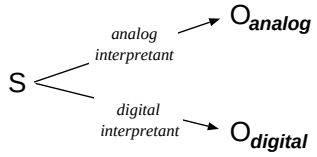

Fig. 11. fields of interpretants (analog / digital)

There are four cases to consider when comparing the eidetic structures of these objects:

i) *the structure of the digital object and of the analog object are the same ($(S,O_{analog}) = (S,O_{digital})$).*

This is the simplest case. The inferential process consists in recognizing in the perceptual configuration of the sign the form characteristic of a legisign of the analog institution, in the same time as the sign is encountered in a digital context. Practically, the perception of the object leads to the formation of a mental object whose structure is known from earlier experience to be involved in the structure of an object which is a tertian, i.e. a law or regularity borrowed from the analog institution. The conception of the digital object is the same as the conception of the corresponding analog object, and nothing in the perceptual configuration of the sign stands in conflict with the expectations of the user based on his habits of the institutionalized analog object (e.g. clock, calculator, notepad, etc...) The adjunction of the adjective 'digital' before those words is legitimate because exactly the same concept comprehends both the analog and digital objects, and there is no reason to invent a new word for it. Corresponding to a case of 'instant knowledge' on behalf of the user, this situation is accompanied by an intensification of the force of habits and legitimization of the analog institution.

ii) *the structure of the analog object can be included into the structure of the digital object without modifying their structures. ($(S,O_{analog}) < (S,O_{digital})$)*

It means that the $O_{analog} \longrightarrow S$ correspondence is a degenerate form of the $O_{digital} \longrightarrow S$ correspondence. The primans of O_{analog} are the primans of $O_{digital}$ or the primans presupposed by the secundans or tertians of $O_{digital}$. Similarly the secundans of O_{analog} are the secundans of $O_{digital}$ or the secundans presupposed by the tertians of $O_{digital}$, and the tertians of O_{analog} are the tertians of $O_{digital}$. The inferential process consists in recognizing in all perceptual configurations of the sign those structures known from earlier analog experiences to be in correspondence with a collection of objects whose structure does not conflict with the structure of the digital object. The structure of the dynamic object is assembled from the structures of all immediate objects present in the perceptual configuration of the sign. The semiosis, which consists in collecting and combining together those structures, stabilizes when the effect produced by the perception of sign corresponds to the effects that the object would have been expected to have produced, had it been the cause at the origin of the perception of all the elements of the sign. Acquaintance with the analog institution being sufficient to reconstruct the dynamic object, the digital object thus obtained would be better referred to as 'pseudo-analog' (e.g. paint programs, sound mixers, Internet phones, etc ...) This case of increased knowledge on behalf of the user is accompanied by the adoption of new habits if the semiosis is carried out sufficiently to go beyond the analog institution, or if some new element in the meantime questions the validity of the process. However chances are that only a degenerate form of the digital object will be retained at the stabilization of the semiosis, and all features that are not taken in charge by the analog institution of the object will simply be discarded, at least in the beginning. The discovery of these features will be part of a learning process, in the continuation of the semiosis. While including the advantages offered by

smooth transitions, the acquisition of new habits will also inherit the shortcomings of the analog institution due to its misadaptation to the digital object. All in all the transition is outlined by an intensification of the force of habits on behalf of the user, in effect, new habits are formed while in the same time it is the analog institution that serves as the basis of their creation. The analog institution is thus further legitimized, and the habitus thereof further maintained and reinforced.

iii) *the structure of the digital object can be included into the structure of the analog object without modifying their structures ((S,$O_{digital}$) < (S,O_{analog}))*

As opposed to the previous case, it is an object taken in a digital context here that serves to institutionalize an object in analog context (e.g. WebTV, etc ...). Prior knowledge of the digital object is required, and the expansion of its structure permits to construct by inference the structure of the analog object. This case lies however outside the scope of the present article.

iv) *the structures of the digital and analog objects are too different to be compared; they are mostly incompatible.*

Two possibilities present themselves; either the eidetic structures of analog and digital objects, bearing no characteristics in common, are totally distinct (as for example when a word taken in two different contexts means two totally different things), or they do have something in common, as when one notices *a posteriori* that the two objects can be related together according to some common aspects of theirs (for example 'UNIX pipes denoted with the " | " symbol connect a program's output to the input of another program, in the same way that water pipes serve to canalize water streams, provided that one is familiar with data streams ...). In either case, the analog institution does not intervene in the course of the inferential process, or only to lead to the construction of a dynamic object that at one point of the semiosis enters in conflict with the digital object and must therefore be discarded. Litteraly not enough information is communicated from the digital object, or the part which is retained by the user amount to a degenerate version of the original object; if the object is a tertian, perhaps only the primans presupposed by the tertian are actually retained in the process. In any case, the amount of information communicated from the digital object does not permit the user to perform the tasks which they are supposed to accomplish. No system of legisigns previously known to the user is adapted to the situation, i.e. neither the existents nor the facts concerning those existents can be taken in charge and explained by any system of legisigns. Hence, new habits must be formed, heuristically or by "reading the manual." Whereas in case i) and ii) there was a reinforcement of the "analog habitus" as primary habitus, it is here substituted for a digital habitus:

> Any given mode of inculcation is characterized (...) by the position it occupies between (1) the mode of inculcation aiming to bring about the complete substitution of one habitus for another (conversion) [here: case iv)] and (2) the mode of inculcation amining purely and simply to confirm the primary habitus (maintenance or reinforcement) [here: case i) and ii)]. [Bourdieu and Passeron, 1990, 3.3.1.1 p. 44]

CONCLUSION

We have identified several aspects in digital representation that have a decisive influence on user's behavior. Because of the strong legacy of the analog institution, objects immediately associated to signs in digital contexts are, whenever there is sufficient ground for it, the objects of the analog world in the first place. In the most simple cases, digital objects are presented as icons of existing analog objects already known to the user. Influenced by the institutionalized function of these objects in society, the user naturally associates to them the laws and concepts controlling their use in the analog context of their encounter. Moving from analog to digital is a step that requires more than the simple transposition of a set of rules from one system to another. Therefore to manipulate digital objects as if they were analog objects the user is forced to accept the idea that there exists a strong analogy between the two systems. Since reasoning by analogy does not bear the force of conviction of the deductive argument, any sort of contradiction appearing in the system will question its validity. It is therefore primordial that external information threatening its coherence should not be introduced into the system, to maintain some sort of stability. Since digital objects as pure creations of the mind are not dependent like the analog objects on the rude laws of nature, in digital environments only the laws created by men have their say which facilitate their acceptance.

"*How do we reason when using computers? how programmable are we?*" The topic is so wide that at this stage the question may still appear to lie unanswered, but we have nonetheless contributed to resituating the problem by offering an approach to it based on Peirce's semiotics. We believe that we have shown that peircean semiotics perfectly answers the need for a theory that takes into account the different aspects of digital representation, leaving behind the classical empirical distinctions afforded to signs (verbal, non-verbal, graphical, musical, etc ...) that unfortunately focus more on the medium itself than on the context of the medium.

This approach has led us to reformulate the original question in much wider terms and led us to ponder over the actual nature of the reality that we usually take for granted: to what extent can it be considered a construction?

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