

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

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**ICONICALLY MODELING THE DEMOLITION OF THE PALAST DER
REPUBLIK**

Juiz de Fora

Abril de 2016

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REPUBLIK**

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... e cada pessoa que, de alguma forma, colaborou com minha formação.

From a certain point onward there is no longer any turning back. That is the point that must be reached.

Franz Kafka (1925)

RESUMO

O fotolivro *Palast der Republik*, do fotógrafo Christoph Rokitta, é um fotolivro independente publicado em 2013, em Berlim. Neste fotolivro, diferentes recursos semióticos interagem uns com os outros, com a intenção de recriar uma nova experiência semiótica sobre o processo de demolição do edifício homônimo. Em oposição à noção trivial de *ícone* como um tipo específico de signo que está para seu objeto em uma relação de similaridade, iremos analisar o fotolivro como um ícone cuja principal característica definidora é a possibilidade de descoberta de novas informações sobre seu objeto através de sua manipulação. Esta característica específica dos ícones é chamada de *critério operacional de iconicidade*. O propósito deste trabalho é descrever e analisar as interações entre os diversos recursos semióticos encontrados no fotolivro *Palast der Republik*, explorando não apenas o critério operacional de iconicidade, mas também o papel de diagramas nos processos de raciocínio e a função de modelos como artefatos epistêmicos. Portanto, será apresentado como recursos semióticos com características morfológicas diferentes interagem no fotolivro a fim de se criar um artefato epistêmico diagramático de seu objeto: o processo de demolição do *Palast der Republik*.

Palavras chave: Fotolivros. Iconicidade. Modelos. *Palast der Republik*. Artefatos epistêmicos.

ABSTRACT

Palast der Republik, by the photographer Christoph Rokitta, is an independent photobook published in 2013 in Berlin. In *Palast der Republik* different semiotic resources interact with one another, in order to reveal a new experience about the demolition process of the homonymous building. In opposition to the trivial notion of icon as sign that stands for its object in a relation of similarity, we are going to analyze the book as an icon whose main feature is the possibility of discovering new information about its object through its manipulation. This specific feature is called *operation criteria of iconicity*. Our aim is to describe and analyze the relations between semiotic resources in this photobook, by exploring not only the operational criterion of iconicity, but also the roles of diagrams in reasoning, and how models function models as epistemic artifacts. Therefore, it will be presented here how semiotic resources with different morphological features in the photobook interact in order to create a diagrammatic epistemic artifact of its object: the demolition of the *Palast der Republik*.

Key words: Photobooks. Iconicity. Modelling. Palast der Republik. Epistemic Artifacts.

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1. Introduction

The book *Palast der Republik* by the photographer Christoph Rokitta, with an Epilog by Claudia Kromrei is an independent photobook published in 2013 in Berlin, Germany. The first edition was printed with 100 copies. The book contains 71 pages and 2 photographic series: the first one consists in 6 photographs, each one from a different demolition core of the building being photographed from different angles. They are presented together with a grid relating the six pictures using only spatial aspects and it is not going to be further analyzed here. The second sequence presented on the book contains 48 photographs divided not only according to spatial aspects, but also according to temporal aspects: the last weeks in which the demolition process took place. Because it is concerned with the *recreation*¹ of the spatial and temporal aspects of the demolition process and because of the way the sign systems and processes (photography, visual diagrams, verbal sign) are related in the book, it can be asserted that it iconically models the process of demolition of the building. We are going to defend this argument mainly based on the mature Peircean^{2]} theory of sign with focus on the operational criterion of iconicity.

The Palast der Republik was an administrative building with cultural and political functions in the former East Berlin, considered by many the major monument ever built by the German Democratic Republic (Heinemann 2005; Kuhrmann 2013; Gerke 2013). After the fall of the Berlin Wall and with the reunification of Germany in 1990, the building was confronted with a debate about its future not only because of its practical function, but

¹ By *recreation* we understand the process of iconically rebuild the demolition process of the *Palast der Republik*, and by doing so, creating an effect analogous to the one created by the object itself (the demolition process) in such a way that S (the photobook) and O (the demolition process) share the same qualities and properties. Although he does refer to written texts (specially poems), the brazilian poet Haroldo de Campos (2011, p.34) defines a semiotic recreation (transcreation) under the following parameters: "In a translation of such nature, one does not translate just the meaning, but the sign itself, its physicality, its own materiality (its sonorous properties, visual imagery, everything that forms, according to Charles Morris, the iconicity of the aesthetic sign. (...) The meaning, the semantic parameter, would be just the demarcational goal in the recreation".

² We shall follow the practice of citing from the Collected Papers of Charles Sanders Peirce (Peirce, 1931–1935, 1958) by volume number and paragraph number, preceded by "CP". The same convention follows for "MS" (1967), "NEM" (1976), "W" (1984), "EP" (1988).

mainly because of its symbolism. This debate lasted around 18 years (4 years more than the amount of time the building was originally in use). Under the excuse of an alleged asbestos (a carcinogenic material) contamination, the palace was closed in 1990 and the decontamination started only in 1998, after almost 10 years lying idle in the middle of the reunited German capital. The demolition of the building began in 2006 and extended itself up to 2008³. The fact that the Palast remained a long time in the Berlin city centre landscape as a ruin helped to build its meaning: the building stood for a longer time as ruin (18 years), than as a structure serving the purpose for which it was built (14 years). After the fall of the Berlin Wall and the reunification of Germany, the reminiscent monuments and buildings of the former GDR emerged as a popular subject in contemporary art, like in the photographic series *The Detachment* by Sophie Calle (1996), in the installation *PdR Weißbereich* by Nina Fischer & Maroan el Sani (2001) and the video *The Last Day of the Republic* by Reynold Reynolds (2010) (Gerke 2013). Just like in the examples here presented, the photobook *Palast der Republik* by Christoph Rokitta (2013) is a piece of artistic investigation focused on the demolition of the building.

The photobook “Palast der Republik” is a notable example of intermedial artifact, presenting us a *new semiotic experience*⁴ about the demolition of the Palast der Republik in Berlin, through the coupling between different semiotic resources such as: (i) an initial grid with the 48 photographs, (ii) a complete floorplan from the demolition area, (iii) the 48 photographs, (iv) a simplified floorplan from the 8 main cores of the building, (v) a simplified grid of the 48 photographs and (vi) written texts. In this context, a *coupling* characterizes a process where certain types of signs interrelate and constrain other types of signs in a co-dependence relationship where no element of the relation is privileged.

The closest category already developed that dialogues with the definition of *coupling between semiotic resources* is the “media combination” proposed by Rajewsky

³ For more information about the demolition of the Palast der Republik see Kuhrmann 2006; Schug 2007; Holfelder 2008 and Staiger 2009.

⁴ By "new semiotic experience" we mean an experience based on diagrammatic features that the interpreter could not achieve by other means - such as the contemplation of the building itself, or any other portrayal of the building.

(2005, p.52). In this definition “two media or medial forms of articulation are each present in their own materiality and contribute to the constitution and signification of the entire product in their own specific way”. Clüver (2011, p.15-16) went further by defining three modes of media combination: (i) multimedia texts that combine “separable and separately coherent texts, composed by different media”; (ii) mixmedia texts that “contain complex signs in different media, that would not achieve coherency or self-sufficiency outside that context”, and (iii) intermedia or intersemiotic texts that “call upon two or more sign systems and/or media in such a way that the visual and/or musical, verbal and kinetic aspects become inseparable or indissociable”. This idea of a concrete articulation where several semiotic resources can be found is developed by Wolf (2005) as one of the possible definitions of “media”. As he states, media

(...)are specified principally by the nature of their underlying semiotic systems (involving verbal language, pictorial signs, music, etc., or, in cases of ‘composite media’ such as film, a combination of several semiotic systems), and only in the second place, by technical or institutional channel (Wolf, 2005, P.253).

Therefore, by classifying, for example, “photography”, “written text” and even the “layout of the page” as different media, and by stating the presence of relations between them, the photobooks are thus an intermedial phenomenon, where it is possible to attest “a crossing of boundaries between media” (Clüver, 2011, p.8). Although many authors (Rajewsky 2005, 2010; Bruhn 2010; Müller 2010; Clüver 2011) agree that such definition of intermediality is a very broad one and that it is possible to find several other definitions for the field depending on the phenomena being analyzed, we are not going to dwell on that, but on the effects of such relations.

In our research, the photobook *Palast der Republik* is going to be approached as a model of the demolition process of the homonymous building. As a model, the photobook can be described an *iconic model*, capable of representing structural relations and, in the case here analyzed, dynamic relations between spatial and temporal aspects of demolition with precision. The manipulation and observation of such semiotic resources

allows the interpreter⁵ to reveal properties about the demolition process that could not be discovered by any other practice related to the Palast der Republik's demolition - and it happens because of several factors related to the materiality of the book: they are responsible for constraining the semiotic manipulation possibilities and, therefore the information that is brought to us.

Our aim is to describe and analyze the couplings - which is a type of interaction between semiotic resources - that can be found in the photobook "Palast der Republik", exploring the notions of iconicity, diagrammatic reasoning and models as epistemic artifacts. We are interested in how different semiotic resources (photographs, diagrams, maps and written text) are coupled in the same process (Figure 01). We intend to provide a description and an analysis of the morphological variety of the sign systems interactions in the photobook following the three (not exclusive) classes (icon, index, symbol) and subdivisions (image, diagram, metaphor) proposed by Peirce.

⁵ The interpreter is the embodiment of the effects (Interpretant) produced by the sign "(...) a Sign has an Object and an Interpretant, the latter being that which the Sign produces in the Quasi-mind that is the Interpreter by determining the latter to a feeling, to an exertion, or to a Sign, which determination is the Interpretant" (CP 4.536).

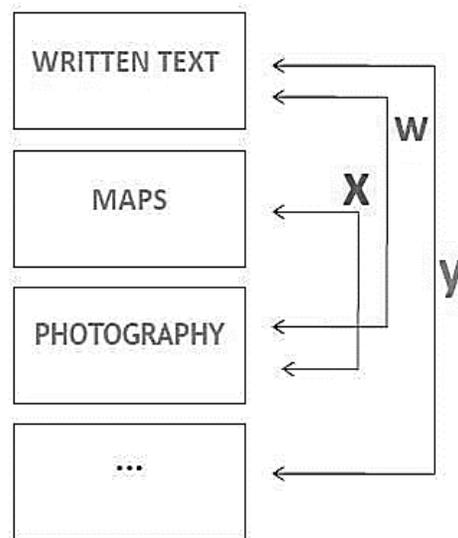


Figure 01: diagram of the methodological approach here presented: the analysis of the relations between sign systems (W, X, Y,...)are going to be studied here instead of the signs themselves (written text, maps, photography,...).

In the chapter number two, we are going to introduce the Peircean notion of semiosis based on his three basic and hierarchically ordered categories that can be used to distinguish every single possible sign: firstness, secondness and thirdness. The theory of categories play a central role in the development of his Semiotics and Phenomenology system, especially of his “most fundamental division of signs” (CP 2.275). In the characterization of signs according to the kind of relation they hold with their object, Peirce distinguished icons, indexes, and symbols as matching, respectively, relations of resemblance, contiguity, and law between S and O (sign-object relation) in the triad S-O-I (Sign – Object – Interpretant). Each class of sign is going to be presented in this chapter, but with a focus on the first class: *icons*.

As the notion of iconicity is presented in the third chapter, different classes and types of icons are going to be distinguished. The three classes of icons suggested by Peirce (images, diagrams and metaphors) are also going to be introduced in this chapter

in order to provide a general overview of the Peircean Semiotics theory and terminology. Further, the traditional, but somehow imprecise definition of icons as signs that share qualitative features with its Object is going to be ruled out. The notion of icons as “signs of resemblance” (or “similarity”, or “likeness”) (W 5:243; MS [R] 491:1-2; MS [R] 637:33-34; EP 2:460-461; W 5:379-80) can be troublesome because of: the inconsistency and lack of criteria to judge what is similar; the triviality in characterizing icons mainly as similar to their objects (since everything is similar to everything at some point); the non-symmetrical relation between the resemblances of the sign and the object; the folkish concept of faithfulness, that implies an ultimate or unique meaning of the object; and the fact that “resemblance” is a non-exclusive feature of iconic signs. In order to clarify the discussion around the nature of icons, we are going to argue that the main property that defines a sign as iconic is not a simple resemblance feature, but its potential of discovery. And this potential is known as the *operational criteria of iconicity* (Stjernfelt, 2007; 2011).

In the fourth chapter we are going to focus on one specific class of icons: the diagrams. As Peirce states “All necessary reasoning without exception is diagrammatic. That is, we construct an icon of our hypothetical state of things and proceed to observe it” (CP 5.162), which means that every act of necessary reasoning depends on the construction, manipulation and observation, of diagrams - regardless of being mental or material (concrete) diagrams⁶ (MS 404; MS 293; Hoffmann 2005, 2007; Arnold 2011; Týlen et. at 2014) . For the construction, manipulation and observation of diagrams to present proper results, it follow a number of specific rules and conventions. Diagrammatic reasoning is here approached as a case of distributed cognition, where the diagrams are not a final product of the process of reasoning, but an active entity. Because of the rules and constraints that allow the interpretation of a phenomena, “material” diagrams are here approached as an specific kind of artifacts: epistemic artifacts (Knuuttila and Voutilainen 2003, Knuuttila, 2005a, Knuuttila 2005b, Knuuttila and Boon 2011), that can be used both as a cognitive tool for creating knowledge and as a subject-matter of reasoning.

⁶ The division between “mental” and “material” diagrams (and, further, on Section 4.1. between “mental” and “material” models) is a functional division with didactic purposes.

The following chapter focus on the problems regarding the relation between S-O in modeling practices. We firstly present the definition of models according to the Semantic Conception of Theories (Suppes, 1961; van Fraassen, 1980; Newton and French, 1990). In this approach, theories are groups of models regarded as structures that fulfill the function of representation due to a relation of isomorphism with its target-system. But such a view on models sets aside the fact that models are an heterogeneous class of entities and propose that models stand for their objects in a relation of isomorphism (Van Fraassen 1980; Suppe 1974, 1989) or similarity (Giere 2004). We criticize this notion, pointing out to the fact that the defining characteristic of models (since they are diagrams) is their experimental potentiality as epistemic artifacts: instead of trying to define what models are, and what kind of relationship they establish with their objects, the notion of “epistemic artifact” stresses the possible uses of them, and what kind of effect they produce. Finally, we propose that photobooks can be approached as an epistemic artifact, just as any scientific model of phenomena.

The sixth chapter focus on the analysis of our object of study: the photobook “Palast der Republik”. A brief explanation about the building Palast der Republik, in the former East Berlin is be introduced, presenting its main historical and architectonic discussion - with focus on its demolition in 2008. Further, we scrutinize the book by presenting a general introduction about its main features following a rigorous analysis of the second photographic sequence of the book. All the sets of couplings that can be observed in this photobook seems to serve the purpose of semiotically recreate the demolition, by producing in the photobook an effect analogous to the one created by the object itself (the demolition process of the ruin). After that, the main diagrammatic characteristics of the book are presented.

At last, in the seventh chapter a discussion is going to be led about how such a semiotic approach can provide us an approach where photobooks are understood as artistic epistemic artifacts. By assuming that photobooks are diagrammatic signs of their objects, the discussion about the relationship between art and science can be reframed: both the artistic qualities as well as the epistemic value of them are connected through

the notion of *model*. Such an approach is important, because signs and sign-relations are addressed here as means for understanding something, for reasoning about it and, consequently, for discovering more information about it.

2. Some Peircean Semiosis: an introduction to semiosis and iconicity

Peirce defined meaning (*semiosis*) as a phenomenologically based process (De Waal 2001; Ransdell 1983). The notion of “phenomenology” in Peirce’s Semiotics is does not refer to Edmund Husserl’s positivism philosophical school, but is related to the study and classification of “appearances” without regarding the presence of a “real” dimension in the subject-matter of investigation – since they might exist in the “real” world or not, as it is going to be presented further (Ransdell 1983). According to De Wall (2001, p.17), the aim of Peirce’s phenomenology “is to determine what kinds of elements are universally present in all phenomena, what are their characteristics, and how these elements relate to one another”. In Peirce’s own words (MS [R] 464:28): “Phenomenology is the science which describes the different kinds of elements that are always present in the Phenomenon, meaning by the Phenomenon whatever is before the mind in any kind of thought, fancy, or cognition of any kind”, and “The business of phenomenology is to draw up a catalogue of categories and prove its sufficiency and freedom from redundancies, to make out the characteristics of each category, and to show the relations of each to the others” (CP 5.43). In order to understand this philosophical concept of phenomenon, the three basic and hierarchically distinct categories of semiotic entities proposed by Peirce must be introduced.

The first category defined by Peirce regards the simplest constituent of all phenomena, as considered without relations to anything else. This property can be found in every entity and Ransdell (1997) calls it “monadic” property. According to the author, “A monadic property is a wholly intrinsic property of a thing, which means that, in regarding a thing as having such a property, one is making no implicit reference to any second thing”⁷. This category is called *Firstness* and deals with the qualitative aspects of phenomena

(...) in which there is not comparison, no relation, no recognized multiplicity (since parts would be other than the whole), no change, no imagination of any modification of what is positively there, no reflexion, - nothing but a simple

⁷ Available at: <<http://www.iupui.edu/~arisbe/menu/library/aboutcsp/ransdell/ICONIC.HTM>>

positive character. Such a consciousness might be just an odor, say the smell of attar. (EP2:150)

The second category, namely *Secondness* regards relationships with “dyadic” properties (Ransdell 1983). The entities described under such category are to be found in a two-term relationship, in which “an object is the object purely in virtue of being opposed to, or connected with, another object” (De Wall, 2001, p.18), establishing a relationship with something external to it. But this kind of relationship is not subjected to any third entity, as Peirce states:

Category the Second is the Idea of that which is such as it is as being Second to some First, regardless of anything else, and in particular regardless of any *Law*, although it may conform to a law. That is to say, it is *Reaction* as an element of the Phenomenon. (MS [R] 339:108r)

According to Peirce (CP 1.358), the second category meets the notions of “Another, Relation, Compulsion, Effect, Dependence, Independence, Negation, Occurrence, Reality, Result” without the mediation of any other relata. But although it is related to the idea of a simple “existence” or even “actuality”, it is not identified with any conception of “real”, including the one of a “real world” or “real environment”. Nevertheless this is a scant concept, since

(...) for even such elementary dualities or oppositions as ‘here’ vs. ‘there’, ‘this’ vs. ‘that’, and ‘now’ vs. ‘then’ already go beyond mere twoness or duality or otherness inasmuch as there must be some third entity relative to which one of them can be distinguished as being ‘here’ rather ‘there’ (Ransdell, 1983, p.50).

And this distinction property is performed by a third entity, that behaves itself as a “rule”, a “law” or a “regularity”, that mediates the relation between a Second and a First. This third category of representation is called *Thirdness* and possesses “triadic” properties. According to Peirce (CP 1.328), “had there been any process intervening between the causal act and the effect, this would have been a medial, or third, element. Thirdness, in the sense of the category, is the same as mediation”. But it is important to point out the fact, that a Third is not an entity that command the other two relata from outside of the relation, “but rather the ordering power in its relata” (Ransdell, 1983, p.51). Peirce summarizes the three categories in the following quote:

The First is that whose being is simply in itself, not referring to anything nor lying behind anything. The Second is that which is what it is by force of something to which it is second. The Third is that which is what it is owing to things between which it mediates and which it brings into relation to each other. (EP 1:248)

The theory of categories developed by Peirce plays a central role in the development of his system of thought. For Hookway (1992, p.80), the “theory of categories is a set of highly abstract conceptions which function as a complete system of *summa genera*; any object of thought or experience belongs to one or another of the categories”. One important notion regarding the three categories is the one of “reducibility” (see De Waal 2001, Short 2007). It means that they “cannot be reduced to one another” and that “they are complete, meaning that there is no fourthness, fifthness, sixthness, etc” (De Waal, 2001, p.12). In other words, one cannot outline triadic relations in means of second or first ones; however, all relations involving four, five or even more entities can be reduced to simpler ones. And although, under abstract conditions, Firstness can be prescindend of Secondness, and Secondness can be prescindend of Thirdness, Ransdell argues that “no authentic relation is ever analyzable reductively into any combination of dyadic and monadic properties, and that, similarly, no authentic dyadic property is analyzable into a combination of monadic properties” (Ransdell, 1983, p.16).

The process of semiosis is a prototypical example of Thirdness, since the relation between its two terms cannot be “in any way resolvable into actions between pairs” (EP 2:411). Indeed, this relation is intrinsically connected with the conception of a “Sign”, since

(...) in its genuine form, Thirdness is the triadic relation existing between a sign, its object and the interpreting thought, itself a sign, considered as a constituting the mode of being a sign. A sign mediates between the interpretant sign and its object. (CP 8.832)

In order to define a *sign* one must have in mind that, before any further development of the concept, everything that can be experienceable is potentially a sign (Ransdell 1983; Short 2007; De Waal 2001). But the experience related to it goes beyond any relation with a sensorial perception since signs can be “something merely dreamed, imagined, conceived, envisioned, hallucinated, or of which we are aware in any other way, provided that it is referable to and describable, and thus communicable in principle”

(Ransdell, 1983, p.12), being then defined as *phenomenal* entities, in relation to Peirce's concept of Phenomenology already presented here.

Any sign can be embodied in a wide diversity of materials: it can be embodied in a piece of paper, as a word or a photograph; it can be embodied in a scent, as the smell of a perfume; and even people can be interpreted as signs. In the same way, one sign can be embodied in several materials: the word "stop", can be found on an iron, a wood or a plastic slab – but it can also be shouted, or interpreted when a person raises his hand with his palm facing another person. Therefore a sign "is something capable of revealing something or making it manifest, directly or indirectly, to some capable of responding to the sign appropriately (Ransdell, 1983 p.9).

Along his writings, Peirce proposes several descriptions of what a *sign* may be, describing its most fundamental aspects, relating it to the whole of his theory and regarding all the different facets in can exhibits in the most different provided situations (W 3:66-8; MS [R] 599:28-36; MS [R] 321:15-6, 19). But one of them can be regarded as a precise formulation of what is most relevant and primary to the conception of signs: "A Sign is anything which determines something else (its interpretant) to refer to an object to which itself refers (its object) in the same way, the interpretant becoming a sign, and so on *ad infinitum*" (CP 2.303).

This formulation presents us an irreducible triadic relation between a sign (S), its object (O) and its interpretant (I). We will hereafter refer to this triad as S-O-I. That is, according to Peirce, any description of semiosis involves a relation constituted by three irreducibly connected terms (CP 2.242), and it can be represented in the diagram below (Figure 02):

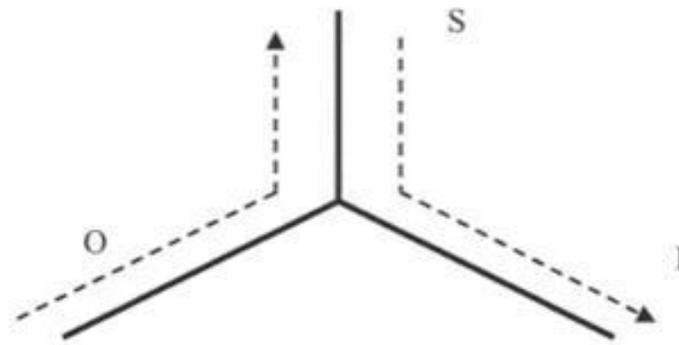


Figure 02: diagram of the triadic relation between S-O-I

This definition provided by Peirce is extremely pertinent since it presents two clear advantages in relation to other formulations: (i) it is an extremely abstract notion of sign, which allows it to be applied to an incredibly wide range of possible situations and conditions; and (ii) it is intrinsically related to the notion of a “chain of semiosis” (Ransdell, 1983, p.68) or “chain of signs” (Atkin, 2010⁸). Peirce endorses, along his writings (CP 1.339; MS [R] 318:18-9; MS [R] 321:15-6, 19), that any sort of sign is destined to be interpreted in another sign and so on continuously since:

(...) what is indispensable is that there should be an interpretation of the sign; that is that the sign should, actually or virtually, bring about a determination of a sign by the same object of which it itself is a sign. This interpreting sign, like every sign, only functions as a sign so far as it again is interpreted, that is, actually or virtually, determines a sign of the same object of which it is itself a sign. Thus there is a virtual endless series of signs when a sign is understood; and a sign never understood can hardly be said to be a sign. (MS [R] 599:28-36)

In such a process an object is semiotically responsible for bringing about a sign of itself which, consequently, causes this sign to create a further sign of the same object over and over, in an chain of “neither beginningless nor endless” (MS [R] 318:18-9) semiosis. This specific feature of signs is of main importance since they make it clear for

⁸ Available at: <<http://plato.stanford.edu/entries/peirce-semiotics/>>.

us that signs are, by no mean, regard as a passive agent that remains unaffected unless an external entity peruses it or gives it any sort of meaning – which does not mean that signs can be transformed through use and interpretation (Ransdell, 1983). In short, signs continuously generate new signs.

Peirce (see De Tienne 2003, Hulswitt 2001, Bergman 2000, Queiroz and El-Hani 2006) also defines Sign as a medium for the communication of a form or a habit embodied in the Object to the Interpretant, so as to determine (in semiotic systems) the interpreter's behavior:

[...] a Sign may be defined as a Medium for the communication of a Form. [...]. As a medium, the Sign is essentially in a triadic relation to its Object which determines it, and to its Interpretant which it determines. [...]. That which is communicated from the Object through the Sign to the Interpretant is a Form; that is to say, it is nothing like an existent, but is a power, is the fact that something would happen under certain conditions (MS 793:1-3. See EP 2.544, n.22, for a slightly different version).

In other words, a Sign is both “a Medium for the communication of a Form” and “a triadic relation, to its Object which determines it, and to its Interpretant which it determines”. In Peirce’s works, Form is defined as having the “being of predicate” (EP 2.544) and it is also pragmatically formulated as a “conditional proposition” (EP 2.388) stating that certain things would happen under specific circumstances. According to De Tienne (2003), Peirce is emphatic in pointing out that form here is nothing like a *thing*. It is something incorporated to the object (EP 2.544, n. 22) as an habit, a “rule of action” (CP 5.397, CP 2.643), a “disposition” (CP 5.495, CP 2.170), a “real potential” (EP 2.388) or, simply, the “a permanence of some relation” (CP 1.415). The form transmitted from the object to the interpretant through the sign is not the particular shape of the object, but a regularity, an habit (Queiroz et al. 2011). This process depends on the interaction between the components involved in a self-corrective dynamic (and maybe self-arranged), which Peirce dissociates from the intentional notions of an interpreter or speaker. Meaning, therefore, is nothing like a referent, but an action in the future. Regarding this notion of *form* the previously presented diagram of a S-O-I relation, can be upgraded to the following (Figure 03):

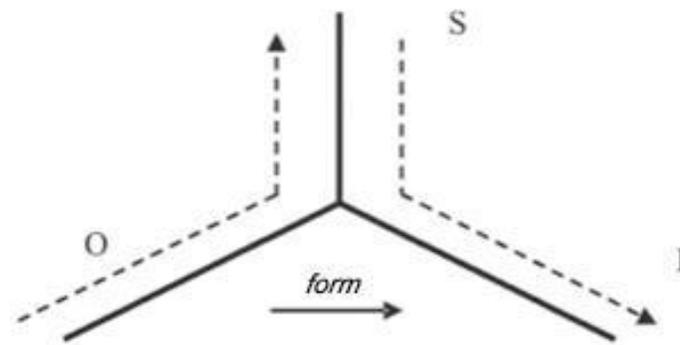


Figure 03: S-O-I relation as the transmission of a form: The relationship S-O-I “communicates/conveys a form from the object to the interpretant through the sign (symbolized by the horizontal arrow). The other two arrows indicate that the form is conveyed from the object to the interpretant through a determination of the sign by the object, and a determination of the interpretant by the sign” (Queiroz et. al 2011).

This form is incorporated in the object (primary constraining of semiosis). The interpretant is the effect produced in an interpreter. The sign (medium) occupies the position of mediation between the object and its interpretants. In short, semiosis is essentially triadic, involving “a cooperation of three subjects, such as a sign, its object, and its interpretant, this tri-relative influence not being in any way resolvable into actions between pairs” (EP 2:411).

In order to understand all the possible types of signs that can be distinguished and characterized as parts of an “systematically inter-related vocabulary”, we are going to limit ourselves to the basic set of distinct categories developed first by Peirce between the years of 1867 and 1885. This set consist in three different trichotomies that can be cross-combined generating 10 classes⁹:

⁹ For an introduction to Peirce’s extended classifications of signs, see Savan 1977; Litzka 1996; Farias & Queiroz 2000, 2003.

- (i) The first trichotomy regards the different possible signs, and they can be a quality (qualisign) (EP 2:291), an actual existing thing or event (sinsign) (EP 2:291) or a general type (legisign) (MS [R] 914:6).
- (ii) The second trichotomy defines signs according to the relation between the sign and its object. This can be a relation of similarity or analogy (icon) (W 5:243), of contiguity (index) (CP 2.305) or a relation mediated by a law or regularity (symbol (EP 2:274).
- (iii) The third trichotomy is based on the interpretant determined by the S-O relation. This determination can be a qualitative possibility (rheme) (EP 2:292), na actual existence (dicent) (EP 2:2920) or an intended determination (argument) (EP 2:204).

By now we are going to dwell only on the second trichotomy developed by Peirce since, according to him they are the three fundamental kinds of signs underlying meaning processes – icons, indexes, and symbols (CP 2.275).

2.1. The most fundamental division of signs - Icons, Indexes and Symbols

In his “most fundamental division of signs” (CP 2.275), Peirce characterized icons, indexes, and symbols as matching, respectively, relations of similarity, contiguity, and law between S and O (sign-object relation) in the triad S-O-I (Sign – Object – Interpretant). As Atkin (2010)¹⁰ states, by defining these classes it was possible to classify signs according to the role their object plays in the meaning process, relying on the constraints that the object imposes to the nature of the sign, “no matter whether the object it refers to exists and no matter whether it is interpreted as a sign or not” (De Wall, 2001, p.70).

Drawing the characterization of the classes in the second trichotomy in relation to the three categories presented in the previous section, one may define them as such:

Given that a certain entity, S, is a sign of a certain object, O, then *if and only if* what enables S to be that sign of O is the fact that (i) S has a certain monadic

¹⁰ Available at: <<http://plato.stanford.edu/entries/peirce-semiotics/>>

property (quality, firstness), then S is an ICON of O. Or if it is the fact that (ii) S stands in a certain dyadic relationship (secondness) with O, S is an INDEX of O.

Or if it is the fact that (iii) S stands in a certain triadic relationship (thirdness) with O (the third term of the triad being the interpretant of S as a sign of O), S is a SYMBOL of O. (Ransdell, 1983, p.63)

Before describing each one of the classes and their properties, we must draw attention to the fact that they are non-exclusive. It means that one specific sign can present in its same structure iconic, indexical and/or symbolic characteristics. Therefore by isolating the classes according to their aspects is an abstractive approach, since the analysis of each sign is dependent on conceptions and tendencies previously implied in one's habits of interpretation. As Ransdell (1983, p.64) asserts:

Iconicity, indexicality, and symbolicity have distinctive but complementary roles (...) corresponding to the threefold categorial aspects of the entity which is the semiotic object, signs of each type being fit to co-operate with signs of the two other types conjointly revealing or manifesting the entity in its various aspects.

2.1.1 Icons

As Icons are signs with monadic properties, as presented above, the only possible relationship it could establish with its object should be a qualitative one: sign and object should share the same qualities in order for the first to be an icon of the latter. And because S and O share the same qualities and properties, icons are understood as signs that stand for their objects through similarity or resemblance, no matter if they show an spatiotemporal physical correlation with an existent object or not (CP 2.276):

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. It is true that unless there really is such an Object, the Icon does not act [as] a sign; but this has nothing to do with its character as a sign. (CP 2.247)

This independency of any actual real object is well characterized by Peirce, when he formulates that:

An *icon* is a representamen by virtue of a character which it possesses in itself, and would possess just the same though its object did not exist. Thus, the statue of a centaur is not, it is true, a representamen if there be no such thing as a

centaur. Still, if it represents a centaur, it is by virtue of its shape; and this shape it will have, just as much, whether there be a centaur or not. (CP 5.73)

Hence any S that represents its O through an intrinsic property of S (which belongs to S, as related to both the material qualities and structures or to the properties perceived as belonging to S) is an icon of O, and can only be interpreted as an icon of O, therefore “anything that signifies on the ground of its own qualities alone is an icon” (Short, 2007, p.215). An analogous quality cannot be interpreted as a co-incident event, an index of O, or as a convention related to O. That is how the Icons work: it cannot relate itself to its object, unless through a property, that it possesses in itself – which can be superficial, structural or simply the interpretative effect produced by the sign. Considering the sharing of those properties in common as “resemblance”, Peirce defines it as “... an identity of characters; and this is to say that the mind gathers the resembling ideas together in one conception” (CP 1.365). Generally speaking, an iconic sign communicates a habit embodied in an object to the interpretant, so as to constrain the interpreter’s behavior, as a result of a certain quality that the sign and the object share in common (see Queiroz and El-Hani 2006).

But the notion of similarity (or resemblance, or likeness) as the main feature to propose a definition of Icons may be troublesome because of some specific internal qualities of the Icons themselves, that goes way further of simply possessing “looking alike” features. Therefore icons are going to be further analyzed in the Section 2.2.4.

2.1.2. Indexes

Unlike Icons, indexes are signs characterized by possessing a dyadic relation with its object. It means that it does not relate to its object by any virtue of similarity, resemblance or analogy with it, but because of “brute existential interactions” (Ransdell, 1983, p.64). In order for a sign to be an Index, a dynamic spatial connection between sign and object must exist - although, as Short (2007, p.220) highlights, this connection between them “does not require one to be the cause of the other”. But, unlike icons, “an

index is a sign which would, at once, lose the character which makes it a sign if its object were removed” (CP 2.304).

The notion of spatiotemporal co-variation is the most characteristic property of indexical processes. The examples range from a demonstrative or relative pronoun (such as “there”, “here” or “then”), which “forces the attention to the particular object intended without describing it” (CP 1.369), to physical symptoms of diseases, weathercocks, thermometers, among others. Peirce, in instance, uses an “old-fashion hygrometer” as an example of an indexical sign:

For instance, an old-fashioned hygrometer is an *index*. For it is so contrived as to have a physical reaction with dryness and moisture in the air, so that the little man will come out if it is wet, and this will happen just the same if the use of the instrument should be entirely forgotten, so that it ceased actually to convey any information. (CP 5.73)

In short, an indexical sign communicates a habit embodied in an object to the interpretant as a result of a dynamic spatiotemporal connection between sign and object.

2.1.3. Symbols

As presented above, an Icon is a sign of a certain object (that might exist or not) regarding the resemblance between their properties and qualities. An index is a sign of a certain object (that exists in the “real” world) in virtue of a dyadic brute existential interaction between them. A symbol, in turn, is a sign of its object because it produces interpretants as a result of an S-O interaction. In Peirce’s words:

A *symbol* is a representamen which fulfills its function regardless of any similarity or analogy with its object and equally regardless of any *factual* connection therewith, but solely and simply because it will be interpreted to be a representamen. (CP 5.73)

The interpretant is generated by a determinative relation of law, rule or convention (CP 2.276) mediating the interaction between S-O. According to Peirce (CP 2.307), a symbol is “a Sign which is constituted a sign merely or mainly by the fact that it is used and understood as such, whether the habit is natural or conventional, and without regard

to the motives which originally governed its selection". In other words, a symbol is "a sign of that object that is assigned to it by a rule of interpretation" (Short, 2007, p.221).

Just as Peirce uses the statue of a centaur as an example of iconic sign, and a hygrometer as an example of indexical sign, he uses the abstract general concept of a "word" as an example of symbolic sign:

A *Symbol* is a Representamen whose Representative character consists precisely in its being a rule that will determine its Interpretant. All words, sentences, books, and other conventional signs are Symbols. We speak of writing or pronouncing the word "man"; but it is only a *replica*, or embodiment of the word, that is pronounced or written. The word itself has no existence although it has a real being, *consisting* in the fact that existents *will* conform to it. It is a general mode of succession of three sounds or representamens of sounds, which becomes a sign only in the fact that a habit, or acquired law, will cause replicas of it to be interpreted as meaning a man or men. (EP 2:274)

Summing up the main information about icons, indexes and symbols, the following table can be presented:

Type of sign	S-O relation	S-O-dependence	
Icon	Similarity	Monadic (S)	Dependent of intrinsic properties of S
Index	Contiguity	Dyadic (S-O)	Dependent of S-O spatio-temporal correlation
Symbol	Law	Triadic (S-O-I)	S-O dependent of I mediation

Table 01: The three types of signs proposed by Peirce, their relation to the Object and their dependence regarding the relation S-O.

3. Iconicity: images, diagrams and metaphors

As presented in the Section 2.1.1., icons are signs that stands in a relation of similarity (likeness, resemblance) with its object (no matter if the object is an existent one or not). So, using the terms already provided to understand Peirce's classificatory system, an icon is a "Firstness", which means that it is a simple quality. According to Ransdell (2005), "An icon is any possible qualitative content of consciousness – what Peirce calls a "Firstness" – considered in respect to its possible function in cognition as the form (that is, quality or character) of an actual or possible object"¹¹. Therefore, a pure icon is unrelated to anything else, existing only as a "quality" or "a possibility". It means that the meaning process in that an icon is to be found does not involve the denotation of an object. According to Peirce, in such a pure iconic meaning process, an icon "serves as a sign solely and simply by exhibiting the quality it serves to signify" (EP2:306). As Johansen argues (1993, p.94), this definition of a "pure icon" is weak and problematic since "an icon can be summarized as an appearance in the mind that by exhibiting or representing its own qualities may function as a possible sign of everything else that appears and exhibits an identical quality". As a direct effect of such strong character of "possibility" and its unrelatedness to any object, a pure icon "can convey no positive¹² or factual information; for it affords no assurance that there is any such thing in nature" (CP 4.447).

Johansen asserts that a pure icon "does not exist other than as an idea conceived of as a qualitative possibility" (Johansen, 1993, p.105), but Peirce (CP 2.276) assures that

(...) most strictly speaking, even an idea, except in the sense of a possibility, or Firstness, cannot be an Icon. A possibility alone is an Icon purely by virtue of its quality; and its object can only be a Firstness. But a sign may be *iconic*, that is, may represent its object mainly by its similarity, no matter what its mode of being. If a substantive be wanted, an iconic representamen [i.e. sign] may be termed a *hypoicon*. Any material image, as a painting, is largely conventional in its mode of representation; but in itself, without legend or label, it may be called a *hypoicon*.

¹¹ Available at <<http://www.iupui.edu/~arisbe/menu/library/aboutcsp/ransdell/EPISTEMIC.htm>>

¹²"Philosophy distinguishes itself from mathematics in that it seeks *positive knowledge* – meaning knowledge of things real. In this, philosophy differs from mathematics, which studies the necessary consequences of arbitrary hypotheses and has no interest as to whether its object is real" (De Waal, 2001, p.15).

Therefore, in order to proceed in the explanation about the main features of iconicity, we must distinguish “pure icons” from “iconic signs” (hypoicons). According to Johansen (Johansen, 1993, p.95), three changings must take place in the understanding of “icons” in order to perform such passage from pure icons to iconic signs:

First, the quality has to be embodied, just as the passage from qualisign to sinsign. *Second*, an actual functioning sign will never be pure. In addition to its predominant iconic features, indexical and symbolic features will play a role in the sign. *Third*, for an actual sign to function as a predominantly iconic sign, some principle of selection is needed. This condition may seem strange, because the ground of the relation between iconic sign and object is defined as similarity.¹³

In short, a hypoicon is then a thing which functions as a sign if, and only if, the form (see Section 2.) embodied on it behaves as an icon. In order to understand such a condition, Ransdell (2005) uses the concept of a cartographic map as an example:

For example, a map is not an icon proper (since it is a material object), but it can function as an iconic sign for a given territory in virtue of the fact that it embodies a form or icon proper (exhibited by the lines drawn on it) which is *identical* with the form (structural features) exhibited by or embodied in that territory¹⁴

By taking this example in consideration, it becomes clear that the similarity between sign and object in iconic signs occurs in respect to the specific form that is being transmitted to the interpretant. A map and the territory it represents have a huge number of aspects in which they are not similar at all. But the character that justifies the use of the iconic sign (and that makes the sign an iconic sign) allows the existence of relations of similarity between the sign that embodies it and the object.

As with all the categories developed by Peirce already presented here, hypoicons can also be divided following the same hierarchical structure:

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

¹³ The third change mentioned by Johansen is not going to be discussed now, since it is one of the main premises that are going to be developed in the section 3.4. It is mentioned now in order to keep the wholeness and the intention of the quote.

¹⁴ Available at <<http://www.iupui.edu/~arisbe/menu/library/aboutcsp/ransdell/EPISTEMIC.htm>>

represent the representative character of a representamen by representing a parallelism in something else, are metaphors. (CP 2.277)

In the following sections the three hypoiconic categories are going to be presented and described – with an special focus on the second category: diagrams.

3.1. Images

Images can be defined as a First Firstness sign, which means that it works a simple quality sign, as Jappy (2004) argues “whence it follows that a simple quality is sufficient for the sign in which it inheres to function as a sign: qualities are such as they are independently of anything else”¹⁵. Therefore, it shows a simple structure usually related to direct and superficial similarity to its object. An example of iconic image could be a color chart (Figure 02), made of several cartons with different paint colors: "if a piece of red carton is used as a sign exhibiting the color of the paint you want to buy, then it functions as a simple iconic sign, an image, of the desired color" (Johansen, 1993, p.98).



Figure 02: A color chart as an example of iconic image (Source: <http://uniaotexturas.com.br/wp-content/uploads/2014/01/cartela-de-cores-19962.jpg>)

Other examples given by Johanssen (1993, p.98) to iconic images are: “A producer of after-shave lotion may claim that his product functions as an olfactory icon, an image, of a certain scent characteristic of human maleness. An actress’ scream may function as

¹⁵ Available at: <<http://www.commens.org/encyclopedia/article/jappy-antony-iconicity-hypoiconicity>>

an auditory image of an expression of horror”. But as simple qualities without any relation to anything else are not only difficult to find, but also difficult to conceive and to operate with, we are not going to dwell on this specific category.

3.2. Diagrams

Diagrams are iconic signs regard as of Second Firstness. They represent, through the relations between their own parts, the analogous relations that constitute the related parts of the object it represents (Stjernfelt 2007, Hoffmann 2007). Therefore, the objects of a diagram are always relations:

(...) a Diagram is an Icon of a set of rationally related objects. By *rationally* related, I mean that there is between them, not merely one of those relations which we know by experience, but know not how to comprehend, but one of those relations which anybody who reasons at all must have an inward acquaintance with. This is not a sufficient definition, but just now I will go no further, except that I will say that the Diagram not only represents the related correlates, but also, and much more definitely represents the relations between them, as so many objects of the Icon. (NEM 4:316)

Therefore the structure of diagrams is not necessarily related to any concept of visual similarity: rather, diagrams work as a concretization “of intelligible relationships” (Johanssen, 1993, p.99). In order to prove this point, Peirce presents the following diagram (Figure 03):

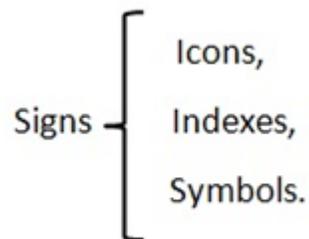


Figure 03: Example of diagram

Peirce describes the diagram above as such: “This is an icon. But the only respect in which it resembles its object is that the brace shows the classes of icons, indices, and

symbols to be related to one another and to the general class of signs, as they really are, in a general way” (CP 2.282). In order to prove that the visual features characters of a diagram do not indent to and do not need to be similar to the analogous features of the represented object, Johansen (1993, p.99) shows the following to diagrams (Figure 04 and Figure 05), as alternatives to diagram presented above:

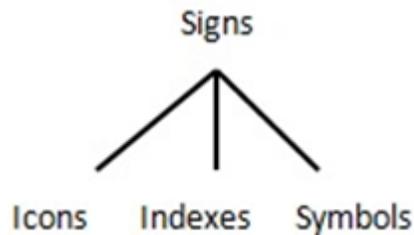


Figure 04: first alternative for the diagram presented in the Figure 03

Signs: (icons, indices, symbols)

Figure 05: second alternative for the diagram presented in the Figure 03

As a conclusion of such an experiment, it is possible to assert that there are more than just one possible mode to represent visually a set of relations that can be found in one object. Therefore diagrams are not only iconic signs that we can create but, more importantly, that we can experiment and operate with in order to observe (or discover) a hidden property or relation. According to Peirce (CP 5.162), the only way through which a person can acquire new knowledge about relations is by creating, observing and experimenting with diagrams:

All necessary reasoning without exception is diagrammatic. That is, we construct an icon of our hypothetical state of things and proceed to observe it. This observation leads us to suspect that something is true, which we may or may not be able to formulate with precision, and we proceed to inquire whether it is true or not. (...) We not only have to select the features of the diagram which it will be pertinent to pay attention to, but it is also of great importance to return again and again to certain features.

And because diagrams are iconic signs of intelligible relationships, its material features is of main importance, since they restrain the possibilities of creation, observation and experimentation – and, therefore, of reasoning. This specific feature of diagrams is going to be extensively explored in the section 4 and its subheadings.

3.3. Metaphors

The metaphor is an icon where the sign is to be found in a relation with the object in terms of the effects it produces – namely, the *intepretants*. Because of the presence of the intepretant in its composition, metaphors can be considered as the “genuine hypoicon” (Jappy, 2004, p.20) are they are regarded as Third Firstness’ signs. Which means, that “it is by a triadic relation that metaphors achieve their signification” (Hiraga, 1994, p.15).

A metaphor communicates an indirect comparison. Differently from diagrams, in which one of the relata is an abstraction of the represented thing in structural terms, a metaphor is comparison with the intepretant of another sign. This comparison is structured in terms of parallelism¹⁶. As an example one may present the sentence “my co-worker is a pig”. In such a sentence, a metaphor (“my co-worker is a pig”) signifies its object (“my co-worker”) by establishing a parallelism between its object (“my co-worker”) and another element (“a pig”). It does not mean that the person works with an actual pig (the animal), but that a parallelism can be found between the co-worker’s behavior and a pig’s behavior: both are disgusting, nasty, etc.

But it some attention must be drawn to the fact that Peirce’s notion of iconic metaphor extend itself further from the simple notion of metaphors as a merely linguistic and literary device. Johansen (1993, p.101) argues that the rise of the pillar of mercury in thermometers can be a metaphor that signifies the rise of the temperature (figure 06): “The parallelism exhibited by the thermometer and the temperature consists in the fact

¹⁶ For more information about the concept of paralellism in the case of iconic metaphors, see Jappy, 2004. Available at <<http://www.commens.org/encyclopedia/article/jappy-antony-iconicity-hypoiconicity>>

that the heat is translated into a visual sign where the pillar's height indicated the temperature's 'height'".



Figure 06: a mercury thermometer as an example of iconic metaphor (<http://www.yms.co.za/wp-content/uploads/2015/09/Fridge-Thermometer.jpg>)

Naturally, the relation between the rise of the mercury pillar and the rise of the temperature is mainly an indexical one (since the first is a physical response to the latter). However, according to Johansen (1993, p.101), "from the point of view of iconicity a parallelism exists between sign and object".

3.4. The problem of resemblance

The concept of Iconicity, that will lead this work, comes from the semiotics of Charles S. Peirce. Starting from the definition given in the previous section, Icons are signs that share qualitative features with its Object, with means that they establish a relationship of resemblance with the structures and interpretative effects of the sign. But the notion of similarity (or resemblance, or likeness) as the main feature to propose a definition of Icons may be troublesome because of some specific internal qualities of the Icons themselves, that goes way further of simply possessing "looking alike" features.

According to Stjernfelt (2013, p.90) this notion of similarity, when so applied, can lead to a series of vulnerabilities, such as “trivializing of it to identity; the psychologizing of it to refer to non-objective feelings of resemblance; the lack of criteria for judging two phenomena as similar”. Even Peirce himself, after some time (around 1900), started to define icons mainly by their own qualities and not by any explicit relation of resemblance:

Signs are of three kinds, 1st, the *icon*, which represents its object by virtue of a character which it would equally possess did the object and the interpreting mind not exist (...). (MS [R] 142:3-4)

An *icon* is a sign which would possess the character which renders it significant, even though its object had no existence; such as a lead-pencil streak as representing a geometrical line. (CP 2.304)

An *icon* is a representamen which fulfills the function of a representamen by virtue of a character which it possesses in itself, and would possess just the same though its object did not exist. (CP 5.73)

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. (EP 2:291)

I define an Icon as a sign which is determined by its dynamic object by virtue of its own internal nature. (CP 8.335)

One of the first problems in characterizing icons mainly as signs that stand in a relationship of resemblance (similarity) with their objects is in the *inconsistency* on defining what is *similar*. The mainstream notion of similarity as a property from entities that share qualities in common sets aside modes of relation between S and O that can possess iconic features: such as contrast, difference and strangeness:

For example, if a drunken man is exhibited in order to show, by contrast, the excellence of temperance, this is certainly an icon, but whether it is a likeness or not, it may be doubted. (EP 2.13)

On the other hand, signs that shares almost all the same recognizable properties with its objects cannot be said to held an iconic relationship with them. Actually even their categorizations as “signs” and “objects” may be questioned – but their similarity cannot. It is impossible to deny that two twins can be strongly similar to one another. But the same certainty does not apply in stating that one is an icon of the other (Goodman, 1968, p.4). Therefore: “Resemblance consists in a likeness, which is a sameness of predicates.

Carried to the highest point, it would destroy itself by becoming identity. All real resemblance, therefore, has a limit" (W 1:79), but this limit is highly questionable and dependent of several factors unrelated to the own qualities of the icon.

It can be concluded that it is impossible to define precisely how much similar to its object a sign must be in order to be an icon. As resemblance is a concept that cannot be measured or quantified in an objective manner, its effects cannot be predicted or estimated. It is a non-objective notion that has different parameters according to the entities properties, the relations between them, and the interpreters of such relations. This non-objectivity brings us to another problem: the *triviality* in characterizing icons mainly as similar to their objects. Resemblance is a very trivial concept of relations since "no two things are so different as to resemble each other in no particular" (W 1:169-170). So icons "stand for anything more or less; for they stand for whatever they resemble and they resemble everything more or less" (W 1:328). In other words: "It means that anything resembles anything by the simple fact of having properties" (Chevalier, 2015, p.55). It is important to note that one thing is directly related to the other: as it is impossible to establish an objective analysis of what resemblance really means and of how similar something should be in order to be an icon, it is also impossible to define what is similar and what is not – everything can be similar to everything, since one cannot measure resemblance.

Another problem in the notion of resemblance lies in one of its most basic - and naïve (Goodman, 1968, p.3) - definitions: "Similarity is generally *symmetrical*: if A is similar to B, then B is also similar to A; while sign-relations are generally *asymmetrical*: if A signifies B, it does not follow that B signifies A" (Stjernfelt, 2007, p.9). Many examples can be given in order to prove this point: the statue of a dog can be an icon of a dog, but a dog cannot be an icon of its statue (or of the class of things under the definition of "statue"); an specific instrumental song of a band can be an icon of the band, or of the public that hears it, or of the decade when it was made – the neither of them can be an icon of the instrumental song; and while the portrait of a man can be an icon of him, the man cannot be an icon of his portrait.

A deeper problem with the symmetry in the concept of resemblance is that it implies a simplistic folk notion of *faithfulness* on the iconic sign in relation to its object. An icon of a man cannot be faithful to *the* meaning of a man simply because there is no ultimate or unique meaning of a man:

To make a faithful picture, come as close as possible to copying the object just as it is'. This simple-minded injunction baffles me; for the object before me is a man, a swarm of atoms, a complex of cells, a fiddler, a friend, a fool and much more. (Goodman ,1968, p.6)

Another example consists in the fact that it can be said that a zebra is an icon of a donkey because they share some clear visual similarities, but:

The case is different, if I surmise that zebras are likely to be obstinate, or otherwise disagreeable animals, because they seem to have a general resemblance to donkeys, and donkeys are self-willed. Here the donkey serves precisely as a probable likeness of the zebra. (CP 2.281)

In this case the resemblance between a donkey and a zebra cannot be used as a reason to assure that they share any other features in common. A zebra can be an icon of a donkey regarding their visual similarities, but the same two entities cannot be icon and object in regard of other properties. So, just as with the other points presented above the notion of faithfulness is extremely non-objective, since "nothing is ever represented either shorn of or in the fullness of its properties" (Goodman, 1968, p.9).

Lastly, resemblance is a *non-exclusive* feature of iconic signs. Indexes can also be similar to their objects in their own terms (physical connection):

Photographs, especially instantaneous photographs, are very instructive, because we know that they are in certain respects exactly like the objects they represent. But this resemblance is due to the photographs having been produced under such circumstances that they were physically forced to correspond point by point to nature. In that aspect, then, they belong to the second class of signs, those by physical connection. (CP 2.281)

3.4.1. The operational criteria of iconicity

It can be concluded from the previous section that resemblance is not a sufficient concept to define any iconic relation between sign and object (Goodman 1968, Stjernfelt

2007). And the probably best solution for the problem of resemblance lies in another quote from Peirce, as he steps away from defining icons as signs of resemblance and focus on their own internal qualities:

For a great distinguishing property of the icon is that by the direct observation of it other truths concerning its objects can be discovered than those which suffice to determine its construction (CP 2.279)

In this passage we can notice that the main property that defines a sign as iconic is not a simple resemblance feature, but its capacity of discovery. Therefore, the main property that defines a sign as iconic is not a resemblance feature, but the discovering of new information about the object through the manipulation and observation of the sign: “This is the distinctive feature and value of iconic representations: a sign resembles its object if, and only if, study of the sign can yield new information about the object” (Hookway, 2002, p.102; see also Hookway, 1994). And this property is known as the *operational criteria of iconicity* (Stjernfelt, 2007, 2011).

Bearing this definition, the first point to be regarded here is the fact that the operational criteria of icons and the traditional notions that approach them as signs that hold similarities with their objects are not conflicting. It is rather “an elaboration on the concept of similarity” (Stjernfelt, 2007, p.78), focusing on its epistemological effects, instead of trying to define what a *relation of resemblance* between sign and object might be.

To approach a relation of resemblance with focus on its epistemological effects makes evident the most important feature of icons signs: they are the only kind of signs¹⁷ (in Peirce’s basic trichotomy – see Section 2.) that can reveal new information about its

¹⁷ Indexes are signs that indicate their objects, they do not give us any unknown or unexpected information about the qualities of their objects, since they an index “asserts nothing; it only says “here!” It takes hold of our eyes, as it were, and forcibly directs them to a particular object, and there it stops” (W 5:162-3). Symbols, in turn, are signs whose interpretants are generated by a determinative relation of law, rule or convention. It means that they can only presents us information that were previously acquired and conventionally interpreted as such: “It is thus itself a general type or law (...). As such it acts through a replica” (EP 2:292). But as pure signs does not exist, we can acquired new information about the object from indexes and symbols because of “they are not deprived of iconicity; the very fact that we can learn more about their object from them is proof of their iconicity” (Stjernfelt 2007:78).

object through its manipulation and observation (Hookway, 2002; Hoffman, 2005; Stjernfelt, 2007, 2011):

Given a conventional or other general sign of an object, to deduce any other truth than that which it explicitly signifies, it is necessary, *in all cases*, to replace that sign by an icon. This capacity of revealing unexpected truth is precisely that wherein the utility of algebraic formulae consists, so that the iconic character is the prevailing one [our emphasis]. (CP 2.279)

The reason for this epistemic property to be directly related to iconicity is clear: iconic signs make their objects “immediately available as they are in themselves” (Ransdell, 1983, p.72), sharing qualities in common with them, by “partaking in the character of the object” (CP 4.531). Icons preserve the structure of their objects, representing them (objects) – partially or in their totality - through characters of their own (icons). Therefore, it is not a preservation of structure by means of physical resemblance (as the commonplace approach of visual iconic signs suggests) or of a parallelism of features. It must preserve the structure that embeds the cognitive rules of manipulation that one must perform in order to extract new information from the icon. For this exactly reason “so many algebraic attempts in the humanities have proved sterile: they have merely exchanged some concepts with letters and have not furnished a motivated (that is, iconic) formal set of rules for their manipulation” (Stjernfelt, 2007, p.79). Thus the most crucial approach to a sign in order to prove its iconic character must be directly related to its capacity of make new information about the object by means of its own internal rules. The importance of the operational criteria of iconicity lies in the fact that it allows a wide class of entities to be studied as signs that can produce new information – from algebraic formulas to artistic works:

The manipulation of an equation or of an algebraic statement is, in this respect, perfectly equal to the manipulation of a picture or a text or any other icon in order to make it reveal some more similarities that immediately observable (Stjernfelt, 2007, p.79)

But, from the three classes of icons (see Section 2.), *diagrams* are the most adequate for performing necessary reasoning since: “All necessary reasoning without

exception is diagrammatic. That is, we construct an icon of our hypothetical state of things and proceed to observe it" (CP 5.162).

4. Diagrammatic reasoning

Peirce's doctrine of signs is, according to the logician Pietarinen (2006, p.377), "the art of reasoning and the theory of self-controlled, deliberate thought" where signs are understood as means of reasoning and, consequently, means learning about something. The process of reasoning and inquiring upon premises is closer to what he calls "a scientific result"¹⁸ (CP 6.428) than any "correct" conclusion about those premises (Hookway, 1992). Diagrammatic signs play a specific role in this context. Peirce claims that: "Remember it is by icons only that we really reason, and abstract statements are valueless in reasoning except so far they aid us to construct diagrams" (CP 4.127). Therefore, diagrams are the most important tools for necessary reasoning (CP 1.66; CP 2.267; CP 3.363; CP 5.162; CP 6.471) aiding not only the scientific methods of constructing knowledge, but also developing systems of communication, from trivial daily cognitive practices to complex problem-solving tasks (Tylén et al., 2014).

Before understanding the central role of diagrams in necessary reasoning processes, it behooves us to clarify what "diagrams" mean in this context. As already presented in the Section 2., diagrams are iconic signs of relations that are "constructed according to the rules and conventions of, and by means of the elements and relations available in, a certain system of representation" (Hoffmann, 2007,, p.7). Thus they are approached here beyond the common-sense notion of diagrams as equations or graphics with lines and numbers. Diagrams as tools for reasoning can be algebraic notations, gestures, works of art, geometrical representations, tables and schemes, computational systems, syllogisms, verbal sentences, and even internal cognitive processes (EP 2.17; Hoffmann 2005; Stjernfelt 2007; Paavola 2011; Arnold 2011; Tylén et al. 2014; Dondero and Fontanille 2014; Queiroz 2014 (Peirce NEM 4:47-48) defines *diagrammatic reasoning* as follows:

¹⁸ It must be emphasized that, under the notion of "science" here presented, we assume (for methodological purposes) that a very diverse scope of scientific activities can be approached as a single monolithic entity.

By diagrammatic reasoning, I mean reasoning which constructs a diagram according to a precept expressed in general terms, performs experiments upon this diagram, notes their results, assures itself that similar experiments performed upon any diagram constructed according to the same precept would have the same results, and expresses this in general terms. This was a discovery of no little importance, showing, as it does, that all knowledge without exception comes from observation.¹⁹

From this quote by Peirce, the process of diagrammatic reasoning can be divided into three main steps: (i) the *construction* of a system of representation guided by general rules; (ii) the experimental *manipulation* of the relations that can be found on such a system of representation; and the (iii) *observation* of the results from the previous manipulation. According to Hookway (1992, p.189), diagrammatic reasoning is “valuable because we can experiment upon manipulable icons when we cannot experiment upon reality. Experiment upon and manipulation of icons replaces experiment upon and observation of reality”. This possibility of manipulation reduces not only the internal cognitive effort by “individual or social thinking processes in situations that are too complex to be coped with exclusively by internal cognitive means” (Hoffmann, 2007, p.5), but also “ascertain what the necessary consequences of possible facts would be’ in a situation where the facts are so complicated that these people cannot deal with them in their usual way” (CP 3.559). The examples are many: instead of memorizing all the stations from a subway system and their specific distribution along the lines, one can consult the respective subway map in order to achieve all the optimum information (Atã, Bitarello, & Queiroz, 2014); instead of painting the walls of a room with all the desired colors, one can use a color chart to compare the possibilities and choose one color from the available options (Hookway, 1992); among others.

But just as with every category of signs (see Section 2. and its subheadings), *pure* iconic diagrams are fictitious, and can only exist as theoretic ideals:

¹⁹ When considering diagrammatic reasoning within Peirce’s philosophy of signs, it is expected that his system of representation of logical inferences through Existential Graphs would be approached. According to Hoffmann (2007, p.2): “The logical operations that are possible by means of his Existential Graphs are only *one* form of diagrammatic reasoning besides others”. As we are interested in the general mechanisms that involves the practice of diagrammatic reasoning, the Existential Graphs method is not going to be addressed here.

A Diagram is a representamen which is predominantly an icon of relations and is aided to be so by conventions. Indices are also more or less used. It should be carried out upon a perfectly consistent system of representation, one founded upon a simple and easily intelligible basic idea. (CP 4.418)

And this mixed character of diagrams is essential for performing reasoning upon an Object, since “In all reasoning, we have to use a mixture of *likenesses*, *indices*, and *symbols*. We cannot dispense with any of them” (EP 2: 10). But between indexes and symbols, the latter performs a fundamental role within diagrammatic reasoning processes, since the functionality of diagrams “rests upon a framework of conventions” (Hookway, 1992, p.188). For example, there are various kinds of maps that represent the same geographic territory: topographical maps, political maps, road maps, resource maps, among others. Although their object may be the same, the conventions that regulate the proper *manipulation* of the icon is dependent on several different conventions, according to each kind of map. The more symbolic features in the diagram, the more satisfactory is its manipulation, since the manipulation is dependent on the set of rules and conventions give by the system of representation of the diagram:

‘Theaetetus-Socrates-stands-sits-and’ can be interpreted as an icon, because it represents a certain relation. (...). But, if we read ‘Theaetetus stands and Socrates sits’, we have a diagram, because this sign represents a relation that is carried out upon our grammatical ‘system of representation’ as defined by syntax. (Hoffmann, 2005, p.46)

The internal character of the system of representation of diagrams must, thus, be “normative” and “compelling” (Hoffmann, 2005, p.48). *Normative* in the sense that the rules and conventions for manipulation must be given, clearly and directly, by the sign itself (Zhang and Norman, 1994); and *compelling* in the sense that these rules constrain the possible operations that can be performed upon the diagram, as well as determine “- (...) within a range of possibilities – the outcome of experiments (Hoffmann, 2005, p.47). But not only a consistent system of rules is important for the proper manipulation of the diagram, but also the familiarity of the interpreter with the given system of representation. The awareness about the rules of the diagram and the possibilities of its manipulation can be an effective mean of dealing with unexpected results (Hoffmann 2005, Paavola 2011, CP 4.530).

Not only the manipulation of diagrams, but also their construction and observation are not fixed procedures. They are highly dependent on a series of factors such as (i) the configuration of the system of representation, (ii) the amount of symbolic features that can be found on them, (iii) the purposes of the both the construction and the manipulation, and (iv) the cognitive locus of the diagram - internal or external to the mind of the interpreter (Kazmierczak, 2003; Hoffmann, 2005, 2007; Stjernfelt, 2007; Arnold, 2011, Hoel, 2012). The latter is a persistent problem in the discussion about the process of diagrammatic reasoning and is going to be approached next.

4.1 “Mental” diagrams and “material” diagrams

According to Skagestad (1999), one central hypothesis from Peirce’s theory of signs regards the fact that the difference between the internal and the external locus of signs (see also Hoffmann, 2005). Skagestad discusses the following quote from Peirce develops this hypothesis by giving the following example:

A psychologist cuts out a lobe of my brain (*nihil animale a me alienum puto*) and then, when I find I cannot express myself, he says, ‘You see, your faculty of language was localized in that lobe.’ No doubt it was; and so, if he had filched my inkstand, I should not have been able to continue my discussion until I had got another. Yea, the very thoughts would not come to me. So my faculty of discussion is equally localized in my inkstand (CP, 7.366).

According to Skagestad (1999), the importance of such passage is not in the fact that, by using an inkstand, a person would be able to articulate and communicate its thought through the act of writing. What really matters here is that fact a person is able to *think* through the act of writing: an inkstand is so necessary for the process of reasoning just as well as a part of his brain. Peirce (NEM 1:122) proposes that “All our thinking is performed upon signs of some kind or another, either imagined or actually perceived”. But further, in the same quotation (NEM 1:122), he specifies that “The best thinking (...) is done by experimenting in the imagination upon a diagram or other scheme, and it facilitates the thought to have it before one’s eye”. It means that the internal cognitive

process of reasoning and the external signs are not two different possibilities of the same reasoning practice, but that they are two moments of such a practice.

This double-character of reasoning is rooted in very own nature of diagrams (as seen in the previous section, the only sign through which one can perform reasoning), as they can be both external and internal:

A Diagram, in my sense, is an Object, whether of sense perception (more appropriately of vision, but possibly of touch), or of imagination (as ordinarily represented as patched up pieces of former perception), or of something like inchoate intention. (...) Intentions and desires are essentially general, as perceptions and their reproductions are essentially concrete. (MS 293)

But how the internal and the external features of diagrammatic reasoning relate is not yet clear among the authors that try to describe such a process, since a variety of interpretations of the problem can be found. Some authors such as Hoffmann (2005, 2007) states that “Only experimentations in concrete situations reveals what might already be given implicitly in our own systems of knowledge” (Hoffmann, 2005, p.47); and “While I am following Peirce regarding his definition of diagrammatic reasoning, I restrict the use of the term to processes in which *external* representations are an irreducible part. (...) my point is simply that I do not call those mental operations ‘diagrammatic reasoning’” (Hoffmann, 2007, p.6). According to his approach of what *diagrammatic reasoning* might be, internal cognitive processes are not only not-diagrammatic (does not reveal information), but are also not necessary in the diagrammatic reasoning process. On the other hand, Hoffmann (2007) points out that authors from psychology traditions of research, as well as from cognitive sciences, understand as “diagrammatic reasoning” the process of interpreting diagrams (Larkin & Simon 1987; Glasgow et al. 1995; Hegarty 2000), focusing mainly on the internal cognitive processes rather than on the external representations. Kazmierczak (2003, p.187) provides us a good example of how unclear is the relation between internal and external in approach diagrammatic reasoning, when she says that: “Diagrams can be studied not only in terms of the pattern recognition and diagrammatic reasoning, but also as mental schemes of cognition”, assuming that “mental schemes of cognition” and “diagrammatic reasoning” are contrasting terms.

In order to clarify such a discussion, we are going to approach the diagrammatic reasoning processes as cases of distributed cognition (Hutchins 1995; Clark & Chalmers 1998). In this approach, distributed cognitive processes encompass not only what happens inside the brain of the interpreter, but also what is external to them. Just as in the example given by Peirce about the part of the brain and the inkstand, both mental and material diagrams are important for performing diagrammatic reasoning, and the suppression of one of these two configurations of diagrams, would negatively affect the whole reasoning and the effects it may produce. But the relation between the mental diagrams (those constructed inside the interpreter's brain) and the material diagrams (external to the interpreter's brain) is not a point-to-point correspondence. We do not build mental diagrams as a replica of the observed material diagram, but we develop them further. These internal cognitive processes of diagrammatic reasoning are a "(...) rational ability to imagine different courses of action and their possible results" (Pietarinen and Bellucci, 2015, p.5). What both of them have in common is that fact that they share a diagrammatic structure based on relations, whose manipulation is constrained by rules and conventions (NEM 3.749; Dondero and Fontanille, 2014; Tylén et al., 2014; Pietarinen and Bellucci, 2015).

But, although mental diagrams are not an identical transposition of the material diagrams to mind, the former is constructed upon experimenting with the latter. According to Ambrosio (2010), the efficacy of material diagrams is to be found exactly in the cognitive process that they trigger inside the interpreter's mind. The role of material diagrams is to "provide sensory stimuli for cognition" (Kazmierczak, 2003, p.186), since "there is no cognitive ability without a corresponding object" (Hoffmann 2007, p.19). According to Dondero and Fontanille (2014, p.147):

Diagrammatic reasoning can be understood essentially as the process of observing and reconfiguring the relations that make up the parts of an object of investigation; manipulating what is visible makes it possible to expand what is conceivable. This sort of manipulation is only possible owing to the cognitive resources of spatial plasticity, or the manipulability and rational malleability of visual forms.

In our approach of diagrammatic reasoning as a process that, inevitably, includes both the experimentation with mental and material diagrams, the first step presented in the previous section is actually not necessary in all of the cases: (i) the construction of the material diagram. It is also possible that a person gets in touch with a material diagram that was constructed by a second person (that can be completely unknown to him). For example: when the person uses the map of a subway, reads a poem, measure the distance between two countries in a globe, among other cases. So, from the moment there is a material diagram available, the person can start experimenting with it by (ii) mentally constructing a diagram based on the abstract percepts from the material diagram. The perceivable normative and compelling diagrammatic properties of the material diagram are central for a successful construction of the mental diagram, since they provide the interpreter with an overview of relations with potential for experimentation (Kazmierczak, 2003; Ambrosio, 2010; Hoel, 2012; Dondero and Fontanille, 2014). And this potential is dependent on the presence of rules and conventions that constrain the whole process of diagrammatic reasoning. So, from the moment a person built a mental diagram, he can start (iii) manipulating its relations and its properties, since “A drawing or model may be employed to aid the imagination; but the essential thing to be performed is the act of imagining” (MS 616). This third step is mainly guided by two principles: the principle of *abstraction*, which discards “unnecessary or irrelevant information in order to identify the core elements or relations” (Týlen et al., 201, p. 275); and the principle of synthesis, which “show relations between elements which before seemed to have no necessary connection” (Hoffmann, 2005, p.49).

So, as a result of the experimental manipulation of mental diagrams, new elements as well as new forms of relations are made available for the interpreter, so that he can (iv) observe them. It is exactly in this process of observation that unexpected results, surprises, and unnoticed and hidden relations among the parts (CP 3.363) are made available:

No singular act of sudden flashes of insight is thus sufficient to explain what is going on in the process of colligation of observed facts. That process rather has to do

with observing some rational relations sufficiently compelling and general, that may commonly and invariantly be involved in those facts. (Pietarinen and Bellucci, 2015, p.4)

So, the conclusions obtained by the observation of the results of the manipulation of the mental diagrams are then converted to perceivable relations and properties through the (v) manipulation of the material diagram – the same that triggered the whole process. But, in some cases (named *theorematic reasoning*²⁰), the conclusions do not follow from the premises given in the original state of the material diagram, forcing the interpreter to manipulate the material diagram by “introducing and adding some auxiliary individuals or constructions” (Pietarinen and Bellucci, 2015 p.2). This experimental step is, according to Peirce (MS 633), one of the most fundamental steps in any “genuine reasoning”, since:

Now a Diagram is essentially a Sign that is both definite (or no vague) and Determinate (or concrete, in the sense of not being general); so that something more than vague abstract thought is indispensable in genuine reasoning; and thought that is not brought down to earth by a present sensuous object is, almost if not quite inevitably, both vague and general.

As the proper manipulation of the material diagram is executed, it behooves the interpreter to perform the last step in the diagrammatic reasoning cycle: (vi) the observation of the results and conclusions from the manipulation of the material diagram. This step allows the interpreter to get in contact with the consequences and the effects of the whole diagrammatic reasoning process, which are able to “catalyze and support innovative thinking processes and interpersonal communication” (Týlen et al., 2014, p.264):

(...) not even the simplest necessary consequence can be drawn except by the aid of Observation, namely, the observation of some feature of something of the nature of a diagram, whether on paper or in the imagination. (MS 455-6)

By approaching diagrammatic reasoning as a case of distributed cognition, it is clear that diagrams are not any sort of final effect or final product of the process of discovery of information or coordination of “vague abstract thoughts” (MS 633), but a

²⁰ For more information on both Corollarial Reasoning and Theorematic Reasoning, see EP 2:96; NEM 4:42; NEM 4:49; NEM 4:38; EP 2:297-298; MS [R] 318:55-6; CP 6.471; Hoffman, 2005; Hookway, 1992; Týlen et al., 2015, Pietarinen and Bellucci, 2015).

creative practice “in which we express a certain interpretation of the problem at hand” (Hoffmann, 2005: 49; see also Tylén et al., 2014). For this reason diagrams play a fundamental role in any scaffolding process, ranging from dealing with everyday problem-solving situations up to constructing models.

5. Models and the Semantic Conception of Theories

Among the possible functions of diagrams, working as a model is one of the most important functions from the scientific point of view (Downes, 1992; Frigg, 2002; Frigg and Hartmann, 2005; Knuuttila, 2005a; Giere, 2004). Among the many theoretical approach of models that were developed along the last decades, the dominant one is the Semantic Conception of Theories (Suppes, 1961; van Fraassen, 1980; Newton and French, 1990). One of its benefits is the fact that by approaching the nature of *theories*, it can be applied to a large number of philosophical issues:

The Semantic Conception of Theories today probably is the philosophical analysis of the nature of theories most widely held among the philosophers of science; it frequently is used to analyze and treat other philosophical problems. (Suppe 1989: 3)

According to this approach, theories were conceived as extra-linguistic entities (Suppe, 1977). It contrasted with the syntactic approach that addressed a theory as a “purely syntactic structure consisting of a set of axioms. To interpret a theory was to specify a model for it, which makes all the axioms of the theory true (or false)” (Knuuttila, 2005a, p. 37). So, instead of being a collection of statements and propositions, theories are consisted by families of models (structures²¹) and arrangements of hypothesis:

To present a theory is to specify a family of structures, its models; and secondly, to specify a certain part of those models (...) as candidates for the direct representation of observable phenomena. The structures which can be described in experimental and measurement reports we call appearances: the theory is empirically adequate if it has some model such that all appearances are isomorphic to empirical substructures of that model. (Van Fraassen ,1980, p.64)

So, in a simplified manner, theories are groups of models regarded as structures that fulfill the function of representation due to a relation of isomorphism with its target-

²¹ According to Knuuttila (2005a, p.37): “Structures are defined either by the use of set-theoretical predicates (Suppes 1961; da Costa and French 1990) or by the use of suitable mathematical language (van Fraassen 1980)”. Frigg (2002, p.4) presents the following description of structures formulated by Machover (1996): “A structure S is a composite entity consisting of the following ingredients: (i) a non-empty set U of individuals called the domain (or universe) of the structure S, (ii) a set O of operations on U (which may be empty), and (iii) a non-empty set R of relations on U”.

system. Many are the problems of such a statement: (i) the facts that models are not an homogeneous class of entities; (ii) the concept of isomorphism; (iii) the concept of similarity; and (iv) the notion of models as entities that symbolically represent their target systems. In the next sub-sections we are going to approach each one of these problems in order to get to the core of a diagrammatic theory of models: their epistemic value.

5.1. Models and heterogeneity

The heterogeneous character of models is attested by many authors (Achinstein 1965; Giere 2004; Downes 1992; Rothbart 2004; Frigg and Hartmann 2005; Knuuttila 2005a, 2005b; Knuuttila and Boon 2011; Bokulich 2011). According to Bailer-Jones (1999, p.32) it is not just the entities we call models that present several different material and/or mental configurations, but also the discussion around them between the philosophers of science:

The discussion of models in the philosophy of science has heterogeneous beginnings, testifying to a variety of theoretical, formal, and practical aspirations that appear to have different and even conflicting goals (Bailer-Jones 1999: 32)²².

This general heterogeneity concerning models and their usage finds its roots in the fact that there is no single or ultimate concept of scientific practice. Models can be used “for the purposes of scientific reasoning, theory construction and design of experiments and other artefacts” (Knuuttila, 2005a, p.310-311), and can “function as proto-theories, pedagogical devices, or as tools for generating and testing hypothesis. (...) models can perform an explanatory function as well” (Bokulich, 2011, p.33). Just as with diagrams (see Section 4. and its subheadings) they can perform different functions, from simply carrying a message about its object up to aiding problem-solving situations. As a consequence, material models can assume different configurations in order to be more suitable for each practice it may be designated for. We can address several entities as models, all of them with different morphological properties: “from a physical construction

²² As we are interested in the diagrammatic features of models, we are not going to map and present all these discussions and points of view on models.

in a display case to an abstract set of ideas” (Achinstein, 1965, p.102), “a line drawn in the sand to indicate landmarks or (...) cosmological models of a multidimensional universe” (Rothbart; 2004, p.VII); the general representation of a human cell or a mathematical equation (Downes, 1992, p.146), among others. Frigg and Hartmann introduce a series of categories under which models can be specified:

(...) phenomenological models, computational models, developmental models, explanatory models, explanatory models, impoverished models, testing models, idealized models, theoretical models, scale models, heuristic models, caricature models, didactic models, fantasy models, toy models, imaginary models, mathematical models, substitute models, iconic models, formal models, analog models, and instrumental models (Frigg and Hartmann, 2005, p.740)²³.

As a consequence, models can be easily regarded as entities that relate not only to theories. Knuuttila (2005a), and Frigg and Hartmann (2005) point out that models can also relate to phenomena and to data:

On the one hand, a model can be a representation of a selected part of the world (the “target system”). Depending on the nature of the target, such models are either models of phenomena or models of data. (...) On the other hand, a model can represent a theory in the sense that it interprets the laws and axioms of that theory (Frigg and Hartmann, 2005, p.740)

As already specified in the previous section, *models of theory* can be regarded as structures, whose function is to prove a theory (or a law) to be true or to be false. A good example of what a model of theory may be is the equation for Newton’s first law of motion (Frigg and Hartmann, 2005, p.743). This law can be stated in English as follows: “Every body persists in its state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by force impressed” (Newton, 1999, p.416). This law can be expressed in the following model (equation):

²³ Giere (2004, p.747) also presents some categories in common with the authors, when he states that: “(...) the things that are commonly called models seem to form a quite heterogeneous class including physical models, scale models, analogue models, and mathematical models, just to name a few.

$$\sum \mathbf{F} = 0 \Leftrightarrow \frac{d\mathbf{v}}{dt} = 0.$$

Figure 07: Theoretical model of Newton's first law of motion.

Models of data are idealized and abstract versions of a collection of data obtained from the direct observation of specific features of the world (Frigg and Hartmann, 2005). Such models provide a clear and objective overview of the data collected and they play a “crucial role in confirming theories because it is the model and not the often messy and complex raw data that is compared with a theoretical prediction” (Frigg and Hartmann, 2005, p. 743). One example of model of data can be the typical population pyramids model, which makes possible to predict features of a population from a specific place according to the data collected (Figure 08).

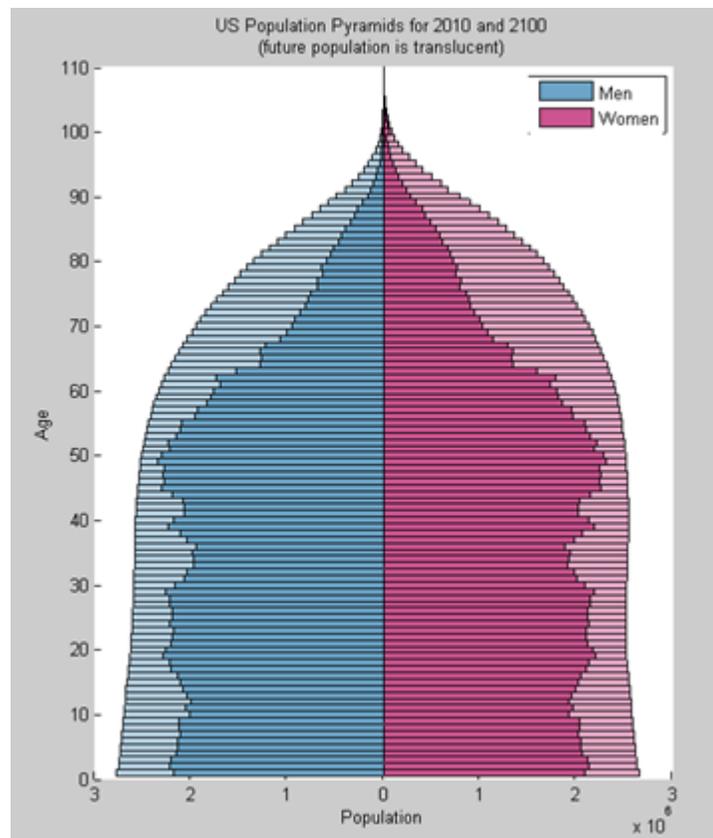


Figure 08: USA population pyramid for the years 2010-2100 (Source: <http://www.mathworks.com/matlabcentral/mlc-downloads/downloads/submissions/35794/versions/1/screenshot.png>)

Models of phenomena relate to “relatively stable and general features of the world that are interesting from a scientific point of view” (Frigg and Hartmann, 2005, p.741). Some examples are Dalton’s billiard ball models of molecules (Figure 09), Watson’s double helix model of DNA, any scale model of any building, among others (Frigg and Hartmann, 2005, p.741).

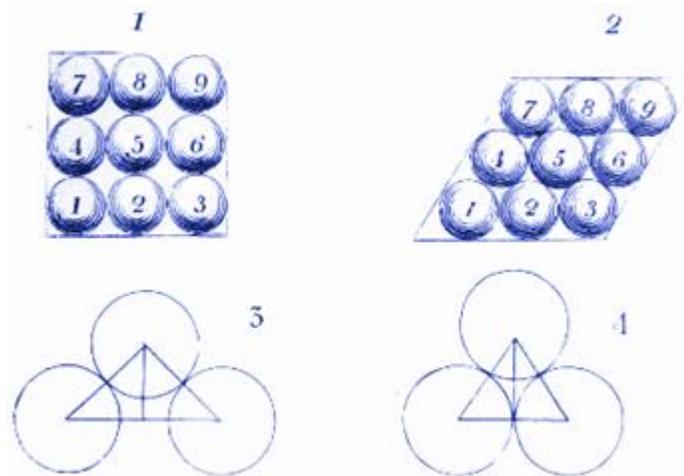


Figure 09: John Dalton’s model of water molecules both in liquid and solid states (source: <http://www.famousscientists.org/fs/wp-content/uploads/2014/10/john-dalton-water-molecules.png>)

All these three categories of models are taken to be *representations* of their target-systems. From the moment we assume that a model is a representation of something else, the following question is posed: “What fills the blank in ‘M represents T if and only if _____, where M is a model and T is target system?’” (Frigg and Hartmann, 2005, p.741). According to the Semantic Conception of Theories, the answer is “M is *isomorphic* to T”.

5.2. Models and isomorphism

The main authors from the Semantic Conception of Theories agree that the relation between a model and its object is a relation of *isomorphism*²⁴ (van Fraassen 1980; Suppe 1974, 1989). According to them, these relation holds for every model, regardless of its morphological features or the practices they are connected with. But, as seen in the previous sub-section, models are a very heterogeneous category of entities, therefore a series of problems are raised as a consequence of such an overall assumption. According to Downes (1992), isomorphism is a concept that works rather well in meta-mathematical cases, but when applied to general scientific cases it becomes an inaccurate criteria.

The term isomorphism comes from linear algebra and indicates:

(...) a one-to-one correspondence (mapping) between two sets that preserves binary relationships between elements of the sets. For example, the set of natural numbers can be mapped onto the set of even natural numbers by multiplying each natural number by 2. The binary operation of adding two numbers is preserved—that is, adding two natural numbers and then multiplying the sum by 2 gives the same result as multiplying each natural number by 2 and then adding the products together—so the sets are isomorphic for addition. (Hosch 2016)²⁵²⁶

Therefore, isomorphism is an algebraic concept originally applied to relations between two (or more) entities present the same structure, but are constituted of different elements. But, in the scientific practice “the relationship between theoretical and empirical model is typically weaker than isomorphism, usually a homomorphism, or sometimes an even weaker type of morphism” (Lloyd, 1988, p.14). And it happens because the formal properties of an isomorphism are not completely adequate to describe the relation between models and their objects: isomorphism is symmetric and reflexive²⁷ (Knuuttila

²⁴ See da Costa and French 2000; and French and Ladyman 1999, for accounts on *partial isomorphism*.

²⁵ “A bijection, also called a one-to-one correspondence, is a function that is simultaneously injective and bijective. (...)The usual notation for the function inverse to f is f^{-1} . (...) An important property of bijections is that you can convert equations involving f to equations involving f^{-1} : $f(x) = y$ if and only if $x = f^{-1}(y)$ ” (Joyce; 2015, p.1).

²⁶ In Encyclopædia Britannica. Retrieved from <<http://www.britannica.com/topic/isomorphism-mathematics>>

²⁷ See section 3.4 to see a similar argumentation against the notion of *similarity* as a defining feature of icons.

2005a; Frigg 2002). Besides it is also transitive: “if A is isomorphic to B and B to C, then A is isomorphic to C” (Frigg 2002: 6). Frigg (2002, p.11) gives the following example of how this feature of isomorphism is inaccurate in the case of models:

Take the bronze bust of Popper’s in the corridor of the philosophy department. It represents Popper. If I take a photograph of the buste (sic), the photograph represents the buste (sic). But from this is it does not follow that the photograph represents Popper, and in fact it does not.

Another inconsistency pointed out by the author is the fact that isomorphism is an insufficient criterion for establishing a relation between model and object, since it is possible to have two entities that are completely isomorphic to one another and even so are not model-and-object (since they do not belong to the right ontological categories):

In many cases neither one of a pair of isomorphic objects represents the other. Two copies of the same book, for instance, are perfectly isomorphic to another, but neither is necessarily a representation of the other (Frigg, 2002, p.12).

The multiple reliability from both models and objects is also a reason why isomorphism is not a good criterion to define the relationship between them. According to Frigg (2002, p.13), “we find that quite often the same structure is used several times in different contexts and even across different disciplines” (Frigg, 2002, p.13). Some examples are: the structure “ $1/r^2$ ” can be found as the “mathematical skeleton” from Newton’s law of gravity, as well as from Coulomb’s law of electrostatic attraction; or a general model of a cell that can be applied to a “large group of interrelated models that enable us to understand the operations of all cells. The model is not a nerve cell, nor is it a muscle cell, nor a pancreatic cell, it stands for all of these” (Downes; 1992, p.145).

But the opposite relation can also be found: instead of having one structure than can be mapped onto different objects, it is also possible to have one object represented by different structures: “It is a commonplace that one can represent the same subject matter in different ways. (...) a scale model of the wing of an airplane represents the shape of the wing differently from how a mathematical model does” (Frigg and Hartmann, 2005, p.741). So, we can see that several non-isomorphic structures can be found both as

models as well as objects, reinforcing the inconsistency with the notion of isomorphism in the scientific practice.

The last point raised by Frigg (2002) and Knuuttila (2005a; 2005b; 2011) concerns the possibility of have models standing in inaccurate and false relationships with their objects²⁸. The notion of isomorphism does not accept inaccurate and false models. But models are, in most of the cases, idealizations, abstractions, simplifications and approximations of their objects. Usually “what might appear to be misrepresentation could also be a part of a purposeful representational strategy” (Knuuttila, 2005a, p.315), where “(...) adjustments are made where literal correctness does not matter very much in order to get correct effects where we want to get them; and very often (...) one distortion is put right by another” (Cartwright, 1983, p.140). Such an “inaccuracy” of models is central in the process of construction of a model, since it consists in selecting (hiding, skewing, emphasizing), for a specific aimed purpose, the most significant properties of the object (Rothbart 2004; Knuuttila 2005a).

5.3. Models and similarity

In view of such problems with the notion of isomorphism, Giere (2004; see also Godfrey-Smith 2006; Weisberg 2007) introduced the notion of similarity²⁹ as a substitute for the former. As we already presented the main problems with the notion of similarity in the Section 3.4., we are not going to dwell on it here again. Instead we are going to focus on the consequences of such a notion. As models can be similar to empirical systems in several degrees and manners,

(...) a scientific theory turns out not to be a well-defined entity. Nothing in the structure of any model itself could determine whether it belongs to a given family

²⁸ See also Suárez 1999, 2003, 2010.

²⁹ Frigg and Hartmann (2005, p.742) propose that models that stand in a relation of similarity with their objects are a specific category of scientific models: the analogical models. They present the following example: “There is an analogy between the Earth and the moon based on the fact that both are large, solid, opaque, spherical bodies, receiving heat and light from the sun, revolving around their axes, and gravitating toward other bodies”.

of models or not. It is up to the scientific community to judge whether the resemblance is sufficient. (Knuuttila 2005a: 39)

So, by adopting the notion of similarity as the criterion that links scientific models and their objects, is not the features of the models who are responsible for their representational function – but the intention of the scientist. According to Giere (2004) a model only starts to *represent* something if the scientist intends to use it as a representation: “It is not the model that is doing the representing; it is the scientist who is doing the representing” (Giere, 2004, p.747), since “scientists are intentional agents with goals and purposes” (Giere, 2004, p.743). So, although many features from both isomorphism and similarity may overlap sometimes, the most distinctive feature of the latter is the focus on the intention of the model-maker and the model-user, who pick out the appropriate similarities according to the goals of the scientific practice:

I take the stand that, in principle, anything can be a model, and that what makes a thing into a model is the fact that it is regarded or used a representation of something by the model users. (...) We make something into a model by determining to use it to represent. (Teller 2001: 397)

Clearly resting all the power of models to relate themselves to their objects solely on the intention of users is a problem inside any scientific practice – since any attempt to objectively measure or define *intention* is very fuzzy and unclear. Also, it gives room to many inconsistencies regarding the traditional notion of representation, as Friggs (2002, p.19) points out:

Can I simply put a dot on a piece of paper and take it to represent an atom? As long as representative power solely rests on intention there is no way to rule out such cases – anything can be taken to represent anything, there are no limits.

Therefore, seeking for a way to understand how models function based in the notion of similarity proposed by Giere (2004) is, as Frigg argues, “too liberal to account for scientific representation” (Frigg, 2002, p.19). But representation itself is a looser criterion to distinguish models from other scientific entities, since not all models aim to represent, and since *representation* already presumes that the scientific practice is a finished product.

5.4. Models and representation

An almost unanimous consent among philosophers that are concerned with the roles of models in science is that models fulfill their scientific purpose by means of representing aspects and elements of the world (French and Ladyman 1999; Morrison and Morgan 1999; da Costa and French 2000; Frigg 2002; Bailer-Jones 2003, 2009; Giere 2004). This unanimity is such a strong feature of any approach on models that, according to Knuuttila (2005a), even some authors that argue against the Semantic View of Theories agree that the main feature of models is their ability to represent (Hughes 1997; Suárez 1999; Frigg 2002; Frigg and Hartmann 2011):

In order to be a source of knowledge a model must be representative. (...) if we wish to learn from a model about the world – and I take that this is often the case – we are committed to the claim that the model involves some sort of representation. (Frigg 2002, p.2)

But what this representational status actually concerns is rather unclear, since regarding the relationship between models and their objects only on terms of “right” and “wrong” or “true” and “false” might be problematic. Many are the reasons for it: (i) models can be independent of their objects; (ii) models are also entities that aid experimental practices; (iii) models can also be constructs whose locus is internal to the mind; and (iv) representation is not a dyadic process, but a triadic one.

By assuming that models are diagrams, we consequently assume that they are iconic signs. As seen along the subsections from the Section 2., icons are the only kind of signs able to signify without having any actual real object (CP 2.247; CP 5.73). Icons signify by means of its own qualities (EP2:306; EP 2:291; CP 8.335; CP 5.73; Short 2007). Therefore, the iconic feature of models³⁰ makes them “independent from any target systems” (Knuuttila and Boon, 2011, p.314). It is exactly this independence that they hold

³⁰ According to Frigg and Hartmann (2005, p.741), *iconic models* are a category of models that are “supposed to be a naturalistic replica or truthful mirror image of the target”, such as “(...) wooden cars or model bridges, which are either enlarged or downsized copies of the original”. One do not partake on their classification, since – as presented along this study – similarity is no accurate criteria for defining icons.

from their objects that allow both the model-makers as well as the model-users to work on abstractions, idealizations and approximations, by adding, distorting or even subtracting elements from the models (Morrison and Morgan, 1999; Godfrey-Smith 2006; Weisberg 2007). According to Knuuttila and Boon (2011; p.314): “(...) modellers, instead of striving to represent some real target systems directly, rather construct simple, imagined model systems to which only a few properties are attributed”.

Thus an inaccurate or even “false” representation of the object might well be suitable for the scientific aims they are destined: “Many scientific models cannot be considered as clear-cut representations of any specific external systems” (Knuuttila, 2005a, p.44). And to assert that models are independent entities that can signify by means of their own morphological features allows a more objective view on the “different purposes for which they are used in scientific practice” (Knuuttila and Boon, 2011, p.314).

Representation is also not the only purpose models serve. They can also be tools for experimenting, manipulating, inquiring and intervening in the world (Frigg, 2002):

Models often present us some tentative mechanisms, processes or solutions that can then function as a basis for various inferences. (...) Interestingly, even bad models and errors give us knowledge, which runs counter to the idea that knowledge is based on representing things rightly (in relevant respects and aspects). (Knuuttila, 2005a, p.45)

The representational approach of models infers that the objects they are signifying, as well as its features, are already known. Moreover it also assumes that we know *how* to appropriately represent the objects of the models. This assumption does not match the notion of scientific practice defended by Peirce (see Section 4.), since it places models not as instruments for reasoning and inquiring, but for merely didactic communication or remembering:

The representational approach also seems to assume that we already know how to represent the objects to be represented and have the appropriate means at hand. But if this were the case we would not need to represent the object in the first place for other than perhaps didactic and practical purposes (for those who do not

know what we know and for the purposes of communicating and remembering).
(Knuuttila 2005a: 45)

So, by approaching models as representational entities, its experimental character is putted aside: it focus on a supposed relationship where both the representational means of model as well as its objects are already known and presented on its most appropriate manner. This approach excludes one of the most crucial steps of the signifying processes in which models participate: the process of *modeling* – or model-construction (Lloyd 1988; Downes 1992; Morrison and Morgan 1999; Frigg 2002; Knuuttila and Boon 2011). The importance of modeling lies on the fact that it “is intertwined with the construction of new phenomena, theoretical principles and scientific concepts” (Knuuttila and Boon, 2011, p.311). And this connection between the construction of models and construction of phenomena happens because, instead of being direct representations of objects whose properties are already known to the person who is modelling and/or manipulating the model, models are entities that contribute for several experimental processes, mechanisms and scientific activities in general:

Apart from simplifications, approximations and idealizations, scientific modelling involves significant conceptual work, which covers such epistemic activities as discerning specific types of phenomena, conceptualizing 'non-directly observable' objects, properties, or processes, and bringing phenomena under specific types of 'non-empirical' theoretical principles or concepts. (Knuuttila and Boon, 2011, p.313)

And this experimental potentiality of models is due to the fact that they are diagrams in the peircean sense. So, by means of building, manipulating and observing models, one can discover more information about their objects, and reason upon them in a more systematic and efficient method.

Hughes (1997) propose an account of modelling where the meaning process does not rely solely on representation. According to him (Hughes, 1997, p.S327-S328) this process occurs in three steps: “denotation, demonstration and interpretation”. In the first step, one establishes a relation of representation between the model and its object. In the

following step, as Frigg and Hartmann (2005, p.744) sum up, “one investigates the features of the model in order to demonstrate certain theoretical claims about its internal constitution or mechanism; i.e. one learns about the model”. Finally, in the last step, one converts the claims and conclusions about the model into its object. Each step from Hughes (1997) DDI account can be paired with the three main steps of diagrammatic reasoning (See Section 4. And its subheadings.): denotation-construction; demonstration-manipulation; interpretation-observation. But the problems with his account is that: is still recurs to the notion of representation (instead of construction of building) and it cannot be appropriately applied to mental models.

Downes (1992, p.152) criticize the representational approach, pointing out to the fact the problem concerning mental models is not simply related to isomorphism, but with the notion of representation itself:

(...) it is not clear just exactly what the representational status of theories is, or if they are representational at all. (...) This is emphasized by the difficulty of finding a suitable alternative to isomorphism, and whether, once arrived at, such an alternative will apply to mental models in the same way it applies to socially constructed models.

Just as in the process of diagrammatic reasoning, models provide us new information and insights about their object from the moment they are both “mental” and “material”. According to Weisberg (2007) first one must construct and analyze material models, and then one might be able to establish an epistemic connection between them and their objects, since “modeling typically involves a theoretical (re)description of the target phenomenon as well as the development of theoretical principles and scientific concepts” (Knuuttila and Boon, 2011, p.316). Following this, it is possible to assure that we can only learn about objects and phenomena by experimenting with constructed material models and mentally experimenting with them. Therefore, the structure presented in the Section 3. About diagrammatic reasoning can be applied to the case of models: (i) construction of the material model, (ii) mental reconstruction of the material model, (iii) manipulation of the mentally constructed model; (iv) observation of the results from the manipulation of the mentally constructed model; (v) manipulation of the material model

based on the mental experimentation; (vi) observation of the results of the whole process. Thus models are not mere representations of their objects, but entities that aid inquiring and reasoning, which brings us to the last problem concerning the commonplace notion of representation: its dyadic character.

As Giere (2004, p.751) points out, a considerable portion of philosophical theories about “the scientific representation of the world has focused on dyadic relationships between language-like entities and the world”. As seen, the author tries to establish a triadic relation by placing the human interaction as the third element of the triad. Knuuttila (2005b, p.1261) also defends this idea by saying that “in one way or another, that representation is a triadic relation involving either the ‘users’ or ‘interpretation’”. But, from the moment we assume a Peircean approach, we must turn to the definitions of *representation* given by himself:

Representation is a relation of one thing, – the *representamen*, or sign – to another, – the *object*, – this relation consisting in the determination of a third, – the *interpretant* representamen, – to be in the same mode of relation to the second as the first is to that second. (MS [R] 491:1)

Representation, by which I mean the function of a sign in general, is a *combinant*, or *trifile*, relation; since it subsists between the *sign*, the *object* represented, and the interpretant or sign of the same object determined by the sign in the mind of the person addressed, or in other field of signification. (MS [R] 145(s))

Therefore, the third element of the triad is not the interpreter but the *interpretant* (see Section 2.). The interpretant allows the establishment of endless chains of semiosis, since it is the effect produced by the relation between sign (model) and object (what the model signifies). And it is exactly the effect that the models produce that renders them the status of *epistemic artifacts*.

5.5. Models as epistemic artifacts

As seen in the previous sections, authors such as Suppes (1961), van Fraassen (1980) and other supporters of the Semantic View of Theories argue that the most important part of models, that aids scientific and philosophical investigations, is their

structure and, consequently, their content. According to Knuuttila and Boon (2011, p.310), this traditional approach assume that the epistemic value of models is due to the “representational relationship between them and their ‘target systems’”. Because of the whole problematization around the traditional notion of representation, it behooves us to approach models as epistemic *artifacts* (Knuuttila and Voutilainen 2003; Knuuttila 2005a, Knuuttila 2005b, Knuuttila and Boon 2011).

The crucial feature of this approach is that instead of trying to define what models are, and what kind of relationship they establish with their objects, it stresses the possible uses of them, and what kind of effect they produce (Knuuttila and Boon, 2011, p.310). This approach “(...) pays attention to the diverse tasks of models in science, such as prediction, design of experiments, theory development and scientific understanding” (Knuuttila and Boon, 2011, p.316). This multifunctional artifactual approach of models conceives them as “intentionally constructed and materially embodied things, epistemic artifacts, the constraints of which are characteristically turned into affordances for epistemic purposes” (Knuuttila, 2005a, p.49). The material features of these artifacts provides them the necessary material and temporal consistency that allows the manipulation of them, making them tangible and, aiding internal cognitive activities that affords scientific reasoning.

The epistemic role of models is, thus, directly related to their diagrammatic features: the symbolic rules and conventions that can be found in an icon of relations, constrain³¹ the manipulation possibilities and, consequently, the reasoning process that can be performed upon them. It contrasts with the notion of models proposed by Giere (2004), which places the constraints inside the mind of the model-maker or the model-user: it is not the intention of the person who is constructing and/or manipulating the icon that renders them an epistemic character – but the model’s own qualities and features.

³¹ See the notion of *scaffolding* in Larkin and Simon, 1987.

This approach solves the problem of heterogeneity, since it is not important any more if the object of the models is a theory, a collection of data or a phenomena, but the epistemic effect it produces. It also discards the discussion about isomorphism and similarity – turning it down for the Epistemic Criteria of Icons, since models are diagrams. Finally it admits the process of representation as a triadic process, that produces and interpretant: the epistemic effect. But it still does not address mental models in a proper manner: in our study we assume that the epistemic value of modelling lies on the effect *both material (artifactual) and mental models* produces. It is exactly the construction, manipulation and observation of them in the same process of reasoning that allows the emergence of the epistemic effect.

So, by approaching material models as epistemic artifacts that aids the construction of mental models, the boundaries regarding the notion of models are stretched. It allows the study of artifacts other than equations, graphs, maps and other traditional entities that fall under the commonplace definition of models. In order to approach such a question, we are going to present in the following chapter one example of artifacts that are not usually regarded as a model: *photobooks*.

6. Photobooks as epistemic artifacts

The expression *photobook* is commonly used to refer to photographic publications in general, regarding the wide range of publishing possibilities. According to Shannon (2010, p.55), we understand as photobooks “various publications created in diverse circumstances, from a range of political, social and aesthetic viewpoints, resulting in the misleading homogenization of a vast swathe of published photographic material”. As Badger and Parr (2004, p.6) states:

A photobook is a book – with or without text – where the work’s primary message is carried by photographs. It is a book authored by a photographer or by someone editing and sequencing the work of a photographer, or even a number of photographers. It has a specific character, distinct from the photographic print.

Further, Shannon (2010, p.55) also tries to define photobooks considering their artistic features, as she says that “the term ‘photobook’ typically defines a book created to fulfil a primarily artistic function (...). According to Badger and Parr (2004), such publications are more ambitious than commonplace books, illustrated with photographs. By choosing the word “ambitious” they are referring to the existence of several concerns related to the development of an own artistic language other than the typical one that connects photographs and books. Thus, such books have a primarily artistic character, whose definition concerns more than simple coffee-table books, photographic catalogues or a simple compendium of artistic images. The photobook is, itself, the artistic product. According to Boom and Prins (1989, p.12):

“A photobook is an autonomous art form, comparable with a piece of sculpture, a play or a film. The photographs lose their own photographic character as things ‘in themselves’ and become parts, translated into printing ink, of a dramatic event called a book

In the catalogue *Latin-american Photobooks*, the editor Horácio Fernandez (20011, p.13) affirms, in the introduction, that “the gender is, since a long time, an effective medium of presentation, communication and reading of photographic series”. So, although photobooks are achieving more importance in the contemporary times, its presence in the

history of photography is somehow remarkable. Between 1844 and 1846, William Henry Talbot published *The Pencil of Nature* (Talbot 1898 [1844-1846]), the first book illustrated with photographs to be commercially published. In this photobook he exhibited to the public his experiments with calotypes for the first time. In the 20th century, Moholy-Nagy published, the photobook *Malerei Fotografie Film* (Moholy-Nagy 1927). This publication was his first attempt to present his theories and ideas related to an experimental production of photographs, which were later further developed and applied by him during his career as professor from the Bauhaus school of design. It was also in a photobook, that Ansel Adams first presented his new thematic and technical approach of the whole photographic process. He published *Taos Pueblo* (Adams, 1930), the publication that marks the beginning of his photographic production of landscapes from USA's west. Recently, the technical facility to conceive and publish photobooks increased the number of publications. According to Fernandez (2011, p.13): "(...) the importance of photobooks is becoming increasingly recognized in exhibitions and publications", regarding it as a contemporary phenomenon in the history of photograph.

In this study we are going to approach photobooks as epistemic artifacts, focusing on two of its main distinguishable characteristics:

- (i) Its great concern with a *sequential presentation of images*, seeking to achieve a consistent unity instead to simple queue several "single masterpieces" (Shannon, 2010, p.56). According to Badger and Parr (2004), photobooks are books whose meaning is created through the presentation of a series of photographs.
- (ii) The relation between different semiotic resources (photographs, written text, typography, layout, maps, drawings, among other) (Shannon, 2010) that contribute to the creation of a single artistic object.

Based on these features, we are going to analyze the photobook *Palast der Republik* (Rokitta, 2013) as a paradigmatical example of photobook that can work as a model (and, consequently, as an epistemic artifact).

6.1. The photobook *Palast der Republik*

The photobook, published in 2013 in Berlin with only 100 copies, contains two photographic sequences about the demolition process of the Palast der Republik, in the German capital. The first sequence consists of (i) 6 photographs, each one from a different demolition core of the building being photographed from different angles and (ii) a grid relating the six pictures according to a spatial aspect (the position of each picture in the grid relates to the position of the core in a bird-eye point of view of the demolition area) (Figure 10). On every page, together with each photo, a floorplan of the demolition site is presented, where the respective core shown in the photograph is highlighted in white. A diagram of the spatial grid with the 6 pictures can also be found every page, with the place of the respective photo also highlighted. Together with the photo, the grid and the floorplan, is a small written text with specific information about the day when all the pictures were made (28.09.2008) and about the cores of the building that were photographed (Figure 11). According to Rokitta (2013, p.5), in the introduction of the book, this series “retains the condition and the physical presence of the exposed cores just before the beginning of the final demolition moment”.



Figure 10: grid with the 6 photos from the first sequence (Rokitta, 2013, p.11).



Figure 11: Example of page from the first photo sequence with all the elements described above – the photograph, the floorplan, the grid and the written information (Rokitta, 2013, p.12).

This sequence only recreates the spatial aspects of the demolition process. Since it lacks the temporal aspects of the demolition of the Palast der Republik it is not an exemplary model of it. Therefore it is not going to be further analyzed in this research.

The second sequence presented on the book contains 48 photographs divided not only according to spatial aspects, but also according to temporal aspects: the last weeks in which the demolition process took place. According to the photographer: "The following second series consists of six images taken in a weekly-rhythmus, that kept hold the actual state of the cores. Over a period of several months, it became a serie (sic) that shows how the original presence and massiveness of the cores gave way to an increasing fragility until the last pieces of the Palast finally disappeared" (Rokitta 2013: 5). In this statement, also found in the introduction of the book, the new feature shown in the sequence is notable: the concern with temporal aspects of the demolition process, making the iconic manipulation of the ruin process more palatable as if it only presented its spatial aspect.

In the first page of the second series we can also find a grid, but a more complex one: the 48 pictures are distributed as shown in the picture below (Figure 12):



Figure 12: Photographic grid with the 48 photos from the second sequence (Rokitta 2013, p.21).

The inclusion of the temporal aspect in the second photographic sequence is extremely important for the creation of a model of a demolition process, considering that such processes are composed from a solid mass that loses shape with the passage of time. In other words, the spatial character of the architectural ruin is modified within the variation of time.

In the next 48 pages the following elements can be found: (i) a photography, a (ii) diagram, a (iii) floorplan of the demolition site and a (iv) small piece written text with information about the photograph shown in the respective page (Figure 13).



Figure 13: Example of page from the second photo sequence with all the elements described above – the photograph, the floorplan, the grid and the written information (Rokitta, 2013, p.32).

It is going to be presented here how all the semiotic resources in the book relate and contribute for the creation of a model of the demolition process.

6.1.1. The Palast der Republik in Berlin

The Palast der Republik (Figure 14) was located in one of the most central blocks in the center of Berlin, where the former Berlin City Palace stood for years, before being bombarded in the Second World War and then demolished by the government of the former East Germany under the claims that it represented the Prussian imperialism that once prevailed in the German territory. Built during the years of 1973 and 1976 and considered by many the major monument ever built by the German Democratic Republic, it originally held the parliament (the executive power and the central office of the party were housed in other buildings) as well as theaters; cultural centers; bowling alleys; concert halls and restaurants, offering the people the opportunity to cohabit freely in a political and cultural environment. According to Marcuse (1998, p.335):

The idea of combining the seat of the legislature with public theaters and publicly accessible restaurants and entertainment is the exact opposite of what is being developed in the new West Berlin government center, with its fortress-like concept and its careful attention to controlling access and use – not that there were not similar concerns in the GDR, but even so the form of the Palace of the Republic was designed to demonstrate openness rather than control.

Therefore the symbolism of the Palast der Republik was its main feature: although built in a dictatorship, it represented the coexistence of public life and political issues as well as the sovereignty of the public space over the private (Marcuse, 1998).

The concern with the way the GDR was seen in the foreign countries (especially in the Federal Republic of Germany) reflected not only on the practical use of the building but also on its aesthetics: according to Kuhrmann (2013, p.2), in the beginning of the seventies, the East German government began to attach great importance to the image of the GDR as an cosmopolitan, international and modern country, with an particular

design lexicon, although consistent in relation to the international modern architecture ideals - those being exported from West Berlin, a fresh source of inspiration for the architectonic development in East Berlin.



Figure 14: The Palast der Republik during the eighties (Source: www.failedarchitecture.com)

In 1990, after the fall of the Berlin Wall and the reunification of Germany, a huge discussion about the buildings and monuments of the former GDR took place (and it extends until today) and, being the most significant building in the history of East Germany, converting itself in a contemporary relic after the fall of the wall, the building was confronted with a debate about its future, that lasted around 18 years (4 years more than the amount of time it was originally in use). As it was announced by the Berlin's Chamber of Deputies: "Whenever a system of rule dissolves or is overthrown, the justification for its monuments – at least those which served to legitimize and foster its rule – no longer exists" (Gerke, 2014, p.5). The rejection of the building because its inarguably powerful symbolic meaning was quite obvious at the time, although an aesthetic rejection also took place in the debate. The design lexicon of the "GDR-Modern" was rejected in a

large scale, with the Palast the Republik as one of the many buildings in such style that were demolished back then.

Under the excuse of an alleged asbestos (a carcinogenic material) contamination, the palace was closed in 1990 and the decontamination started only in 1998, after almost 10 years laying idle in the middle of the reunited German capital. During the years of 1998 and 2003 almost 5000 tons of the fiber was removed from the building structure (Gerke, 2013, p.3). From 2003 on a group of artists gathered together and started giving the empty ruins a new function: the Palast began to stage cultural events and artistic exhibitions and performances under the name of “Volkspalast”. But even with this strategy of appropriation, the demolition of the building began in 2006 and extended itself up to 2008, period when the concrete-made cores of the building were left in sight (Figure 15), while, by then, the Palast had already lost its main characteristics: the cubic, slightly asymmetric shape, the mirrored brownish-gold windows and the marble façade. On 2013, the president Joachim Gauck laid the foundation stone for the rebuilding of the former Berlin City Palace in the place.



Figure 15: the demolition site of the Palast the Republik in 2008 (Source: <http://www.storyal.de/>)

The fact that the Palast remained a long time in the Berlin city center landscape as a ruin helped to build its symbolic meaning: the building stood for a longer time as ruin (18 years), than as a structure serving the purpose for which it was built (14 years). Therefore addressing the building as a ruin raises more questions and possibilities for the interpretation of such architectonic piece and its symbolisms, whether it is understood as a place in the memories of individuals, a central historical artefact or even as a symbol of a dictatorship and all its developments. And, according to Gerke (2013, p.8):

Within the terms of modernism, destruction is the best way to conserve. For we are living in a cultural environment, in which, on various levels, all destructions are documented, archived, interpreted and processed artistically. In that sense one could say that it's no pity about the Palace of the Republic: destruction has made it famous. Had this not been the case, it would be a building as many others and would probably not have received its prominence.

6.1.2. Semiotic resources

In order to focus on the spatial and temporal aspects presented in the book, the following elements are going to be presented: (i) the initial grid, (ii) the complete floorplan, (iii) the photographs, (iv) the diagrams of the initial grid, (v) the simplified floorplan and (vi) the written text.

The initial grid, as already presented above, is composed of 48 pictures put in order according to spatial and temporal aspects: the spatial displacement is presented on the lines and the time development is presented on columns (Figure 12). The 48 pictures are distributed in 2 axes as shown in the picture below (Figure 16):

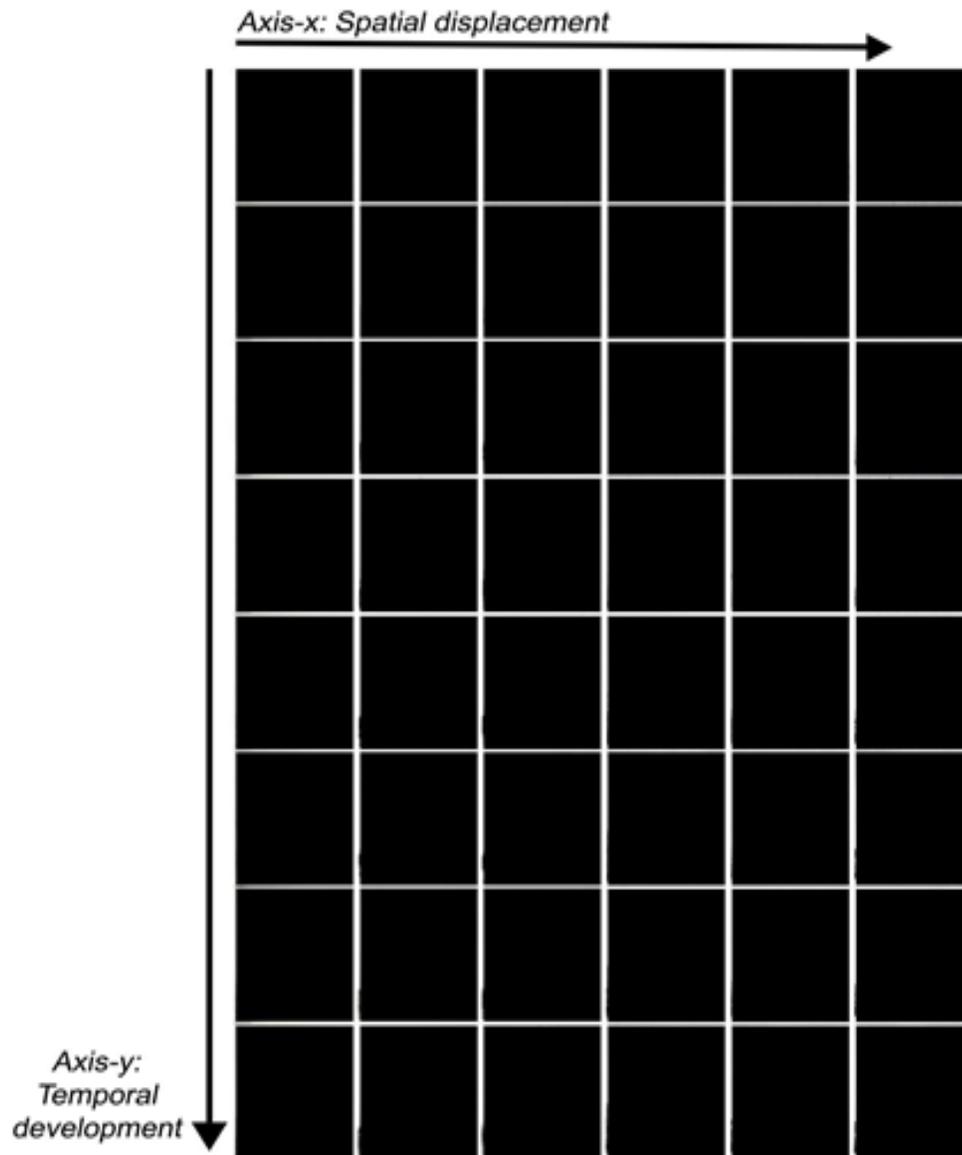


Figure 16: Diagram of the spatial and temporal aspects in the photographic grid of the second sequence.

As represented in the diagram above, as we move from the left to the right on this photographic grid (axis-x), we change the object of the photograph according to its location in the demolition site: 8 cores are presented in the 6 series photographs: the first and the second cores are presented together in the first column and the seventh and the eighth are also presented together in the sixth column. The other 4 cores are divided in

the 4 central column of the grid. As we move from the top to the bottom (axis-y), every line represents a different week in which the photographs were taken, from the first (05/10/2008) to the last (06/12/2018). This grid is the most explicit reference to the relation between space and time in the development of the demolition process.

The complete floorplan can be found before the first photographic sequence, in the page 06 (Figure 17). It features a bird eye point of view map from the whole Museum Island (where the ruins were located) as well as the course of the Spree river around it, helping us to locate the place where the building with its eight cores once stood, since it has already been demolished and the replacement process has already began with the reconstruction of the Berlin City Palace. It is possible to notice a small red dot in the floorplan (Figure 18): it represents the position of the photographer (“Aufnahmestandpunkt”) while photographing the image that follows the map in the page where all the 8 cores of the building can be seen:

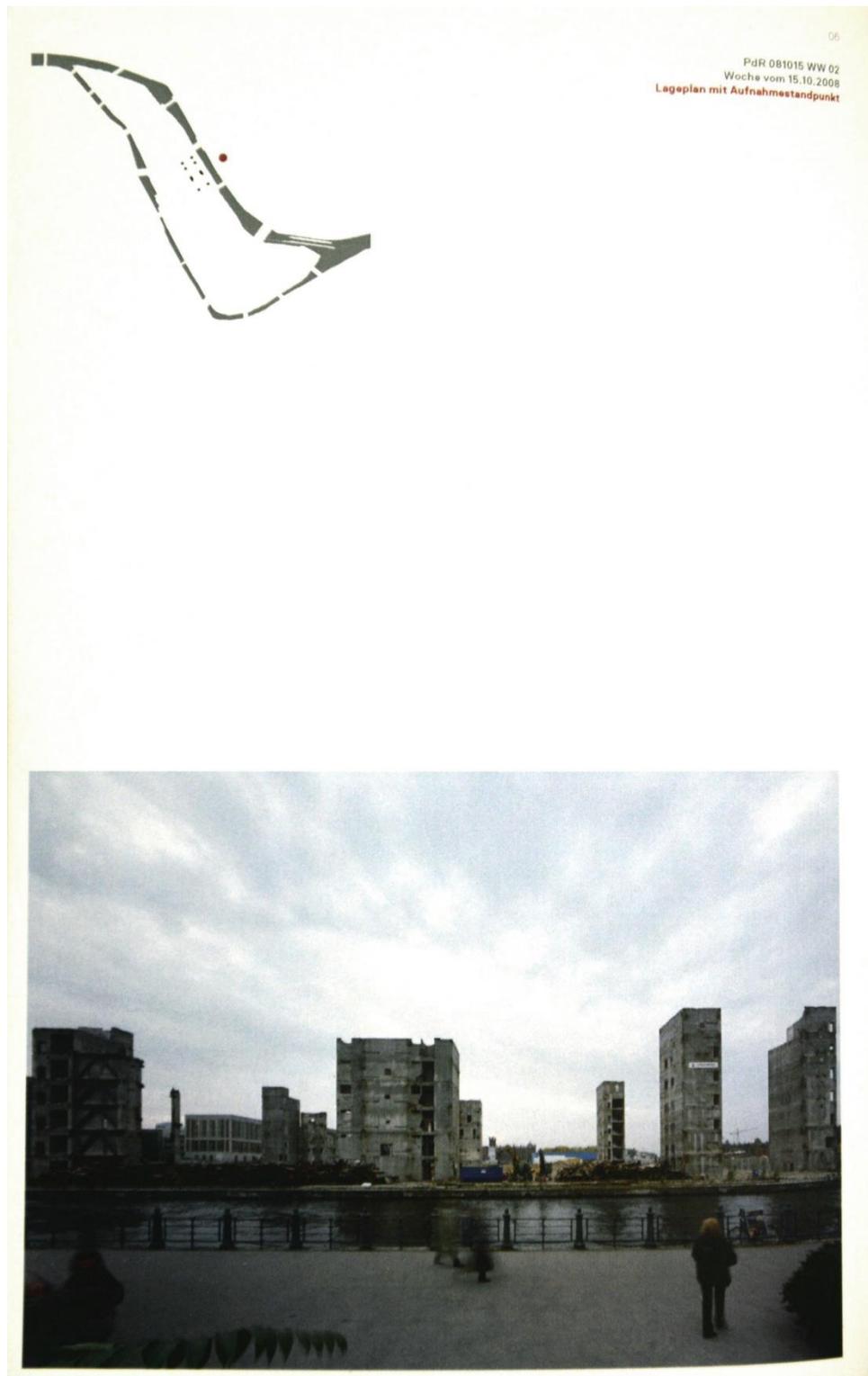


Figure 17: The complete floorplan and the photograph that follows it (Rokitta, 2013, p.6).



Figure 18: Detail of the complete floorplan

The next four elements (the simplified grid, the simplified floorplan, written text and the photographs) can be found in every single page of the second sequence, displayed as in the figure below (Figure 19):

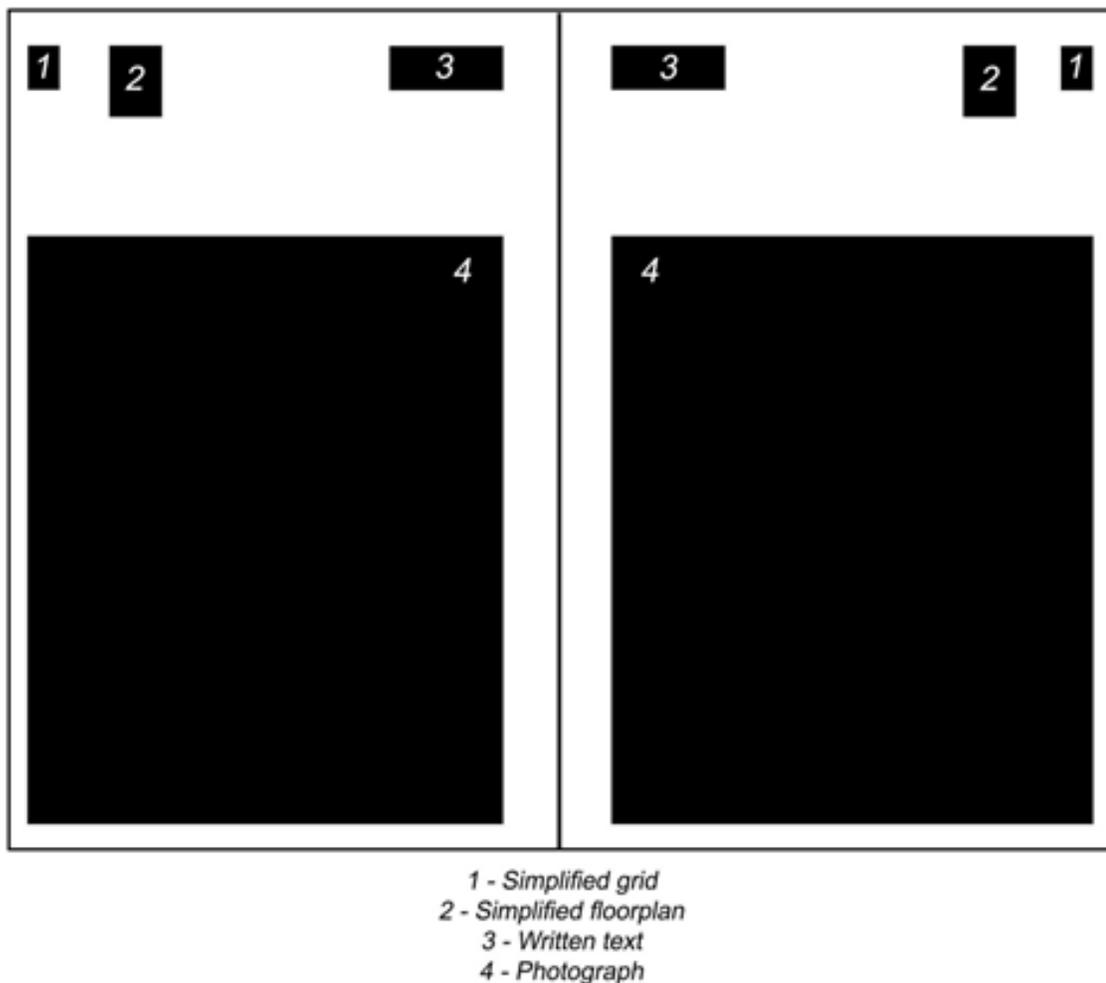


Figure 19: Diagram with the elements that can be found in a two-page spread of the photobook.

The simplified grid can be understood as a diagram of the initial grid, composed by 48 squares, each one representing a photograph and can be found in the upper outside corner of every page (Figure 20). It relates the photograph presented on the respective page to its position in the initial 48-photographs grid. It works as an artifact that helps us to locate the temporal “position” of the specific photograph in the whole demolition process. It works by highlighting in white the square that represents the photograph in the initial grid.

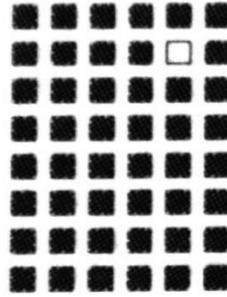


Figure 20: simplified grid from the page 32.

The simplified map is a cutout from the complete floorplan presented in the page 06 and works as a diagram whose function is to indicate us the specific position of the core represented in the photograph it accompanies (Figure 21). It can be found near the simplified grid on every page of the second photographic sequence. Although the simplified grid helps the interpreter to find the position of the core in the demolition process (a diagram that shows the space subjection to time), the map introduces more information as it presents us the specific location of the core not in relation to the temporal development (as the simplified grid), but the location of the photographed core in the construction site. It is of main importance, since it situates the photographs of the unrecognizable structures of the Palast der Republik in the place where the building once stood: near the Spree River, allowing us to identify the photographed cores as the cores of the homonymous building. The photographs, as indexes are characteristically reactive, and this reactive predominance operates as a “trustworthy witness” of the demolition process. But, as an index, it only points to an object - it does not present further information about the object. Therefore the importance of such a relational icon as the simplified map in the whole system of relations between the semiotic processes.

Just as in the simplified grid, the core related to the photograph in the page is highlighted in white while the other core remains gray.

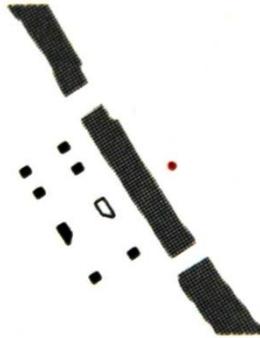


Figure 21: Simplified map from the page 32.

The specific information about the date when the photographs were taken and the number of the core photographed can be found in the small piece of written text on the upper inside corner on every page of the second photographic sequence (Figure 22). In the first line of the text, the following structure can be read: “PdR year month day Kx” for example in the page XXX: “PdR 081025 K3”. The first three letters are an abbreviation of the name of the building (“Palast der Republik”); the following numbers refer to the date in which the picture were made (as in the example - 08: year of 2008; 10: month of October; 25: day of the month), and the two last characters inform us the number of the core (K is the first letter of the German word for core, “Kern”). This first line encodes all the important information about the temporal and spatial aspects of the demolition process. In the following two lines of the small text the information are made explicit: “Woche von 25.10.2008”, translated to English as “Week from 25.10.2008” and “Kern 3”, translated as “Core 3”. Consequently, each photograph follows a different text.

PdR 081025 K6
Woche vom 25.10.2008
Kern 6

Figure 22: Written text from the page 32.

The last element introduced in this analysis are the photographs. All of them were taken using the same strategy: they are all frontal photographs of the cores, with a highly geometric composition, where no living being can be found: the only characters in the pictures are the cores and their architectural surroundings, as well as the machines and instruments used in the demolition. The color palette from the pictures is also a very desaturated and limited one, with all colors reduced to tones of brown, green, gray and blue (Figure 23).

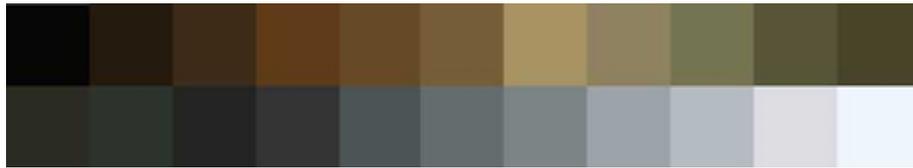


Figure 23: Color palette from the pictures in the book.

These characteristics help us to focus on the physical changes to which the building was subjected during the demolition process, since no other element “disturbs” the image.

All these features make the influence of the Düsseldorf Photography School very clear with its almost documentary and scientific approach of the representation of the object. Blake Stimson (2004)³² wrote once about the photographs from Bernd and Hilla Becher (the main representatives of the Düsseldorf School):

As much as we might want them to be, the photographs ‘are not illustrations’, notes one observer flatly, but instead render their subject ‘by means of the network of photographs’; when the images are viewed together they provide, he continued, ‘an anatomy lesson’, that is an account of the relations between constituent parts.

The methodological procedure that characterizes this moment in the history of photograph is concerned with the creation of a typological vocabulary for architectural

³² Available at: <<http://www.tate.org.uk/research/publications/tate-papers/photographic-comportment-bernd-and-hilla-becher>>

representations, where the “objectification” of the subject have central place in the photographic sequences. This methodological system is based on a series of limitations, which can also be found in the photographs in the “Palast der Republik” photobook (except for the black and white chromatic spectrum) (Figure 24):

Their system is based on a rigorous set of procedural rules: a standardised format and ratio of figure to ground, a uniformly level, full-frontal view, near-identical flat lighting conditions or the approximation of such conditions in the photographic processing, a consistent lack of human presence, a consistent use of the restricted chromatic spectrum offered by black and white photography rather than the broad range given by colour, precise uniformity in print quality, sizing, framing and presentation, and a shared function for all the structures photographed for a given series. (Stimson ,2004)³³

³³ Available at: <<http://www.tate.org.uk/research/publications/tate-papers/photographic-comportment-bernd-and-hilla-becher>>



Figure 24: photograph in the page 32.

In a schematic manner, the semiotic resources can be presented as following (Table 02), in relation to their (i) semiotic nature; (ii) formal characteristics; and (iii) their function in the modelling process:

Semiotic Resource:	Semiotic nature:	Formal characteristics:	Function in the modeling:
Initial Grid with 48 photographs	Mainly iconic	The 48 pictures are distributed in lines and columns. The 8 cores of the demolition are distributed in the 6 vertical columns (the 1 st and the 2 nd are presented in the same column, as well as the 7 th and the 8 th) Every line represent a different week in which the photographs were taken, from the first (05/10/2008) to the last (06/12/2018).	This grid is the most explicit reference to the relation between space and time in the development of the demolition process, allowing the reader to have a general overview of the whole documented demolition.
Photographs	Mainly indexical	They are all frontal photographs of the cores, with a highly geometric composition, where no living being can be found: the only characters in the pictures are the cores and their architectural surroundings, as well as the machines and instruments used in the demolition.	Helps us to focus on the physical changes to which the building was subjected during the demolition process. The photographs, as mainly indexical signs, are characteristically reactive, and this reactive predominance operates as a “fidedign witness” of the demolition process.
Diagrams of the initial grid	Mainly iconic	It is a diagram of the initial grid, composed by 48 squares, each one representing a photograph and can be found in the upper outside corner of every page. It whighlights in white the square that represents the photograph presented on the page in the initial grid.	It relates the photograph presented on the respective page to its position in the initial 48-photographs grid. It works as an artifact that helps us to locate the temporal “position” of the specific photograph in the whole demolition process, as well as informing us which core is in the photograph.
Floorplans	Mainly indexical and iconic	Just as in the simplified grid, the core related to the photograph in the page is highlighted in white while the other core remains gray.	It situates the photographs of the unrecognizable structures of the Palast der Republik in the place where the building once stood: near the Spree river, allowing us to identify the photographed cores as the cores of the homonymous building.
Written text	Mainly indexical and symbolic	In the first line of the text, the following structure can be read: “PdR year month day Kx” for example in the page XXX: “PdR 081025 K3”. The first three letters are an abbreviation of the name of the building (“Palast der Republik”); the following numbers refer to the date in which the picture were made (as in the example - 08: year of 2008; 10: month of October; 25: day of the month), and the two last characters inform us the number of the core (K is the first letter of the German word for core, “Kern”).	It schematically encodes all the important information about both the spatial and temporal aspects of the demolition.

Table 02: The main characteristics of the semiotic resources in the photobook

If we analyze the relations between these four resources in one single page, only the spatial aspects of the demolition *area* are recreated - not of the demolition *process*. The information “Kern 3” can be related to the photographed core and, together with the information brought by the simplified floorplan about the amount of remnant demolition cores of the building and their specific position. We can also relate both the information “Kern 3” and the highlighted form in simplified floorplan with the photograph that can be found in the page (Figure 25). Therefore, a sequence of pages must be taken into consideration in order to recreate more accurately the spatiotemporal aspects of the demolition process.

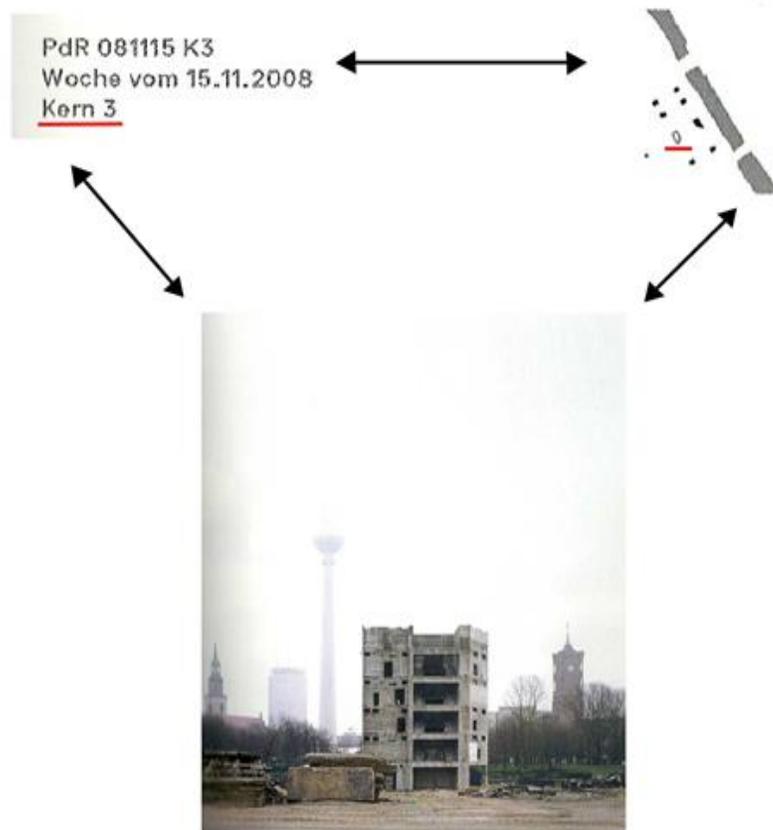


Figure 25: Example of couplings with focus on the spatial aspects between the resources cited above (Rokitta, 2013, p.47).

To understand how the demolition can be recreated in the book, we are going to present two possible readings departing from the structure presented in the initial grid (Figure 26).



Figure 26: two possible sequence readings departing from the structure presented in the initial grid.

As shown above, as we move from the left to the right on this photographic grid, we go from the first two cores (presented together in one photograph) to the last two cores (also presented together in one photograph). And, as we move from the top to the bottom, every line represent a different week in which the photographs were taken, from the first (05/10/2008) to the last (06/12/2018). Taking the photograph presented in the top left corner of the grid as a reference, we are going to show how the spatial aspect of the demolition process is recreated moving from the left to right (Figure 27), and how the temporal aspect of the same process is recreated going from the top to the bottom (Figure 28).

The figure below presents a montage assembling the resources present in the pages that correspond to the spatial displacement in the first week of the demolition process, as in the first possible reading (Figure 27).



Figure 27: Montage with resources from the pages 22, 23, 24, 25, 26 and 27: spatial displacement in a sequence of one week (in this case, the week of 05.10.2008) (Rokitta, 2013).

In such a sequence the interpreter is allowed to have a general view of all the cores. But the demolition as a process is not recreated, since it lacks the temporal aspects - we can not see the changes in the cores. It works as a simple statement of how they looked like in one specific week. From the moment the photographs are disposed in such a sequence, the presence of the simplified grid is necessary to understand the order of the spatial displacement.

When a single sequence moving from the top to the bottom of the initial grid is taken into analysis, it is then possible to relate these elements to a spatiotemporal process. The montage below recreates this reading possibility (figure 28). But it is important to highlight, that in the case of a sequence showing one specific core (or pair of cores, in the case of the cores 1, 2 and 7, 8), the simplified floorplan does not change - therefore it is not presented in the montage below.



Figure 28: Pages 22, 28, 34, 40, 46, 52, 58 and 64: Temporal development in a sequence of one core (in this case cores 1 and 2, presented together) (Rokitta, 2013).

By merging both sequence configurations shown above in the photobook, it is possible to recreate the temporal and the spatial aspects of the demolition process in a more consistent manner. So the distribution of the pages of the book is very important to allow the proper observing and manipulation of the photobook as presented in the picture below (Figure 29): the photograph in the upper left corner is the first to be presented. It

follows the red thick line in the picture below until the last photograph is presented: the one on the bottom right corner.

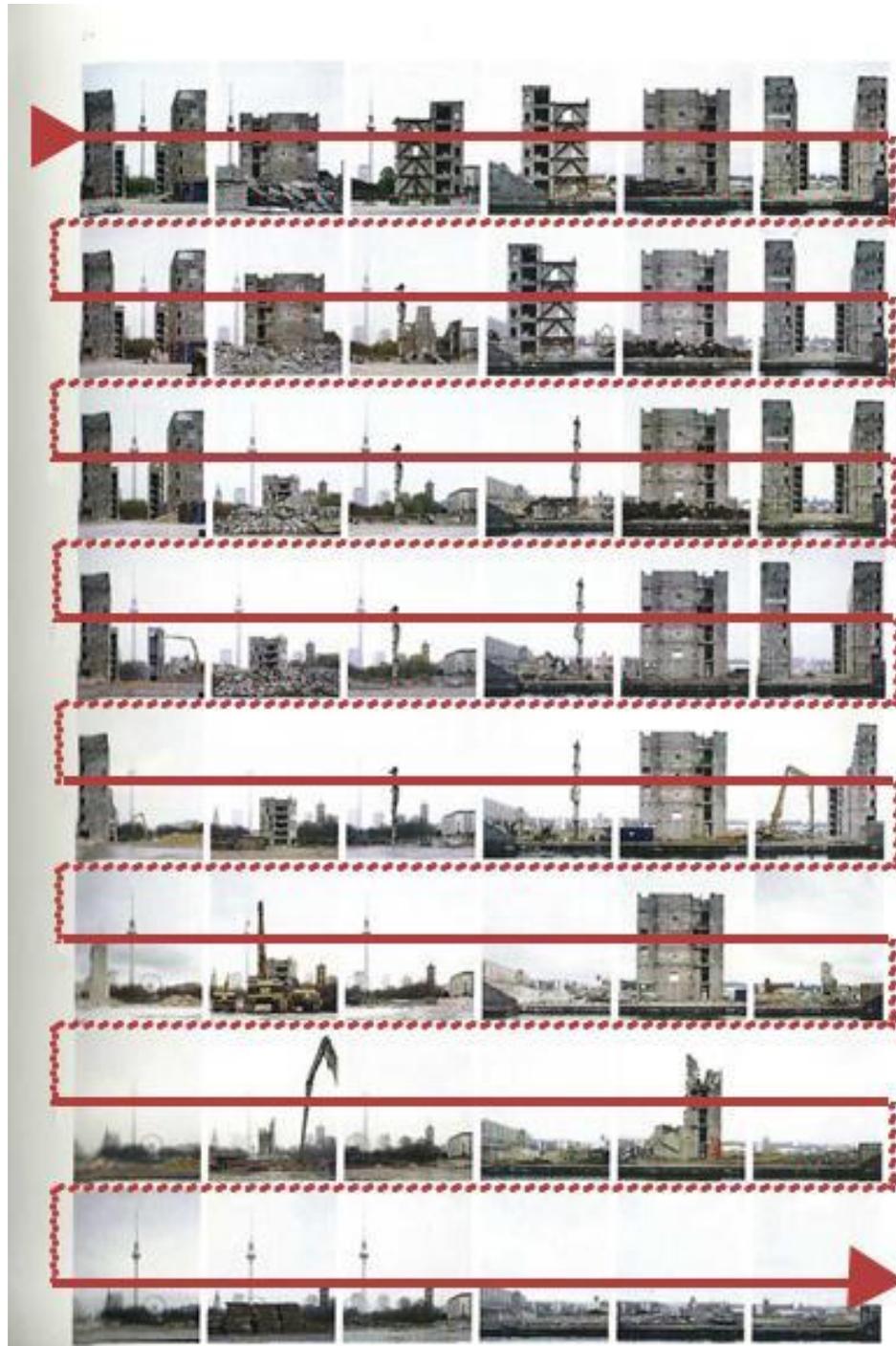


Figure 29: diagram presenting the order of distribution of the pages in the photobook.

6.1.3. Diagrammatic features

From the analysis of the photobook, recurring to the theoretical background presented in the Sections 2. 3. and 4. (and their subheadings), is then possible to outline the main diagrammatic features of it.

Firstly, it is a diagram constructed not only by mainly iconic signs (the initial grid and the diagrams of the initial grid), but also by signs that are mainly indexical (the photographs) and signs with a clear mixed character (the floorplans and the written text). And it is exactly the way that the different semiotic morphologies of each sign constrain the others that produce the diagrammatic effect of the book.

But the symbolic character of the photobook is not present just on the semiotic resources that compose it. It is also present on the rules and conventions that guide our manipulation of this specific system of representation: the photobook. This specific book has the typical form of a western codex: “a set of handwritten, printed, illustrated or in other ways inscribed sheets, fastened together by one side” (Cardoso 2014, p.139). The importance of the material characteristics of the book itself is not related only to the particularities of its appearance. What is central about this point is who do these material characteristics affect the meaning process (Moeglin-Delcroix 2012). For example, it is not possible to see all the pages of the book at once. The pages are presented in an ordered sequence that can only be read forwards or backwards: in the case of the *Palast der Republik*, the demolition process can than only be accelerated or regressed. Although one can experiment with the book by passing the pages ignoring its the normative order, one does it consciously: he knows that he is manipulating the book in a non-usual and, in some specific cases, wrong way. According to Moeglin-Delcroix (2012, p.58-59):

The book has an ordered sequence of pages. Such a characteristic implies two things: the spatial unit of the page or of the double spread viewed simultaneously, and the length of time where this space itself is understood and located, which means that the page has not the autonomy of a painting, but appears and disappears, in turn, when it is prescribed by its position in the sequence.

This passage also points out to another characteristic of the western codex format that influence the manipulation of the book: the space of the pages. The conventions regarding the localization of elements inside the borders of the pages constrain our reading and consequently connect the all the resources that are to be found inside one page. Because of this convention, we know that the resources from page a given page are all related to the same spatial-temporal object: the signification is constructed through the relations that are mentally established between the semiotic resources in the pages.

Another diagrammatic feature of the book is related to the fact that through the material manipulation of the book we are allowed to mentally manipulate both the temporal and the spatial characters of the demolition process. We do not need to rebuilt the building and demolished it again in order to perceive this characters: we can simply read and manipulate the book. Therefore, it is clearly an artifact made for manipulation that allows the person who is manipulating it to get in contact with information about the demolition that, in this point, would not be reachable through the object itself.

7. Final comments

In this research we've analyzed the photobook *Palast der Republik* as an artistic epistemic artifact, whose semiotic properties can be defined as such: it is an intermedial artwork that presents a coupling of different semiotic resources; it is an icon allowing the discovery of new information about the object; it is a diagram, an icon of relations, that can be manipulated in a process of reasoning and inquiry; it is a model since it interprets a phenomena and recreate it by its own representational (in the triadic sense) means; it is an epistemic artifact, a material entity whose constraints aids the emergence of affordances for epistemic purposes.

The object of the photobook is, at a first glance, the demolition process of the *Palast der Republik* in the former East Berlin. It is worth mentioning that the relevance of this specific building can be distributed among several dimensions (social, historic, architectonic and semiotic). As seen, the *Palast der Republik* was a building whose functions were not only administrative, but also cultural and political - affecting different dimensions of the East-German society. After the reunification of Germany, its symbolism represented a threat to new capitalist system that began to rule the former East German. Following a long discussion that lasted almost 20 years the building was finally demolished, after remaining as a ruin in the centre of Berlin. Its demolition has, therefore, consequences and implications in several knowledge fields, among them history, politics, sociology, and arts.

What is particularly interesting about the photobook is related to the kind of semiotic treatment about what seems to precisely characterize the object it stands for. It presents an intermedial process, where several semiotic systems are coupled, dedicated to the recreation of the of a spatiotemporal phenomenon. Thus the research question that guides the work is: *how* certain semiotic resources interact in order to recreate the spatiotemporal demolition of a building? "*How*", evidently, refers to the semiotic mechanisms and processes required to perform such a task. In order to effectively approach it, we have turned to the semiotics of C.S. Peirce.

The semiotic approach of models provides what can be considered as a heuristically interesting conceptual frame to think about artistic artifacts. The very own configuration of the photobook allows us to “extract information [about the object] by means of abstraction” (Týlen et. Al, 2014, p.284): through the manipulation of a diagram about one specific demolition process, information about demolition processes in general is revealed. Peirce calls it “generalized percept” (CP 8.144) or “perceptual judgment”:

[T]he perceptual judgment ‘this chair appears yellow’ has vaguely in mind a whole lot of yellow things, of which some have been seen, and no end of others may be or might be seen; and what it means to say is ‘take any yellow thing you like, and you will find, on comparing it with this chair, that they agree pretty well in colour. (CP 7.632)

Just as a generalized notion of of “yellowness” can be prescind from a perceptual judgment on a yellow chair, a generalized experience of a demolition process can be prescind from the photobook *Palast der Republik*. Therefore, the photobook *Palast der Republik* is a model not only of one demolition process, but of demolition processes in general. Taking the perceptual judgment even further it is possible to state that this photobook models a much more abstract process: a spatio-temporal variation. And this ability of comprehend the representation of both concrete and abstract processes attests the very broad modeling potential that artworks can have: by manipulating them, we can analyze the relations that constitute thee represented phenomena in different levels of abstraction.

It is exactly this capacity for generalization that diagrammatic models present, that allows this approach to reframe the discussion about relationships between art and science. According to Ambrosio (2015, p.13): “‘generalized’ percepts are not just constructions – they are hypotheses that can be somehow tested empirically”. Therefore, by approaching artworks as diagrams, both the artistic qualities as well as the epistemic value of them are connected through the notion of *model*. Consequently, the problem regarding art and science is treated in a distinct way from the usual, opening paths for new reasoning methods, stimulating new inquires and scaffolding new inferences.

This research produced at least two partial or preliminary results that we wish to highlight: (i) diagrammatic constructions, and the interaction between different semiotic resources (coupling) that constitute them, provide us with precise triadic representations of spatiotemporal process of transformation; and (ii) such constructions can act as epistemic artifacts able to reveal properties or information about its objects, stimulating further reasoning and inquiry.

Such an approach is important, because signs and sign-relations are addressed here as means for understanding something, for reasoning about it and, consequently, for discovering more information about it. And the establishment of such a systematic methodology for the analysis of artworks, can achieve a large scope of application, covering areas such as translation studies (because of its concerns with iconic properties), cognitive semiotics (since it address models as tools for reasoning), intermedial studies (because of the focus on the relations between different semiotic resources), among others.

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