ABSTRACT
This paper tries to model an “esthetical behavior” supporting the interconnected structures. Based on the concept of structural self-organization it defines the collectivity as a set related by the structural relations. While the structure (esthetical or not) is a concept, the representation or the image is an intuition (according to Croce). Nearby the structure, opposite to the function, is the image as an intuition. The esthetical structures are characterized by significant intuitive representations. Thus, the perception of the structural self-organization of a work of art is, finally, an intuition. Or, the esthetical function is the expression of the work of art. The concept of the esthetical structure and the intuition of the esthetical representation form the two sources of the conception/reception of a work of art. We introduce the notion of “interconnected esthetical collectivity” and, on this background, we try to model an esthetical behavior supporting the esthetical locality concept.

Keywords: interconnected esthetical collectivity, esthetical locality

1. INTRODUCTION
“The knowledge has two forms: it is an intuitive knowledge or a logical knowledge; a knowledge by the imagination or a knowledge by the intellect; a knowledge of the individual or a knowledge of the universal; of the things considered each separately or a knowledge of their relations; it is, finally, a producer of images or a producer of concepts.... The intuition means, frequently, the perception, i.e. the knowledge of the happened reality, the perception of something as real” (Croce 1971).

A complex system perception, as of a work of art, means first of all the perception of a self-organization of the system or of the relations that organize the system. To perceive a complex, said Wittgenstein, “means to perceive the relations of its constituent parts in a determined way” (Wittgenstein 1991). On the other hand, one of the natural characteristics is the association in collectivities. Professor Moshe Sipper said in the foreword to a recent book, that through the computing terrain during the past few years a new wind has been swept, “slowly changing our fundamental view of computers. We want them, of course, to be faster, better, more efficient - and proficient – at their tasks. But, more interestingly, we are trying to imbue them with abilities hitherto found only in nature, such as evolution, learning, development, growth, and collectivity” (Castro and Zuben 2005). We can observe collectivities in the not living world (universe galaxies, solar systems, crystalline units), in the living world (ant hills, bee swarms, nations) as in the artificial world (paintings, especially the abstract ones, architectures, cities). What properties are behind the relations that organize the collectivities, or, better said, the relations of association in collectivities? Maybe is the gravity, the symmetry or the survival instinct or, maybe, an esthetical property? In one word it is structural self-organization. The self-organization is based on structural relations (not dependable on time) between structural entities. The self-organization can be structural or functional (relations dependable on time).

The definition of the term collectivity deduces from the definition of the term set. “A set can be selected by a membership or can be constructed by a relation which substantiate the membership or by bringing in the set elements which fulfill the relation defining it” (Drăgănescu 1985). Because N. Bourbaki names “collectivizing relation” the relation defining a set, we name collectivities only the sets selected or built based on relations. Therefore, we exclude the sets selected by the membership, (the most general definition of the set). A collectivity does not mean, in our point of view, a set made, for example, of {a star, 5, a planet, a crystal, c, an ant, a bee, a man}.

The relation that proves the membership of a collectivity is resulted from its structural properties: a collectivity is made of smaller structural entities. For example, an interconnecting relationship is composed of a set of nodes and links which is equivalent with the graph definition (a set X of nodes and an application Γ of X in X which gives the set of connections). The link, the connection is a structural property for an interconnection or a graph.

2. ESTHETICAL STRUCTURE AND INTUITION
A basic concept in this article, which we have used but not explained, is the concept of the structure. The structure concept, at the beginning with the meaning of
understood, inferred.

"functional" works of art). The work of art is a pure representation (of the image) form, in our opinion, the esthetical structure, alike opposite to the function, is the image as an intuitive representation. Thus, the esthetical expressions are representations or images of an esthetical structure (work of art) which can be perceived in a certain succession, a temporal. The structural self-organization of a work of art means a spiritual esthetical synthesis or an (esthetical) expression. "The esthetical functionality" is replaced by an "esthetical process", the essence of which is, according to Croce, the expression.

The structure is a concept while the representation or the image (Croce 1971) is an intuition. Nearby the structure, alike opposite to the function, is the image as a sensation. The esthetical structures are characterized by significant intuitive representations. Thus, the perception of the structural self-organization of a work of art is, finally, an intuition. "The result of a work of art (the conception and/or the reception, m.n.) is an intuition" (Croce 1971). The representation, in Croce’s opinion, is an intuition that detaches and emphasizes on the psychic background of sensations. The representation is an elaboration of sensations, and therefore is an intuition. The concept of the esthetical structure and the intuition of the esthetical representation (of the image) form, in our opinion, the two sources of the conception/reception of a work of art. By the structure and the intuition, a work of art closes itself, the functional behavior isn’t necessary to be understood (except the design and the other "functional" works of art). The work of art is a pure structure, an esthetical structure, which must be understood, inferred.

The esthetical structures are esthetical collectivities, i.e. sets built with the help of the esthetical relations resulted from the esthetical properties. An esthetical relation is a relation that spiritually expresses the connections between the collectivity entities on the basis of the esthetical properties (e.g. synthesized by the binomials beautiful-ugly or symmetric-asymmetric). The esthetical relations are by definition structured. "The complete process of the esthetical production can be symbolized in four stages: a) impressions; b) expression or esthetical spiritually synthesis; c) hedonic accompaniment or pleasure of beautiful (esthetical pleasure); d) translation of esthetical fact in physical phenomena (sounds, tones, motions, combinations of lines and colors). Anybody observes that the essential point, only which is proper esthetical and real is the point b, which is absent to the naturalistic manifestation and construction, and which is nominated, at their turn by metaphor, expression" (Croce 1971). The (esthetical) expressions are representations or images of an esthetical structure (work of art) which can be perceived in a certain succession, a temporal. The structural self-organization of a work of art means a spiritual esthetical synthesis or an (esthetical) expression. "The esthetical functionality" is replaced by an "esthetical process", the essence of which is, according to Croce, the expression.

The structure of an esthetical collectivity can be, as any structure, self-organized locally and globally. An interconnecting structure is locally estimated by neighborhoods. The locality is the behavior or the structural self-organization of an (esthetical) collectivity around an origin. In case of an esthetical collectivity, the origin can only be spatial. The article refers to the spatial origins of a structure and the locality definition covers the first meaning of the structure concept (connection between parts). The globality is the behavior or the structural self-organization of an (esthetical) collectivity around a property. For example, the works of art can be estimated by the help of symmetrical or asymmetrical properties. The globality definition refers to the second meaning of the structure concept. Therefore, an esthetical structure can be estimated, as any structure, by measures of the locality and the globality.

On the other hand, the architecture of an esthetical collectivity, connection concept between the esthetical structure and the esthetical function (the expression of the work of art), produces a global meaning, an intuition, of the collectivity with the aim to understand the unity between the structure and the expression of that esthetical collectivity. We can talk about universe’s architecture, a crystallographic system’s architecture, a house’s or a town’s architecture, an enterprise’s architecture, a computer’s architecture, an interconnecting architecture, a communication architecture or, finally, an esthetical architecture (of a work of art). The esthetical architecture measures by the degree of membership to certain esthetical global properties. The symmetry, hierarchy, homogeneity are also global properties, not only esthetical ones. We must not to confound the architecture concept, leading
to an intuition on the collectivity, with globality concept, which is a measure of the collectivity.

We shall concentrate, in the following sections of this paper on certain esthetical structures. We try to give examples of works of art (paintings) which we analyze from the point of view of the locality and globality. Analyzing in this way, we probably have succeeded to algorithm a part of the expressions of the works of art and to understand inferring them. Our application can lead towards an “artificial” esthetics.

3. INTERCONNECTED ESTHETICAL COLLECTIVITIES

The interconnections made of N nodes and L links model very well, in the sense given by Wittgenstein to the perception of structural self-organization, a collectivity. The nodes are the members of the collectivity that are tied by links. This type of collectivities we shall name, further, interconnected collectivities. The interconnected collectivities will not limit at the sets with the same type of nodes (resulting collectivities with non homogenous nodes) and/or at the sets with the same type of links (resulting collectivities with non homogenous links). What is certain, the structural entities, which form the collectivity, are interconnected one way or another. We should limit, without losing too much of generality, to the orthogonal interconnections or orthogonal collectivities. Any number of nodes of an interconnection can be represented as a product of integer numbers, N=m r, …m 1. On the basis of this representation, to each node of an interconnection we can associate an address X with r digits, 0 ≤ X ≤ N-1. Further, we present some orthogonal interconnections as collectivities, i.e. sets selected or built by relations.

A generalized hypercube, GHC, is an orthogonal collectivity with N=m r, …m 1 nodes interconnected in r dimensions. In every dimension i of a collectivity the m i nodes are interconnected all by all. The relation which establishes the interconnection of N nodes all by all is: the nodes addressed by X = (x r x r-1 … x 1) are connected addressed by X’ = (x r x r-1 … x 1), where 1 ≤ i ≤ r, 0 ≤ x i ≤ m i – 1 and x i ≠ x i. The hypercube, HC, is a GHC with N = m r. The binary hypercube, BHC, is a HC with N = 2 r nodes, and the completely connected structure, CCS, is another HC with N = m nodes.

A generalized hypertorus, GHT, is another orthogonal collectivity with N=m r, …m 1 nodes interconnected in r dimensions. In every dimension i, 1 ≤ i ≤ r, the m i nodes being "collectivized" in a torus. The relation which establishes the r tori of GHT collectivity is: the nodes addressed by X = (x r x r-1 … x 1 ... x r) are connected with the nearest neighbor nodes addressed by X’ = (x r x r-1 … x 1 ... x r), where 1 ≤ i ≤ r, x i = x i ± 1[modulo m i]. The hypertorus, HT, is a GHT with N = m r nodes and the torus, T, is a HT with N = m nodes. BHC can be and HT with N = 2 r nodes.

A generalized hypergrid, GHG, is, also, an orthogonal collectivity having N=m r, …m 1 nodes interconnected in r dimensions. In every dimension the m i nodes are being collectivized in a chain, or, better said, every node X is connected in a grid with the nodes addressed by X’ = (x r x r-1 … x 1 … x i+1, x i+1, x i+1) and x i ≠ m i – 1; x i = x i+1 + 1, x i = 0, x i = m i -1, for 1 ≤ i ≤ r. The hypergrid, HG, is a GHG with N = m r nodes. The chain, C, is a HG with N=m. A binary hypercube can be, also, a hypergrid with N = 2 r nodes.

GHC, GHT and GHG are collectivities represented as homogenous at links interconnections or homogenous interconnections (the collectivities are homogenous at nodes, also; this paper does not refer to the non homogeneity at nodes). Most generally, the non homogenous collectivities can represent as non homogenous (at links) interconnections. Examples of non homogenous collectivities are the collectivities represented by generalized hyper structures, GHS, (Lupu 2004). A GHS is an orthogonal collectivity with N=m r, …m 1 nodes interconnected in r dimensions and in which every node X is collectivized (connected) in every dimension i, 1 ≤ i ≤ r, to the nodes addressed by a collectivizing (interconnecting) vector \( \bigcup_{j=1}^{m_i} X^j \).
specifies that a node of GHS is connected (non homogenous) by a vector of elementary collectivizing structures instead of a single structure in the homogeneous collectivities. This is non homogeneity at links of GHS specified by the collectivizing vector having, on the one hand, \( r \) elements, and on the other hand, \( k_i \), \( 1 \leq i \leq r \), elementary collectivizing structures (homogenous) for which are specified the unions \( \bigcup_{j=1}^{r} X^j \). So, \( X^j \) are homogeneous elementary structures, like tori, grids, and chains, and must not be disjoint for a dimension.

In the figure 3 we present an interconnected collectivity from the artificial esthetical world, an esthetical interconnected collectivity. It is a work from 1930 of Piet Mondrian, one of the first abstractionist painters. In the beginning Mondrian knew a cubist period, working in Paris with Braque and Picasso. It wasn’t long till he separated from them, because of his need to draw of cubism the “logical conclusions”, which they did not draw. Regarding the object, which is still visible in cubism, it could keep the lines, the rhythm and the colors, and order the painting canvas with only one aim, the creation of an autonomous composition (Muller and Elgar 1972). The Mondrian work (fig. 3), except the colors, may resemble with an orthogonal collectivity the nodes of which, in a first phase of study, are at the intersection of the colors. In the figure 4 we present the bidimensional interconnection that corresponds with the Mondrian composition from the previous figure.

In the figures 1 and 2 we give two examples of simple associations in collectivity modeled by a homogenous interconnection (fig. 1) and by a non-homogenous interconnection (fig. 2). At homogenous regular interconnections, as the GHC or HT, the origin position, “point of view”, does not matter. The collectivities, which they model, are spherical. The diameter is the same, doesn’t matter the point of view. At irregular networks, as GHG and other non-homogenous interconnections (e.g. GHS), it matters where the position of the origin is, it matters the point of view. The “structural” behavior around the origin at the collectivities modeled by these interconnections, is not spherical anymore. Why does the origin position matter? Because the structural non-homogeneity of an association in a collectivity from an origin is equivalent to a “functional potential” or, in this article’s case, an “esthetical potential” from the same point of view. For example, the more numerous and more varied the links in an interconnected collectivity from a point of view (a origin) are, the more sophisticated, more adaptable at a demand, or more self-organized the functions are. The interconnected collectivities, homogenous and non-homogenous, can be appreciated, at the beginning, by two general measures: the locality and the globality. The present paper refers only to the locality.

Figure 3: Mondrian, Composition in red, blue and yellow

Figure 4: Interconnected Orthogonal Collectivity Overlapping to Mondrian Composition

4. ESTHETICAL LOCALITY

The collectivities structurally modeled by the interconnections (nodes and links) may be structurally estimated at the beginning, as primordial measures, by locality and globality. The locality, as we explained before, is the spatial behavior of a collectivity around an origin. As in Physics, where the gravity characterizes the attraction between objects, the locality defines a collectivity: the nearest the entities that compose the collectivity are, the best communicated, the best interfered, or in the case of the interconnected collectivities, the nearer the nodes are, the bigger the interconnection power is. In the esthetical collectivities, a bigger interconnection power can mean a bigger expression power. Consequently, the intuition of the structural self-organization of a work of art is bigger. Consequently, the intuition of a work of art is more intense. We name this kind of locality, esthetical locality. The esthetical locality helps us to understand (partially) an esthetical collectivity.
As we have explained in the introduction, the locality definition refers to the first sense of the structural concept, the connection between entities or, in interconnected collectivities (and esthetical ones), the links between nodes. Analytically, the locality in an interconnected measures by neighborhoods, neighborhood’s reserve, Moore reserves and, synthetically, by diameter, degree or average distances. As any property which organizes the entities, the locality may be studied first structurally (topologically) and then functionally. In the present case, the esthetical functionality is replaced by the expression, as we have already explained. Therefore, the locality of an esthetical interconnected collectivity will be defined by two partial localities: a structural locality and an expressive locality (which replaces the functional locality from my earlier works). The structural localities appreciate by the simplest measure: neighborhoods. The neighborhoods divide in surface (or radial) neighborhoods and volume (or spherical) neighborhoods. The surface neighborhood of an interconnected collectivity represents the entities, components or nodes number at the logical distance \( d \), \( SNd(O)=N(O) \), where \( O \) is an arbitrary chosen origin. The volume neighborhood is \( VN(O)=\sum\limits_{i=0}^{l}N(O) \). The neighborhoods are analytical measures of the structural locality of an interconnected collectivity. But the structural locality can also be measured by synthetic measures, e.g. by diameter: at the same number of interconnected entities, the less the diameter is, the bigger the locality (in the meaning of the agglomeration) is.

The neighborhoods and the diameters are functions on the original position. At the collectivities interconnected in homogenous and regular structures, as the generalized hypercubes or hypertori are, the origin position does not matter. At the collectivities interconnected in irregular structures, as the generalized hypergrids and other non-homogenous structures are, it does matter where the position of the origin is. The topographic model presented in some of my previous works helped us to describe and, therefore, to study the “structural” behavior of the interconnected collectivities in homogenous and, especially, non-homogenous structures. The properties of the locality can be better “read” by the diameter contour patterns in the structural relief of an interconnected collectivity.

Besides the contour patterns, we have also introduced a measure which helps us to estimate this structural relief from the locality point of view: the state of agglomeration. The structural localities of an interconnected collectivity are more or less agglomerated and can be read by the help of the diameter contour patterns, as we have explained in the previous paragraph. The depth of the valley (minimum diameter) informs us about the maximum agglomerated locality, and the height of the peak (maximum diameter) about the minimum agglomerated locality. Thus, the structural state of agglomeration of a node (entity) of an interconnected collectivity is given by the interconnection diameter computed with the origin in the corresponding node. The contour patterns of the structural states of agglomeration constitute a map with the structural relief of the interconnected collectivity.

The structural locality is invariable information depending only on the topology of the interconnected collectivity. A point of view explicitly expressive on the esthetical locality can consider a parameter \( E(O) \), where \( O \) is the origin of the collectivity, which can depend on logical and physical distances between the collectivity entities \( (d_i, d_j) \), the colors of the entity \( (c) \), the movements of the entity \( (m) \), the “pictorial” message distribution \( (p) \) or/and other factors.

Expressive locality of an esthetical collectivity is measured, as the structural locality, by neighborhoods: an expressive surface neighborhood, \( ESN(O)=E(O)N(O) \), and an expressive volume neighborhood, \( EVN(O)=\sum\limits_{i=1}^{D}E(O)d_iN(O) \}. The neighborhoods measure analytically the expressive locality. As for the diameter, in the case of the structural locality, there is a synthetic measure for the expressive locality of an esthetical collectivity, the expressive average distance. Through this average distance, we can give a definition to the expressive state of agglomeration: the expressive agglomeration state of a node (entity) of an esthetical interconnected collectivity is given by the expressive average distance of the esthetical interconnection computed with the origin in the corresponding node. The expressive agglomeration state is so much bigger as the expressive average distance is less. By the aid of the contour patterns of expressive states of agglomeration can draw a map, which depict the expressive relief of the esthetical interconnected collectivity. We shall refer to other works on the expressive locality.

The surface and volume neighborhoods, on the one hand, and the diameter or the degree, on the other hand, are analytical and synthetic evaluation means of the interaction capacity of an interconnected collectivity, measuring the structural locality. By the expressive neighborhoods and, synthetically, by the expressive average distance express which part of the structural locality is used in the esthetical process implemented on an esthetical collectivity. The expressive neighborhoods and the expressive average distances express the expressive locality of the esthetical collectivities.

To evaluate the structural locality of an interconnected collectivity, esthetical or not, near neighborhoods, we propose a simple and absolute measure of evaluation: Moore reserve based on Moore bound. As it is known, Moore bound is the maximum number of nodes which can be present in a graph given the degree \( l \) and the diameter \( D \): \( N_{Moore}=1+((l-1)^{D-1})(l-2)) \). This bound is deduced from a complete \( l \)-tree having \( D \) diameter and is the absolute limit for the diametrical volume neighborhood, \( VN(O)=\sum\limits_{i=1}^{D}N(O) \), in any graph (interconnected collectivity) with the degree \( l \) and the diameter \( D \). Except for the complete \( l \)-ary trees, this bound is difficult to attain. Petersen graph, completely connected structures or the rings with odd nodes number, are
interconnections reaching the Moore bound. Therefore, it makes sense to compute for an interconnected collectivity how far is this bound: the farther away the Moore bound is, the worse the structural locality is. This is implemented by the Moore reserves.

The surface Moore reserve is characterized by the difference between the number of nodes in a corresponding Moore tree at the distance $d$, with the degree $l$, and the surface neighborhood in the considered interconnected collectivity: $SMR_d = (l-1)^d - N_d$. The Moore reserve is defined by the difference between the Moore bound at the distance $d$ and the volume neighborhood: $MR_d = N_{Moore}(d) - VN_d$.

Let us come back at the bidimensional esthetical collectivity of fig. 4 and let us address the nodes corresponding to a mixed radix number system. From figure 5 results a "logical" GHG interconnection (logical because it does not take into consideration physical distances). GHG of fig. 5 is an interconnected collectivity with $N = m_1 \times m_2 = 4 \times 5$ nodes, from which 5 are intersection points (nodes) "false", "non visible". The network is a kind of "logical" raster of Mondrian work specifying the visible and non visible "nodes" (the intersection points of the colors). The generalized hypergrid, GHG, is a non homogenous (non spherical) network, the structure of which is not the same, regarding each node as an origin. In brackets are written with bolds the diameters depending on the origin position or on the "point of view". The structural relief is like a valley or, better said, a doline in a karst areas and it is drawn in the figure 6. The maximum agglomeration (the bottom of the doline having the minimum diameter) is in the middle of the "logical" network where there are the two nodes with diameter 4.

We notice that the two nodes are not invisible. Coming next, raising up towards the doline edge, there are six nodes (from which two are false) having the diameter 5, eight nodes (from which three are false) having diameter 6 and, finally, the corners of the network with diameter 7.

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Let us comment this distribution of states of agglomeration on the GHG collective corresponding to the Mondrian work. The maximum agglomeration (the minimum diameter, 4), an inverse "ridge" with two visible nodes (intersections of colors), is placed between the two of the most interconnected areas, on the left side and on the right side of the painting, in the "logical" middle of the interconnected collectivity. Climbing up to the doline edges, we come across a contour pattern with diameter 5 that have the invisible nodes asymmetrically arranged (an invisible node in the left colors intersections and an invisible node in the right colors intersections). The asymmetry of the invisible nodes increases at the contour pattern with diameter 6 towards the right-top side, the asymmetrical part of the painting. Mondrian leaves us, towards the right-top side, only with the painting edge, the red square, the biggest one. Mondrian painting is an asymmetrical work "as far as it is devoted to the worship of the Imperfection, deliberately leaving some things unfinished to complete by the play of the imagination" [Okakura, Tea Book]. In this way, the Asymmetry is a structural communication, a kind of a structural dynamism [Lupu, Interconnecting] in the physical collectivity representing Mondrian painting and in which there are two areas of local importance, the nodes \{00, 02, 03, 04, 10, 12, 13, 14\} and \{20, 21, 22, 30, 31, 32\}, placed asymmetricaly and non homogenously.

5. CONCLUSIONS

The (inter)connections are "patterns of discovery" (Alessio and Smith 2008). The interconnected collectivities are our models to esthetical behaviors. We have begun to model esthetical behavior by esthetical locality, a measure which can be estimated by neighborhoods, expressive states of agglomeration, expressive relief of the esthetical interconnected collectivity. We have exercised the esthetical model.
based on esthetical locality on an abstract painting of Mondrian. The esthetical locality makes the connection between the interconnection power and the expression power.

The preoccupations of artificial intelligence, artificial life and artificial sapience (Mayorga 2007) are the most well known. Why not an artificial esthetics?

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