

A NEW THEORY FOR SIGNS IN CARTOGRAPHY

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Abstract

The signs, used in the Cartography are shown from four different sides: as a physical structure, as a meaning, as a method of acquisition and as a part of a sign system. There is a determination between the graphical signs described in the legend and the cartographical signs, which function in the field of the map. The meaning of the signs is discussed as a meaning of a sign; as a relationship toward the rest of the signs and as designated characteristics of its object. The graphical and cartographical signs are adopted in a different manner: while the graphical sign is comprehended by the reader (its meaning is described in the legend), as the meaning of the cartographical sign composed by numerous graphical signs is interpreted in the context of the map.

The shown theory is able to answer some of the unsettled/unsolved inquiries in the Cartography and contribute for simple understanding of the cartographical signs in the process of study.

About the signs in Cartography have been written in abundance. Despite all, there are many theoretical questions that the existed theories of a sign do not show a sufficient explanation, for instance: 1. The presence of the map's information which is not on the line directly by the author but it can be extracted and used by the reader; 2. How does the meaning of the sign as a general abstract concept, (a forest, a city, a factory), which is described in the legend is changed to designate of concrete forest, city, or factory with their individual characteristics? 3. What is the source of the meaning of the signs that are not described in the legend and the signs on the maps that do not have a legend? 4. Are signs the letterings? 5. Are the signs in the legend and those in the field of the map the same?

For solving of these and other similar problems in the Cartography, we have elaborated a new theory of the sign in the Cartography. There the sign is considered of **four sides**¹: 1) as a material sign vehicle; 2) as a mental meaning; 3) as a manner of perception by the reader; 4) as a part of the sign system.

1. STRUCTURE OF THE SIGN

Bi-componential model of the sign is confirmed in the Cartography: as a sign and its composing elements on the lower level (graphical primitives). However, it does not allow to be given sufficient answer to the above mentioned questions, because it does not make any difference between the sign in the legend and the sign in the field of the map. The sign in the legend, called by us **a graphical sign**, means abstract, collective concepts, existed only in the consciousness of the human beings. In the field of the map, the cartographic sign represents specific objects of the reality with their individual characteristics. Is it possible the same sign to describe both an imaginary concept and a real object? The cartographic signs in contrast to the graphics: a) have a specific location in the field of the map which connects them with indicated by them object; b) inherited the general characteristics of the field of the map as a scale, a projection coordinate system etc.

In explanation of the method of an extraction of the map's information, we introduce one more level of the sign in the Cartography – **a supersign**. The reader of the map creates it when he purposively categorizes by a specific indication and investigates some cartographic signs to obtain information about their objects of the reality. In that, process the

¹ The idea is taken from the American philosopher **Ken Wilber** (1996), who investigates every object in four quadrants: the two above (1 and 2) consider the object as an individual character and the bottoms (3 and 4) – as a part of some system; the right two quadrants (1 and 4) investigate the material structure of the object, and the left ones (2 and 3) – its ideal, spiritual side, its perception by the human beings.

object and by the inherited attributes from the field of the map it is associated in one mathematical defined space with the rest of the cartographic signs.

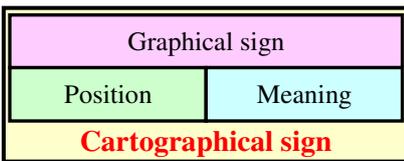


Figure 3. Elements of elementary cartographic sign

The cartographic sign is consisted of one or more *graphical signs*. On the first instance we call it *elementary*, and on the second instance – *complex*.

The illustrating sing for a group of bushes on the left on the figure 4 (marked by an arrow) is elementary. The sign on the larger group of bushes on the right is composed of several point and linear graphical signs and a background.

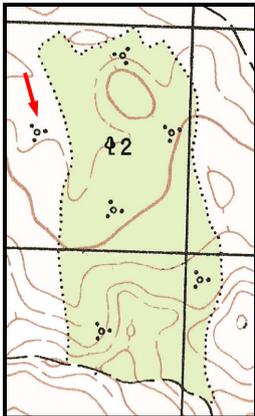


Figure 4

The meanings of the cartographic signs included in the composition of one cartographic sign completed and modified, depending on the general context of the cartographic sign. At the same time, the cartographic sign assume a new meaning, which exceeds the bounds of the ordinary sum of the meaning of the single graphical signs.

If the cartographic signs are separated from, the graphical signs then can be easy to explain the share of the joined parts of the signs on the map: two cartographic signs can have common graphical signs (down below on figure 4 the road is as well as a boundary of the massif of bushes). It is not necessary to think of some explanations about it that one object of the reality is illustrated by several signs on the map (for instance, contour, background, exemplify signs and letterings).

The last ones are just graphical signs, which are parts of the cartographic sign so that every object of the reality is described as an exact one cartographic sign.

1.4 Supersign

When the signs are functioning in the field of the map among them occur connections of proximity, neighborhood, adjacent; connections of the type one-many etc. In view of spatial similarity in the mutual location of the signs and of their objects those connections are valid and for the objects which are marked by the signs. How have those connections been apprehended? The Bertin's theory is very influential in the cartography, according to it we apprehend the map as series of partial images which the French cartographer defines as "*the smallest meaning visual form, apprehended by one look*". That theory places the reader of the map in passive position as an observer.

We present other model of the reading of the map. According to it when the reader is working with the map she/he acts purposefully depending on the object of the specific research, she/he imaginarily categorizes the signs that are of interest to him/her and she/he can ignore the rest of them. The selection of the signs and theirs method of a categorization illustrate one original creative action which includes previous knowledge. A group of signs are examined with a view to the set purposes and the results of the research are transferred from the signs toward their relevant objects of the reality. The process of the purposeful imaginary categorization of the cartographic signs, their research in purpose obtaining of information about their objects we call it *superinterpretation*. The



Figure 5

possibility information of the map to be received which is not included by its author, follows from the similarity between the spatial disposition of the objects in the reality and that of their signs on the map, which requires an investment of previous knowledge. The selected signs with a purposeful target by the reader illustrate *an imaginary cartographic sign of a higher level* which we are going to call *a supersign*. For instance, if we need to determine the settlement area on the figure 5 we must merge imaginarily the signs on the separated districts in one supersign.

The supesigns can be created by variety thematic, spatial or simply conditional criteria depending on the purposes of the research. Here, we are going to pay attention only over one particular type of a supersign where the signs of the different objects are categorized purposefully to illustrate an object of a higher class. For instance, on the figure 5 the sign of the populated area is consisted of cartographic signs of districts, streets, single buildings etc. That kind of a categorization of the signs we are going to name by the term *a hipersign*. In contrast to the remaining supersigns, the hipersign illustrates a differentiated object of the reality which is shown on the map by its components. By using single graphical signs (in that case on the figure 5 – letterings) can be shown characteristics of the objects illustrated by hipersigns.

2. MEANING OF THE SIGN

If we adhere to the widely spread out among the cartographers thesis, that the legend describes through the meaning of the signs, we are not able to explain why there is a frequent appearance of maps that do not have a legend but are able to be use of full value. According to the classical cartographic theory, such maps cannot be understood and apprehended. For this, issue obviously the theory passes the practice therefore; we offer a new concept, which illustrates three kinds of meanings of the cartographic sings and four sources of their meaning.

We can compare the cartographic signs with the chess-pieces on the chessboard. Before the game of chess starts, the chess-pieces have specific meaning: *Meaning of the chess-piece* (a pawn, a castle, a knight etc.) and *a significance of the chess-piece*, which can be measured in number of pawns. Likewise, the graphical sign has a specific meaning – to illustrate a particular type of objects and significance, following by its comparison with the rest of the signs at the sign system. By the time, the chess game starts, the meaning of the chess-pieces is changing: first, they receive specific *attributes* (particular opportunities for movement and participation at the game); second, their *significance* is changing, depending on their interrelation with the rest of the chess-pieces (the pawn is more valuable when is the only one or it is on the horizontal before the last one).

Even the meaning of the chess-pieces can be modified in the course of the game time: the white pawn, which has been already reached the eight horizontal is turned into a queen. Using this method when the graphical sign is put on the field of the map within the boards of a cartographic sign, its meaning is changed. Its specific location connects it with a particular real object and can illustrate its specific characteristics. Its significance is determined not only as a comparison with the rest of the signs at the sign system but also from its surrounding on the map.

We discuss the meaning² as a complex quantity, which has three compound parts: *meaning*, *significance* and *attributes*.

2.1. Kinds of meaning of the Cartographic sign

2.1.1. Sense of the sign

The sense of the Cartographic sign is to represents a specific object of the reality. The same sign can have different sense in specific communication situations. On the figure 6 the graphical sign of a coniferous tree can mean a single tree having the meaning of a landmark (a reference point) (figure 6b) as well as a little forest (figure 6c) and it can only explain that the forest is coniferous (figure 6a).

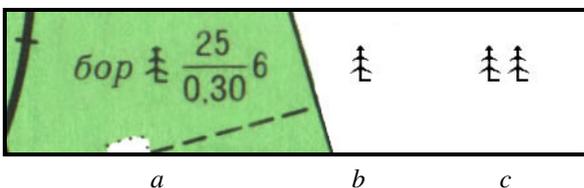


Figure 6

The cartographic sign must activate in the reader's consciousness the concepts of the marked object by it.

By the means of the sign, the reader of the map connects the illustrated on the map with his previous memories and knowledge. Therefore, we divide the meaning of the sign to a *conventional* (which is usually understood by every member of the society) and *subjective* (which is expressed by the respect of the reader toward the object, marked by the sign, its personal ideas connected with the object).

2.1.2. Significance of the sign

When a sign is appeared at the field of the map, it maintains connections with the rest of the signs. Its meaning is changed depending on whether it is a single one or one of many, whether is a larger or smaller than the rest of the signs, whether is closer or further than the another object we are interested in. That part of the meaning of the cartographic sign we call *significance of the sign*. It is defined as *a correlation of the sign in relation to the rest of the signs of the map* and it is always relative.

The significance of the sign can be result of: a) *the outward appearance of the graphical vehicle*: larger and more vivid signs are interpreted intuitively as more important; b) *the specific situation of the map*: the boundary between Germany and Austria has one significance, and this between Syria and Israel – different; c) *the purposes of the research* on the map: the objects that we are interested in are more valuable than the rest; d) *the reader's knowledge* about the objective

² The meaning of the sign not as a static inclusion by the time of the maps' creation but as *a shaft of possible attributes of the sign* which are interpreted and construed by the reader of the map by the purpose of data acquisition of the illustrated by it object. In the grammar, the adjective is the attribute of the noun as well as for us the meaning is the attribute of the sign – something that complements it, gives it meaning, determines it but the sign has own existence even without it.

area; e) *the reader's visual skills* of the map: some people can better define the differences of the visual variables of the primitives than the others.

2.1.3 Characteristics of the sign

In view of the fact, that the cartographic signs resemble the outward appearance, structure and location of their objects, they can be a source of determination of variable characteristics of those objects, as a length, area, co-ordinates etc. In addition, the cartographic sign system allows to use letterings for an illustration of the specific characteristics.

Every cartographic sign, during its functioning in the field of the map attains *the three dimensions of the importance: sense, significance, characteristics*. On the map, there cannot be a sign that does not mean any specific object; consequently, every cartographic sign has *sense*. Since there are at least two signs on the map then every of them will have some *significance* regarding to the other.

The cartographic sign, even if it does not illustrate other characteristics of its object at least it shows the location of the object consequently, it is a carrier of *characteristics*.

2.2 Origin of the meaning of the cartographic signs

Since we dispute the thesis, that the meaning of the cartographic signs is a result occurred generally from the legend we must give what its resources are. According to the propound theory of the sign its meaning has four sources: 1) its *own/proper meaning* of the sign; 2) meaning of *the external components* of the map including from the legend; 3) meaning of the sign as its *functioning* on the map together with the rest of the signs; 4) meaning, which comes from *the cartographic rules*.

▪ **Proper meaning** of the sign comes from *the similarity between the sign and the object*; from the *symbolic meaning* of the graphical signs composing the cartographic one from the *frequent use* of the signs at the specific context. That is why the proper meaning of the signs allows us to understand and read maps, which do not have a legend.

▪ **External components** as a *title, a legend, a description of the theme of the map* undoubtedly have a significant role to the formation of the meaning of the signs but we need to take into consideration that they define only the meaning of the graphical signs as general conclusion of generic terms. In the field of the map, this meaning has changed and added.

▪ **The functioning of the sign** at the field of the map not only determines *the significance* of the sign but also *changes and complements the meaning* of the sign. Positioned on a particular place of the map, the sign already does not mean an abstract meaning but a specific object of the reality with its proper characteristics and interdependences with the rest of the objects.

▪ **The cognition of the cartographic rules** allows the reader more complete and adequate to interpret the meaning of the sign. The readers without any experience and skills about a work by a map miss the major part of the meaning of the map. Every one of the levels of the structure of the sign can be a carrier of a part of the meaning of the sign.

The graphical primitives in the greatest extent are carriers of proper meaning through the cartographic symbol; the graphical signs receive their meaning by the legend; cartographic signs – during their functioning on the field of the map, and the supersigns – from the understanding and interpretation of the contents of the map.

3. THE SIGN AS A MANNER OF PERCEPTION

The perception of every sign is multistage process, which is divided usually in two parts: *recognition of the sign and appropriation of the meaning of the sign*. Besides them, we are going to discuss two more stages: one preparatory stage *an introduction with the external components* of the map (a title, a legend, an area band etc.) and one finishing stage *superinterpretation* of the meaning of the sign where is obtained the information of the map that we are interested in.

3.1. The introduction to the external components

Researches of the activity of the eyes³ of the one, who is reading the map, show that she/he first introduces himself to the external components that describe the map, the object of the map or the field of the map.

³ M. Dobson, G. F. Janks

The meaning of that behavior is the reader to be able to understand the theme of the map and the graphical marks on it. Most likely, it is connected to the process of the apprehension “from the top down-wards”. Since it is clear what to expect, the reader can make meaningful suggestions about the type and the meaning of the signs. In that way we save time during the apprehension of the cartographic image because the identification of the familiar objects is considerably faster than the one of the unfamiliar objects.

3.2. The identification of the sign

The familiar and unfamiliar signs are identified by different method. When the reader considers that she/he works in familiar surroundings, she/he identifies the signs by several consecutive processes of a categorization. First of all she/he determines the places of the variation of the intensity of the light irritations and afterwards generates simplest elements as lines and edges (geons). They are combined in graphical primitives which on the other hand are unified in graphical signs. Considerably faster are recognized the familiar signs. When a human being considers that she/he works in familiar surroundings she/he creates hypothesis what kind of a sign she/he sees on the basis of previously created models and then she/he verifies whether it is well-founded or not.

3.3. Apprehension of the meaning of the signs

Even though the process is complicated the route of the identification of the sign is accomplished on the subconscious level. The major part of the meaning of the signs however, it is apprehended consciously. The symbol meaning of the signs makes an exception.

3.3.1. Understanding of the meaning of the graphical signs

In the process of a coding of the sensuous information, the identified *graphical sign* is related toward a specific kind of signs. Its meaning is formed by two factors: a) its own and its composing graphical primitives *symbolic meaning*; b) the meaning of the legend of the map. The symbolic meaning proceeds unintentionally in the consciousness⁴ and precedes the meaning of the legend which has higher priority. Regardless of the source, *the meaning of the graphical sign is an abstract term, which can be understood*, and not simply to be read in the legend. If the reader is not familiar with the kind of the objects marked by the sign, then its meaning is devoid of *sense* but there is *significance* as a result of the comparison with the rest of the signs of the legend.

3.3.2 Superization⁴ – unification of the graphical signs into a cartographic sign

The reader apprehends a group of graphical signs as an image of one object of the reality at that point is created imaginarily a cartographic sign. On figure 4, 10 graphical signs (five signs shows that the vegetation is shrubby, one of the signs shows that the vegetation is deciduous and one of them shows – average height of the bushes, and the boundaries of the massif are illustrated by two linear signs and an area) show the massif of bushes. The process acquires as well cartographical knowledge and experience as determined effort of the reader. During the superization simultaneously by the activities of the subconscious level *the principals of the perceptual categorization, proximity, simplicity, similarity* etc. *the recognition of the cartographic codes* has a role there. In the process of the superization the meaning of the graphical signs constructing the cartographical sign depending on their specific role is changed (see figure 6). The attained meaning of the cartographic sign is regarding to the sign taken alone without connection to the rest of the signs.

3.3.3 Interpretation of the meaning of the cartographical sign

The cartographical sign illustrates at the field of the map a specific object not an abstract concept as the graphical sign. It functions in particular surroundings among with the rest of the signs and into the context of the showing on the map. Thence it follows that a new sheaf of knowledge, which are added to the attained importance in the process of superization. The interpretation of the meaning of the cartographical sign consists of creating of an imaginary model to the illustrated by the cartographical sign of an object in which the meaning attains a specific communication situation of a map and the location of the sign among the rest of the signs.

⁴ “*Superization* – a semiotic process where a specific set of single signs are united into one whole.” (Dobrev and Dobrova 1994, p. 144).

3.4. Superinterpretation

The superinterpretation represents an imaginary purposeful *categorization of the cartographic signs* and extraction of information of the interdependences between the signs, which is transferred over their objects. The process is accomplished when there is a creation of an imaginary model of the objects, illustrated on the map. However, it can be extracted information, which is not set directly by the inventors.

4. LANGUAGE OF THE MAP

At the cartographic literature, *a sign of equality between the language and the sign system of the map* is often put. According to us, the language of the map is more universal term, which includes the sign system. We go into at the language of the map as it is consisted of *an alphabet and a grammar*. In a view of the fact that the map in contrast to the written text, it consists variety of elements as such as a graphic, a text, different images etc. then more accurate would be, instead of an alphabet of a single kind of signs to go into the components of the map. Under the grammar of the map, we will understand the rules, which operate during the creation and use of the map. However, in a view of the fact, that besides, them by the understanding of the map instead of a grammar we use the semiotic term *a code*.

4.1. Components of the map

According to the propounded theory, the map has three kinds of components: a) *a field of the map*, which represents a *model of the space* of the map's object; b) *internal components* (cartographic signs) and c) *external components*, which describes the field, the internal components or the theme of the map by no cartographic methods. Together they create the material part of the language of the map. The map can perform its role without the presence of some of them.

4.1.1 Field of the map

The field of the map is not simply an empty space as it is described by Ramirez (2004) or a blank sheet of paper where the signs to be settle. According to our theory of the cartographic sign, *the field of the map is a model of the space of the illustrated on the map the part of the reality*. It has a dual nature: on one hand is the part of the physical space on the other hand – by its attributes it is connected to the cartographic region. In the classical cartographic theory, characteristics as such as: a spatial range; a scale; a plane and elevation co-ordinate systems; a represent surface; a projection; physic sizes are considered as characteristics of the entire map. The map can have one or more inserted maps and their characteristics are different. Besides, only part of the content of the map shares those characteristics, which do not influence over the external components.

By taking a point of view that, the field is a real component of the map; the described characteristics at the previous paragraph have found their carrier.

4.1.2. Internal components of the map

The cartographic signs are the internal components of the map are. When the signs are put in the field of the map, thankful to their location they are connection to the corresponding objects and they do not mean abstract conceptions as graphical signs in the legend anymore but real objects. However, they inherit some of the characteristics of the field of the map, as a scale, a projection, a co-ordinate system. As such, the signs cannot be carriers of the characteristics of the field; because one map can have, different sources, each of them can have its own characteristics. Out of the field of the map, for instance in the legend, the signs do not possess those characteristics.

4.1.3. External components

The external components of the map characterize the object of the map; the field of the map or the map itself. They are sign vehicles, written or graphical, but they are not cartographic signs because they are not connected to the field of the map. Even though they are physical located in the space of the map's field, they do not inherit its characteristics. *The external components describe the context where the signs function*. Very often, the one that are in use are the following:

- **Title-part**, includes a title, a nomenclature and a kind of the map (educational, political, administrative etc.);
- **Scale**, that can be numerical, descriptive and graphical;

▪ **Legend**, which is consisted of graphical signs, a text description of the signs and an explanation text, describing the data in reference to accuracy, range, actuality etc;

▪ **Description of the field of the map**: a section of the relief, including schemes and scales, projections, a comprehend surface etc;

▪ **Description of the subject of the map** by schemes of the administrative division, the magnet declination etc, and the descriptive texts;

▪ **Description of the map**-a publisher, a year and method of a creation, authors etc;

▪ **Schemes for a location** of the territory;

▪ **Illustrations**, as images and diagrams, which describe the image of the map and the decorative elements, that make the map more attractive;

▪ **Index of the objects** – the location of the illustrated objects is described in alphabetical order;

▪ **Advertising materials**.

To be explained the role of the above-described components; let us compare the map with a theater performance. As well as the actors create figures of particular characters, the cartographic signs illustrate particular real objects. The actors need a stage and decors to be able to reproduce a particular atmosphere. On the map the role of the stage is performed by the field of the map, and the decors are the external components.

4.2. The cartographic codes

The cartographic codes are combination of that principles, rules, preliminary signs and abilities, including visual, which are necessary to be accomplished a particular process of a communication by the map. To be able to communicate the creators of the map and its reader must use if not the same at least similar codes.

The cartographic codes are numerous and versatile therefore, there can be illustrated their different classifications: the codes, the map is created according to the codes; the codes, according to them, the signs functioning in the field of the map and the codes of the communication, by which the map realizes its tasks. Further down will be discussed only the codes of the map's creator.

A hierarchical orderly system of codes is used when the map is creating, which guaranty its quality. On the each of the levels of the sign system corresponding a different group of codes, as the codes of the lower levels are subordinated on those from the higher levels. That is the way to be ensured the realization of the whole conception of the cartographic production.

4.2.1. Hypercode of the map

In the hypercode is inserted the major conception, purposes, which are haunted while the map is creating. It is the most important code on which the realization of the entire codes is obeyed. The hypercodes are divided in two groups: *instructive* codes, on their basis the kind of the presented map's information is determined and *technical*, they control the quantity (accuracy, particularity, completeness) of the data and determine the graphical capacity of the map according to the instructive codes.

Depending on the purpose of the creation of the map, the instructive hypercodes can be *ideological* including religious and nationalistic; *advertising*; *artistic*, *scientific*, *educational*; *informational* etc. The generality between them is that they require a particular misrepresenting of the data: a reduction of the information to be emphasized another part. For instance, the advertising maps, the advertised objects are marked by clearer signs (larger, brighter etc.) in comparison to the rest of objects which in different context can be more important.

4.2.2. Macrocode of the map

In the cartographic literature has been often spiking about the sign system but has never mentioned what unites the signs in the system. The macrocodes fill in the emptiness in the offering theory. When the projection of the signs is based on unified macrocodes, the signs have connecting general idea and homogeneously represent their objects. Therefore, when we talk about the sign system we have in mind *a comprehensive composition of graphical signs, formed on the grounds of a general macrocode*. The major task of the macrocodes is to bind and organize single graphical signs in a sign system of the map. The macrocodes are obeyed on the hypercode. The kind of the signs and the differences among them are selected so that they meet their purposes by which the map is created in general.

The macrocodes are divided in four different kinds: *logical* (controls the general, fundamental requests over the sign system, as purposefulness, completeness, economy of the language, instructive similarity and equivalent, hierarchy, completeness, homogeneity of the sign system etc.) *classificational* (principles of a classification of the objects and of the reflection of the classification of the sign system); *codes of option of a cartographic method of illustration*; *the codes of option of the general style of the signs*.

4.2.3. Graphical codes

It is regarding to the construction of the particular graphical signs within the bounds of the sign system. About those codes is written extremely a lot that is why here we are going to classify them in three groups: *informational* (ensure the ability of the signs to carry more meaning in them), *visual* (the signs to be apprehended quickly and correctly) and *esthetical* (the signs to be attractive to the reader).

4.2.4. Microcode of the map

These are the rules of the influence of the visual variables of the graphical primitives (a color, shape, size, orientation etc.) they are: a) *general*, which show the influence of the variables and the abilities to transfer characteristics of the objects and b) *specific*, that determine which of the characteristics of the illustrated objects what kind of variables to be illustrated.

5. CONCLUSION

The theory we have introduced, in many ways overstep the limits of the traditional understanding in the Cartography. But it gives opportunity of the explanation of the structure and the function of the cartographic signs. The major moments in the theory are: the extraction of the cartographic signs from the graphical ones; an introduction of the process of the superinterpretation and the idea of the supersigns; an illustration of the meaning of the sign as a compound of three components (sense, significance and characteristics) having four sources (proper meaning, from the external components, from the functioning of the sign and from the cartographic rules); introduction of the idea of the field of the map as a model of the cartographic space, as well as an inheritance of the characteristics of the field by the internal components of the map; hierarchical arranged codes which control the purposefulness (hypercode) the unity of the sign system (macrocode), the construction and apprehension of the signs (graphical codes and microcodes).

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This paper is published in Conference Proceedings of *International Conference on Cartography and GIS*, Borovec, Bulgaria, January, 25-28 2006
<http://www.datamap-bg.com/conference/index.html>