ABOUT THE CARTOGRAPHICAL SIGNS

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Abstract

All signs used in the cartography we call 'cartographical signs'. But not all of them have cartographical meaning – to mark concrete objects from reality in the field of the map.

The signs in the cartography are shown in four hierarchical levels: graphical primitives, graphical signs, cartographical signs and super-signs. The signs on the each level are consisted of one or several signs from lower level and have their meaning. According to the classical cartographical theory there is no significant difference between the graphical signs depicted in the legend of the map and cartographical signs functioning in the field of the map. In this article 10 differences between this signs are considered to underline the distinction. Two classifications of the signs are also considered: according to its appearance and according to its relation to the object marked by them.

The shown theory gives answers some of the unsolved inquiries in the cartography and contributes for simple understanding of the cartographical signs in the process of study.

1. Introduction

Different notions for designation of signs, for setting up the map, are used in cartographical literature, such as: *conventional signs*, *symbol*, *marks*, *sign vehicle*, *graphical signs*, *cartographical signs.* As an example, the American cartographer Raul Ramirez (2004) in his extensive work on theoretical Cartography replaces '***sign***' with term as *feature*, *shape*, *symbol*, *prime.* Are all these terms have one and the same meaning or express different notion? The problem in not just in that there may arouse misunderstanding and one and the same objects are called in different way, but and in that it seems that the odd authors put different meaning in those terms.

In Russia and most of the ex-socialist countries' cartographical literature the problem in terminology is different: all signs in Cartography are designated with the same term: *conventional sign.* Various in their meaning signs are called the same: the sign of the sign system, the sign for legend, the sign over the map and e.g. are called in the same manner.

On other hand numerous cartographers subdivide the signs over the map on graphical, from the natural language and reckon language. That's make a confusion because letters and digits are also cartographical signs.

In the present article we do not intend to impose or to reject definite terms, but to present a semiotic theory of the signs in Cartography.

2. The conception of the sign

It may be said that semiotics is a science of the signs, their meaning and the way the people accept them.

The sign is a thing that replaces other thing in some manner or in some quality (Pearce 1987). The main characteristic of the sign is it's meaning, which connects it with its object. In that way there are the trinity: ***sign → meaning → denotation***. Placed on the angles of a triangle these elements generate the famous semiotic triangle of Frege. The main role of the sign is to create a model in the mind of the reader. And even if the meaning of the sign is known, for instance the meaning of graphical

signs in the legend of the maps, the model is different for every reader. To explain this it is necessary to include one more element in the semiotics triangle – the notion for denotation. In that way, even the sign has one and the same formal meaning, the concepts, the ideas, which this notion calls in the people is different.

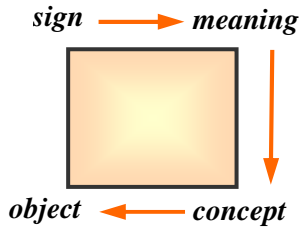


Fig. 1 Semiotic square

The Semiotics is one of the most developed science in the during the XX century. Semiotics can be used in Cartography to clarify the structure, functioning/ working, adoption and understanding of signs in Cartography. We consider that it is correct to use the term '***sign***' for denoting the main expression means in Cartography. When we use terms like *mark*, *shape*, *feature* we should explain particularly their meaning and in what they differ from the notion sign.

Some ways are below, in which in the Cartography literature is written for cartographical signs.

2.1 Sign vehicle

The expression ***sign vehicle*** is used to separate the sign from its meaning. It derives from the understanding of bilateral essence of the sign: as a means of expression and its meaning. If the sign has bilateral or unilateral essence is a matter of dispute, which borne form almost a century in semiotics. The essence of the dispute is not if the sign has its own meaning or it is a physical object, which in a defined moment can be given sense to mark. The Polish scientist L. Zavadowski states this question as follows: if we call a gardener people, who has garden, so can we decide that *gardener* has a bilateral essence (people + garden)? Zavadowski writes: If this person is not having a garden any more, he is not a gardener any more, but he stays a person. Analogically, if the sign looses its meaning as a sign, it continues to be a physical object. Therefore many semioticans conclude that the sign has no bilateral essence, and it is a physical object, which under defined circumstances has a meaning. The expression ***sign vehicle*** takes a side in this dispute and we should forbear to using it in the Cartography, at least until the semioticans does not give us a synonymous solution of the problem.

2.2 Symbol

The symbol is a kind of a sign, which is permanently connected whit the denotation of it in the mind of large group of people. Its meaning engendered by a rule, law or of its lasting usage in a context. The symbols are perceived easier and faster, because they are already known and have the ability unconditionally, in association to guide the thoughts of the reader towards their objects or their characteristics (Vasilev 2006a). One of the most popular classifications of the signs is Pearce's, according to it the signs are divided into ***icons*** signs, which resemble their objects, **indexes** (signs, which do have a logical connection with their objects) and **symbols** (Pearce 1897). In Cartography this classification looks as follows:

2.2.1 Conventional relationship

Connection ***sign*** → ***object*** is established according to the agreement between the creator and the reader of the map. The sign has no visual or logical connection with the object. We will mark off the signs, which do have permanent established connection with their object (symbols) of the signs, which only on the concrete map defines a particular object.

Fig.2 Kind of signs with conventional connection

▪ ***Signs – symbols***, which are often used for designation of a particular kind of object and according to this it is connected to the readers' mind. Example of this is the graphical sign, which is used to designate the border of a country on the fig.2 (above). Its usage for determination other kinds of objects would be confusing because of its traditional meaning.

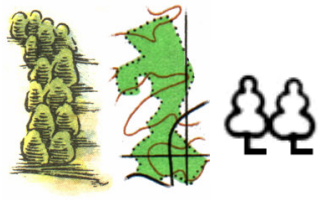
▪ ***Non-motivate signs***, which do mean something over the map only because of the meaning that gives the legend. With the sign on figure 1 (below) on one map can be denoted a factory, the same

sign over another map may dente mine for mineral resources, and over a third one – a completely different object.

Both types of signs are matter of understanding between the people. But sign-symbols are determined in the past, they are only or primary used for the concrete type object, as follows their usage has become traditional.

2.2.2 Iconic relationship

This relationship is carrying out form the likeness between the sign and the respective object. We denote them according to the likeness:



a b c

Fig. 3 Kind of signs with iconic

▪ ***Images***. When the graphical sign resembles the representative object in the way it looks. On the fig.3a is denoted forest, through artistic sign, which resembles the way a forest looks.

▪ ***Schemes,*** when there is a likeness in the plan outlines between the sign and the object, without having visual similarity. On fig.3b the forest is denoted through its outline, without looks like a forest.

▪ ***Metaphors***, when the object is represented with signs that mould its essential indications or parts. On fig.3c the forest is denoted through visual likeness not with itself but with its essential part. – the tree. Here the economic connection is not between the sign and the object, but transferring the thought from the partial to the whole makes the denotation. The sing leads the thought to the tree, and it by itself – to the forest.

2.2.3 Index relation

Index is a sign that designates because of its logical relation with the object. Without resemble it physically, the sign has the quality to **direct** the thoughts to the object, to **indicate** or **characterize** it.

▪ ***Directing signs***: when the reader sees a sign the thoughts his are not guide to the representation of the sign itself, but to other object. We will give an example with the pictograms on fig. 4 the crossed tools, on the left, does not show their presence, but guide the thoughts to repair, and after that to a service- station. The masks guide our thought a theatre, and the plane – to airport. In contrast to the metaphor, the guiding index does not represent a significant part of the cartographical object: there might not have masks in the theatre, and the airport remains its essence even when all the planes are gone. This is not true about the forest – if all the trees are cut down the forest becomes a cutting area. According to this the pictogram that signifies the forest through a tree is a metaphor, but the pictogram that signifies theatre by a mask is icon sign.

Fig. 4

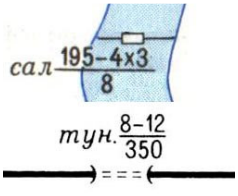


Fig. 5

▪ ***Characterizing signs***. The maps include numerous letterings clarifying depicted objects. Some of them are individual: the width of a river, bridge-hoisting capacity. The connection between them is bilateral: on one hand the carrying information of the sign is concrete for the object, and on the other hand – the lettering itself gives us a hint for having an object of a definite kind. Two letterings are shown on fig. 5, they characterize the object as a definite kind (raft – above; tunnel – below) and as a quantity.

▪ ***Indicative signs***. The letterings for geographical designations are included here. They point undoubtedly towards the concrete object.

The symbols are only one kind of sign, used in Cartography. Therefore it is a logical mistake to replace a *sign* with a *symbol*, and it looks like that: Europeans and Czechs live in Europe.

2.3 Conventional sign

It is very popular to use the term *conventional sign*. Practically it is always used to designate the signs in the Russian Cartography literature. The term accepts, on the fact, that the through the description of the signs in the legend meaning of the signs is conventional agreed between the map creator and map readers. Many maps show up, which does not contain legend or have a legend on which not

all of the used signs are described, in the past few years. They are used on full value, despite all. The classical Cartography theory is unable to answer the question: where does the meaning of these signs follow form? According to the propound theory of the sign its meaning has four sources: 1) its *own meaning* of the sign; 2) meaning of *the external components* of the map including from the legend; 3) meaning of the sing as its *functioning* on the map together with the rest of the signs; 4) meaning, which comes from *the cartographic rules* (Vasilev 2006b). According to classification of the signs, shown above, the conventional signs are only a part of the signs, used in Cartography. Therefore it is incorrectly to call all signs in Cartography 'conventional'.

3. Structure of the signs in the Cartography

We consider the signs in the Cartography in four hierarchical levels. The most of the theories (Vasmut, 1983; Lutii et all., 1986; Ramirez, 2001; Foote and Crum, 1995) discuss only two levels: ***signs*** and ***primitives***. Cartographical signs function on the map according to our conception. They are composed from graphical signs, described in the legend of the map. Graphical signs are consist of graphical primitives. The reader of the map can group together some cartographical signs in a super-sign. Thereby we give four levels of signs: ***graphical primitives***; ***graphical signs***, ***cartographical signs*** and ***supersigns***.

3.1. Graphical primitive

We place the graphical primitives on the lowest level of the structure of the signs, which we define them as the smallest graphical elements, on which we add or carry definite meaning. We divide the primitives, according to the connection with definite objects in reality, on two groups general and concrete.

▪ ***The General graphical primitives*** do not contain individual information about the object. The can be used to construct great number of graphical signs. The geometrical figures are an example of such primitives. For instance, the graphical sign consists of four graphical primitives (three dots and a circumference). The general graphical primitives function, within the framework of graphical sign, can be: integrating – to attach the graphical sign to a group of signs; differentiation – to differentiate the graphical primitive upon the others; esthetical – to attach completeness or esthetical value of the sign.

Фиг. 6

▪ ***Concrete graphical primitives*** are constructed in the way to present spatial information about an object in the reality. That is the outlines of linear and area objects. The main function is to transfer individual information for their object. Except with it, the concrete graphical primitives have always the function of the general graphical primitives. The primitive which shows the curves of a road is concrete, for example. But in the same time, it may show the way the road looks (integrating function). A tourist's map is show on the fig.6, on which the road classes are presented by the width of the lines, by the count of the lines and by their colour.

Every primitive possess two systems of changeability: spatial and visual system, in order to execute the functions described below.

▪ ***The spatial system of primitives*** has two functions: 1). to point out the place the primitive should be within the framework of graphical object, when the sign consists more than one graphical primitive; 2). to describe the form of the concrete graphical primitives.

▪ ***The visual system of variables*** is used to describe the external appearance of the graphical primitive and for coding information in it by means of the legend. The system of the six optical varieties, defined by ***Jacques Bertin*** in his book '*The Semiology of Graphics*' (1967): *shape, hue, orientation, value, size* and *texture*, can be assume as the base of development. The French cartographer describes the visual variables as a ingredient of the sign, but we can assume this as a true only for the

simplest signs. Most of the signs consist of many graphical varieties, every of which may have different sizes, colours, structure and so on. That's why we examine the six visual variables of *Bertin* as quality of the graphical primitives.

3.2 Graphical sign

As a graphical sign we understand a complete graphical image consisting graphical primitives (lines, points, backgrounds, etc.), which mark generalized, abstract notion (forest, road, spring).

Fig. 7

Graphical sign usually is described in the legend on the map and is it part of the sign system on the map. It does not represent any object from reality. On the fig. 7 is shown two cartographical signs that represent springs. The cartographical sign above on the figure is composed of a graphical sign:⊙, composed of two graphical primitives: ○ and ·.The cartographical sign below on the figure is composed of two graphical signs: lettering *Пейчинка* and point sign ⊙.

There are many classifications of signs in the cartography. Cartography signs contain different kind graphical signs – linear contours, areas or non-scale explanatory sings. Because of this it is difficult to classify cartography sings and it is better to classify graphical sings. Twelve kind of graphical sings divided into three groups are listed bellow:

▪ ***Signs, localized in points*** – point of insertion, rotation angle and local scale are characteristic for them. The four kind of point graphical signs are: *geometrical shape* (fig. 8a), *pictogram* (fig. 8b), *diagram* (fig. 8c), *image* (fig. 8d) and *lettering* (fig. 8e).

The idea that letterings are a kind of graphical signs which can compose a cartographical signs solves the problem which is a trouble for many cartographers. In their signs classifications Salishchev (1990) and Foote and Crum (1995) omit the letterings. Keates (1982) consider the letterings as a special case in the cartography. According Ramirez (2004) there are three languages used in the cartography: natural language, numerical language and cartographic signs. In our theory about the cartography signs letterings are presented as graphical sings composed by graphical primitives (the characters in the letterings). In this way they fit naturally into others representational tools in cartography.

a b c d e
Fig. 8 Point graphical signs

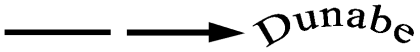


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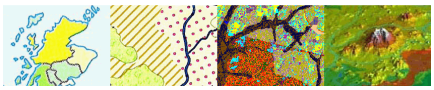
Fig. 9 Linear graphical signs


a b c d
Fig. 10 Areas

▪ ***Linear signs***. The linear sings are *line* (fig. 9a), *arrow* (fig. 9b) and *lettering along the line* (fig. 9c). The letterings on the line are linear signs because contain text of lettering and line on which it is located.

▪ ***Areas.*** The sings located at the area can be divided into four groups: *tints* (fig. 10a), *hachure* (fig. 10b), *raster images* (fig. 10c) and *3D graphical signs* (fig. 10d).

3.3 Cartographical sign

Cartographic sign is visual accepted graphical sign (or a group of graphical signs), which due to its meaning, and its concrete position in field of the map has the ability to represent definite object in the reality.

Each cartographic sign in the map represents a specific object. According to that, we add to the meaning which the cartographic sign acquire of the graphical sing and primitives the sense to mark a specific object with individual characteristics and peculiarities. The common functioning of signs over the map engenders new meaning, which is interpreted in the maps' context.

3.4 Supersign

There exist different theories according to the way the cartographic signs should be read. For instance, J. Bertin (1967) accepts that the map should be read through sequence of single images, which he defines as "at least sensible visual form, accepted whit a single look". In our theory the perception

of information of a map is examined as an active and purposeful process of grouping the cartographic signs.

The grouping of the signs works at the same principles as the grouping the digitals in the numbers: 1 and 2 can form 12 and 21 also. The digitals do not loss their identity when they make the number. Only the new meaning is occurred (unit, decimal number, hundred etc.). In the similar way if the sings of settlement and airport are put together they acquire the new meaning. But the number 12 do not mark anything concrete without the noun – for instance 12 apples or 12 degree. This can shows that the meaning of cartography signs appears in definite context. The combination between city and airport can be interpreted in different ways: the airport is near to the city; the airport is situated on the west of the city, the western parts of the city are very noisy etc. According to the concrete observation targets, the reader groups the signs that concerns him and ignores the rest, in his mind. From the groups of signs, through creative impulse, in which are involved preceding knowledge, the reader gets only the information that interests him. In that process the reader uses previous knowledge.

We call ***superinterpretation*** the process of purposefully imaginary grouping of cartographical sings and creation of new information for the object. As a results of this the new information is obtain. The sings chosen by the reader with the definite purpose represent imaginary cartographical sings from higher rank – ***supersign***.

Many cartographers are made the attempts to determine the quantity of the information on the map. But the results are not satisfactorily. The idea about grouping of cartographical signs in supersigns can give the answer of this question. According the theory we offer adoption of the map is a subjective and purposefully process in which the reader uses his previously knowledge and experience. Because of this the quantity of the information on the map is as infinitely as the reality described on the map.

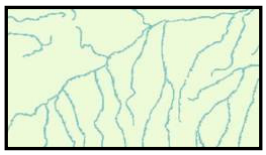


Fig. 11 Supersign – river net

There are many reasons for grouping the signs. Figure 11 shows grouping of the cartographical sings from one type (rivers) in supersigns (river net). The reader of the map set the spatial environment and criteria for groping and in this way the new study object is created. The investigation of this object (total and average length, density etc.) leads to obtaining the new information for the reality shown on the map.

Fig. 12 Supersign - settlement

Figure 12 shows other reason for grouping. The signs of buildings, quarters and parks presented in the legend make the new object – settlement. There is not sing for this object in the legend of the map. Different objects are grouping in that case to show **differentiated object of the reality.**

The spatial relations between signs of the objects (overlaying, crossing, contiguously) are other type for grouping. This has importance at the generalization and topological analyses.

4. Ten differences between graphical and cartographical sings

Visually the cartographical sign and graphical sign may be similar (fig. 13) but they are very different in the essence. Part of the problems in classical cartography is because of the difference between the cartographical and graphical signs is not always taken into account. The differences between the above mentioned sings are as follow:

1. The cartographical sign has a concrete location on the field of map and the graphical one is a part of the signs system and of the legend of the map. The location of the cartographical sign allow: a) to be connected with the determined object from the reality; b) to make measurements concerned to the object; c) to be compared with the other signs, this may change its meaning.

2. The cartographical sign has the attributes derived from the field of maps which is not possession of the graphical sign. In the field of map the cartographical sing has scale and projection the same

as the map and concern the concert region from the reality. The measurements made on the cartographical sign (length, area, distance) concern its object from the reality.

3. The cartographical sign mark the *real object* on the field of the map (fig. 13) and the graphical one – *abstract* (fig. 13b). The general, abstract concepts which not exist in the reality are usually described in the legend. The graphical sign on the fig. 13b does not present a real object but the cartographical sign on fig. 9a marks concrete mine and the sign is a *model of its object*.

a

b

Fig. 13

4. The cartographical sign is in 'a correspondence' with the rest of the signs on the map but the graphical sigh is compared to the signs in the legend. The characteristics of the graphical signs depend on the map maker. He can make the sign bigger or smaller, in bright or dark colour. The value of the graphical sign among the other signs is determined by the author of the map. The value of the cartographical sign is determined by the depicted object in comparison with the objects around. The value is also determined by the reader of the map and depends on its aim to use the map.

5. The meaning of the graphical signs is described in the legend ***it is seen*** after reading the description. The meaning of the cartographical signs ***is interpreted*** in the context of the map and its concrete location on the map. The sign for spring shown on the legend gives rise to determined notions concerned to the understanding the meaning of the word "spring". The same sign put on the determined site on the field of map is connected to the concrete spring and cause different notions and associations. This may be spring in the desert or in the region with many springs, may be known by the reader of the map also the object may has determined characteristics given by the lettering to the sign.

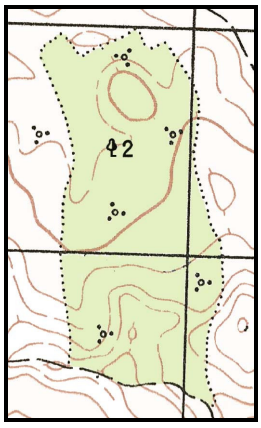


Fig. 14

6. One cartographical sign may contain several graphical signs. They may have different functions (fig. 14): some of them depict location and size, others show the kind of the object and the third depict the object (with letterings, labels). There is 2 ways for connecting the graphical signs. The signs may be connected as graphical objects (***visual connection***). In this case the principles of perceptive grouping (the reader of the map determines which graphical signs constitute the cartographical sign) have main role. After that their meaning are connected (***meaning connection***). Its role in the border of the cartographical sign is determined.

7. The meaning of graphical signs in the scope of the cartographical sign may be changed. For example, fig. 14, the sign on the left mark the location of the small group of bushes but in the border of the massive on the right the sign shows the kind of the vegetation. On the other side the meaning of the cartographical sign overcome the meaning of the consisting graphical signs because of the cartographical sign is interpreted in the context of the map.

8. The graphical signs can be share between two cartographical signs. The southern border of the vegetation shown on the figure 14 coincides with field road. In this case the road is a part form the picture of the bush area and marks its border.

9. The map *reader* can unite the cartographical signs in supersigns. This marks the objects from higher rank composed by several differentiated objects. The map *creator* connects the graphical signs to make cartographical signs.

10. The meaning of graphical signs is given by the legend or result from *cartographical symbolic*. There is four sources for the meaning of cartographical signs: legend, *cartographical symbolic, cartographical rules and sign function on the map.*

5. Conclusion

It was shown that the notions as mark, symbol, conventional sign, sign vehicle etc. do not cover the notion for cartographical signs. The signs used in the cartography can be divided into four groups:

graphical primitives, graphical signs, cartographical signs and supersigns. This allows solving some of theoretical problems of the cartography:

- Determination the quantity of the information on the map. It is shown that as a model of the reality the map allows obtaining of more information than setting in the beginning. Because of this it is meaningless to look for quantity of the information. The functioning of the cartographical signs and its relation with other signs is one of the sources of meaning of the signs.
- About the source of information which can be obtained by the map but is not putted there by the map creator. The previous knowledge and purpose fullness are used by the map reader at the process of ***super interpretation*.** This leads to creation of supersigns. Study of this signs created by the map reader gives a tool for obtaining the new information about the reality.
- About signs classification. Because of complexity of cartographical signs the classification is meaningless. One real object can be mark on the map by several graphical signs with different kind (fig. 14). The classification according outward kind can be used only for graphical signs.

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