

# APPLYING GESTALT THEORIES AND GRAPHICAL SEMIOLOGY AS VISUAL READING SYSTEMS SUPPORTING THEMATIC CARTOGRAPHY

Grazielle Anjos Carvalho

Ana Clara Mourão Moura

Universidade Federal de Minas Gerais – UFMG, IGC – Depto. Cartografia,

Av. Antônio Carlos, 6.627 Pampulha - 31270-901 Belo Horizonte - MG

grazielleac@ufmg.br, anaclara@ufmg.br

**ABSTRACT** – Information can be represented in innumerable ways, so it is the task of the graphical designer to identify the best way for this. Cartographic studies are focusing the use and the innovations on geotechnologies, but the way the products are published is not being considered so important, and the consequences are a great amount of maps that have ambiguous communication. Out of several studies of the graphical treatment of information in cartography, in this work we highlight Graphical Semiology and Gestalt Theory. Graphical Semiology defends the premise that all and any relations between represented objects can be expressed by six visual variables (size, tone/value, color, form, orientation and granulation), three properties relating to the levels of organization of the data (classified as ordered, quantitative or selective) and three ways of implementation (points, lines and areas/zones). Graphical Semiology is connected, at the same time, to several theories of form and of representation and to information theories, developed by contemporary psychology. Gestalt is a German school of psychology and its studies mainly focus on the field of visual perception and applicable models of communication. The Gestaltist movement acted mainly in the field of form theory, making relevant contributions to the studies of perception, language, intelligence, learning, memory, motivation, exploratory conduct and social group dynamics. Through numerous studies and experimental researches, the Gestaltists formulated their theories surrounding the fields mentioned. When applied to Cartography, it allows the evaluation of the advantages and the limits of the visual variables applied to cartographic semiology and, therefore, allows also the formulating of rules for a rational use of cartographic language. In Cartography, Gestalt acts in a way to aid the map's final composition, seeking to apply the conceptual, consubstantiated and fundamental categories of harmony, contrast and visual balance, through the application of its laws. According to Gestalt theory, the cerebral stimulus does not occur at isolated points, but in regions. In the perception of form there is no posterior process of association of several sensations, like in the retina. The first sensation is already of form, global and unified. In general, there are eight Gestalt laws: unit, segregation, unification, closure, continuity, proximity, similarity and *prägnanz*. Thus, this article considers the

importance of the graphical treatment of cartographic information supported in these two theories. Cartographical representation is the main graphical form used by geographers in representing relations that occur in space. However, different professional areas have also been using this language. Cartography aims for clear and objective conveying of a phenomenon's spatial relations. As a vehicle of communication, cartography is a form to represent spatial knowledge in a synthetic manner. Since there are innumerable possibilities for this technique, the best quality of produced results is desired. For such a task, cartography relies on theories specializing in the graphical treatment of information, nevertheless, these are often neglected by the cartographic designer. Applying such graphic treatments, with the help of both Graphic Semiology and Gestalt, is thus necessary, so that the information is conveyed clearly and, at the same time, allowing the relations within the whole to be comprehended by any user, without great difficulties or dualities of interpretation.

## 1 INTRODUCTION

Information can be represented in innumerable ways. According to Martinelli (1991), it is the responsibility of the graphical designer to know how to apply the monosemic system of signs comprehensively to each issue intended to be visually transcribed, carefully observing the perceptive properties of the visual variables.

*“The bidimensional plain can be exploited in several ways, according to the nature of the correlations we wish to impose to it. This assessment defines the three main modes of graphic construction: maps, graphs and flow charts (organograms, dendograms, chronograms and fluxograms).”* Marinelli (1991).

*“Cartography is a language exclusively visual, and, for that, it is submitted to physiological laws of image perception”,* asserts Joly (1991).

Spatial phenomena may be manifest as points, lines or zones, and the data may be classified and represented as ordered, selective/qualitative (classificatory or binary) and quantitative. Once the nature of the data is understood, we may classify them and, later, we may choose the best graphical treatment for the information. Out of all studies on graphic treatment of information in cartography, we highlight Graphic Semiology and the Gestalt Theory.

In order to know the properties of visual language and for better using it, J. Bertin developed Graphic Semiology.

Graphic Semiology is connected, at the same time, to several theories of form and of representation and to information theories, developed by contemporary psychology. When applied to Cartography, it allows the evaluation of the advantages and the limits of the visual variables applied to cartographic semiology and, therefore, allows also the formulating of rules for a rational use of cartographic language, affirms Joly (1991).

For Bertin (1986): *“Neographic, or Graphic Semiology, uses properties of the plain to demonstrate relational similarities, of order and of proportionality between associated data. Neographic is the monosemic level of the image world. Neographic defines sign system. ‘A graph’ assigns all constructions made inside this system, being a diagram, a flow chart or a map”*.

Gestalt is a German school of psychology and its studies mainly focus on the field of visual perception and applicable models of communication. According to Fernandes (2001): *“Gestalt affirms the guiding principal that says that we always see things within a conjoint of relations. The Gestalt theory asserts that the first sensation already has form and is global and unified. We do not see isolated parts, but relations. For our perception, that is the result of a global sensation, the parts are inseparable from the whole.”*

Both Graphic Semiology and Gestalt are important fundamentals to constructing cartographic analyses. Duarte (1991) underlies the importance of them for cartographic work:

*“Artistic expression is integral also to all cartographic work, in the instant the cartographer seeks to provide information in the most appropriate manner, through graphic language, respecting the rules of Graphic Semiology and keeping in mind the optic of aesthetic aiming to achieve the ideal of beauty. (...) The cartographic representation must be understood as a technical work that aims to communicate an idea without allowing contradictory interpretations, seeking beauty through harmony attained between all components (symbols, colors, letters), in a way to provide correct information. In a cartographic representation, the artistic and the scientific should form a harmonious conjoint, aiming to satisfy the reader, not only with the beauty of the work, but also with the level of information provided.”*

## **2 GRAPHIC SEMIOLOGY**

Bertin (1967) affirms that all relations between the objects to be represented may be expressed by six visual variables, three properties – referring to levels of data organization – and three ways of implementation. The author recognized six visual variables: size, tone (value), color, form, orientation and granulation. However, only the first four are used with frequency. These visual variables may manifest as points, lines or areas (zones). These are the so-called ways of implementing Graphic Semiology. The three properties of the level of data organization refer to classifying data as ordered, quantitative or as selective.

Le Sann (2005) stresses *“respect for the existing relations between data concerning the same information constitutes the conceptual base of Graphic Semiology. Therefore, quantitative information is required to be translated through a quantitative visual variable. Ordered information, through an ordered variable”*, and so on. The determination of the appropriate way in which to present certain information depends of the information itself.

Thus, “a city will be represented by a point or an area, according to the representations scale. Rivers, limits and roads are represented by lines, while for densities and any information occupying an area, zones are implemented.”

### 3 GESTALT AS A VISUAL READING SYSTEM

*Gestalt is a School of Experimental Psychology. It is considered that Von Ehrenfels, a Viennese philosopher from the late 1800's, was the precursor of Gestalt psychology. Later on, in approximately 1910, it had its more effective beginning with three main theorists: Marx Wertheimer (1880/1943), Wolfgang Kohler (1887/1967) and Kurt Koffka (1886/1941).*

*The Gestaltist movement acted mainly in the field of form theory, making relevant contribution to the studies of perception, language, intelligence, learning, memory, motivation, exploratory conduct and social group dynamics. Through numerous studies and experimental researches, the gestaltists formulated their theories surrounding the fields mentioned. Opposing subjectivism, psychology of form is inspired by nervous system's physiology, when trying to explain the relationship of the subject-object in theories of perception.” (Gomes Filho, 2000:18).*

In cartography, Gestalt acts in a way to aid the map's final composition, seeking to apply the conceptual, consubstantiated and fundamental categories of harmony, contrast and visual equilibrium. According to Gestalt theory, the cerebral stimulus does not occur at isolated points, but in regions. In the perception of form there is no posterior process of association of several sensations, like in the retina. The first sensation is already of form, global and unified.

Wertheimer, in a lecture to the Kant Society in Berlin, 1924, affirmed: “*The basic thesis of gestalt theory might be formulated thus: there are contexts in which what is happening in the whole cannot be deduced from the characteristics of the separate pieces, but conversely; what happens to part of the whole is, in clearcut cases, determined by the laws of the inner structure of this whole.*”

The physiological correlates of perception and action are not individual stimuli, but unified events. They are, as stressed by Wertheimer, Gestalten.

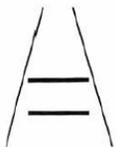


Figure 1 (a): Straight lines

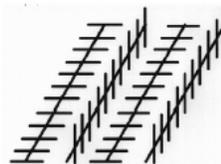


Figure 1 (b): Parallel lines.

Figura 1(a) One line seems larger than the other because both are seen in relation to their position inside the angle. Figure 1 (b) gives the impression that the diagonal straight lines that run NE-SW are not parallel, but are getting closer at their extremities. This occurs due to the fact that the human eye cannot interpret the composition as if it were a juxtaposition of parallel diagonal lines and small lines arranged both vertically and horizontally. Our looking tends to automatically see a third element, resulting from the sum of the parts.

Engelmann (2002) asserts that the whole should be considered something other than the simple combination of its elements: “*Werheimer said, during the years that followed 1912, that Gestalten are basically different from what was then called sensations. Gestalten, perceived at first, can be taken apart. But the parts are always parts of the forming Gestalt. It is completely mistaken, the sentence falsely attributed to Gestaltists that asserts that ‘the whole is more than the sum of its parts.’ The Gestalt psychology is different from those that mention sums of elements. On the contrary, Gestalt precedes the existence of the parts. The determination occurs from above or descendent, rather than from below or ascendant.*”

In a similar way to Graphic Semiology, Gestalt presents general laws that serve as a scientific foundation for a visual reading system. “*In other words, a perceptive and rational groundwork was created, a sort of a b c of visual reading, that will allow and favor all analytical and interpretative articulation of object form, particularly, regarding the use of further conceptual categories.*” Gomes Filho (2000).

#### **4 APPLYING GESTALT LAWS TO GRAPHIC TREATMENT OF SPATIAL INFORMATION**

In general, there are eight Gestalt laws: unit, segregation, unification, closure, continuity, proximity, similarity and *prägnanz*. Following are the Gestalt laws:

4.1) **Unit:** *a unit may be consubstantiated in a unique element, which ends in itself, or as a part of the whole. Still, in a broader sense, it may be understood as a conjoint of more than one element, configuring the ‘whole’ as such, meaning, the object itself. The formal units that configure a whole are perceived, generally, through relations between the elements (or sub units) of which it is comprised. One or more formal units may be segregated or perceived within a whole through several elements such as points, lines, plains, volumes, colors, shadows, brightnesses, textures and others, either singularly or in combinations. The map’s orientation constitutes a unit as a whole. On the other hand, each north (magnetic, planed or true) can also be considered a unit or a sub-unit, within the whole.*

4.2) **Segregation:** *Means the perceptive ability to separate, identify, make evident or bring out formal units in the whole or in parts of this whole. Naturally, it is possible to isolate one or more units, according to differences in the stimuli produced by the visual field (dependent of the forces of one or more types of contrasts). Segregation can be*

*accomplished through several means, such as: with points, lines, plains, volumes, colors, shadows, brightness, textures etc. With regard to visual reading, it is also possible to establish levels of segregation. For example, identifying only the main units of a more complex whole, as long as it is enough, for the desired goal of analyzing and/or interpretation of object's form.*



Figure 2: Segregation factor – Urban map of São Lourenço – MG. In this map, the following are segregated as principal units: road infrastructure (in white); hydrograph (Rio Verde and its tributaries – in blue), The Parque das Águas and vegetation (green) and the urban center (pink). <http://www.hotelglobosaolourenco.com.br/mapaurbano.jpg>.

4.3) **Unification:** *Refers to equality or similarity of stimuli produced in the field of vision, by the object. Unification is verified when factors of harmony, equilibrium, visual ordering and, principally, the language's coherence or formal style of the parts or of the whole, are present in the object or in the composition. It is important to emphasize that, obviously, unification also manifests itself in degrees of quality, which means that it varies in its formal organization, from better to worse. In this case, it is possible to attribute qualitative indexes to a given reading. Furthermore, two basic principals also compete in formal organization, which are the laws of proximity and similarity, when they are present in part or in the object as a whole, as will be seen below.*

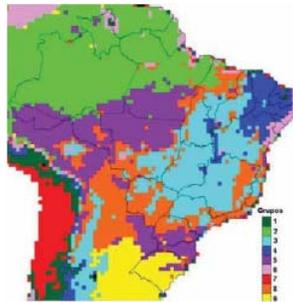


Figure 3: Unification factor – Classification of Brazil's vegetation covering, using NDVI's grouping analyses and data.. In this map, it is possible to identify the Unification factor

through color association. The unit is created by the chosen visual variable's proximity and similarity factors to represent the vegetation cover of Brazil. <http://www.scielo.br/img/revistas/rbeaa/v7n1/n1a14f01.jpg>

4.4) **Closure:** *The closure factor is important to the formation of units. The forces organizing a form spontaneously direct them to formation of units in all the closed units. In other words, a sensation of visual form closure is obtained by continuity in a defined structural order, meaning, by way of grouping elements in a way to constitute a total and more closed or more complete figure. It is important not to mistake the sensation of closure, regarding Gestalt law, with physical closure, contour of an object's elements, present in almost all object forms.*



Figure 4: Closure Factor – Map of Brazil's soils. Note that there is no outline delineating the area occupied by certain soil types, but, even so, the units in this map are formed by an association of colors. [www.portalbrasil.net/images/mapabrasil\\_solo.gif](http://www.portalbrasil.net/images/mapabrasil_solo.gif).

4.5) **Continuity:** *Is the visual impression of how the parts follow each other through perceptive organization of form in a coherent manner, with no breaks or interruptions of trajectory or in visual fluidity. Continuity also refers to element's tendencies to accompany each other, in a way to allow good continuity of elements, such as: points, lines, plains, volumes, colors, brightness, textures, tonal scales etc. Or of a movement in an already established direction. Good continuity is active in or concurs, almost always, an object reaching its best possible form, the most structurally stable form.*

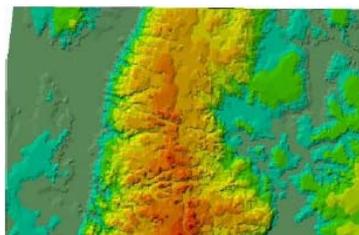


Figure 5: Continuity factor – Hypsometric map – chart of Curimataí – MG. Color composition, going from colder colors to warmer colors, forms a tonal scale that helps identifying relief distinctions in the two larger units of the image's configuration. Bambuí is represented by greener tones and Espinhaço is represented by warmer colors.

4.6) **Proximity:** *Optical elements close to each other tend to be perceived together and thus to constitute a whole or units within a whole. Equally, the stimuli nearest to each other, either by form, color, size, texture, brightness, weight, orientation, etc, will often tend to be grouped and to constitute units. Proximity and similarity are factors often acting together and mutually reinforcing, to constitute units and to unify forms.*

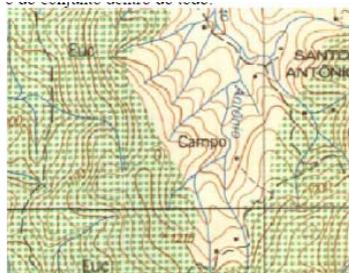


Figure 6: Proximity factor: Topographic map of Caeté – MG. The many “green dots” in this map lead us to see them together, thus creating a unit. The fact that they are near to one another and are identical helps seeing a conjoint within the whole.

4.7) **Similarity:** *Likeness between form and color also lead to the tendency to construct units, in other words, to establish groupings of similar parts. If conditions are equal, the stimuli most similar to each other, either by form, color, size, weight, direction etc., will often tend to be grouped, to constitute parts or units. If conditions are alike, the stimuli originated by similarity and in greater proximity will also present a greater tendency to be grouped, to constitute units. Similarity and proximity are two factors that, not only compete for the formation of units, but also for promoting the whole’s unification and of what is seen, in the sense of harmony, order, visual equilibrium.*



Figure 7: Similarity factor – Brazil’s biomes.. In this map, the color’s similarity requires that we group them in distinct classes and then associate them to different classes of Brazil’s biomes. In this manner, the similarities between colors ask us to identify different units within the whole. [www.wwf.org.br](http://www.wwf.org.br)

4.8) **Prägnanz:** *prägnanz is the basic Gestalt's law of visual perception and thus defined: "Any stimuli pattern tends to be seen in a way that the resulting structure is as simple as is allowed by the given conditions, regarding harmony and visual equilibrium. A good prägnanz presupposes that the object's formal organization, in a psychological sense, will tend always to be the best possible, from the structural point of view. Therefore, it is possible to assess and to establish the following criteria of qualification or organizational judging, for this system's effect: a) the better the visual organization of an object's form, in terms of reading comprehension or interpretation speed, the greater will be its prägnanz degree. b) Naturally, the worse or the more confusing the visual organization of an object's form is, the smaller its prägnanz degree will be. In order to facilitate prägnanz judgment, it is possible to establish a grading or indexing system, for example: low, medium and high or grades from 1 to 10, respectively, from best to worse.*

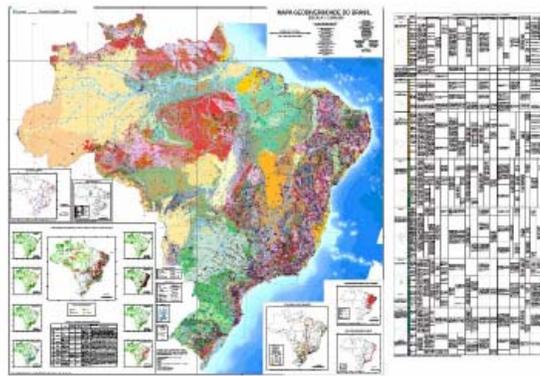


Figure 8: *Prägnanz* factor (b): Map of Brazil's geo-diversity. The map of Brazil's geo-diversity presents low *prägnanz*, meaning the high degree of overlapping information on different themes makes it confusing and difficult to read, demanding a great effort from the reader for its understanding.

## 5. CONCLUSIONS

Cartographic studies are focusing the use and the innovations on geotechnologies, but the way the products are published is not being considered so important, and the consequences are a great amount of maps that have ambiguous communication.

Cartographical representation is the main graphical form used by geographers in representing relations that occur in space. However, different professional areas have also been using this language.

Cartography aims for clear and objective conveying of a phenomenon's spatial relations. As a vehicle of communication, cartography is "[...] a form of expressing spatial knowledge, that, better than others, is able to compensate for heterogeneity of languages

*and of levels of depth, bringing into focus, in a synthetic manner, phenomena and their inter-relations.”* (Rigamonti, 1988: 253 apud Moura, 1994).

Since there are innumerable possibilities for this technique, the best quality of produced results is desired. For such a task, cartography relies on theories specializing in the graphical treatment of information, nevertheless, these are often neglected by the cartographic designer.

Applying such graphic treatments, with the help of both Graphic Semiology and Gestalt, is thus necessary, so that the information is conveyed clearly and, at the same time, allowing the relations within the whole to be comprehended by any user, without great difficulties or dualities of interpretation.

### **SPECIAL THANKS**

We thank the Pró-Reitoria de Graduação - UFMG, which supported us in the activities of disseminating this studies among the students and the users of geotechnologies in Brasil.

### **BIBLIOGRAPHIC REFERENCES**

BERTIN, Jacques. A Neográfica e o tratamento da informação / Jacques Bertin; tradução de Cecília Maria Westphalen – Curitiba: Editora da UFPR, 1986.

\_\_\_\_\_, Semiólogie graphique. Paris – Neuchatel: Mouton-Gauthiers-Villars, 1967.

DUARTE, Paulo Araújo. Cartografia temática. Florianópolis: Ed. da UFSC, 1991.

ENGELMANN, Arno. A Psicologia da Gestalt e a Ciência Empírica. Contemporânea. In: Psicologia: Teoria e Pesquisa, São Pulo, Jan-Abr 2002, v. 18 n. 1, p. 1-16.

FERNANDES, Ivanise P. C. Mapa turístico da região central do município de Ouro Preto. IGC - UFMG, Especialização em Geoprocessamento, 2001.

GOMES FILHO, João. Gestalt do Objeto: sistema de leitura visual da forma. São Paulo: Escrituras Editora , 2000.

JOLY, Fernand. A cartografia. Campinas, SP. Papyrus, 1990.

LE SANN, Janine Gisele. O papel da Cartografia Temática nas Pesquisas Ambientais. Revista do Departamento de Geografia, 2005, n. 16.

MARTINELLI, Marcello. O ensino de cartografia temática como alfabetização da linguagem da representação gráfica. In: XV Congresso Brasileiro de Cartografia, 1991.

MOURA, Ana Clara M. O papel da cartografia nas análises urbanas; tendências no urbanismo pós-moderno. Cadernos de Arquitetura e Urbanismo, Belo Horizonte, 1994, n.2.