

BERTIN GRAPHIC SEMIOLOGY AND ITS RELEVANT CONTRIBUTIONS FOR RESEARCH AND TEACHING IN BRAZIL

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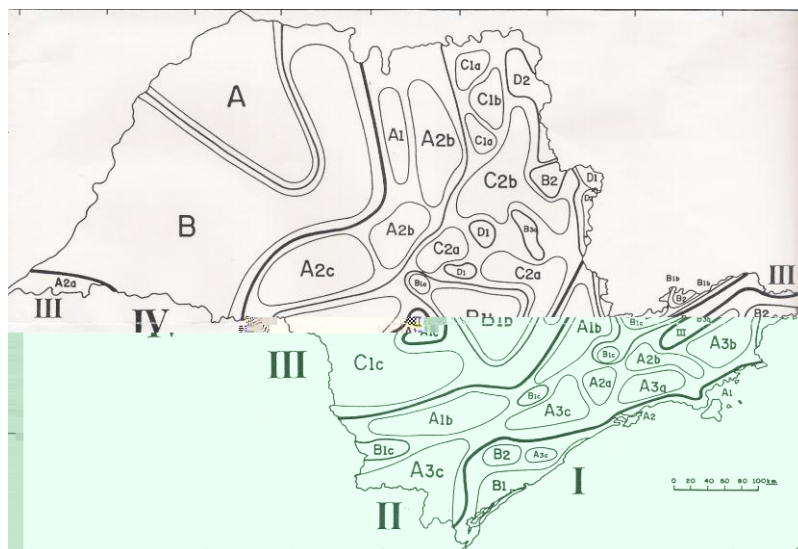
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ABSTRACT

The paper outlines the relevance of Jacques Bertin's Graphic Semiology and its contribution to tactile cartography, as developed at the Geography Department, University of São Paulo in Brazil, during 26 years of research and teaching. After making an overview of these initiatives, it is emphasized the results achieved with the theoretical and applied studies on mapping for users with visual impairment. A tactual graphic language was developed and tested with children and school teachers, having Bertin's work as its basis. It was also proposed a set of activities to introduce graphic and cartographic concepts, as a preparation to map use and guidelines to tactile map production. It is suggested more research on special needs and multisensory cartography in a way to reach everyone. There is the need of further studies to apply Graphic Semiology in different areas, to a wide group of users, mainly using new digital technologies and Internet.

BACKGROUND AND OBJECTIVES

The first study based on Graphic Semiology, as proposed by Jacques Bertin (1967, 1977), was done by the author between 1982 and 1987 (Vasconcellos, 1988). It had as main goal, the graphic treatment of information and mapping applied to climatic comfort in the State of São Paulo, Brazil. This study used graphic semiology in all phases, from data collection, organization and treatment (matrix analysis) until the communication of its results through a synthesis map with the comfort zones, having the legend as a matrix with 936 entrances based on locations and attributes, grouped in 5 classes which were used to classify the state of São Paulo in different comfort zones, as seen in Figure 1. The method allows the reader to know the criteria used and to follow all the steps before reaching the final map. The application of Bertin's proposal to the area of climatology showed the potential of these methods to research and teaching in geography and cartography, as well as in education, as shown by Gimeno (1980).



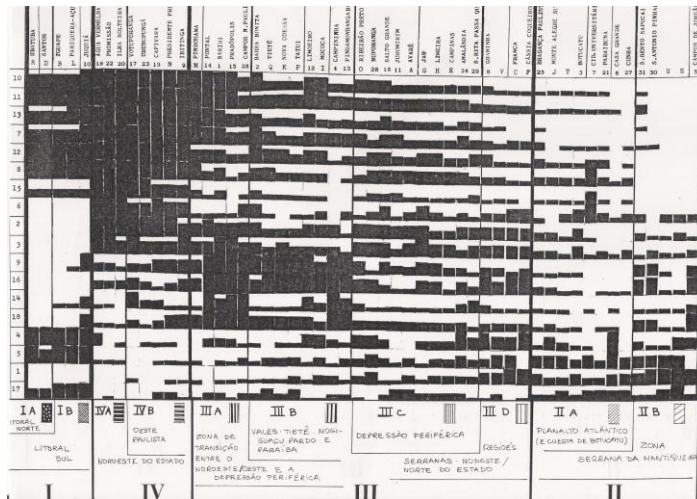


Figure 1 - Comfort zones map and legend with Bertin's interpretation matrix, State of São Paulo (Vasconcellos, 1988).

Since 1984, as faculty member at Geography Department, several courses on introduction and thematic cartography were given to students, also workshops introducing the graphic and cartographic language. During those academic events, an effort in disseminating Bertin's ideas were made both at the university and outside with experiences directed to schools, teachers and children.

The most important achievement was the application of Bertin's graphic semiology to tactile cartography, which started in 1988 by the author and continued until nowadays. At the time, it was a new research field at the University of São Paulo and in Brazil, as well. The paper main goal is to summarize these outcomes, review the results and indicate future possibilities.

APPROACH AND METHODS

The study concentrated attention on two areas: 1. Tactile graphic design and production - analysis, construction and tests of various techniques and cartographic products; 2. Tactile graphics use - evaluation of the communication process and development of training programs for teachers and visually impaired students. An extensive bibliography was organized (Vasconcellos, 1991, 1992, 1993) and a theoretical framework proposed to discuss tactile mapping in the field of cartography (Figure 2 - perspectives and dimensions in cartography), as presented in previous publications of the author (Vasconcellos, 1993a, 1995, 1996).

In this framework, cartography is seen at the center, as a communication process. This issue was extensively studied by cartographers all over the world for decades. In the author's framework, the idea is to adapt and highlight what is relevant to tactile mapping, in terms of cartographic dimensions and perspectives, including in communication, as summarize below. The variables in green color (Figure 2) are the most relevant ones for tactile map production and use, of course they vary, depending on map purposes, reproduction techniques, user special needs, etc. Other perspectives and dimensions, such as art and precision, may have secondary roles in the process of tactile map design and use. Also the nature and degree of visual impairment might have a considerable influence in mapping making decisions. The research done with children showed that low vision users might have problems in using maps, usually there are greater difficulties than with the blind users who can take advantage of their tactual sense, can read Braille and concentrate more in the tasks.

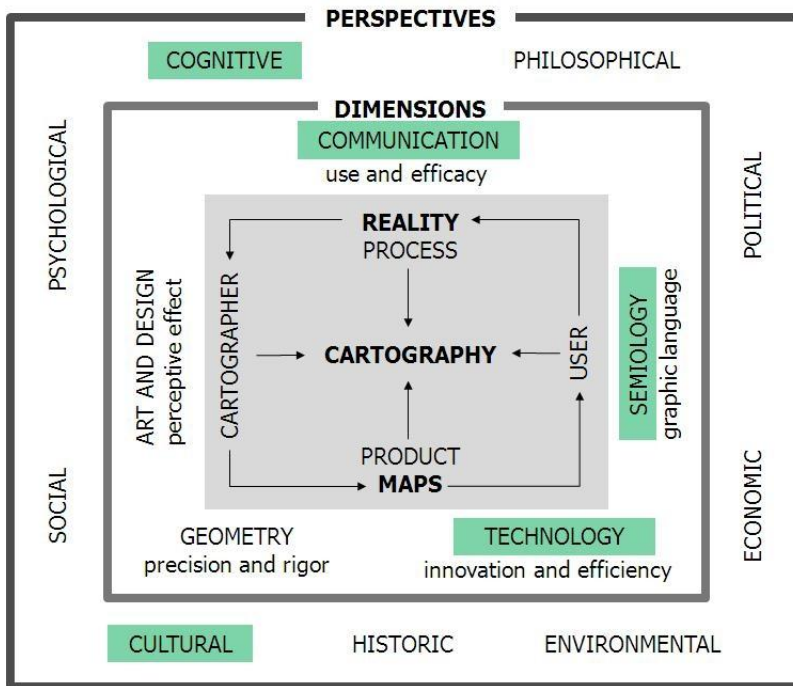


Figure 2 – theoretical framework for tactile cartography (Vasconcellos 1995)

In Figure 3, the scenario for tactile map production and use is presented in several steps which are interrelated and depend primarily on a few determinant factors. These factors are different from the view point of map makers and users. Earlier models of cartographic communication models were based on two separate spheres, one of the map maker and the other of the map user. It must be stressed that in case of maps in tactual format, both users and makers must have an active role, although the nature of that role is diverse (Vasconcellos, 1996 p.96). Many cartographers in several countries have contributed to the area of tactile mapping, such as Wiedel (1972, 1983), Edman (1992). Cartographers or other map makers working with tactile cartography must be aware that tactile map design phase (data nature analysis, reduction and generalization, choice of graphic language) is absolutely vital to achieve a good map directed to people with any visual impairment. That is the reason why Graphic Semiology has such an important contribution to tactile cartography.

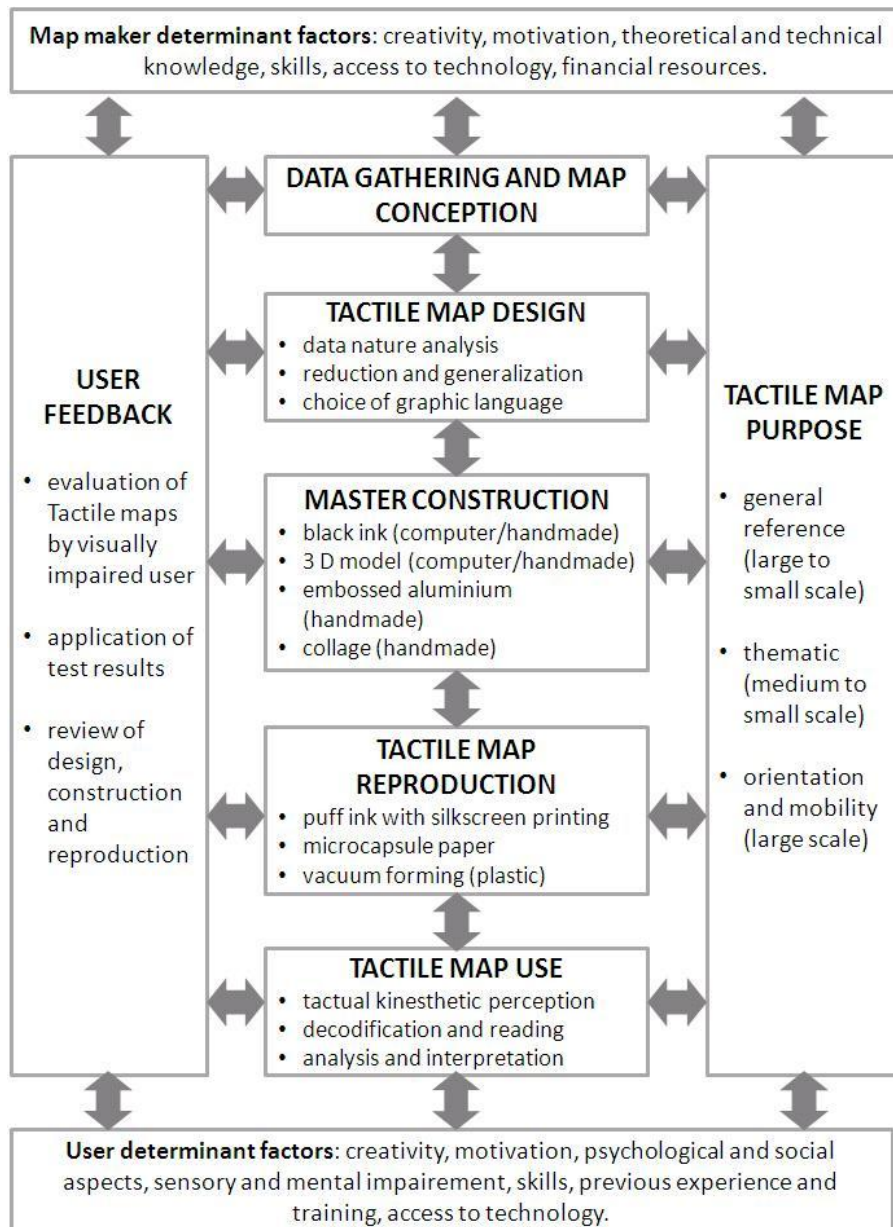


Figure 3 – The scenario of tactile map production and use as a communication model (Vasconcellos 1994, 1995)

The main objective of the research presented in this paper was to develop a tactual graphic and cartographic language directed to tactile mapping. To accomplish this goal, graphic semiology as presented by J. Bertin were applied. The visual variables proposed in his work (1967) were translated to a tactual format, in order to be accessible to no visual users. (Figure 4 - Visual variables adapted to tactile format).

	VISUAL: 2 DIMENSIONS			→	TACTILE: 3 DIMENSIONS			
	POINT	LINE	AREA		POINT	LINE	AREA	
PLAN							VOLUME	
SIZE							SIZE	
VALUE							VALUE	
TEXTURE							TEXTURE	
FORM							FORM	
ORIENTATION							ORIENTATION	
COLOR							ELEVATION	

Figure 4 – Bertin's graphic variables adapted to tactile format, adding elevation (Vasconcellos, 1991, 1993)

Visual variables can be seen by touch if one uses elevation and makes the necessary adaptation to allow tactual perception or limited vision. The use of textures, either showing order or differentiation of data is strongly advisable. The signs in point, line and area modes are used for the first exercise to introduce cartography to children and to prepare school teachers to deal with graphic and cartographic language. Games and other attractive teaching materials, besides maps and graphics, in different scales, were constructed and evaluated. Below is the description of the different steps composing the program delineated to prepare children to be map makers and users.

This methodology was used, at first, to introduce graphic representations and basic geographical concepts, e.g. plan view, scale, distance, location and orientation, to low vision and blind students.

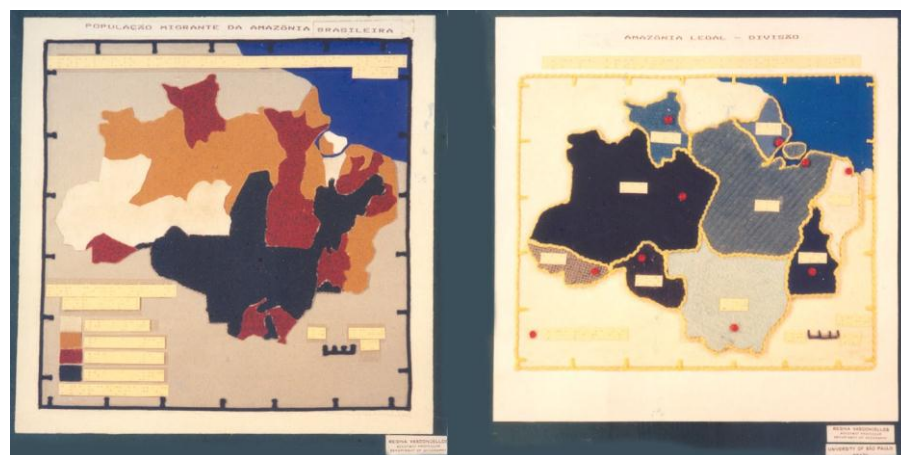
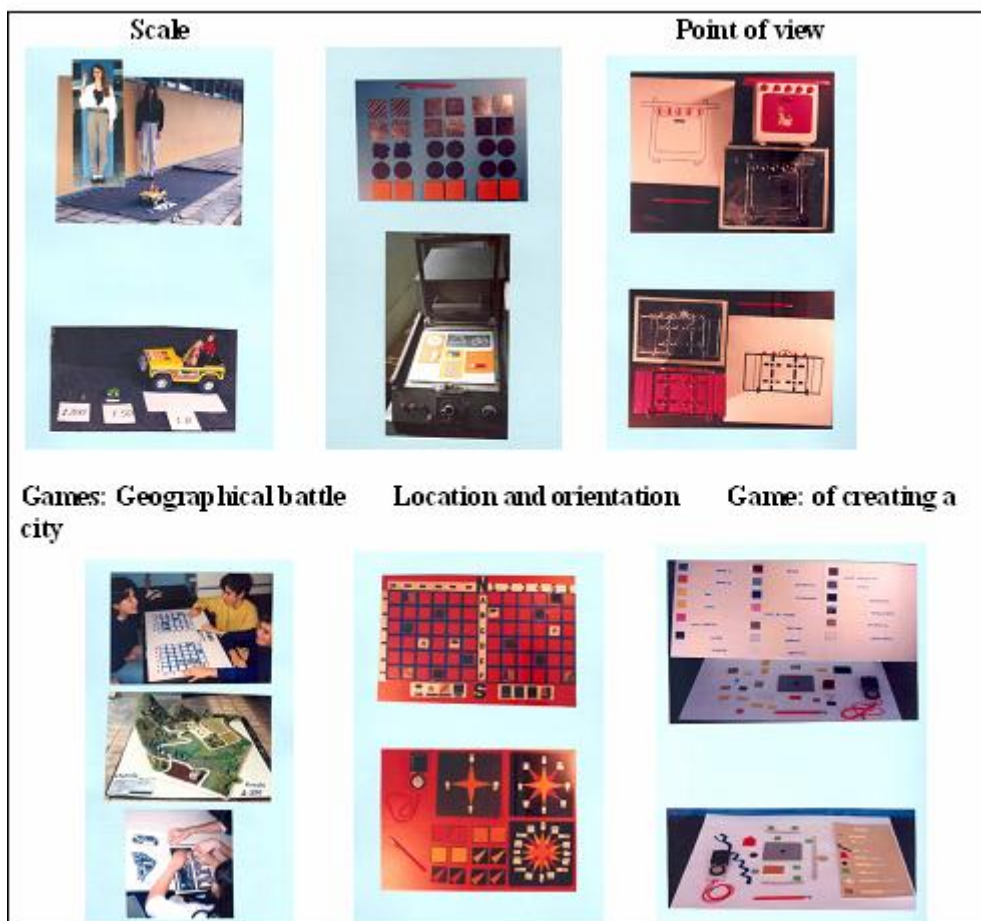


Figure 5 - Examples of tactile materials produced to introduce graphic language to blind and low vision children (Vasconcellos, 1992, 1993).

The program design to introduce cartographic concepts to children have six phases with different materials produced for each one of them: 1.the tactile graphic language (memory game with tactile graphic variables as proposed by Bertin); 2.concept of scale, reduction and distance (activity using dolls, cars in several sizes and a classroom map); 3.point of view (graphic representation of objects in vertical and horizontal views, avoiding perspective which is too abstract for blind kids); 4.location and orientation (game Geographical Battle with coordinates and hemispheres); 5.map reading (the complete address of the school, from classroom to the universe); 6.map legend and the combination of all previous five steps (exercise of constructing a city using tactile/visual variables in a mat with sticky pieces). Finally, tactile maps as seen at the examples of materials, could be showed and read by the users. This program was tested and proved

to be very effective with blind and low vision children and also older kids with small adaptations. Figure 5 shows some examples of materials and tests being applied.

RESULTS: Bertin's maps to see are good to blind users!

Bertin (1967, 1980) emphasized the difference between maps to SEE and maps to READ. Also Bonin (1975) made an effort to simplify Bertin's semiology in a book called *Initiation to Graphics (Graphique)*. In a matter of fact, those maps are better to blind and low vision users, to be seen by touch. What is good for conventional maps are not always right to the tactile format. Generalizations have to be greater, map details have to match the resolution of touch which is not as good as the resolution of vision. The idea of the collection of maps, suggested in Bertin (1980), solves the problem of information cluster which is very serious in tactile cartography and can make map reading almost impossible.

The author proposed a set of guidelines directed to map design; production and use, which were defined after tests with 200 visually impaired children and adults, 80 school teachers also evaluated the methodology and the constructed materials, as show a few examples in Figures 5 (Vasconcellos, 1993). Some of the suggestions about map design (Vasconcellos, 1995 p.1759-1760) listed in the guidelines are:

- * it is advisable to create and use conventions as much as possible to facilitate graphic information reading;
- * the map key is very important for the visually impaired, they are experts in decoding a legend and it should be used even for drawings;
- * proper reduction and generalization are vital, also size and distance between signs are important because tactual perception has a different resolution and is not global, as the blind user must put together pieces of information to form the image;
- * enough relief and contrast together with the use of redundancy help in achieving better map design with the needed clarity. Accuracy and precision very often have a secondary role. Sometimes the solution is to make a collection of maps instead of trying to add too much information in a single map;
- * decisions about the tactile graphic language depend on the data and its nature, on the type of master, on the reproduction method and on the special needs and background of the visually impaired user.

Regarding map use, there are some rules to be followed because of particular needs of the visually impaired persons. In general, more previous training will be necessary in all cases, because this user does not usually have access to the same amount of graphic representations as the sighted user, since an early age. However some existing problems, blind users can have an extremely good ability of decoding map keys because they are able to use both hands simultaneously, one on the key and the other on the map.

It is very important to be able to classify all cartographic materials considering levels of complexity, previous experience and training. Each map has to be analyzed regarding its design, master construction technique and reproduction system to be grouped and ordered in terms of its actual use for better communication. Many times, one map can be suitable for a category of users and not for others, unless previous training and assistance during map use are provided. Culture may be a determinant factor regarding map design.

The author's proposal of graphic semiology applied to tactile cartography was an innovative study which brought very positive outcomes. In the last 15 years, this initiative have been expanded and a team of researchers have continued the work with tactile maps. It was presented in many ICA conferences from 1991, in Bournemouth, UK. In the last 23 years, the work was published at national and international levels, many courses and workshops were given and several graduate students concluded their studies applying Bertin's ideas, with special attention to school cartography and teaching materials directed to geography education (Sena & Carmo, 2005). Two of these doctoral students received the ICA Travel Award, and both based their work in Bertin's Graphic Semiology, one was related to tactile cartography (Sena, 2002, 2005, 2008) and the other was about tourist maps design and production (Fiori, 2005, 2008), in this case, Bertin's visual variables were studied having in mind tourist maps as seen in Figure 6.

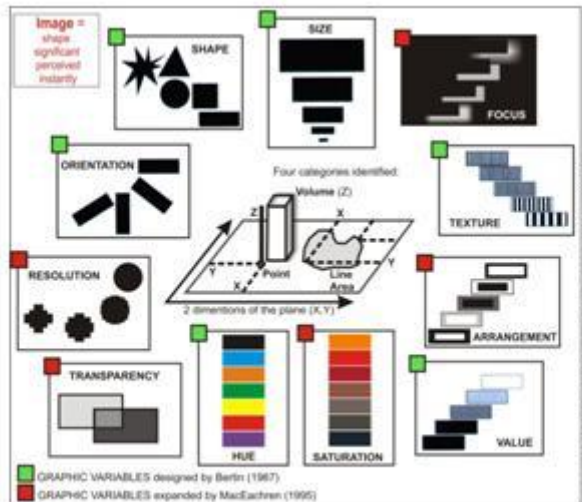


Figure 6 - Bertin's Visual Variables adapted by Fiori S. for Tourist Cartography (2005).

As it has been highlighted, the influence of Bertin's work at the University of São Paulo has been profound and, with no doubts, it is marked by relevant achievements. The Laboratory of Geography Education (LEMADI) at the University of São Paulo is today a reference center for tactile cartography with the involvement of faculty members, graduate and undergraduate students, and school teachers.

Many national and international conferences were organized, several publications and research developed in cooperation with other countries such as Canada, Chile, Argentina. These results related to Tactile Cartography are just part of the Bertin's Graphic Semiology influence in Brazilian Geography and Cartography. There are so many initiatives and so much been done in the areas of school cartography as well as maps and children, in terms of national and international meetings, publications, teaching and research as pointed out by Vasconcellos & Andersen (1995), Almeida, R.D. e Almeida, R.A. (2007, 2006).

FINAL REMARKS: vision is looking at the future not forgetting the past

The paper called attention to the potential of the tactile graphic language in school, work and everyday life because it has the power to connect the visually impaired to the audio visual, even virtual world of images (Vasconcellos, 2001, Almeida & Tsuji, 2005); it also promotes integration with independence, and facilitates communication in general. Special needs cartography is, however, more than maps for the visually or physically impaired user. It can and it should be extended to all population groups which need special maps or those who have to deal with different issues related to map production and use. People gather information mainly through sight, the ones with any kind or degree of visual impairment will depend on special cartographic materials and images. Many maps are still not available in formats which use other senses to perceive images, such as touch and sounds.

New technologies have introduced great changes and improvements in the area of tactile map production and use. Tactile maps with Braille text have been produced and used in many countries. However, the resolution is low, map size has to be large and interpretation of shape is extremely difficult. Furthermore, only a minority of blind people read Braille. In the late 1980's a tactile-audio system called Nomad was developed. This system combined touch and sound so that a tactile map, when touched, spoke the information under the finger. Much more information could now be placed on a tactile map and Braille was no longer required on the map. After research and improvements on NOMAD system, became available Tactile Graphics Designer or TGD. This new system allows the blind and visually impaired to draw their own maps and graphics using a combination of software and hardware, printer and embosser (Parkes, 1998). In terms of digital technologies there is an extensive list of new outcomes and possibilities, such as the ones described by Almeida & Tsuji (2005).

Tactile maps can also help the blind user to navigate through space, inside buildings, and outside in nature. It is very important that we understand the best and most effective way to design, reproduce, and distribute tactile maps. All kinds of cartographic materials should become available for all senses and for an interactive way of use, to open up our world dominated by images to the ones with visual impairment.

It is up to us to look for new pathways to continue Bertin's work, applying graphic semiology in different formats and innovative ways, also using new media such as Internet and digital cartography. Still not fully

studied some of Bertin's contributions, such as matrix analysis applied in first grades through undergraduate classes, such a great method to organize data and to understand relationships, besides representing them in graphic/cartographic forms. It is needed good software to facilitate data management and visualization, followed by map construction and all kinds of presentation of results, even to depict a simple map legend.

There are still some challenges in designing, reproducing and using special needs maps in our digital world. Maps and cartographic materials present, in some cases, many difficulties to the blind and low vision users. It is necessary to promote graphic literacy in all levels. Training the map user, investing in capacity building related to the map maker both cartographers and non specialists should be in the agenda for cartography. In any case, technology brings enormous opportunities for cartography and the integration of users with special needs to the main stream. Multisensory maps are realities nowadays, maps are everywhere in our lives, even at a distant Amazonian native community, they play an important role (Almeida, 2001, 2005). Vision is also being open to work with the past and the future, to look for new pathways.

REFERENCES

- ALMEIDA, Rosângela. A. (2007). *Org. Cartografia Escolar*. São Paulo: Contexto.
- ALMEIDA, R.(Vasconcellos); Tsuji, Bruce (2005). *Interactive Mapping for People Who are Blind or Visually Impaired*. In Taylor, D.R.Fraser. *Cybercartography: Theory and Practice*. Elsevier, Amsterdam. p.411- 431.
- ALMEIDA, R. (2006). *Mapeando a Comunidade – Sugestão de Aula de Geografia*. *Jornal da Tarde*, 12A, 19 de setembro. São Paulo. <http://www.usp.br/nce/educomjtpaginas/comunidade.pdf>
- _____ (2005). *Ethnocartography Applied to Environmental Issues*. In: *Proceedings of XXII ICA Conference - Mapping Approaches into a Changing World*. La Coruña, Espanha. p.1-8.
- _____ (2001). *Cartography and Indigenous Populations: A Case Study with Brazilian Indians from the Amazon Region*. *Proceedings, 20th International Cartographic Conference – ICA*. Beijing, China.
- _____ (1999). *Mapping Memories and Places: A Cartography for and by the Elderly*, 19th *International Cartographic Conference – ICA*. Ottawa, Canadá. *Proceedings*, v. 1, p. 429-435.
- BERTIN, J. (1967). *Semiology Graphique: les diagrammes, réseaux, les cartes*. La Haye, Monton & Gauthier-Villars, Paris.
- _____ (1977). *La Graphique et le Traitement Graphique de l'Information*. Flammarion, France.
- _____ (1980). *Voir et Lire*. In: *Cartes et Figures de la Terre*. Centre Georges Pompidou, Paris.
- BONIN, S. (1975). *Initiation à la graphique*. Epi, Paris.
- EDMAN, Polly K. (1992). *Tactile Graphics*. American Foundation for the Blind, New York.
- FIORI, S. R. (2005) *Touristic maps: the challenge of using art in the digital era*. In: *Proceedings of XXII INTERNATIONAL CARTOGRAPHIC CONFERENCE*. *Mapping Approaches into a changing world*. v.1. La Coruña, Espanha: *International Cartographic Association*, p.1-10.
- _____ (2008). *Mapas para o turismo e a interatividade: proposta teórica e prática*. (Tese de Doutorado). Faculdade de Filosofia, Letras e Ciências Humanas, Departamento de Geografia, Universidade de São Paulo, São Paulo. 310p.
- GIMENO, R. (1980). *Apprendre à l'école par La graphique*. Editions Retz, Paris.
- PARKES, Don. (1998). *Tactile Audio Tools for Graphicacy and Mobility: A circle is either a circle or it is not a circle*. *The British Journal of Visual Impairment*. Vol 16.3: 99-104.
- SENA, Carla C. R. G.(2002) *O estudo do meio como instrumento de ensino de Geografia: desvendando o Pico do Jaraguá para deficientes visuais*. Dissertação (mestrado). Departamento de Geografia da FFLCH - USP. São Paulo.
- _____ (2008) *Cartografia Tatil no ensino de Geografia: uma proposta metodológica de desenvolvimento de recursos didáticos adaptados a pessoas com deficiência visual*. Tese (doutorado). Departamento de Geografia da FFLCH - USP. São Paulo.
- SENA, Carla C. R. G. CARMO, Waldirene R.(2005) *Produção de mapas para portadores de deficiência visual da América Latina*. In: *Anais do X ENCONTRO DE GEÓGRAFOS DA AMÉRICA LATINA - EGAL*. São Paulo, Brazil.
- VASCONCELLOS, R.; ANDERSON, J. (1995) *Maps for and by Children: possible contributions by cartographers*. In: *Proceedings of XXII INTERNATIONAL CARTOGRAPHIC CONFERENCE.- ICA*, Barcelona, Spain. *ACI*, v. 01, p. 384-392.

- VASCONCELLOS, R (2001). Tactile Maps in Geography. In: Susan Hanson; Franz E. Weinert; et alli. (Org.). International Encyclopedia of Social & Behavioral Sciences. Elsevier, 2001, p. 15435-15437.
- _____. (2000). Atlas Geográfico Ilustrado e Comentado. São Paulo, FTD.
- _____. (1996). Tactile Mapping Design and the Visually Impaired User. In: Wood, C. & Keller, P. (Eds.) Cartographic Design: Theoretical and Practical Perspectives. John Wiley & Sons, England.
- _____. (1995). Tactile Mapping for the Visually Impaired Children. Proceedings 17th International Conference - ICA. Barcelona, Spain, 2, 1755-1764.
- _____. (1994) Tactile Map Design and the Visually Impaired User. Symposium on Cartographic Design and Research, Ottawa, Canadá.
- _____. (1993). Representing the geographical space for visually handicapped students: a case study on map use. In: Proceedings 16th International Conference - ICA. Cologne, Germany, 2, 993-1004.
- _____. (1993a) A Cartografia Tátil e o Deficiente Visual: uma avaliação das etapas de produção e uso do mapa. PhD thesis, 2 volumes, Department of Geography, FFLCH, University of São Paulo, Brazil.
- _____. (1992). Tactile Graphics in the teaching of Geography. In: 27th IGC Geography is Discovery Technical Program Abstracts, Washington D.C., 639-640.
- _____. (1991). Knowing the Amazon through Tactual Graphics. In: Proceedings XV International Cartographic Conference - ICA. Bournemouth, Great Britain, 1, 206-210.
- _____. (1988). O Tratamento Gráfico do Conforto Térmico no Estado de São Paulo – um Ensaio Metodológico. Master dissertation, Department of Geography, FFLCH/USP, São Paulo. 2 volumes.
- Wiedel, J.W. & Groves, P. (1972). Tactual Mapping: Design, Reproduction, Reading and Interpretation. University of Maryland. College Park, USA.
- Wiedel, J.W. ed. (1983). Proceedings of the First International Symposium on Maps and Graphs for the Visually Handicapped. Association of American Geographers, Washington D.C.