TACTILE MAPPING FOR VISUALLY IMPAIRED CHILDREN

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Abstract

The paper presents the results of five years of research on tactile mapping for visually impaired children carried out at the University of São Paulo, Brazil. Based upon empirical research, the author has developed a model for tactual cartographic communication which emphasizes the nature and role of map use. A programme to introduce cartographic concepts to children is suggested and the need for education and training is also discussed.

1 Introduction

As we reach the end of this century, the graphic language is becoming even more relevant to our children than ever before. Maps and graphics can help to develop the concept of space and to enhance all knowledge about our world, nowadays when visualization is the basic channel of communication. Most of the spatial data are not available for the visually impaired and they need be translated to a tactual format. Tactile maps and graphics are relevant because they help to overcome informational barriers for those who cannot see, facilitating their way in school, work and everyday life.

Cartography has given considerable attention to mapping for the visually impaired, mainly related to the production process. New technologies have introduced great changes and improvements in the area of tactile map production and use. However, to be used effectively and efficiently, maps must be evaluated and tested by the user. For the blind and visually impaired user, successful cartographic communication requires adopting new approaches as many of problems this group encounters in the process of communication do not follow those identified for the sighted user.

Technological and financial constraints have an impact on tactile map production and within the research done they influenced both map design and map use. Taking into consideration the users degree of sensory impairment, previous experience and cartographic skills the research revealed ways to improve tactile mapping production and use. The results also emphasized the relevance of early training and the need for a programme designed to introduce the tactile cartographic language to the young users. In addition, the research drew attention to the advantages of working with multisensory maps which can be appreciated by both visually impaired and sighted children.

2 The cartographic process applied to tactile maps

2.1 New approaches towards cartographic communication

Tactile maps are effective examples to stress the significance of the Cartographic Communication Process which has been widely studied by cartographers in the past. The questions what, how and to whom summarize the essence of this process that starts with the reality to be mapped by a cartographer. A few more questions might be added to those three basic ones, such as when and where, why and with what results.

The final results of the research conducted at the University of São Paulo showed the high efficacy of the tactile graphic language and its importance regarding space perception and acquisition of geographical knowledge, mainly when the user has visual impairment. In a previous work, the author proposed a new model for cartographic communication stressing the role of feedback given by the user during the process of map production [1,2]. Theoretical studies associated with practical experiences led to the construction of a new model for tactile map production and use which is shown in Figure 1.

The basic idea is to have a dynamic structure where all variables are interrelated and connected with each other. The proposed system stresses the role of the tactile map user, as his feedback must be taken into consideration during all stages of the cartographic process. Evaluation of tactile maps by the visually impaired user is a prerequisite to reviewing map design, construction and reproduction.

The consideration of map purpose, to which orientation and mobility were added, together with data gathering and map conception are the initial stages of the tactile cartographic process. The map user should participate in the entire process, which must not be divided in two spheres as it was done in the past. The map maker and the user are both entitled to have an active role, although different in nature. Determinant factors to the user and the cartographer are listed in the diagram on Figure 1. It has to be noted that some of factors are the same for both cases, such as creativity, motivation and skills or natural abilities. Others are specific to each case, as theoretical and technical knowledge for the map maker, or psychological influences and sensory impairment for the user. The full range of variables put together in this diagram expresses well the complexity of the cartographic process, mainly when all relations between those variables are considered.

In the cartographic communication models presented in the past, the map maker was always seen in a separate sphere opposed to the map user. In the same way, map production stages including map design were followed by map use stages with evaluation at the end of the whole process. This scheme can be observed in most models previously proposed by cartographers. Perhaps this has been a result of the lack of applied research since the time when the communication paradigm was strong in theoretical cartography.

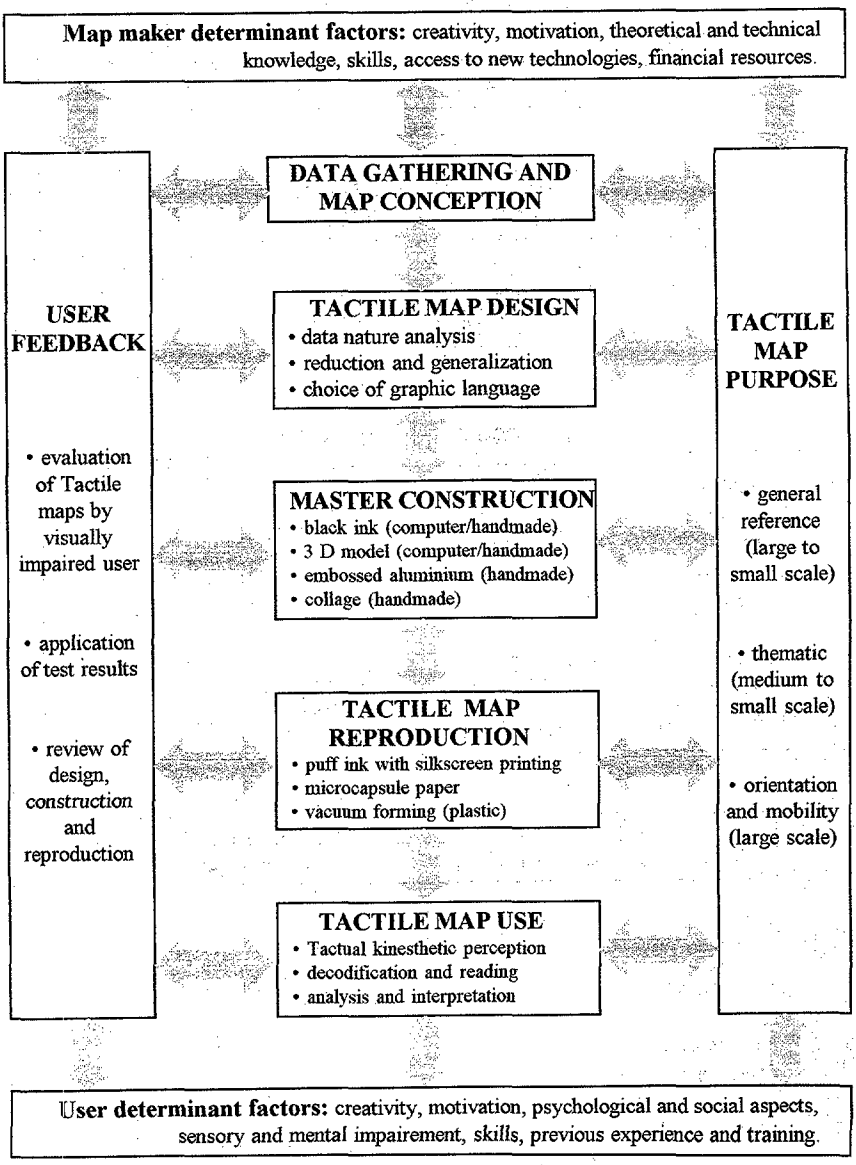
A variation of this model could include education and training inside the cartographic process as a relevant stage to reach successful communication, as shown in Figure 2. Cartographic education and training relates to both map producer and user, and it is required to everyone involved with maps. Tactile map producers are less frequent a cartographer, than in any other case. They are, mainly, teachers, parents and computer specialists. It is rather common to see electronic maps being made not by cartographers because all the available technologies make it easier for the computer specialist to produce maps. Unfortunately, computer specialists lack cartographic knowledge to design a good map, as many teachers and most parents.

In this way, our present reality stresses the need for education and training of all producers and users. They both need to understand the cartographic language, to learn how to make and read a map. This will a great challenge for cartographers in the next decades.

2.2 Tactile map production

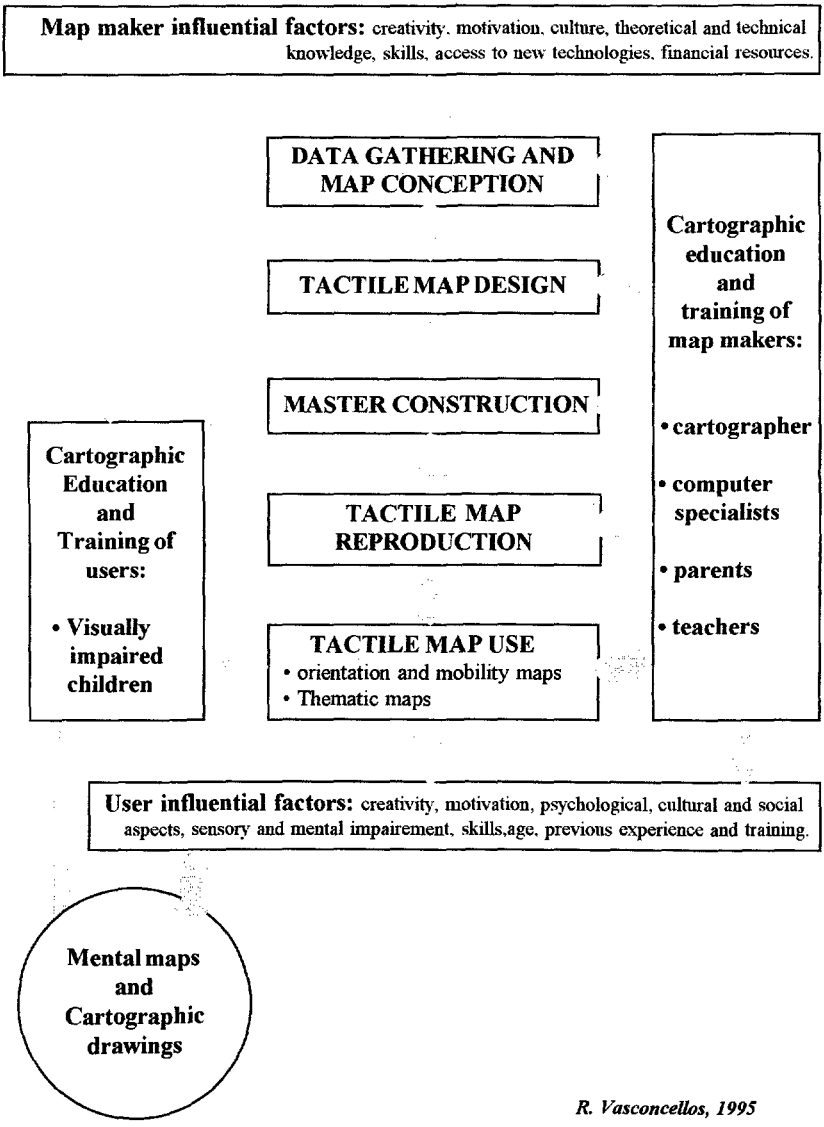
The production of a tactile map has particular stages which are different from conventional cartography. Tactile cartography always has to use some kind of relief to convey information and the user has to use touch to read it, even when using computer technologies. There are other forms of communication which can help the visually impaired user to get the message,

Figure 1 - Tactile Map Production and Use



R. Vasconcellos, 1994

Figure 2 - Cartographic Education in the Process of Map Production and Use



such as sounds. Many authors have contributed significantly to the field of tactile cartography with a considerable amount of theoretical and applied researches on map production and use [3,4,5,6,7,8,9]. Several studies have concentrated on map design and the proper use of tactile symbols [10,11,12.13].

The tactile map maker and the visually impaired user have specific needs and because of that, to communicate geographic information and spatial data, some of the problems to be avoided in cartography, become qualities and conditions to produce good tactile maps. They need a much higher degree of generalization with omissions, exaggerations and distortions never imagined by the conventional cartographer. Tactile cartography should be based on different concepts, following other rules and using distinct techniques, both in map design and production.

Techniques to make masters and to reproduce them were tested and evaluated during the research done by the author. The paper presents some of the advantages and existing limitations of these different methods related to tactile map design and use. The masters were done in black ink for reproduction with the silk-screen process and puff ink on paper; embossed aluminium or collage for vacuum forming with braillon plastic in a Thermoform copying machine.

The methods for making and reproducing masters must be chosen accordingly with several factors: technical and financial restraints such as lack of equipment and funding; number of copies needed; user skills and degree of training; nature of data and proper use of the cartographic language and techniques. Design is the key step in map making. The reproduction method will define the right technique and the proper design to produce a tactile master. As a result of applied research, a set of guidelines directed to map production were prepared [1] and it is listed below.

About map design:

- 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. 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 cartographic skills of the visually impaired user.

About map reproduction:

- it is advisable to make maps in both visual and tactile formats, using colors when possible. In this case, information for low vision users, as conventional writing, can not be in relief to avoid noise for the blind user.
- microcapsule paper and puff ink should be avoided with new users because their low relief capabilities. They have some strong points, such as price of copies and possibility of using computer drawing masters.
- thermoformed plastics can have a much greater variety of textures and elevations, being a better choice to represent all kinds of information and a wide collection of data.

2.3 Tactile map use

Applied research for several years has led the author to emphasize the role of the map user in the cartographic process [14,15,16]. It is essential to take in consideration the user feedback and all the complexity of variables involved. As seen in Figure 1, evaluation should be present during the production process, aiming at better maps to suit the user. Regarding map use, there are some rules to be followed due to particular needs of the visually impaired. 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. 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. They have a great potential of learning how to use the cartographic language, but they do need more opportunities and better materials.

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. A good example is the comparison between the degree of reduction and generalization applied to map construction when directed to visually impaired users from different cultures. It is well known that blind persons do not have the same level of touch perception. There has been much research on brain differences, natural abilities, multiple intelligence and previous experiences and opportunities, but, unfortunately, not related to map design and use.

Another factor which can influence map use is the nature and degree of the visual impairment. One might think that is easy to deal with the user with low vision than the totally blind, regarding maps and graphics. Tests and past evaluations have proven the contrary, since the partially sighted young people hardly use either vision or touch efficiently. Also they do not have a definite and constant situation regarding the degree of visual acuity, not to mention the psychological problems and the social and cognitive restraints. This situation makes all decision regarding map design very difficult when effective communication is to be achieved.

The graphic materials constructed in Brazil were tested with over 200 visually impaired students and they were evaluated by 80 special education school teachers. As a result of tests, a training program directed to the visually impaired user was outlined. Graphic materials, exercises and games were constructed to introduce the basic concepts selected, e.g. point of view, proportion, scale, distance, location and orientation. The program also includes the introduction of all tactile graphic variables in the format of playing cards, which was presented previously by the author [14,15]. In order to practice map key and grid use, together with mastering the last stages of decoding and reading maps, two exercises were proposed. They are the full address and the building of a city, integrating all informations and skills needed to use maps. Suggestions to improve map use efficacy are listed below.

About previous training:

- basic geographical concepts, such as proportion, scale, point of view, location and orientation, must be well understood before working with maps.
- the graphic language has to be introduced to the user prior to map reading through exercises with the visual and tactile graphic variables.
- relief models help children to understand physical space; they are less abstract and should precede the introduction of maps.

About map use:

- cartographic materials must be classified, considering levels of cartographic complexity, user previous experience, skills, age and grade adequacy.
- activities and games can facilitate the process of learning cartography and geography.
- the visually impaired user needs personal assistance or very clear instructions to read maps.

More research relating map use and psychology is needed, including the consideration of mental maps and cartographic drawings made by children. Studies on development stages of blind kids, mainly based on Piagetian theories [17,18] can help to find answers. Andrews [19] made an important contribution to the theme, but there is still a lot to be discussed and, certainly, more research is necessary with the visually impaired in mind.

3. Future Trends in Tactile Cartography

3.1 The need for research and dissemination of tactile maps

Cartographers have made more efforts related to tactile map production, than to deal with map use and dissemination of products. There is a real need for making tactile graphics widely available and for setting up a new agenda for the next years.

With this purpose, the 4th Symposium on Maps and Graphics for the Visually Impaired "The Power of Tactile Cartography in Education and Mobility", was organized on the behalf of ICA by the University of São Paulo, Brazil. It was held at the Department of Geography, University of São Paulo, from 20th to 26th, February, 1994. Of over 200 participants from five continents, there were 155 from Brazil and 48 from other countries. The participants came from several universities, academic and no profit institutions, and public offices, with a large group of school teachers.

This event was the first to be held in Latin America and the main goals were to disseminate tactile cartography in South America, to present current map design and production, and to discuss the new available technologies. These goals were fully achieved through the activities which were developed. There were oral and poster presentations followed by three main panel discussions. A Technical Exhibition of equipment and products was visited by participants as well as by visually impaired users. During the Symposium, it was held the International Map Exposition "Tactile Cartography around the World" showing maps from 23 countries. Also a Workshop on Tactile Map Design and Production was offered by the ICA Commission on Tactile and Low Vision Map.

It was a very good opportunity to exchange ideas, to plan future cooperation between professionals in different areas, to consolidate proposals and joint activities in Brazil, in Latin America, and world-wide. Doors between the academic world and the institutions related to the visually impaired were opened in many ways and, most of all, the need for more maps and graphics in the tactile format was underlined.

The ICA Commission on Tactile and Low Vision Mapping is planning a new agenda for the next years, which will include several goals, such as organizing the 5th Symposium, preparing a Tactile Atlas for Children, and disseminating information through workshops and seminars.

3.2 New digital technologies for map production and use

New political, social and economic facts, together with a variety of technological innovations are bringing important changes to Cartography in all levels. Taylor [20] has presented an excellent analysis of this matter, calling attention to the need of new concepts for cartography, considering the social and cultural contexts, without the predominance of the technological paradigm. Kanakubo [21] has also pointed out five main theoretical issues facing cartography today and four of them do mention computer resources and the new digital technologies.

The relevance of graphic representations nowadays, in our everyday life and at school or work, has been discussed by the author in a previous paper [15]. The visual perception is the most important channel to construct the concept of space, to acquire spatial information and geographical knowledge. For the visually impaired users, graphic representations are extremely necessary because the blind person might need a map to find his way inside buildings. All types of cartographic materials should become available in the tactile format, including thematic, reference and mobility maps. Tactile maps and graphics are the only way for the blind person to see images of our world, to get acquainted with its changing realities. The new technologies and the super information highway can help to produce and to disseminate these materials.

The ICA Commission on Tactile and Low Vision Mapping is proposing one of its terms of reference to be the developing technologies for electronic audio-map supplements, and automated tactile image production and use. There has been research with these kind of equipment, mainly with NOMAD, a device developed by Dr.Don Parkes in Australia, which has been used in many countries. NOMAD adds sounds to tactile graphic representations besides other features such as drawing directly on the pad. Both digitalised speech or sounds from our environment are stored in the computer to be activated by touch. Several layers of information related to each map could be combined and stored.

Dr.Don Parkes, from the Research Unit in Spatial Cognition and Choice at the University of California, and Tricia d'Apice, from St.Lucy's School for Visually Impaired Children in Australia, have completed a Map Reading Kit, a multi-media audio-tactile graphics that works with NOMAD. Other cartographers [22] and specialists are doing major projects on tactile automated cartography, such as the Tactile Map of the New York Subway, coordinated by Dr.Karen Luxton, from Baruch College.

Nowadays, new digital technologies might even bring the communication paradigm back on the scene, since new products on screens will have to be evaluated as communication means of spatial information. Cognitive and perceptual researches are going to be needed in order to improve map design in all hardware and software forms.

4 Final remarks

The studies with Tactile Cartography, doing tests and evaluating results, have shown some relevant facts: 1.Tactile maps and graphics are the only way for the visually impaired to "see" images and graphic representations of our word. It is fundamental to design, to reproduce, to distribute and to teach how to use these types of materials. 2.Tactile Cartography can facilitate the space perception process and geographical knowledge acquisition for everyone, especially children, either sighted or sensory impaired.

The visually impaired person, deprived of sight, have no other choices than perceive the world through tactual/haptic, hearing and smelling sensations. They also use, with great

success, these senses to navigate in space as well as to learn about the world we live. This fact enhances the need to shift from tactile to multisensory cartography. I always stressed the relevance of creativity and motivation both to the producer and the user, in designing and reading a product, such as a map; for a multisensory teaching material to be creative and motivated is even more important.

Five years working with visually impaired students made it very clear that we are not paying enough attention to our senses, and most of all, we are not educating our children to develop their sensory potential. The fact that our culture is completely dominated by the sense of sight have transformed visualization to the basic media for all communication. The new information era based on computers and networking communication will enhance our needs to rely on the visual world, making this trend even worse.

It is also vital to detect failures during the whole process of cartographic communication, problems might be located at any stage such as design, master construction and reproduction. The user feedback should be considered in all levels to review the decisions taken by cartographers, and to suggest new products, such as a tactile multimedia atlas or multimedia mobility maps. Tactile cartography can help the visually impaired, facilitating their access to our world dominated by images. It is very important to design, to reproduce, to distribute and to teach the blind and low vision people to use the cartographic language. In the future, cartographic education should be extended to all map makers and users.

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