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The effect of volumetric (3D) tactile symbols within inclusive tactile maps

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ABSTRACT

Point, linear and areal elements, which are two-dimensional and of a graphic nature, are the morphological elements employed when designing tactile maps and symbols for visually impaired users.

However, beyond the two-dimensional domain, there is a fourth group of elements – volumetric elements – which mapmakers do not take sufficiently into account when it comes to designing tactile maps and symbols.

This study analyses the effect of including volumetric, or 3D, symbols within a tactile map. In order to do so, the researchers compared two tactile maps. One of them uses only two-dimensional elements and is produced using thermoforming, one of the most popular systems in this field, while the other includes volumetric symbols, thus highlighting the possibilities opened up by 3D printing, a new area of production.

The results of the study show that including 3D symbols improves the efficiency and autonomous use of these products.

1. Introduction

Tactile maps are a group of resources that show graphic information using relief (Picture 1). Tactile symbols are included within this type of resources and are normally used with their corresponding legends. These products help persons with visual impairment to understand features of the environment around them through the sense of touch and are often used, for instance, to communicate and teach geography or in the acquisition of orientation skills for facilitating mobility through specific environments (Edman, 1992).

According to the literature, there are three types of morphological element used in the design of tactile maps (Picture 2), tactual symbols, or any tangible graphic for the visually impaired, namely: point, linear and areal elements (Amick et al., 2002; Correa Silva, 2008; Edman, 1992; Welsh and Blasch, 1980).

However, a fourth category of design elements, volumetric (3D) elements (Wong, 1993), is barely used in the design and production of these types of products. This is partly due to some limitations of the most commonly used production systems (Picture 1): microencapsulation and thermoforming (Perkins, 2002; Rowell and Ungar, 2003b).

In line with this, several notable studies have been conducted to compare these two, or other, methods of production, with varying results. Ungar et al. (2005) or Dacen Nagel and Coulson (1990) suggested that the microencapsulation method was a more appropriate system to produce tactile maps than thermoforming, although other researchers such Pike et al. (1992) obtained similar results in their experiments with children involving both types of systems. Finally, Gardiner and Perkins (2002) noted important advantages of thermoformed over microencapsulated paper maps, among others, because in their studies well-designed thermoformed maps offered consistently better results than microencapsulated ones. One of the main problems of the thermoforming system is the time cost involved in generating a master to produce the map. On the other hand, the microencapsulated system is cheaper than thermoforming if a single copy of the map or a short series of them needs to be produced; its resistance, however, is not enough for continued or critical use due to the known degradation of the swell paper used in their manufacture. In any case, both techniques allow light, flexible and, therefore, portable maps to be produced, for use in real contexts or in indoor situations.

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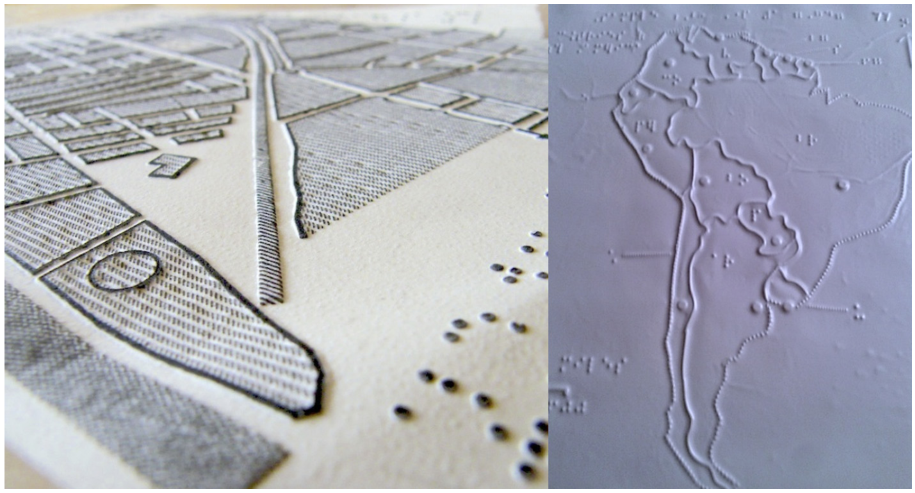


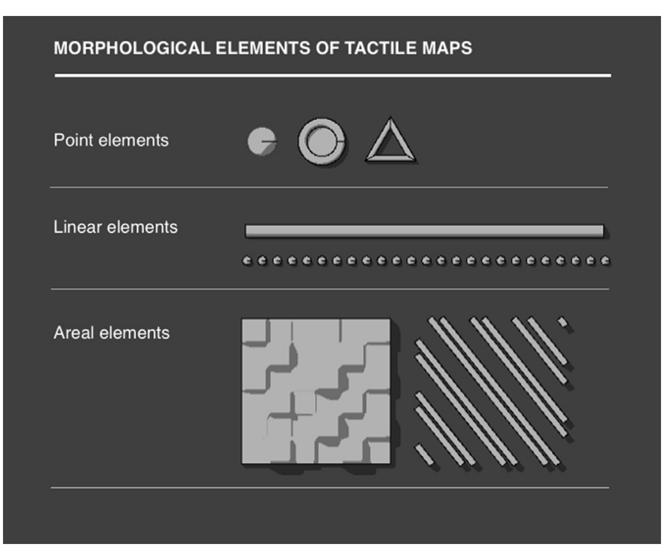
Picture 1. Image of a tactile map produced using microencapsulation (left) and a monochrome thermoformed map (right).

The novelty presented by this work is the study of some possible applications for volumetric elements, basic prisms (Picture 3), applied as punctual tactile symbols in order to improve the usability of tactile maps. In this case, 3D printing is the technique used to manufacture these symbols since it can produce more complex geometries than traditional methods (Chua et al., 2003).

Through 3D Printing it becomes possible to produce final maps in short series or even rapid master pieces to evaluate the product before launching it. Nowadays, the price is constantly decreasing and the final cost of one piece consumes less time and expense than producing, for example, an industrial master (thermoforming system). Although they are not portable because the tactile maps produced by 3D Printing are rigid, they are durable.

In any case, the use of one system or another to produce a tactile map depends on the aims and the requirements, and any system can be useful depending on the intended purpose of the map.

In this study the researchers have selected the thermoform process to compare it with the 3D Printing system. The decision to choose thermoforming is mainly due to the fact that it offers better control over the height contrast of the elements of the map than in the case of the microencapsulation process; according to Gardiner and Perkins "establishing the relative height of features in multi-level design is an important part" (of the process of designing tactile maps and symbols) (Gardiner and Perkins, 2002). This fact makes it possible to produce more similar conditions between the selected methods in terms of geometry. Microencapsulation, however, does not allow the production of a multilevel of heights within the relief elements on the tactile map. This is why it was not considered in this experiment.

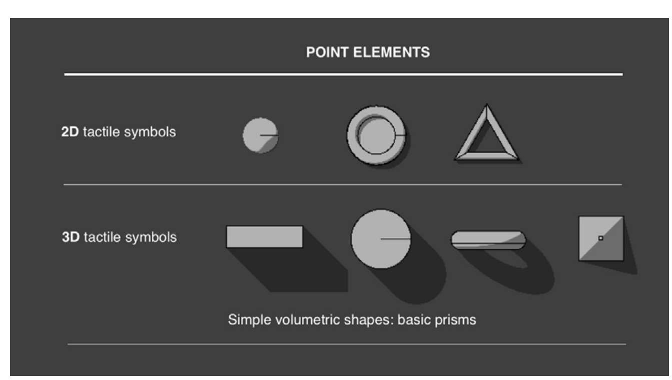


Picture 2. Sample of some representative shapes of the three types of elements used to design tangible graphics.

1.1. Important factors in users and tactile maps

Some of the most important factors to be mentioned for the design and use of these products are:

- In general, the lower tactile acuity of the sense of touch, in comparison with the sense of sight (Schiff and Foulke, 1982).
- Secondly, the need for verbal assistance from a Mobility Instructor. These devices are normally used in audio guidance to make it easier to understand the tactile stimulus explored.
- Thirdly, user familiarity (previous experience) with these products. The ability to read a tactile map depends on the skills, exploration strategies, experience and training of the people using it (Jover et al., 2008). These factors allow blind users to recognize the information offered by a tactile product more accurately and effectively, even in real contexts (Perkins and Gardiner, 2003).



Picture 3. Sample of 2D and Volumetric (3D) tactile symbols. 3D symbols have greater height contrast.