# Relief Representation in Museum Itineraries

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*Abstract*

*The paper has the aim to explore relief representation mode able to transfer meanings of objects present in museum itineraries into an effective language understandable by people with visual disabilities. The research, also supported by issuing of indications by the General Directorate of the Museums of MIBACT, which require facilitating the communication of cultural heritage to all types of users, arises from an analysis of European museum realities that highlights the different approaches to this topic. The development of a methodology has, as its basis, a study of perceptive abilities and learning procedures of the visually impaired, which is accompanied by some considerations on methods of relief representation. From these premises some procedures and good practices are developed, which seek to identify effective and efficient solutions for a correct communication for the haptic perception of cultural information towards visually impaired people.*

*Keywords: visual impairment, relief representation, tactile panel, tactile communication, visual-tactile representation.*

## Introduction

*Relief representation* has several characteristics depending on the field of use.
Tactile Maps are used in case of Wayfinding (connected to "cognitive or mental maps", that people form in their minds when they explore more or less known places); Tactile Information Panels are used in museum communication, both for closed and open-air museums (parks or archaeological areas); finally Tactile Plates are used in a tourist communication or as a learning tool.
Further variables are constituted by the nature of supports used (aluminum sheets, acrylic sheets, sheets of cardboard with relief printing, or thermoform) and processing techniques (rapid additive or subtractive prototyping).

Syntax of *relief representation* is linked to that of visual representation and results in identification of methods that take into account different factors, from haptic discrimination (to facilitate reading with fingertips and for the use of the visual residue by the visually impaired), to the kind of blindness (blind from the birth or in a late age).
*Relief representation*, thanks also to the "Guidelines" of 6th July 2018 issued by the General Directorate of Museums of MiBACT, which introduce the *Plan for Elimination of Architectural Barriers* (PEBA), is increasingly requested in the form of Tactile Maps to guide visitors in museum, Tactile Information Panels to be associated with objects present in the exposition area, and finally Portable Tactile Plaques to allow consultation of information during a museum tour.

## Recent solutions

*Relief representations* are used in different cultural contexts, to allow effective communication for the visually impaired and the blind.
Are analyzed solutions used in some museums, according to the 2019 report provided by the non-profit association Themed Entertainment Association in collaboration with AECOM, among the 10 most visited in the world:
1 - Paris *Louvre* (10,200,000 visitors);
6 - *British Museum* of London (5,869,000 visitors);
9 - *Natural History Museum* in London (5,226,000 visitors).
To these is added the *Cité des Sciences et de l'Industrie* where there is also a library for visually impaired.

*Louvre Museum, Paris*
Louvre Museum presents three different tactile communication solutions for the visually impaired: maps/information tactile panels referring to the building and rooms of the museum; tactile panels referring to permanent collections; tactile panels for temporary exhibitions.
Tactile panels referring to the museum, section of the "*Pavillon de l'Horologe*", use a form of representation with mongian projections in plan and section/elevation, where is displayed a tactile visualization of the current museum and of the foundations area of the Castle of Louvre dating back to 1380. In the Islamic Art section there are some points of interest with tactile panels reproducing three-dimensional objects that cannot be touched by visitors (fig. 1). Finally, in the section of temporary exhibitions, such as the one present in 2019 called *Techniques et Gestes*, there are tactile panels, in addition to reproducing the phases of the first forms of printing, representing some tools for the mobility of characters and for drawing on the plate with burin.

*British Museum, London*
In the British Museum there are portable plates for the visually impaired placed in special pockets at the entrance/exit of each room. In some rooms are present 3D models that reproduce architecture or objects from the classical world, such as the Parthenon in Athens.

*Natural History Museum, London*
Natural History Museum has some points of interest where are reproduced 3D paleontological finds, organized to be explored aptically by the visually impaired.

*Cité des Sciences et de l'Industrie, Paris*
The museum has been very careful to blind visitors since

*Fig. 1. Touch point of interest to "read" objects that cannot be touched by visitors. Louvre Museum, Paris.*

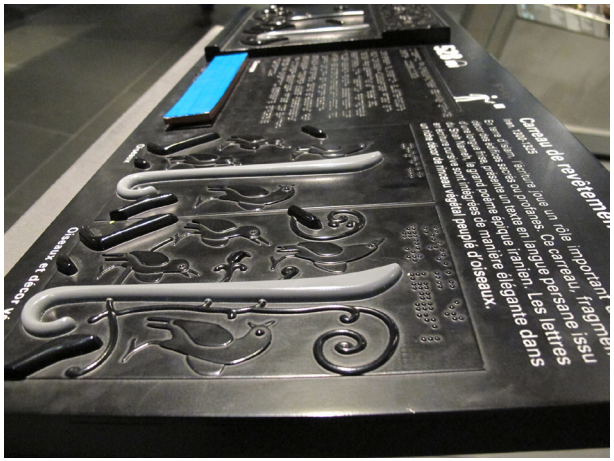


*Fig. 2. Bronze tactile map that describes the spatial articulation of the building and its surroundings. Cité des Sciences et de l'Industrie, Paris.*

its building, in fact it has a reading room for the visually impaired. The spatial organization of the building and surrounding gardens are displayed in a tactile map located in the external access points (Fig. 2). Inside, in the main hall, there are several 3D representations that allow the understanding of the overall spatial organization. Tactile information panels are also present in permanent or temporary exhibitions.

Italian scientific literature has been dealing with the topic since the early 1990s: 1993, MURST research coordinated by Prof. Emma Mandelli with the outcome of the seminar *Il disegno per l'apprendimento delle forme da parte dei soggetti non vedenti* (*Drawing for the learning of shapes by blind people*); 1996, issue 26 of the journal *XY, Dimensioni del Disegno*, single issue entitled *Il disegno oscuro* (*The dark drawing*); 2006, monograph by Lamberto Nasini and Hasan Isawi, *Una geometria per comprendere lo spazio senza percepirlo visivamente* (*A geometry to understand space without perceiving it visually*) [Nasini, Isawi 2006]; 2013, article *Universal Design: ruolo del Disegno e Rilievo* (*Universal Design: role of Drawing and Survey*), in the journal *Disegnare Idee Immagini* n. 46; 2018, Summer School organized in September by the UID on the theme *Rilievo dei Beni Culturali e rappresentazione inclusiva per l'accessibilità museale* (*Survey of Cultural Heritage and inclusive representation for museum accessibility*).
*Occhio della mente* (*Eye of the mind*) conferences organized by the Chiossone Institute in Genoa since the mid-1990s.
Manuals are: 1994, Fabio Levi and Rocco Rolli with *Disegnare per le mani. Manuale di disegno in rilievo* (*Drawing for the hands. Relief drawing manual*) [Levi, Rolli 1994]; French instruments for *Dessin en Relief* (DER) [Brie, Morice 1996].
Some indications of "normalized" procedures refer to braille and "black" characters (that is, letters written in relief in the Latin alphabet):
ISO 24503:2011, defines the characteristics of braille points;
ISO 17049:2013, identifies the spaces that must be kept free to allow Braille read in signs and panels in general (relief models, panels and tactile maps);
ISO 19028:2016, refers to information that must be present in a tactile map, defined as: "information map for the visually impaired that provides a good idea of public spaces, public transport, parks, which is made recognizable using, for example, convex lines (raised) and/or convex or hollow surfaces (engraved signs), tactile signs, braille and/or raised characters, and/or enlarged characters, and

*Fig. 3. Visual-tactile map, detail of the braille characters. Museo delle Mura, Rome.*

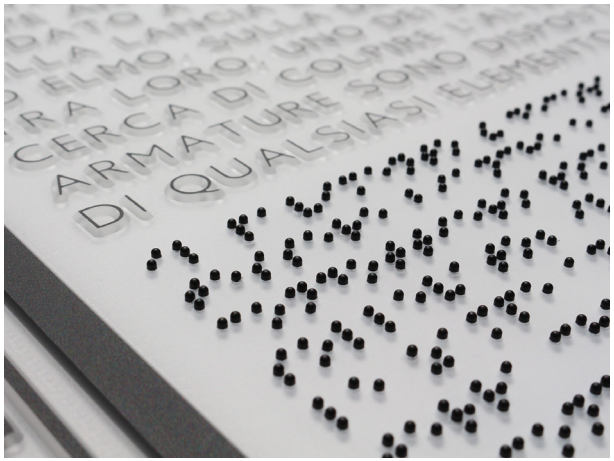
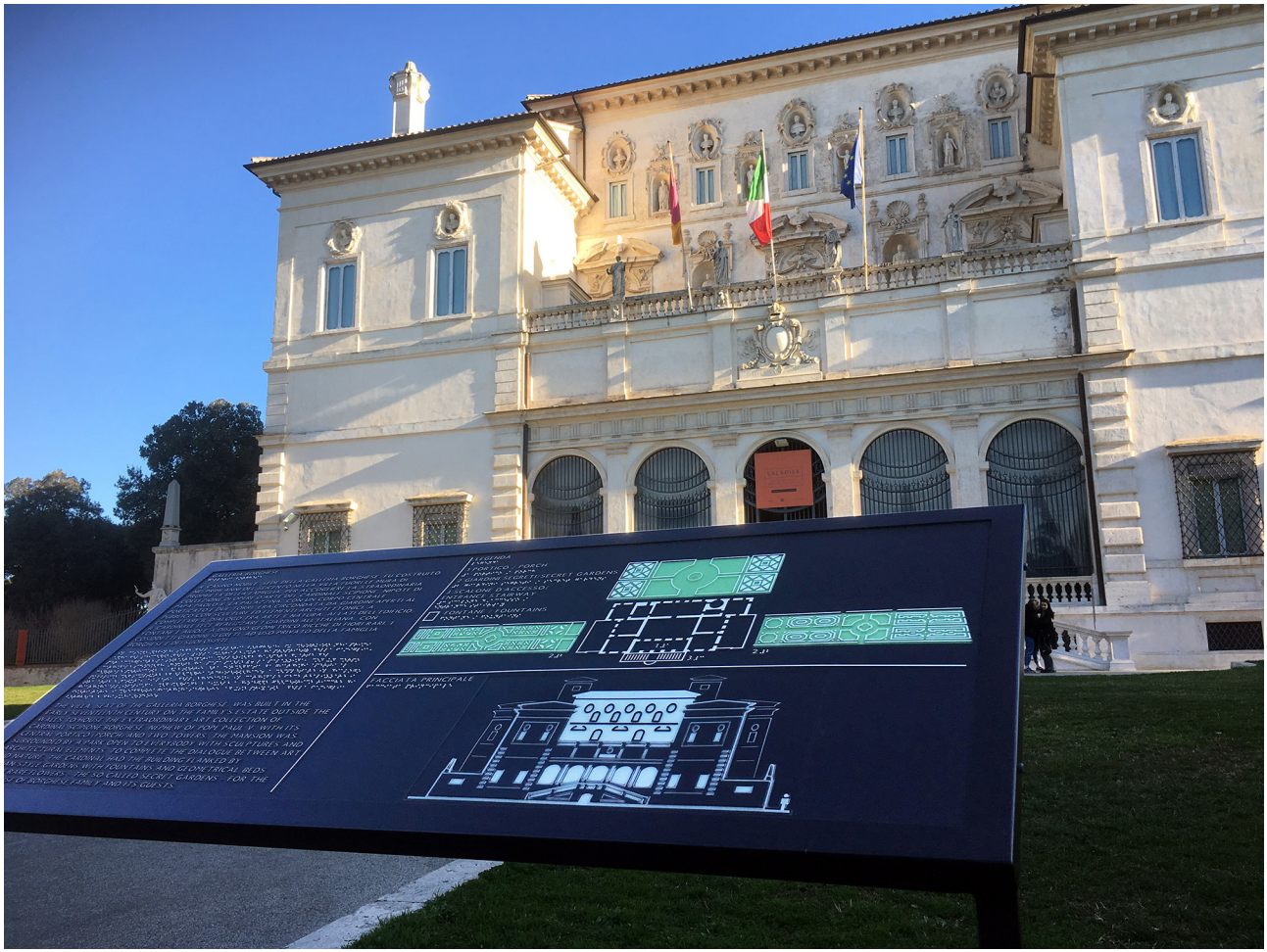



*Fig. 4. Exploring a map. Hands analyze the plan following non-linear paths.*

*Fig. 5. Visual-tactile map. Example of a process of synthesis and graphic reduction to facilitate recognition of the visually impaired by haptic exploration.*



can be of two types: tactile map installed in buildings, etc. o have the format of a portable booklet";
ISO 24508:2019, provides guidelines and design requirements for tactile symbols and fonts used to provide information to people who need non-visual or non-auditory information. It is applicable to products, structures and equipment in homes and transport, services and packaging, where tactile symbols and characters can be used;
UNI 8207:2003 (Undergrounds – Signage for travelers – General requirements) regards the signs to be installed in stations and along underground lines, the dimensions of letters in "black", in relief and the height of the braille.
Reading tactile solutions, in literature and of normative rules, shows a great heterogeneity in terms of graphic signs used and captions supporting the panels, where there are not always words written in "black", and braille presents "heights" outside the provisions of ISO and UNI standards.
In the past, some attempts have been made, conceptually incorrect, to insert, for example, the transposition of the value "500 lire" on the coins of the Italian Republic. The size of "braille" was scaled and compared to the size of the coin, resulting undetectable by haptic exploration. Blind people were able to recognize the coin because it was made of a double metal alloy (like the current 2 Euro coin), which sounds, on percussion, unlike those made with only one metal.

## Methodology

Like the definition of the syntax of a language [Gibson 1950], where rules and variations are defined with use over time, the same procedure is necessary for a representation in relief for the visually impaired, a discipline/ language of new acquisition. Today there are no codifications recognized by the scientific community and users regarding the transcription of "visible" reality.
Only recognized language is Braille alphabet, which takes its name from its creator Louis Braille. It developed from the first half of the 19th century, organized according to a system of 6 points in relief, of univocally determined size, placed on a 2x3 matrix, where each textual character (so-called in "black") corresponds to an equivalent braille character, formed by a combination of the 6 raised points on the matrix; syntax and punctuation remain the same as in "black" writing (fig. 3).

Braille alphabet allows only a "translation" of the textual area, while "visual translations" are increasingly required, especially in the museum context.
How can I translate the visible?
From a graphic point of view, implications are the same as those related to a composition of representation, that is to identify the characteristics of the sign (trace), the phenomenal position of representation plane, to evaluate the process of emphasizing-excluding the elements compared to the purpose of representation [Massironi 1982].
The search for normalization paths of relief representation procedure was born from the need, in museum context, to emphasize a textual descriptive communication of some phenomenal realities and to facilitate their understanding.
Sign can have different thicknesses (generally expressed in millimeters), different types of weft (solid line, dashed line, dot line, in turn with different intervals between the different elements that compose it), multiple combinations to form textures as a filling of closed geometric figures, with or without margins. In relief representation it can assume the characteristics of object, outline or weaving functions.
Phenomenal position of representation plane generically contemplates all modalities expected by descriptive geometry, from the generic position of the perspective with

*Fig. 6. Visual-tactile map, detail of different depth levels. Galleria Borghese, Rome.*

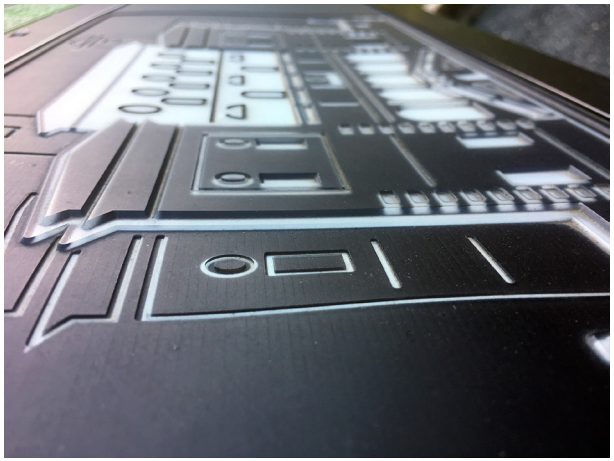
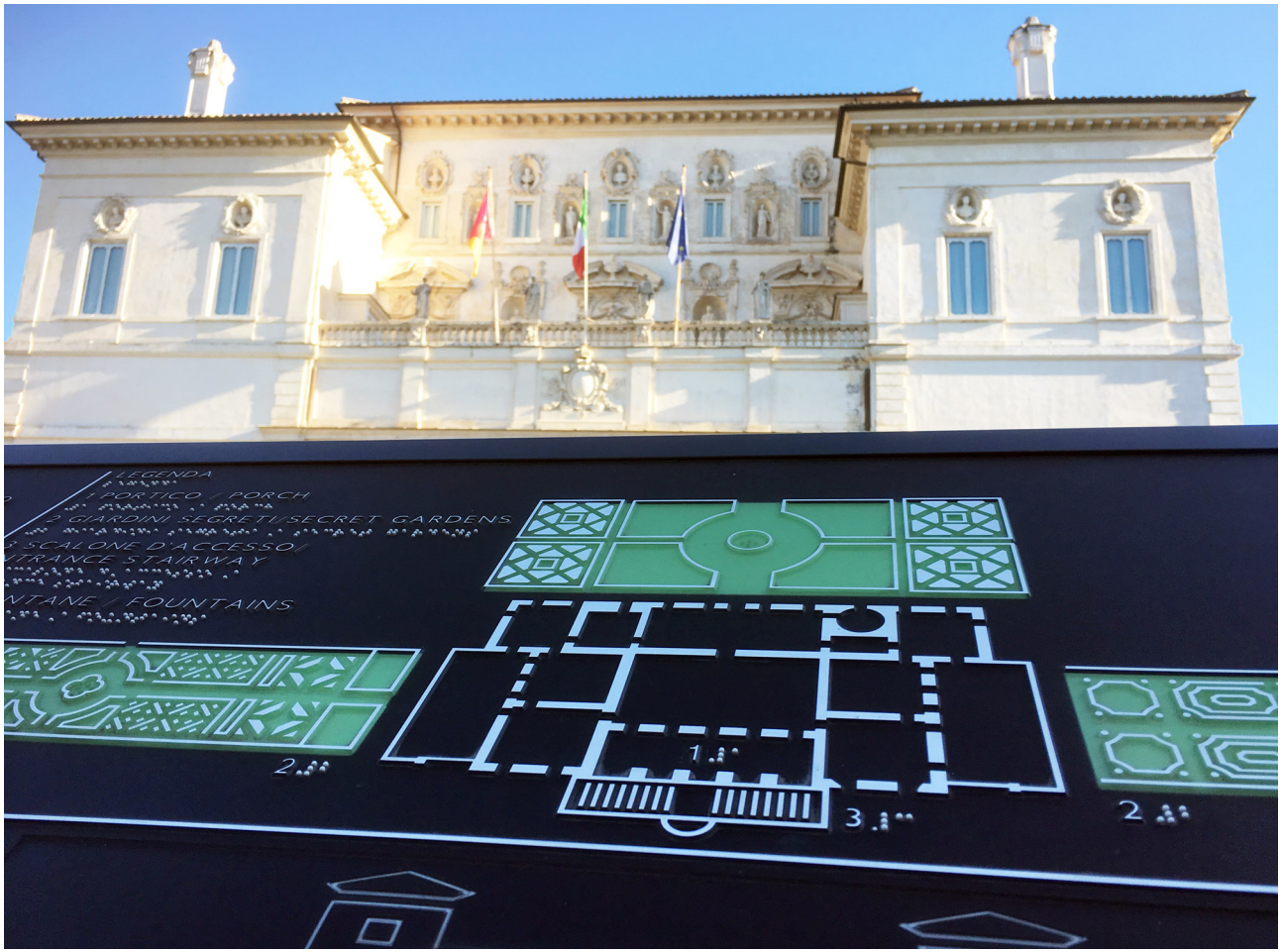


*Fig. 7. Visual-tactile map where color is used to highlight the gardens. Galleria Borghese, Rome.*



an inclined frame up to particular cases of orthogonal projections (table of the twelve methods) [de Rubertis, 1993]. As for tactile perception of the visually impaired, a frontal projection is more understandable, using orthogonal projections, since a mental abstraction process better includes a transfer of geometric shapes, however arranged in space, using an improper perpendicular projection center on the representation plane.
Emphasis-exclusion process is the main tool that representation makes available for making critical choices with the use of signs, which can emphasize some aspects or exclude others. This is the reason why the representation of a landscape, for example urban landscape, critically highlights some parts of the city, deliberately excluding everything that does not want to be emphasized, unlike photography, which however artistic and targeted it cannot make a selection, therefore excluding, what is not relevant in the communication process.
Emphasis-exclusion process depends on the ability to perceive the signs with the use of haptic exploration.
Coding a relief symbology requires a thorough knowledge of characteristics of the sense of touch, of haptic perceptibility and of mental processes of memorizing information acquired by a visually impaired person with that medium. Touch is, in fact, analytical and a perception of the whole is obtained through the organization of a sequence of partial information. Synthesis is therefore a complex process and can become difficult if a representation exceeds, for example, maximum dimensions allowed by the movement of the arms of a person, considering also that for exploration, mainly, two hands are used side by side or separated (fig. 4).
Furthermore, haptic exploration should not be understood as a succession of acts along a linear path or in any case always the same in all directions. The work of the hands is very complex and varies every time: it depends on the image to be analyzed, on its shape, on its complexity; by the characteristics and experience of the person who is exploring; from the level of depth of his analysis; from the time he thinks he has available, from intermediate results he has gradually achieved, from any aid he has, etc. [Levi, Rolli 1996].
Furthermore, haptic discrimination is limited and incapable of grasping very small details, so these must certainly be represented larger than those perceivable by sight: for example, a raised line is not perceptible below 0.5 mm of thickness, while braille dots must be at least 1 mm high.
Main requirements of "relief representation" are:
- careful s*election of elements to represent*, simplifying signs to be made in relief, taking into account that thickness of the sign must be contained within the minimum and maximum threshold of the perception of the fingers;
- *control of proposed forms in relief* within the geometric

*Fig. 8 Visual-tactile map, detail: example of a line used as a texture. Museo delle Mura, Rome.*

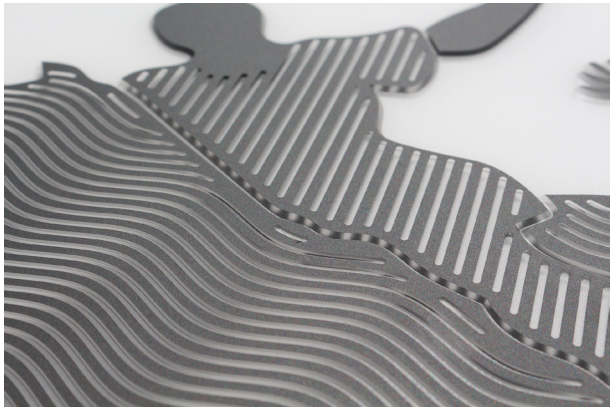
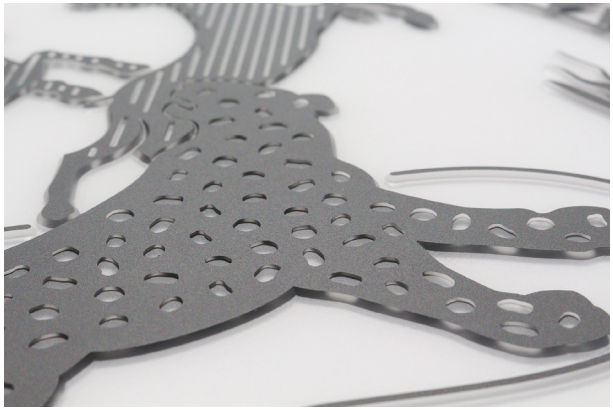


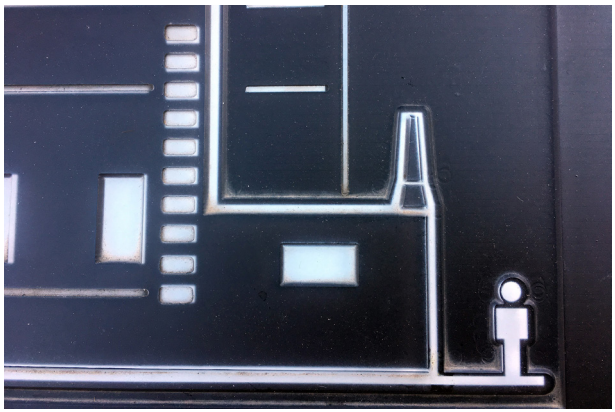
*Fig. 9. Visuo-tactile map, detail: example a surface with texture that describes the spotted skin of a cheetah. Museo delle Mura, Rome.*



and semantic recognition of the elements that are described;
- *pleasantness in the haptic perception* of lines and surfaces that are proposed to document the phenomenological reality;
- *scale of representation*, known elements of reference help to understand the size of the objects represented;
- characters according to ISO 24503: 2011, ISO 17049: 2013, ISO 19028: 2016, ISO 24508: 2019, UNI 8207: 2003 and ANSI A117.1: 2003;
- *compatibility of graphic language* and representation methodology used with the medium.

*Selection of objects to be represented* is a part of the emphasis-exclusion procedure, previously mentioned, and also contemplates figure-background relationship. Relief representations should be devoid of elements that make images more pleasing to the eye, given that the goal is to make them recognizable to the touch sense and that "complementary" information is misleading respect to recipients and the level of communication to be obtained. In addition, often, there are difficulties due to the constraint of using orthogonal projections, since it is necessary to make people understand different depth levels of objects, or their spatial development (fig. 5).
This criticism is overcome by using a particular production technique, with tactile panels made of transparent methacrylate and processing by CNC machine. Upper part of the panel is excavated and/or engraved, using some levels (on 3 mm thick slabs, there are 3 layers that can be used) where is established a hierarchy of elements that must be placed lower and those that must be placed higher (fig. 6). Plates are printed in the rear part, so that they can be read from above, all informations that must not have tactile but only visual relevance. Even this type of information must go hand in hand with the hierarchy of elements that are made in a "tactile" way.
Another element, to complete the emphasis-exclusion path, is the coloring, that can be given as a base to the transparent methacrylate plate: in the part below the area that is not printed, it has a background color that must make the reading of the elements placed at the top optimal, to facilitate reading for the visually impaired and, consequently, to all those who use sight as a privileged communication channel (fig. 7). These characteristics make the information panels visuo-tactile.
*Control of proposed forms* in relief provides different levels of geometric and semantic recognition: for points, care must be taken that they are not confused with the letter-points of the Braille alphabet; lines must be at least 0.5 mm wide, as a minimum graphic perception threshold. Furthermore, a distinction must be made between the "object line" (to represent a filiform object), the "contour line" (which delimits a surface) and the "weaving line" (when it constitutes the weaving/texture that serves to sample a surface) (fig. 8). Surfaces, in order to be better recognized, must be of the closed type, considering that only raised contour is not sufficient to satisfactorily define a surface, requiring textures; textures must be at least 2 mm away from the contour lines, while, in the internal part, between them, they can also be closer [Levi, Rolli 1994] (fig. 9).
*Pleasantness in haptic perception* involves the study of a texture as a function of exploration through fingertips and possibility of recognizing inserted geometric shapes. Also in this case a distinction must be made between symbolic textures, with respect to the meaning of what to express, or iconic, such as rectangles arranged in parallel rows to document a masonry in *opus latericium*, or the use of an oblique texture to 45 degrees.
*Scale of representation* is a decisive element to help understand the size of an object represented. In fact, for objects that have a size greater than what can be perceived by the simultaneous use of two arms (and therefore cannot

*Fig. 10. Little man represented on scale, referring to the represented object, facilitates the understanding of the whole dimensions. Galleria Borghese, Rome.*



be perceived in their entirety, which the view allows), dimensional scale must be understood with respect to a known element, which can, for example, be the figure of a man (fig. 10). A further consideration is a correct correspondence of the elements that semantically compose the representation to the haptic perception, since in many cases a correct metric scale ratio can lead some geometric elements to assume, in a reduction path, the dimensions that can no longer be discriminated by use of touch.
In addition to responding to ISO and UNI standards indicated above, "*braille*" *and* "*black*" characters must include a minimum distance between geometric elements in relief and the position of descriptive text in "black" and in braille, defining functional fields. The "black" text must use a sans serif typeface in capital letters, to allow a better distinction of those letters of the alphabet that can create misunderstandings of recognizability from lowercase, remembering that only 30% of the blind knows braille, while the majority recognizes letters of the Latin alphabet.
Finally, *compatibility of graphic language* must be related to the type of support where "relief representations" must be placed, according to the degree of workability by CNC machine with subtractive prototyping.

## Conclusions

In *relief representation*, the process of defining sign elements and their syntax is the subject of research into the field of representation. Hope is a possibility of defining some normalization paths for procedure tested to fill the gap still unresolved by entities accredited for this purpose at national and international level such as ANSI, ISO and UNI.
Methodology reported in this paper has been tested favorably (with satisfaction from stakeholders) on multiple projects, but does not claim to be a solution to a problem that requires transversal skills of scholars of cognitive psychology, representation and forms of production associated with different types of graphic output and by typhlologist (experts who know the problems related to blindness at 360 degrees). It is hoped that the scientific disciplinary sector of representation will constitute a proposing part of meetings and further experiments, to define a representative framework based on recognizable and shareable rules with all those people interested in dissemination of tactile messages to complement communication-based on visual messages.

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