DESIGN AND DEVELOPMENT OF FLOORING FOR THE SIGHT-IMPAIRED: 'GUIDE PROJECT'

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ABSTRACT

About 45 million people worldwide suffer total blindness and 135 million are sight-impaired, which means that almost 180 million people suffer serious sight impairment.

This paper presents the results of a project on the design and development of a ceramic product for persons with sight impairment, to facilitate their orientation in public places.

On the basis of the needs and habits of this group of persons, all the chromatic conditioning factors and textures which could serve the proposed aim were studied.

After the compiled information had been analysed, different solutions were considered, for flooring as well as for wall tiling, using different forming and decoration techniques.

Finally, a floor tile solution has been proposed that consists of only 3 special pieces made with a technique adaptable to any ceramic surface.

The proposed solution also attends to the needs of the people with some remaining sight and has a warning function for the sighted, without causing any added difficulty to persons with other types of disabilities.

The objective of this project is the application of this system in the inner flooring of public buildings, which would notably improve the orientation and movement of sight-impaired persons in places like banks, stations, city councils, etc…, thus also extending one of the functionalities of design, its social dimension.

1. OBJECTIVES/INTRODUCTION

At the present time, there are some 180 million people worldwide that suffer important visual handicaps.

The main objective of this project consists of making a product that is 'perceivable' by these people, which will help orient them inside institutions and public buildings (airports, banks, libraries…), since it would not be of much use to make a product destined for private rooms, because blind as well as sighted persons are able to find their way around the home without any difficulty.

If anything characterises ceramics, this is its universality. It is found throughout the world and wherever we look, we can always find it around us. Therefore, if it is so universal that it reaches everywhere, why should it not also reach everybody, including that large minority, the sight-impaired?

1.1. CONDITIONING FACTORS

The decorative patterns, textures and colours shall be appropriate for the perception of the preferential users targeted by the project (perception in this group is fundamentally tactile, by hand or white walking stick [20,21]), while the resulting product will also need to respond to the aesthetics currents of the moment, i.e. pleasant to the view of sighted people.

A survey of the different bibliographic sources found in the documentation showed that the following points needed to be taken into account:

1.1.1.Wall tiling

- Decorative patterns:

  1. – Schematic representation of the figures.
  2. – Elimination of superfluous details that could confuse a person.
  3. – Maximum simplification of perspective without deforming the reality of the objects.
  4. – Using symbols that serve as a reference point for the location of features that are to be highlighted.
  5. – Assurance of the appropriate size of these patterns so that the exploration lines (the displacements of the hands in a vertical and horizontal direction) are appropriate for locating the different elements.
  6. – Using very clear lines and, above all, breaking these down until reaching a simple line, in order to be able to decipher this as accurately as possible.
  7. – Not using superposed lines or drawings and, in case they are used, distinguishing these by different heights.
  8. – Keeping the patterns proportional when there are different sizes.

- Textures

  1. – In the case of wall tiling, it is very important that the textures should be pleasant to the touch.

  2. – In flooring, to distinguish different areas, different textures can be used, just as different heights.

- Colours

  Many studies have been conducted on the perception of colours[19].

  - Among the sight-impaired, there are not only those wholly are completely blind, but there are also those who still retain some remains of sight, people with serious visual difficulties that traditional ophthalmology cannot solve with common glasses or surgical operations.
  - This group of people can manage to perceive colours if the position of the colours is well-chosen.
  - The most important feature is the colour contrast. For this, it is necessary to differentiate the large surfaces with one colour and the small details with another, totally different one.
  - The contours of the decorative patterns shall also be sharp, with colours that contrast with the background. The following presents some combinations that have been studied at length by professionals for good reading and perception by the reader:

Figure 1

1.1.2. Floor tile

- Roughness of the floor

  As far as roughness is concerned, we will need to take into account the features indicated previously in the wall tiling, but in this case, the high or bas-relief should be more pronounced, since although the white walking stick is an extension of touch, it does not have the same sensitivity as the tips of our fingers, or finger mobility. It always follows the same line (from right to left).

- Surface hardness

  The floor tile will need to be of appropriate hardness, as it is for interiors with intense pedestrian traffic.

GLAZED FLOOR TILES					UNGLAZED FLOOR TILES		
Area	**Abrasion UNE-EN 14411**	**Scratch hardness (Mohs)**	**Stains**	**Gloss**	**Area**	**Deep Abrasion**	**Stains**
Exteriors and building accesses	Class 4_{2100r}	6	Class 3	<15 doormat	Exteriors and building accesses	<393 mm^3	Class 3
Area of heavy inner traffic	Class 4_{2100r}	6	Class 3	<15	Area of heavy inner traffic	<393 mm^3	Class 3
Area of moderate inner traffic	Class 3_{1500r}	4	Class 3	<15	Area of moderate inner traffic	<649 mm^3	Class 3

- Applications of special colours

  The chromatic treatment shall be the same as in the case of the wall tiling.

2. DEVELOPMENT

A flooring was sought that would serve as an orientation and guide for the fully or partly blind. Sight-impaired persons need a series of pronounced textures in the flooring for the walking stick to detect these obstacles and warn the persons of any changes in the floor; however, for people with a physical disability, this series of roughnesses poses a problem because of slipping of the wheelchair (according to ANSI A117.1-1998[1], ADDAG 4.29.2 and ASTM C1028, the static coefficient of friction must exceed 0.6 for horizontal surfaces and 0.8 for sloped ones).

Therefore, it was necessary to look for a compatible project for all the groups that had some type of disability.

First, it was thought to design a square floor tile, size 40x40cm, with a series in bas-relief in which a person, through the walking stick, could recognise the icon that it contained for a better position.

It was considered to make bas-reliefs in which the walking stick would introduce itself and could decipher the information provided in the tile.

2.1. DECORATIVE PATTERNS

Very easy abbreviations were chosen as regards design and understanding:

- The abbreviations WC are familiar in every language.
- The 'i' for information has been used as a reference in any European city, as an information point for any question, in any location.
- As a third abbreviation, it was thought to use the letter 'D', as the initial for 'Direct Destination'. This piece would signal the path to follow that would lead the blind person directly to the place the person wished to go, without needing to go through the information point.

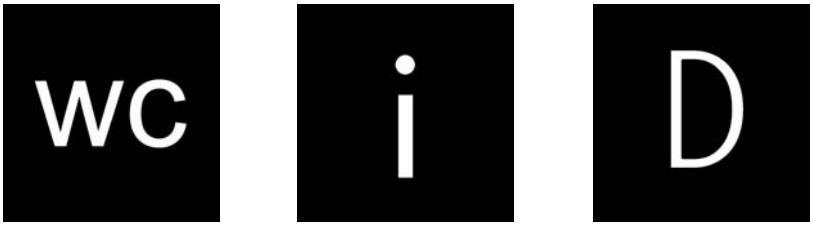


Figure 2

These pieces would be accompanied by a base piece. This would consist of a centre groove, of about 3 cm, which is the standard width of the end of the walking stick.

Together with this piece there would be another, making it possible to follow a curve in case it was necessary to turn right or left, so that uniting the pieces would form a path for arriving at the desired point.

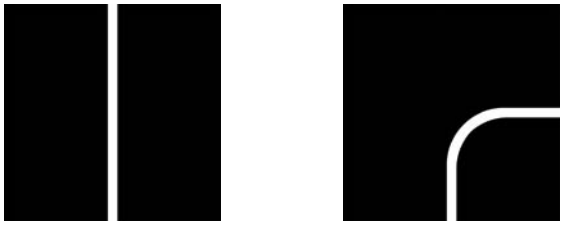


Figure 3

This breakdown would enable placing this flooring in public buildings, where signalling pieces would be found at the entrance followed by a base piece.

Thus, if a blind person wished to go to the information site, the person would detect, by means of the walking stick, the piece with the initial 'i' and, immediately followed by the base piece, the start of the path leading to the information site.

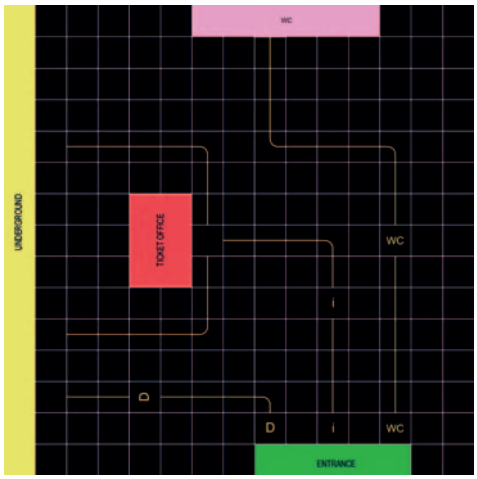


Figure 4

Prototypes were made on a plaster block. For this, a Pacer Cadet 1200 milling machine was used, and several trials were run of depth and width so that the walking stick would fit into the groove and be able to move through it without any type of inconvenience. The technical characteristics of this machine are:

Working area	1220mm (X), 700mm (Y), 60mm (Z).
Material	Steel and aluminium construction that provides maximum stiffness for high-quality cutting.
Driving systems	Precision bearings at all the axes.
Spindle	Inverted drive spindle. 1.2 kW, maximum speed 24,000 rpm. Floating head for perfect constant depth engraving.
Maximum input levels	4m/min.
Withdrawal of shavings	Cyclone cone for shavings with self-commutable extractor.
Controller	32 bit processor of with a look-ahead program for 2D and 3D movement. Unchanging, readily updateable logic support for adding new characteristics.
Software	Pacer XMC-E, heightened machine control software executed in a PC with Windows XP-Pro.

Figure 5

To make the groove, different computer applications were used: first, a Gaussian defocusing was drawn and Adobe Photoshop was applied, in a scale of greys, to smooth the bas-relief line. The BitCam program was then used to render the figure going from the scale of greys to numerical data. Finally, the groove was made using the own software of the Pacer milling machine.

However, an error was noticed in the arrangement of the groove, since the walking stick is used by sweeping it in a rhythmical way in front of the body, from left to right with a view to detecting possible obstacles; therefore, the walking stick always goes ahead of the back foot, enabling detection of the free path for the step.

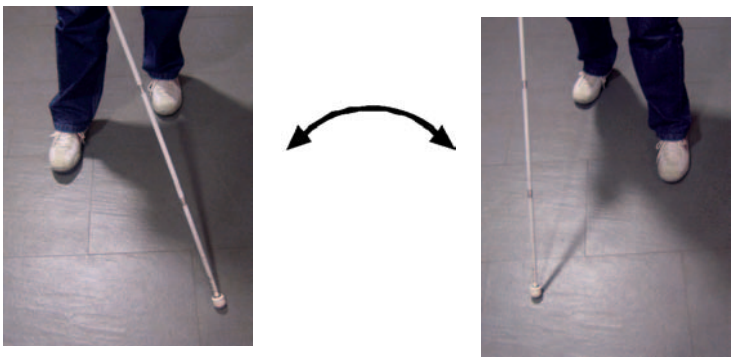


Figure 6

For this reason, the idea of tying the walking stick to a groove would inspire little confidence in a blind person.

On the other hand, when the incompatibilities between physically and sight-impaired persons were analysed, the depth and width of the groove (3x30mm) could be a disadvantage because of wheelchair slipping.

It was then thought to replace the wide groove by three narrower and shallower grooves, thus avoiding the inconvenience in the movement of the physically handicapped.

Three grooves were made so that the blind person, when moving the walking stick from right to left, would notice the three grooves instead of one, and thus be able to differentiate the guide path from the tile-to-tile joints. In this case, the depth of the guide could be much less, since it would not serve as a 'rail' but would simply suffice if it enabled the person, moving the walking stick from side to side, to notice a vibration and detect the path.

New trials were performed with the milling machine to test widths and depths again in the piece.

WIDTH	DEPTH
0,5 mm.	0,1 mm.
0,8 mm.	0,2 mm.
10 mm.	0,3 mm.

This new idea of using the walking stick on the tile would be much simpler and would generate much more confidence and security in a blind person when this person moved and used this guide track, particularly, since it would not entail any change in the person's walking habits.

This new change in grooves was also made in the turn piece.

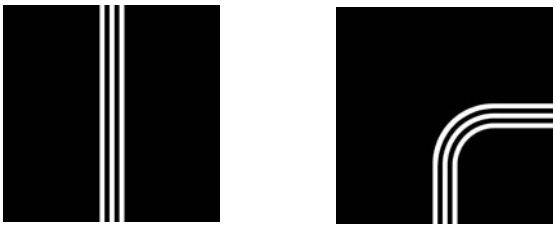


Figure 7

As far as the initially proposed signalling pieces are concerned, deciphering the icon represented in the tile would be difficult with the walking stick and, in addition, a different piece would need to be made for each public building where this flooring was to be used.

It was then thought of a signalling piece without any type of icon, so that it would not depend on the building where it was installed. This new piece was therefore texturised with

circles in bas-relief, which, when brushed by the walking stick, would allow perceiving a change in texture.

The circles (according to standard UNE 127029 'Prefabricated tactile concrete tiles, rough structures formed by projections of buttons in bands perpendicular to the direction of traffic' [22]), also known as buttons, are used to signal the end of the pavement and the start of the road. They are typically used in ramps, where they are located in the approach to a traffic light, zebra crossing or corners, to indicate that the pavement has ended.

This texture is already recognised by the blind as warning symbol of an urban obstacle ahead.

The proposed bas-relief would not impede the movement of the physically disabled (depth = 1 mm).

The texturised piece would signal that very close to it there was a slab with indications, on a lectern or in a plate or as tiling in the wall, where information would be provided regarding the section where the blind person was located.

The base piece was thus chosen, with the heavy traffic and anti-slip requirements already mentioned, for texturising. At first, it was thought of decorating both parts of the piece, so that the blind person would notice better the change in relief.

This was found to be a confusing message for the persons involved, because they looked right and left, feeling with the walking stick, trying to find a lectern or a wall.

Therefore, only one part of the piece was texturised.

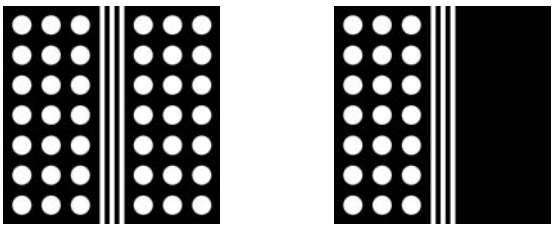


Figure 8

As the guides were centred right in the middle of the piece, the piece was positionless, i.e. it could be turned 180º if it was desired to place the texturised part along a particular side that the institution involved wished to signal, when it came signalling the information.

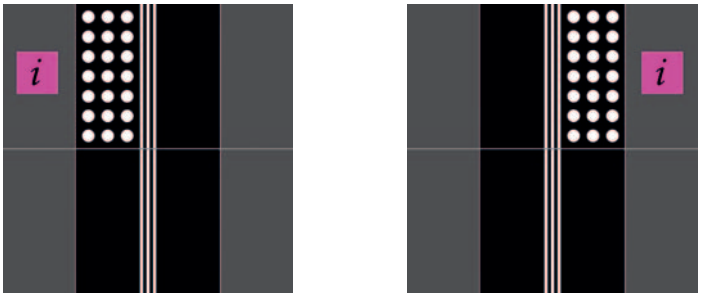


Figure 9

The project was then simplified in three mutually combinable pieces with a great variety of possible installation arrangements, enabling a guide path to be laid out and followed until reaching the desired destination point.

2.2. COLOUR STUDY

Once the graphics had been defined, colour was studied.

The colour of the chosen base piece needed to be dark so that there would be a great chromatic difference between this and the guide signals – why? Because the chosen colour needed to stand out on the surface, in order to be perceived by everybody, both by the sighted and the sight-impaired.

The three chosen test colours were sky blue, red and yellow, and these were surrounded by a dark surface in order to analyse the contrast between the two areas.

Of the three combinations, yellow was chosen because this was found to be the colour that displayed the greatest chromatic difference with the chosen background colour.

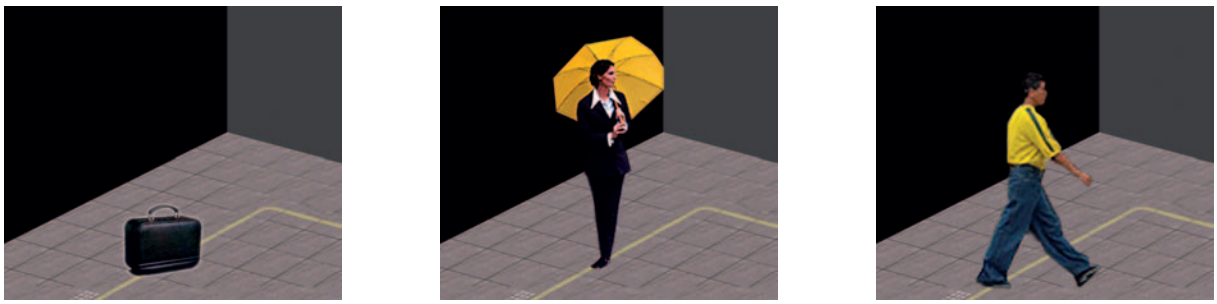
Another reason for the choice of the yellow colour instead of the other two is its familiar warning character in the urban context:

- A yellow colour used on the curb of a pavement means no parking in this area.
- A network of lines drawn in a cross means no stopping here.
- When road works are being conducted, yellow signals indicate precaution is required.

Thus, for the above reasons, it was concluded that yellow was the most appropriate colour for decorating the grooves.

This colour, applied to the project, would mean:

- NO PARKING, care would need to be taken not to park objects there that could obstruct the path for blind pedestrians
- NO STOPPING on the yellow track
- PRECAUTION, travel with care along this track as a blind person may be encountered on the path, who will not see us.



Figuraa 10

Once the drafting process and the study of what the piece to be made should look like had ended, a prototype of the piece was fabricated.

3. CREATION OF THE PROTOTYPE

The designed floor tile was made in through-body coloured porcelain tile. Sandblasting used to make the bas-relief, a technique that is beginning to find its way into the ceramic sector.

This technique has been widely used by great craftsmen of natural stone.

Its most widespread use has been in funeral art, in particular in making gravestones. The people charged with making these worked with natural stones, such as marbles, granites, and alabasters…

On these blocks, they carved flat or three-dimensional figures sculpting, by erosion, the selected drawing or text.

In the marble sector, it has also been used for decorating borders.

Figure 11

This technique was chosen because it can be applied on different types of substrates without requiring investments in press punches and, therefore, involving no constraints in the selection of the floor tile.

The process consists of subjecting the piece to erosion by blasting a jet of sand at high speed and pressure. The areas that are not to be eroded must be protected with masks, which may be of three types: glue, adhesive vinyl films and metal plates.

Using the graphics already studied in the previous sections, we prepared the corresponding masks, using 100% black and 100% white. In the place where erosion was required, 100% white was required and the rest in black.

With these photolithos, screens with 21 threads were made so that the following screen print step would have an abundant layer.

Once the pieces had been screen printed with a polyurethane resin, they were dried at ambient temperature; after the required drying time, the glue became a hard surface which was difficult to remove.

The piece with the mask application was processed by sandblasting, using a MASTER PRO with AUTOMATIC BOOTH (this is an accessory that enables reducing engraving time to a third and eliminates the problem of rubber pull-out by the brush hairs).

MASTER PRO	Turbine	Voltage	Air flow rate	Max pressure	Dust decantation	Water purge
	Three-phase 5hp	220/380 V	450-3.000 l/min	8 kg.	Cyclonal	Semiautomatic

AUTOMATIC BENCH	Belt speed	Arm speed	Max. weight	Max. thickness.
	0,3-14 mm/sec.	7,5-26 mm/sec.	800 kg.	16 cm.

Once the bas-relief had been made with the sandblasting machine, these pieces went through the cleaning and glue removal process.

For greater precision and rapidity in sandblasting, masks were made on metal plates (similar to stencils). This technique would be the one used in a high production process, since the level of definition is much more exact.

4. PERFORMANCE OF THE GLAZE TRIAL

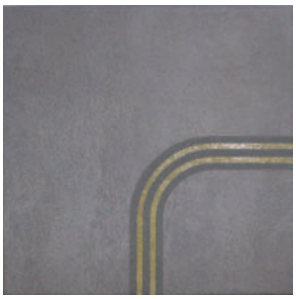
For the application of the glaze three techniques were considered:

1. – Bulb application of the glaze in bas-relief, although this could distort the bas-relief.
2. – Dry screen printing trials were run, by means of a 36 thread screen.
3. – The possibility was also tested of making the screen print with a flat screen on the lines left between the grooves.

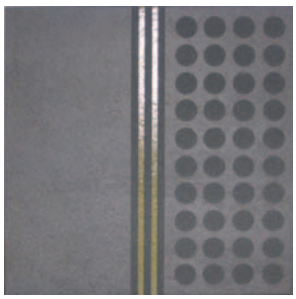
After analysing all the trials, we decided on the approach involving screen printing of the two lines between the three grooves of the bas-relief; the other trials were discarded because, on the one hand they reduced the depth of the bas-relief and, on the other, because the lines were not so well defined or had the desired intensity as with a conventional screen print on a flat substrate.

Two photolithos were made for the three pieces. With these photolithos, screens were made of 90 threads. The three pieces with the bas-relief were screen printed and fired in the kiln at a temperature of 1000º C. Thus, finally, the three pieces were obtained that composed the project.

Base piece



Turn piece



Informative piece

Figure 12

Two possible applications of this project can be observed in the following examples: the first is located in a city council and the second in a bank.

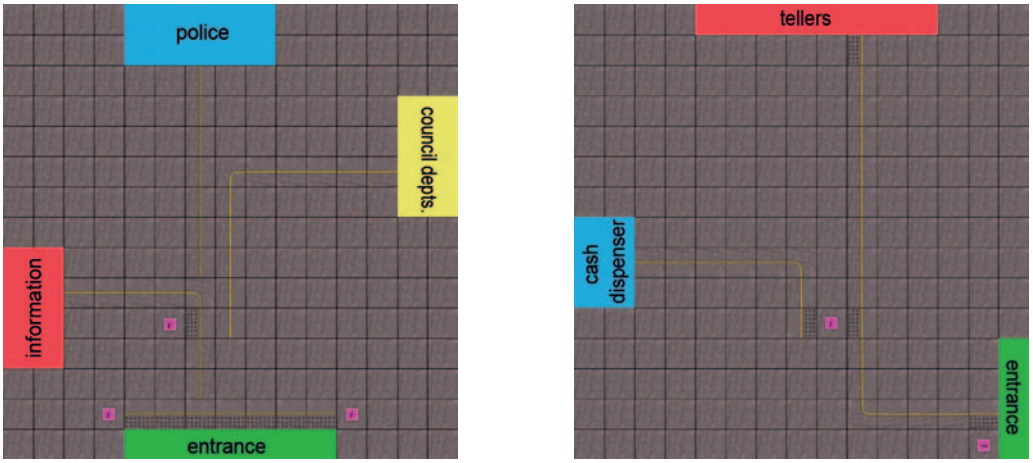


Figure 13

A part of the non-developed project consisted of the application of fluorescent glazes which, without changing colour in daylight, could serve as a guide for sighted people if a building was blacked out.

5. ACKNOWLEDGEMENTS

- To the Escola d'art i superior de disseny.
- To the company Vives Azulejos y Gres, S.A.
- To the ONCE organisation for the blind.
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