Abstract

This paper aims to present the interconnections between Color and Ergonomics, enhancing the color ergonomic function, and how it may be taken in consideration when elaborating Urban Chromatic Plans that are concerned with the population comfort. On the elaboration of urban chromatic plans, color is usually applied in order to establish a harmony between buildings and their background, often contributing to the environment monotony. However, color has other properties that enable making some elements to stand out from their surroundings, without destroying the pretended harmony. Color, when applied with a scientific criteria, can also act as an identification, or orientation, element accomplishing an ergonomic function that will benefit the entire city population. The cities’ population is a combination of people with various needs and different disablements. Therefore, inclusive and ergonomic design should embrace the widest possible range of users, but its issues are primarily focused on people with motor limitations and tend to forget visual disabled people. Though, we must consider that the city population is constituted by an extensive variety of people, with different visual acuities and limitations and, also, by a high percentage of older people, which have more difficulty to see small details and the obstacles that could be present on their way.

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1. Introduction

When designing urban chromatic plans, Color Specialists usually base their projects on the existing environmental colors and the region traditional colors or, in the case of historic cities, on samples of the buildings coating extracts and in file collections that tell the city chromatic and architectonic history. Moreover, on their essays to create harmonic ensembles, the chosen colors tend to be very close or even similar to their background. However, color can have other functions different from merging with the environment.

Color is not a simple element for the environment definition and unification; it is a visual characteristic that stands out from the chaos and complexity of the visual field. It is, also, an easy way to achieve the identification of the different city zones, and to promote the orientation of the population, because color is the objects characteristic which the eye first perceives, even before form or texture. By its properties, color can change visually the size of an object and, also, it can make them appear closer or further away. Color interactions can modify other colors that stand nearby, as well as a color appearance can change under the influence of different illuminations. All this make us consider that color can be an important ergonomic factor that must be taken in account when creating urban plans.

Cities are, generally, a complex of streets, architecture and open spaces that originate confusion and causes difficulties to the orientation of visitors and inhabitants. This complexity aroused the necessity to create networks of elements that would help city users to find their way. On these networks, the signage and the urban furniture elements are included, which need to be clearly seen in order to fulfil their functions.

2. Color perception

«Color is not the property of objects, spaces, or surfaces; it is the sensation caused by certain qualities of light that the eye recognizes and the brain interprets»[1]

«Although the idea of “colour” may seem a simple concept, it conjures up very different ideas for each of us. To the physicist, colour is determined by the wavelength of light. To the physiologist and psychologist, our perception of colour involves neural responses in the eye and the brain, and is subject to the limitations of our nervous system...»[2]. Also, considering its physical properties, color is experienced differently depending on whether it is a direct color, the color perceived from a light source, or a reflected color from a surface, and when mixing colored light, reflected colors, or direct and reflected colors, the results are quite different.

Since the beginning of time color identifies itself with light, being the sun its first known source, and color is the very small region of the electromagnetic spectrum that the human eye can see. Sir Isaac Newton, in 1676, decomposed through a prism the white light of the solar spectrum in a multicolored light beam, recovering the same white light through a second prism. The ensemble of his experiences established the principles for the color additive system, constituted of colors of light, where the primary colors were blue, red and green, corresponding to those perceived by the eye sensors. The process of mixing directly light colored beams is called additive synthesis because the colors combination adds light energy, on one or more wavelengths of the light spectrum zones, to the light flux emitted toward the eye by light source, activating the correspondent eye sensors, and the result will be a color clearest then the brighter of the component colors.

The objects color is the result of an absorption and reflection process, where the perceived color is the result from the mixing of the wavelengths that were not absorbed, being then reflected. This mixing process is called subtractive synthesis, because the light energy is removed, in one or more wavelength ranges, to the luminous flux reflected by the object toward the eye, that activates one or more receptors of short, medium or long waves. The result of this mixing will always be darkest then its components and, theoretically, the result of the absorption of the three principal colors – yellow, cyan and magenta –is black, the total absence of color and light.

A reflected color can be changed whenever a colored beam insides upon it. Then the color will be dyed by the light beam color as it was paint by a water color.

The color mixing may be achieved by an eye reaction, when different colors are put together and the eye perceives them as one. This phenomenon that is applied, among others, on the pointillist painting, four-color printing, mosaic panels, or even television, is called partitive synthesis and the resultant color luminosity is equal to the average of all mixed colors.
On the environment, a color is never seen isolated. And every color influences or is influenced by the other colors by which it is surrounded, often originating afterimages of a complementary color, caused by eye fatigue and the consequent successive and simultaneous contrasts that will change the colors nearby.

Temperature is one property that is intrinsic to colors and can contribute to change the way as they are seen because warm colors tend to advance while cool colors recede. The same phenomenon happens with light and dark colors and it must be considered when working with volumes or surfaces that we want to stand out or merge with the colors background.[3]

3. Ergonomic Color

“Inclusive Design is a way of designing products and environments so that they are usable and appealing to everyone regardless of age, ability or circumstance by working with users to remove barriers in the social, technical, political and economic processes underpinning building and design”. [4]

Concerning urban chromatic plans, this definition may be applied to Ergonomic Color, as it implies that color applications in these plans must be concerned with all the city’s population needs, erasing, as much as possible, the differences between able and disabled people, and contributing to the amelioration of everyone’s quality of life.

Color on environment is not a simple element for definition and unification; it becomes a visual characteristic that stands out from the chaos and complexity of the visual field. It is, also, the easiest way to achieve the identification of the different city zones, and to promote the orientation of the population, permanent or temporary, because color is the objects characteristic which the eye first perceives, even before form or texture – that’s why color and ergonomics come together. Color utilization as a mean to show the way, has been punctually employed successful in interior and exterior spaces, therefore we could assume that a sensible and general application to urban furniture, may be a way to the successful resolution of the orientation problem within the city.

Color application to the built environment as mean to show a specific way, or to identify a city zone, has been rarely used. But it is a problem that isn’t easily solved as it reduces considerably the creativity of architects and can lead to an oppressive monotony that will be disagreeable to the zone inhabitants. Contrary to this, a pertinent color application to urban furniture may achieve this purpose.

On their development cities became, generally, a complex of streets, architecture and open spaces that originate confusion and causes difficulties to the orientation of visitors and inhabitants. This complexity aroused the necessity to create networks of elements that would help city users to find their way. On these networks are included the signage and urban furniture elements, which need to be clearly seen in order to fulfil their functions. As it was stated before, color may be the easiest way to increase the urban furniture elements visibility, and a coherent application of a chromatic planning to urban furniture, may originate a system which will function simultaneously as an identification factor for the different city quarters and as an orientation factor for its inhabitants and visitors. In parallel, color application to urban furniture will also become an inclusivity factor, by incrementing these elements
visibility and use. We should also note that, by their size and location, urban furniture and signage elements will not be as imposing as the building colors, even though they can resolve the identification and orientation problem.

Despite a recent growing concern about color psycho-physiologic connotations and its application to the environment, color urban plans scarcely refer to color application in urban furniture and signage. In parallel, a bad use of color in urban furniture and signage systems contributes to a lack of visibility that is an impeachment to the fulfillment of their functions, as well as it is a factor of social exclusion for people with deficient and older vision.

Fig. 2. Color applied to urban furniture, increases its visibility.

4. Ergonomic Design

“Inclusive Design is a way of designing products and environments so that they are usable and appealing to everyone regardless of age, ability or circumstance by working with users to remove barriers in the social, technical, political and economic processes underpinning building and design”. [5]

“Ergonomics is about designing for people, wherever they interact with products, systems or processes”. [6]

The objective of an ergonomic design must be considered as an “interaction between the individual and the environment”, and “can be described in terms of personal control that can be exerted by the individual over the environment”. [7] So, an ergonomic design must be a good design, because its objective must be “to ensure that designs complement the strengths and abilities of people and minimise the effects of their limitations, rather than forcing them to adapt”, and in order to achieve this purpose it is necessary to understand the characteristics and necessities of all population. [8]

We must consider the impossibility to contemplate all the needs of people with high level of disabilities. However, adaptive environments should be designed in order to ensure that a higher percentage of the population can enjoy all the environment facilities. Whenever we design for disabled people, we are improving the quality of life for the entire population. As Brown [9] writes: “Integration does not imply that every conceivable option open to all unimpaired people can be made equally available to every impaired person. It does demand, however, that there should be a sufficient range of options open to any impaired individual to enable him or her to function as a mature person and pursue a personal lifestyle as satisfying in its own way as his/her neighbour’s”.
The average of worldwide elders is increasing, and the estimated percentage of older people (over age 65) for 2030 will range from 17% to 29%, within Asia, Europe and North America; including a faster growing subgroup of people aged over 80 years [10]. The estimates of Portuguese population, published by the Instituto Nacional de Estatística (Statistics National Institute) in June, 2014 [11], also shows that Portuguese people live longer and, consequently, the ensemble of the population tends to age.

Table 1. 2014 Instituto Nacional de Estatística estimation for the Portuguese population (INE 2014).

<table>
<thead>
<tr>
<th>2013</th>
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<td>Existing population — 10 427 301</td>
<td></td>
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<tr>
<td>Women — 5 469 281</td>
<td></td>
</tr>
<tr>
<td>Men— 4 958 020</td>
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<tr>
<td>Births decrease — 7,9%</td>
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<td>Deaths decrease — 1,0%</td>
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<tr>
<td>Life expectancy (2001/2003) — 76,98 years</td>
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<tr>
<td>Women— 80,12 years</td>
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<tr>
<td>Men — 73,55 years</td>
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<tr>
<td>Life expectancy (2011/2013) — 80,00 years</td>
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<tr>
<td>Women— 82,79 years</td>
<td></td>
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<tr>
<td>Men — 76,91 years</td>
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| People older than 65 years — increased   |      |
| People younger than 15 years — decreased |      |
| Aging index: Older people / Younger people = 106-136 / 100 |      |

Previsions for 2060

| Aging index: Older people / Younger people = 307 /100 |

Besides living longer, population remains more active to a longer age, despite the fact that aging brings with it changes in perception, cognition and control of movements. So their requirements must be taken in account because, regardless to their limitations, elderly, and visual disabled people must be able to get out and about locally in order to age well and live independently. The desire to get out does not diminish with old age and older people can continue practicing a large variety of outdoors activities if the environment allows it. On contrary, when it isn’t easy or enjoyable to get outdoors their quality of life will diminish, as well as their physical health. The difficulty to get around is often due to the environment poor design. Older and visual disabled people move about more frequently on foot and it presents big difficulties on poor design environments. Accessible open spaces, with good paths, safe crossings, plentiful seats, and visible signing will improve older people’s perception of supportiveness and safety [12].
Inclusive design and ergonomic design, in their recent development issues, are primarily focused on people with motor limitations and tend to forget visual disabled people. Though, we must consider that the city population is constituted by an extensive variety of people, with different visual acuities and limitations and, also, by a high percentage of older people. Insofar as people grow older, their ability to see small details decreases and eyes have a crescent difficulty of adaptation to sudden changes of light or a quick change in focus. Bearing in mind the visual limited population, only a small percentage is unable to see any color and the main part is able to distinguish luminosity differences [13]. Therefore, to have better visibility conditions, under an inclusive design perspective, urban furniture must present a good chromatic and luminosity contrast. Considering this, Per Mollerup[14] states that “color can be seen from longer distances than other graphic elements” and that “in signage differentiation is the first and foremost role of color”.

5. Conclusions

Urban furniture isn’t a simple ensemble of decorative elements to embellish the city, it must accomplish an amount of functional requirements in order to assure its functionality and fulfill the population needs, facilitating their lives and contributing to their comfort. Consequently, in order to accomplish its functions, urban furniture needs to be seen and an appropriate colour application improves considerably its visibility. Also, when the urban furniture chromatism is the same for a city area, they may be converted in effective signage and identification elements that will contribute for a better orientation within the city.

In accord with the prescriptions of the Royal National Institute for the Blind (RNIB), UK, pedestrian paths must be easily identifiable and differentiate themselves from the adjacent walls. Likewise, every present objects must detach themselves from the background, in order to be recognized as obstructions. Every urban furniture element — fences, bollards, lamp posts, litter bins, benches, etc. — must present a strong chromatic and light contrast with the environment, so that they can stand out and be more easily recognized, among other, by visual disabled people [15].

So, the application of a chromatic planning to urban furniture, may originate a system which will function simultaneously as an identification factor for the different city quarters and as an orientation factor for its inhabitants and visitors. In parallel, colour application to urban furniture will also become an inclusivity factor, by incrementing these elements visibility and use.
Acknowledgements

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References

[6, 8] IEHF 2015