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Coloured Lighting, Urban Underground and Human Beings:
relationship inquiry through showcase analysis

ABSTRACT

The contemporary city appears as a chaotic entity, in continuous evolution and growth, with an increasing request of fast connections: for this reason a high number of design efforts are dedicated to support mobility flows on long/medium distances, favouring the use of underground spaces. These new infrastructures are perfect and efficient public interiors, conceived as "machine spaces" and designed ergonomically for a stereotype traveller [1]. As an opposite trends, several undergrounds were designed taking into account the qualitative perception of the space: they are completely transformed in containers of high-quality experiences for positive waiting periods especially through coloured and varied lighting. Quantity, intensity and distribution of light and also the dynamics of both the chromatic colour temperature (CCT) of white light and the hue of the coloured lighting can create a more interesting and comfortable environment. This paper analyses the impact of coloured lighting on the perception of the users through a showcase analysis and describes the relationship with human beings and environment in order to prefigure new possible insights for high quality public indoor urban environments.

1. METHODOLOGY

The methodology of this study is based on a multi-disciplinary bibliographic review in the fields of colour, light, perception, environmental psychology. The aim is to understand the relationship between human beings and built underground public interiors under certain lighting conditions. The paper is organized in a prior part concerning the literature review and a secondary part of showcases' analysis using three main factors:

- **Coloured lighting (CL):** the natural/ artificial, the cool/warm CCT, the brightness/intensity, the distribution of light in a balance of variety and contrast and a balance of unity and complexity, the chromatic complementary selection, the symbolic/artistic value, the way-finding value, the dynamics, the enhancement of architecture.
- **Urban underground (UU):** the environment, the spaciousness, the enhanced architecture and materials, the identity, the animation.
- **Human beings (HB):** evaluative impressions such as pleasant, interesting, comfortable, safe; opposite feeling such as arousing-calming.

2. INTERACTION BETWEEN HUMAN BEINGS, ENVIRONMENT, LIGHT

The focal point of this paper is the investigation of the reciprocal relationship of CL + UU + HB with the aim to understand what kind of lighting attributes are preferred and what kind of lighting scenarios can define a more comfortable, interesting or safe environment.

2.1 UU + HB

In the big urban areas, the necessity of new infrastructures to support mobility flows of people is an emergent and spread phenomena. The evolution of the city is based on connective networks into urban anonymous locations, enormous underground pathways, dark galleries into the bowels of the earth and connective corridors that host nearly millions of passengers each day for a short period of transit. Constantly lit by artificial lighting, the underground spaces are often perceived negatively because their features are too unnatural and poorly designed: these places shows a lack of identity, because they are not characterized by the people that inhabit them, they are not relational because they do not create reciprocal relationship between users and they do not represent historical or cultural references. According to Marc Augè, these *"non-places"* are built for a stereotype user

in order to create efficient structures based on standards and ergonomics parameters: everything is calculated for the maximum result in terms of decibel, lux, length of pathways, typologies and quantity of information given [1].

2.2 HB + UU

The underground stations are exchange zones of individuals, *"terrain vague"* made of casual social meeting and rigid behaviours because they are strictly regulated by few but mandatory rules. Despite of the fact that the passenger of the subway is thought as a common subject or just a client of a service, in the book *"Un ethnologue dans le metro"*, Marc Augè focus on some behaviours of the travellers of the subway in a very iconic way. He describes the repeated social rites that take place, day by day, in the urban playground of the underground stations: the activity is recurrent, regular and without surprises to the observers, every transit is repeated equally each day. The ritual and social paradox of the subway is that all individuals are alone in their activity but in the meanwhile they live a social and collective situation: they are a crowd without participating to any feast but they are also alone without being isolated [2]. The users of the subway deal with time and space adapting himself to the situation and being somehow obliged by a chronic hurry, moving quickly in the corridors and on the stairs. This particular places of interchange are very meaningful because they symbolize the space where people pass from an activity to another, performing instrumental behaviours, moving simply from one place to another but generally transforming their social rules.

2.3 CL + HB

Light is an indispensable environmental input for human beings, with physiological and psychological effects [3]. Primary importance of light for human beings is vision in order to see, understand and use the space, orient by perceiving physical surroundings, limits and details. More than vision, light has psychological effects on human beings because it can foster a sense of safety and security, contributing to the comfort perceived. In addition to this, the quantity and colour of light arouses definite emotional reactions and aesthetic preferences somehow related to our emotional and instinctive senses [4]. More in general, the information of the perceived urban environment is codified by the human visual system that interprets certain regularities in the luminous phenomena in relation to three characteristics of light: intensity, wavelength and distribution in space. The intensity refers to the perceived luminance (brightness) of objects and surfaces: it is a subjective factor because it is an interpretation modified by psychological factors. The wavelength enables the understanding of colours and is related to the relationship between the light spectrum emitted and the light spectrum reflected by the objects and surfaces in the space. The distribution of light contributes to the making sense (legibility, coherence, complexity and mystery) [5] of the urban environments: it dynamically shapes the environment itself, showing or hiding certain information, dimensioning its volume, guiding the eyes in understanding it, suggesting its atmosphere.

2.3.1 CL + HB: Perception of light and its effects

The majority of the studies that aimed to systematize the relationship between perceived attributes of lighting and emotional reactions revealed that people use brightness and distribution of lighting as a basis for their judgments about interior spaces. Moyer stresses that light has the capability to create shape and emotional responses through the use of compositions and organization of lighting elements [6].

The research of Flynn connects lighting conditions to users' mood: non-uniform lighting generates relaxation and bright and uniformly lit interiors boost the feeling of spaciousness [7]. More than this, his researches pointed out that relaxation is related to non-uniform wall lighting, perceptual clarity to higher horizontal lighting in a central location, spaciousness to uniform lighting and bright walls [8]. The Bartlett group's studies concluded that people generally prefer brightly lit interiors and, according to Moyer, they are attracted by brightly lit objects more than by softly lit objects. On the other hand too high contrast lighting scenes creates confusion and it is necessary a lower lighting between the different spots to form visual bridges in the view. The review of literature reveals also that lighting composition and direction can be useful for safety and security perception, reducing the fear of crime by increasing the visibility, decreasing the opportunities for criminal acts and also strengthening the community confidence, cohesion and social control [9].

2.3.2 CL + HB: Perception of colours and its effects

Literature reveals that most people have similar emotional reactions to different colours: this is explained by several psychologists as the result of cultural learning. On the other hand, cross-cultural studies concluded that emotional reactions of people to colours are more innate than learned. Heinrich Frieling [10] presented the findings of a study on the psychological effects of coloured light on human beings. The subjects of this study were asked to look into red, yellow,

green, and blue light. This study revealed that red is a stimulating colour, yellow is a tensing colour but releasing at the same time, violet-blue increases the inner reactivation, concentration and calmness and green stimulates similar emotions as a balanced and diffused light.
Studies have also shown that human beings require a balance of unity and complexity in the built-environment because the natural conditions humans beings are used to are with changing variables while the unnatural conditions are the static or too chaotic ones. Faber Birren [11] stresses that people expect all senses to be moderately stimulated at all times in the built-environment: the lack of complexity is generally not preferred and results in adverse psychological reactions. Conversely, human beings tend to get easily confused when they are subjected to different, incoherent visual stimuli. For this reason, a balanced constantly changing environment can determine normal consciousness and positive, aroused perception. In lighting design, Mahnke [12] stresses that in the total environment there should be colours in changing degrees of lightness (light and dark), CCT (warm and cool), and intensity (strong and weak), providing a good balance of variety and unity: variety is necessary for attraction and interest; unity is essential for a favourable impression.

3. INTERNATIONAL CASE STUDIES OF UNDERGROUND URBAN INTERIORS

The selected and analysed showcases listed below are some of the best practises useful to understand how light and colours can create comfortable and high quality environments.

3.1 Berlin, Potsdamer Platz Station

Since the summer of 2000 the Potsdamer Platz in Berlin has built three Heliobus Light Pipes, respectively 14 metres, 17 metres and 21 metres high. They are the key element of the architectural design for the remodelled square because of their iconic structure but also for their sustainable function. They connect the surface level architecture and the underground station below providing the necessary light during the day: the aesthetics of the Light Pipe is achieved by the use of Heliobus technology, using direct sunlight as the prominent source and reflecting the rays inside a lined glass tube covered internally by a high reflective material [13]. The sustainability of the lighting project is insured by the high levels of transferred light from outdoor to interior spaces using almost no energy during the day. Moreover natural light provides very changeable effects in intensity (light and darkness) and CCT variations according to solar incidence at different daytimes.

3.2 Munich, Westfriedhof Subway Station

The forty years old subway station "Westfriedhof" (opened in 1971), located at the border of the districts *"Neuhausen-Nymphenburg"* and *"Moosach"* in Munich, was re-designed in 1998 by the cooperation of the architecture office Auer-Weber and the municipal Underground Department. Moreover the MVG commissioned the lighting designer Ingo Maurer with illuminating the platforms of the underground station [14]. He conceived a strong lighting design atmosphere, creating a place that conveys pleasant and comfortable feelings. Above the platform they installed eleven oversized concave aluminium luminaries, each measuring 3.80m in diameter with differently lacquered interiors, bathing the station in blue, red and yellow light and dividing the platform into different colour shadings. The walls and the ceiling are drenched in blue light and lend the station, that is completely realized in concrete, the character of a cave, whereas the platform itself is rather bright. Despite the spotlights there are no dark corners. The lighting project elevates the platform to a stage and immerses it in a warm light: rather than feeling exposed, the waiting passengers feel a sense of protection.

3.3 Munich, Freiheit Station

Another interesting lighting work realized by Ingo Maurer is the Freiheit station of Munich. The aim was to lend the station a fresh, cheerful character, modernizing it with a distinctive look through both lighting and coloured surface design of ceiling, walls and floor. The lighting designer installed 3200 mirror elements on the roof using 204 square caissons and creating a sense of great openness reflecting and doubling the space. Two complementary colours dominate the scene creating an interesting chromatic scenario with a provoking and entertaining vivid atmosphere. A luminous yellow shines from the large walls behind the tracks; the pillars, which are covered with blue tiles, are lit by an appropriate LEDs lighting that also intensifies their colour. The remaining walls and floor are covered by a unique silvery-grey material. Moreover square cases for the light sources are arranged irregularly on the ceiling, adding a dynamic aspect to the platform [15].

3.4 Oklahoma, Light Gallery Underground

Designed in 2007 by the office Elliott + Associates Architects, this underground series of passages located in Oklahoma City and known as *"La Conncourse"* use coloured light to orient, give information and identify specific functions of each corridor. The coloured lighting has a functional meaning, useful to enhance the

LIGHT + COLOUR	HUMAN BEING	ENVIRONMENT
natural / artificial	comfortable	-
cool/warm CCT	arousing / interesting	animation
brightness / intensity	safe	spaciousness
variety + contrast	pleasant	identity

Figure 1 - Berlin, Potsdamer Platz Station, Heliobus Light Pipe

LIGHT + COLOUR	HUMAN BEING	ENVIRONMENT
variety + contrast	arousing / interesting	animation
unity + complexity	comfortable	space enhancement
complementary chromatic selection	arousing / calming	identity
symbolic / artistic value		space enhancement

Figure 2 - Munich, Westfriedhof Subway Station, Auer-Weber

LIGHT + COLOUR	HUMAN BEING	ENVIRONMENT
brightness / intensity	comfortable	spaciousness
variety + contrast	interesting	identity
complementary chromatic selection	arousing / interesting	identity
enhancing architecture and materials		space enhancement

Figure 3 - Munich, Freiheit Station

LIGHT + COLOUR	HUMAN BEING	ENVIRONMENT
wayfinding value	interesting	identity
symbolic value	pleasant	space enhancement

Figure 4 - Oklahoma City, Light Gallery Underground

LIGHT + COLOUR	HUMAN BEING	ENVIRONMENT
symbolic / artistic value	cultural interest	identity
dynamics	arousing / interesting	space enhancement

Figure 5 - Oslo, Nydalen Station

perception of the public space and to identify specific zones of the city. It is used to lit the space in a very iconic way but also to communicate with the passers-by, signalling the direction and creating an emotional atmosphere dipped into colours. The lighting sources are coloured fluorescent T8 tubes: blue lighting conduces to institutions, red lighting to hotels and green lighting is used for connective corridors. More than this, the longest gallery is a permanent installation of light. The walls are made of pierced steel, the floor is yellow and the ceiling is backlit with a blue coloured light: when the two colours merge, a white light is created on the opposite wall of the gallery [16].

3.5 Oslo, Nydalen Station

The *"Tunnel of Light"* is a work of art performed in August 2003: light, music, technology and architecture are shaped together as an integral synesthetic whole and they also dynamically interacts with the users of the escalator of the Nydalen Station thanks to several sensors integrated in the space. The concept is about guiding the travellers during their daily route into an half a minute experience of dynamic sounds and lights that together perform different seasons. The architect Kristin Jarmund initiated the *"Tunnel of Light"* project cooperating with a group of artists to develop the multimedia concept: the technical light and sound installation is integrated in a 27 metres long translucent glass tunnel wrapped around the station escalator [17]. Lighting and sound installation comprises 800 individually controlled pairs of Cold Cathode light tubes and 44 individually controlled loudspeakers.

4. CONCLUSIONS

To summarize, the schemes show the relationship of CL+UU+HB: specific characteristics of light and colours occur in the specific environment of urban underground with specific effects and impacts on the perception of the space by the users.

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