

Color and Colorimetry Multidisciplinary Contributions

Vol. VIII B

Edited by
Maurizio Rossi



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Coloured lighting in the experience of urban spaces: research, results and guidelines

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1. Introduction

Urban lighting is not only useful to enable night vision but also to improve the aesthetic value of the city creating better spaces for the public realm. The perceived urban environment lit by artificial lighting is codified by the human visual system that interpret certain regularities such as intensity, wavelength and distribution in the space of the lighting phenomena. The colour of lighting is also an important feature in the nocturnal experience of the cityscape because it can arouse definite emotional and aesthetical reactions and affect people behaviour and enhance their experience of the urban space.

The methodology of this study is based on a preliminary multi-disciplinary bibliographic review in the fields of light, perception, architecture and design, investigating the perception of the users. The second analytical part of the research is based on a multiple-method survey strategy about case studies, from where a qualitative reflection about the coloured lighting in the urban environment is derived.

In particular, this research would investigate common trends of preference about coloured and also the cool/warm Correlated Colour Temperature CCT of the white light. Coloured lighting would be described in its balance of variety and unity, complexity and interactivity with its meaningful functions: communicating, attention marking, identity making (ambiance), way-finding, architecture enhancing, socially engaging.

2. The new role of public urban lighting

The increased interest about urban lighting in the last few years is mainly due to changes in the way the public spaces are used at night. More than ensuring the basic requirements of safety and security for people, urban lighting today makes the contemporary city alive and vital after dark, determining the involving, memorable, distinctive experience of the nightscape[1]. The urban lighting embodies new human-oriented roles aimed to:

- City Ambiance: shaping the identity of the city, adapting to its inhabitants' activities, perceptions and patterns of use, [2]; increasing the attractiveness of the city and the comfort of people within it, enhancing the "urban beautification", "pleasantness" and "amenity" and providing a general feeling of well being [3].
- Communication: codifying messages, supporting information and simplifying the readability of the space with a cognitive, aesthetic and symbolic rule [4].
- Social engagement: supporting the collective and interactive use of the city, increasing the participative and experiential fruition; encouraging and reinforcing the trust relationship between individuals and their urban environment [5].
- Architectural enhancement: emphasizing the surfaces of the city, architectural

details and facades in relation to the materials and lighting fixture disposition and style. [6]

- Attention marking: creating a focal glow, commanding attention, creating interest and separating the important details to the unimportant ones. [7]
- Wayfinding: improving orientation, guiding the eye of unfamiliar users in the urban environment. Orienting in the nocturnal urban space means using well-lit focal points and landmarks. [7]

3. Studies about the perception of coloured lighting.

Coloured lighting belongs to the category of the intangible elements of the environment that has been investigated in many disciplines such as the environmental psychology and the lighting design.

3.1. Cool and warm white lighting

Many studies about the perception of lighting in the urban space are referred to the use of white lighting that has been demonstrated to positively change the nocturnal perception of the city. In 2005, an on-field survey in Lyon (France) was conducted: EVALUM, Evaluation de lumières urbaines pour un éclairage durable (standing for Evaluation of the urban lighting for a durable illumination): the researchers discovered that people are more satisfied by the use of 3000K warm white lighting in respect to yellow lighting (SAP) and to cool white lighting (4000-4200K).

In 2006/2007, the Lighting Research Center of Troy, New York, conducted a series of images comparison tests to evaluate the human perception in relation to the street lighting made with different lighting spectra. (Yukio Akashi and John Bullough, from LRC). It confirmed that the 90% of people preference is for white lighting that is perceived as more secure for pedestrian in respect to the SAP (monochromatic yellow) lighting.

The results of another survey conducted in Shanghai in 2007 at the University of FuDan found that almost the 90% of the people interviewed prefers white lighting considering it more authentic while the 95% felt that white lighting offers a more comfortable and better environment: white light gives to the urban environment a more brilliant, natural aspect assuring safety. [8]

3.2 Coloured lighting

A wide part of literature has examined the influence of coloured lighting in the 'perceived pleasantness' of public environments. Although the optimal lighting design should be strongly related to users and contexts, it appears that specific coloured lighting, generally perceived as pleasant, may result in very specific and similar emotional reactions. This is explained by several psychologists as the result of cultural learning but, on the other hand, some cross-cultural studies conclude that emotional reactions of people to colours are more innate than learned.

In 1990, Freiling presented the findings of a study on the psychological effects of coloured lighting on human beings. The subjects of this study were asked to look into red, yellow, green, and blue light. Their comments were tape-recorded and presented in accordance with Wundt's "wind rose of emotions" that separates emotions into the categories of arousing-calming, pleasant-unpleasant, tension-release. This study reveals that red is a stimulating colour, yellow is a tensing colour but releasing at the same time, violet-blue increases the ability to concentrate and

leads to calmness and green stimulates similar emotions as a balanced and diffused light.[9]

Cool colours, such as blue and green, have a relaxing effect, whereas colours with a long wavelength, such as orange and red, are stimulating. Warm colours are perceived as being protective. Clear and saturated colours are generally experienced as more pleasant, but are also more strongly associated with fear than cool colours. Dark colours are perceived to be more dominant and more strongly provoke hostility and aggression. [10,11,12]

Warm colours are apparently more successful to claim the attention of people (example: shop windows), but where people experience a mental stress, it is better to keep the colours cool with their calming effect. [13]

In addition to this, Valdez and Mehrabian [12] have shown that not only colour hue evokes emotions but also the saturation and brightness (i.e. intensity) that increase the stimulation and dominance.

3.3 Variety and Unity

Studies have also shown that human beings require a balance of unity and complexity in the built-environment in relation to colour and light: this is because the natural condition is the balance of changing variables and the unnatural condition is the static or too chaotic situation [14]. The research reveals that the lack of complexity is not preferable for human beings and it results in adverse psychological reactions. On the contrary, human beings tend to get easily confused when they are subjected to different visual stimuli.

Besides that, other researches point out that human beings can maintain normal consciousness, perception and thought only in a constantly changing environment: Mahnke stresses that light should provide a good balance of variety and unity for example in changing degrees of lightness (light and dark), CCT (warm and cool white lighting) and using the complementary of the dominant colours. Variety is necessary to attract and arouse interest, while unity is essential to create a favourable impression. [9]

4. The research question

The background statement is that urban coloured lighting could become a meaningful and positive tool for city enhancement and people engagement, starting from the understanding of people perceived pleasantness. This research about the importance of coloured lighting in the experience of public spaces claims at investigating what kind of lighting performances do meet people's preference and interest and what kind of feelings these elicit. The arising research question is: how the coloured lighting can be designed in a conscious and reflexive way in order to improve the perception of spaces, to set meaningful messages and codes of communication, to enhance the feelings of well being of the inhabitants, changing the mood and the aesthetic perception of the city.

5. ELSE

5.1 Method and procedure

An on-going virtual, indirect visual survey based on the observation of lighting stimuli was conducted: ELSE, Environmental Lighting Sustainability in the Environment [15] provided data about the individual experience (perception) of several preselected urban lighting settings (stimuli) that were analyzed using quantitative methods. This was followed by a netnography in order to collect feedbacks and to understand meaningful attitudes, perceptions and imagery of the users about the stimuli from a qualitative point of view.

5.2 Participant

For the first part, 121 respondents (62 male 51.2% and 59 female 48.8%) took part in the survey. The average age of participants was 30.6 years old (18-24, 7.4%; 25-34, 52.9%; 35-54, 29.8%; 55-64, 8.3%; 65+, 1.7%) and the average level of education was post-graduate degree (62%). The highest majority of participant was from Italy (75.2%).

The second part was basically focused on user-generated content, collecting free and open comments from collective web-sites such as Flickr. More than this several threads in urban culture and urban project related forums were opened to collect information and judgements about lighting in a oriented and guided way. [16]

5.3 Stimuli and data collection

Seven lighting stimuli were presented through images and videos for an indirect observation. The attention of the participants was directed to some relevant lighting features showed in the pictures and in the videos and they were invited to express their perceptions using Likert scaling questions.

In this study, the data (average of results and frequency of agreement and disagreement) were elaborated to understand the correlation between the coloured appearance of light and preference and interest toward the stimuli.

Part of the stimuli were deepen in the netnography: an external observation of textual discourse was translated into researcher's field notes starting from textual conversation of forums and images related comments or tags from photo sharing sites.

5.4 Results

The first elaboration of data was based on the measured participants level of agreement and disagreement about pleasantness and interest of stimuli (the statements were ranked with the Likert Scaling with -2 "strongly disagree", -1 "disagree", 0 "neutral" answer, +1 "agree", +2 "strongly agree"). Pleasantness is subjective and depends on how much the individual likes or dislikes the environment (answering to the statement: I like the appearance of the space); the interest is dependent on information load and complexity (answering to the statement: I would feel surprised and excited in this space).

The results of the survey (Figure1) showed clearly that certain stimuli were more interesting and pleasant for people in relation to the presence of meaningful and dynamic coloured lighting. In particular:

Strijp-S was the most appreciated project with the highest results in terms of preference and interest in relation to the colour of lighting: the general ambient lighting, assured by a uniform traditional street lighting, is accompanied by an unconventional system of lighting useful for pedestrian safety. This interactive flashing lighting on the floor positively characterizes the street and assure safety: red flashing to gather attention of passersby and signal the presence of car and green flashing when the street is free for passenger.

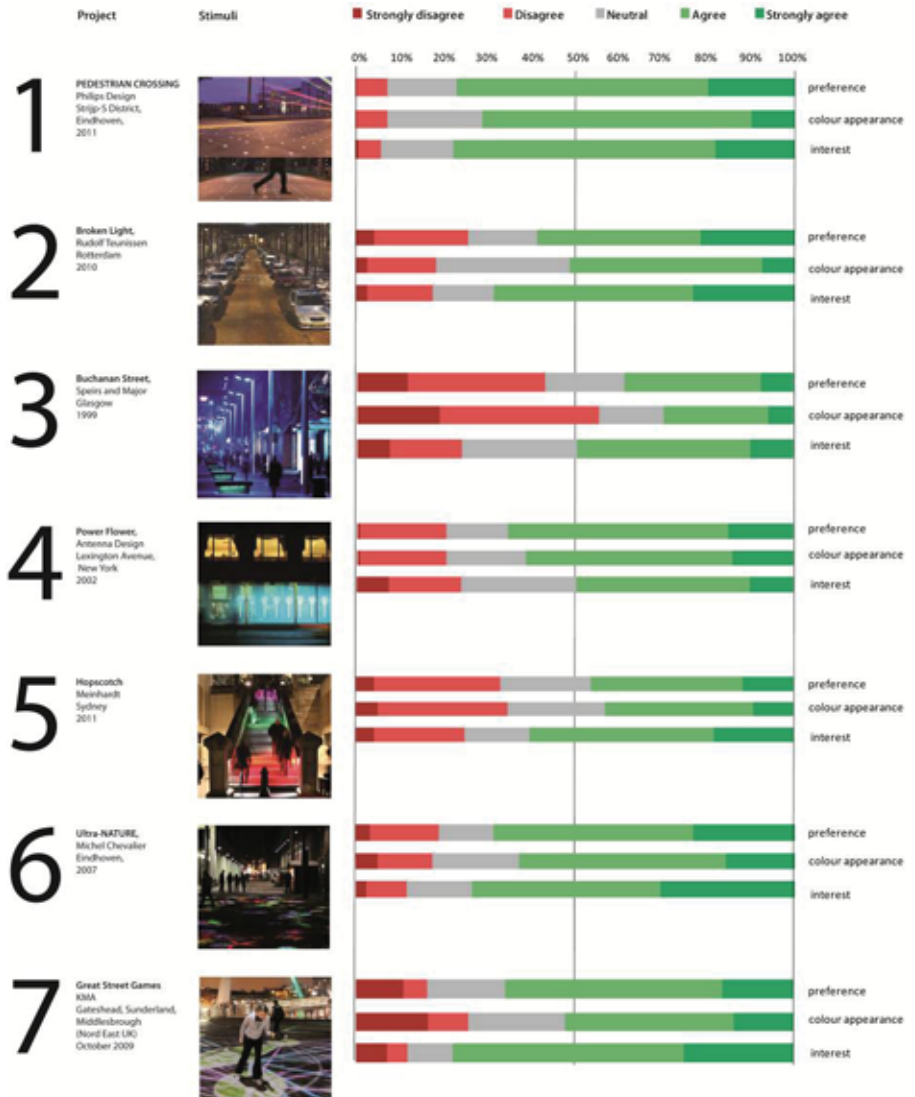


Fig 1. ELSE: stimuli and results

Broken Light showed an interest related to the colour appearance of light in respect to the distribution of lighting. This means that the warm white lighting is more appreciated than the unconventional distribution of light. Moreover it was clear from the netnography that the preference about the distribution depends on cultural background and also involvement in the knowledge about the project(Figure 2)

Buchanan Street presented a very impactful and particular lighting setting: full saturated blue colours for a commercial street. Conversely, it was absolutely not preferred by people that showed a really low agreement for the colour appearance of the scene. The complete blue scenario seemed to be too much unconventional and far from both traditional lighting setting and from cognitive schemes and expectations of the majority of respondents (Italians). The partial explanation of this negative attitude could be that, de-contextualizing the image and not giving information about its historical and socio-cultural importance, the blue lighting doesn't show evident advantages and positive values in comparison with the traditional lighting systems. (Figure 2)





	Stimuli	Source	Comments Negative
2		Forum Skyscrapercity International Forum Skyscrapercity Italy	"I really like this lighting scheme in Rotterdam (Rotterdam citizen) it does look pretty cool! I really like the fact that it isn't a straight and common lighting scheme and that it integrates light, design and art into one unique product" "I find it marvelous" "It's terrible. An aquarium. I personally believe that lighting in the city, but among all in the suburbs, should be the minimum as possible..."
3		Forum Skyscrapercity International Forum Skyscrapercity Italy	"In special areas, these colourful schemes might fly" "It looks too much a discotheque" "I like it very much, it is for a pedestrian, quite modern and big street; something that doesn't exist near I live." "It's ok, but it cannot be something absolute in the urban environment. The ideal concept is to have a lighting system that is related to palaces, places or squares in order to characterize them. A complete way. It is exaggerated." Flickr "How low those blue mood lighting lights up the street!" "great blue lights." "Lovely colours of light here." "The colour scheme is so amazing. "Purple and blue and red? I would have never thought they could look this amazing together." "Amazing colour. Glasgow looks good!"
4		The New York Times (http://www.nytimes.com/2002/01/17/garden/walk-and-they-walk-with-you.html)	"If the range were wider, Ms. Moeslinger said, passersby would not understand their role in controlling the display. [...] People strolling along Lexington Avenue seemed to grasp that they were responsible for the eruptions of light behind them. "It kind of followed me," said Melissa Hartman[...] Eventually, a Bloomingdale's greeter strolled out of the store and wagged a gloved finger at a window. A flower blazed into action. As imitative as baby ducks, pedestrians wagged their own fingers, and to their satisfaction watched the flowers burst into bloom."
7		Flickr Blogs	"Wow! Such colours - especially the inner arch of the bridge. Looks amazing. Make sure you win against the smogs and mackems mind!" "Oh, that looks really cool! Why do we never get such interesting things happening in boring old Chelmsford?!" "I came across this event last night. Unfortunately I didn't have my camera with me. It was really amazing. The technology worked perfectly. I had never seen anything quite like it. Congratulations to whoever it was who put this event on." "I love this idea. I think it's part of a new movement in video gaming that is starting to insert the virtual environment into the space of the actual world. Think this is a great initiative - just wish I was anywhere nearby to try it out." "Interesantísima la propuesta, una forma de revitalizar el espacio público, de propiciar la convivencia social aunque se trate de algo efímero. Una forma de sacar de su encierro (cibemático a las nuevas generaciones. Arquitectos!!!!) tenemos mucho que tomar de estas experiencias para nuestras propuestas urbanas."

Fig.2. Netnography field notes

The most interesting and pleasurable stimuli were Great Street Games, Power Flower and Ultra-Nature. These stimuli present an interactive use of coloured lighting systems, in addition to the existing traditional lampposts: this extra lighting system defines a pleasant and more complex scene, leaving untouched the readability and the coherence of the space. The arousal is probably favourably

enhanced by the unexpected, unconventional and surprising ways of using coloured light within a complex interplay of elements: complexity and richness of stimuli are able to satisfy the human needs of exploration. As previously seen in other studies, human beings require a balance of unity and complexity in the built-environment in relation to colour and light in order to balance their natural preference to naturally changing variables[14]. Moreover the interactivity and low intensity of lighting contributes to the effect of mystery, driving people in the lit scene with the promise of obtaining more information or interactions while exploring the space. Other scholars describe the experience of a dark space pierced or pinpointed with light as something creating a sensation of mystery that invites examination and offer the opportunity for discovery [7].

6. Conclusions

Lighting colour and its distribution can define the identity of the city, decoding the spatial relationships of different zones, accompanying night activities, marking the city rhythms about city activities and uses. Coloured lighting should be used in a meaningful way, as an attention-getting tool with its symbolic meanings and signalling effects: colours of lighting can communicate explicitly or implicitly some public or private messages, underlining positive events or emergencies. These signalling coloured effects can be realized through unconventional, interactive coloured system that are preferred and considered interesting.

Light can also be a guide for people in their way-finding and orientation by marking paths, defining specific areas, identifying zones with specific functions: the introduction of opposite colour temperatures into a urban space determines the flexibility to create a warmer or cooler mood and emphasizing focal points. In addition to warm and cool colour temperatures, LEDs provide a wide range of colours defining orientation in space and time: colours are used in special occasions and events.

Coloured lighting can also cope with the architecture enhancing volumes and materials, decoding the sites and the typologies of lit buildings but also overvaluing the buildings' surfaces according with existing colour palette and textures. Finally and more complexly, coloured lighting can also define the city ambiance, the symbolical and emotional appeal of the space, infusing vitality and animation with the use of colours and dynamic lighting. In addition to this, it is necessary to stress that the selection, the preference and perception of a lit scene varies in a correlated way in relation to the provenience culture because socio-cultural parameters can influence the choices toward particular lighting environment [17].

Lighting can be also dynamic without being gaudy or banal providing areas of excitement, social engagement and points of emphasis and interest within the place, while satisfying comfort and security. Each of the previous mentioned elements of light can be useless and even distracting if used meaninglessly: light should represent the directive force of human visual awareness assisting in the creation of significant forms and spaces with symbolic and useful meanings. The results of the study provide a starting lighting framework for the formulation of an overall, comprehensive, lighting design plan that should focus more on features rather than

quantitative ones. As designers we should persuade that the quality of light is far more important than the quantity of light [7]. The achievements of this qualitative methods of analysis can be transferred into lighting design strategies in order to support the design process for the creation of new smart, sustainable, experienced cities.

7. Limitations and Suggestions for Future Research

This preliminary approach can be implemented by increasing the number of participants in the virtual ethnography in order to gather a higher statistical number of responses and a richer panorama of results. This increment can provide a wider and cross-cultural view about the argument and can also test if lighting attributes and responses vary in accordance to the context, culture, age, and gender of participants. More than this, in order to better validate some assumption about attributes of lighting arousing certain emotional effect and reaction of people, it can be conducted a deeper analysis of correlations between lighting, people and the city, passing from the virtual ground to the real observation: investigation in situ about the impact and experiential relevance of ad-hoc public urban lighting installation.

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