A Three Step Method to Design Lighting in Hotel Rooms Through a User Centered Approach

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Introduction

The quality of light depends on photometric parameters such as quantity (Boyce, 2003; Cuttle, 2004), colour temperature (Knez, 1995), and spatial distribution of light (Durak, Camgöz Olguntürk, Yener, Güvenç, & GürçInar, 2007). It also depends on the user perceiving the luminous environment (Knez & Kers, 2000; Rikard Küller, 1986) and the use of the luminous environment (Butler & Biner, 1987; Nakamura & Karasawa, 1999). Methodologies of past studies instructed people to give their environment appraisal by imagining being in an empty room (Van Erp, 2008) or a furnished room (Nakamura & Karasawa, 1999), using a reduced scale model (Oi, Kasao, & Takahashi, 2007), or in a real situation (Oi, et al., 2007; Tabuchi, 1985). However, most of the studies focused on light perception have been conducted in laboratory settings. Even if some of these studies involve highly elaborated experimental design, it was felt appropriate to consider visual factors simultaneously under realistic conditions (R. Küller, Ballal, Laike, Mikellides, & Tonello, 2006).

Moreover, very few studies investigate the relation between lighting and individual preference in hotel, although hotels managers and architects are starting to recognize the importance of hotel design both from an architectural and an interior design perspective (Countryman, 2001; Siguaw & Enz, 1999).

This study also aims to better understand the perception of lighting in hotel rooms from a user's perspective. The design of a luminous environment must consider different parameters for creating an environment that matches the expectations and needs of the user (Boyce, 2003). The study is also designed in three steps in order to highlight light perception based on a user centered approach.

Methodology and Main Results

The originality of this work lies in the "waterfall" approach, since each phase in the study uses the results obtained in the previous stage. A classic analytical approach of psychophysics aims at evaluating the influence of a parameter on individual behaviour. Instead, we based preference on a global approach, which takes the environment as a whole where individuals interact.

The first phase of our study aimed at understanding how a customer in a hotel room experiences the light. In other words, it was to clarify how and when the lighting was influencing the customer's experience. To this aim, a qualitative approach was conducted through individual interviews (30 to 45 minute each). Eighteen customers (66% male, N=14 business) were interviewed in two different hotels (3* and 4*). The interview started with general observations which led to the identification of the customer's conception of comfort in hotel. Then questions focused on the role of lighting and also daylighting in the general assessment of the spaces.

As an example, the quotation bellow illustrated the results that we obtained:

"Well, for me, comfort is to have the right temperature, the right lighting, light and noise" UG25

Discourse analysis was done through each individual corpus in order to identify the

Fig. 1: Example of one tested set: color temperature of the light

relevant elements. Those parameters retained as relevant are: interaction with natural light, the quality of light, and the convenience facilities. The perception is also influenced by the user's activity. Six basic use situations were found: arrival in the hotel room, leisure time, working time, sleeplessness, the situation switch on and the situation switch off. It also appears essential to be able to personalize lighting depending on the use in the different main situations in a hotel room.

The second phase of this work consisted in identifying the lighting parameters that influence an individual's evaluation. Thirty nine images representing the same hotel room were rendered in 2D (V-Ray rendering engine) and grouped into several sets. Each set was the declination of a luminous parameter in three or four modalities. The images were produced in relation to typical situations which were identified in the previous step (Figure 1).

The experimental device was set in a real hotel lobby 103 customers (60 % business, 67% male) were asked to choose the most preferred and the least preferred luminous environment using a computerized questionnaire.

On one hand, this approach allowed for the identification of relevant parameters contributing to the appreciation of a hotel room, regarding esthetical parameters (shape and colour of luminaires) and photometrical parameters (quantity and orientation of the luminous flux). For example, the figure below shows the preference for lighting condition with different color temperatures (CCT).

Statistical analyses (Friedman test) showed that colour temperature of light influenced the appreciation of the environment. The colder light was less appreciated than the warmer (mean ±SD: 4200°K=1.79 ±1.1; 2700°K=2.78 ±0.8;

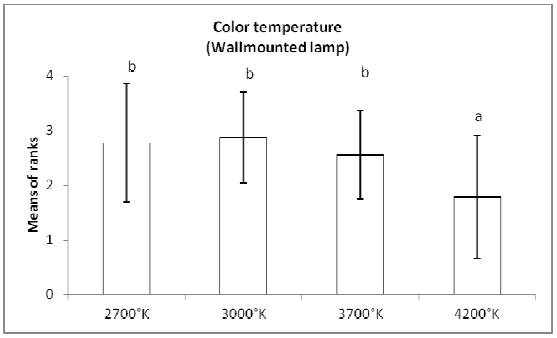

Fig. 2: Influence of the colour temperature of light from a wall--mounted lamp on preference of lighting scenarios. Friedmann test, mean rankings characterised by the same letter are not a significantly different risk (α = 0.01)

3000°K=1.13 ±2.9; 3700°K=2.56 ±0.8) (Figure 2).

On the other hand, this step revealed different preferences of lighting conditions according to the situation, which was then evaluated (data not shown). Lighting conditions were different in terms of quantity and colour temperature. Hence, those results led to an operational selection when designing the experimental device in real situation.

The third phase investigated the contribution of illuminance and colour temperature (CCT) to the user's room assessment in a real hotel room. More specifically, this step aimed at better understanding how the user's activities influence his/her perception of the lighting condition in a hotel room.

The study involved 203 customers (53% male) in a hotel room specifically equipped to implement the testing (3*hotel). They were asked to evaluate the same four lighting conditions during three different activities: watching a movie, typing a text on a computer, and looking at him/herself in a bathroom mirror. These activities are respectively named situation of leisure, situation of work, and situation in the bathroom. Two parameters were considered: illuminance (30% (Dim); 100% (Bright) of luminous flux) and CCT (Warm White (WW): 2700 °K; Cool White (CW): 4200 °K).

After seeing the four conditions for each situation, users had to assess the lighting

Fig. 3: Picture of the lighting conditions. A.Dim WW; B: Bright WW; C: Dim CW; D: Bright CW

conditions on a visual analytical scale. As an example for the working time, the question was: *When you are working, do you like this atmosphere?*

In the situation of leisure, users preferred the warmer and dimmer condition (Dim WW) and discarded the colder and brighter condition (Bright CW).

In the situation of work, users preferred the warmer and brighter condition (Bright WW) and discarded the other conditions (Dim WW, Dim CW, Bright CW).

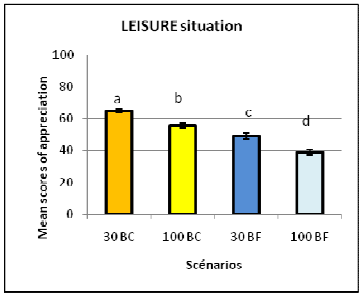

Fig 4: Mean scores of appreciation of lighting conditions Dim WW, Bright WW, Dim CW and Bright CW for a situation of leisure. Mean scores identified by the same letter are not significantly different (ANOVA, α <0.01).

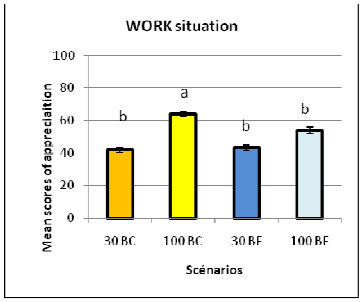

Fig. 5: Mean scores of appreciation of lighting conditions Dim WW, Bright WW, Dim CW and Bright CW for a situation of work. Mean scores identified by the same letter are not significantly different (ANOVA, α <0.01).

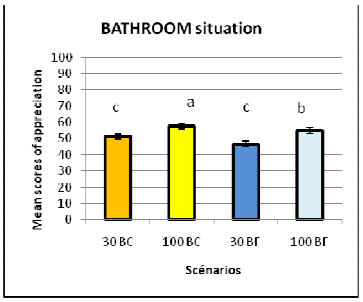

Fig 6: Mean scores of appreciation of lighting conditions Dim WW, Bright WW, Dim CW and Bright CW for a situation in the bathroom. Mean scores identified by the same letter are not significantly different (ANOVA, α <0.01).

In summary, statistical analysis revealed significant differences between lighting condition preferences, according to the activity experienced. In the situation of leisure, people preferred a subdued atmosphere. In other situations (when the user is working or looking at him/herself in a mirror), people expressed a preference for the brighter lighting, that provided more visual comfort.

Academic and operational benefits of the study

This study contributes to a better knowledge of the construction of the perceptive experience of humans in their From an academic point of view, this study shows the influence of the user's situation on lighting preference. Moreover, this study brings a methodological contribution to the study of the perception of a physical environment by its users. This study introduces a three-step approach to reach a better understanding of the interaction of humans with their physical environment.

From an operational point of view, the aim of this study is an optimization model of perceived quality in hospitality that would take into account cognitive processes in situation as well as light characteristics: quantity and colour of lighting interacting with design elements, furniture, accessories, materials, etc.

As a perspective, the validation of the perceived quality model could also include

the evaluation of its solidity in new situations with entry keys of new uses according to the kind of establishment and/or customers.

In other words, this study's results are directly applicable to hospitality specialists, engineers and lighting designers by means of inducing a simplification of the conception process for future comfortable luminous environments in a similar context.

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References

Boyce, P. (2003). *Human factors in lighting.* CRC.

Butler, D. L., & Biner, P. M. (1987). Preferred Lighting Levels : Variability among Settings, Behaviors, and individuals. *Environment and Behavior, 19*(6), 695-721. doi: 10.1177/0013916587196003

Countryman, C. (2001). *An atmospheric scale for the evaluation of hotel lobbies.* Purdue University.

Cuttle, C. (2004). Brightness, lightness, and providing'a preconceived appearance to the interior'. *Lighting Research & Technology, 36*(3), 201.

Durak, A., Camgöz Olguntürk, N., Yener, C., Güvenç, D., & GürçInar, Y. (2007). Impact of lighting arrangements and illuminances on different impressions of a room. *Building and Environment, 42*(10), 3476-3482.

Fernandez, P., Giboreau, A., & Fontoynont, M. (work in progress). *Contribution of lighting to the customer's comfort in hotel rooms: results of a field study.*

Knez, I. (1995). Effects of indoor lighting on mood and cognition. *Journal of Environmental Psychology, 15*(1), 39-51.

Knez, I., & Kers, C. (2000). Effects of indoor lighting, gender, and age on mood and cognitive performance. *Environment and Behavior, 32*(6), 817.

Küller, R. (1986). Physiological and psychological effects of illumination and colour in the interior environment. *Journal of Light & Visual Environment, 10*(2), 33-37.

Küller, R., Ballal, S., Laike, T., Mikellides, B., & Tonello, G. (2006). The impact of light and colour on psychological mood: A cross-cultural study of indoor work environments. *Ergonomics. 49*(14). 1496-1507.

Nakamura, H., & Karasawa, Y. (1999). Relationship between illuminance/color temperature and preference of atmosphere. *Journal of Light & Visual Environment, 23*(1), 1-1.

Oi, N., Kasao, M., & Takahashi, H. (2007). The Preference of the Indoor Illuminance and Color Temperature: Scale Model Experiment Assuming Daily Activity. *Journal of Environmental Engineering* (614), 87-92.

Siguaw, J., & Enz, C. (1999). Best practices in hotel architecture. *Cornell Hotel and Restaurant Administration Quarterly, 40,* 44-49.

Tabuchi, Y. (1985). Development of Lighting Technique for Living Space based on Analysis of Atmosphere. *Journal of IEIJ, 69*(10), 35-41.

Thapa, D. (2007). *Hotel lobby design: study of parameters of attraction.* Texas Technology University. Unpublished work

Van Erp, T. (2008). T*he effects of lighting characteristics on atmosphere perception.* Master, Eindhoven University of Technology, Eindhoven.