# From words to ambience: towards an architectural daylighting design based on users' perceptions and behaviours.

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# From Words to Ambience: Towards an Architectural Daylighting Design Based on Users' Perceptions and Behaviours

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**Abstract**
*This paper presents an investigation aiming to demonstrate the possible move from words to ambience in order to achieve an architectural daylighting design. This latter is mainly based on the users' perceptions and behaviours. It was assumed that the daylighting conceptual tools of an architect namely words, shapes and numbers could correspond together in such a way they characterize various luminous environments. Hence, a post-occupancy evaluation (POE) is undertaken and allows collecting several varying data including users' expressed perceptions and observed behaviours, measured physical parameters of the luminous environment and built space as well as the characteristics of the climatic, cultural and social context. These data are in form of textual expressions, numerical quantities or categorized shapes. The statistical analysis of these data reveals several correspondences between four words, e.g. luminous, and several parameters variably leading to furniture characteristics, architectural space properties as well as the user's behaviour.*

**Keywords:** Daylighting, Ambience, User, POE, Architectural design, Conceptual tools.

## 1. Introduction

When shaping forms in order to create an architectural space, designers commonly express their intentions by words associated to drawings. A first sketch is then mostly associating texts to figures. These words are often those of the designer but are not necessarily the users' ones. This divergence between the designers' and the occupants' points of view is basically leading to a perceptual difference between the both [1].

However, an increasing focus is given nowadays to users' perceptions and behaviours in architectural daylighting design [2]. This attitude becomes more obvious when reminding that no technological development could work efficiently without making an allowance for its users. Hence, this study attempts to demonstrate the feasibility of an architectural daylighting design resulting from the users' perceptions and behaviours analysis. It was supposed that the daylighting conceptual tools of an architect namely words, shapes and numbers could correspond together in order to characterize various luminous environments.

## 2. The luminous ambience

The notion of ambience introduces a different way to investigate the user's relationships to the architectural space. It focuses on a new dimension that is the sensorial one [3]. This latter is principally based on a physical signal which could not be significant only if it is perceptible. Because no signal could exist alone, the ambience is plural. Besides, it pays more attention to the architectural space than other research fields interested by the user-environment relationship. The morphological character of the architectural space is taken into account when studying ambience. Hence, such studies investigate several parameters and require an approach involving various research techniques. They also need specific means for the collected data analysis. The post-occupancy evaluation (POE) seems to be one of the most appropriate approaches.

## 3. The daylight POE

The POE is a 'place centred method' involving the users, point of view [4]. The diagnostic POE, in particular, uses different research techniques in order to collect various data [5]. Because of the large interest accorded to daylighting, as a topic, a daylight POE was developed and widely applied [6, 7].

Thus, a daylight post occupancy evaluation (POE) was undertaken in an office building in the city of Biskra, Algeria. This city lies in the northern region of the Sahara desert, with a semi arid hot climate. The experiment took place during the month of July and August in the building of La Caisse Nationale

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des Assurances Sociales (a major state insurance company) and twenty four offices (42 % of the total number of offices) were studied (Figure 1).

Figure 1: Different exterior and interior views of the CNAS building

The daylight Post Occupancy Evaluation allows collecting several varying data such as users' expressed perceptions and observed behaviours, measured physical parameters of the luminous environment and built space and also the characteristics of the climatic, cultural and social context. Four different research tools were used in order to collect such data: i) questionnaire, ii) behavioural map, iii) photometric measurements, and iv) architectural survey. The obtained data was organised in respect to the previously specified architect's conceptual tools (textual expressions, numerical quantities and categorized shapes).

**4. Associations between words, shapes and numbers**

The users were asked, by means of a questionnaire, to point out if their workplaces are luminous, shiny, non-glary and spacious. The four words were selected from an extensive literature review related to the topic of daylighting [8]. Whilst the three first words are directly linked to daylight, the last one is indirectly associated to it. In fact, it has been revealed that an architectural spacious could be perceived as spacious due to its daylighting design. In the questionnaire, these words were consciously written in dialectal Arabic and French. Because, the pilot study shows that the words expressed in academic Arabic and French only are not obviously well received and understood by the office users [9].

The present investigation aims to find associations between these words, numerical (photometric) data of the luminous environment and the morphological and topological characters of the architectural space. The first preferred colour for the user was taken as a morphological indicator. Thus, it would possible to provide for designers a set of several different indicators linked to each of these words. These sets should make them able to design the corresponding luminous environment. The collected data was statistically analysed. A multiple correspondence analysis (MCA) was accomplished. The correspondences between each word and other indicators were examined. The results were extracted from the graphical outcomes produced by the MCA.

A major number of users associate the word luminous to four characteristics. Three of these latter are linked to the luminous environment whilst the last one is morphological (Figure 2). The first indicator is the ratio between the front vertical illuminance/ behind vertical illuminance (the category varying from 1 to 1,5). The second one is the ratio maximal luminance/minimal luminance (the category > 0,5). The third one is the contrast between the luminance of the desk blotter to the desktop surface one (the category varying from 2,5 to 3). The fourth indicator is the ratio between the occulted area of the window to the total walls area of the architectural space (category r=0,05).

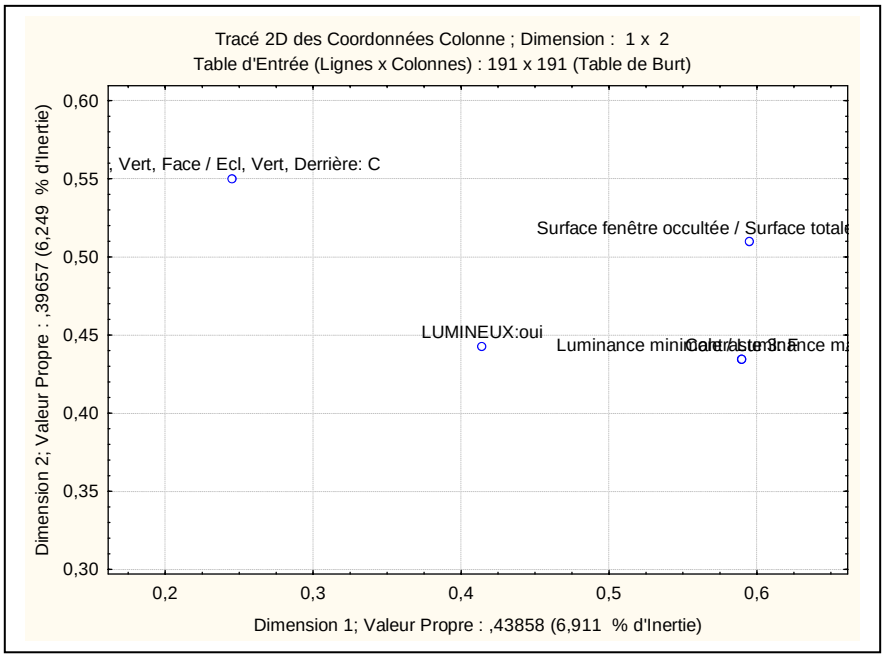


Figure 2: The various correspondences for the word ‘luminous’.

The word shiny is linked to four data related to the morphology of the architectural space. The first one is the conformation area (category varying from 20 to 25 square meters). The second is the ratio occulted window area /total walls area (category r=0,07). The third is the ratio original window surface/ façade wall surface (category r > 0,5). The last one is the first preferred colour for an office (the yellow colour).

Only two indicators are linked to the word non-glary. The first one is morphological and consists on the ratio original window area /total walls area (category r=0,08). The second one is the contrast between the luminance of the desk blotter to the desktop surface one (the category varying from 2,5 to 3).

The last word spacious is linking to two morphological, one topological and another photometric data (Figure 3). The morphological data are: i) the ratio original window area / façade wall area (category r<0,10) and ii) occultation percentage (category varying between 0 and 0,1%). The topological data is the central axial position of the window in relation to the axis of the architectural conformation. The photometric one is the contrast between the task luminance value and the macro visual field maximal one (category r. >2,5).

All these associations allow the definition of four different architectural conformations that could be qualified as samples of a user based daylighting design. These conformations were described in such a way they could directly serve as guidelines for the architects.

**5. A luminous architectural conformation**

An architectural conformation could be described as luminous when it posses specific morphological and photometric characteristics (Figure 4). It is the case where the user is sitting in front of the window (daylighting source). This position allows to the user receiving more natural light from ahead than the back (a ratio r. >1,5).

Also, the more sparkling objects from the user’s macro-visual field must reflect more than the double of what is reflected by the less sparkling ones. That is to say, when the window is the maximal

luminance source, the inner surfaces of the façade wall must be sufficiently clear to be close to the window luminance values.

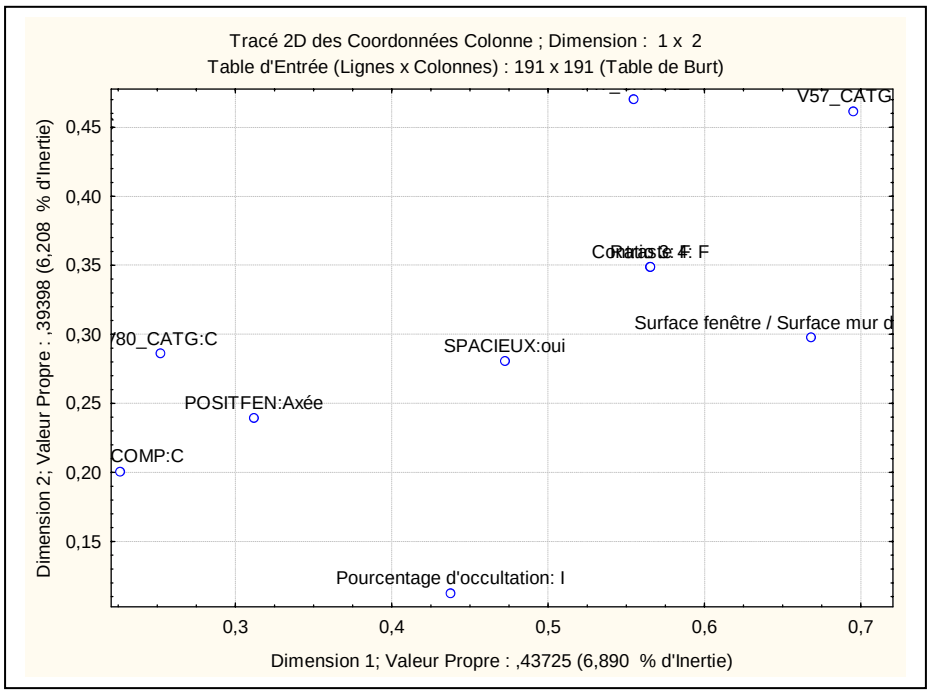


Figure 3: The various correspondences for the word ‘spacious’.

Besides, the window surface has to be equal to 5% of the total inner area of the architectural conformation without the façade wall one. It is also required that the desktop must be clearly coloured and less reflecting than the desk blotter surface. The luminance value of this latter must vary from 2,5 to 3 time superior than the desktop one.

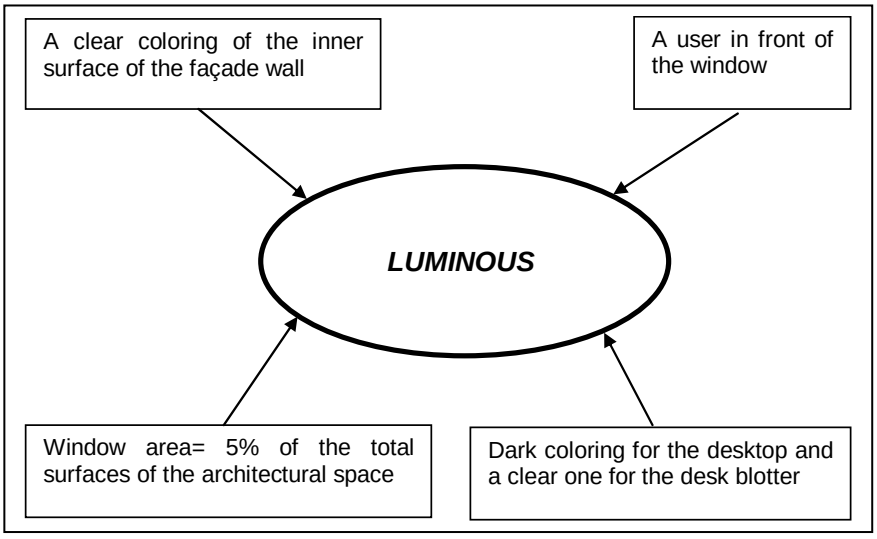


Figure 4: The various requirements to achieve a ‘luminous’ architectural conformation.

**6. A shiny architectural conformation**

A shiny architectural conformation is principally characterised by morphological parameters (Figure 5). The inner surfaces will preferably be yellow which is reminiscent of the sun. Its area is required to vary from 20 to 25 square meters. This implies to deduct that shiny also signify an objectively large conformation.

The window area is equal to the 7% of the total area of the architectural conformation. The window area could also be computed through its ratio to the façade wall area. The architectural conformation tends to be transparent because the window area is nearly equal to the half of the façade wall area. In the case of an office with a façade wall width of 4m, a deep of 5m and a height of 3,5m, the first ratio will give a window area of 6,23$m^2$ whilst the second ratio will give a ratio of 7$m^2$.

**7. A non-glary architectural conformation**

From the user's point of view, a non-glary architectural conformation depends on morphological and photometric characteristics (Figure 6). The photometric characteristic is related to the micro-visual field and precisely the contrast between the desktop and the desk blotter luminance values. A contrast similar to the one required for the luminous conformation must be respected. Besides, the window area must be equal to 8% of the total area of the architectural conformation.

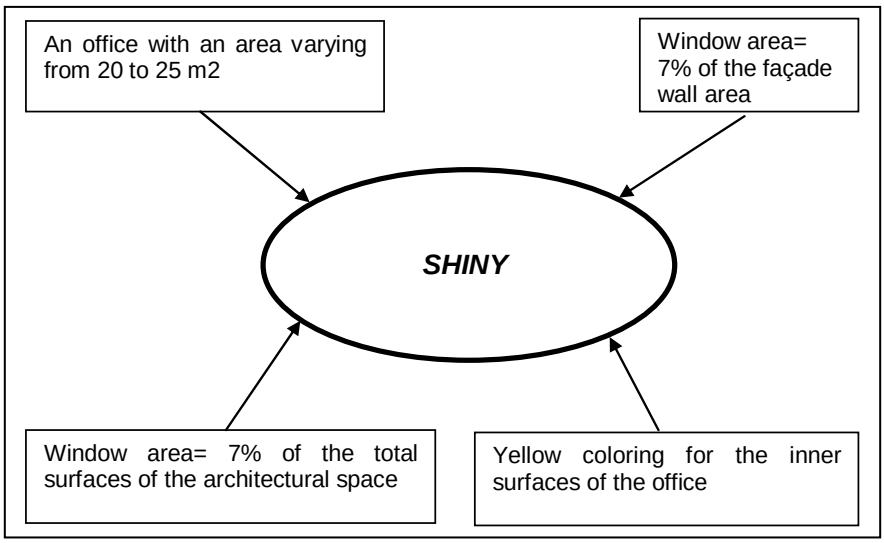


Figure 5: The various requirements to achieve a 'shiny' architectural conformation.

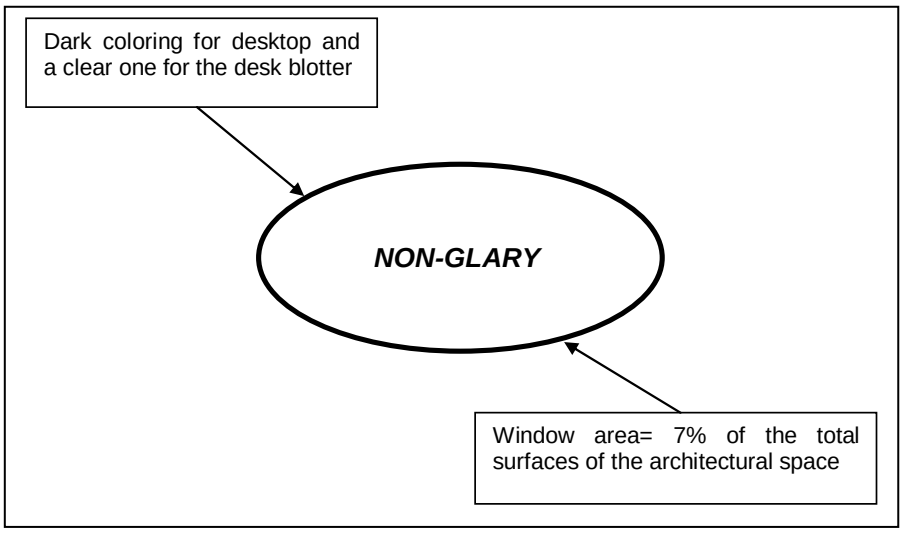


Figure 6: The various requirements to achieve a 'non-glary' architectural conformation.

**8. A spacious architectural conformation**

The architectural conformation spaciousness is the unique case associating a topological characteristic to the morphological and photometric ones (Figure 7). The axial location of the window in the conformation plan is linked to the user's perception of the architectural conformation spaciousness.

The window area must not exceed the 10% of the façade wall one. An occultation percentage of 10% is admitted by means of movable shading devices. However, it must keep in mind that this occultation has not to affect the advantages in relation to the access to a view outside and the desire of sun admission.

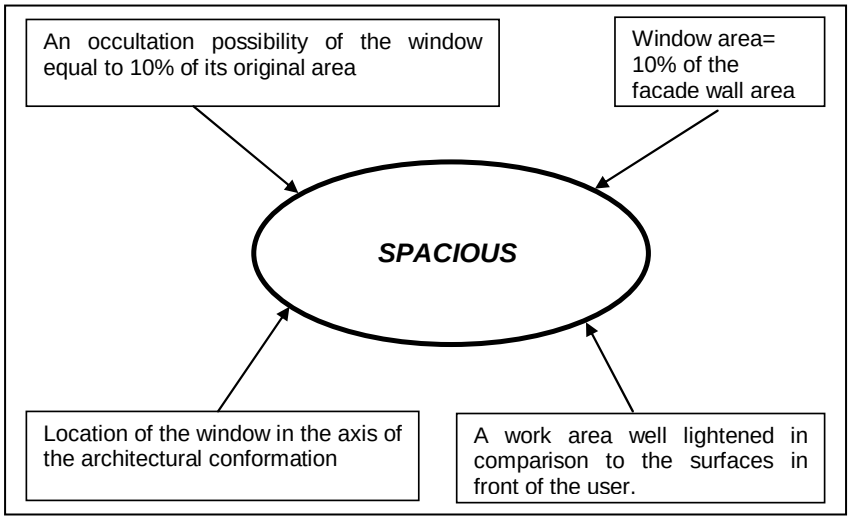


Figure7: The various requirements to achieve a 'spacious' architectural conformation.

The user's task must be sufficiently lightened. The paper used in the office work must be clear in such a way that its luminance value would be 2,5 times superior than the maximal value in the macro visual field. This could be also signifying that the user needs to avoid the location in front of the window.

## 9. Conclusion

Accordingly to the present-day research needs requiring more focus on the built environment users, this research work investigates the feasibility of an architectural daylighting design based on the occupants' point of view. This latter is defined through their perceptions and behaviours. The research results demonstrate the possibility of constituting guidelines to serve architects when designing luminous ambiences in offices under clear sunny skies. Four luminous ambiences were defined to serve designers: i) luminous, ii) shiny, iii) non-glary, and iv) spacious. The outcomes reveal the importance of the morphological characteristics (window area, and surfaces colouring), the topological ones (location of the window in relation to the architectural conformation) and the user's behaviour (occultation of the window by means of movable shading devices, location of he desk in relation to the window). For a future work, it will be interesting to associate other kind of ambiences (thermal, visual, acoustic…). This will achieve one of the main goals of the notion of ambience that is multisensoriality.

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