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Lighting Design a Natural Part of Architecture with Strong Connections to Important Goals in Society

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Abstract

Methods used for lighting design have a surprisingly strong connection to important goals in society of visual comfort, public health (Pauley 2004) and to the protection of animals, plants and ecosystems (Gathreaux & Belser 2006). This put high demands on the development of a process of lighting design that contribute to a high fulfilment of these important goals. Lighting design is a process of 4 basic steps. Step one) the space; step two) the user; step three) the design of daylight and the complementary lighting; step 4) the design of the practical application (Säter 2012). The lighting design process can be performed in many ways. The user centred lighting design process is focused on the support of the individual and give, when in use, the individual user a strong support from light, psychologically, physiologically and visually (PPV). The energy efficient lighting application should not be designed in a way that contradicts other important light related goals. The use of the energy efficient lighting design process need to handle the fulfilment of goals for energy efficiency in a way that do not stay in conflict with the experience of visual comfort, public health and conservation of nature. In order to protect animals and plants from negative effects from artificial lighting, an eco-lighting design process should be taken into use.

Keywords: Lighting design processes; Fulfilment of light-related goals

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Introduction

The lighting designers work has, despite being one consultant by many in the building process, a surprisingly strong connection to important light-related goals in society. The choices that we do according to lighting and the use of photon flows concerns both visual comfort, light-related public health and conservation of nature and the life of animals, plants and ecosystems. By tradition is lighting something that often is handled from a standard with predesigned static levels of light or from a design perspective where the contractor gives the resources for a small amount of more exclusive projects. Reasons can be found for treating every public lighting application both in the indoor and the outdoor environment more carefully and by law guard that the lighting applications are designed in a way that do not risk disturb the health of humans, animals, plants or ecosystems.

Only with the protection of the law will the resources be available to fulfil goals about visual comfort (VC), light- related health (LRH), nature conservation (NC) and Energy efficient lighting (EEL). It is often the lighting designer that work hard to get the financial resources needed by convincing the contractor about the need of time and money to be able to in a better way fulfil the light-related goals. This is done by a lighting design that is more carefully performed than the European standard for indoor lighting. The standard is developed by CIE, CEN and is recommended by ISO. If the law state that the lighting design need to be done in a way that lead to an application that gives humans light- related support psychologically, physiologically and visually (PPV). If in the same time the lighting designer need to assure that animals and plants and ecosystems do not get hurt by the use of the outdoor lighting. It is likely that this should give the lighting designer the resources needed to fulfil light-related goals of great importance in society. The resources needed for lighting design could by that be present in the building process.

When the importance of light-related goals will be more known, it is likely that the cost for lighting design will be seen as negligible. Lighting design is a handicraft and a natural part of architecture and can be designed in a congenial way with the architecture and in a way that support the concept of the interior design. If lighting design is done in a careful way the “design ambition” does not need to stay in conflict with the goals of VC, LRH, NC or EEL.

Problem Area and Relevant Research

In lighting design, photon flows are used to make the life in the indoor and outdoor environment more efficient and pleasant. Despite lighting is needed and a natural part of architecture, photon flows used for a complementary lighting for indoor or outdoor environments, can be a disturbance for the diurnal rhythm of man. In the same way it can be a disturbance for the life of animals, plants and echo systems (Pauley 2004; Gathreaux & Bolser, 2006). The way photon flows are used for lighting purposes is vital since it is related to goals about visual comfort (VC), light- related health (LRH), nature conservation (NC) and light-related energy efficiency. Photon flows can be

used for lighting purposes in a way that generates disturbances or have beneficial effects. Lighting design need to be done carefully because of contradictory needs. These needs should be balanced together and be put into hierarchy and be seen as more or less important and be handled in a way that gives a high fulfilment of light-related goals. Relevant research can be found in a multidisciplinary spectrum of knowledge within for instance photobiology, physiology, zoology, botany, ecology, architecture, interior design, lighting science and ergonomics. Energy efficient lighting applications (EELA) for indoor and outdoor environments is concerned all areas of knowledge here mentioned but it cannot be excluded that more areas of knowledge will be of a great interest in the future. The lighting applications in use today are primitive compared to what is needed to get a higher fulfilment of the goals of VC, LRH, NC, and EELA. The development of methods for lighting design is crucial to get a higher fulfilment of the light- related goals.

Methods

The method used is to write down common knowledge in lighting design and combine with a literature review (Säter, 2012) in topics that can be seen around the lighting design process (LDP). The literature is related to the space, the user and the design of daylight and complementary artificial light for the outdoor and the indoor environment and the design of the practical application.

Results

The literature review reveals that lighting design is connected to important goals of society. The review also shows that all four steps in the (LDP) need to be used to get a high fulfilment of these goals [Säter 2012].

Goals Concerned Visual Comfort

VC is a visual experience given by the combination of colour on the surfaces in the view and level of light in the task lighting and for the ambient light. The experience is dependent on the interaction of photon flows with the surfaces in the space through transmission, absorption and reflection (TAR). The experience is for the user related to the visual sight and to the sensitivity of the channels into the CNS (Ingvar, 1981).

Goals Concerned Light-Related Health

LRH can partly be defined as Vitamin D-production and a well functioning diurnal rhythm (Holick 2011; Wirz-Justice & Fournier).

Goals Concerned Plants, Animals and Natural Conservation

Aspects of light-related NC is mapped out by scientists often looking close to the life of a certain animal, type of plant or a specific eco system (Gathreaux & Belser 2006).

Goals Concerned Energy Efficient Lighting Applications

Energy efficient lighting applications (EELA) can be designed based on a template with a predesigned level of light and a recommendation of an energy efficient light source. It can also be done with a more carefully design with a synchronization of photon flows from daylight and the complementary lighting application. When daylight is used as much as possible and energy efficient light sources are used as little as possible, a high fulfilment of the goal of low energy consumption for lighting purposes is met. Both for countries far from and close to the equator, shading of daylight to avoid glare and an overheated workplace need to be used to get the desired reduction of the energy consumption and not an increase related to energy used for cooling.

The Findings of Iprgs and Melanopsin

In the beginning of year 2000 was the findings of ipRGC and melanopsin accepted. (Berson, Dunn & Takao, 2001; Provencio et al., 2000). Brainard and Hanifin (2005) describe man and light from a photobiological perspective.

In the journal of medical hypothesises wrote Steven Pauley (2004) about a better practice (in lighting design) now. The lighting design should give the same support physiologically as daylight.

TAR

Anders Liljefors describes (1999) that photon flows are emitted towards surfaces that in different proportions transmit, absorb and reflect photon flows.

The Need of Living in the Rhythm of Daylight

Photobiological knowledge points out the importance of living in a stable diurnal rhythm and that the level of light in the indoor environment is too low to decrease melatonin during the day. (Wirz- Justice & Fournier, 2010).

Connected to the Light at the Place where the user Lives

Ann Justice- Wirtz writes about the need of staying in the rhythm of light at the place where the user lives. (Wirz- Justice & Fournier 2010).

The Role of Colours in the PPV Support of Humans

The choice of colours for the surfaces in the space are crucial to get the future more daylight mimicking lighting for the indoor environment well functioning and give, despite being in a rhythm from low to high, an experience of visual comfort. The close contact with daylight gives a psychological support for being alert during the day, a natural contact with nature and/ or the sky that is stimulating. In the same way gives daylight signals for the diurnal rhythm to the persons working in the space and

triggering for visual perception. This increase in psychological, physiological and visual support from daylight cannot be done without a careful design of colours.

The computer calculated lighting design process (CCLDP), (Säter, 2012) can be used when a design based on predesigned levels of light is wanted and the fulfilment of goals is not prioritized. When light-related goals are important the appropriate method that gives the highest fulfilment of goals need to be used. The user centred lighting design process (UCLDP), (Säter, 2012) is used to get a good psychological, physiological and visual (PPV) support for the user. An ecological lighting design ECOLDP can be used when the protection of animals, plants and ecosystems, from a misuse of photon flows are needed. The EELDP can be used when the energy efficient lighting need to be performed in a way that do not stay in conflict with VC, LRH, NC and EEL. Knowledge of action spectrum of EMR for humans, animals and plants is needed to fully develop UCLDP, ECOLDP and EELDP as methods for lighting design.

The design of colours is crucial when working with an increased use of daylight. The colours that are visual comfortable on the highest level accepted in the indoor space and still attractive in the lowest level of light seen as secure in the space, should be chosen. If the colours on the surfaces are not experienced as visually comfortable on the highest accepted level of light in the space, the users risk experiencing visual discomfort. If the colours chosen do not appear as visually attractive in the lowest accepted level o light, the space might be experienced by the users as dull. Windows and the lighting application for the indoor environment is a natural part of the architecture and the interior design that can be done in a congenial way with the design concept for the space or be designed in a way that contradict the concept. The work with the design of an attractive and pleasant lit environment need to be fulfilled simultaneously as other important light-related goals.

Discussion of Methods and Results

Discussion of methods: The goals for lighting design here mentioned can be increased in number. There is a lack of knowledge about action spectrum for EMR and more knowledge is needed to make light sources that when used gives a better support PPV as can be seen in dynamic phototherapy (DPT). The lack of the complete action spectrum for humans, animals and plants is an important part of the literature that is missing.

Discussion of results: Since we do not know the action spectrum of EMR for humans. And do not know the specific wavelengths that pass through melanopsin in the ganglion cells, daylight is the safe alternative that gives us a healthy light. The sun has good and bad sides, the good should be used and the bad avoided.

The build up of the goals for lighting design here mentioned, is in the beginning and need to be specified in a more detailed way. The development of

the process of lighting design that lead to a fulfilment of light-related goals is in the very beginning. The process is described in a shallow way and need to be more carefully pictured. When contradictory needs of the lighting application are present, the goals should be put into hierarchy and seen as less or more important. The beauty and comfort of the space is a main goal that needs to be fulfilled at the same time as VC, LRH and EEL.

Conclusions

The artificially emitted photon flows in the indoor environment is a replacement for the sun and the lighting application can be done in many ways. Many goals can be put on the design of the practical application. Goals for lighting design can be defined as an attractive space, VC, LRH, NC and EEL. More knowledge need to be developed about photon flows emitted in the space towards surfaces in interaction with each other by transmission, absorption and reflection (TAR). The design of the interaction of photon flows and surfaces is a key for the well functioning lit environment that makes it possible to use daylight on high levels to get an increased PPV support for humans in the indoor environment. An important part of future work with lighting design is the development of a lighting that gives a compensation for staying away from daylight during the day.

Abbreviations

CCLDP- Computer calculated lighting design process
DPT- Dynamic phototherapy
ECOLDP- Ecological lighting design process
EEL- Energy efficient lighting
EELA- energy efficient lighting application
EELDP- Energy efficient lighting design process
EMR- Electromagnetic radiation
LDP- Lighting design process
LRH- Light-related health
NC- Nature conservation
PPV- Psychological, physiological and visual support
TAR- Transmission, absorption and reflection
UCLDP- User centred lighting design process
VC- Visual comfort

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