Socializing Light: Towards Interactive City Lighting on 4 levels

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Introduction

In this position paper, we formulate a vision on the development of interactive city lighting towards social ambitions on four levels. We share our approach, especially from the perspective of a designer in a multi stakeholder environment for public street lighting, by discussing three real design cases that illustrate the four levels of our vision. In working on these cases in the public space with real stakeholders and real users, we often encounter ethical issues. We conclude our paper with arguments for an ethical debate related to the design of public interactive lighting.

Within the broad context of City Lighting, in this paper we focus on the design of public street lighting. Since long, street lighting systems are owned and managed by municipalities. Modern LED lighting technology and advanced infrastructure and control systems offer new opportunities for street lighting that go beyond mere functional lighting for a safe transit space.
Municipalities nowadays address ecological and societal ambitions to the design of public lighting:

- Ecological: reduced energy use and reduced light pollution
- Societal: enhanced feelings of comfort, safety and security, increased social cohesion, aesthetically pleasing urban environment, enhancing identity to particular areas of the city

Given modern technological developments, we recognize the following four levels of interaction in the development of interactive city lighting:

- Dynamic lighting, based on predefined lighting settings triggered by predefined triggers (e.g. timers), explored in case *Zilverackers*
- Adaptive lighting, based on predefined lighting settings triggered by low bandwidth sensors (e.g. light sensors, microphones), explored in case *Stratumseind*
- Interactive lighting, involvement of users in the development and selection of real-time light settings, by high bandwidth sensors (eg. camera's, touch screen, personal mobile devices), explored in case *Amsterdam ArenA*.
- Social lighting, interaction based on recognition of emotions and social relations between users and systems, no case available yet

Case Zilverackers

An example of a project that applies a solution based on dynamic lighting is Zilverackers. The municipality of Veldhoven, The Netherlands asked The Lux Lab to design a smart lighting solution for a bicycle path that runs through an ecological zone. The proposed solution aimed to use different lighting settings (varying in color and intensity) at different times to accommodate different stakeholders (figure 1). The proposed solution offers four settings. In the early evening the path is intensely used by commuters, particularly children heading home. A bright white light is aiming to increase cyclists' feelings of comfort and safety. Later in the evening as traffic ceases the light dims to a light that is less disturbing for animals and plants but still provides good visibility for cyclists During the night as there is hardly any traffic the wild life becomes the most important stakeholder. Therefore, the light is dimmed to the equivalent of 'full moonlight'. In the morning bright cool white lighting setting is used to increase alertness of the cyclists.

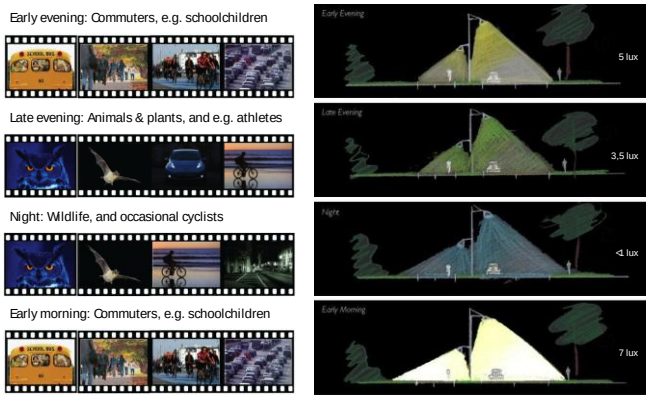

Figure 1 - Design sketches by The Lux Lab

The proposed solution differs from traditional lighting installations as it aims not just to reduce the energy use but at the same time to increase life quality in the ecological zone while not sacrificing safety of the road users. The role of the designer is to understand the needs and requirements from the various stakeholders, and to integrate seemingly opposing needs into a solution that is attractive, or at least acceptable, to them. To gain understanding about their acceptance of the solution a workshop was held with representatives from different stakeholder groups. The workshop revealed varying and sometimes even conflicting needs (table 1). The most important observation is that while all stakeholders were at least fairly positive towards the concept as a whole, the ranking of key parameters differed significantly.

Table 1 - Stakeholder key parameters and priorities for further development

	Police	Supplier	Environmental organisation	Users	Municipality
Ecology	4	3	1	3	2
Social safety	1	2	2	2	1
Energy efficiency	6	4	3	1	6
Atmosphere	2	1	4	4	3
Promotional value	5	6	5	5	5
Purchase and maintenance costs	3	5	6	6	4

Based on the positive feedback of the stakeholders, the decision was made to invest in a set of prototypes to be placed at the site for further acceptance testing. Figure 2 illustrates the different lighting settings applied during the test. The study involved 21 participants, who each got to experience two contrasting settings, and answered questions related to the perception of safety and comfort in the settings and acceptance of the overall concept. From the results it can be concluded that the participants accepted the dynamic lighting concept with predefined settings.

Figure 2 - Lighting settings on prototypes placed at the site

Case Stratumseind

An example of a project that aims to apply adaptive lighting is Stratumseind. In this bar district in Eindhoven, the ambition is to apply lighting schemes that influence the mood and behavior of visitors. Although there is some knowledge about the influence of lighting on mood and behavior most of the studies were conducted in lab settings, and little is known about the effect in real life settings. When the street is quiet lighting settings aim to make the atmosphere more vibrant. When stress levels of people are increasing the light settings aim to calm down people to avoid aggression and escalation. The design further involves smart use of sensors and automatic camera image analysis algorithms to automatically change the lighting settings upon certain triggers. Since there is insufficient knowledge if lighting settings will indeed be effective, an exploratory study is conducted to see if an effect on the mood and stress levels of people can be established. For this exploratory study The Lux Lab designed a pyramid on which different scenes can be projected (see figure 3).

Figure 3 - Exploratory design to test impact of lighting

Questionnaires were addressing the perception of safety and atmosphere during the settings, and a heart rhythm sensor was applied to measure stress levels during the calm and stressful scenes. A preliminary analysis of the questionnaire results indicates influence of the scenes on the atmosphere, although not statistically significant due to the limited number of participants. The scores on parameters 'frightening', 'threatening', 'tense', 'mysterious', 'restlessness' and 'hostile' are higher in the stress scene, and scores on the parameters 'relaxed', 'homey' and 'tranquil' are higher for the relaxed scene.

Case Amsterdam ArenA area

The area around the Amsterdam ArenA is scheduled for a pilot with interactive lighting. The lighting system uses remote control as well as sensors to adjust the lighting to specific circumstances, with the aim to increase safety and reduce energy. Due to the diversity in use and visitors of the area, with the Ajax football stadium, the Heineken Music Hall, a shopping boulevard, offices and residential use, the lighting settings can be tuned to the public.

The project will start with an experiment with interactive street lighting to gain experience with how such a system can work in public space. Tests will be done with e.g. crowd management: can we guide flows of people with lighting? Will people intuitively recognize what to do in such cases? What kind of interaction is meaningful in public space? And how will the interaction be done?

Conclusion and discussion

The role of the designer is to understand the various stakeholders, and to integrate seemingly opposing needs into an attractive solution that increases the quality of nightly city life. Modern lighting technologies enable municipalities to allow increased interaction of users of the public space with the urban lighting system. We have proposed four levels of interaction: dynamic, adaptive, interactive and social lighting. In the discussed cases, we have designed light settings for specific contexts, we tried to influence the mood and behavior of people by applying different light scenes, and finally we are designing for opening the infrastructure of street lighting for citizen participation in developing and selecting light scenes.

Interactive city lighting can be used to achieve societal objectives, but this inherently raises several ethical issues. When the intention is to use the lighting to increase the quality of life in the city, apparently there is an assumption of a desired direction and a mechanism to get there. For instance lighting cues can be provided to users at opportune moments to increase social cohesion and perceived safety based on real-time collected data and information on social behavior. But who is defining what desired behavior is? Who will decide what is allowed to do in public space, and who is allowed to do that? What data and information may be automatically collected and stored? Who is the owner of the network and the information (and are they trustworthy)? Is there an opt-out?

The design of interactive street lighting systems is no longer just a technological design process, but it becomes more and more a social design process. Therefore ethical design issues become apparent. The responsibility for the integrity of the social systems becomes more dominant than technological feasibility.