Interacting with Light Apps and Platforms

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Abstract. In the near future, highly dynamic light sources will be embedded in the areas in which we live and work, as well as in the objects within these areas. All these light elements will be connected, and digitally controlled. This development will turn our environments into lighting platforms that will not only allow us to observe our surroundings and perform our tasks, but can also support many other functions and activities. Furthermore, through sensor networks, such platforms will have knowledge about their environment, and will be able to autonomously respond to users. This vision requires us to rethink the way we interact with light as well as the way light interacts with us.

Keywords: Light, Apps, Platforms, Interaction, Office, Breakout.

1 Introduction

The developments in artificial lighting are very rapid. Modern LED light sources are small, energy efficient, and durable. They are highly dynamic and properties such as brightness, color (temperature), direction, and focus can be can be easily controlled and adapted to our desires. The nature of this new type of lighting will allow many light sources to be embedded in the environments in which we live and work. All these sources are connected to each other as well as to sensors and other equipment. These environments can be seen as platforms that can provide various services, supporting people in performing the activities they intend to do.

In contrast to the technological developments, the way we interact with the modern light sources has hardly changed since the invention of electric light. We still use switches (although sometimes in modern disguise such as capacitive touch) to turn on a single lamp or a pre-defined group of lamps. In some cases we are able to gradually dim our lights, or to choose a preferred color. However, dynamically controlling settings like intensity and color of more complex sets of light sources is almost exclusively done via complicated systems that are supposed to be used by trained professionals (e.g. for use in theatres and clubs).

Also practices towards application of lighting in smart environments according to the Ambient Intelligence vision are rather conservative. Most autonomous behavior of lights concerns simply switching on or off, triggered by either a timer or a passive infra red (PIR) motion sensor. Some systems use the level of (natural) light to determine how much extra light is required from an artificial light source to meet the desired light levels.

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We envision a future in which light systems are part of an intelligent platform. The system supports or even stimulates the users in their activities and enhances their experience. Lighting will be controlled in collaboration with the environment. The user will no longer control individual light sources, but rather interact with the environment as a whole. In the remainder of this paper we formulate important directions of research to develop this vision. We also introduce a case in which we will explore our research questions in a research-through-design approach [1].

2 Directions for Research

Our research will be explored in three important areas: first new opportunities for the use of intelligent lighting, second the development of light platforms and services, and third the development of new interaction styles for user-system interaction.

Opportunities for Lighting. Providing adequate visibility to be able to perform a task is a primary function of lighting. Even in this area many opportunities arise to better support tasks by more flexible lighting, able to adaptively respond to changing needs and circumstances (eg. tasks, number of persons, multi-purpose environments, social relationships, daylight conditions etc.).

Moreover, many services on the envisioned light platforms can go beyond adequate or appropriate task lighting. Exploring the (latent) needs of users in a particular domain, combined with existing knowledge on the effects of light can provide useful starting points to find innovative concepts. Knoop [2] discusses the visual (e.g. perception and cognition), emotional (e.g. mood and atmosphere) and biological (e.g. circadian rhythms, alertness) effects of lights. Applying the knowledge about these effects of light can for instance lead to more productive or comfortable working environments. Another interesting effect of lighting is the social dimension [3]. Light has an effect on the social relations and social interaction between people. Using this knowledge, we can for instance create ambient lighting that can be used to encourage cooperation. Lighting can also be used to influence behavior using principles of persuasive technology [4], [5].

Besides the effects on people and their behavior, we recognize opportunities in the use of light as an information medium. We do already get a lot of information from the light in our environment. Natural light subtly tells us something about the time of the day, and lights in your neighbors' house lets you know they are home. The notion 'information decoration' [6] describes a class of ambient displays [7] in which unobtrusively and aesthetically presented information informs the user in the periphery of his attention. Light could very well function as a medium in this concept. Lighting could for instance be used to display presence and availability information. But if light is used as an information medium, then how will this information be understood? And how is informative light distinguished from illuminative light?

Light Apps and Platforms. Modern electronic products often serve multiple purposes. These are systems that provide various services to the user. Services offer functionality and information that is tailored toward the user with respect to context

(eg time, location, activity, company) and user preference. This trend is most obvious in modern smart-phones platforms. An added value for such platforms is especially created by the 'user generated content', which means that new services can emerge and be build on other services. Lighting solutions could benefit from a similar structure: the applications will determine the actual function and value of the system at a given moment. Lighting solutions will shift from single-function luminaires towards light 'apps' and 'platforms'. These platforms can provide us with suitable atmospheres, information about our environment, support our social connections, and support our activities in many other ways. Applications can be provided by experts, but also by the end-users themselves. Exploring the potential of end-user programming of light apps is an area of interest.

There are several prerequisites to make the platforms and apps a success: not only technical issues in terms of connectivity, repositories and so on, but also business model and user experience issues are relevant. Who will be app developers; professional experts or end-users? Where will people download or buy their apps? What critical mass of apps has to be developed for a community to take off? What standards and protocols need to be established? What business model will underlie this concept? How will we integrate sensor networks and third party lighting equipment? How do applications rely on the platform elements in different locations? In other words, will an app work if you take it to another location? Who will adapt or fine-tune apps for specific locations or platforms.

User-System Interaction. In contrast to the relation between a switch and a light bulb, the relation between a person and a light platform is not straight forward, as the platform has many light sources that each has various properties. Controlling dynamic lighting that comes from many different sources creates the need for new forms of interaction. Furthermore, the amount of different functions that such a lighting system will perform in a dynamic context, creates additional challenges for the interaction. A comprehensive interaction paradigm is required that allows various users to select, control, and configure applications in a meaningful way.

It is tempting to develop a smart-phone app to allow people to control the light platform. However, there are alternative ways of controlling these light apps, which may be more attractive or appropriate depending on various parameters such as the context and frequency of use. For instance the field of Tangible Interaction [8] offers advantages such as direct manipulation and physical affordances to create meaningful interaction.

As we also envision the platform and the environment to be an active participant in the interaction with the user, an important part of the interaction research concerns the behavior of the system. Within the field of Ambient Intelligence a central question regards the balance between user control and system automation. We believe that this balance can be achieved by considering user and system as two agents in a collaborative decision making process that can be initiated by any of the two agents. The system may provide a suggestion, and the user may suggest a change. Over time, user and system will be able to learn from one another resulting in more fluent interaction. Analogy with concepts in human-human interaction, such as social

translucency and common ground [9] may provide useful starting points and brings up other interesting directions such as the matter of intention and surprise. In some occasions, a specifically intended effect is desirable, while in other cases there is room for variation and new suggestions.

3 Case: The Modern Office

Offices are becoming more open and dynamic. People work on flexible desks in open spaces, and the office provides new types of spaces for activities focused on for instance social interaction, (informal) meetings and relaxation. The needs of the 'new' office workers could be addressed and supported by dynamic lighting solutions. Time management, space appropriation, presence awareness and knowledge sharing are some of the relevant topics. An interesting type of space in the modern office is the 'breakout area'. This is an area where people can have informal meetings, sit down to read, have a brainstorm or just have a coffee. The dynamic use of this space makes it particularly interesting as the initial context to explore the opportunities of light apps and the interaction with the platform. Lighting solutions could support the different activities in the breakout area by providing a suitable atmosphere or stimulate for instance concentration, creativity, or relaxation. Light could also be used to create separate zones in the breakout area to support the use of the area for multiple activities that go on simultaneously. Finally, light could be used as an information source, providing information about the use of the area, the people in it, or about other things that are relevant to the different activities.

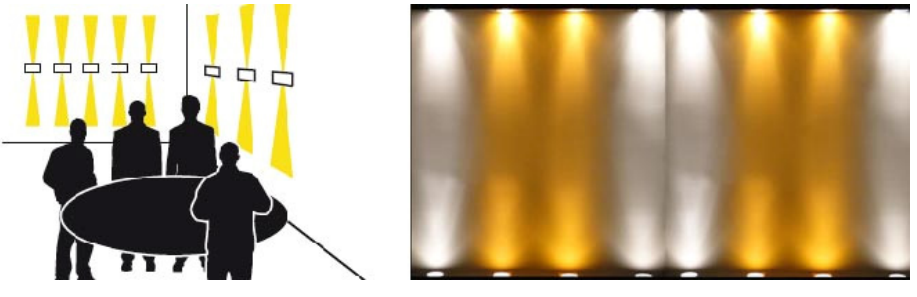

Fig. 1. Prototype by Occhialini et al.; Light indicating the progress in a meeting

An example of such a system was developed by Occhialini et al. [10] see figure 1. Their system supported timekeeping in meetings or a series of presentations using an unobtrusive lighting pattern on the wall that constantly informs the people about the progress of their meeting. We have taken this concept and implemented it in an initial light app on a new light platform element. This same platform element was also used for another app that provides atmospheric lighting, and could again be used for numerous other applications, see figure 2.

Fig. 2. Initial element of a lighting platform running the 'meeting timer' app (left) and the 'atmospheric lighting' app (right)

Development of a Testbed. To further explore the potential of light apps in the case of the breakout area, we are developing a testbed, see figure 3. The testbed is situated in our department and is used on a daily basis by staff and students of the department for the intended purposes. The area contains basic light infrastructure with wall washing, down-lighting, and dedicated lamps. All lights are electronically controlled and the functions described above are available to the users.

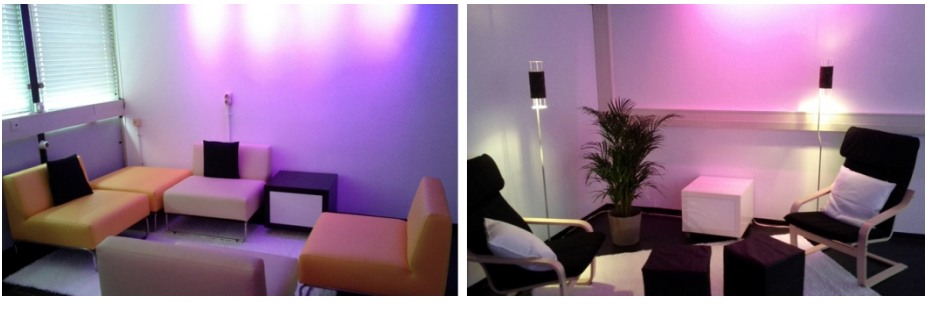

Fig. 3. Initial arrangement of the Breakout area testbed, featuring an individual area (right) and small group facilities (left) with dynamic lighting equipment and sensors

In the breakout area testbed, we will explore and develop new applications, various light platform elements and novel interaction styles, see figure 4. Formative evaluations using qualitative methods (both longitudinal in situ studies, as well as controlled studies) of these systems will allow us to identify the common or valuable elements. The main questions are: 1) How can we support the activities that take place in the breakout area using light? 2) How will the user experience the light concepts? (*how do users actually "use" the system, what is the perceived usefulness of different apps, is there any stress or distraction? etc.*) 3) How will the users communicate with the system and how will the system behave? (*do people understand how to interact with the service, accurately perceive the displayed information, what is the cognitive load of interaction? etc.*) Follow-up design iterations will allow us to work towards a new paradigm for the interaction with light.

Fig. 4. Selection of initial interaction opportunities (left-to-right): Information decoration display, smart phone lighting control, meeting timer hourglass, atmosphere selection cube

4 Conclusion

In the future, our environments will contain many embedded light sources that will together form light platforms on which various applications will run depending on the current usage of an area. Besides interesting light concepts and a service infrastructure, a new paradigm for interaction with these environments is required in order to benefit from its full potential. Our current research frames these questions.

We employ a design-research approach in the context of a breakout area to develop and explore new interaction styles with various applications and a light platform. Successive iterations of evaluation and design will allow us to work towards a new paradigm for the interaction with light apps.

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