M-Beam: A Tangible Atmosphere Creation Interface

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ABSTRACT
Light Emitting Diode (LED) based lighting systems have introduced radically new possibilities in the area of artificial lighting that go beyond functional illumination. The new types of luminaries can easily consist of hundreds of separate light sources, with each source having many individually controllable parameters including colour, intensity, and saturation. Traditionally different lighting atmospheres in the home are created using decorative white light and candles. With LED based luminaries the diversity and richness of atmospheres that can be created have grown dramatically. One of the main challenges in lighting atmosphere creation is enabling a user to create such atmospheres easily. In this paper we present the design and implementation of M-Beam – a physical interface that can be used to set the atmosphere based on the desired atmosphere mood. The physical appearance of the M-Beam expresses the atmosphere the user is trying to create while also reflecting the current state of the system.

Author Keywords
LED, Lighting, Atmosphere, Physical Interfaces.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors.

INTRODUCTION
The advances in Light Emitting Diode (LED) technology have caused a profound change within the lighting industry. This is in part due to the LED's key properties of being physically small, highly efficient, digitally controllable and soon, very cheap to manufacture. With the highly adjustable characteristics of LED lighting the function of lighting goes beyond functional illumination. One of the areas where the richness of LED lighting has the potential to change our design freedom radically is in lighting atmosphere creation.

In this paper we define atmosphere as the observable affective state of an environment. In other words, you can observe that a room's atmosphere may be associated with a certain feeling such as being happy or romantic, without having to feel that way yourself. The complex thing about atmospheres is that anything in the room can influence it. These things can be deliberately chosen by people, such as with the wall colour or playing music. However, there are also uncontrollable factors like the weather outside or the mood of the people inside the room. It is the combination of all these influences that determine what kind of atmosphere a room may be perceived as having. Some influences are more dominant than others, for example a room can be beautifully illuminated by the morning sun, but the mood of atmosphere may be perceived as being very tense if there is also a serious business meeting taking place.

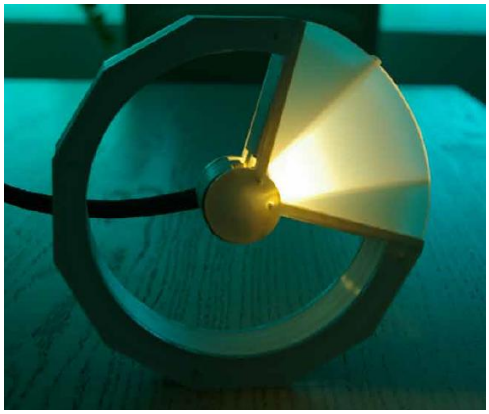

Figure 1. M-Beam: UI concept to control atmosphere

The focus of our research was on influencing atmospheres to try and create a particular mood. The two main influencing factors used were light and music. Depending on the desired (selected) mood for a room's atmosphere the light and music would then be altered to provide an output that would potentially influence the atmosphere so that it would be perceived as having the selected mood. Moods can be expressed in many different ways; we were interested in exploring how the mood can be expressed in the physical interface both in the form of the user interface (UI) as well as in the interaction with it so to facilitate the selection of moods for an atmosphere.

In this paper we present a UI concept resulting from this exploration named the "M-Beam" (see Figure 1). M-Beam is a user interface for controlling certain atmosphere influencing factors. It was designed with the intention to provide optimal freedom of mood expression (for the intended atmosphere) as well as to communicate clearly the current state of the system (mood) to users.

RELATED WORK

Lighting based atmospheres and atmosphere controls

Several examples of influencing an atmosphere with colored lighting are described in the literature. There is also a number of existing products that support lighting based atmosphere creation. A notable example is the Philips Living Colors luminaire. It provides people with a simple way of adding colored light into their homes so to create different atmosphere moods using light.

Another example is the Citizen-M hotel that offers a selection of different lighting based atmosphere moods for their guests. When guests check in online they can select from a range of atmosphere moods and when they arrive at the hotel the room automatically sets itself up to try and provide this. For controlling the mood of the atmosphere it uses a preset approach where every preset is described by an icon and a keyword such as 'romantic'.

Despite the growing interest in atmosphere creation only a few examples of dedicated user interfaces for altering atmospheric factors can be found. Lucero et al. [3] presented a light control for controlling atmospheric lighting in a bathroom that used the weather as a metaphor for describing light effects. They used a device with a small touch screen that can replace a conventional light switch [3]. Ross introduced a tangible object to set the desired mood for an atmosphere in a living room [5]. In another publication, Mason and Engelen described a tangible user interface for controlling the light in a hotel room [4].

Expressive UI

Expressive or emotional UIs are known in the literature. A notable example is an alarm clock [8] created by Stephan Wensveen. The sliders on the side of the clock set the alarm time, and multiple combinations of the sliders can reach the same result. The pattern of the sliders tells the system something about the mood of the user: a messy pattern could mean the user is stressed, while a nice even pattern could mean 'relaxed'. The system then responds with an appropriate way of waking the user up in the morning [8].

Carousel [5] is another example of an expressive UI that combines atmosphere creation with expressive tangible interaction. It consists of an object with several possibilities for interaction. The 'flags' on the top of the device can be arranged in different patterns, showing an 'open' or 'closed' position. The flags also had a wooden and a metal side, expressing 'warmness' or 'coldness' respectively.

We see the mood-setting as a central part of the UI, expressed through the physical state of the interface. The essence of the interface design is that physical state of the interface should reflect the overall mood. The projects by Wensveen and Ross also touched upon this idea with their 'traces' of interaction. We take this link between mood and the physical appearance of the interface as the most important interaction with the UI with a goal to make the interaction with and appearance of the UI as a part of the total atmosphere.

The rest of the paper is structured as follows: firstly we describe the results of the user investigation that was aimed at understanding how people create atmospheres in their homes. Secondly we present the design and the implementation of the M-Beam prototype, and we finish with the user evaluation of the prototype.

USER INVESTIGATION

People's perception, method of creating and underlying need for having different atmospheres in the home varies greatly depending on their age, culture, social status and other factors. For this reason we decided to focus our attention on one specific group of people.

Socially active young adults (Dutch, age 25 - 32) were chosen as a target group for the M-Beam concept. The choice was driven by the assumption that people from this group already have ample experience with different forms of multi-modal atmospheres in clubs, bars and other public places. Consequently, they might be more open to the creation of similar experiences in their home environment.

A set of contextual inquiries [2] was conducted to investigate how people from this target group currently create atmospheres in their homes, and what products they use to do it. The contextual inquiries were performed in the participants' homes, and the participants were asked to use their own products during the inquiry. They were asked to create two different atmospheres in their living rooms: one for a 'party' and another for a 'romantic' night in. They could use whatever they wanted to create these atmospheres. During the creation of the atmospheres the participants had to talk about all of the steps they were taking, and how it contributed to the atmosphere. Six participants were visited in total (average age: 27, 2 females).

The researchers created detailed descriptions of the living rooms of the participants and the items they used to create the atmospheres. Participants were interviewed afterwards.

One of the main findings from the study was that all participants started the atmosphere creation process by adjusting the lighting. They either dimmed the lights, or added colour or other small lamps. As a second step all of the participants adjusted the music, both genre and volume. Other factors that were of influence to the atmosphere were location and accessories. The location in the room was interesting, because participants showed a strong preference for specific locations in which they wanted to create the atmosphere. These locations were very personal and different for most of the participants. For example, 'romantic' meant sitting on the couch for one of the participants while it meant sitting at the dinner-table for the other. The use of accessories was also interesting, but seemed to be very personal. One participant used scented

oil to set the mood, but she also expressed that the same scent could be used to support different moods.

The main conclusion was that music and light were the two main factors selected for influencing a room's atmosphere. Moreover music and light not only affect the atmosphere, they are also easily manipulated. In contrast, the furniture arrangements for instance also contribute to the atmosphere, but remain mostly constant.

The results of the inquiry were used as a starting point for the designing of the M-Beam system that is described in more detail in the next section.

DESIGN

The design was distilled from several co-creation sessions. After each session a short user-evaluation was held to select the best ideas. With these winning ideas another co-creation session was held to elaborate on these ideas. All the sessions were organized using physical sketching techniques so that interactions could immediately be felt and shown. We believe that this physical approach to brainstorming was the best method to experience immediately the interactions that the participants came up with.

Linking mood with physical stance of the interface

One of the important goals of the M-Beam design process was to be able to represent moods by the physical stance of the interface. Tinkering and card sorting methods were used to identify the links between stances and moods.

Tinkering is a brainstorm like session where the participants suggest ideas in a physical form rather than written or sketched. The tinkering sessions were done with a group of volunteers from the office at [removed for review]. The participants were asked to build physical interactive objects using tinkering materials. The task was to create objects that could express a specific mood by the way they moved and looked physically. After several tinkering rounds the group was asked to build a final object that could express the whole range of moods. All the tinkering objects were kept for later use as inspiration for the design phase and a group discussion was held so the participants could describe and explain their objects. These explanations were video recorded to ensure the participants responses were not lost or misinterpreted later in the design process. After this the researchers made a series of cards with pictures of the three main concepts from the tinkering sessions. Each series of cards (three series) consisted of a range of physical stances of the objects. The researchers asked six participants to arrange the cards from a 'sad' mood to a 'happy' mood.

The tinkering and card-sorting sessions gave clear directions for the design of the physical interface. During the sessions several keywords were determined by the group that best described the concepts. Table 1 shows which keywords were allocated to which mood. The used keywords show that angle as in physical orientation (up, pointing downwards, upwards spiral) appears to be a clear common parameter. Another parameter that was apparent in several ideas from these sessions was the openness of the object. Closed objects represented strongly a sad mood, while open objects suggested happiness.

Table 1. Moods and associated keywords

Happy	Calm	Sad
up	stability	closed
festive	smoothness	enclosed
upward spiral	grounded	low
open posture	wideness	heavy
release	slow-down	pointing downwards
open	natural colours	narrow
		limited perspective

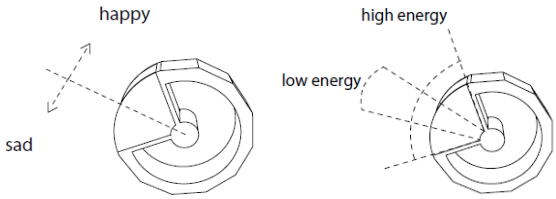

Figure 2. Setting mood by manipulating the M-Beam.

M-Beam prototype

The prototype consisted out of a physical interface (see Figure 2) and a 'behind the scenes' controller for music and light. The system used an approach described by Skowronek et al. [7] to determine the mood of any given song, and to categorize it. Attached to these mood categories are light settings that vary the hue, saturation and amount of coloured light. When the user selected a mood using the interface, the system would automatically choose the most fitting music and light-settings.

The user interface itself is a light-emitting object that co-exists with the atmosphere creation system. Its form is a round angular shape with an aperture that emits light (see Figures 1 and 2). By placing the M-Beam on one of its angled sides, the angle of the light-beam is changed giving the overall object a different expression. The aperture can be adjusted as well, to give the beam of light a different width. The light emitting from the object remains constant, only the angle and width can be changed. Combining the angle of the beam with its width allows the user to express different moods for the system to create, where angle is associated with sad and happy or valence and beam width with low or high energy or arousal. In this respect the system uses two dimensional Russell's circumplex model of affect [6].

The system interprets the user's input and selects the appropriate songs and light-settings. The physical appearance of the interface changes when the user is interacting with it. It changes in such a way that it expresses the mood of the atmosphere that is being created, and by doing so it stays in harmony with the atmosphere. The interface expresses the overall intended mood of the atmosphere, and fits in with both the light-settings and the music in the room.

The concept is best described with an example, seen from the user's perspective. When a user wants to create a 'happy' mood, they use the interface to activate it. To express happiness the user can adjust the angle of the light-beam so that it points upwards to the ceiling, and to accentuate a high-energy happiness the width of the beam can be widened.

The system interprets these two settings as being a 'happy' expression and selects an appropriate song and light-setting. The user has now experienced the creation of an atmosphere in which the interaction with and the physical appearance of the interface are in harmony with the resulting atmosphere. The interface is designed to keep on fitting in with the atmosphere that is being created by the user, even after the interaction has ended.

EXPLORATORY EVALUATION OF THE M-BEAM

The goal of this experiment was to find out if there is consistency among users in how they interpret the angle and width of the light beam when setting the prototype UI in relation to the desired mood setting.

Every participant experienced four different atmospheres consisting of a combination of coloured light and music (see Figure 3). Every atmosphere was repeated three times leading to a total number of 12 trials. The presentation of atmospheres was counter-balanced.

Figure 3. Test environment with two different colour settings

After every trial the participants were asked to position the prototype in such a way that it would reflect the atmosphere the best. The physical possibilities of the prototype, being the change in angle and the beam-width, were explained to the participants. However, during this explanation no hints were given as to the function or effect of these physical actions.

The atmospheres (music and coloured light) were sad, carefree, romantic and powerful. The colours of the light and the choice of music were determined beforehand, for music based on the classification method proposed by Skowronek et al. [7] and for colour based on the work of Fagerberg et. al [1].

We observed higher correspondence for the two "extreme" atmospheres i.e. happy and sad. For happy most of the participants positioned the interface upwards with the wide beam-width while for sad atmosphere, the interface was pointed downwards with a narrow beam-width. The notion that a downward object expresses sadness, and an upward pointing object expresses happiness appears to be true. However if we look at all four atmospheres it seemed that the angle was actually associated with arousal and not valence (as it was intended in the prototype). Moreover we have not found a clear correspondence in relation to the valence. Indeed, when the participants were asked to explain the motivation for positioning the prototype in a particular way 5 of the 8 participants indicated that they related the angle to the amount of energy (arousal) in the atmosphere while they had problems with rating the atmosphere on the level of happiness and sadness (valence).

CONCLUSION

In this paper we presented the M-Beam – a physical interface for controlling atmospheres using mood as a way to define what combination of music and coloured light should be used to create the atmosphere. The M-Beam is an example of an expressive UI for its appearance and operation directly relates to the desired mood setting.

The results of the evaluation showed that there were some inconsistencies between the way participants expressed different moods using the UI and how the system interpreted it. Overall the participants were positive about the prototype and of the way of controlling the atmosphere as a part of a total experience.

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