Designing Multi-user Lighting Interfaces: Four strategies to implement Social Translucence

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Figure 1: By looking through the monocular interface, users can adjust the lighting parameters in the area of view by turning the rings.

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Abstract
In this work, we investigate how to design multi-user interfaces for shared environments by implementing social translucence: Visibility of socially relevant information, awareness of other people, and accountability for actions. By designing and analysing 126 multi-user lighting interface concepts, we define four strategies to implement socially relevant information into a user interface. The strategies are: (1) to direct attention towards the context, (2) to present information about previous interactions, (3) to make information about needs and wishes explicit, and (4) to facilitate pre-evaluation of a light setting and its impact.

Author Keywords
Multi-user Interaction; Social Translucence; Lighting Systems; Interaction Design

ACM Classification Keywords
H.5.2 User Interfaces; D.2.2 Design Tools and Techniques

Introduction
In daily life, people constantly coordinate behaviour amongst each other [1]. To do so, they need contextual and social information to gain awareness of the needs and wishes of others. Due to this awareness of a

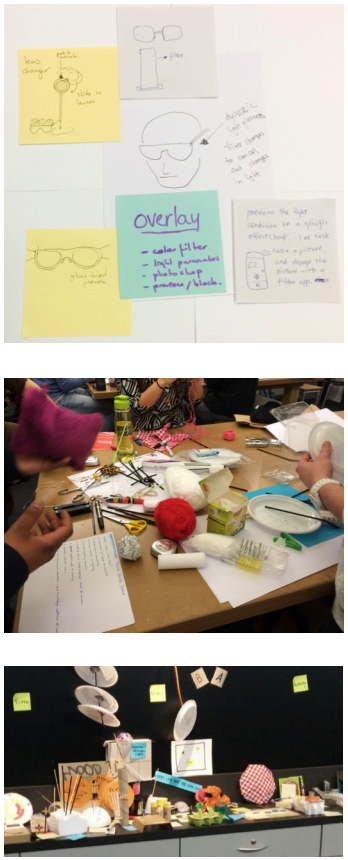

Figure 2: An indication of the approach: (a) one of the clusters resulting from the brainstorms with peers, (b) the workshop with students, (c) a selection of mock-up prototypes resulting from the workshop with students.

situation people can assess what actions are appropriate, which makes them accountable for these actions. The relation between *visibility* of socially relevant information, *awareness*, and *accountability* was first described by Erickson and Kellogg in their social translucence framework [1]. Social translucence has found much resonance in the design of geographically distributed digital interfaces, since distributed interaction inherently lacks contextual and social information. However, many systems in shared environments that use personal mobile phone applications as interfaces (e.g., smart thermostats, smart television, and connected lighting systems) seem to have equally low visibility of socially relevant information [2]. So in collocated interaction, designing for social translucence seems just as relevant.

In our work, we investigate how socially relevant information can be designed into interfaces for connected lighting systems. Lighting systems are, due to developments in networking and LED technology, drastically changing in terms of number of manipulable parameters and flexibility of use. Furthermore, individual lighting settings could potentially better support people's activities but in a shared environment this might lead to unwanted influence on others [2], which makes this an interesting multi-user case. In this paper, we take a research-through-design approach to identify *what* social information might be relevant when interacting with a lighting system and *how* this information can be translated into an interface.

Approach

To get an extensive overview of possible lighting interfaces that implement socially relevant information we performed three creative sessions. In the first session, the first two authors of this paper generated 17 mock-up prototypes of lighting interfaces for an open-plan office, using the process as described in [2]. The five thematic clusters that resulted from analysing these mock-ups formed the starting point for the second session, where new interface ideas were generated together with two peer design-researchers resulting in 60 concepts (figure 2a). Lastly, we performed a one-day workshop with 18 students from graduate and undergraduate design education. The students extracted socially relevant information from a contextual enquiry of lighting use in the home and office environment. Next, they translated the information to 49 mock-up prototypes of lighting interfaces (figure 2b and 2c).

All 126 interface concepts resulting from the three sessions were used for analysis. Through discussion amongst the authors and peers, all concepts were iteratively clustered on recurring types of information and on common ways of translating this information. The resulting four strategies describe ways to implement social translucence in multi-user lighting interfaces. The strategies, and some of the interface concepts they derived from are presented in the next section.

Results: Four Strategies

1. Direct Attention towards the Context

In distributed socially translucent interfaces, socially relevant information is usually represented within the interface. However, in collocated situations the context usually contains much of this information already. So instead of translating necessary information into an interface, the interaction could actively direct people's attention to the implicit information that is available in

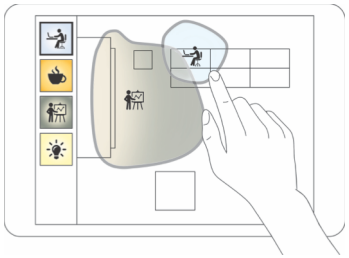

Figure 3: In this interface, users claim an area by drawing a circle around it and applying their light setting (based on an activity presets) to the area.

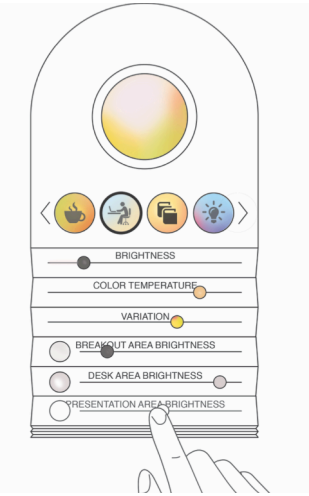

Figure 4: In this interface, with each parameter that the user sets a more detailed parameter folds out underneath. The number of unfolded parameters can inform about the effort the last user put into the interaction.

the context. An example interface is illustrated in figure 1. With this interface, the user looks through the monocular to the area where s/he wants to make an adjustment to the lighting. In this way, the interaction directs the user's attention towards the space at the moment of interaction, to perceive the available implicit information: people in the space, use of space, atmosphere, on-going activities, etc. This information can help the user to envision how others might be affected by the adjustment.

2. Present Information about Previous Interactions
Changing the lighting in a space can affect multiple people in that space, but might impact the person that previously set the lighting in particular. This person is responsible for the currently used light setting (that is about to change) and might have had good reasons to make this light setting. It could, therefore, be valuable to present information about the previous interaction to a new user within the interface. In this way, the current user can evaluate whether the intentions of the previous user with the light and the light setting itself are still relevant; and thus to what extent adjustments to this setting are acceptable. Figure 3 shows an example interface where light presets representing activities can be applied to areas in a room. If the previous user set the light in an area to 'brainstorm mode', but if the context shows that this area is no longer used for a brainstorm, the current user could decide that the light setting is no longer relevant and s/he might adjust it. Similarly, when a previous user claimed a large area but only a small part is used, the current user could decide to apply a new light setting to the unused part of the area. Next to presenting a comparison between the intention and current use of the light, the interface could also present information about *how* the previous interaction went. For example, the effort that the previous user spent in the interaction could be an indication of his/her appreciation of the current setting. Depending on the interface, a setting that was created with high effort could be more difficult to retrieve after an undesired adjustment. An example interface that shows effort can be seen in figure 4.

3. Make Information about Needs and Wishes Explicit
In the previous strategies, the implicit contextual information needs to be interpreted by the user to provide information about whether an adjustment will be accepted by others. Another strategy would be to present information about the needs and wishes of other people explicitly in the interface. This information could include, e.g., the *appreciation* of light settings (for example, how much users like a preset), the *appropriateness* or *importance* of light for certain activities (for example, reading might always need a higher brightness level), or the extent to which people *accept* an adjustment (either per parameter or in general). Figure 5 shows an example interface that uses acceptance as a parameter. With this interface, people can indicate their acceptance of changes to the light by limiting the user in changing certain parameters. Another option would be to allow users to physically take parts of the interface along, to shield control from others. Interesting to note is that accountability shifts from the person that is making an adjustment to the other people in the room: the user can not be blamed for making an inappropriate adjustment if the information about that inappropriateness was not provided by the people in the affected space first.

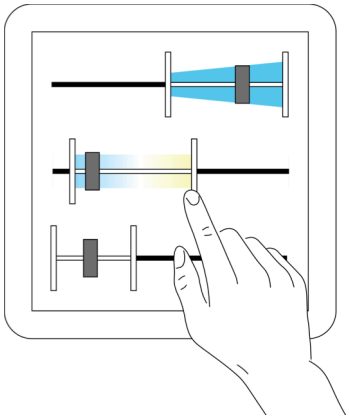

Figure 5: Users can create boundaries for each lighting control parameter (e.g., brightness and colour temperature) by moving the ends of each parameter slider. The slider can only be adjusted within these boundaries.

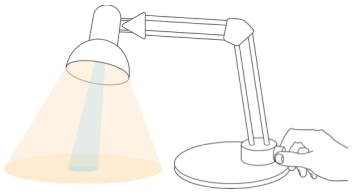

Figure 6: In this interface, a small light beam from each lamp presents a preview of an interaction. Only after the user is satisfied with the local light, it is applied it to the space.

4. Facilitate Pre-evaluation of a Light Setting and its Impact

Even if people are aware of the needs and wishes of others, it might be challenging to find a light setting that suits the social context, especially since detailed lighting control is rather new to people. Interfaces could support people in estimating what impact an adjustment might have on others by facilitating pre-evaluation of an envisioned light setting, before the adjustment is applied to the space. Presenting a preview of a light setting could facilitate this pre-evaluation. In figure 6, a preview of the envisioned light setting is shown in a small part of the local lighting before the user applies the light setting to the overall lighting in the space. Another possibility is to add an augmented lighting preview layer to the context, to show the impact of an adjustment on others in the space. This could, for example, be added to the monocular interface in figure 1.

We expect that enabling evaluation of the envisioned light setting can not only help to prevent unexpected lighting settings, but could also play a significant role in making people more acquainted with the new lighting control parameters that modern lighting systems offer. The previews can offer a safe way to experiment with light, which could trigger more exploration.

Conclusions

In this work-in-progress paper we discussed how to design multi-user lighting interfaces, by implementing social translucence. By analysing 126 multi-user lighting interface concepts, we obtained four strategies that can be used by interaction designers to implement socially relevant information into multi-user lighting interfaces. The strategies are not exclusive: multiple strategies can be combined into one interface. While the strategies are based upon example lighting interfaces, we expect them to be broader applicable to interfaces of other types of systems for shared environments.

In our future work, we aim to further develop a selection of socially translucent multi-user lighting interfaces. We aim to first evaluate whether people perceive and understand the information represented in the interface. Next, we are planning a longitudinal in-context evaluation of such interfaces to learn how visibility of socially relevant information affects the use and appreciation of lighting systems in shared environments.

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