PLEASURABLE & EMOTIONALLY-ENRICHED EXPERIENCE: AN EXPLORATION THROUGH LIGHT

Frederic Pfister / Jaesik Yun / Bokyung Sohn / Youn-kyung Lim
Dept. of Industrial Design, KAIST
pfister.fred@gmail.com

ABSTRACT

As we considered the light as an interesting medium for interaction exploration, we focused on an explorative approach for pleasurable and emotionally-enriched experience. We first attempted to design prototypes to explore new opportunities for light application. Then we conducted a user study to gather qualitative feedback through open-ended prototypes. As a result we describe different emotionally guided explorations that open on opportunities for new experiences with light.

Keywords: emotional design, open-ended prototyping, light

INTRODUCTION

Looking at the stupefying usages of light in very diverse ways i.e. not only as lighting equipment; we have here clear evidences of the deep involvement that has light in nowadays-daily life, that made us consider the light as a medium worthy of being the focus in the research of new interactions. We find LEDs everywhere; light is used to capture the attention in the streets at night or to display information. There is no doubt towards the benefits of light, its behavior and its interactions with the users. In the case of the home environment we still tend to use light primarily as a lighting source but there is much room for exploring the roles of this ubiquitous media - i.e. light - in terms of emotionally enriching and giving pleasurable experiences through enabling people to experience its flexible and dynamic qualities.

The feedback people perceive from light is bounded by our daily life and the intuitive behaviors of light around us. Several light behaviors are perceived and interpreted naturally by anyone. A solid or static light will indicate a status, most likely “ON” or “Selected” (e.g. Coffee machine, Dish washer). A light blinking regularly will be asking you to pay attention, to select among choices or indicate that something is in process (e.g. Closing doors in a subway, Vending machine, ATM). A light may also be blinking depending on parameters therefore giving indications on the activity of a process (e.g. HDD Led, Network Router).

In these examples we see light used as a signaling medium, not giving anything else than brief information. But we do also have the example of a very specific pattern often used to indicate a sleeping mode referred as “breathing” (e.g. MacBook status light). Our motivations are based on the impressions that a user would appreciate to be able to bring his environment to life in a very personal manner as we see from the example of the MacBook status light. By being a self-expression of his feelings it would enhance the affective bound between him and what surrounds him.

Our exploration is meaningful among the related explorations that focus on the practical aspects of a light vocabulary (Pintus, 2010), the playfulness of responsive lights (Seitinger et al., 2010), or a tangible interface for the illumination of a room (Tsukada et al., 2009). We focus on the emotional enhancement of light as a personal device. We present light in an uncommon form to invite people to use it as they want. It was confirmed thanks to the user-study we conducted with our prototypes. As a result we have an overview of new design approaches to light.

EMOTIONAL LIGHT

We pursue the goal of offering pleasure to the user combined with the opportunity of bringing life to his environment. In a globalized market because of mass production there is little space for personal and self-expression. We thought that by embedding our prototypes onto his surrounding a user can have an opportunity to embody dynamics to his own belongings and environments and thus breaks the static feeling often encountered in a personal space.

What light specifically brings to the interaction experience is its very own nature to be versatile and therefore enables a large variety of applications. It supports passive and calm interaction with people and the environment. We also found in light the duality of being able to be limited and shaped in an enclosure as well as being projected on whichever surface and then on adapting itself to the surface. Because of its attributes we are able to justify the exploration of light behaviors as a medium for interaction design.

Light is a flexible and fully controllable medium (Color, Brightness, Direction) and with the addition of patterns a personal behavior might be created. It is also a medium known for its ability to change the mood but in a passive and peaceful way. Therefore a user will have enhanced chance to experience a pleasurable feeling through one of his settings.

We developed our prototypes with the perspective of an open-ended product. That has been done through the research of wide range of possibilities combined with no pre-defined narrative of use neither through the product design or with its embedded functionalities. Lim, et al. (2010) and Lee, et al. (2010) already went through similar process in previous research work and it supported our intention to use this process.

PROTOTYPING FOR EXPLORATION

CONCEPT

Playfulness

Based on the explorations carried out by Brown (2009) and Gaver et al. (2004), we are encouraged to give a try to ludic engagement and playful product. We are focusing on the emotionally enriched experience; most likely these experiences will occur in a ludic way while playing around with our product. As a ludic engagement is by definition spontaneous and without any particular purpose which goes perfectly along with our next goal: open-endedness.

Open-ended exploration

As we proceed to this research, we want to make sure we are being practical, though technologies may enable the embodiment of such life-feeling emotion through the experience of light in the environment. We want to discern what makes and characterizes a pleasurable experience from a user point of view. Instead of figuring out the expectation from a designer's point of view we try our best to be open-ended as a similar approach to the drift-table by Gaver (2004).

Interactivity or Control?

In the exploration of interactions with responsive light study conducted by Seitinger et al. (2010) the user is faced with a product over which he has no other control than through the embedded sensors (the light automatically responds to ambient sound and vibration). Thus the limited features of the product limit the interactions with the product because users have no control over the output else than the limited input method. Whereas we chose to offer a user a full control on the output as to then explore what are his desires concerning the light behavior patterns. The downside of this could be then a separation between the prototype and the environment as the prototype is not able to sense any parameters of the environment. However, as we focus on open-ended exploration, we decided that any sensor input would have limited the interaction and may imply some specific kind of narrative of use.

PROTOTYPING

We chose to explore and investigate light as a playful, interactive and emotional medium; first through prototyping and then to go through a user-study with our prototypes. Each user would be given the final versions of our prototypes for a few days. It enables us to have insights and feedback from users. It is important for us to have insights from the user, as our goal is to discover the user-driven implications of light behavior pattern applications in their own environment when they try to make their own surroundings emotionally enriched and felt-alive. The questions we asked ourselves for this study are: **What would be the most desirable light expressions of the things that can be embodied by our prototypes? To what things or situations would the user be more likely to apply dynamic light behaviors with our prototypes in order to make it emotionally enriched and more desirable for them?**

Requirements

To accomplish this through our study we wanted the prototypes reliable enough to be used by any users with as few constraints as possible. It is also important that the narrative of use is not self-contained in the prototype but that the prototype opens itself to any kinds of usages thus bounded only by its features. Our requirements are the following: there will be a lighting source which is able to glow in any color, and the user will have the control over the parameters of the light i.e. Color, Brightness, Pattern. The prototype will be powered with batteries, and the prototype should be light enough to be placed anywhere.

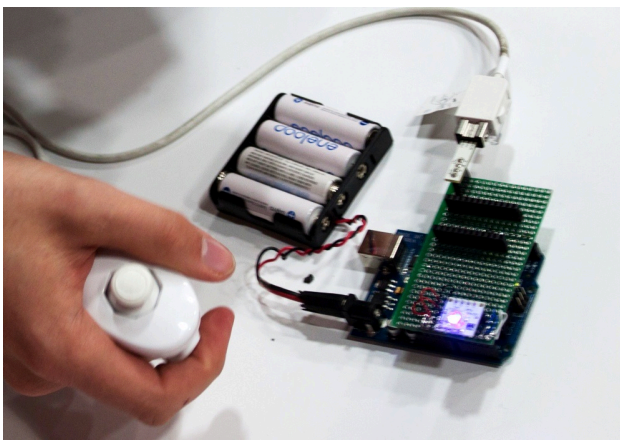

***Figure 1**: Wii Nunchuck interfaced with a LED*

Prototyping steps

We had several iterative steps to design the final prototypes for this study. The first approach was to have a controller for the parameters of the light behaviors. We prototyped it using a Wii NunChuck remote with a joystick having 2 buttons and an accelerometer (Figure 1). The accelerometer was the central input for this device. By rotating the controller along the X-axis you could modify the hue value of the light, and the brightness was controlled with a rotation along Y-axis. The interactions between your moves and the behavior of the light offered a fluidity and soft response to the user's moves.

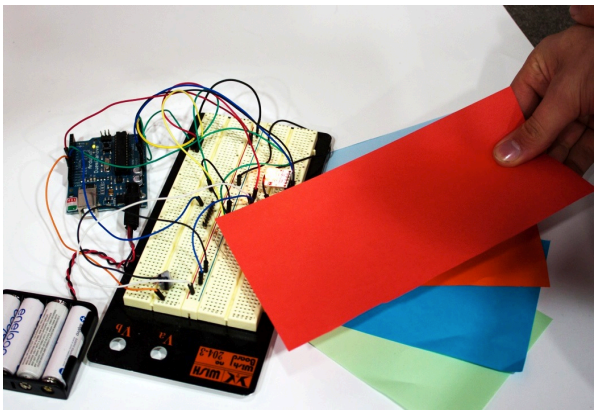

***Figure 2**: Color sensor interfaced with LED*

Although the accelerometer is in 3 axes, the convenience enables only the usage of 2 axes, i.e. X and Y. Through our own trials of using this prototype, we concluded that this can be an intuitive way to control parameters but we also realized that it was at the same time not allowing users to be able to precisely control which color lights for which amount of time to be shown in the pattern. With our prototype, we intended to enable users to be able to have a full control over what they like to create.

Another approach was then to explore the possibilities offered by a color sensor, as an easy way to choose the color of the light. We prototyped using colored paper in order to try to see the possibilities of such kind of sensor (Figure 2). We were limited by the precision of such kind of sensor, as it required a very precise initialization process and a control of ambient light conditions. A control was possible on the color range of the light but we couldn't perfectly match the light output to the physical color of the

paper. Although it gives a very intuitive control on the color of light, it has two limits: 1) the physical color is hardly matched when copied with light, and 2) after some trials we came to realize that through this way of interaction it is very difficult to create a life-feeling emotion as we wanted the user to express himself through light behaviors. We could have created a tangible interface to achieve our goals but after reflections and thanks to the trials done with the first prototypes, we concluded that this option would result in a rather complicated task.

A new horizon

Along our research for the related works, we found a useful product designed by ThingM (Mike Kuniavsky and Tod E. Kurt). Their product called BlinkM "are ultra-bright wide angle smart LEDs" and could be described as a module integrating a RGB High-Power LED with a microcontroller embedding memory and interface with an open source software for any computer. This is a useful functionality for our purpose as the module is directly controllable through a computer with an USB interface.

Therefore we went for the software solution as the interface between the user and the light module. The software provided by ThingM being open source it allowed us to adapt it to our needs. It initially enabled us to choose the color and the brightness of light and to create patterns, and we then only had to tweak it slightly for the more specific needs of the user-study case. Tweaks include an auto saving procedure with a timestamp of the patterns sent to the BlinkM modules, modifications of the pattern durations parameters as to offer a larger choices to the user, and a simplified GUI.

***Figure 3**: a)Ping; b)Wax-E; c)Ping is open so we can see battery and connector; d)USB connection to the PC*

Tweaks

We tweaked the products to best fit our need, we created Ping (Figure 3a) and Wax-E (Figure 3b) which are basically enclosures for BlinkM and BlinkM MaxM respectively. We also added an embedded battery and an easy-to-use connector (Figure 3c) to program the prototype with a computer (Figure 3d).

Software

The software we used in order to set the light parameters is the Open Source software that we were able to use and modify according to our needs. In order to fit our goals we slightly changed the user-interface and added options so that a user could select any color and assign it to the prototype through a simple USB interface between the module and the prototype. This could be done without any prior configuration. He only had to unscrew the bottom part and then plug the connector onto the USB interface on his computer. Then the color he chose could be solid or blinking at a frequency according to him. This was done through the creation of pattern as it can be seen in Figure 4.
He was also able to create color gradient. This was done through the creation of pattern as it can be seen in Figure 4 as well.

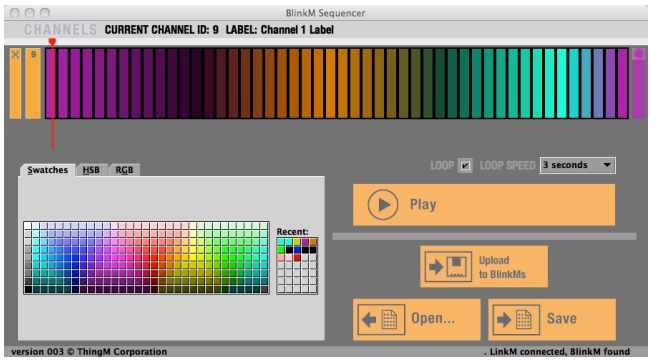

***Figure 4**: Screenshot of the software*

Software also enabled easily the creation of color gradients and it was also possible to set up the period of the pattern in seconds.

Once the pattern was created on the computer just a click on upload would send the pattern to the

prototype and it would start lighting up accordingly to the setup.

USER STUDY

The user study carried out was aimed to have a qualitative idea of the user's usages of light in his or her environment. It involved 4 users: the first user is a student (age 25) living with her parents, the second user is an office worker (age 31) living with her parents, the third user is a student (age 22) living with her parents and the last user is a worker (age 38), who is married and has 2 children.

We conducted the user study with these 4 users and each of them was first introduced briefly to the prototypes, specifically about how to create their own patterns of light behaviors for the prototypes. Then 5 Ping prototypes and 1 Wax-E prototypes were given to them for 3 days. During these 3 days they were asked to give us feedback of what they considered relevant when using the prototypes. The feedback was reported to us in real-time through their mobile phones (pictures and text) by sending their usage ideas to the Me2day site (http://me2day.net/), which is a Korean micro-blogging service. At the end of the 3-day period we met again each user and had a debriefing time with them.

***Figure 5**: Printed instructions for software and prototype*

The real-time feedback gave us around 35+ usage situations or insights. Out of them 26 were with a picture. The hardware part of the prototypes, i.e. Ping and Wax-E, were actively used during the study, but due to the complexity of our software in its functionality, the users reported that they were not comfortable with the creation of patterns and it limited their usages. A larger sample of results and data would have been collected with an improved interaction, especially for the creation of patterns.

Information and instructions given to users

We explained to the users the composition of prototype package, the instruction to use the software with prototype and how to change batteries. Also we explained the usage of Me2day to the users who have not used a micro-blogging service before. With these explanations, we had a tutorial time to try it by themselves. We gave a printed manual (Figure 5) about the instruction of battery exchange and software operation to prepare for users who may forget about how to use.

User-created Patterns

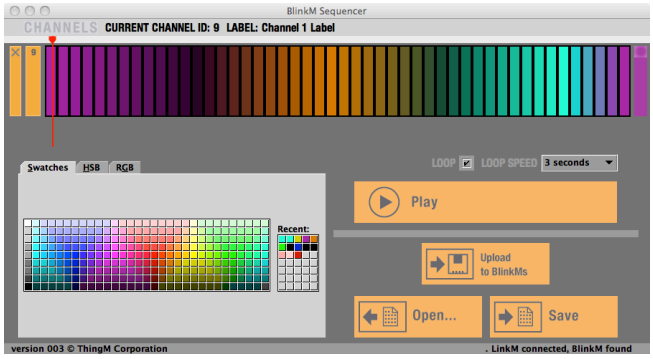

***Figure 6**: The default pattern*

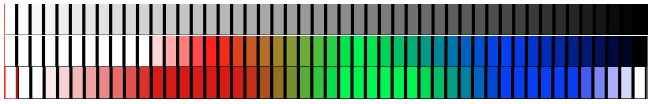

***Figure 7**: Examples of user-created patterns*

There was a default pattern that we installed in each prototype (Figure 6). This pattern was only for demonstration, but if a user does not want to create patterns, they could just play the default pattern. From the result, to begin with, users used the default pattern, and after then, they created their own patterns. Through the user study, patterns created by participants were various (Figure 7). Averagely, there were four to seven patterns in each user's result.

They made patterns from their preference or proper patterns for certain situations and purposes. They

tried to make various patterns before succeeding in satisfying their own taste. After that, they focused on a diversity of the ways of applying the prototypes to appliances rather than creating a new pattern.

RESULTS AND DISCUSSION

From the data the users uploaded to the Me2day site and the data we collected during the debriefing session, we extracted the followings: 1) the colors and the frequencies they created for the prototype usages, 2) the users' originally intended ideas of their usages of the prototypes and their actually created atmospheres and usages, 3) the contexts of the usages, and 4) any existing objects they mentioned as comparisons to what they created.

We organized the data about usage ideas into "color", "frequency", and "context" in order to better understand the environments of the usages and the settings of the prototypes that the users created. Also, in most of the usage cases, the users first thought about where to use the prototypes, and then set the color and the frequency that matched to their purpose. Therefore, we compared the user's originally intended ideas with their actually created atmospheres to find out how much the original intention is achieved by using the prototypes and also to understand what unintended ideas came out through their exploration with the prototypes in-situ. For the comparisons of the ideas they created with any analogous existing objects to their ideas, we wanted to investigate if the user wanted to create a new product that does not exist or if they copied and supplemented an existing product. It will be helpful to analyze user's needs in light as a medium to give emotional enriched experience.

Through organizing and categorizing the data in these keywords, we discovered various interesting findings. We describe the most important and meaningful insights integrated from this analysis in the following section.

EMOTIONAL EXPRESSIONS AS A COMMON GOAL

Grouping factor

We first analyzed the patterns that repeat among several users. It is like a "herd" phenomenon (Figure 8.e); something interesting seems to emerge as they group the modules to a single purpose. Multiple pings are being used in a single purpose, to express a single emotion. Although there is the possibility for them to create any pattern using a single ping, the user seems to want to have several of them to enhance the dynamics of the light behaviors. They try to have them synchronized, to feel like they are communicating together. A random synchronization of their patterns evokes an event, something rare and worthy to wait for (Figure 8.f).

The herd is used in different contexts, but if we select one to describe the most relevant one, a user created a pathway by using them - thereby splitting the herd but still linked altogether for the same purpose (Figure 8.g)– and it aroused a feeling of

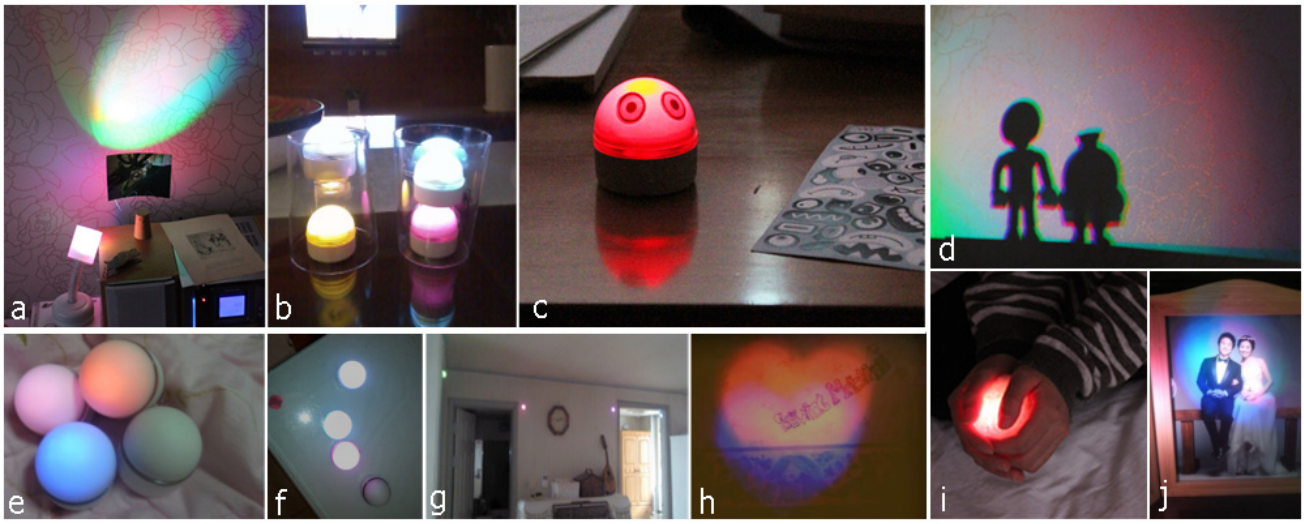

Figure 8: *a)Color projection b)Ping Construction c)Eye Stickers d)Shadow e)Herd of Ping f)Synchronization g)Pathway h)Heart shade i)Pet j)Colored frame*

companionship. The prototypes were also used in structure with transparent cups, placing several prototypes inside and then stacking them as seen in Figure 8.b.

Companionship

Also, there was an interesting finding that the users feel companionship with the light. In most cases of the user research, the prototypes were used as a mood lamp, but in some cases, they were used as a living thing.

User1 thought Ping as a company of her that "gives light to my life", and she revised Ping according to her own sense. She added eyes to Ping to feel it more like a living pet (Figure 8.c). Also it gives a cute feeling. She also commented that if it has the same frequency with the human breathing rate, it will give more alive feeling. In addition, a slowly changing color from straw yellow to orange like a glow lamp gives comfortable feeling, and it fits to an artificial pet.

The son of family2 got a feeling of Ping as a pet or an egg. In his case, he hugged it inside his cloth as if he hugged his pet. By doing that, he saw the light brighten all over his body inside the cloth and felt warmness.

Light itself gives warmness that we can feel between human and human. Although there is a slight difference between two cases (while User1 intended to make a pet with Ping and added some eyes to make it better, the son did not intend, but felt that the Ping seems alive), companionship and affection in both cases comes from that warmness of light expressed by warm color and slow blinking frequency. There is a similar example related to this. User1 mentioned that she has warm-hearted feeling when holding delicate red Ping (Figure 8.i). It is just a light with red color, but she can feel some warmness by holding it. It can be inferred that hot feeling of red color and the warmness of light cause that warm-hearted affection. Another interesting thing is that they got companionship affection from a simple lighting without interaction. The light we use in our daily life is not an interactive lighting, but a simple generic lighting. If we can give a certain feeling such as a companionship by just a simple lighting expressed through proper forms, it could be used in many ways and in various situations.

DIY Light – Open-ended product

An interesting finding in the research and debriefing was that the users' behaviors showed the following similarities when choosing parameters –i.e. color, position, blinking frequency - of the prototypes.

Generally the users want to make their own light and they want to express their preferences or emotions. Furthermore they try to change the feeling of light, and after adapting it, they were being satisfied by the trials' results. Especially they were satisfied because of the different feelings the prototypes express compared to other lighting devices. These results mean that they feel attracted towards the light that they made on their own. They can feel the expressions of themselves through the open-ended product, and we believe that it can be considered being successful.

Being invited to play with light by an easy interaction also enabled the users to use the prototypes in a non-intrusive way. They did not have to pay attention all the time trying to "use" them. After they customized the light behaviors as they like, they applied the prototypes in their environments on their own ways to play with them and also to enjoy their created use situations.

Color-frequency

We also discovered interesting findings about color and frequency of the light. Users did not use a variety of colors and frequencies even though our software was designed to enable the users to choose whichever they wanted. Once they found a combination of color and frequency they liked, they tend to stick to the combination they made, and applied it to various contexts. For example, user1 made a light of the same frequency with the human breathing rate with the color that changes from straw yellow to orange. She mentioned that she used the color because she liked the color of a glow lamp, and the frequency because she wanted to get a comfortable feeling. After she found the perfect combination for her, she thought about where to use

this light. User2 liked blue color, so she set the light into a combination slowly changing from white to blue after various trials using other colors, and found appropriate situations to apply. Instead of choosing a color that fits certain situation or context, users first made a color of their personal preference, and after that, they looked for places or objects to apply. Concerning the frequency, most of the users preferred slow frequencies (10 to 30 second period) to fast frequencies (1 to 5 second period).

Appliances

There were many usages that applied the prototypes to other materials or objects. In the case of Wax-E, there were interesting usages using shadow and the effect of prismatic refraction. A user made a shadow of mystical feeling by directing the light of Wax-E towards the toy figures, and commented, “Guess who!”(Figure 8.d). Other user cut the middle of a paper in heart shape, and put it in front of Wax-E, to create the shadow like Figure 8.h. Another interesting usage was applying Wax-E with music. A user synchronized the light frequency with music in random colors, and directed the light to the wall. It made mystical atmosphere combined with the o.s.t of the movie “The curious case of Benjamin Button” (Figure 8.a). Also there was an appliance using Wax-E with a photo frame giving elegant mood to the pictures (Figure 8.j).

In Ping’s case, there was a usage using the reflection of glass. A user put Pings inside a glass cup, and put them on the glass surface of the table. The lights’ reflection caused more indirect light, thereby creating better atmosphere (Figure 8.b). Another interesting appliance was to use Ping covered with fluffy cloth creating cozy and soft mood. This appliance created warm feeling by combining the visual sense of red colored light and fluffy feeling of the cloth (Figure 8.i).

CONCLUSION

Our intention was to explore an emotional environment creation when the users are enabled to create it through the use of dynamic qualities of light. We conducted our explorative user study for this through an open-ended prototyping method that leads users themselves to have control over what they desire to create. We gave them 2 different setting types of prototypes that they can control color and frequency with. We carefully designed these prototypes to make sure that they can maximize the possibility of discovery-oriented user-driven creations through the iteration of various prototyping ideas.

The important contribution of our research is that it led us to discover that light has a great potential to be re-created and re-shaped for new design applications which may support people’s emotionally enriched experiences. The result showed us that we can use light not only as a simple mood lamp, but also for various creative usages that were not conventionally available usages of light. They customized them by controlling color and frequency of light to suit their tastes and needs. Also they gave meaning and had attachment to light like a pet. They used prototypes as a group and embodied a story to each usage. Sometimes, they utilized shadow as a mean for creating new ideas. They also used light with other materials like a fluffy cushion to make a mysterious mood.

Through these results, we expect that our research will open up a new space for more extensive applications of light for further exploration in design research and practice especially for the enhancement of experience- and emotion-oriented approaches.

ACKNOWLEDGMENTS

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