Effect of Aesthetic Design Elements on Tabletop Display Interaction

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Abstract. Recent technology developments in the field of tabletop display systems have provided new types of user experiences that were unavailable in traditional vertical displays. While substantial amount of work has been done on new technologies and usability tests for a tabletop display system, not much attention was focused on aesthetic design aspect. In this paper, we studied the effect of aesthetic design elements on tabletop display interactions, especially focusing on users' emotional satisfaction and usability. For this purpose, two different tabletop display systems, one aesthetically well designed with 5 selected design elements (color, typography, form, graphic, and sound) and the other not, were tested in an intelligent collaborative environment. The user study showed that an aesthetically well-designed tabletop system not only influenced users' emotional satisfaction but also usability by enhancing the abilities in human perception, and eventually affected overall user experience with the system.

Keywords: Aesthetic design elements, Tabletop display.

1 Introduction

In recent years, tabletop displays, often called as interactive tabletops and surfaces, have been getting a great deal of attention. Display technologies, such as projectors, flat panel displays (LCD, LED, and so on), coupled with sensing technologies, enable direct and natural human-computer interaction with hands as an input device. While much of the research attention has focused on developing new technologies capable of new types of interaction, for example, multi-touch interaction [1], new interfaces integrated with existing interfaces [2–4], little work has been done on the aesthetic aspects of tabletop display design [5], which may significantly influence user experiences. On the other hand, researches on other types of system have supported the importance of aesthetic design elements in human-computer interaction [6–8]. Experiments with different types of ATM layout revealed that the apparent usability is strongly affected by the aesthetic aspects rather than the inherent usability [6, 7].

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Another research on Web design showed that simplicity and beauty affect the user experience and interpretation of the design [8].

In this work, we studied the effect of aesthetic design elements on tabletop display interaction, especially focusing on users' emotional satisfaction and usability. At this stage of research we only investigate the overall effect of aesthetically oriented design resulted from the combination of several aesthetic design elements, not the effect of individual element on user experiences.

2 Tabletop Display Environment

A collaborative working environment called "Intelligent and Responsive Space (IRS) [9, 10], which consists of a tabletop display, three surrounding wall screens and mobile devices, was used as a test environment in this study. This space is utilized mainly for a group meeting or presentation. The tabletop display system, which plays a key role in this environment, was built horizontally by using a large display (55 inch LCD unit) and an infrared LED touch panel. Users can operate this system with bare fingers by manipulating a virtual keyboard/mouse and handling interactive menus and icons.

Two versions of interactive tabletop display systems were used in this study (Fig.1). The first version was designed mainly focusing on technology development [9]. The second version incorporates aesthetic design elements [10]. The 2nd version uses the same technology and has the same functional aspect, and the only difference is the design aspect.

Fig. 1. Two versions of tabletop display systems (top: 1st version, bottom: 2nd version with consideration of aesthetic design elements)

3 Aesthetic Design Elements

To make aesthetically well-designed system, aesthetic design elements for the tabletop display interaction environment were extracted based on a research about

human cognitive response to an artifact [11]. According to his research, aesthetic responses in human cognitive process are adaptation for detecting physical features such as color, tone, shape, pattern, etc. These aesthetic responses through sensory interface are immediate and involuntary, apparently distinguished from analytical responses which usually take longer. These responses may affect the further determination of preferences, thus a positive aesthetic response is more likely to lead to a positive ultimate preference than negative. We selected target design elements that may affect aesthetic response in tabletop display interaction. Five elements were selected: Color, typography, form, graphic, and sound.

Color plays one of the most important roles in recognizing an artifact. Proper selection of color scheme and well designed combination of them attract users' attention [12], improve readability [13] and increase participant [14]. In an interface design, however, color should not be overused which usually causes heavy cognition load. We chose a minimal number of color sets (4 for background and 4 for foreground such as icons and commands) to emphasize the distinction between foreground and background and keep the unity of design (Fig.2).

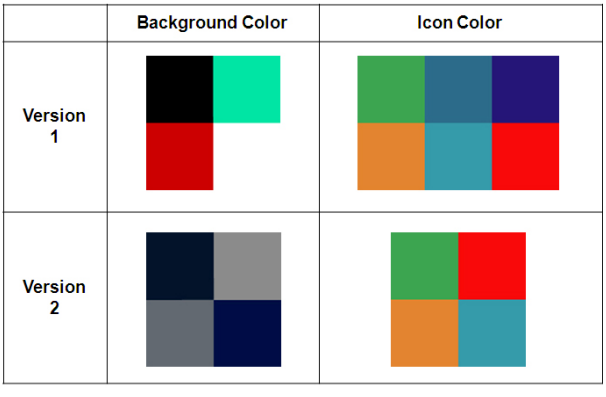

Fig. 2. Two different color sets used in the 1st version (left) and the 2nd version (right). In the 2nd version, background colors were chosen to have similar color tone to prevent distraction.

Since a tabletop display is a large horizontal display unlike traditional vertical displays, some displayed objects or texts proximal to one person may be distal to others or even reversed. Thus, readability and especially legibility can be significantly influenced by the selection of typography. According to the guideline suggested in [15], we selected regular type san serif fonts (Fig.3).

We designed the form of tabletop exterior according to the Gestalt laws that humans tend to order our experience in a manner that is regular, orderly, and simple. Compared to the 1st version, all of the peripheral components were enclosed in the exterior box. This design draws user attention toward the main display and eliminates distractions by surrounding structures or peripheral devices (Fig.1 bottom left).

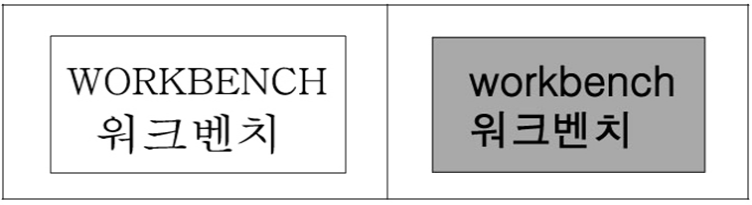

Fig. 3. Two different typography sets for the 1st version (left: Serif font) and the 2nd version (right: Sans-serif font)

Considering that the tabletop display is usually used by multiple users, and both input and output occur on the same display, proper graphic representation for information visualization and manipulation are required. We used interactive animations and special effects helping natural interactions, in the limit not to cause confusion in recognition and evoke cognitive fatigue. As a final design element, proper sound feedback and sound effects accompanied by animations were integrated to improve user responsiveness and give emotional satisfaction.

4 User Study and Results

We performed user studies using these two versions of tabletop to examine the effect of aesthetic design elements on using tabletop display systems. As mentioned above, there is no difference between the two versions in the functional aspect, but only in the design aspect.

We recruited 24 subjects (13 male and 11 female; age 24 to 38) having no experience of using tabletop display systems for the user study. First, users were asked to evaluate the aesthetic satisfaction on two systems after watching the experimenter's demos of the two versions about 30 minutes. In all evaluations, the 7-point Likert scale (1=strongly dislike, 4=undecided, 7=strongly like) was used. In the experiment, each subject was asked to perform 8 simple tasks. We designed the first half of the tasks to assess user cognitive load in performing tasks, and the second half to evaluate manipulability. Completion time for each task was checked throughout experiments. Before running the experiment, each user was trained for about an hour how to use two systems. After completing the tasks, the subject answered the evaluation questions asking about emotional satisfaction and overall satisfaction on each version.

In data analysis, we performed paired t-Tests on each evaluation item to compare two versions (Table.1). Both in aesthetic and emotional satisfaction evaluations, users rated the second version higher than the first version ($p<<0.05$). In addition, we found that there exists high correlation between aesthetic evaluation and emotional satisfaction (Pearson correlation coefficient $R^2=0.61$ and 0.71 for version 1 and 2, respectively). In overall satisfaction on the system, users also gave higher points to the second version over the first version ($p<<0.05$).

Table 1. Evaluation results: Mean of 24 subjects (Within parentheses: Standard deviation)

Evaluation Item	Version 1	Version 2
Aesthetic Satisfaction	4.79 (0.44)	5.82(0.52)
Emotional Satisfaction	4.48 (0.87)	5.61(0.40)
Overall Satisfaction	4.42 (0.49)	6.03 (0.45)

In particular, for the second version, evaluation for overall satisfaction was higher ($p<0.05$) than the evaluation for emotional satisfaction, while there was no statistical difference ($p>0.05$) for the first version. This implies that aesthetic design elements may affect not only emotional satisfaction but also usability. The result on task completion time comparison (Fig.4) strongly supports this argument. In all 8 tasks, task completion time in the second version was lower than that of the first one. In addition, time reduction in the first 4 tasks was higher than the last 4, which means aesthetic design elements greatly affect cognitive load reduction rather than improvements of manipulability.

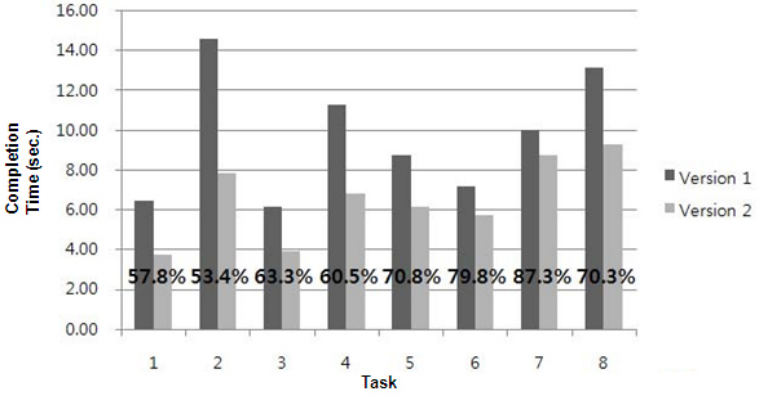

Fig. 4. Task completion time comparison for each task

5 Discussion

In this paper, we identified that aesthetic design elements play a very important role in human-computer interaction in a tabletop display environment. The user study showed that an aesthetically well-designed tabletop system not only influences users' emotional satisfaction but also usability, and eventually affects overall user experience with the system. Before running experiments, we expected that the emotional evaluation for the aesthetically well designed system (2^{nd} system) would be

higher than the original one (1st system). However, contrary to our expectation, the result showed that there is no statistical difference between aesthetic and emotional evaluation after experiencing the system. We thought this was due to the fact that even the 1st system scored high value (4.79) in aesthetic evaluation. We may evaluate the effect of aesthetic elements on the emotional satisfaction more clearly by testing two different systems with more distinction in aesthetic aspect. As future directions, we need to design and perform extensive user studies to identify the impact of each aesthetic design element on optimal user experience.

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