Recognizing Cultural Diversity in Digital Television User Interface Design

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Abstract. Research trends in user interface design and human-computer interaction have been shifting toward the consideration of use context. The reflection of differences in users' cultural diversity is an important topic in the consumer electronics design process, particularly for widely internationally sold products. In the present study, the authors compared users' responses to preference and performance to investigate the effect of different cultural backgrounds. A high-definition display product with digital functions was selected as a major digital product domain. Four user interface design concepts were suggested, and user studies were conducted internationally with 57 participants in three major market countries. The tests included users' subjective preferences on the suggested graphical designs, performances of the on-screen display navigation, and feedback on newly suggested TV features. For reliable analysis, both qualitative and quantitative data were measured. The results reveal that responses to design preference were affected by participants' cultural background. On the other hand, universal conflicts between preference and performance were witnessed regardless of cultural differences. This study indicates the necessity of user studies of cultural differences and suggests an optimized level of localization in the example of digital consumer electronics design.

Keywords: User Interface Design, Cultural Diversity, Consumer Electronics, Digital Television, Usability, Preference, Performance, International User Studies.

1 Introduction

Research trends in user interface design and human-computer interaction have been shifting toward consideration of use context [1], [3], [5]. Providing a high quality use experience to customers is one of the most important goals in the consumer electronics product. Reflecting differences caused by users' cultural diversity is an interesting topic in the user interface design process, particularly for widely internationally sold products.

One common example of an internationally selling consumer electronics product is the television. Broadcasting format change, shifting from analog to digital, leads the users to new experiences. The main differences in comparing the high-definition digital television to the analog television are more channels and higher quality picture and

J. Jacko (Ed.): Human-Computer Interaction, Part III, HCII 2007, LNCS 4552, pp. 902–908, 2007.

sound. Technically, hundreds of high-definition broadcasting channels are receivable and multiple sound channels and languages are available. On the other hand, functionalities of playing and managing multimedia files, such as photo and music, and the networking between the multimedia playable products in a home become important parts of the user experience design due to a digital convergence trend. In addition, the use of a flat panel screen such as LCD (Liquid Crystal Display) or PDP (Plasma Display Panel) and the tendency toward larger-sized screens are both resulting in the TV as a high-end consumer electronics product in consumer's home. Given these changes, the importance of user interface using On Screen Display (OSD) and its usability becomes greater than before [2]. From this point of view, it is important to investigate whether the user interface in digital television is affected by users' different cultural background, and to discuss what causes such differences if they do exist.

In the present paper, authors compared users' responses to subjective preference and task performance of the suggested user interface designs to investigate the effect of different cultural backgrounds. A large-sized, high-definition digital television was selected as a major digital product in consumer electronics domain.

2 Methods

2.1 Initial Designs

Through consideration of various context of use and analysis of currently collected usability problems in the previous user interface design at the time, four initial user interface design concepts of OSD menus were suggested (*Type A, B, C, & D)* based on outcomes of a previous review of usability issues in a similar interface, and the proposed contexts of use. Each type was designed to fulfill requirements and presented a unique design concept. Figure 1 provides an illustration of the four design concepts.

- *Type A* used full graphics on the screen with real, photo-like graphic elements. The graphic illustrated a building and houses in a street, each representing selectable items. This type was designed to maximize the designer's creativity and adopt a differentiated design concept in TV OSD.
- *Type B* applied an opposite version of the drop-down menu OSD at the bottom of the screen, though usually displayed at the top of the screen in PC software. This type was designed to minimize the size of the OSD and to allow users not to be disturbed when watching TV programs.
- *Type C* used full graphics on the screen, as in Type A, and maximized the introduction to and help offered by each functionality as a highlighter rolled over each item on OSD.
- *Type D* used two axes, X and Y, with a fixed highlight zone in the middle. This type moved vertically and horizontally with the highlight position. This type was designed to maximize the highlight navigation efficiency with less OSD space.

A Traditional TV menu was added for the subjective preference measure to compare whether the newly suggested four types of concept designs had benefited as planned. Basic interactions were used as the input method for all OSD menus. All five

OSD user interfaces were designed to be manipulated with four-directional buttons, an ENTER button, and a button that functions to go back to the previous level, such as BACK, which is the most common input method in TV surroundings. In addition, ideas to improve functionalities and increase usefulness of TV were suggested. The ideas focused on minimizing basic setup steps and providing personalized TV viewing surroundings.

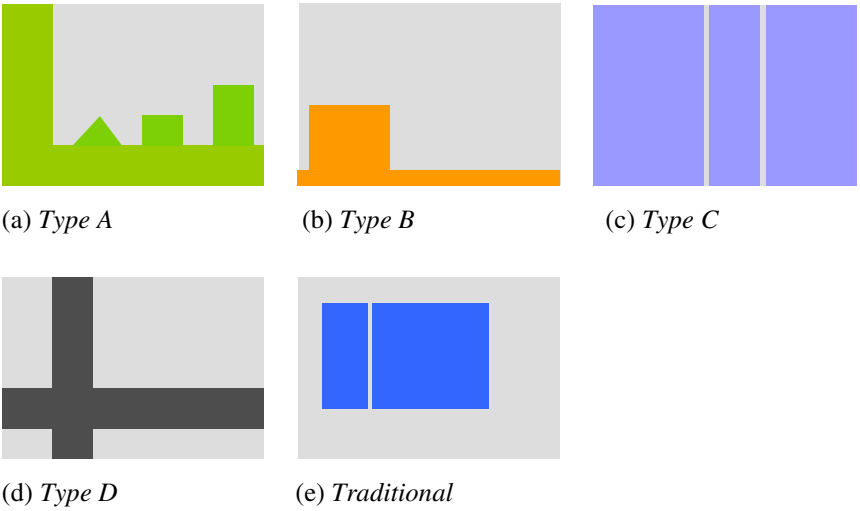


Fig. 1. Draft samples of design concept (*Type A, B, C, D,* & *Traditional*)

2.2 Participants

User studies were conducted internationally with a total of 57 participants in three major market countries: 19 participants in the Republic of Korea, 20 participants in China, and 18 participants in US. The participants were required to have the motivation to purchase a digital TV in the near future or current digital TV owners. No specific technical knowledge or skills were required. Their ages ranged from 21 to 60, and the female-male ratio was about 50:50. Participants were divided into three age groups in each country (21-35, 36-55, 55 and above). Each group consisted of 6 to 8 people.

2.3 Procedure

The studies consisted of three parts: users' subjective preference on the suggested graphical designs; task performance of the on-screen display menu navigation and control; and feedback on suggested new features to enhance usefulness of TV. In each part, both qualitative and quantitative data were collected.

1. In the subjective design preference, relative comparisons using AHP (Analytic Hierarchy Process) [4] were conducted between the five user interface designs. Participants were shown a pair of concept designs one by one and asked to choose

which one they preferred between the two. Then, they were asked of thoughts and impressions of each design one by one.

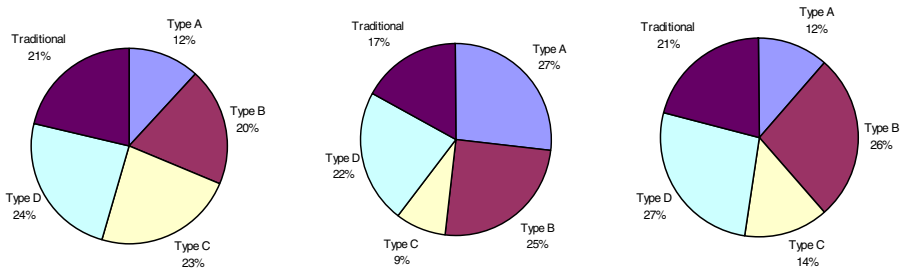
2. In the task performance, the suggested concept designs were built into PC-based interactive prototypes using Flash. The numeric keyboard replaced the remote control buttons, and the prototype was displayed in a 40 inch LCD TV or projector. The tasks were selected to investigate the ease of menu navigation and control under the same condition in the five concept designs. The tasks were given in random order. Error rate, task completion, and task time was measured. The measured three quantitative data were calculated on a 7-point scale for analysis convenience. An error was counted as minus 0.5 point; task completion failure was counted as minus 2 point; and task time over than given maximum time in each task was counted as minus 1 point. After each task, participants were questioned about the difficulties they experienced as well as ideas for improvement.
3. In feedback on the newly suggested digital TV features, participants were given visualized simulation and verbal explanation of user scenarios which utilize the seven newly suggested features and ideas. Participants' expected use frequency and acceptance rate of the features were collected given the condition that their digital TV has those new features. In addition, a moderator elicited participants' detailed opinion of each feature.

This study employed a within-subject experimental design. Prior to task performance, participants were given an introduction and allowed to use prototype for a brief familiarization period. The average test time was 100 minutes per person and regular breaks were given between the sessions.

3 Results

3.1 Subjective Preference on the Suggested Graphical Designs

The analysis of AHP result showed differences between the three countries. *Type A* was considered most preferred by Chinese participants (27%), while it was least preferred by both Korean and American participants (12%). *Type D* (23.6%) and *Type B* (22.9%) were preferred overall in all three countries.



(a) Republic of Korea (b) China (c) US

Fig. 2. Subjective preference of graphical designs

3.2 Task Performance of the On-Screen Display Menu Navigation and Control

Task performance ratings in American participants were highest overall, (average: 5.57, standard deviation: 1.20), Korean participants were second (average: 4.36, standard deviation: 0.95), and Chinese participants were lowest (average: 3.51, average: 2.25). Unlike in subjective design preference, similar patterns were found between three countries. The calculated point revealed that *Type A*, which was closest to the traditional TV menu in navigation, showed the higher performance in all three countries (4.86 in Republic of Korea, 3.50 in China, and 5.82 in US). *Type B* showed the higher performance rating in Republic of Korea (5.07) and US (5.43), but lower for Chinese participants (3.54). *Type D* showed the lowest performance in Republic of Korea (3.00) and US (5.10), while Chinese participants showed slightly higher performance (3.71). However, interviews after the tasks revealed that participants in all countries were confused about what item was currently selected in the OSD and had difficulty with the basic highlighting movement in *Type D*.

In 3 Factor within-subject ANOVA, it was found that all factors (country, participant group, and concept design) showed significant differences (Table 1). In Korea, Type A and Type C showed higher performance, and no significant difference between participant age groups. In China, no significant difference was found between both concept designs and participant age groups. In US, Type A and Type C showed higher performance than Type D, which is similar to Republic of Korea, and age group of 36 to 55 showed significantly lower performance.

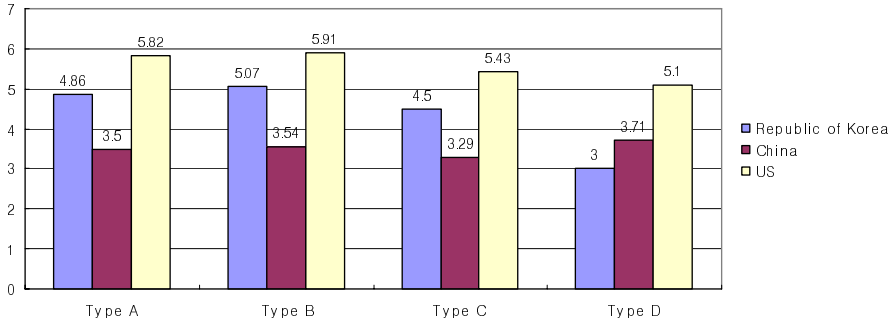


Fig. 3. Task performance of navigation and control

Table 1. 3 Factor within-subject design ANOVA

Factor	DF	MS	F	P < F
Country	2	72.09	23.66	** P<0.05
Participant group	2	55.83	17.69	** P<0.05
Concept design	4	9.80	22.20	** P<0.05
Country x Participant Group	4	23.70	5.68	** P<0.05
Country x Concept design	8	6.67	19.60	** P<0.05
Concept design x Participant Group	8	2.29	7.62	** P<0.05

3.3 Feedback on Suggested New Features to Enhance Usefulness of TV

The suggested features rated higher in expected use frequency also rated higher in overall acceptance. Participants tended to give slightly lower ratings in expected use frequency than overall acceptance (4.63 in Expected use frequency average and 5.06 in overall acceptance average). Chinese participants showed somewhat higher overage ratings in both expected use frequency (5.29) and overall acceptance rate (5.85) compared to American (4.05 and 4.33) and Korean participants (4.56 and 5.01). In the qualitative verbal data, it was found that participants had negative thoughts in all three countries to the additional features in TV comparing to the one they currently owned.

Table 2. Rating average of suggested new features

Country Category	Republic of Korea	China	US
Expected use frequency	4.56	5.29	4.05
Overall acceptance	5.01	5.85	4.33

4 Conclusion and Discussion

There are more elements which consist of user interface design of a complete TV than those discussed in the present paper. This paper focused on three main elements, which were design preference, task performance, and new functionalities.

Difference in subjective design preference between the three countries was found, indicating that preference could be influenced by cultural differences. *Type A*, which showed the most significant differences between countries, was considered new and unique by Chinese participants, while American participants viewed it as dull and obsolete. It was interesting that the two Asian countries showed different results. This may imply a weakness in the small number of samples in this study or possible differences in the countries from a similar region. On the other hand, similar patterns were found in task performance analysis in the three countries, indicating no significant influence by country differences. Participants in all three countries outperformed with *Type A* and *Type C*, which is closest to a traditional TV menu. People still feel comfortable and perform better with a familiar interface.

The results also revealed conflicts between preference and task performance regardless of participants' cultural differences. *Type D* was ranked high in the design preference, but showed lowest performance in the tasks. This indicates that visually preferred design does not always guarantee best usability and user performance, and vice versa.

Participants generally showed negative responses to newly suggested features of TV because of the anxiety of increased complexity in everyday use. The lower point in expected use frequency than overall acceptance indicates that possibility of the new features usage in the real use surroundings may be lower than expected. This implies the importance of deep considerations before accepting a new feature. It is interesting that Chinese participants gave slightly higher ratings than the other two countries,

while people in all three countries showed negative feedback in verbal. The numeric rating did not always match the participants' qualitative feedback.

In the later part of process of the present study, the concept designs which showed significant differences between countries were eliminated. The navigational rules were made according to the way that participants performed better regardless of countries in the final outcomes. Based on findings in the present study, the authors completed a new interface design for the large-sized high-definition television that has been commercialized in the major TV markets. This study indicates the necessity of user studies of cultural differences, and suggests an optimized level of localization in the example of the product user interface design of digital consumer electronics.

Acknowledgements. We would like to thank task force team members in Visual Display Division in the company for their support and collaboration.

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