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A User Interface Style Guide for the Cabinet Operator Module

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Abstract - A reactor protection system (RPS) plays the roles of generating the reactor trip signal and the engineered safety features (ESF) actuation signal when the monitored plant processes reach predefined limits. A Korean project group is developing a new digitalized RPS and the Cabinet Operator Module (COM) of the RPS which is used for the RPS integrity testing and monitoring by an equipment operator. A flat panel display (FPD) with a touch screen capability is provided as a main user interface for the RPS operation. To support the RPS COM user interface design, actually the FPD screen design, we developed a user interface style guide because the system designer could not properly deal with the many general human factors design guidelines. To develop the user interface style guide, various design guideline gatherings, a walk-though with a video recorder, guideline selection with respect to user interface design elements, determination of the properties of the design elements, discussion with the system designers, and a conversion of the properties into a screen design were carried out. This paper describes the process in detail and the findings in the course of the style guide development.

KeyWords: Human Factors Guidelines, A Style Guide, HSI design

1. INTRODUCTION

The human machine interface (HMI) design process is the translation of the design requirements into the appearance and behaviour of the HMI. The human factors guidelines are used to ensure that the design products are within a human's capability and efficient from the human factors point of view. General human factors guidelines mostly describe the human factors principles so the designer has to tailor them to apply them to his design. The design-specific guideline that is specifically dedicated to a unique system and derived from the general guidelines is called the style guide. Thus the style guide addresses the details (close to real products) rather than the generality (broad application areas). In general, the style guide provides easy to use templates to help the user interface design, and these templates help ensure a consistent style and behaviour throughout the design products.

It could be difficult for a designer to select the human factors guideline items related to a target system and to derive a style guide from the items. If they are unfamiliar with the human factors principles then the output is expected to be insufficient and/or incomplete.

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In order to cope with the difficulties and the problems, human factors engineers should take part in the development process. This paper describes the human factors activities carried out to develop a style guide for a system and the findings.

2. STYLE GUIDE DEVELOPMENT PROCEDURE

The overall development procedure is divided into an information acquisition, a selection and a screening, a property determination and a discussion, and a conversion and a review.

2.1 Information Acquisition

The first real development step towards the style guide is to gather information about the RPS and the RPS COM. What RPS functions and what role the RPS COM plays are a basic concern in order to proceed with the development of the style guide because the functions and the user interfaces can not be considered separately.

As the system interface requirements were already documented and given to us, we had a grasp of the system functions and inventory requirements. As a result, we refined the items to be explicitly determined in the style guide such as what screen layout could be expected, which design elements could be used in the screens, what color scheme could be applied, what manners of navigation were required, etc.

To figure out the operation environment and the operation itself in the real situation, we visited a nuclear power plant in which a digitalized type of the RPS MTP similar to the RPS COM is installed. It was confirmed that the RPS COM had the same operation environment as the existing RPS MTP. Through the investigation of the space and location in the real situation, the environmental and anthropometric characteristics could be defined. Because the plant was under a pilot operation, a walk-through for the test operation could be carried out with the support of the local operators and MCR operators. Useful information obtained from the walk-through was the behavioural characteristics of the local operators shown during the testing operation.

2.2 Guideline Selection and Items Screening

In 2003, various human factors guidelines related to the VDU were gathered and a database management system (DBMS) of those guidelines was developed in Korea. Four guidelines from the government, six guidelines from non-government organizations, and six guidelines from the nuclear domain are integrated in accordance with a new classification.

To support an efficient search and update, appropriate keywords were attached to each guideline item, and a search tool so called Keymapper was developed. The Keymapper provides two search methods, one is a keyword-based search and the other is a blind search. The keyword-based search uses keywords attached to each guideline item as a search key and the blind search uses the user input.

Through the Keymapper, a guideline and guideline item selections were performed in the blind search mode. Every design variable and design element defined in the prior step was entered and the search results were merged repeatedly.

Because there were overlapped items selected from different guidelines, high level human factors principles, and items with a non-specific value or not applicable to the style guide in the selected guideline items, a screening was necessary. Also a merging was required in the case where several items described multiple attributes of one design variable, for example, guideline items related to an alphanumeric character and label could be merged into a design variable "button".

2.3 Property Determination and Discussion

The human factors design guidelines hardly provide a specific or optimal value for a design variable (e.g. button) or design element (e.g. line spacing). They often give the recommended range, minimum value, or maximum value. However designers want to obtain not an acceptable range but a specific value in the style guide. With respect to each design element we suggested the specific values and discussed them with the system designers and user interface designers in order to verify that the value could be applicable to all the screens. The information quantity of the screens was frequently discussed to fix a specific value for a design element because the physical size of the RPS COM LCD was only 15 inches.

2.4 Conversion and Review

For instance, NUREG-0700 Rev.2 says "... ,the dimensions of response areas of touch screens should be a maximum height and width of 1.5 inches (40 mm) and a minimum height and width of 0.6 inches (15 mm), ...". If a designer wants to draw a pushbutton group on a touch screen, he has to decide the dimension applicable to all the pushbuttons in the group. In the case that the designer sets the dimension to 30 mm, it is not enough in most situations because the designer uses a design software tool which accepts its own metric (e.g. point) not the millimetre scale. So does the RPS COM design software tool. Therefore we transformed the value in terms of the software tool so that designers could use the value without any conversion. After finishing the drawing work for the representative screens, we had the review group evaluate the drawings. The group consisted of human factors engineers, system developers, and external experts.

3. DISCUSSION

One main concern with the style guide was the responsibility - who developed the style guide? For MMI design activities, the related group can be divided into system designers, user interface designers, and human factors engineers. System designers give the system requirements to the user interfaces designers, and the human factors designers undertake the human factors guidelines. User interface designers have to develop the screens and link them to the real input/output points. As mentioned above, a user interface designer can't deal with the human factors guidelines efficiently under the situation that the development time is limited and a regulation satisfaction is required. In our experience, a small scale project does not take care of the human factors sufficiently, but rather incorrectly. Priority of the guideline items is not appropriately analyzed but chosen at random. As a result, hard work like the redesign or modification of an almost finished design is unavoidable. To cope with this situation, it is desirable for human

factors engineers to take part in the development of the style guide based on the human factors guidelines.

The walk-through performed before the property determination was very useful. As a style guide must give valid design criteria derived from the guideline items to a user interface designer, understanding a real operation environment is essential. Through the walk-through, we could establish the display characteristics, determine the basic design elements such as the viewing distance, confirm the physical size of the design variables, and figure out the operator's behaviour during operation sequences. The display was dimmer than a general LCD because of the touch capability, so a combination of the brightness and a saturation of the colours were carefully considered in the color selection to ensure a suitable legibility.

Sample screens had to be selected in order to verify the design variables drawn on the basis of the temporarily defined design elements. These representative screens were chosen to include every design variable shown in the screen set. By applying the determined properties of the design variables to the representative screens, we could verify that the properties could be implemented in all the screens. Thus the specific values of the design variables could be determined without a complete drawing for all the screens.

It is no wonder that the specific values of the design variables are very useful to user interface designers. To enhance the usability, we transformed the determined values into a drawing software language. User interface designers established a design variable set based on the determined value so that they could easily pick an element in the set to draw a design variable. This method accelerated the drawing process which requires a repeat usage of the design variables.

Among the human factors guidelines used to extract the proper guideline items, a review guideline such as NUREG-0700 Rev.2 was frequently referred to rather than the general user interface guidelines. The reasons for this are (1) the regulatory guidelines provide more precise values with some explanations as additional information, (2) conforming to the regulatory guidelines is required and a review of the design product on the basis of them is inevitable.

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