Amount of information in a single display for efficient situational awareness

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1. Introduction

Operators monitor the information through the interface display and comprehend the situation at the control facility of a nuclear power plant such as MCR. In such a situation, prompt and efficient information processing is essential for a series of processes that recognize and respond to relevant situations. It is important that the display properly provide the necessary information to examine the current situation. When designing the interface display, it is necessary to produce the information requirements to be presented in the display to assist operators in obtaining and processing information quickly. In addition to analyzing information requirements, arraying the information requirements in the display is also an important process.

In the case of designing an interface screen for use in a nuclear power plant, it is particularly necessary to minimize the transition of display at the parameter monitoring. Performing additional operations to find information consumes time and cognitive resources accordingly. Therefore, it is necessary to design the system so as to minimize the screen transition process and to grasp as much information as possible within one display screen. However, a single screen provides too much information, the efficiency of information acquisition and information processing may deteriorate. This can reduce the speed of situational awareness, so it is necessary to examine the optimal number of parameters that do not deteriorate the information processing efficiency.

In existing researches related to display composition, we found several design principles in consideration of human cognitive characteristics in display layout and configuration (Wickens & Holland, 2003; Endsley, Bolte & Jones, 2003). These principles are based on theories of human cognitive such as gaze processing, perception, and cognitive processes. For instance, human gaze tends to navigate from left to right, and navigation tends to avoid edges of display (Parasuraman, 1986). Also, visual scanning is most frequently seen among adjacent elements of the display (Wickens & Holland, 2003). Factors related to visual attention can also be considered in design of display. The human eye is attracted first to the most visible and colored object on the screen (Durranni, 2009), and the sudden appearance of a stimulus like light on can attract visual attention. In addition, studies related to the use of on-screen color were frequently found.

However, little research has been conducted on the amount of information to be placed on the screen during the display configuration process. Since there is a limit to human cognitive capacity, it can be expected that as the quantity or number of information to be processed increases, the speed of information processing will decrease. However, as the number of information increases, the information processing speed will not decrease at the same rate. It is expected that information can be handled efficiently with a certain amount of information. It can be expected that information can be efficiently handled up to a certain amount of information. In this study, we investigate limit of information quantity that can be efficiently processed in one screen through experimental task.

Of course, in the nuclear domain, it is not necessary for all monitoring to be performed by humans alone. In the Nuclear Power Plant, alarms are generated when there are errors in the system status, so that operators can be aware or monitor related parts of the situation. Nonetheless, it would be desirable to place the amount of information that is easy for human to process in a single display. In an emergency situation, it may be necessary to interpret and respond to situations through human monitoring.

In this study, we use the task of situation awareness to experimentally verify the relationship between the amount of information in the interface screen and the speed of performance, and identify the maximum amount of information in the single screen that can be processed efficiently.

2. Methods and Results

We conducted a pilot test to develop the main experimental task. The purpose of the pilot test was to ensure that the speed of performance decreased as the amount of information increased. The experiment was also conducted to determine whether the parameters should be presented at fixed or random locations. If parameter locations are randomly placed, participants should first search for parameter locations for information processing. In this case, it is expected that the effect of the amount of information on information monitoring and situation analysis will be even greater.

On the other hand, in case of the parameters are placed at a fixed position, a situation similar to that of the actual interface display layout can be configured because operators already know the location of the in-screen parameters in the actual field. In this condition,

it may be difficult to identify the effect of the amount of information itself. However, since the location of the variables is fixed, the relationship between the amount of information and the speed of performance excluding the effect of the 'simple location search' process can be examined.

2.1 Experimental Task

The task of pilot test presents a series of parameters named alphabetically on the screen and corresponding numerical values. The participants were asked to solve the experimental questions using the parameters on the screen. The experiment questions were to check on the parameters and select the answers corresponding to the current situation. The reference values and situations are developed for the pilot test.

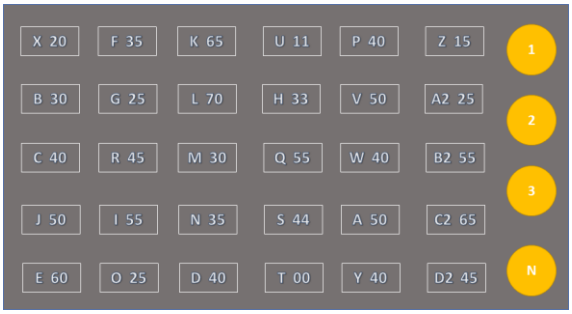

Fig. 1. Example of experimental task screen

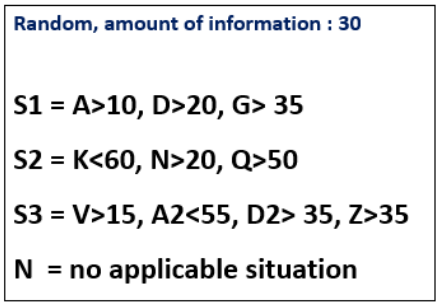

Fig 2. Example of the experimental question

2.3 Results

The test results show that the difference between the conditions of 20 parameters and 30 parameters is larger than the difference between the 10 and 20 conditions under random placement conditions. In addition, comparing the effects of the random placement condition and the fixed placement condition through the paired t-test, there is no significant difference under the conditions of 10 parameters and 20 parameters. However, there were statistically significant differences between the conditions of 30 parameters. It can be interpreted that the searching for the parameter location becomes more difficult when the number of information is increased from 20 to 30 as compared to when the number of information is increased from 10 to 20. In the random placement condition, the deviation of the speed of performance was much larger than the fixed placement condition. This result can be interpreted as a result of the location searching process too.

3. Conclusions

As a result of the pilot test, when the parameters are randomly arranged, it seems that the searching for the location of parameters is greatly affected compared with the condition of the parameters are fixedly arranged. This result is consistent with the expectation that information processing speed will decrease as the amount of information increases. It should be noted that the speed of performance decreased as the amount of information increases even under the condition that the location of parameters is fixed. It can be interpreted that the information recognition and the situation analysis process except the location searching are also affected by the amount of information.

The real-time monitoring of the actual field and the still frame used as the experiment task cannot be seen as the same. However, even when all the screen parameter locations are fixed, it can be seen that the speed of information processing and the situation recognition decrease with the increase of the amount of information to be displayed. Based on the results of pilot test, we will develop the main experimental task with fixed parameter positions. In the main experiment, we will group parameters related to each other closer to the actual environment, and we will add the conditions of varied number of information to investigate the amount of information that speed of situation awareness is significantly lowered.

REFERENCES

[1] R. Parasuraman, Vigilance, monitoring and search, Wiley, New York, 1986.
[2] C.D. Wickens and J. G. Holland, Engineering Psychology and Human Performance, Sigma Press, 2003.
[3] S. Durranni and Q. S. Durranni, Applying Cognitive Psychology to User Interfaces, Springer, New Delhi, 2009.
[4] M. R. Endsley, B. Bolte and D. G. Jones, Designing for Situation Awareness: An approach to User-Centered design, CRC press, FL, 2003.