

Comparing the subjective task difficulty of human operators with task description levels

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1. Introduction

Without the loss of generality, it is reasonable to say that an operating procedure consists of many steps including detailed descriptions that provide necessary information in conducting the required tasks safely and effectively. In this regard, since it is widely perceived that procedures are effective for reducing the occurrence of human performance related problems, the use of procedures is very popular in large process control systems including nuclear power plants (NPPs), commercial airplanes and railway systems [1].

However, the secure of an operational safety by using an operating procedure can be accomplished only if human operators are able to effectively obtain necessary information from it. In other words, it is hard to expect the reduction of human performance related problems, if task descriptions are so ambiguous or incomplete that human operators feel an undue difficulty in identifying “what have to be done” and “how to do it” from procedures [2]. Unfortunately, it seems that a systematic method that can be used to distinguish the proper level of task descriptions is rare [3]. For this reason, Park et al. developed a decision chart that could be helpful for characterizing the level of task descriptions [4]. In this study, in order to ensure the appropriateness of the suggested decision chart, more detailed investigations were conducted with the support of human operators who are working as the operating personnel of NPPs.

2. Characterizing task descriptions - Background

2.1 Key attributes in describing tasks

According to the result of existing studies, it seems that there are some rules to describe a task. For example, it was pointed out that “Each task statement consists of (a) an action verb that identifies what is to be accomplished in the task, (b) an object that identifies what is to be acted on in the task, and (c) qualifying phrases needed to distinguish the task from related or similar tasks [5].” From this statement, it is possible to assume that the level of task descriptions depend on the characteristics of qualifying phrases. In this regard, Park et al. pointed out that the level of task descriptions could be sufficiently distinguished by two kinds of key attributes, such as ACCEPTANCE CRITERION and MEANS [4].

2.2 ACCEPTANCE CRITERION

The meaning of ACCEPTANCE CRITERION is a value or worth that can be used to clarify the

achievement of a given task. This implies that ACCEPTANCE CRITERION needs to specify a desired (or the final) state when the required task has been properly accomplished. In this regard, four types of expressions can be assumed to specify the desired state. They are: objective (OBJ), subjective (SUB), reference information (RI) and no criterion (NC). More detailed information can be found in Ref. [4].

2.3 MEANS

The next key attribute is MEANS. As can be recognized from its name, the definition of MEANS is an explicit and/or implicit method including tool or device which specifies how to actually achieve the ACCEPTANCE CRITERION of a given task. In this regard, it is possible to consider four types of expressions about MEANS: (1) designated (DEG), (2) inherent (INH), (3) no means (NM) and (4) local operation (LO). More detailed information can be also found in Ref. [4].

2.4 A guideline to characterize task descriptions

Based on ACCEPTANCE CRITERION and MEANS, Park et al. suggested a simple decision chart that was elucidated from the results of pair-wise comparisons collected from the subject matter experts of NPPs. Fig. 1 depicts the decision chart with the associated level of task descriptions.

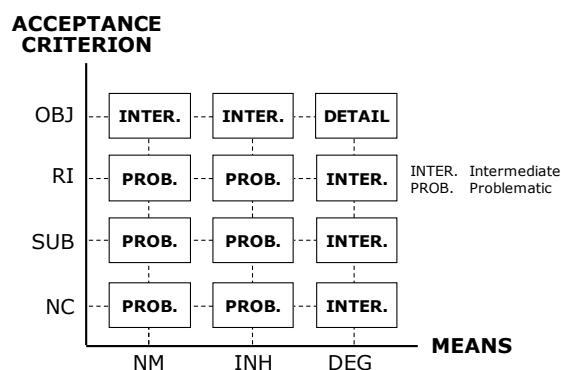


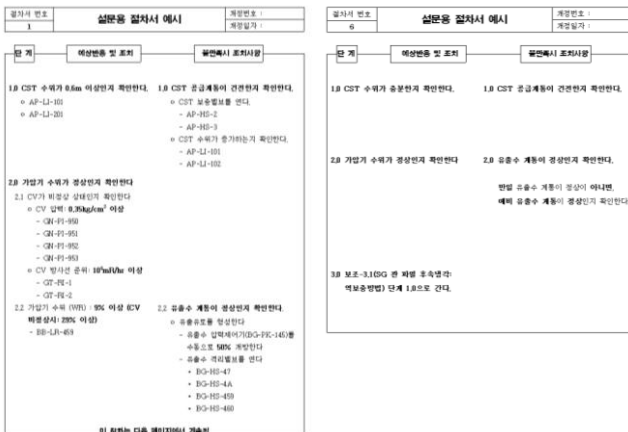
Fig. 1. A simple decision chart to characterize the level of task descriptions

For example, a task that is described by DEG and OBJ can be regarded as “detailed level description” while that of DEG and SUB is “intermediate level description.” In addition, a task that is described by NM and NC corresponds to “problematic level description.”

3. Comparing the subjective task difficulty with the variation of the level of task descriptions

3.1 Data collection

In order to confirm the appropriateness of the decision chart shown in Fig. 1, more detailed investigations were carried out by using 10 kinds of procedures that have been prepared with the different levels of task descriptions. To this end, in total 98 human operators who are working as the operating personnel of NPPs were asked to rate the subjective difficulty of each procedure with five-point Likert scales (i.e., 1 = there is no problem in conducting the required task and 5 = it is very difficult to conduct the required task). Fig. 2 shows two kinds of procedures that have different level of task descriptions.



(a) Procedure described by detailed descriptions (b) Procedure containing problematic descriptions

Fig. 2. Two kinds of procedures described by different level of descriptions

3.2 Comparison results

Table 1 summarizes the mean values of subjective task difficulty scores grouped by the experience level of human operators and the relative percentage of task descriptions appeared in each procedure. In addition, Fig. 3 shows the result of comparisons between the mean values of subjective task difficulty scores with the associated procedures.

Table 1. The mean values of subjective task difficulty scores and the relative percentage of task descriptions pertaining to 10 kinds of procedures

Procedure	Mean value of subjective task difficulty scores with respect to experience years				Relative percentage of task descriptions about each procedure		
	0-5	5-10	10-15	> 15	Detail	Inter.	Prob.
A	2.78	2.41	1.96	2.26	67%		33%
B	4.43	4.33	3.48	3.61	33%	67%	
C	3.61	3.30	2.72	2.91	33%		67%
D	1.30	1.19	1.32	1.22	100%		
E	2.78	3.04	2.60	2.48	80%	20%	
F	2.35	2.41	2.08	2.13	62%		38%
G	2.91	3.19	2.42	2.87	50%	8%	42%
H	2.48	2.30	2.24	2.35	86%	7%	7%
I	4.61	4.56	3.88	3.78	17%	83%	
J	3.57	3.56	2.77	3.26	10%		90%

As can be seen from Fig. 3, although the experience levels of human operators are different, they commonly answered that procedures containing a large portion of detailed task descriptions are easy to conduct (refer to D and H in Fig. 3). In contrast, subjective task difficulty scores showed a deviation when the percentage of problematic as well as intermediate task descriptions increases (refer to B, C, I and J in Fig. 3). This strongly implies that there is a meaningful correlation between the preference of task descriptions and the operating experience of human operators, which was directly comparable with the result of existing study [6].

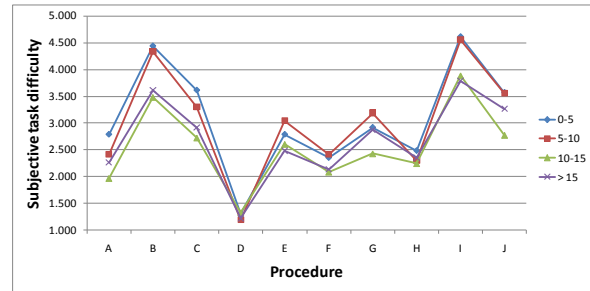


Fig. 3. Subjective task difficulty scores with respect to procedures

4. General conclusion

In this paper, the appropriateness of the suggested decision chart by which the characteristics of task descriptions can be distinguished was investigated. As a result, it was observed that the suggested decision chart seems to be reasonable because it allows us to identify the relation between the level of task descriptions and the operating experience of human operators. Therefore, it is possible to conclude that the suggested framework could be one of the good starting points to scrutinize the effect of task description levels on the performance of human operators.

REFERENCES

- [1] Inspectors toolkit: human factors in the management of major accident hazards. Available at: www.hse.gov.uk/humanfactors/topics/toolkit.pdf
- [2] B. Reer, V. N. Dang and S. Hirschberg. The CESA method and its application in a plant-specific pilot study on errors of commission. Reliability Engineering and System Safety 83, p. 187-205.
- [3] H. McRobbie and J. Y. Fiset. Lessons learned in reviewing processes supporting procedural adherence. 27th Annual CNS Conference & 30th CNS/CAN Student Conference, Toronto, Canada.
- [4] J. Park, S. Park and S. Cho. Some insights to determine the proper level of descriptions about proceduralized tasks. Progress in Nuclear Energy 52, p. 214-224.
- [5] Department of Defense. Human engineering program process and procedures. Mil-HDBK-46855A, 1999.
- [6] S. E. Zach. Control room operating procedures: contents and format. Proceedings of the Human Factors and Ergonomics Society 24th Annual Meeting, Los Angeles, CA, p. 125-127.