Consideration of Command and Control Performance during Accident Management Process at the Nuclear Power Plant

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1. Introduction

The accident at the Fukushima Daiichi nuclear power plants shifted the nuclear safety paradigm from risk management to on-site management capability during a severe accident. The kernel of on-site management capability during an accident at a nuclear power plant is situation awareness and agility of command and control. However, little consideration has been given to accident management. After the events of September 11, 2001 and the catastrophic Fukushima nuclear disaster, agility of command and control has emerged as a significant element for effective and efficient accident management, with many studies emphasizing accident management strategies, particularly man-machine interface, which is considered a key role in ensuring nuclear power plant safety during severe accident conditions.

This paper proposes a conceptual model for evaluating command and control performance during the accident management process at a nuclear power plant.

2. Theoretical background of command and control

The phrase command and control (C2), which has its origins in military terminology, refers to the approach an attacker uses to take command of and exercise control over a compromised system. C2 can be defined as the "the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission" [1].

Figure 1 illustrates a conceptual model for C2, which can be identified as follows [2]:

2.1. Command

According to [2], the following are affected by command output:

- Action constraints
- Information, personnel, and materiel allocation
- Intent
- Participant interaction
- Role and responsibility allocation

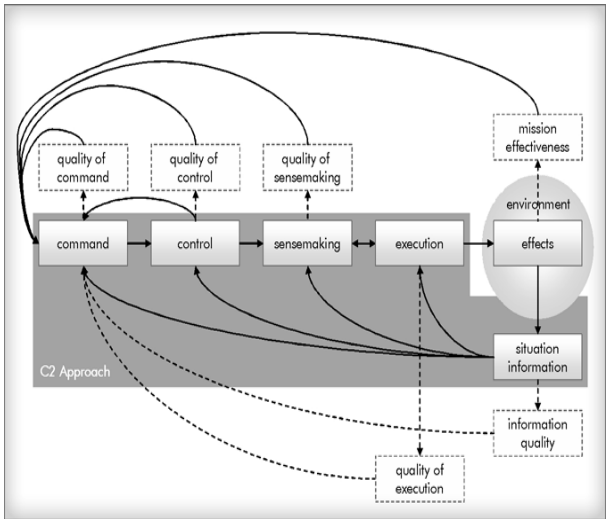

Fig.1. C2 Conceptual model

2.2. Control

The function of the control is to keep all the value within the acceptable limits.

2.3. Sensemaking

Sensemaking is defined as a group of social or cognitive processes that starts on "the information domain with the perception of available information." This group of processes then ends before taking any action that affects any of the domains [2].

2.4. Execution

"The actions involved in execution may take place in any of the domains with direct and indirect effects in multiple domains "[2].

3. Development of the model

A system-oriented model will be used in this paper for the C2 analysis. This type of C2 model "describes and evaluates the operation of specific facilities, technology, and systems used to support the command and control function". In addition, it focuses on communication and information processing systems [3]. The system oriented model is utilized to design the C2 model for accident management, illustrated in Figure 2.

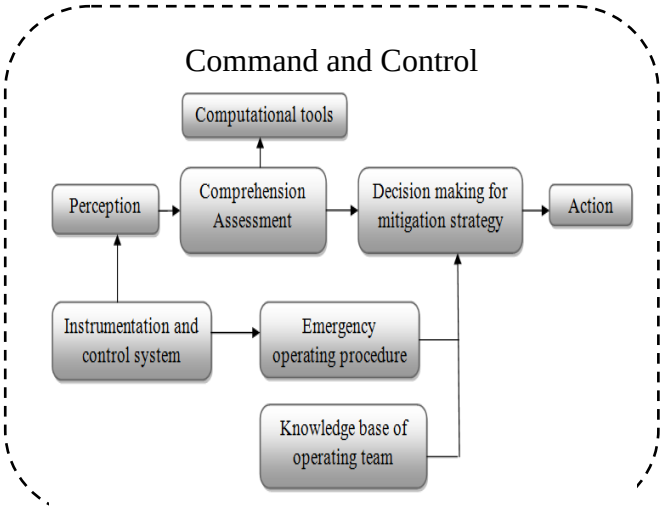

Fig.2. The conceptual command and control model

According to Figure 1, Action will be the output of environment, and it will be affected by all other factors of the model during the accident. The shift crew in the main control room (operators) will control the nuclear power plant according to the emergency operating procedure, which plays the role of control and command through the instrumentation system and the knowledge of the operator.

The design concept of the model will evaluate command and control performance for accident management in nuclear power plant, and it is based on communication and information processing in order to give the accurate and fast decision to mitigate the accident.

The decision making process can be defined as follows:

- "Perception" when the operators in the main control room notice a problem sent by the instrumentation and control system.
- Comprehension assessment will take place by make use of the computational tools to analyze the problem.
- Investigation for information from the emergency operating procedure.
- Operators can develop actions according to what written in the emergency operating procedure and his knowledge and experience.

4. Conclusions

Communication and information processing while responding to an accident is one of the key issues needed to mitigate the accident. This model will give guidelines for accurate and fast communication response during accident conditions.

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