

The development of a speech act coding scheme to characterize communication patterns under an off-normal situation in nuclear power plants

Seunghwan Kim, Jinkyun Park
Integrated Safety Assessment Division, Korea Atomic Energy Research Institute
P.O.Box 105 Yusong, Daejeon, KOREA
kimsh@kaeri.re.kr

1. Introduction

Since communication is an important means to exchange information between individuals/teams or auxiliary means to share resources and information given in the team and group activity, effective communication is the prerequisite for construct powerful teamwork by a sharing mental model [1][2]. Therefore, unless communication is performed efficiently, the quality of task and performance of team lower. Furthermore, since communication is highly related to situation awareness during team activities, inappropriate communication causes a lack of situation awareness and tension and stress are intensified and errors are increased [3].

According to lesson learned from several accidents that have actually occurred in nuclear power plant (NPP), consequence of accident leads most critical results and is more dangerous than those of other industries. In order to improve operator's cope ability and operation ability through simulation training with various off-normal condition, the operation groups are trained regularly every 6 months in the training center of reference NPP.

The objective of this study is to suggest modified speech act coding scheme and to elucidate the communication pattern characteristics of an operator's conversation during an abnormal situation in NPP.

2. Methods

2.1 Data Collection

Based on the above concerns, a full scope simulator installed in the training center of the reference NPP is used to collect useful data. This full scope simulator is a 1000MWe PWR (pressurized water reactor) type plant with conventional control panels and alarms. In the training center of the reference NPP, a set of video recording equipment is installed. This equipment is used not only to monitor which activities have been taken by the operators but also to review and discuss the operators' activities with instructors after each training session.

Thus, all kinds of operators activities (such as valve or pump operations) including communications among the crew members can be recorded on videotapes. The record collection period is from March 2008 to July 2008. During this period, in total, 5 training records performed by 5 different teams are collected. The abnormal scenario used in the analysis was related to

cope of operator's activities when loss of a condenser vacuums.

2.2 Creating Transcript

From the videotapes, we created communication logs (transcript) of each training sessions for communication pattern analysis. In the communication log, we extracted some important information which can be used as major items for the communication pattern analysis.

Each row of the communication log includes:

- The time when a human operator started to communicate
- The time when the human operator finished the communication
- The duration of each communication.
- The human operator who was involved in each communication
- The message contents of each communication

2.3 Communication Pattern Analysis

Communication message in the MCR of a NPP generally contains various data types to be classified. For the communication analysis, we developed modified speech act coding scheme based on Kettunen and Pyy's classification scheme [4].

Table1 represents a modified speech act coding scheme used in this study.

Table 1 A Speech act coding scheme used in this study

Category	Description	Example
Call	A call for a specific person for communication	"RO"
Response	A response for the Call.	"This is Ro Speaking."
Call-Identification	A Caller's self identification to target person	"This is EO"
Call-Id-Ack	A Receiver's Response for caller's self identification	"Yes"
Inquiry	A statement for asking.	"Does the vacuum valve started?"
Reply	An answer for the question.	"Yes, the vacuum valve is started."
Reply-Ack	A statement representing a reply was received	"Yes"

Command	A specific order of responsibility by one to another to manipulate an object.	"Close valve V202."
Command-Ack	A statement representing a command was received	"Yes. I'll close valve V202"
Command-Confirm	A confirm message that command was sent to receiver	"OK"
Suggestion	A statement of recommendation for specific action or an introduction of an idea for consideration	"Should we try to start the charging pump?"
Observation	A statement that describes status of the plant or equipment	"The water level of steam generator is increasing."
Observation-Ack	A statement representing an observation was received	"OK"
Judgment	An expression that judge the situation	"The trouble is occurring because of low pressure of the vacuum pump."
Judgment-Ack	A statement representing a Judgment was received	"OK"
Announcement	A statement to the public which gives information about something that happened or that will happen. Announcement.	"Attention Please. EDG B will be started due to a scheduled maintenance. Three, two, one, go"
Announcement-Ack	A statement representing an Announcement was received	"OK"
Acknowledgement	A statement representing a message was received.	"Yes Sir."

3. Results

The result of overall the communication patterns for an abnormal operating condition are shown in Fig 1.

- CALL (20.8%) : Call, Response, Call-Identification, Call-ID-Ack
- INQUIRY (31.9%) : Inquiry, Reply, Reply-Ack
- COMMAND (24.2%) : Command, Command-Ack, Command-Confirm, Suggestion
- REPORT (14.7%) : Observation, Observation-Ack
- ETC (8.4%) : Acknowledgement and etc.

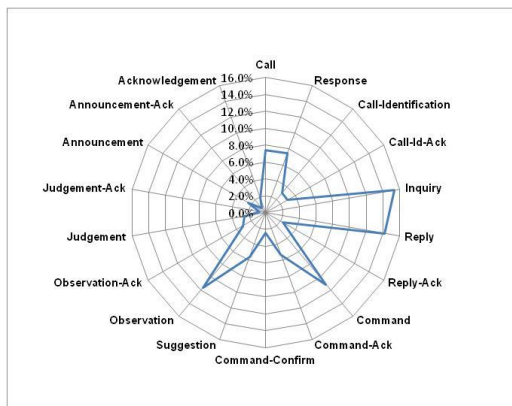


Fig 1 The composition of communication categories

We obtained some insights from results of the analysis.

First, the three major communication patterns are 'CALL', 'INQUIRY', 'COMMAND' Patterns and they cover 76.9% all the communications.

Second, the 'Inquiry (15.4%) / Reply (14.2%) / Reply-Ack (2.3%)' set occupied the highest portion (31.9%) of a conversation because understanding a symptom or trouble and the solving activities were usually expressed by this message pattern types.

Subsequently, the 'Command (11.0%) / Command-Ack (5.2%) / Command-Confirm (2.4%) / Suggestion (5.5%)' set was the second frequently used pattern during a communication under an abnormal operating condition.

4. Conclusion

In this paper, we present a quantitative analysis of a team communication based on a video-taped simulated training session for an abnormal situation in a nuclear power plant. The 'INQUIRY' sets are the most frequent message patterns under an abnormal operating condition.

We observed the percentage of multi-way communication which represents the accuracy and completeness of message transmission.

Finally, it is considered that a communication quality control is an important research area to minimize the occurrence of human errors during a communication in an abnormal operating condition.

REFERENCES

- [1] Hoegl, M. and Gemuenden, H. G., "Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence", *Organization Science*, Vol. 12, No. 4, p.435-499, 2001..
- [2] Schlichter, Koch, & Burger, "Workspace awareness for distributed teams", In W. Conen (Ed.), *Workshop Coordination Technology for Collaborative Applications*, 1997.
- [3] Sian B., Robertson, M., "Maintenance resource management handbook", Washington, DC,. Federal Aviation Administration Office of Aviation Medicine, 1996.
- [4] Ketteun, J. and P. Pyy, *Assessing communication practices and crew performance in a NPP control room environment – A prestudy*, TAU-001/00, 2000.