Situation Awareness in Offshore Drillers

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ABSTRACT

Introduction: A critical human aspect in maintaining safety in industrial settings is the ability of workers to maintain Situation Awareness (SA). This cognitive skill is thought to influence subsequent decision making and performance. A domain in which maintenance of accurate SA is vital is that of the Oil and Gas industry, particularly drillers who work in a high-risk, fast paced work environment. This paper presents preliminary findings from a new study which aims to identify and map the cognitive components associated with drillers' SA during well control. **Methods:** The study uses cognitive task analysis techniques of observation within a state of the art drilling simulator and critical incident interviews with experienced drillers to investigate drillers' SA The goal is to create a Hierarchical Task Analyis of drillers' tasks that require situation awareness whilst conducting routine and hazardous wells operations.

Results: This is a new study and preliminary results will be discussed at the doctoral colloquium.

KEYWORDS

Situation Awareness; Drilling; Task Analysis.

INTRODUCTION

Definition & Theory

A plethora of definitions have been proposed to define situation awareness (SA). However, the most dominant and widely cited definition of SA was proposed by Endsley (1988): SA is "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (p.79). In addition, Endsley's (1995) three level information processing model of SA is the dominant model in the field, being the most investigated and applied in industrial domains. It describes SA as an internally-held, cognitive product of the three hierarchical levels, perception, comprehension and prediction. It is widely accepted that SA is a safety critical factor, as inaccurate SA can lead to poor decision making and unnecessary risk taking, increasing the likelihood of an accident (Stanton, Chambers & Piggott, 2001). For the purposes of this project, Endsley's three level model of SA will be utilized.

Offshore Drilling

A domain in which possession and maintenance of accurate SA is vital is that of the Oil and Gas industry. For example, a survey of offshore installation managers indicated that they felt that loss of care and attention was one of the main causes of accidents on offshore production platforms and drilling rigs (O'Dea & Flin, 1998). Failures of SA have not just been identified within accidents in the industry but also in large scale disasters. The investigation into the Deep Water Horizon drilling rig disaster in the Gulf of Mexico in which 11 lives were lost and caused the worst oil spill in US history has highlighted failures of SA and risk perception as root causes of the disaster (Report to the President, 2011). In fact, it would be difficult to investigate any large scale oil and gas disaster and not find human failures associated with inaccurate SA (Sneddon, Mearns & Flin, 2006). Therefore, it would appear that SA research in the offshore oil and gas industry would have obvious applications.

A particular sample of offshore workers whose SA is vital is that of the drilling crews. Drilling personnel are involved in very high risk activities on the drilling rig or production platform to build or maintaining the underground wells. This high-risk, interactive, fast paced work environment requires high quality SA to constantly monitor and comprehend the state of the well and the drill floor operations so as to be able to make the best decisions and keep accident risk to a minimum.

The literature surrounding SA in the oil and gas industry is sparse. Sneddon et al. (2006) investigated the role of SA in an offshore environment within drilling crews. It was found that accident analysis supported SA as a key factor in errors and subsequent accidents with isolation from events at home, fatigue and stress being perceived to be most significant contributory factors to reduced awareness. More recently, Sneddon, Mearns and Flin (in press) showed that stress and fatigue could be detrimental influential factors on drillers' SA, using their Work Situation Awareness rating scale. Despite this increased understanding, the fundamental cognitive components

H. Chaudet, L. Pellegrin & N. Bonnardel (Eds.). *Proceedings of the 11th International Conference on Naturalistic Decision Making (NDM 2013), Marseille, France, 21-24 May 2013*. Paris, France: Arpege Science Publishing. ISBN 979-10-92329-00-1

required for drillers' SA have not been identified. Therefore, the current research project aims to investigate the cognitive components associated with drillers' SA.

Current Study

This project aims to indentify and map the cognitive components associated with drillers' SA during well control. The research will be conducted by identifying the cognitive skills and associated behaviours in relation to SA for the driller whilst he or she is conducting well control tasks (studies 1 and 2). The information collected will then be used to produce a Hierarchical Task Analysis (HTA) for drillers whilst conducting one or more hazardous well control tasks to identify the steps and cognitive components involved in completing these steps (study 3).

METHODS

Overall, human factors methods commonly used in other industrial domains for data collection and examination (e.g. Stanton, 2005) will be transferred into the new domain of the oil and gas industry Research in other high-risk, high-reliability industries such as aviation and healthcare has sought to understand the cognitive components of SA by producing taxonomies of skills and associated behaviours (Endsley & Garland, 2000; Phipps, Meakin, Beatty, Nsoedo & Parker, 2008). This approach would use two frequently used human factors data collection methods of simulator observations and critical incident interviews for cognitive task analysis (Stanton, 2005; Seamster, Redding & Kaempf, 1997). The HTA method identifies a goal or task and aims to break down the steps to complete this goal into small steps. Cognitive task analysis is then conducted by inferring the cognitive skills and components associated with each of the broken down steps (Stanton, 2005). The observation and interviews provide information to give the most accurate inference of cognitive skills. HTA is appropriate as it has previously been applied to the drilling domain (Stanton & Wilson, 2005). Overall, this method is also appropriate as it is very similar to the frequently used SA requirement analysis which identifies exactly what the operator's SA consists of and what information is required for the operator to complete their tasks or goals (Endsley, 1993). This method involves unstructured interviews with subject matter experts, goal directed task analysis and questionnaires in order to identify the relevant SA requirements. As this project in its infancy with only an initial set of observations and interviews, only preliminary results will be discussed at the doctoral colloqium. However, the expected results will be noted along with the methods and analysis used.

Study 1 – Observation

The aim of study 1 is to identify the cognitive skills and associated behaviours of drillers' SA whilst conducting their most hazardous tasks in the simulator. This is being conducted through observation of approximately 20 drillers' behaviour whilst performing scenarios of hazardous tasks in a drilling simulator. Observation is an ideal method for initial data gathering as it provides the naive researcher with the opportunity to both learn about the new setting and collect initial data (Stanton, 2005). Both live and video recording observation techniques are used such as taking field notes and check lists of behaviours. The data collected focuses on visible behaviours and skills associated with SA, such as where their information sources are and awareness of what the rest of the team are doing, as well as cognitive aspects such as cue recognition and prospective memory. The data will be analysed by collating the information from the observations into recurring themes associated with SA models to produce a catalogue of behaviours and skills associated with drillers' SA. These data can then be later used in study 3's HTA to make inferences about the cognitive components associated with the behaviours and skills.

Study 2 – Critical Incident Interviews

The aim of study 2 is to elicit knowledge from a sample of drillers about their own SA and the involvement of SA in well control events that they have experienced. Critical incident interviews were selected as a data collection method as they both elicit knowledge about tasks and the environment, as well as provide a gauge of SA role in incidents (Crandall, Klien & Hoffman, 2006). The interview schedule includes asking about the individuals' job and tasks, aspects of their SA, as well as talking through a challenging day. The challenging day focuses on a difficult well control task or coping with a well control event e.g. a kick. During this discussion, the interviewee is asked about their own SA, if and how it was involved in the causation of the well control event and the recovery from the well control event.

A sample of 10 drillers plus 10 assistant drillers will be interviewed either via the telephone or during visits to the simulator training days. Once the interviews are transcribed, they will be coded to identify recurring aspects of the drillers' SA. The coding method will include key aspects of SA as highlighted in the literature focusing on Endsley's (1995) three level model. These data will provide the foundation for the hierarchical task analysis by identifying the cognitive components and requirements for accurate SA.

Hierarchical and Cognitive Task Analysis

HTA has previously been used successfully to identify the steps involved in complex tasks allowing for the inference of associated cognitive components in other high-risk, high-reliability industries such as health care (Phipps et al., 2008), as well as in the oil and gas industry (Stanton & Wilson, 2005). The aim of study 3 is to produce a HTA for drillers whilst conducting the most hazardous task(s) to identify the steps and cognitive components involved in completing these task(s). The data from studies 1 and 2 will be used to inform this process, with the aid of a drilling expert to ensure that the task(s) are accurately described. The task(s) to be broken down will be chosen in collaboration with the collaborative company and data from studies 1 and 2, with the expectation that they will cover hazardous aspects of well control. The actual process of HTA will use software to produce the model such as Task Architect. Cognitive analysis will then be conducted on the individual steps to identify the cognitive components associated with drillers' SA during well control tasks.

CONTRIBUTION TO THE FIELD

As a project of this nature has not previously been conducted in the drilling domain, it is expected to produce a data set of behaviours, skills and cognitive components of drillers' SA that has not been collected before. It is hoped that these cognitive components and skills will be able to be generalised to other high risk, high reliability domains as well as inform, theoretical concerns related to SA. It is also expected that this greater understanding can be used to aid industry in indentifying and recording SA within their own competence assurance processes, incident records, as well as being used to inform the design of interventions to improve safety, such as training against identified types of errors. More generally, it is likely that novel measurement and data collection methods will be developed in response to issues that arise during the course of the project.

ACKNOWLEDGMENTS

Acknowledgement: This doctoral research project is sponsored by Maersk Drilling.

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