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Improving situational awareness through the design of offshore installations

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ABSTRACT

Maintaining the situational awareness of control room operators on offshore installations contributes to the timely diagnosis of conditions and making appropriate decisions. This is particularly important when dealing with events and incidents. Recent initiatives aimed at reducing operators' exposure to the hazards of working on offshore installations may have a negative impact upon situational awareness within the control room environment.

This paper discusses mitigation of the negative impact through the design and operation of the installation and control system; either by improving the general level of situational awareness or by specifically targeting the areas affected by these initiatives.

1. Introduction

Maintaining the situational awareness of operators on offshore installations contributes to the timely diagnosis of conditions and the ability to make appropriate decisions. This is particularly important when dealing with events and incidents. Recent initiatives aimed at reducing operators' exposure to the hazards of working on offshore installations may have a negative impact upon situational awareness within the control room environment. These initiatives include reducing time spent by operators on outside activities (e.g., maintenance and inspection) and the introduction of remote (onshore) control rooms. Note that operators performing tasks on external areas of an installation (outside the living quarters) are hereafter referred to as outside operators. Control Room Operators are those operators responsible for control and operation of the process through equipment (e.g., control system) within the control room and direction of outside operators. The objective of this paper is to:

- Discuss the effect of these initiatives on situational awareness
- Identify the measures in place to maintain and improve situational awareness within the control room environment
- Explore future problems and solutions associated with maintaining situational awareness within the control room environment.

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2. Situational awareness within the offshore control room environment

Endsley, Bolte, and Jones (2003) defines "situational awareness" as "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". Put simply, situational awareness is the understanding of what is happening and, given that information, what may happen in the future. Situational awareness also involves an awareness of the risk at the current state and the evaluation of the risk of the future states (Mostia, 2009).

Situational awareness is an essential component within the decision making process. Poor situational awareness (SA) can lead to poor decision making. This is particularly important offshore when responding to abnormal situations and incidents, especially when a timely response is required. "Operators who have lost SA may be slower to detect problems and require extra time to reorient themselves to relevant system parameters in order to proceed with problem diagnosis" (Endsley & Kiris, 1995).

In complex and dynamic environments (such as offshore installations), decision making is highly dependent on situational awareness – a constantly evolving picture of the state of the environment (Endsley et al., 2003). Timely response to incidents is essential in order to prevent escalation of an event. For example, Petrobras P-36 incident reports (Petrobras, 2001; The United States Environmental Protection Agency, 2001) point to poor situational awareness within the control room for failure to mitigate escalation of the respective incidents. This incident is discussed later within this paper in the context of situational awareness. Timely response to an abnormal condition is also important to avoid system shutdowns. Although shutdown systems are in place, there are a number of tasks which can be undertaken to stop the escalation of an incident and thus prevent the requirement for shutdown. Initiation of shutdown introduces additional hazards to regular operation, especially should re-start be required.

A key component of situational awareness is the creation of a clear mental model of the system. Mental models are complex structures people use to model the behavior of specific systems. A mental model is a systematic understanding of how something works (Endsley et al., 2003). Mental models allow a person to predict how a system or organization is likely to behave. Therefore, a comprehensive mental model of the offshore installation is conducive to a high level of situational awareness within the control room. Consequently, training and experience are valuable assets to the control room operator in quickly recognizing an event or situation and then predicting the potential and likely consequences.

Given the definition above, situational awareness can be broken down into three levels as described within (Endsley et al., 2003):

- Perception of data within the environment – dependent on the availability of data to the operators and their ability to recognize it.
- Comprehension of the current system status – the operators' ability to perceive the available data, sort this data into information and utilize this information to discern the current system status.
- Projection – given the information and current system status, the operator will make decisions (projections) regarding potential future occurrences.

It is important to recognize levels within situational awareness in order to identify where changes in work practices affect situational awareness and therefore, where mitigation measures can add most value. It is important to note that several models of situational awareness exist; for example, as Neisser's cycle of perception (Chimir, Abu-Dawwas, & Horney, 2005). This paper focuses on Endsley's model of situational awareness (Endsley et al., 2003).

3. Changes effecting the level of situational awareness within the control room

An offshore installation is an inherently hazardous environment. Designers and operators of installations make significant efforts to provide prevention, mitigation and protection against fire and explosion. Efforts to mitigate other personnel hazards, such as exposure to noise, and slips, trips and falls are also considered within the design. Efforts to minimize the number of personnel exposed and the time exposed to these hazards are part of this mitigation. This is achieved by purchasing more reliable machinery (therefore requiring less maintenance) and automating processes where appropriate, e.g., valve actuation. As a result, exposure to hazards (such as fire and explosion) and occupational health risks (such as exposure to noise) are reduced, which effectively reduce the number of manhours spent outside on the installation (at the immediate equipment interface).

This reduction in manhours is likely to reduce the situational awareness of outside operators and, in turn, control room operators. This hypothesis is supported by the first level of situational awareness: perception. Less time spent in the environment results in less exposure to the data within the environment. Availability of this data is a component of perception. Perception is a component of situational awareness. Further development and testing of this argument may be necessary for verification. One of the key sources of information for control room operators is outside operators, either via radio communication or face-to-face (see Table 1 for a list of information sources). This is significant as Endsley states (Endsley et al., 2003): "In many complex systems, a strong emphasis is placed on the electronic displays and read-outs that are provided, but the reality is that much of Level 1 (perception) situational awareness comes from the individual directly perceiving the environment – looking out the window or feeling the vibration. Verbal and non-verbal communications with others form an additional information source that is drawn upon and contributes to Level 1 situational awareness."

The control room environment itself is also changing. The introduction of remote (onshore) control facilities in support of the offshore control rooms is increasingly prevalent. At present, the operations undertaken from remote control rooms is limited, however, as the use of the technology becomes more familiar, there is potential for offshore installations to be controlled primarily from onshore locations. Indeed, the capacity to do so exists within the current technology. Within the current role, remote control room operators may be required to undertake some control room operations during an emergency or platform abandonment when the offshore control room operators experience high workload volumes or have abandoned the platform.

It is therefore, important to assess the level of situational awareness of remote control room operators in consideration of the information available remote from the installation itself. Table 1 identifies the available information sources for each operator. The remote control room operator has access to the same sources as the control room operator with the exception of face-to-face communication with outside operators and the CCTV (Closed Circuit Television) system (with current technology it is unfeasible to provide CCTV link to the remote control room). In addition, the control room operator (CRO) has ready access to the installation should it be required. This is, obviously, not immediately available to the remote control room operator.

How important is this additional data (available to CROs)? Anecdotally, responses range from strongly desirable to essential. However, experience of controlling installations from a remote

Table 1
Sources of information available to operators.

Outside operator	CRO	Remote CRO
• Alarms (e.g., PA)	• Alarm system	• Alarm system
• Auditory cues	• CCTV	• CCR – video conferencing
• Communications with other operators	• CNN/weather channel	• CNN/weather channel
• Communications with CRO	• Communications with outside operators	• Communications with outside operators
• Olfactory	• Communication with other operators within the CCR	• Control room – video conferencing
• Visual	• Control system	• Control system
	• F&G panel	• F&G panel
	• Face-to-face communication with outside operators	• Radar
	• Radar	• Other control room equipment
	• RCR – video conferencing	
	• Other control room equipment	