Chapter 7

Managing Differences in Situational Awareness Due to Roles in the Design–Use Process of Complex Systems

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ABSTRACT

This chapter describes how Situational Awareness (SA) can differ between roles in the design-use process. SA is not traditionally used to describe awareness between roles in the design-use process. However, SA between individuals or groups having various roles in the design-use process could be described, assessed, and used as a tool for improving a design process.

INTRODUCTION

Complex systems are in themselves costly and their rational is that they provide high values in the settings that they are used in. If the system fails to function or functions suboptimal the consequences for this could be costly, severe or even devastating. A specific problem is when a situation could not be managed, due to lack of SA.

This chapter explains SA as a concept and how the SA concept could be used to describe the design-use process. The chapter also describes how various roles in the design-use process affect the design and thereby also future situations where the end product is to be used. Later in the chapter, the focus is on how to manage the actual design process, given the premises explained in the earlier part of the chapter.

SITUATIONAL AWARENESS

SA is a frequently used term in Human Factors (HF) literature. It is a term used by users, researchers, developers and more. What SA is about is to know what is going on in the past, present and the future. SA is a central concept for complex systems with human in the loop, partly due to its positive correlation to performance. Therefore, it is important to regard SA already in the develop-

DOI: 10.4018/978-1-4666-6485-2.ch007

ment of complex systems, to understand what it is, what dimensions it has, and how to manage those insights for development purposes.

In the late 80's and early 90's there were a healthy and fruitful debate in the research community about SA, what it was, and how or if it should be defined. Even though not all questions that arose in that debate has been answered, more recent work has to a large extent focused on using the concept in various domains, and less focused on questions on definitions.

SA is a concept that has been proved to be useful first, within the aviation domain, and later in a wide area of domains. The wide recognition and frequent use of the concept indicates that it fills a need. SA has been defined and re-defined several times. It is difficult to clarify statements about high or low SA without explicit reference points. Also, the SA concept could be positioned to other concepts to help understand the concept.

First, the issue of SA is related to decision making in dynamic systems, where speed and accuracy of operator response is critical. As automation and task complexity increase, an operator is at greater risk of becoming lost in a system. This tendency is especially common in multimodal systems, where a specific display unit can, at different times, represent quite different physical states of the world. Accordingly, system failures due to mode errors have become more common. The SA concept has proved to be a fruitful framework for categorising operator errors, for instance, pilot errors in civil aviation (Endsley, 1995b, Jones & Endsley, 1996), or errors associated with offshore drill crews (Sneddon, Mearns, & Flin, 2006).

Second, SA is closely related to established concepts in the information-processing paradigm, predominately in human factors research. SA is often regarded as being principally in the cognitive domain (Hartman & Secrist, 1991). One SA model in mainstream HF research that includes information processing comprises three levels. Endsley's (1988), definition of SA seems to have attracted most adherents; "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. 792). Based on this definition Endsley (1988; 1995b) has developed a SA model that comprises three levels:

- Level 1, perception of task relevant elements. For instance, a pilot has to perceive task elements such as other aircraft, display meters, enunciators, and radio messages.
- Level 2, interpretation of task elements. On this level, a synthesis is made that go beyond the characteristics of the perceived elements. Information is interpreted in terms of its relation to pertinent goals. A fighter pilot, for instance, should be able to assess the intentions of enemy aircraft on the basis of their number, distance, speed and formation. Equally true is that a civilian pilot must assess intent of other aircraft such as in a busy air corridor.
- Level 3, projection of future states. This represents the highest level of SA, where the operator predicts the unfolding of events which, in turn, provide a basis for decision making. A fighter pilot realising an enemy attack predicts its speed and direction and then chooses the optimal alternative - counter attack, evasion action or retreat. Heavy air traffic over a civilian airport has comparable prediction requirements.

Each of these levels contains identifiable cognitive processes and attendant performance deficits. Lack of SA at level 1 may be caused by a range of factors that include vigilance decrements, discrimination failures and non-optimal sampling strategies in supervision. Errors at level 2 are related to mismatches between system characteristics and an operator's mental model. Level 3 errors may occur in spite of accurate perception and interpretation of task relevant information, as