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Training for Situation Awareness

Michael T. Hertz

Norman R. Hertz

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Michael T. Hertz
Progeny Systems Corporation
Manassas, VA 20110
Norman R. Hertz
Progeny Systems Corporation
Manassas, VA 20110

Situation awareness (SA) is not fixed but is malleable and can be enhanced by training. The operating premise is that SA is measurable given the many theories of SA. This paper identifies the various methods and approaches that have proven effective in training for greater degrees of SA. The loss of ,or insufficient SA is not viewed as inattention or lack of focus but instead, it is very likely that the person lacked the skill set to perform the job. The amount of training necessary for the person to effectively perform the work is helpful if it reduces the workload and informs decision making. A person is set up for failure if one of the requirements for the job requires a high degree of situation awareness without a sufficient skill set. This paper will present some suggested methodologies for enhancing SA to overcome the notion that SA is immutable.

Obviously the topic "Training for Situation Awareness" is not new. Endsley and Robertson (2000) were published in a book chapter that had the same title as this paper with the added words "Individual and Teams." There is no intent to model this paper after the earlier publication but will approach the topic from a point of view that there is no preferred model for measuring SA and errors of judgment occur without association with SA. For example, error chains are formed when errors of judgment are made just from a lack of ability.

Situation awareness "means that the pilot has an integrated understanding of the factors that will contribute to the safe flying of the aircraft under normal or near-normal conditions. The broader this knowledge is, the greater the degree of situational awareness" (Regal, Rogers, and Boucek, 1988, p. 65) as cited in Adams, Tenney, and Pew (1995). Adams, Tenney, and Pew (1995) states, "this definition stresses that successful realization of these processes depend on the prior knowledge with which the pilot meets such data." They report that the definition also stresses"that the ideal body of prior knowledge is prodigious in depth and breadth, as it includes not only up-to-the-moment understanding of current flight and aircraft status but also the background knowledge that lend familiarity to or permits understanding of any datum that could arrive in terms of the full range of situations, implications, and response options that go with it (pages 86-87)."

It is possible to increase situation awareness by training which provides prior knowledge. Situation awareness is not based upon native intelligence but instead is based upon knowledge that is developed during training. In the literature, situation awareness is sometimes treated as a personality trait such as extraversion. Personality traits by definition are enduring and unchanging. As long as situation awareness is thought of as a personality trait, the understanding of situation awareness and situational awareness training will not advance.

If situation awareness was an enduring personality trait then it would not be necessary to provide training. A person could be administered a "situation awareness" test and the results used for job placement. In practice, situation awareness is treated as trainable for there is no other reason why previous jobs experience or professional supervision would be required as conditions of employment. Industry treats training and previous experiences as risk mitigation in the situational awareness domain.

Training Perspectives

Training situational awareness can work in this fashion: Through the development of schemata (long-term memory) through training, the operator does not need to attend to every detail of the environment to have a reasonably complete assessment of the situation. This model of SA predicts that the relationship and quality of SA is dependent on the completeness of the knowledge the pilot has stored in long-term memory and the operator's working memory capacity .

> "The very definition of SA implies that human performance in any task cannot improve unless the trainee begins to develop a comprehensive body of domain specific knowledge and a detailed understanding of how the knowledge should be used to improve task performance." (Vincenzi, Hays, and Seamon, 2000, page 364).

SA is of interest to pilots—both aviation and maritime, power plant operators, and process control operators because their performance is affected by the amount of SA present. The delta between good and bad or effective and ineffective decisions is based on a proper understanding of the current system. Researchers design interventions to improve SA and find that performance is improved without an increase in SA (Brooks, Switzer, & Gugerty, 2003). These findings suggest that SA training affects performance without a concomitant increase in measurable SA. These findings may mean that the SA measures are insufficiently robust or that the construct of SA may not be independent from performance. Training for SA could very well focus on increasing job skills.

The following underlying competencies are considered as potential candidates for training (Banbury, Dudfield, Horman (2004, page 80) :

1. "to think ahead to future phases of the flight, instead of simply noticing events, in order to maintain SA
2. to perceive loss of SA, both of their own and of others, and to act on that knowledge
3. to re-evaluate criticality decisions by seeking data to disprove, rather than confirm, the current course of action
4. to balance workload, both manual and cognitive, between crew-members effectively."

The items will be addressed in order.

- Item 1—training could be designed such that it is standard operating procedure for person to visualize the flight in its entirety prior to beginning the flight or to visualize the entire process control activities. The visualization will prepare persons to be able to predict and plan for alternative actions prior to actual occurrence.
- Item 2—persons should be trained to identify the behavioral characteristics of themselves and others when loss of situation awareness occurs. Moreover, they should be prepared to act upon the behavioral indicators of the loss.
- Item 3—the critical approach is to disconfirm the decisions rather than to confirm because of the prevalence of confirmation bias. The process of disconfirmation is a standard procedure in philosophical approach to advancing science.
- Item—Excessive workload will cause the person to miss key indicators of events that begins the development of an error chain.

Bolstad, Endsley, Howell, and Costello (2002) evaluated two training modules—preflight training and contingency planning. "Their findings were that the modules were somewhat successful for improving SA and the pilots found them informative and useful (page 25)". Similar content to preflight training and contingency planning were identified earlier in this paper as domains in which training would assist in enhancing SA.

Endsley and Garland (2000) provided training recommendations for improving SA. They reported that good task management strategies appeared to be critical for dealing with task interruptions and distractions. The development of comprehension was another area in which training would be helpful. The third area in which training would be of benefit would be in planning in order to anticipate future events. A final area to provide training would be to assist persons in performing their own situation assessments.

Fowlkes, Merket, and Oser (2000) state that SA is vaguely defined and there is little prescriptive guidance available for how to train for SA. They suggested that behavioral indicators can be used to infer whether crews note relevant information. They further stated that behavioral statements lend themselves to the development for training objectives and ultimately to the development of assessment tools.

Sethumadhaven (2011) stated that only when individuals make accurate meta-cognitive judgments about SA can they adopt better monitoring strategies and be equipped to handle automation failure. The results from their study suggest that controllers who had better confidence in their SA tended to have better SA and those with better SA were faster in responding to automation failure. It is possible that meta-SA training programs can be used to improve comprehension of operators in dynamic situations by helping operators develop better monitoring and control strategies.

Training Content

Comprehensive body of knowledge
Plan and think ahead (be out front of the aircraft or ship)
Perception of loss of SA
Disconfirm critical decisions
Distribute workload
Preflight training
Contingency planning
Task management
Development of comprehension
Planning to anticipate future events
Perform self assessment of SA
Behavioral Application of training objectives
Metacognition

Based on the training content identified in the literature, there is no magic bullet that points the way directly to increasing SA. SA is a complex phenomenon that is used to explain deficient performance while the literature is saying that SA is not performance. If not, performance, than what? Deficient performance can be explained by lack of training, lack of cognitive or psychomotor skills, motivation, or other variables. One of the reasons that the SA research has generated the volumes of research has been the failure of the research to approach SA as a unitary construct.

How has the development of measures of SA improved performance? It would more productive if training was focused on the components of SA such as, planning, the process of disconfirming theories, task management, and metacognition.

The proposal advanced in this paper is that the focus of situation training should be in individual components instead of the end product of SA. SA should be decomposed on the constructs that predict performance and hence SA.

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