ACQUISITON OF SITUATION AWARENESS REQUIRMENTS FOR ARMY BRIGADE OFFICERS

Jennifer M. Riley, Debra Jones, Cheryl A. Bolstad, Mica R. Endsley
SA Technologies, Inc.
Marietta, Georgia USA

In today's operational settings, we are bombarded with data from many sources including media devices, long- and short-range sensors, fellow team members, feedback from unmanned vehicles, etc. Success (and even survival) depends on rapidly sorting through, understanding and assimilating vast quantities of data. Whether one is in a commercial cockpit dealing with heavy air traffic and hectic weather conditions, or involved in complex battlefield scenarios with distributed forces and rapidly paced activities, the ability to be versatile and make the right decisions will depend on having a good grasp of the true picture of the situation, which involves far more than having a lot of data. It requires that the data be transformed into the required information in a timely manner. In light of this, we have begun to emphasize dominance of information. The goal for our Army's future is to "see first, understand first, act first, and finish decisively" (US Army White Paper, Concepts for the Objective Force), so our focus is on how we can manage data to do this.

Our task as system designers is to determine what data are critical to task operations, when this data is needed, who needs it, and what form it needs to be presented in. In most contexts, the body of available data will need to be processed and interpreted slightly differently by different individuals, each of whom has varied and dynamically changing but inter-related information needs (e.g., the brigade CO, S3, and S2). Further, the data must be properly understood by each individual within the context of a joint mission to facilitate "good" problem analysis and decision making. The overall goal, then, should be to develop and maintain high levels of situation understanding among all involved in the combat planning and execution process. This is difficult, and is also one of the most critical aspects of operation in many domains today. Success will go to those who understand how to combine and present the vast amounts of data to provide relevant information (whether it is to the pilot, the physician, the business manager, or the army decision maker) that can be used to further or meet the goals of the task.

This critical understanding of what is happening in the environment around us and how it affects our goals and actions is situation awareness. Situation awareness (SA) is formally defined 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"* (Endsley, 1988). A key benefit of looking at SA is that it tells us how data needs to be combined and understood. Instead of loading the operator with separate pieces of miscellaneous data, provided in haphazard fashion, SA requirements provide guidance as to what the real comprehension and projection needs are.

Determining situation elements that are important for a particular operator's SA, for example in military conflicts, has frequently been approached using a form of cognitive task analysis called goal-directed task analysis (GDTA), illustrated in Table 1. In this analysis, the major goals of a particular job class or position are identified, along with the major subgoals necessary for meeting each of these goals. Associated with each subgoal, the major decisions that need to be made are then identified. The SA needed for making these decisions and carrying out each subgoal are also illuminated. These SA requirements focus not only on what data the operator needs, but also on how that information is integrated or combined to address each decision.

Table 1. Format of Goal-Directed Task Analysis

Goal

Subgoal

Decision

Projection (SA Level 3)
Comprehension (SA Level 2)
Data (SA Level 1)

Expert elicitation, observation of operator performance of tasks, verbal protocols, and analysis of written materials and documentation may form the basis for the analyses. The analysis has been conducted with a number of operators from a given position or job class, who are interviewed, observed and recorded individually, with the resultant analyses pooled and then validated overall by a larger number of operators. We have begun to complete GDTA of brigade level army positions, including the Intelligence Officer (S2), Operations Officer (S3), Logistics Officer (S4), and the Fire Support Officer (FSO). Preliminary GFTA results provide insight into the kinds of tools that may provide SA requirements for these positions, as well as support comprehension and near-future projections. Table 2 provides a goal excerpt from a preliminary GDTA conducted for the brigade level S3 officer.

Table 2. Excerpt of Goal-Directed Task Analysis for S3 Officer

1.3 Identify tactics and courses of action
1.3.1 Determine best maneuver route

- *What routes are available?*
  - Projected ability of route to support movement
    - Trafficability
      - Road type/conditions
        - Terrain
        - Weather
        - Weapons damage
        - Ordnance
- *What is probability of exposure to enemy on route?*
  - Projected risk of exposure
    - Areas of cover and concealment
      - Terrain
      - Visibility
        - Weather

The analysis typically includes many goals and subgoals, however they may not all be active at once. At any given time, more than one goal or subgoal may be operational, although they will not always have the same prioritization. The analysis does not indicate any prioritization among the goals (which can vary over time), or that each subgoal within a goal will always be active. Unless particular events are triggered, for instance, the subgoal of "Determine best maneuver route" in this example may not be active for a given S3.

The analysis strives to be as technology-free as possible. How information is acquired is not addressed. The way in which information is acquired can vary widely between individuals, over time and between system designs. Furthermore, the analysis seeks to determine what operators would ideally like to know to meet each goal. Though operators often must operate on the basis of incomplete information, and though some desired information may not be available at all with today's system, for purposes of design and evaluation of systems, we need to set the design goal to measure against what they ideally need to know. This allows us to avoid artificial ceiling effects based on today's technology.

It should be noted that static knowledge, such as procedures or rules for performing tasks, is outside the bounds of an SA requirements analysis. The GDTA focuses only on the dynamic situational information that affects what the operators do. It seeks to provides all of the dynamic information requirements for a particular position or job. If multiple positions are analyzed (e.g., the CO, XO, S2, S3, etc. of a bridge level staff) you essentially get ideal SA requirements for the given team (Team SA). In addition, the GDTA results provide insight into redundancy in SA requirements that may occur across goals and across positions. Thus, the technique highlights instances of Shared SA (where team members need to know the same kinds of information for collaborating and making decisions). For example, for course of action analysis and wargaming activities, the S3 and S2 both require information regarding enemy locations and projected actions, as well as comprehension regarding how the terrain will affect potential friendly and enemy movement, weapons effectiveness and lethality, threat to friendlies, etc.

Once information and SA requirements for the brigade battle staff are identified, we can move into the development of system designs for successfully providing the multitude of SA requirements that exist for our military. Endsley (1995) has developed a set of design principles based on a theoretical model of the mechanisms and processes involved in acquiring and maintaining SA in dynamic complex systems. Furthermore, we can evaluate new system designs to determine if proposed concepts actually help SA, does not affect it, or inadvertently compromises it in some way. Understanding the information requirements necessary for success in military operation is critical to building an understanding of the knowledge available in the environment. The importance of facilitating SA is critical to meeting the challenge of data overload in operations. The structure approach described here can aid in understanding the information needs of our military and in identifying and evaluating novel system concepts aimed at improving performance and agility in decision making.

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