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**SITUATION AWARENESS
REQUIREMENTS ANALYSIS FOR
EMERGENCY MANAGEMENT PLANNING**

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THE PROBLEM OF DESIGNING TO ACHIEVE GOOD SITUATION AWARENESS

In this context, *Situation awareness* (SA), as addressed in this concept paper, is the degree that people responding to an emergency (1) are aware of the situation in which they find themselves, (2) understand the meaning of the situation as it affects their abilities to pursue goals, and (3) accurately anticipate how the situation is likely to change as time passes. (Endsley, Bolté & Jones, 1995) To the degree that people have good situation awareness, they can adapt as the situation unfolds, even as the situation develops in ways that are not anticipated. Poor situation awareness has been implicated in most emergencies that cascade towards disastrous outcomes.

THREE STAGES TO DESIGNING EMERGENCY SUPPORT SYSTEMS THAT SUPPORT GOOD SITUATION AWARENESS

*Emergency communications systems*¹ can be designed to help emergency responders achieve good situation awareness. Developing an emergency communications system that supports good situation awareness is a design problem that can be divided into three stages (Pauls, et.al, 2009)

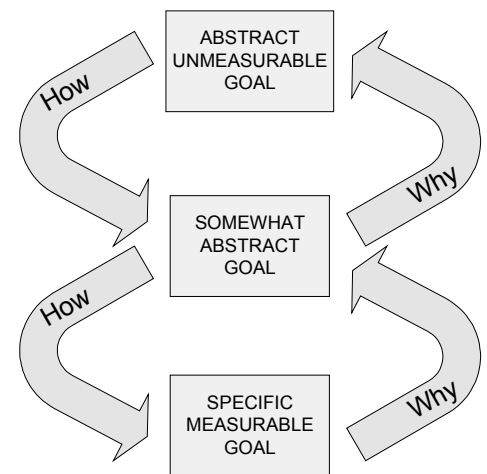
1. **Figure out what information people require to make good decisions during emergencies.** A method for conducting such an analysis is the subject of this concept paper. Understanding the information needs of people in various roles is especially important to achieving good shared SA during large scale emergencies where people from many agencies must cooperate to achieve common goals. While analyzing the information required to achieve good situation awareness is the necessary precursor to the next two design stages, it is the most frequently neglected stage.
2. **Figure out the sources where the needed information can be acquired.** While the engineering community understandably focuses on sensor technologies, a great deal of valuable information must also be acquired from people. There are problems when the first stage is not completed: (1) important information is either not provided at all or is not provided when it is most needed; and (2) not just the needed information, but *all* the available information is provided, resulting in information overload and additional time spent finding the relevant information.
3. **Figure out how that information can be presented in a way that best supports user goals.** Presenting information requires careful design to avoid requiring people to spend unnecessary time searching for and deciphering information. Good design helps responders avoid information overload.

¹ The term “emergency communications system” meant to include all the components that are designed to help people meet their emergency response goals, including both physical components (e.g., computers and their input and display devices, alarm systems, graphical information systems, and buildings and facilities) and social components (e.g., procedures, protocols, rules and regulations, and training materials).

In our experience, neglecting the first stage is a common problem. Because emergency roles often differ significantly from those roles that people normally assume, they often fail to anticipate the information needed to make decisions critical to their new emergency team roles. Further, people responding to emergency communications systems often fail to anticipate and provide the information that people in other roles need to pursue their objectives. The result is that untimely and missing information creates misplaced priorities and costly and serious delays and inefficiencies.

SITUATION AWARENESS REQUIREMENT ANALYSES

A Situation Awareness Requirement Analysis is proposed as a means to discover the information that an information transfer system must provide to emergency responders so that they can adapt as situations evolve. The proposed method is similar to SA requirements analysis described by Endsley and her colleagues. They recommend the use of a *goal-directed cognitive task analysis* where high-level abstract goals are broken down to increasingly specific goals. The more specific goals are then further broken down to the specific decisions that people must make to enable the goals. This goal decomposition approach is illustrated in the figure on the right.



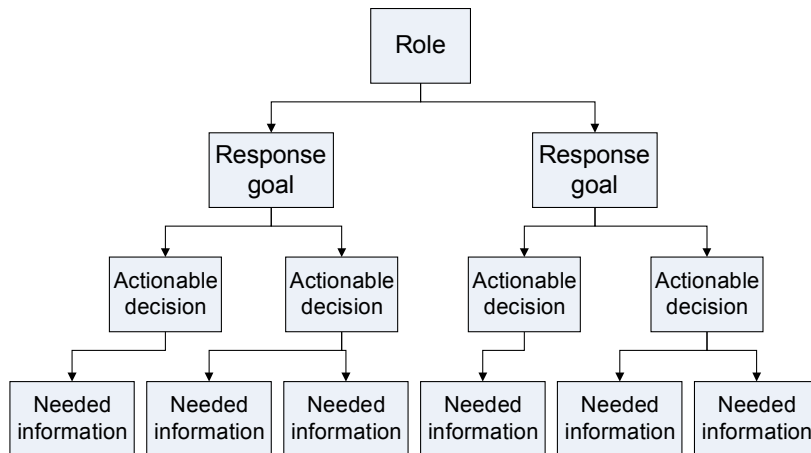
The Endsley approach is poorly suited for planning emergencies requiring interagency cooperation. It is designed to discover SA requirements for expert operators who use well-defined interfaces with advanced technological equipment. For example, it has been used to describe SA information requirements for airplane flight decks and military weapons systems. The approach works well for roles that are very complex roles (e.g., an airplane pilot) that are not specific to particular scenarios.

To improve how well a situation awareness requirements analysis would work for understanding the information requirement needs of emergency responders who must cooperate in unfamiliar ways, we adapted the approach in three ways that differ from the SA requirements analysis described by Endsley and colleagues.

First, we carefully described one or more scenarios. The SA requirements approach described here focuses on emergency operations for a specific scenario where roles often differ significantly from those that persons routinely occupy. During emergencies that require coordinated responses by several agencies, responsibilities are distributed among people and sometimes physical artifacts, especially computers that assume various roles in different locations.

Second, we carefully describe the roles assumed during the scenario. Because roles and their associated goals may change depending on the type of emergency, the various

roles must be carefully defined. In particular, persons may be filling roles with which they are not completely familiar, so describing the role carefully is essential to accurately completing the analysis.



Third, we organize the results in a diagrammatic tree. The results of the analysis are presented as an *abstraction hierarchy*, described by Rasmussen and his colleagues as mapping the “‘territory’ in which an actor (decision maker) has to navigate in order to comply with their work requirements.”

(Rasmussen, et al., 1994) In the approach described here, the abstraction hierarchy is comprised of roles, goals (used to fulfill the role), decisions (that must be made to pursue each goal), and information (required to make each specific decision). The hierarchy can be presented as a simple tree, as shown in the accompanying diagram and used by Groner (2009) in a study using the approach examining the information needs associated with a hypothetical use of elevators to evacuate occupants during a fire emergency. The tree format is more quickly and easily understood than a written narrative.

WORK PLAN

The approach involves five essential steps that correspond to the levels in the abstraction hierarchy.

1. Choose and describe the emergency scenario. (Unlike the detailed scenario customarily used to develop an exercise, this scenario should realistically reflect the ambiguities inherent during the early stages of an emergency.)
2. List the roles of people whose actions determine whether the response will be successful. An agency may have people who assume more than a single role. For example, the Incident Command System defines various roles that may be assigned to people from one or more agencies.
3. For each role, describe the associated emergency response goals.
4. For each goal, describe the actionable decisions that they may need to make during an emergency to meet the goal.
5. For each decision, describe the information that is needed to make the decision.

The SA Requirements Analysis is ideally conducted prior to a tabletop exercise, either as a separate “workshop” or as “homework” for the tabletop exercise. In either case, the analysis

would be conducted by agencies, organizations and groups that need to work effectively together in the event of a complex emergency as represented by the chosen scenario.

In our experience, much of the time and effort expended during tabletop exercises is devoted to figuring out the same information needs that is the goal of the SA Requirements Analysis, but in a less systematic ways leading to potentially serious errors of omission. Further, when a SA Requirements Analysis is conducted before the tabletop exercise, participants in the tabletop exercise can devote all their time and energy to solving the problems of interagency coordination, the primary purpose for the tabletop exercise.

The SA Requirements Analysis can be expanded, to include the second and third stages of the SA design process, figuring out where required information can best be acquired and how it can best be presented to facilitate good situation awareness without excessive information processing overhead and information overload.

The Regenhard Center is seeking an opportunity to pilot the Situation Awareness Requirements Analysis in a moderately complex interagency setting. The analysis is a logical starting point in the development of subsequent exercises involving the same scenario. We expect that the starting with an SA Requirements Analysis workshop will yield beneficial effects throughout the planning process.

SUMMARY OF ANTICIPATED BENEFITS FROM USING THE SA REQUIREMENTS ANALYSIS

In summary, agencies participating and sponsoring the emergency planning process would benefit from the Situation Awareness Requirements Analysis in each of the following ways:

- People in various agency roles learn about their own information requirements
- People in various agency roles learn to anticipate the information that they may need to provide to people in other roles.
- People designing exercises would learn what “injects” they need to run a realistic exercise, that is, what information they might need to provide so that participants are better able to make the types of decisions that might encounter in an actual emergency.
- People designing the means for presenting information needed during an emergency would learn the key goals around which the information should be organized.
- Exercises based on the results of the SA Requirements Analysis would be more efficient and less frustrating, providing participants’ with a greater confidence that they understand their respective roles and how their response goals can be accomplished through cooperation with people in other roles.

In summary, a Situation Awareness Requirements is the logical first step in planning complex interagency responses to emergencies because it provides an efficient and comprehensive means to figuring who will need what information to effectively respond adaptively during an emergency.

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