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VALUE OF SITUATION AWARENESS INFORMATION REQUIREMENTS ANALYSIS AND INFORMATION FLOW ANALYSIS

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About Christian Regenhard

Christian Michael Otto Regenhard was born on August 25, 1973. He was raised in Co-op City, Bronx, New York. After graduating from the Bronx High School of Science, he served five years in the United States Marine Corps, leaving as a decorated Recon Sergeant. He traveled extensively, often to remote areas of Central and South America, to pursue his love of rock climbing and diverse cultures. After studying language, art and writing at San Francisco State University, he was hired by the Fire Department of New York (FDNY), graduating from probationary school in July 2001. He was assigned to Ladder 131 when he was killed in the collapse of the World Trade Center on September 11, 2001 at age 28.

About the Center

The Christian Regenhard Center for Emergency Response Studies (RaCERS) is an applied research center focused on development of a mix of grounded theory and traditional empirical analysis in the areas of emergency response, coordination of first responders, and dynamics of large-scale incident management and response. The Center is unique in its devotion to first responder-defined and actionable research on policy aspects of emergency response and homeland security from a perspective inclusive of police, fire, and emergency medical services. *Tax deductible donations can be made care of the John Jay College Foundation, 524 West 59 Street, New York, NY 10019.*

About the College

Since its founding in 1964, John Jay College of Criminal Justice has been a leader in the field of public safety, with a diverse variety of academic programs and research capabilities devoted to the study of emergencies and law enforcement organizations such as the fire service, police departments, emergency management offices, and security concerns unequaled by any other academic institution in the United States.

One of the unique aspects of John Jay is its student body. Our students represent a diverse mix reflecting New York, but also the nation and world. Our in-service students include many mid-career emergency responders from virtually every local, state, and federal law enforcement, security, and emergency response organization. As such, we have a unique and long-standing commitment to educating current and future leaders in the emergency response field. John Jay lost over 60 of its alumni, faculty, and students on 9/11. As such, we are uniquely dedicated to enhanced responder safety and effectiveness.

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VALUE OF LOCALIZED SITUATIONAL AWARENESS INFORMATION REQUIREMENTS AND INFORMATION FLOW ANALYSES

(ver. 03/14)

ANTICIPATING INFORMATION REQUIREMENT WILL HELP ACHIEVE GOOD SITUATIONAL AWARENESS DURING EMERGENCY OPERATIONS

Situational awareness (SA) 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 (cf. Endsley, Bolté & Jones, 1995).

Good situational awareness requires good information. To the degree that people can acquire accurate and timely information, they can make adaptive and timely decisions, even as the situation develops in ways that are not anticipated. During any complex incident, SA requires communications among persons in various roles, from various organizations. The process can be difficult; by the time that people realize that they must make an actionable decision, it may be too late to request all the needed information. Also, persons are often too busy with their own concerns to anticipate that others will need the information that they can provide. Difficulties in establishing good situational awareness have been implicated in most emergencies that cascade towards avoidably negative outcomes. Anticipating the information required to make decisions, and how it can be acquired, is likely to improve decision making during emergencies.

GOVERNMENT PROVIDES STRATEGIC FRAMEWORKS FOR STRATEGIC COMMUNICATIONS, BUT OMITS WAYS TO FIND THE CONTENT OF THOSE COMMUNICATIONS

Persons responding to an emergency situation often lack all the information they need to make good decisions—they need to receive information from persons in other organizations and organizational units. Federal, state and local governments provide many frameworks that facilitate communications, but these are limited to strategic planning. Specific information requirements for tactical decision making are not covered—for good reason. The content of communications inevitably depends on the specific scenario and the particular agencies involved. For example, the National Incident Management System (NIMS) is a widely adopted framework that encourages the development of communications protocols and procedures, but does not directly address what information is likely to be required and how it can be acquired. Further, NIMS advocates for integrated communications as a means to facilitate “common situational awareness,” and discusses “multi-agency coordination entities” as needing to “ensure each agency involved in incident management as providing appropriate situational awareness and resource status information” (FEMA 501-2, rev 0, page 25). However, NIMS does not provide advice about how this can be accomplished. The analytic approaches described in this concept paper attempt to remedy

the omission. The approach involves two analytic methods: (1) a situational awareness information requirements analysis; and (2) an information flow analysis.

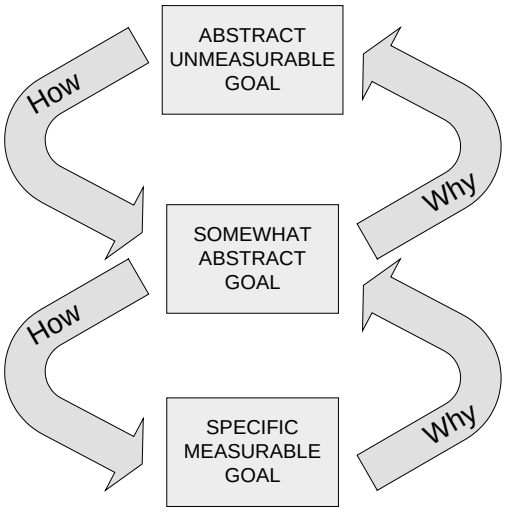
TWO STAGES TO DESIGNING EMERGENCY SUPPORT SYSTEMS THAT SUPPORT GOOD SITUATIONAL AWARENESS

Emergency communications systems can be designed to help emergency responders achieve good situational awareness. We propose a two-step solution to developing an emergency communications system that supports good situational awareness (Pauls, et.al, 2009)

1. **Use a S*ituational Awareness Information Requirements Analysis* to figure out what information people need to make good decisions during emergencies.**
2. **Use an *Information Flow Analysis* to figure out the sources where the needed information can be acquired, and what information persons should send to others who need to make actionable decisions.**

SITUATIONAL AWARENESS INFORMATION REQUIREMENTS ANALYSES

Transportation Research Board (TRB) sponsored research by the Regenhard Center has demonstrated the feasibility of using a Situational Awareness Information Requirement Analysis as a means to discover the information that emergency responders need to adapt as situations evolve. The method is similar to SA information requirements analysis described by Endsley and her colleagues who recommend the use of a *goal-directed cognitive task analysis.* 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. Four steps are involved.



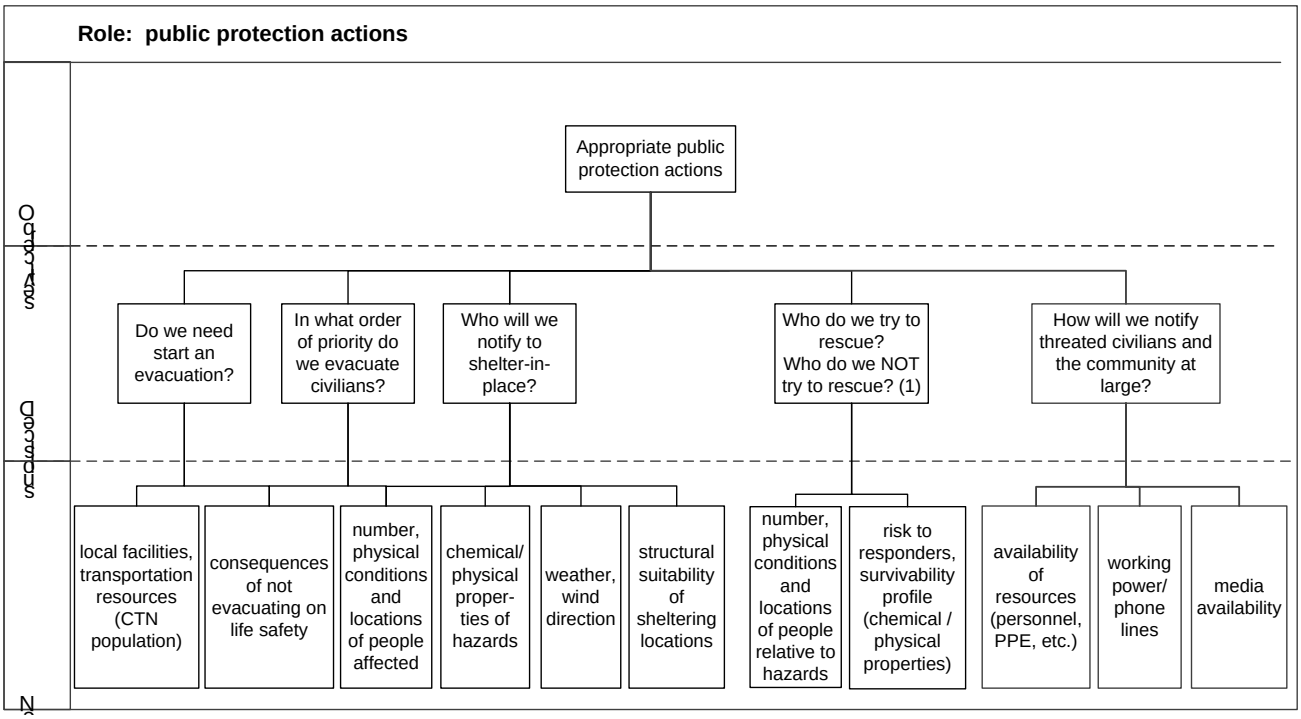
First, one or more scenarios are described. The SA information requirements approach described here focuses on emergency operations for a specific scenario where roles often differ significantly from those that persons routinely occupy.

Second, the functional roles that are assumed during the scenario are described. Functional roles are not the same as persons' positions in organizations. Because roles 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. Moreover, persons from more than a single organization may be called on to assume particular roles.

Third, the goals, actionable decisions and information requirements are described.

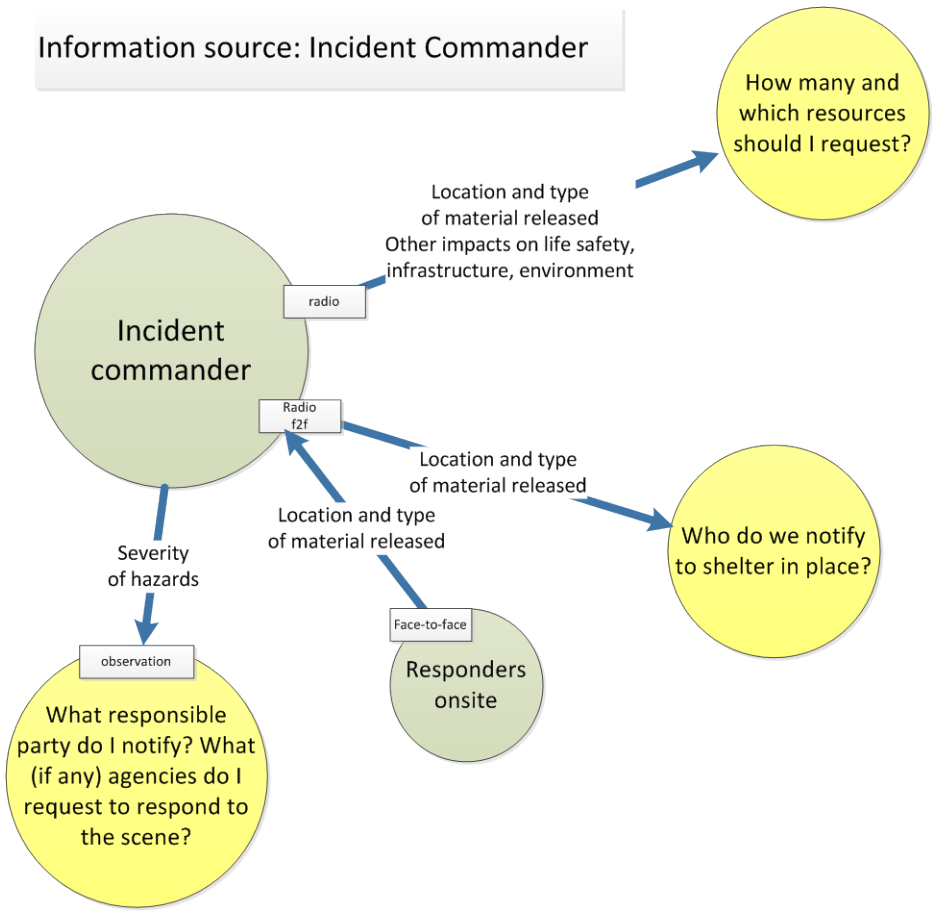
There are objectives that must be realized to fulfill the responsibilities of each functional role. And to realize each objective, there are actionable decisions that must be made. Finally, there are requirements types of information that needs to be acquired to make each actionable decision.

Fourth, an abstraction hierarch is used to describe the findings. 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, objectives (used to fulfill the role), decisions (that must be made to pursue each objective), and information (required to make each specific decision). The hierarchy can be presented as a simple tree, as shown in the accompanying diagram from our pipeline emergency research. Research is needed to find how abstraction hierarchies can most easily be developed and how they can be represented so that they are most quickly and easily understood.



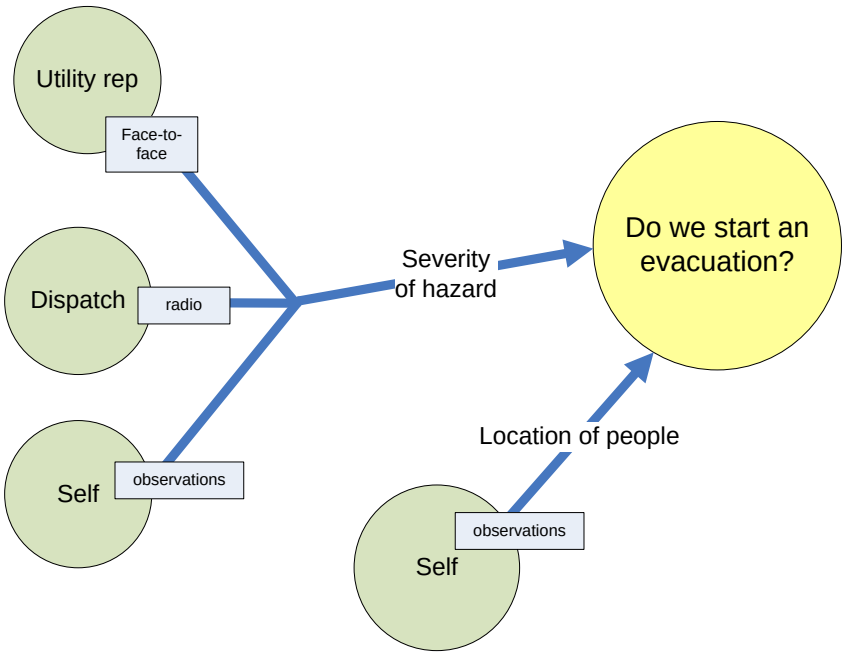
INFORMATION FLOW ANALYSIS

Once the required information has been discovered, an information flow analysis is needed to identify the sources of that information and the best ways to relay the information. In our approach, the information flow analysis uses the findings from the situational awareness information requirements analysis. A diagram from the findings of the TRB pipeline emergency communications study illustrates an information flow analysis. At the center of the diagram, the functional role and associated actionable decisions (from a situational



awareness information requirements analysis) is shown (large circle), along the information required to make the decisions (the arrows), the sources of information for the information (smaller circles) and the means for communicating the information (small rectangles). Preparing information and sending it in a timely manner to the decision maker is a common problem during emergency responses. In our study of pipeline emergencies, the two most common reasons for communications failures were: (1) people did not collect the information needed by someone else, and (2) people did not know to whom the information should be sent. Data from an information flow analysis can show to whom people should send required information. An example of the flow of information from source to recipients is shown in the diagram below, also from the pipeline emergency communications research. In this example, the incident commander is the likely source of information for a number of actionable decisions, some of may be his or her responsibility. Having conducted this type of analysis beforehand, persons will be better prepared to quickly collect and provide this information, helping to ensure that decisions are made in an accurate and timely manner.

Recipient role: Public protection (incident commander)



RESEARCH IS NEEDED ABOUT HOW BEST TO "LOCALIZE" DATA COLLECTION AND REPRESENT FINDINGS

Research already completed has demonstrated that situational awareness information requirements and information flow analyses are feasible. However, the real benefits of these analyses will not be realized until the approach is tested and disseminated at the local level.

- Information that is locally collected and analyzed will reflect differences in functional roles and the use terminology and practices, yielding results that are more easily understood and have greater face validity.
- Information that is collected and analyzed locally will have greater "buy-in," that is, findings generated locally will be more credible and more likely to influences preparations for interagency communications during emergencies.

Because the analytic methods employed in this research are likely to be far more effective when conducted locally, additional research is needed that investigates best practices about how local jurisdictions can use these methods to discover and model the functional roles, actionable decisions, required information, and information sources and communications means.

Research covering best practices for the local use of these analytic methods would include how to collect data and how to model the data. Possibilities for collecting data include questionnaires, individual and group interviews, workshops and tabletop exercises. Possibilities for representing the findings include diagrams (as shown above), tables and narratives. The relative ease-of-use and usefulness of the various approaches needs to be investigated.

SUMMARY OF ANTICIPATED BENEFITS FROM USING THE SA REQUIREMENTS ANALYSIS

In summary, agencies participating and sponsoring the emergency planning process would benefit from the Situational Awareness Information Requirements and Information Flow Analyses in each of the following ways:

- People in various agency roles learn about their own information requirements providing them 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 other agencies.
- People in various agency roles learn to anticipate the information that they may need to provide to people in other roles, and exactly for what reasons.
- People who do not directly participate in the data collection and analysis would still have access to findings that are quickly and easily understood.
- 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.

In summary, these analyses pick up where strategic communications frameworks leave off. The Situational Awareness Information Requirements would identify the specific information needs of persons who make actionable tactical decisions, and the Information Flow analysis would identify the sources of that information and how it can best be communicated to the tactical decision maker.

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