EXPLORING COGNITIVE WORK WITHIN A 911 DISPATCH CENTER: USING COMPLEMENTARY KNOWLEDGE ELICITATION TECHNIQUES

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This study evaluates the differences in user information acquired from scenario-based versus non scenario-based knowledge elicitation for the design of 911 dispatch simulations. During the non-scenario condition, participants answered probe questions concerning their work activities and emergency response procedures. During the scenario-based condition, participants were presented with an emergency scenario and described the necessary steps required to respond to the situation. Preliminary analysis implies that information derived from non scenario-based knowledge elicitation may focus more upon the defined protocols of workgroups whereas information gathered from scenario-based knowledge elicitation may be more concerned with procedures and interactions that are unique to a certain workgroup. Results suggest that the use of scenario-based knowledge elicitation is more likely to allow designers to tailor simulations that conform to the unique culture of an emergency dispatch center workgroup than non scenario-based knowledge elicitation.

INTRODUCTION

When a 911 call is placed to an emergency dispatch center, a quick response and the appropriate allocation of emergency resources is critical. Efficient emergency response depends on accurate recording of patient and situational information, effective communication amongst response personnel, and accurate dispatching of resources (Holzman, 1999). The ability to shave seconds off an emergency response time "…can make the difference between life and death…." (p. 13).

Akin to technical systems used by paramedics and other sectors of emergency management services (EMS), 911 dispatch systems are safety critical systems. Safety critical systems are systems whose failure can lead to extensive damage to property, infrastructures, or loss of human life (Knight, May 2002). Although previous research has studied the design and effectiveness of these technologies per se in certain EMS domains, research has been slow to determine how technical systems can support the cognitive and collaborative aspects of human performance in the domain of emergency dispatch centers. Due to the importance of 911 dispatch systems on human welfare, it is imperative to study the *user-centered* or *group centered* design of such tools to improve the overall efficiency of EMS.

In order to develop an effective group-centered system, it is necessary to elicit knowledge from those who will use the system in their daily activities. For quality system design, end users cannot be perceived as generic to the design process (Salvo, 2001) but rather must be acknowledged as experts in the domain for which a given system is to be designed. However, knowledge elicitation of users may incur through various processes and formulations. This paper explores two distinct forms of knowledge elicitation: (1) *scenario-based* (2) *non scenario-based* methods.

Scenario-based and Non Scenario-based Design

Scenario-based methods focus on presenting experts with real world problems that draw out their experience as it is used in context, for the purpose of acquiring deep-seated knowledge that can in turn be used for design. Rosson and Carroll (2002) indicate that scenarios are simply stories about people carrying out an activity that typically incorporates characteristic elements of setting, actors, task goals, plans, evaluation, actions and events. In short, scenario-based knowledge elicitation utilizes problems embedded in story format with the goal of maximizing users' access to their episodic and procedural memories.

Scenario-based design can take various forms within knowledge elicitation activities (e.g., human-computer interface design, see Carroll, 1995; participatory design, see McNeese, Zaff, Peio, Snyder, Duncan, & McFarren, 1990). According to Jarke (1999), the use of scenarios in knowledge elicitation gives designers better insight as to how the system will ultimately be utilized. In one form of scenario-based design, users are given a situation

that is familiar to what they have encountered on their job (Hoffman, Shadbolt, Burton, & Klein, 1995). They then describe the actions they would take in response to that situation. The incorporation of scenarios into knowledge elicitation allows designers to capture aspects of workflow and interaction that are unique to a particular organization or workgroup. Without the personalization of collected information, such characteristics may be overlooked in the system design process.

In contrast, non scenario-based knowledge elicitation refers to methods typically focused on the user's generalized declarative knowledge derived from policy, books, manuals, standard operating procedures, etc. that typically involve semantic information not represented in story or problem-based format. In turn, these methods may utilize probes or other question-answer techniques that seek general knowledge from a user that is not anchored to episodes or event-driven cognition. Our perspective and expectation is that the knowledge obtained in non scenario-based knowledge elicitation is likely to have less content related to context (inclusive of physical, organizational, and cultural context). At certain junctures, scenario and non scenario-based knowledge elicitation (and design) may overlap and feed off of each other to obtain comprehensive coverage of a novice or expert's knowledge.

The purpose of the current study was to evaluate the differences in user information acquired from scenario-based knowledge elicitation versus non scenario-based knowledge elicitation and how these differences can potentially affect the user-centered design of a 911 dispatch simulation system. Differences between the nature and focus of the information acquired from the use of scenarios in knowledge elicitation may be different from user knowledge acquired without a given scenario. In particular, our own use of the information to be acquired from experts is to help inform the new design of a 911 crisis management simulation termed *NeoCITIES* (see Jones, et al. 2004 this volume).

The NeoCITIES Simulation

As just mentioned, part of the aim of this study is to facilitate direct transfer of knowledge from both types of knowledge elicitation into a more veridical development of the NeoCITIES scaled world simulation. NeoCITIES is a variation of a simulation designed by Wellens and Ergener (1988) and is a scaled world of crisis management operations. NeoCITIES is a prototype in development that, when completed, can be used as a tool for training 911 dispatchers. In NeoCITIES, participants are assigned to 2-person teams. The simulation requires the joint interaction of three teams wherein each team represents one of three emergency management services indigenous to a city's infrastructure: hazardous material (hazmat), fire, or ambulance. Each user is presented with the same interface depicting a fictional city. Throughout the simulation, the users are presented with emergency scenarios taking place in the city. The participants must communicate with each other to be sure that the correct resources are dispatched to each emergency situation. During certain operations, resources may become limited and time pressure may develop in scenarios thus causing information overload effects. The present research espouses that the differences in information elicited from scenario-based versus non scenario-based knowledge elicitation can affect the scenarios, tools, and communication measures used in crisis management simulations such as NeoCITIES.

METHOD

Five employees of a 911 county dispatch center in Central Pennsylvania participated in this study. Two of the employees were dispatch supervisors and all were trained as 911 call takers and emergency resource dispatchers.

Procedure

The interviews were conducted in two separate visits to the dispatch center. The first visit served as the non scenario-based condition; the second visit served as the scenario-based condition. To initialize the non-scenario based condition, the researchers first interviewed the two supervisors in a joint session. In the non-scenario condition, three dispatchers were observed and questioned as they performed their tasks in their work areas (in situ assessment). The researchers asked the participants probe questions regarding the nature of their jobs and their standard procedures when responding to 911 calls (see below).

1. *Walk me through the procedures that you follow after receiving a 911 call. How are resources dispatched?*
2. *How do you share information and communicate with other dispatchers and EMS workers during an emergency situation?*

During the second visit to the dispatch center, two researchers conducted another joint session with the supervisors, this time initializing the scenario-based condition. On this occasion, the researchers began the interview by presenting the participants with a scenario (see below). The scenario described an incident that had

recently occurred in the same region the dispatch center was located. Therefore, the supervisors and the dispatchers were familiar with the scenario since they played key roles in the allocation of emergency resources to this actual accident. This particular scenario was also chosen due to the fact it involved the dispatching of fire, ambulance, and hazmat resources which are all key aspects of NeoCITIES. It is worthy to note that this *reality-centric* scenario provided an anchor that stimulated memories that workers may have had during the actual accident (therein emphasizing *spontaneous access of memories* without being told, Bransford, Sherwood, Vye, & Reiser, 1986).

> *Scenario:*
> *A sudden snow squall reduces visibility on a major highway to almost zero percent. A head on collision between two vehicles escalates into a 50 car pile up including trucks carrying hazardous material. Calls begin to come into the center concerning this accident. Their reports include sights of flames, smoke, as well as individuals trapped in their cars. Walk me through the procedures that you follow from these reports.*

For each session, the researchers took handwritten notes as the participants responded to the questions in the first interview and the scenario in the second interview.

Data analysis was performed via open coding. Open coding is a process in which portions of interview data are divided into meaningful categories and subcategories (Trauth, 2000). Results are obtained through the evaluation of common and diverse themes, facts, and opinions that are presented throughout the interviews.

RESULTS

Table 1 lists the categories and sub-categories that resulted from open coding. Data analysis revealed that the participants made references to the structure and workflow of the 911 center in both conditions. However, the 911 center's response model was only mentioned in the non-scenario condition, whereas specific descriptions of dispatcher duties were made only in the scenario condition.

In both conditions, the participants gave specific details concerning general procedures when responding to emergency calls. These steps included the extraction of basic information from the caller, the input of the information into the computer aided dispatch system (CAD), and the dispatching of resources.

Interactions amongst EMS workers were described in both conditions. During each visit, the participants described how the dispatchers will actively talk to each other to learn more information about an incident. Yet it was not until the scenario condition that we learned that field workers (e.g. firemen, police and paramedics) often use technologies such as radios or cell phones to communicate with dispatchers during an incident. This allows dispatchers to update the CAD as the situation progresses. Also not discussed in the non-scenario condition is the fact that field workers may make requests for tools other than usual emergency resources. Dispatchers may then contact local vendors or companies who can lend such resources to pacify the situation.

Table 1

Category	Category Description	Interview
Center Structure:	framework and workflow of the dispatch county	
- Center Model	reference to the response model used by the dispatch center	nsc
- Dispatcher Duties	roles and duties of dispatchers depending upon the nature of an incident	sc
Emergency Response Timeline	series of steps that taken in response to a 911 call	nsc sc
Dispatcher Interactions with CAD	reference to the input of information into the CAD	nsc sc
Human/Human Communication and Interaction:	interactions between professional EMS workers	
- Dispatcher/ Dispatcher	exchange of information amongst the dispatchers	nsc sc
- Communication Technologies	specific references to interactions via communication technologies	sc
Other Resources	dispatcher's obtainment of emergency resources not directly related to fire, police, hazmat, or ambulance	sc

nsc –information from this category was given in the non scenario condition
sc –information from this category was given in the scenario condition

DISCUSSION

Preliminary results suggest that the nature of the information given by the participants varied between the scenario and non-scenario conditions. During the non-scenario interviews, the information was largely focused on general procedures about emergency call response, perhaps more indicative of general knowledge formed from policy, standard operating procedures, rules of engagement, and achievable values. For instance, the participants emphasized issues such as the prioritization and classification of incidents, the verification of an incident's location, and the confirmation of resource availability. Additionally, the participants went into great detail explaining the electronic worksheets, tools, and features of the CAD. One might classify this as general knowledge that is used but perhaps not personalized or formed (i.e, social constructed for meaning or sense making) for situations, incidents, or real world cases.

Although many of the above factors were also addressed in the second visit which utilized the scenario condition, the information given focused highly on the complex network of personnel and resources involved in emergency response. For instance, the participants described the importance of cognitive multitasking in emergency response. When responding to incidents, dispatchers must simultaneously (a) listen to the caller describing the incident (b) concentrate on what other dispatchers are saying to their callers (c) enter information into the CAD (d) determine the severity of the incident and (e) listen for verbal cues by supervisors signifying that certain actions must be taken. Additionally, the participants also described communication patterns and interactions among colleagues that take place during an incident and the manner in which these exchanges determine what information is entered into the CAD. Such interactions include the dispatchers' use of hand gestures to relay information amongst each other, the occasional amplification of a dispatcher's voice while receiving a call so that other dispatchers can hear important information, the use of instant messaging, as well as eyeing other dispatchers' monitors to obtain vital information. In short, although information regarding the dispatch center's response model was gathered from the non-scenario condition, results from the scenario condition further suggest that, within a model, certain procedures, protocols and interactions may be modified to conform to a group's specific culture. This takes the position that elicited knowledge was more highly specific to personal, situational, and even cultural demands that where encountered with more non-routine problems.

The results of the current study imply that information derived from non scenario-based knowledge elicitation may focus more upon established well-defined protocols of workgroups whereas information gathered from scenario-based knowledge elicitation may be more concerned with procedures, communications and interactions that are specific to an individual workgroup and its culture. Because workgroups have their own cultures and procedures, probe questions alone may not fully capture how individuals interact with each other and their resources to respond to a given problem situation. On the other hand, the use of scenarios in knowledge elicitation reveals more insight into a workgroup's unique methods and activities in addition to knowledge gained from non scenario-based elicitation. These findings are consistent with Jarke's (1999) stance that scenario-based design as a form of knowledge elicitation gives designers better insight into the configuration, processes, and network of an organization.

Another aspect of the way we conducted scenarios was that they employed familiarity (i.e., the events were similar to ones they had actually experienced in real workgroups). The familiarity of the scenarios with past experience is considered to be an important component for users to convey the insightful aspects captured in their memories that might go unnoticed with non scenario knowledge elicitation or with scenario-based techniques that fail to include familiar episodes. In conclusion, if NeoCITIES is to be developed as a prototype for training 911 dispatchers, it is important that designers consider not only the general requirements of the system, but also how to tailor the simulation to (1) personalized knowledge that results in meaning/sensemaking (2) the culture of a particular organization.

ACKNOWLEDGEMENTS

The authors would like to extend their gratitude to Edward Glantz, Erik Connors, and Priya Bains for their efforts during and after the sessions.

This material is based upon work supported by the Office of Naval Research, Division of Cognitive Science, Collaborative and Knowledge Management Program Grant, Dr. Michael Letsky, Program Manager (Grant No. N00140210570); and the National Science Foundation (under Grant No. EIA-0306845). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Office of Naval

Research (ONR) or the National Science Foundation (NSF).

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