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Group Information Seeking in a Computer-simulated Environment: An Application to Emergency Response

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ABSTRACT

Groups in risky, time-constrained situations may be confronted with problems that cannot be solved by following predefined procedures. They must therefore engage in a collective search for relevant information, cooperating and collaborating as they move towards the deadline. This research develops theory about the impact of risk and time pressure on group information seeking processes. The theory is to be evaluated in the domain of emergency response, where both risk and time pressure are present, along with a pervasive need for decision making groups. A computer-simulated emergency environment is designed and developed to serve as the testbed for evaluating the theory. Implications from the results of this research should help lead to better systems to support group information seeking and decision making by expanding our understanding of the underlying cognitive processes involved.

Keywords

Group information seeking, emergency response, time pressure, risk.

INTRODUCTION

Emergencies require coordination and shared responsibility within groups of response personnel, creating pressing needs for accurate and timely information exchange among members of these groups. The time pressure and uncertainty induced by emergencies require group members to seek and process information from an evolving range of sources under highly volatile conditions (Mendonça, forthcoming; Mendonça and Wallace, forthcoming). Helping emergency response groups to get the right information at the right time is important for them to make well-informed decisions.

Many Group Decision Support Systems (GDSSs) facilitate group communication and decision making. However, groups with the aid of GDSS do not always outperform groups without the aid of GDSS (Dennis, 1996; Hightower and Sayeed, 1996). The reasons are various, and may be considered from two perspectives: the systems may not meet groups' communication and decision making requirements, and/or the system functions are not fully utilized by the users. Understanding how groups use information systems to communicate, coordinate and make decisions is therefore critical to help overcoming the system defects and improving the system design (Gu and Mendonça, 2004; Gu, Mendonça and Wu, 2003). In emergency and many non-emergency situations, information seeking and handling are integral parts of the group decision making process. By improving understanding of groups' information seeking and handling activities in a computer-mediated emergency environments, this work is expected to lead to better understanding of how GDSSs and other information technologies can best support these activities.

THEORETICAL FOUNDATIONS

The objective of this research is to investigate group information seeking activities in emergency response, and in particular how risk and time pressure can impact these activities in a computer-simulated emergency environment. This study develops a hypothesized model (shown in Figure 1) that explains how groups seek and process information during the response to emergencies. A set of research propositions concerning first- and second-order effects associated with two key elements of emergency situations, time pressure and risk, are proposed. These two factors directly affect the information seeking and handling processes over time, and ultimately affect information foraging performance, which is measured in two

perspectives: efficiency and effectiveness (Halfhill, Sundstrom, Lahner, Calderone and Nielsen, 2005; Annett, Cunningham and Mathias-Jones, 2000). The hypothesized model is then evaluated using data from professional groups addressing simulated emergency situations.

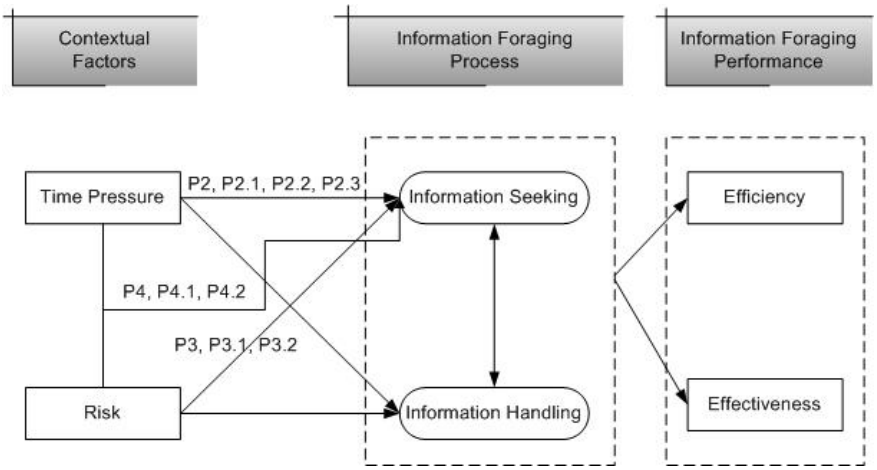

Figure 1. Model of Group Information Foraging Behavior

The multi-stage nature of group decision making process (Blumberg, 1994) suggests that group information seeking behavior may decrease over time. Moreover, the collective information sampling process (Stasser et al, 2000; Stasser and Titus, 1987) reveals that seeking and handling of common information (i.e., information originally known to all group members) has a decreasing trend consistent with the general trend of group information seeking, while seeking and handling of unique information (i.e., information originally known to one group member) shows an increasing trend. The following propositions are therefore proposed:

Proposition 1: The time and effort devoted to seeking information decrease across the successive stages of group information foraging.

Proposition 1.1: The time and effort devoted to seeking *common* information decrease across the successive stages of group information foraging.

Proposition 1.2: The time and effort devoted to seeking *unique* information will not decrease since the temporal bias has a counteract effect on the general decreasing trend of information seeking.

When facing time pressure group members initially accelerate their information seeking and handling, increase the amount of their coordination by sending more information (Karau and Kelly, 1992; Parks and Cowlin, 1995). As time pressure increases, groups tend to change their initial search strategies more quickly, restrict their information seeking to a lesser, more task-relevant extent, filter some activities and allocate more resources to handle task-relevant information (Maule, Hockey and Bdzola, 2000). The following propositions are therefore proposed:

Proposition 2: The time and effort devoted to seeking information decrease faster under high time pressure than they do under low time pressure over time.

Proposition 2.1: The time and effort devoted to seeking *common* information decrease faster under high time pressure than they do under low time pressure over time..

Proposition 2.2: The time and effort devoted to seeking *unique* information decrease faster under high time pressure than they do under low time pressure over time.

Although groups' seeking for both common and unique information decreases at a faster rate under high time pressure than under low time pressure, such decreasing happens most possibly in seeking for common information as time elapses. The following proposition is therefore proposed:

Proposition 2.3: The decreasing rate in unique information seeking is lower than that in common information seeking.

Under risky conditions groups need information about the environment and the interacting with the environment, but they will rely more on their heuristics to evaluate the uncertainties/probabilities about these two types of information (Tversky and Kahneman, 2002). The heuristics is usually related to the unique information held by every domain-specific role in the group. Therefore, with high level of risk groups have a higher information need for unique information than groups with low level of risk. The following propositions are therefore proposed:

Proposition 3: The time and effort devoted to seeking information under high level of risk are more than that under low level of risk.

Proposition 3.1: The time and effort devoted to seeking common information under high level of risk are no more than that under low level of risk.

Proposition 3.2: The time and effort devoted to seeking unique information under high level of risk are more than that under low level of risk.

At the beginning of decision making process, the time and effort groups devoted to seeking information under high time pressure and low risk condition may be higher that that under low time pressure and high risk condition, but on average the time and effort groups devoted to seeking information is believed to be higher under low time pressure and high risk condition than that under high time pressure and low risk condition. The time and effort groups devote to seeking information (denoted "TE") follow the inequality:

Proposition 4: $TE_{HH} > TE_{LH} > TE_{HL} > TE_{LL}$.

The increasing time pressure leads to faster decrease on common information seeking, thus the time and effort groups devote to seeking common information (denoted "C") follow the inequality:

Proposition 4.1: $(C_{HL}, \ C_{HH}) > (C_{LL}, \ C_{LH})$.

The higher the level of risk is, the more time and effort groups devoted to seeking unique information. The time and effort groups devote to seeking unique information (denoted "U") thus follow the inequality:

Proposition 4.2: $U_{HH} > U_{LH} > U_{HL} > U_{LL}$.

Subscript in the propositions refers to the levels of time pressure and risk, that is, L represents low and H represents high.

METHODS

A computer-simulated emergency environment (launch online at http://emprov.njit.edu), denoted as Emergency Management imPROViser (EMPROV), is designed and developed to serve as the testbed for evaluating the theory (shown in Figure 2). Two contextual factors, risk and time pressure, are manipulated with two levels (low vs. high) in the simulated environment. Computer logs and conversation transcripts were collected and coded for data analysis. Each group member took on one of five roles: Coordinator (CO), Police Department (PD), Fire Department (FD), Medical Officer (MO), and Chemical Advisor (CA). Their task was to allocate resources from various sites to meet the given goals for the response. Each non-CO role could view unique information (i.e., information about resources at the sites belonging to that role, but not information about sites belonging to other roles). Alternative resources (AR) were also available at various sites, and information about them was common (i.e., it could be accessed by all roles).

Data sources

To provide traces of information seeking and decision making, various data streams were captured, all of which are time synchronized for analysis. Computer logs recorded which information was sought by individuals through the interface, and what decisions were made by the group. A sample record from the log file is shown in Table 1. It shows that participant CA in group A session NFA1 clicked site C at 7:33:36 PM. This represents a request for information about resources at site C. The stream value of P means this event is part of the information seeking process.

Session	Group	Participant	Stream	Time	Event
NFA1	A	CA	p	7:33:36PM	C

Table 1. Sample Records from Computer log file

All studies were video- and audio-taped. The second data source used here is the transcripts of group conversations, which are coded in a way that is similar to the computer logs, as shown in Table 2.

Session	Session ID
Group	Group ID
Participant	CO, PD, FD, MO or CA
Stream	p – process; d – decision.
Time	Time stamp indicates when this conversation happened; synchronized with log files.
Event	If stream indicates this record belongs to "process", then record the sites appeared in the conversation; if stream indicates this record belongs to "decision", then record the sequence of the sites, the resource codes, and corresponding goals mentioned in the conversation.

Table 2. Coding Schema for Conversation Transcripts

For example, two lines of transcripts from session NFA1 group C are "7:42:04PM, MO, I have at P, I have 12 medical personnel with no vehicles" and "7:45:43PM, CA, Okay all of my, at C I have 20 chemical suits, no CO2 or vehicles. I have 10 chemical protections suits with 3 protection and no vehicles, and G I have two separate CO2 and no vehicle so". These two lines are coded to two records as shown in Table 3.

Session	Group	Participant	Stream	Time	Event
NFA1	C	MO	p	7:42:04PM	P
NFA1	C	CA	p	7:45:43PM	C
NFA1	C	CA	p	7:45:43PM	G

Table 3. Sample Records Coded from the Transcripts

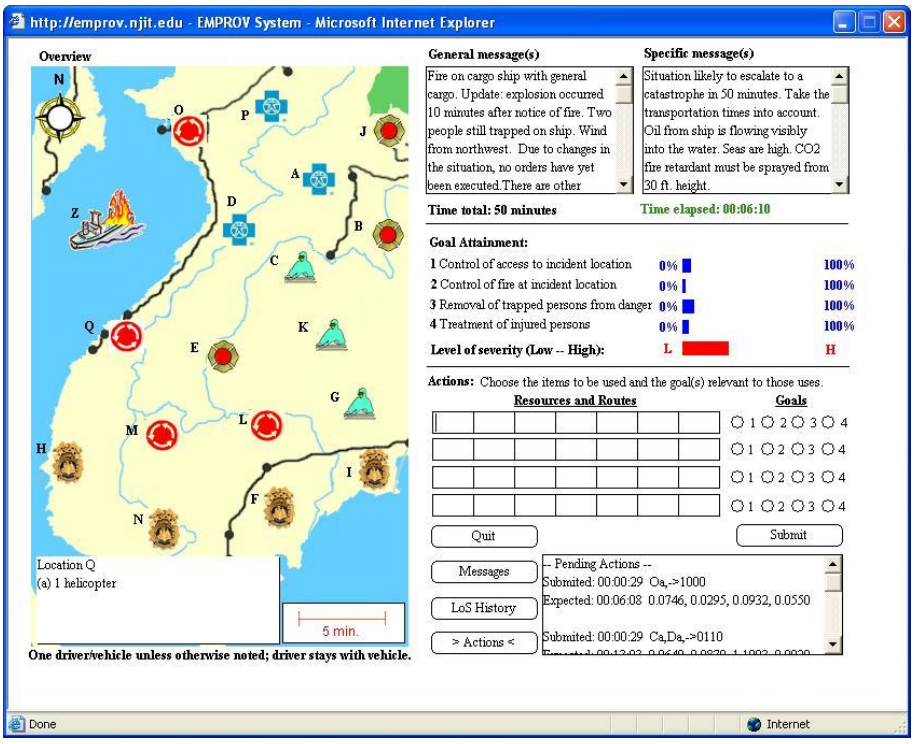

Figure 2. Interface of EMPROV Prototype

Measures

Information seeking behavior is measured by the frequency of searches for information, tabulated as the number of sites accessed in the information seeking process. One possible typology of information is common versus unique. From the perspective of group members, information may be common (if it is known to all group members before the discussion), partially shared (if it is known to part but not all group members) or unique (if it is held by one member before the group discussion) (Dennis, 1996; Propp, 1997). The proportion of number of searches for different types of information is another measure. Information may also be categorized according to the owner of the site where resources are stored. The sites in each case are therefore categorized by the group they belong to, or as belonging to all groups (denoted alternative resource sites).

An assumption about the tasks is that the amount of information relevant to solving the task is same for each group. The more search for information a group makes to solve the task, the worse its information seeking performance is. Thus information seeking performance may be defined as the reciprocal of the number of searches for information.

PRELIMINARY RESULTS

Data to conduct a preliminary investigation of group information seeking behavior in emergency response were drawn from a series of studies on group decision making in simulated emergency response scenarios (Mendonca et al, 2001). Two factors, member expertise and decision support, were examined in the preliminary study. The results suggest that member expertise had a significant impact on groups' search behavior, and that decision support had a significant impact on (i) groups' search for common information and (ii) the allocation of search activities between common and unique information (Gu and Mendonça, 2004).

CONCLUSION

The proposed model of group information foraging in emergencies provides a way to understand the process of group information seeking, and opportunities to improve foraging performance under the condition of time pressure and risk. Future work in this specific domain include experimental and field studies to evaluate the group information foraging model, which in the long term will lead to computational modeling of cognition in group information seeking and handling. Evaluation of the propositions should lead to better systems to support group information seeking and decision making by expanding our understanding of the underlying cognitive processes involved as well.

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