Dynamic Emergency Response Management for Large Scale Decision Making in Extreme Events*

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"That's what makes us a great country. The little things are serious and the big ones are not" – Will Rogers

ABSTRACT

Effective management of a large-scale extreme event requires a system that can quickly adapt to changing needs of the users. There is a critical need for fast decision-making within the time constraints of an ongoing emergency. Extreme events are volatile, change rapidly, and can have unpredictable outcomes. Large, not predetermined groups of experts and decision makers need a system to prepare for a response to a situation never experienced before and to collaborate to respond to the actual event. Extreme events easily require a hundred or more independent agencies and organizations to be involved which usually results in two or more times the number of individuals. To accomplish the above objectives we present a philosophical view of decision support for Emergency Preparedness and Management that has not previously been made explicit in this domain and describe a number of the current research efforts at NJIT that fit into this framework.

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Keywords

Extreme Events, Muddling Through, Decision Support, Dynamic Emergency Management

INTRODUCTION

Extreme events are complex and difficult to understand. Managing such diverse and unpredictable situations calls for many people to interact together in the form of groups: tens, hundreds, or more likely, thousands of individuals working collaboratively. These groups have dynamic membership whereby individuals come and go as the needs of the emergency management and response change. Katrina can be viewed as an extreme event that was both natural and man made if one considers the actions of mankind over the past hundred years in destroying natural mitigation conditions and making short sighted decisions. Another significant characteristic of extreme events is that they do not recognize or stop at either geographical or political boundaries. In the case of Katrina we had and have numerous problems arising from the lack of coordination, cooperation, and collaboration throughout the areas of planning, mitigation, response, and even consistency of recovery. It is highly unlikely that in an extreme event, whether natural or man made, that all those that need to collaborate will have trained together nor that the problems they will face will be well known ahead of time, and the numbers escalate for major international events. Different individuals are most likely needed in the many different phases from planning through response and finally recovery. The results are hundreds of individuals in various roles of providing expertise, doing analysis and recommending or decision making. Another example of the large number of organizations that become involved is related by Chen, Sharman, Rao, Upadhyaya, and Cook-Cottone's (in press) account of response to a large October snowstorm in upstate New York that left over a million people without electricity for up to ten days. Among the organizations that needed to coordinate were local response organizations at the village, town, city or county level, New York Electricity & Gas, the State Emergency Management Office, State Health Department, State Highway

Authority, Federal Emergency Management Agency, Coast Guard, Army Corps of Engineers, National Guard, National Weather Service, the Red Cross, and Americorps, plus others.

Logistic chains for extreme events are likely to be one of the most demanding of the distributed team requirements especially internationally. They require large distributed teams for planning, timely response, and extended recovery periods. Even Katrina demonstrated the failure of this function in a developed environment for diversities extending from medical care to ice all the way to reliable housing. Some large single corporations are demonstrating the inability to know their own supply chains with respect to contamination of food, medicines or potentially harmful toys let alone the government doing oversight. A recent study further confirms the need for large scale, distributed Communities of Practice in many of the subfields associated with emergency preparedness and management (Turoff and Hiltz, 2008). This would include the added benefit of reducing information overload among practitioners especially as the complexity and hence, the amount of information, increases. There is, however, a paper in the literature that lays an important foundation for decision making in extreme or unexpected challenges in large scale events. This was originally proposed as the way that important government policy decisions should be arrived at. In 1959 Lindblom wrote a classic paper about the concept of making decisions by "the science of muddling through" rather than by a "scientific" process of setting goals and deducing logical resulting actions. The following summarizes and contrasts the two views of decision making discussed:

1. Scientific deductive decision making with complete knowledge of all relevant variables and values from which an optimization can be made by use of resulting obvious criteria for the decisions.
2. The subjective comparison of a limited number of alternatives relying heavily on experts and their past experience and expertise, where they are focusing on a judgment based upon a few of the most important values.

This might be an over-simplification of a superb paper proposing a different form of decision making for governmental decisions at all levels. However, it strikes us that in the context of the unexpected such as occurs in disasters and emergencies, "The Science of Muddling Through" should be required reading for practitioners, designers, and researchers concerned with Emergency Preparedness and Management. Furthermore it is a foundation for the approach to collaborative decision processes that we have taken in most of our writings in this area producing a ‘collective intelligence’ where the group will produce a better outcome than any individual member of the group would have.

Ill structured, wicked events call for flexibility in decision-making as well as improvisation with the available assets to best accommodate a situation to lessen the chances for the worst outcome and increase chances of the best. Traditional management styles of one or two people in charge of making all the decisions must be replaced by the expertise of the group and defer to that expertise during the response efforts. As the magnitude of an event grows, so too does the group of people to manage. It has been suggested that implementing an incident command system as a hierarchical network is the best solution for managing a large and unknown situation, allowing for flexibility for those in charge (Moynihan 2007). We differ very much with this view and offer the challenge of how to turn a large scale team of professionals into an instant HRO (High Reliability Organization, Weick and Sutcliffe, 2001), networking even when they have never worked together before.

In 1979 Lindblom published a follow-up paper restating the concepts of muddling through in a comparative analysis of different types of "incrementalism." In that paper he listed the stratagems for muddling through that could also be termed as "disjointed incrementalism." What is startling for our purposes is how much they seem like the concepts underlying High Reliability Organizations and concepts of "sense making" which are increasingly popular in Emergency Management operations (Van de Walle and Turoff, 2008). Quoting Lindblom from the 1979 paper:

1. A greater analytical preoccupation with ills to be remedied than positive goals to be sought;
2. A sequence of trials, errors, and revised trials;
3. Analysis that explores only some, not all, of the important possible consequences of a considered alternative
4. Fragmentation of analytical work to many (partisan) participants in policy making (e.g. stakeholder analysis and community participation)

We must also include one other passage (Lindblom, 1979) which is synonymous with the quote by Will Rogers at the beginning of this paper:

> "A fast-moving sequence of small changes can more speedily accomplish a drastic alternation of the status quo than can an only infrequent major policy change." (page 520)

The above seems to be the way practitioners have to actually plan and execute responses and recovery in this field.

After reviewing some characteristics of extreme events we will present some current research at NJIT that can provide support for the more "subjective" approaches advocated by Lindblom to collaborative decision analysis and action taking in various phases of emergency preparedness and management.

CHARACTERISTICS OF EXTREME EVENTS

Large and unforeseen events create a host of unique problems that must be addressed spontaneously and expeditiously. Learning how to manage and expect the unexpected (Weick and Sutcliffe, 2001) calls for an approach to be implemented by management that has a trickle down effect for abstract thinking and quick improvisations in new or unexpected situations. This calls for teams of experts to form as many subgroups as may be necessary in order to address the extreme event. A system must be designed to allow for adequate representation of needed expertise, and management must defer to that expertise. Time and time again it has been seen that in unexpected problems, decision authority flows down to those closest to the situation in either location or knowledge. In the HRO literature this is known as Deference to Expertise. The role of upper management becomes the important one of conducting oversight and seeking additional resources to meet demands (Turoff et al, 2004a). Decision making cannot be statically in the hands of a few centrally located individuals. As the situation changes, delegation of decision making should adapt to allow for those experts best suited to have authority to make decisions. At best in an extreme event we can know who with what talents are available, but we won't know who everyone is that should be called in, or who is able to be called in, to a state of active participation until events and problems begin to unfold. A problem must be observed and identified before it can be accurately addressed. The concurrent need for a fully dispersed command and control center where anyone can participate from where they happen to be, without having a single physical center (Turoff, Chumer, Van de Walle, and Yao, 2004a), was clearly demonstrated by the events of Katrina and the terrorist attacks of 9/11. In those cases the physical structures of static, centralized command and control centers were rendered inoperable by the emergencies that had deleterious effects on the ability of the responders to perform effectively. However, having a fully dispersed command and control center, and delegating authority based upon the expertise of the participants for the current requirements, will promote continuous ability to function effectively in the face of an extreme event.

When individuals are not actively involved, they are often on stand-by and need to be kept apprised of the situation and be on standby to contribute their expertise when the situation calls for it. These teams of experts work collaboratively in the form of virtually distributed teams, addressing subsets of the problem by incorporating a "divide and conquer" strategy in order to focus and address all problem areas to the best of their ability. A virtual organization is created from the overall available experts, dynamically using those who are needed at any particular time (Mowshowitz, 2002). This way, as each situation is unique, so is the group of experts who will work in the decision making process to help minimize damages and maximize the next, best state from which to work. Creating a system that is dynamic to match the needs of a volatile diverse extreme event is required (Turoff et al 2004a).

Now that there is no doubt that we are going through a severe shift in climate conditions it is becoming clear that we are generating more extreme weather based natural disaster events. Just about every region in the US has faced examples of excessive weather conditions in the past few years that have resulted in large scale disaster or emergency circumstances that were not in the predicted scope of prior planning.

LARGE GROUPS AND SUBGROUPS OF DECISION-MAKING TEAMS

Often emergency teams are partially distributed virtual teams and in the case when disasters cross political boundaries this is more representative of the situation that needs true virtual team collaboration. Historically, that has been the area that has seen a great deal of prior work at NJIT in such topics as software development teams and project management teams (Hiltz, Fjermestad, Ocker, and Turoff, 2006). A partially distributed virtual team is a hybrid team whereby there are some individuals collocated in subgroups, and the subgroups are distributed from one another (Huang and Ocker, 2006). In an emergency, people from each organization that is involved in the response may form such distributed collocated subgroups. The challenge is for the subgroups to form an effective team. A system must enable the teams to overcome the inherent difficulties of working in such teams. For example, collocated members may tend to have "collocation blindness" (Bos, Olsen, Nan, Shami, Hoch, and Johnston, 2006) whereby they will resist reaching out to distributed members even when the best expertise lies outside of the collocated group. Deferring to Expertise (HRO theory) is something too often lacking in extreme events.

Real-time, effective decisions are required of experts collaborating on management and response. Without effective response, outcomes can be catastrophic, with more dire consequences than expected or experienced previously.

Errors in management and decision making can exacerbate the situation and result in greater injury, loss of life, or a disastrous financial toll. Lessons learned from past experiences include the need for a feedback mechanism in a support system so that the processes of an event can be critiqued and further utilized to promote learning from failures. Characteristics or values of success need to be identified and integrated into the information system. Expecting the unexpected and managing disasters effectively calls for a system with dynamic features conducive to support group collaboration on a large scale.

Thurstone's Law of Comparative Judgment helps to reflect best a groups' opinion by breaking complex situations down to a manageable set of characteristics. We have made a major theoretical modification to Thurstone's method that allows complete dynamic voting and the introduction of new items with a fluctuating number of contributing voters possible on any subset of preference items in the list (White, Turoff, and Van de Walle 2007a; White, Plot nick, Turoff, and Hiltz 2007b). The critical contribution is a new measure of uncertainty that provides a separate Thurstone scale that shows the greatest possible uncertainty condition that results from some items having only a few votes and others having a lot more. These results in a second Thurstone's scale that can be lined up with the first scale to show the potentially large variations that can occur for items that are new and/or have currently only a small number of evaluations.

The approach provides two separate visualizations based upon the interval scales generated by the Thurstone method. If two alternatives are at the same point this means that half of the individuals who are voting on that comparison prefer A to B and the other half prefer B to A. The linear distance between the two is the current vote. Thus, $P(A>B) = P(B>A) = .5$ is the zero difference point between the two options. In the second scale those not voting but who indicate they are likely to vote at some point are assumed to be able to drive the vote back in the opposite direction and this gives a new version of the scale that measures the uncertainty when compared to the original scale. The first votes cast are meant to expose any disagreements so they can be brought out and discussed by everyone focusing on the particular problem, quickly bypassing areas of agreement and saving precious time. With this method anyone can change their vote at any time based upon the discussion that has occurred about what appears to be meaningful disagreements. The interval scale provides a visual measure of the degree of agreement on the relative preference of any two items. With this feedback, and the visual information provided by the second scale that shows the uncertainty as previously mentioned, experts have a more complete understanding of the level of agreement and status of opinions for decision making. People may choose to vote via "paired comparisons," rank order, "yes," "no," "no judgment," or "no judgment at this time" thus showing other participants their intention to vote in the future. The feedback mechanisms of the voting scheme allow participants to see just how many vote changes have occurred for any one item in the list. We are adapting the standard Delphi design practice of only encouraging those that are confident in their judgment to express a preference (Linstone and Turoff, 1975).

Thus, this new method allows for providing a group reflection of individual experts to vote, revote, or not vote at all on a given situation, depending upon the relevance of the decision to the experts' domain of knowledge. These subsets of experts can then work more effectively given the dynamic nature of the event, and with the aid of Internet technology, from anywhere, anytime, and asynchronously. Research supports that implementing the following list of characteristics into a distributed group support system aid the decision making process such that better solutions are produced (Linstone and Turoff, 1975, Turoff 2002, White, Turoff, and Van de Walle 2007):

- Asynchronous interaction by an individual
- Anytime, anywhere participation in decision processes
- Informative visual feedback of present group state on issue
- Ability to vote on an issue, not vote, wait for more information to vote, or change a vote based on the changes in merit from evolving information input
- Visual feedback system on real time vote outcome
- Anonymous voting
- Total vote changes on any item and histogram of recent vote changes over time
- Contribution to any part of the decision process by any team member

Next, figure 1 provides an example of a decision process that could be used in conjunction with this set of characteristics. Note the directions of the arrows between the processes. These demonstrate that anyone can participate in any part of the process at anytime; this is crucial as the experts can change their minds, change a vote on a given decision based on the changes in merit of the arguments. Discussion is stimulated by disagreements made salient to the participants by a visual voting feedback system. This discussion amongst experts furthers understanding of a given situation and lessens ambiguity. In many cases the individuals converging on a specific problem will have different professional backgrounds and represent different viewpoints. In such situations the quick recognition of differences in meaning (ambiguity) is critical to reaching the stage where the more difficult issue of uncertainties can be dealt with.

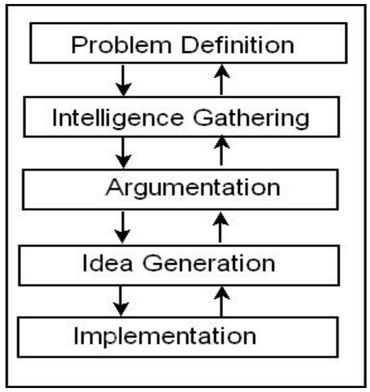

Figure 1 Continuous and Dynamic Decision Process Model

Thus, expertise is used when it is most needed. Teams of experts should be in a standby mode ready to respond anytime when disaster strikes. However, the system must be used by the contributors in the interim because having a history of using the system regularly will promote ease of use; waiting until a disaster to use a system impedes making full use of its capabilities. Only when a system is used on a day to day basis will the experts and teams be able to interact efficiently and effectively use it as a means to communicate and solve problems. This means that the thousands of people involved, who come from a great many different organizations and affiliations, must have access to the system between emergencies. This is for the purpose of replacing the need for a physical system as the basis for an HRO (e.g. nuclear power plant, aircraft carrier) with a virtual command and control system which they can fine tune and train on a continuous basis (Turoff, Chumer, and Hiltz 2006). They can become part time participants in a virtual organization where they can also develop the social relationships and other factors necessary to evolving a team and developing trust in each other's capabilities necessary to allow for the sharing of roles and responsibilities in any event with an unknown duration.

This approach allows those who feel confident through experience and/or expertise to self choose the problems to which they believe they can contribute. The shared motivation to reduce or mitigate the harm occurring in an emergency or crisis and the trust that only those that feel qualified to contribute are enough to eliminate the problems we usually fear in group collaboration due to Arrow's paradox. What we hope can be accomplished in this type of collaborative process is "collective intelligence" (Hiltz and Turoff, 1978, 1993) where the group result is better than any one member would have reached working alone and where decision making can occur as quickly as a single individual seeking to collect and consider carefully all the available information that might influence the process.

Accessibility to an easy to use management system can also create a bank of experts in which subsets can dynamically come together and handle unforeseen situations with the best outcome given the set of events. Such dynamically formed groups of experts need a system to support making fast decisions based on merit. No one can predict ahead of time the perfect teams for problems that cannot be predicted ahead of time. What is needed is a system that is open to all the participants and provides the necessary information and alerts for individuals to find the problems they feel they can contribute to at any given moment or place in the response activity.

A dynamic emergency system has been proposed by Turoff et al. (2004a, 2004b, 2006) which will provide for supporting dynamically changing teams of experts as they respond to or plan for extreme events. By focusing on roles, changes in personnel assigned to those roles can occur seamlessly and not adversely impact the effectiveness of the team. Each individual needs to have access to information that is relevant for an effective response. Flexibility, robustness and a dynamic nature are keys to effective handling of such emergencies. It is proposed (White, Plotnick, Adams-Moring, Turoff, and Hiltz, 2008) that a dynamic voting Delphi like process can further increase effectiveness and ameliorate some of the problems that are inherent in rapidly changing, critical environments.

A High Reliability Organizational approach is best suited for environments in which the smallest of errors can prove disastrous and where knowledge building from lessons learned in an open environment is desired (Weick et al 2001). Characteristics of High Reliability Organizations that contribute to their ability to manage the unexpected include a preoccupation with failure such that it is watched for and learned from, and where there is deference to expertise (Weick, 2001). The solution to handling extreme events well must include the use of a system that supports those characteristics. Today it is extremely difficult, if not often impossible, to get information on mistakes because of liability concerns. This long term hindrance is being ignored. Rather mistakes should be seized upon as opportunities for learning and improvement.

Other benefits of consistent use of a system are that users will meet one another and have a means of building trust within a virtual social network (Turoff et al., 2004a). On the other hand, during large scale or unexpected events, numerous participants in the command, control and analysis process may not have interacted before or having a plan that fits the circumstances. The secret for planning in emergencies is having a process that works and known resources that can be commanded, not in designing decisions ahead of time. Trust may need to develop quickly as swift trust, and/or have challenges not present in more static, well-defined situations (Iacono and Weisband, 1997, Coppola, Hiltz, and Rotter, 2004). A person in a decision role may be reluctant to hand over that role to someone they do not know well enough to trust to carry out the role as well as they do. This is what leads to individuals working until exhaustion becomes a problem where it concerns making reliable decisions. Roles have to function on a 24 hour, 7 day basis. This also requires systems that track accurately the status of any response so that those taking over roles can have all the information dealing with an open response event. Familiarity with a system is a critical factor, especially when the participants in a crisis are further challenged with duress from psychophysical symptoms (Turoff et al, 2004a) such as the Threat-Rigidity Syndrome. Even during down times, it is important for participants to stay abreast of the situation so that when they come back on shift, they are aware of any drastic changes and can seamlessly continue the teamwork as an effective member.

When experts work collaboratively with a goal of learning from one another and sharing common interest, a Community of Practice (Wenger, McDermott, and Snyder 2002) can emerge, which strengthens the likelihood of good performance in situations of great stress. If the system has been used previously and is well understood, attention can be focused on the emergency and not diverted to issues of system use.

A Virtual Community of Practice can form with each player having a role that can be called upon as the need arises. Like a library in a programming language, teams of experts are needed that are specific to a problem and its needs as the crisis evolves and a list of priorities expands and contracts as the merits of the decisions change over time. Thus, a system must be able to manage dynamic changes in roles used and the people filling those roles.

PRESENT RESEARCH

One of our current efforts is a dynamic voting wiki with quick access to group support tools for real time information distribution across the Internet. Large or extreme events can span many miles, and given the multi-cultural, multi-lingual environment in which we live, a wiki that can handle many languages, thus lessening the interpretative burden that comes with not speaking the native language of the location where the most damage may be occurring, is proposed to be a suitable platform. For example in response to the 2006 Tsunami, many people came together, requiring great variation in languages in which to make a rapid, timely response more manageable for a diverse group (White, Turoff, Van de Walle, 2007a; White et al., 2008).

A related effort has been to seek an appropriate multiplayer gaming environment where people may take on roles of offense and defense with respect to countering threats or making them worse. This would lead to an iterative cycle of improved plans with the uncovering of flaws on the defense or offensive side. Such games could be played continuously and asynchronously and offer the challenge to the participant to actually make it a part time recreational occupation for training (Hendela, Yao, Turoff, Hiltz, and Chumer, 2006). Unfortunately, none of the current generation of asynchronous groupware really provides the underlying knowledge structure needed. Therefore we have currently been working on a system to allow for true collaboration in the formation and specification of any threat or defense scenario (Yao and Turoff, 2007). Once such a system is demonstrated we have the key tool to develop a game that allows such scenarios to be played off against one another. Choosing reactive options in such a game would function much like the decision support systems we have described throughout this paper.

Associated with the aforementioned efforts is one where we have been attempting to design and implement a disaster scale that would not only be more meaningful to the average citizen, but would be scored in a local area by professionals or citizens who have experienced similar events as a type of a public, online poll collecting estimations on the damage that would take place locally (Plotnick, Gomez, White, and Turoff 2007). The scale arrived at by a Delphi process among a graduate student class follows. Note that the lowest values for informative purposes were the two that are most often reported (financial loss and recovery costs). What citizens want to know are the other variables in the following Thurstone's scale. Many of these variables are better estimated by local citizens with experience in prior similar disasters or local experts familiar with things like local building codes and practices. Using national estimates does not give informative estimates when the threat is on the way. One needs local estimates of each variable on this scale.

Each of the dimensions below can have a local scale of the degree of damage estimated by the local community "experts" on a continuous basis from the earliest detection of the current threat right up to its actual occurrence, and then afterwards as actual damage assessment occurs.

Scale	Value	Disaster Damage Dimensions	Value	Disaster Damage Dimensions
20	**20.00**	Casualties and Fatalities		
19				
18	**18.00**	Utilities Impact		
17				
16	**16.60** **15.90**	Potential to Spread Ability of local response adequacy		
15	**15.43** **15.40**	Loss of Command and Control Infrastructure Damage	**15.40** **15.38**	Resources for Aid/Containment Time needed for response
14	**14.82**	Duration of Disaster		
13	**13.09**	Public Reaction		
12	**12.96**	Geographic Impact		
11				
10	**10.07**	Time to Return to Normal		
9				
8	**8.61**	Chance of imminent reoccurrence		
7				
6				
5				
4	**4.70**	Financial Loss		
3				
2				
1	**0.01**	Financial Recovery Costs		

Table 2: A Thurstone scale for the relative importance of measures of disaster impact (Plotnick et al, 2007).

If we are going to take many types of extreme events seriously we need to do much more about meaningful citizen involvement, as they are the true first responders (Palen, Hiltz, and Liu 2007). The area that has the greatest payoff for handling extreme events is the more complete involvement of the communities and their citizenry in all phases of disaster preparedness and response. This should be our first line of defense

OBSERVATIONS AND CONCLUSIONS

Too much of the literature confuses collaboration with terms like coordination and cooperation. What we are after for emergencies and disasters is true collaboration among the group that forms to solve a given problem as defined in the following scale of group communication commitment:

Degree of group communication commitment scale

1. Competitive – no trust in passed information
2. Informative – honest information exchanged on what is being done by each party
3. Coordination – mutual scheduling of what tasks each party is doing when
4. Cooperation – mutual agreement on what tasks each party is going to do.
5. Collaboration – mutual agreement to work together on the same tasks.

Such groups are self determined and a given individual may be involved in other such groups at the same time. Lindblom in his book, “The Intelligence of Democracy,” (1965) put it in very clear terms (page 3): "that people can coordinate with each other without anyone's coordinating them." In disaster planning and response it is full scale collaboration that is needed and we would extend the above quote to be coordination, cooperation, and collaboration. This view flies in the face of classical views of management that do not recognize the potential capabilities of fully distributed collaborative networks of individuals and the potential for "collective intelligence" (Hiltz and Turoff, 1978, 1993). This can only occur if some degree of collaboration is undertaken.

Many of the proposed automated approaches to handling events in disasters are a waste of time. What we need is creative and dedicated individuals trained and motivated to deal with the unexpected. This view is shared by others as well (French and Turoff, 2007; Carver and Turoff 2007). Where we need automation is in helping to reduce information overload in the Emergency Management field, which is growing a lot faster in the volume of documents than in the wisdom we are seeking. Too much that is obvious as to what has to be done is not being done because of reasons such as our increasingly aging infrastructure and a lack of emphasis on mitigation in Emergency Preparedness. Perhaps the one effort that might turn this around is the creation of an Emergency Preparedness and Business Continuity audit that would create a comparative measure for a given type of organization or facility of how well prepared it was for an emergency event (Turoff et al, 2006). Agreeing on the components of such an audit measure would be an excellent application of the voting technique discussed in this paper by large, heterogeneous groups of professionals. Many of the broader concepts discussed in this paper have been more thoroughly covered in a recent handbook chapter on Decision Support for Emergencies (Van De Walle and Turoff 2007).

We feel that the words of Lindblom make the best concluding observation for this paper:

> "Even if all the administrators had at hand an agreed set of values, objectives, and constraints, and an agreed ranking of these values, objectives and constraints, their marginal values in actual choice situations would be impossible to formulate….I know of no way to describe or even to understand what my relative evaluations are for, say, freedom and security, speed and accuracy in governmental decisions, or low taxes and better schools than to describe my preferences among specific policy choices that might be made between the alternatives in each of the pairs." (page 84, Lindblom 1959)

This is the reason why decision authority naturally passes to those closest to or on the scene in a disaster (Turoff et al, 2004). They are the only ones that can know based upon experience and expertise, what are the meaningful alternatives from which a choice can be made. As one moves up the chain of command the types of decisions at higher levels have to do with oversight and the consequences for the logistic chain to support the local operation.

REFERENCES

1. Bos, N., Olsen, J.S., Nan, N., Shami, N.S., Hoch, S., and Johnston, E. (2006) ‘Collocation Blindness’ in Partially Distributed Groups: Is there a Downside to Being Collocated? *Proceedings of the CHI 2006*, Montreal, Quebec, 2006.
2. Carver, L., and M. Turoff (2007) Human Computer Interaction: The Human and Computer as a Team in Emergency Management Information Systems *Communications of the ACM*, March 2007, 33-38.
3. Chen, R., Sharman, R., Rao, H.R., Upadhyaya, S.J., and Cook-Cottone, C.P. (in press) Coordination of Emergency Response: An Examination of the Roles of People, Process, and Information Technology, in Information Systems for Emergency Management, (Van de Walle, B., Turoff, M., and Hiltz S.R. eds) in the Advances in Management Information Systems monograph series (Zwass, V. editor-in-chief), Armonk, NY: M.E. Sharpe Inc. Anticipated 2009.
4. Coppola, N., Hiltz, S. R., and Rotter, N.(2004) Building Trust in Virtual Teams. *IEEE Transactions on Professional Communication*, 47, 2, 95-104.
5. French, S., and Turoff, M. (2007) Decision Support Systems, *Communications of the ACM*, 50, 3, 39-40.
6. Hendela, A., Yao, X., Turoff, M., Hiltz, S. R., and Chumer, M. (2006) Virtual Emergency Preparedness Gaming: A follow up study, *Proceedings of ISCRAM 06*, May 14-17, NJIT, Newark NJ, ISBN 90-9020601-9
7. Hiltz, S. R., and Turoff, M., (1993) The Network Nation: Human Communication via Computer, 1978 Addison Wesley, MIT Press.
8. Hiltz, S.R., Fjermestad, J., Ocker, R. and Turoff, M. (2006) Asynchronous Virtual Teams: Can Software Tools and Structuring of Social Processes Enhance Performance? In Volume II: Human-Computer Interaction in Management Information Systems: Applications, Dennis Galletta and Ping Zhang, editors, Armonk, NY: M. E. Sharpe, Inc., 119- 142.

9. Huang, H., and Ocker, R. (2006) Preliminary Insights into the In-Group/Out-Group Effect in Partially Distributed Teams: An Analysis of Participant Reflections, *Proceedings of SIGMIS-CPR '06,* Claremont, California.
10. Iocono, C. S., and Weisband, S. (1997) Developing Trust in Virtual Teams, IEEE.
11. Lee, J. S., Lee, S. L., Damon, S. A., Geller, R., Janus, E. R., Ottoson, C., and Scott, M. J. (2006) Risk Communication needs in a chemical event, *Journal of Emergency Management*, 4, 2, 37-43, full report http://www.wetp.org/wetp/public/has1_get_blob.cfm?ID=1051
12. Lindblom, C., (1959), The Science of Muddling Through, *Public Administration Review*, 79-88.
13. Lindblom, C., (1979), Still muddling, not yet through, *Public Administration Review*, November/December, 517-526.
14. Lindblom, C, (1965) The Intelligence of Democracy, Free Press.
15. Linstone, H. and Turoff, M. (1975) The Delphi Method: Techniques and Applications, Addison Wesley Advanced Book Program, 1975 (available online at http://is.njit.edu/turoff). Available at http://is.njit.edu/turoff, last access 18 August 2007.
16. Mowshowitz, A. (2002) Virtual Organizations, Quorum Books.
17. Moynihan, D. (2006) From forest fires to Hurricane Katrina: Case Studies of Incident Command Systems, Networks and Partnerships Series, IBM Center for The business of Government.
18. Palen, L. Hiltz, S.R. and Liu, S. (2007) Citizen Participation in Emergency Preparedness and Response. Communications of the ACM special issue, 50, 3, 54-58.
19. Plotnick, L., Gomez, E. A., and White, C., (2007) Furthering Development of a Unified Emergency Scale Using Thurstone's Law of comparative Judgment: A progress Report, *Proceedings of ISCRAM 2007, 4th International Conference on Information Systems for Crisis Response and Management*, Delft, the Netherlands, May 13-16, Brussels University Press.
20. Turoff, M., and Hiltz, S. R., (2008) Information Seeking Behavior and Viewpoints of Emergency Preparedness and Management Professionals Concerned with Health and Medicine, Report to the National Library of Medicine, February, 2008. (Will be Web accessible)
21. Turoff, M., Chumer, M., and Hiltz, S. R., (2006) Emergency Planning as a Continuous Game. *Proceedings of the 3rd International ISCRAM Conference, Newark, NJ.*
22. Turoff, M., Chumer, M., Van de Walle, B., and Yao, X., (2004a) The Design of a Dynamic Emergency Response Management Information System (DERMIS). *Journal of Information Technology Theory and Application, (JITTA)*, 5:4, 1-35.
23. Turoff, M., Chumer M., Hiltz, R., Klashner, R., Alles, M., Vararheyi, M., and Kogan, A., (2004b) Assuring Homeland Security: Continuous Monitoring, Control & Assurance of Emergency Preparedness, *Journal of Information Technology Theory and Application, (JITTA)*, 6, 3, 1-24.
24. Turoff, M, (2002) Past and Future Emergency Response Information Systems. *Communications of the ACM*, 45, 4, 29-33.
25. Turoff, M., Hiltz, S. R., Cho, H-K, Li, Z., and Wang, Y. (2002) Social Decision Support Systems. *Proceedings of the 35th Hawaii International Conference of System Sciences*.
26. Van de Walle, B. and Turoff, M. (2008) Decision Support for Emergency Situations, In F. Burstein and C. Holsapple, Eds., Handbook on Decision Support Systems, International Handbook on Information Systems Series, Springer-Verlag, (This chapter will be open on the Web).
27. Wenger, E., McDermott, R., and Snyder, W. (2002) Cultivating communities of practice: a guide to managing knowledge, Harvard Business School Press, Boston, Mass.
28. Weick, K. and Sutcliffe, K. (2001) Managing the Unexpected: Assuring High Performance in an Age of Complexity, Jossey-Bass Publishers.
29. White, C., Turoff, M. and Van de Walle, B (2007a). A Dynamic Delphi Process Utilizing a Modified Thurstone Scaling Method: Collaborative Judgment in Emergency Response. *Proceedings of 4th Information Systems on Crisis Response Management*.
30. White, C., Plotnick, L., Turoff, M., and Hiltz, S.R. (2007b) A Dynamic Voting Wiki, *Proceedings of 13th Americas Conference on Information Systems*.
31. White, C., Plotnick, L., Aadams-Moring, R., Turoff, M. and Hiltz, S.R. (2008) Leveraging a Wiki to Enhance Virtual Collaboration in the Emergency Domain, Proceedings *of the 41st HICSS*.
32. Yao, X., and Turoff, M., (2007) Using Task Structure to Improve Collaborative Scenario Creation, *Proceedings of ISCRAM 2007, 4th International Conference on Information Systems for Crisis Response and Management*, Delft, the Netherlands, May 13-16, Brussels University Press.