Mega-Collaboration: The Inspiration and Development of an Interface for Large-Scale Disaster Response

Christine M. Newlon
IU School of Informatics
cnewlon@iupui.edu

Mark Pfaff
IU School of Informatics
mpfaff@iupui.edu

Himalaya Patel
IU School of Informatics
himpatel@iupui.edu

Gert-Jan de Vreede
Center for Collaboration Science
gdevreede@unomaha.edu

Karl F. MacDorman
IU School of Informatics
kmacdorm@iupui.edu

ABSTRACT

The need to gather and use decentralized information and resources in responding to disasters demands an integrated interface that can support large-scale collaboration. This paper describes the development of a collaboration tool interface. The tool will surpass existing groupware and social networking applications, providing easy entry, categorization, and visualization of masses of critical data; the ability to form ad-hoc teams with collaboration protocols for negotiated action; and agent-augmented mixed-initiative tracking and coordination of these activities. The paper reports user testing results concerning the data entry interface, emergent leadership, and the directed negotiation process. The paper also discusses planned enhancements, including formalized collaboration engineering and the use of a disaster simulation test bed.

Keywords

Collaboration, thinkLets, virtual teams, autonomous agents, mixed initiative multi-agent system.

INTRODUCTION

To respond to major disasters and crises, we must be able to gather information and resources from diverse and unexpected sources. Over the days and weeks following the event, we must be able to effectively use the information and resources in the disaster response effort. Neither of these processes is easy, especially in the chaos of a disaster. Hurricane Katrina served as a wake-up call on these issues for most Americans, and provided an interesting study in contrasts. While access to communications and the Internet was limited in the disaster zone for the first few days, it was the decisions being made elsewhere that either conquered the chaos or surrendered to it. For example, Dan Chaney, a former Unix administrator in California, set up a Hurricane Katrina missing-persons database on a Linux server in his house which received more than 800,000 hits daily by the end of the first week (Vijayan, 2005). By contrast, most of the $854 million in donations offered to the government was never even collected. Only $40 million of it had been spent two years after the hurricane (Solomon and Hsu, 2007). In the first example, we see an agile response to the crisis that used modern technology to gather information and provide it to those in need of it. In the second, we see how a failure to mount an ad-hoc response can result in a bad outcome.

While better preparedness will help address some issues, we will never have a perfect disaster plan sitting on the shelf when a disaster strikes. Disasters are unpredictable and require us to invent our response as the situation develops. This is why improving the effectiveness of ad-hoc disaster response has become a significant area of research. Studies on the development of hastily formed networks, on grassroots social networking, and on large-scale collaboration design have contributed to a growing consensus on the need for the distributed management of disasters and for interfaces to support their management.

The development of systems for such support presents significant design challenges. To collaborate more successfully, participants must to come to agreement on the problem definition, group norms, and individuals' roles. They must be able to capture information and pass it to those who need it. They must be able to make decisions by forming a consensus among massive numbers of participants. Fortunately, social networking and research on large-scale teamwork indicates approaches to manage these challenges.

This paper describes a research project to support mega-scale collaboration for disaster response. In particular, the paper describes the theory behind this interface, the participatory design process to develop it, and the means by which we have validated the design concept.

BACKGROUND

Research on disaster response has a long history. However, the growth of information and communication technology (ICT) has created new areas of research and new potential solutions. Ethnographic studies on the World Trade Center attack, the Hurricane Katrina recovery, the London Tube bombings, the California wildfires, the SARS epidemic, and various earthquakes around the world show that the public are usually the first responder in a crisis (Palen et al., 2007a, Palen and Liu, 2007). The public has led the way in appropriating crisis-response technology. Recent mega-disasters have spurred a new kind of *mega-collaboration* in which thousands of people spontaneously work together via the Internet (Newlon and Faiola, 2006). The need to connect aid donors and recipients has highlighted the role of blogs, listbots, and online bulletin boards updated by ordinary citizens and their grassroots organizations.

The multi-person and multi-organizational networks that form after a disaster are called *ephemeral groups* (Farnham et al., 2006), or *hastily formed networks* (Denning, 2006). A hastily formed network (HFN) is defined as a rapidly established network of people from different communities who work together to achieve an urgent mission in a shared conversation space. One example of a grassroots HFN was documented following the Virginia Tech shooting in April 2007 (Palen et al., 2007). It formed spontaneously through the use of social networking sites by students at the school and the general public. This HFN had already compiled a complete list of victims before the officials at the scene had released one. It is just one example of the public's ICT-enabled collaborative action in response to a disaster (Schneider and Foot, 2004, James and Rashed, 2006).

Grassroots self-organization and the emergence of creative group behavior among those affected by a disaster contributes to the adaptability, creativity, and improvisation that are critical to the success of relief efforts (Harrald, 2006). However, technology-empowered volunteers can present a serious management problem. Although they are geographically dispersed and demographically diverse, they must be coordinated as part of the overall response to avoid adding to the chaos of a disaster instead of reducing it (Denning, 2006; Newlon and Faiola, 2006). Therefore, a trade-off must be made between command-and-control requirements for the efficient delivery of services under extreme conditions and the need to respond creatively to unforeseen problems and coordinate thousands of spontaneous volunteers and emergency organizations (Harrald, 2006). Palen's studies and others indicate that advances in ICT challenge the conventional models used by government planners and will require a new relationship between official responders, non-governmental organizations (NGOs), and the public (McNeese et al., 2006, Currion et al., 2007). They call for new ICT designs that foster collaboration between government responders and citizens.

DESIGNING A MEGA-COLLABORATION INTERFACE

In general, collaboration demands that individual participants function as a team, traversing the team-building stages of *forming, storming, norming,* and *performing* (Tuckman, 1965). To succeed teammates must establish common ground by combining their individual mental models of the problem into a team model. This involves both the convergent processes of information pooling and cognitive consensus as well as the divergent processes of specialization and transmission of information to the appropriate expert (i.e., transactive memory; Mohammed and Dumville, 2001, Birnholtz et al., 2005, Convertino et al., 2008). It has been demonstrated that a computer interface can guide a forming team through this development process (Farnham et al., 2000). Therefore, it follows that large-scale collaboration in a distributed environment can be facilitated by an interface that captures individuals' mental models and facilitates the negotiation of team models.

The design of such an interface involves social, psychological, and technological research problems. The formation of mental models is a dynamic process that depends on both the individual and the situation. Capturing such models requires a flexible interface capable of supporting a representation of many different types of entities and relationships. An even greater difficulty is facilitating the model-negotiation process in a dispersed and heterogeneous team. These challenges are particularly daunting, because they must be met for a team of thousands. However, on-going research offers potential solutions (Klein et al., in press, Newlon et al., 2008a, Newlon et al., 2008b).

Our testing indicates that it is possible to guide individuals through the definition of their mental models via a three-tier application design (Newlon et al., 2008a, Newlon et al., 2008b). As flexible architectures for software development have matured, it has become easier to capture the users' concepts and route them to a back-end database through a process mediated by middle-tier business logic. This allows these concepts to be categorized as events, goals, tasks, roles, actors, and resources (van der Veer and van Welie, 2000), which makes them easier to compare and manipulate. The online conversation surrounding this process can also be captured and preserved in its context (Newlon, 2007). In this way, an interface can harness the data-crunching power of a modern database to support users in converting their thoughts into representations that can be compared with those of their teammates.

Technology can facilitate the model negotiation of a dispersed and heterogeneous team. *Collaboration engineering* enables the design and deployment of repeatable collaboration processes for teams working on high-value collaborative tasks (Briggs et al., 2003). It facilitates team modeling by constructing a negotiation process from a sequence of individual process segments called *thinkLets* (de Vreede et al., 2006). Each thinkLet supports a pattern of the team-model negotiation process, these being divergence, reduction, clarification, organization, evaluation, and consensus building. By breaking the team activity into segments, each with one of these goals, it is possible to build a negotiation process that captures all the ideas contributed while allowing participants to focus quickly on what is important. In short, a thinkLet is "a named, packaged facilitation technique captured as a pattern that collaboration engineers can incorporate into process designs" (de Vreede et al., 2006). We anticipate that the innovative application of thinkLets to complex mental models represented in a relational database will enhance the MCT's capabilities.

Specifications

Concept and Scope

To meet its design goals, the MCT must allow individuals to come together on the Internet, discuss issues, and form teams to address them. Once each team is formed, the interface must support the development of both individual and team mental models, including goals and action plans that relate to the common interest of the teammates. The interface must provide input, output, and team management mechanisms to support this. The tool's interface must enable mega-collaborating teams to form a robust picture of their data, while automatically creating a data structure to manage it. Based on the results of a study by Farnham (2000), a key assumption of the MCT is that the ability to explore this picture together as a team-building exercise will encourage teams to move from competitive to cooperative behavior.

However, this kind of tool faces several constraints. The users must have the ability to gain access to the MCT. They must develop sufficient interest in joining a team and in helping each other. They must understand both the interface and the subject matter well enough to develop and negotiate data models and action plans. This means that they must be able to learn the interface quickly and under stressful conditions.

Use Cases

To elaborate on the MCT concept, we developed a number of theoretical user profiles and use cases, we developed were drawn from actual users and events documented in the wake of Hurricane Katrina. Table 1 shows the representative users for which we developed profiles.

Type	User	Motivating Goal for Use
Local Emergency Responders	District Fire Superintendent	Determination of Priorities
Volunteer Labor Organizations	Firefighters' Union Coordinator	Resource Coordination
Non-Profit Aid Organizations	Red Cross Coordinator	Resource Coordination
Military Organizations	National Guard Coordinator	Response Activity Tracking
Federal Emergency Responders	FEMA Coordinator	Jurisdiction Coordination
Concerned Common Citizens	Store Manager	Resource Donation
Volunteer Workers	Social Worker	Resource Donation
Volunteer Experts	Computer Expert	Technology Donation
Affected Individuals	Relative	Rescue of Family Members

Table 1. User Profiles

The user profiles in Table 1 demonstrated the diversity of needs generated by a major disaster. The use cases envisioned the ways in which technology could help meet those needs. They revealed that mega-collaboration must provide interrelated solutions to different responders. Therefore, one critical feature of these solutions is that they all draw from the same database, which provides customized interfaces to each user and to each group.

Another feature is the use of software agents to act independently in coordinating the data definition process among the various groups.

Required Features

In addition to basic security, account management, and data architecture considerations, mega-collaboration must support a number of different interactions among users. These are listed in Table 2.

ID	Interaction	ID	Interaction
1	Find Site	10	Develop Mental Models
2	Use Site	11	Negotiate Group Models
3	Find Area of Interest	12	Vote
4	Participate	13	Take Turns
5	Converse	14	Exchange Information and Resources
6	Create Team	15	Form Teams of Agents
7	Join Team	16	Agent-Mediated Playoffs
8	Leave Team	17	Inter-Group Negotiation
9	Disband Team	18	Provide Help

Table 2. Supported Interaction Requirements

Iterative Design Process

Our development process for the MCT began with an initial set of user profiles and use cases, which led to a preliminary set of specifications and a concept prototype (Newlon and Faiola, 2006). We followed this with a more detailed paper prototype and a series of focus group sessions. The set of specifications developed from these sessions led to the first working prototype of the MCT (Newlon, 2008). Our initial concern was to refine the team-building interface and explore the effect that negotiation of mental models had on the team decision process. To date, we have successfully tested the prototype and used our results to design and test a modified user-input screen for the MCT (Newlon et al., 2008a, Newlon et al., 2008b). Our current screen design is shown in Figure 1. We are now applying what we have learned to the tool's next major expansion in functionality. The following sections discuss our findings and how we intend to apply them.

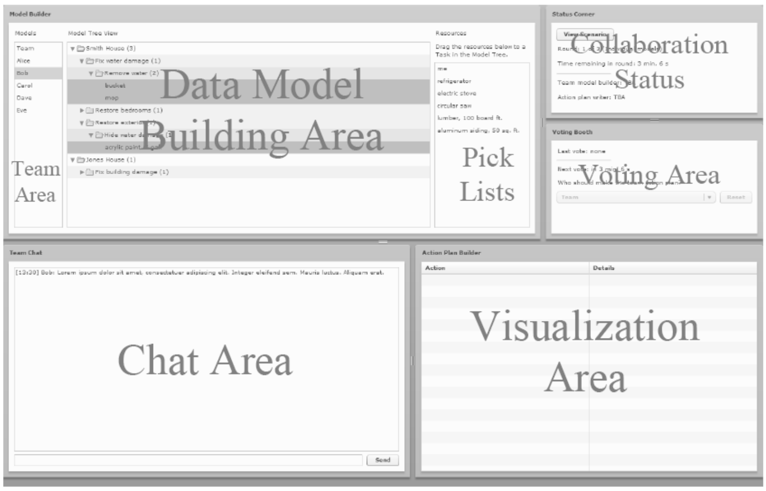

Figure 1. Mega-Collaboration Prototype Interface

Evaluation Methods

Participants

The initial phase of testing used 23 participants, divided into four test teams and four control teams. We varied the problem scenario given to the groups, and the time spent at each stage of the negotiation process, but one test team and one control team completed each testing setup. The demographics were well distributed in both gender and age. Two of the test runs were conducted in a laboratory setting, and two were conducted across the Internet with widely dispersed participants (Newlon, 2008).

In the second phase of testing, observations were made in two stages. In the first (requirements-gathering) stage, 10 male postgraduate students in human-computer interaction worked with the previous version of the interface (Newlon et al., 2008a). In the second (interface-comparison) stage, six female and four male students worked on the interface shown in Figure 1. All 20 participants had reported spending over 20 hours on the World Wide Web in the past month. Only 1 of the 20 reported being “proficient” with project management software.

Instruments

Each trial in both phases included a pre-test containing demographic and technology-experience items. The first phase and the interface-comparison stage of the second phase both included a post-test. The post-test questions used Likert scaling to gather user experience. In the second phase, many of the post-test questions were modeled after the IBM usability questionnaire set using semantic differential and seven-point Likert scaling (Lewis, 1995). These included system usability (10 items), information quality (9), interface quality (3), overall appeal (5), interface learnability (8), emotions elicited by the interface (18), interface aesthetics (20; adapted from Lavie and Tractinsky, 2004), team-creation functionality (6), input interfaces (9), output interfaces (2), and the model-building process (1).

Procedure

Phase 1 tests of the MCT prototype assumed, for experimental purposes, that the process of finding a common interest had already taken place. This allowed the random assignment of participants to the test and control teams instead of self-assignment. The teammates were given some time to read the tool’s instructions and the problem scenario, and were guided through an interface tutorial. They then began the model-building process.

Our initial assumption was that the participants should develop their own mental models first, and then combine them to form a team model. Accordingly, participants were given a fixed period of time during which they could see only their own models, then a period where they could compare their models with their teammates’ models, then a period where they each took turns making additions to a common model. The relative lengths of these time periods were varied based on our experience from the prior tests.

At the end of each round the participants were asked to vote on whether to take another round. Once they voted to move on, the team was asked to elect one of their members as a team representative. This representative then created a team action plan, which was supposed to be based on the developed models and on the verbal support the representative got from teammates through chat. A chat window was always available for intra-team communication, and a view window was available to give participants additional ways to visualize their data. The control teams ran through the same process as the test teams, including the action plan step. But instead of using the model-building component of the interface, they were expected to negotiate their common ground solely through the chat window.

Our initial tests were an examination of the test method itself, intended to determine which of the group’s behaviors were of value in studying the effect of the interface. In addition to gathering standard usability data through the post-test questionnaire and post-test focus groups, we performed conversation analysis of participant communications as each test progressed. We also analyzed in detail the individual and group models and the action plans developed by both test and control groups.

The second phase of testing concerned the MCT’s graphical data-entry interface. We compared the two most recent versions of the interface. The first stage of observation was performed as part of a concurrent requirements-gathering exercise for the tool. The second stage was a scripted performance test and questionnaire. Both stages were conducted in a controlled local setting. The first was performed in two uninterrupted sessions on consecutive days with different people. The second stage took place in one-on-one sessions. Each participant attempted five basic data entry and manipulation tasks within a post-disaster scenario using one of the two interfaces (randomly assigned).

Participants in the first stage had varying levels of exposure to the mega-collaboration project and tool. We allowed this because it lent additional insight to the requirements gathering process. A new scenario was created involving a minimal business proposal to garner capital funding. The participants’ primary goals were to specify the means of production, the supply chain, and a marketing plan for a new product; this loosely defined task allowed observation of a nonemergency collaboration. Participants communicated using only the MCT's features. In the second stage, 10 new participants were recruited who had never heard of the project or used the tool.

RESULTS

Experimental Observations

Usability

Factors affecting usability included data input capabilities and the ability to categorize and visualize the data. Both the initial testing, and follow-up testing with the more advanced entry screen, indicated that the categories of events, goals, tasks, roles, and resources were too rigid. In some cases, the users wanted to use a temporal organization of the data. Users wanted cut-and-paste capabilities, the ability to enter large pools of existing data, and the free-form manipulation of the data after entry. Post-test interviews in the follow-up study revealed a desire to reorganize, attach, and detach partial data hierarchies.

Behavior in Groups

Two patterns of observed behavior may shape the design of the MCT. Conversation analysis of the preliminary tests revealed that teams with emergent leadership tended to produce successful action plans (Newlon, 2008). The follow-up study's results supported a preference for single leaders over shared leadership. A difference in the complexity of concepts between the test and control teams was also observed. Entries to individual models on the test teams tended to be unorganized lists of ideas, but the act of consolidating these ideas into the group model tended to force hierarchical organization, resulting in a more complex group model. This complex organization carried over to the action plans of the test teams, while the action plans of the control teams continued to be unorganized lists of ideas (Newlon, 2008).

Participant Reports

The newer interface demonstrated higher ratings in 7 of 10 system usability items, 6 of 9 information quality items, 3 of 3 interface quality items, 13 of 18 emotional quality items, and 18 of 20 interface aesthetics items.

Discussion

A tool that is difficult to use will not lend itself to operation in the high-stress atmosphere of a crisis. However, usability alone is not sufficient. To justify making the effort to use a tool during an emergency, that use must be demonstrated to make a difference. Therefore, we must examine the process of using the MCT in some detail to validate its design.

Fortunately, the data gathering function of the tool lends itself to evaluation. By accessing the database generated through the use of the MCT, it is possible to examine the entire conversation surrounding the model-negotiation process, the individual and team models, and the action plans that have resulted from them. The richness of the generated data is one of the MCT's major intended features, and the power of having access to it is already evident.

It has also been clear from the beginning that controlled studies are necessary to determine what difference the tool makes in the group thought process. Many of the measurements must be made at the team level, which increases the number of individuals required to achieve statistical significance. This made it tempting to use a within-subject crossover design in hopes of achieving significant results with fewer participants. However, we were dissuaded from this approach by the Farnham study (2000), which demonstrated the dramatic carryover effect a tool can have if it is introduced during the team's forming stage. Therefore, we settled on a controlled, single-test design, with the understanding that even small tests of the early prototypes would provide needed guidance to the tool's developers.

Our design of the interface will be guided by the usability results, but it is the behavioral observations that are most insightful. The role of the tool in supporting development of leadership within the team is clearly a parameter to include in future design and testing, and it may be improved substantially by incorporating more advanced collaboration engineering into the interface. The difference in conceptual complexity between the test and control teams provides an indication of what measurements to take in future tests of the tool. The ability to categorize and manipulate concepts will have an impact of the success of negotiation among members of large and dispersed teams. Therefore, this is one point for investigation in validating the MCT.

CONCLUSION

The need to gather and use information and resources in responding to disasters calls for an integrated interface that can support large-scale collaborative efforts. It is the goal of the MCT development project to create such an interface. This collaboration tool will go beyond existing social networking tools that are increasingly being used by citizens for responding to emergencies. When it is fully developed, it will have a data entry interface that has been designed to allow easy entry, categorization, and visualization of large amounts of critical data. It will also have an interaction interface that supports the formation of ad-hoc teams and provides engineered collaboration protocols for negotiation of coordinated action. These two interfaces will form a basic functional unit, to which will be added a third, agent-augmented mixed-initiative interface to track and coordinate the activities of each unit with those of many similar units. In this way, we hope to break any large problem into small pieces and solve it in a coordinated manner.

In addition to gathering evidence on the importance of the data entry interface, we have gathered evidence on the impact of emergent leadership and the value of the directed negotiation process to the team's outcome. With this background, we expect the next version of the MTC to implement both a more sophisticated interaction interface, and a simple version of the agent-augmented coordination interface.

Another major change will be in our validation method. The MCT can produce testable results with almost any problem these teams are given; and our initial results with theoretical and non-critical problems were valuable to us as the developers. However, they will not validate the MCT's usefulness in an actual crisis. Therefore, we have determined that the more advanced prototypes of the MCT will be tested against an established disaster simulation interface. These tests will use NeoCITIES (McNeese et al., 2005), a computer-based scaled-world simulation designed to mimic the situation assessment and resource allocation tasks of distributed emergency crisis-management teams. This experimental approach will provide a holistic assessment of distributed cognition by providing real-time performance, tool-use, and team communication measures.

REFERENCES

1. Birnholtz, J. P., Finholt, T. A., Horn, D. B. & Bae, S. J. (2005) Grounding needs: achieving common ground via lightweight chat in large, distributed, ad-hoc groups. In: *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 21 - 30. ACM, Portland, Oregon, USA.
2. Briggs, R. O., de Vreede, G. J. & Nunamaker, J. F. J. (2003) *Journal of Management Information Systems,* 19, 31-63.
3. Convertino, G., Mentis, H. M., Rosson, M. B., Carroll, J. M., Slavkovic, A. & Ganoe, C. H. (2008) Articulating common ground in cooperative work: content and process. In: *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*, pp. 1637-1646. ACM, Florence, Italy.
4. Currion, P., de Silva, C. & Van de Walle, B. (2007) *Communications of the ACM,* 50, 61-65.
5. de Vreede, G. J., Kolfschoten, G. L. & Briggs, R. O. (2006) *International Journal of Computer Applications in Technology,* 25, 140-154.
6. Denning, P. J. (2006) *Communications of the ACM,* 49, 15-20.
7. Farnham, S., Chesley, H., McGhee, D., Kawal, R. & Landau, J. (2000) Structured online interactions: Improving the decision-making of small discussion groups. In: *Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work*, pp. 299-308.
8. Farnham, S., Kirkpatrick, R. & Pedersen, E. (2006) Observation of Katrina/Rita deployment: Addressing social and communication challenges of ephemeral groups. In: *Proceedings of the 3rd International ISCRAM Conference*, pp. 39-49. Newark, New Jersey.
9. Harrald, J. R. (2006) *Annals of the American Academy of Political and Social Science,* 604, 256-272.
10. Klein, G. L., Pfaff, M. S. & Drury, J. L. (in press) Supporting a robust decision space. In: *Spring Symposium on Technosocial Predictive Analytics (AAAI-TPA09)*, pp. Association for the Advancement of Artificial Intelligence, Palo Alto, CA.
11. Lavie, T. & Tractinsky, N. (2004) *International Journal of Human-Computer Studies,* 60, 269-298.
12. Lewis, J. R. (1995) *International Journal of Human-Computer Interaction,* 7, 57-78.
13. McNeese, M. D., Bains, P., Brewer, I., Brown, C., Connors, E. S., Jefferson, T. & al., e. (2005) The NeoCITIES simulation: Understanding the design and experimental methodology used to develop a team emergency management simulation. In: *Proceedings of the 49th Annual Meeting of the Human Factors and Ergonomics Society*, pp. 467-471. San Francisco, CA.
14. McNeese, M. D., Pfaff, M. S., Connors, E. S., Obieta, J., Terrell, I. S. & Friedenberg, M. A. (2006) Multiple vantage points of the common operational picture: Supporting complex teamwork. In: *Proceedings of the 50th Annual Meeting of the Human Factors and Ergonomics Society*, pp. 467-471. San Francisco, CA.
15. Mohammed, S. & Dumville, B. (2001) *Journal of Organizational Behavior,* 22, 89-106.
16. Newlon, C. M. (2007) Developing a tool for mega-collaboration. In: *New Media Consortium, Summer Conference 2007*, pp., Indianapolis, IN.
17. Newlon, C. M. (2008) Supporting mega-collaboration: A framework for the dynamic development of team culture. In: *School of Informatics,* Vol. Masters, pp. Indiana University, Indianapolis.

18. Newlon, C. M. & Faiola, A. (2006) Support for mega-team collaboration with cultural tools: Providing a framework for the dynamic development of team culture. In: *Proceedings of the '06 Conference on Cultural Attitudes Towards Technology and Communication*, pp. 235-254. Tartu, Estonia.
19. Newlon, C. M., Faiola, A. & MacDorman, K. F. (2008a) Building the mega-collaboration interface: Behavioral, cultural, and cognitive factors in visualization support. In: *Proceedings of the 12th International Conference on Information Visualisation, 2008. IV '08*, pp. 509-514.
20. Newlon, C. M., MacDorman, K. F. & Scerri, P. (2008b) A new model for mega-collaboration. In: *First International Workshop on HCI for Emergencies, CHI 2008*, pp., Florence, Italy.
21. Palen, L., Vieweg, S., Sutton, J., Liu, S. B. & Hughes, A. (2007) Crisis informatics: Studying crisis in a networked world. In: *Third International Conference on e-Social Science*, pp., Ann Arbor, Michigan.
22. Solomon, J. & Hsu, S. (2007) Most Katrina aid from overseas went unclaimed. In: *The Washington Post*, pp. The Washington Post Company, Washington, D.C.
23. Tuckman, B. W. (1965) *Psychology Bulletin*, 63, 384-399.
24. van der Veer, G. & van Welie, M. (2000) Task based groupware design: putting theory into practice. In: *Proceedings of the Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques,* pp. 326-337.
25. Vijayan, J. (2005) IT pros aid in search for Katrina victims - nonprofit groups, individual volunteers deploy technology to find the missing. pp. ComputerWorld.com.