

Community Response Grid (CRG) for a University Campus: Design Requirements and Implications

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ABSTRACT

This paper describes the initial stages of the participatory design of a community-oriented emergency response system for a university campus. After reviewing related work and the current University emergency response system, this paper describes our participatory design process, discusses initial findings from a design requirement survey and from our interactions with different stakeholders, and proposes a Web interface design for a community response grid system. The prototyping of the system demonstrates the possibility of fostering a social-network-based community participation in emergency response, and also identifies concerns raised by potential users and by the professional responder community.

Keywords

Emergency response, community response grid, CRG, participatory design, social network

INTRODUCTION

Pervasive and networked information and communication technology (ICT) has expanded the possibilities for community participation in disaster response. During the recent California wildfires, for example, residents used Web 2.0 applications such as Google Mashups and Twitter to report and disseminate real-time updates about the crisis (Glaser, 2007). Similarly, in the spring of 2007, as a gunman was wreaking havoc on the campus of Virginia Tech, students on the scene used camera phones to record and share firsthand information with mass media and responders (CNN.com, 2007). Such examples illustrate the potential power of communities sharing information about unfolding crises. Furthermore, ICTs have facilitated community participation during disaster recovery, including identifying victims, locating missing persons, finding shelters, and seeking relief-related information (Palen, Hiltz, & Liu, 2007a).

In light of the importance of ICT-enabled community response to emergencies, a research team at the University of Maryland (UMD) has begun to develop a community-oriented emergency response system – a Community Response Grid (CRG). First introduced by Shneiderman & Preece (2007), a CRG is a geographically-based sociotechnical network that helps local communities become better prepared for and more resilient to emergencies. Empowered by the Internet and mobile technologies, the system helps local communities establish multi-channel emergency communication, report emergencies to officials, receive information from official and community sources, coordinate peer-to-peer assistance, provide emotional support, and build trust.

This broad vision has served as a guide for our work presented in this article. Designing a CRG for UMD requires an understanding of design requirements, including community members' communication preferences and behaviors, and an understanding of how the CRG will fit in with the University's existing emergency plans and systems. After reviewing related work and the current University emergency response system, this paper describes our participatory design process, discusses initial findings from a design requirement survey and from our interactions with different stakeholders, and proposes a Web interface design for the CRG.

RELATED WORK

The field of emergency response research has paid considerable attention to building and evaluating emergency communication infrastructure (Turoff et al., 2004) and to improving organizational and cross-organizational crisis management using ICTs (Lundgren & McMakin, 2004). By contrast, little concerted effort has focused on the human side – how individuals and communities can contribute to ensuring the safety of themselves and those around them. Only recently have researchers begun to systematically study and value ICT-enabled community participation during emergencies. Research about the Pentalk Network – a grassroots computer network set up for farmers and their families at the height of the foot and mouth disease crisis in the UK – showcased the important role of ICTs (particularly the Internet) during a national crisis, revealing how that network not only served as an alternative information dissemination mechanism, but provided a virtual space for interpersonal contact, community discussion, and mutual help among farmers at a critical time (Hagar, 2005). Torrey et al. (2007) provided a nuanced analysis of how the online communities responded to Katrina by facilitating the distribution of donated goods from ordinary people to hurricane victims. They observed two forms of “connected giving” – small blog communities and large forums – and how they were different in managing information and developing trust. Palen, Hiltz, and Liu (2007a) reviewed several community-based online activities in responding to disasters, including online forums generated by the public to find missing people following Katrina and the FluWiki created for building collective knowledge about avian flu prevention. They concluded that the traditional, “linear information dissemination around crisis events from authority to news media to the public is clearly outmoded ... the potential for public involvement in our ‘networked world’ via online forums is only just beginning to be realized” (p. 57).

Research studies concerning community participation within school or campus communities are even scarcer. Most of the few studies about school-related emergency response have only focused on planning or evaluating school emergency response systems from the administrative perspective (Hayes, 2006; Hazinski et al., 2004; Sapien & Allen, 2001). The ethnographic study on the Virginia Tech crisis is a notable exception. In a recent article, Palen et al. (2007b) described some interesting information generation and dissemination activities among campus community members during the Virginia Tech crisis. For example, students used instant messaging (IM), Facebook, and other social networking tools to check the safety of friends as well as to inform others about their own safety. Wikipedia also enabled students and family to collectively generate an accurate list of 32 victims before the university released the information to the public. This research highlighted many potential contributions of ICT-enabled community participation in dealing with the unfolding crisis in a university community. CRGs can build on these strands of existing work and fill some of the important gaps that remain in current research (Jaeger et al., 2007a, 2007b).

CURRENT EMERGENCY RESPONSE SYSTEM AT THE UNIVERSITY OF MARYLAND

Like many other universities, UMD has an Emergency Operations Plan¹ which describes the University’s emergency planning, collaboration, and response policies and procedures. This plan is based on the functions and principles of the Incident Command System (ICS), and the planning committee is led by the University’s Department of Public Safety (DPS). DPS is responsible for managing declared emergencies affecting the safety of the university community. Initial response activities are also performed by DPS at the field response level, through the implementation of ICS principles (i.e., unified command, action planning, span of control, hierarchy of command, etc.) to identify, allocate, and commit resources.

UMD recently launched a text-message-based emergency alert system (UMD Alert) that allows authorized senders to instantly notify subscribers via e-mail and text messages sent to mobile devices.² Since its launch in April 2007, UMD put great effort into promoting the alert system to the community using various marketing strategies (e.g., displaying ads about the service on university busses). By the end of October 2007, over 13,000 students, faculty, staff, alumni, parents, and campus visitors had subscribed. Although UMD Alert and similar systems in use at other universities are great examples of ICT-enabled emergency communication, we have yet to see evidence of community-oriented response systems that encourage and engage community participation in university emergency preparedness and response.

¹ A copy of the Emergency Operations Plan can be viewed at <http://www.umd.edu/emergencypreparedness/umeop/>.

² For more information about the text messaging alert system, see <https://alert.umd.edu/>.

RESEARCH APPROACH

To explore the potential of ICT-enabled community participation in responding to campus incidents, we have begun prototyping a CRG for UMD. We adopt a participatory design approach for developing the CRG, including direct involvement of a diverse range of end-users and stakeholders, iterative prototyping of ideas, and constant reflection on technologies and work practices (Foth & Axup, 2006). Participatory design, as a meta-methodology involving both quantitative and qualitative methods, has become a standard design paradigm for developing information systems (Carroll & Rosson, 2007). In our research, we use multiple methods including interview, survey, observation, and usability testing to collect user needs and design requirements. We are engaging different stakeholders – students, faculty, staff, administration, and DPS – throughout the design process.

Our participatory, iterative design started with a conceptual design for CRGs. After that, we conducted a survey and multiple interviews to gather design requirements. Simultaneously, we began prototyping the CRG's Web component. Our prototype has evolved continuously as new design requirements emerge. Since we are undertaking the system design, in this paper we discuss the conceptual design, design requirements, prototyping, and future plans for evaluating the design.

THE DESIGN PROCESS

Conceptual Design

The conceptual framework of CRG design is shown in Figure 1. One fundamental theoretical assumption underpinning this research is that a CRG is built upon and supported by the existing social networks of a local community. Social networks not only constitute the community's communication structure but also play a critical role by encouraging community participation in the face of emergencies (Shneiderman & Preece, 2007).

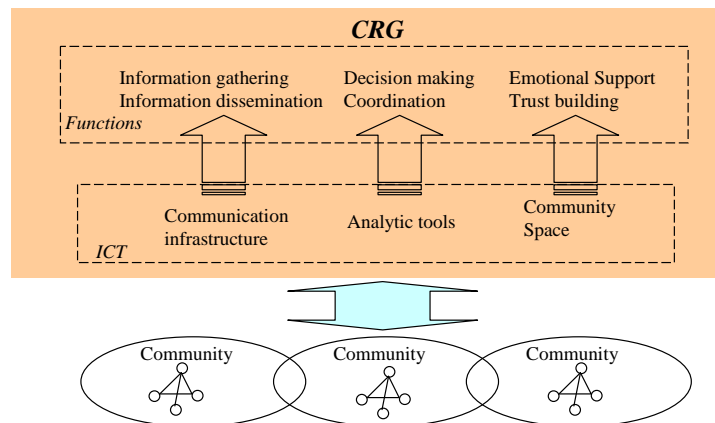


Figure 1: CRG Conceptual Framework

Three core types of ICTs are used to provide corresponding functions in CRGs. First, the infrastructure of CRGs should contain a hybrid system supporting multiple communication mechanisms via different media, such as the Web, radio, and landline or cell phones. Multi-channel communication ensures effective and efficient information gathering and dissemination within and beyond communities. In the event of disruption of one communication channel – for example, landline phone systems – information can still flow between community members and responders through IM, Short Message Service (SMS), and email.

Second, a set of analytic tools can help users synthesize the gathered information and analyze and visualize data, supporting decision making by community members and responders. Integrated in the CRG, these tools can help coordinate peer-to-peer assistance in communities. For example, an analytic tool can match people with medical expertise (e.g. doctors or nurses) in a community when individuals request medical assistance. Community volunteers could also use a calendar to schedule neighborhood patrols.

Third, CRGs provide Web-based communities that enable social interactions, such as an online forum where people share information and experiences, discuss community related issues, and seek emotional support. The community

space should foster trust in the community and encourage active involvement in emergency response. For example, acknowledging community members who offer help to others could encourage additional offers in the future.

Design Requirement Survey

As a first step in our design process, we created a questionnaire that focused on understanding the underlying social networks and communication infrastructure of a sub-community at UMD. This online questionnaire was distributed in early August 2007 to approximately 500 people (students, faculty, staff) in the College of Information Studies at UMD. The survey contained 17 multiple-choice questions, with some questions allowing open-ended comments. From August to October 2007, 128 responses (response rate 26%) were received from students, staff, and faculty, of which 113 were complete (88% completion rate). A distribution of respondents in different groups is shown below:

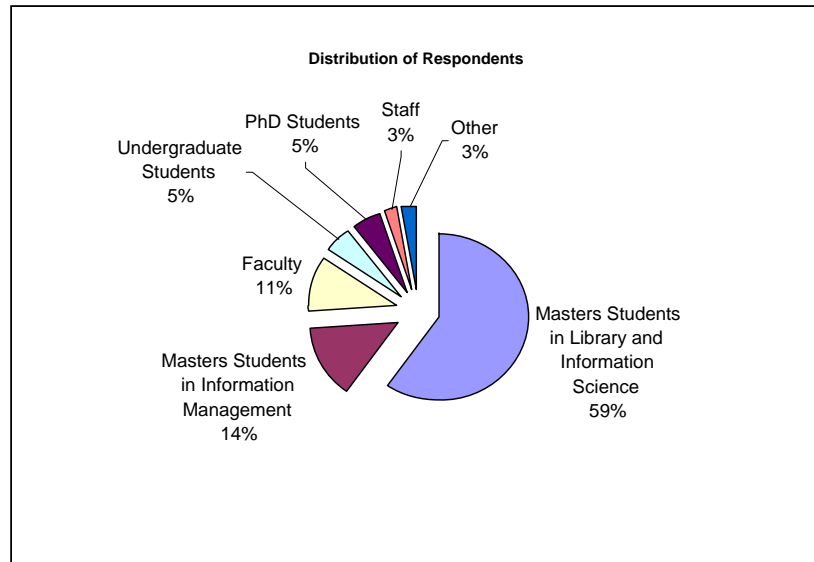


Figure 2: Distribution of Respondents

Questions covered three topics: 1) general communication behaviors, 2) cellular phone usage in emergency communication, and 3) experience and perception of emergency communication. Based on the survey responses, cell phone communication within the community was infrequent for most of the respondents (34% answered “Never” and 32% answered “less than once per month”). However, the respondents who used cell phones frequently employed them for communicating “everything”, from socializing to emergency use. As for learning about campus emergencies, 75% of the respondents reported getting emergency information from emails sent by UMD administrators, and 40% obtained such information from Website(s) maintained by UMD. Interpersonal communication was not a common means of disseminating emergency information. Only 19% received emails and 11% received cell phone calls from friends and acquaintances about campus emergencies.

While 95% of respondents reported owning a cell phone and 87% said they carry their cell phones almost all the time, only 64% used text messaging on their cell phones and even fewer (14%) used their cell phones to access the Internet. Free-text comments indicated that financial expense was the top reason for not using SMS. Most cell phone users only subscribe to the carrier’s voice plans; as a result, receiving and sending text messages both cost extra. Besides the cost concern, other reasons for not subscribing to SMS-based UMD Alert included: fear of spam, email notification seems sufficient, do not use or do not know how to use SMS/MMS, poor usability of SMS/MMS on cell phones, and lack of understanding of the purpose of SMS-based emergency reporting.

Survey results confirmed some of our initial design concepts, yet they also challenged our vision of using mobile devices and SMS for emergency reporting in such an educational community. To summarize:

- Diversity of communication used by the survey respondents strongly support the proposition that a CRG should be an online/offline hybrid system incorporating multiple communication platforms to promote sustainability and universal access to emergency information.

- Frequency of communications within and between social groups indicates active social networks in the College, laying the foundation for social network-based emergency response.
- Since the majority of survey responders obtained emergency information from official emails and Websites, a Web interface for disseminating emergency information is essential.
- An SMS-based emergency reporting mechanism may not be feasible for the population at this time. Although SMS shows great potential in reaching people “anytime, anywhere,” many respondents are still reluctant to use SMS (especially for sending messages) due to cost, usability, and other issues. Again, a Web-based form can be more usable for collecting reports from the community.

However, since the sample was drawn from a primarily graduate college, they may not be representative of the University population as a whole. The proportion of undergraduate students (5%) in the survey is much lower than the overall proportion of undergraduate students at UMD (58%). The degree of reluctance to use cell phones and SMS as methods of emergency communication as observed in the survey may be lower in the undergraduate population consisting mostly younger people (Rainie & Keeter, 2006). Therefore, we will conduct additional surveys in other colleges with larger undergraduate populations and compare the results before making final decisions about whether and how to integrate cell phone-based applications in CRG.

Interactions with University Emergency Response Officials

In parallel with implementing the requirements survey and collecting responses, we held multiple meetings with members of UMD’s Incident Response Team (IRT). We toured UMD DPS Headquarters and interviewed a high-ranking DPS officer. Presentations of and discussion about the CRG were also made for other senior technology, student affairs, and security administrators, which generated further informative suggestions from UMD officials.

While most university officials were positive about the idea of grassroots participation in emergency response, the major concern was the risk of spreading rumors and false alerts through the CRG, which could cause or intensify unnecessary panic in a time of emergency. As the DPS officer explained, “If you have everybody able to do peer-to-peer, then there is wide-spread panic.” The DPS officer also indicated that the social networking approach to emergency response may be valuable at the stages of preparation and recovery; however, during the phase of initial response to an emergency (especially dynamic and life-threatening emergencies), only first responders should be notified and be responsible for handling the situation. As the officer commented:

If you know somebody that is having a heart attack, or you know a bomb threat or fire, we don’t want you to go to the screen like this and log in and put in information – we want you to call 911! [CRG] may be good for some ongoing things, you know, like avian flu, like a snow-storm, not dynamic, life-threatening events...For dynamic, life-threatening emergencies, we don’t want to restrain the population to go to a Website...because we’ve, in the past 30 years, tried to train the public: emergency – 911, emergency – 911.

On the other hand, the officer is enthusiastic about having a CRG that can help to gather, organize, and disseminate information following a disaster. For example, students may post their own safety status on a CRG immediately after a disaster so that parents can check out the site and see if their children are safe. The officer also acknowledged that in a situation when there is a disruption of 911 service, a Web-based system allowing people to send IM or SMS messages to the police would be “very helpful.”

The feedback from professional responders points to the question: what is the most appropriate role for CRGs in emergency response? Although it is quite clear that CRGs may facilitate peer-to-peer communication during emergencies, professional responders seem to be concerned about the content of such communication and its potential negative impact on professional operations. On the one hand, we may challenge the validity of these concerns given that they are situated within the traditional model of emergency response which does not focus on community participation; on the other hand, we must come up with convincing strategies to integrate CRGs into current emergency response practice such that CRGs complement, rather than interfere with, professional responders’ operations.

Based on our interactions with professional responders and university officials, we refined the roles and functionalities of CRGs in the following ways:

- In non-catastrophic situations, reporting through CRGs will be restricted to “slow-moving” or minor emergencies. We will clearly advise CRG users to continue to rely on the 911 system for initial response to “dynamic, life-threatening” emergencies that have to be handled by professional responders.
- In catastrophic situations when the 911 system is overloaded, CRGs will serve as an alternative channel for communication both within communities and between community members and responders. In other words, robust communication should be built into CRGs so that CRGs may act as backup systems during catastrophic events when the current emergency response infrastructure goes down.
- Provide multiple tools to support information sharing and collective action in pre-disaster preparation and post-disaster recovery. For example, in addition to an online forum where members can discuss emergency preparedness tips, a wiki should be added for collective problem-solving such as confirming safety status of individuals, locating missing people, etc.
- To address concerns about false alerts and rumors, we can link CRG user accounts with the UMD directory so that every registered user is potentially identifiable. This strategy should significantly reduce irresponsible rumor spreading commonly seen in anonymous online forums.

Web-based CRG System Prototyping

Based on what we learned about design requirements and about expectations of professional responders, we decided to focus for now on developing a Web-based CRG system as it allows us to explore CRG functions and provides a platform for future extension and exploration. Other communication mechanisms, such as SMS on cell phones, will be incorporated into the CRG in later stages.

We expect our system to fulfill the following goals (G1-G8):

- G1: Provide timely, accurate information about community safety status, including emergency-related news, updates on unfolding emergency incidents, and an overview of the campus safety status.
- G2: Provide guidance and a knowledge base for *pre-disaster* preparedness, including emergency contacts, emergency preparedness guidelines, best practices, safety tips, past events, and lessons learned.
- G3: Provide a set of tools for information gathering and collective problem-solving in *slow-moving* or *post-disaster* situations. As demonstrated in the previous literature, bulletin board system (BBS), wiki, and Google Mashup are likely to be useful for such tasks.
- G4: Allow Web-based reporting of *slow-moving* or *minor* incidents. A user will be able to fill out a form on the CRG and post emergency information such as alerts or requests for help.
- G5: Facilitate and coordinate peer-to-peer assistance. In addition to having a platform for users to post and answer help requests, a CRG should also provide intelligent tools to facilitate the mutual help process. At the same time, a CRG should recognize peer-to-peer assistance accomplished through using the system.
- G6: Establish a mechanism for maintaining emergency awareness and CRG participation. It is important to provide fresh and useful content so that CRG users may visit on a routine basis. Email-based digests and reminders may be sent to users periodically. Online interaction space is also essential for strengthening the community’s existing social ties and expanding these social networks so that a support network is readily available when needed.
- G7: Maintain a balance between protecting user privacy and ensuring authentic identity. On the one hand, each CRG user must have authentic identity information stored in the system; on the other hand, a CRG user must have the choice to conceal personal information.
- G8: Ensure that the CRG compliments, enhances, and functions in conjunction with existing emergency reporting systems, particularly 911.

While most information on the current prototype of the UMD CRG home page (see Figure 3) is self-explanatory, two major components deserve elaboration. First, the campus map is a Google Mashup – a mapping application that allows users to add features and data to the Google Map interface. Colored dots on the map represent locations of incidents reported by CRG users, using the Web form provided in the “Report Incident” section (where we advise users to use 911 if the incident is urgent and life-threatening). A floating text box with a brief description of the incident appears when a user clicks on the dot. Second, following the customized welcome message including the user’s name, the user’s group memberships, and affiliations are displayed (with hyperlinks). We believe such information is important because it reinforces the user’s sense of community and may serve as a motivational factor in offering help to others in the community (Levine et al., 2005; Sturmer, Snyder, & Omoto, 2005)

What distinguishes our CRG from other emergency response Websites is its facilitation of peer-to-peer assistance. A CRG user can request help when reporting an incident, and other community members may choose to offer help when they see the request. This functionality is illustrated in the mock-up of the “Offer Help” page (see Figure 4). After clicking on the “Offer Help” link preceding any request in the table, detailed information about the request and the requester’s contact information will be provided.

Table 1 shows the mapping between the desired goals and the proposed components on current mock-ups:

CRG Goal	CRG Web Component
G1: Provide timely, accurate information about the community safety.	“Breaking News” and the Google Mashup on the home page.
G2: Provide guide for <i>pre-disaster</i> preparedness.	“Training & Preparation” section; important contact numbers listed across different pages.
G3: Provide tools for information gathering and collective problem-solving.	“Report Incident” Web form; Google Mashup on the home page; discussion forum and wiki under “Forum & Wiki.”
G4: Allow Web-based reporting of <i>slow-moving</i> or <i>minor</i> incidents.	“Report Incident” section.
G5: Coordinate and recognize peer-to-peer assistance.	“Offer help” section; list the resolved events with names of those who provided help in “Past Events” section.
G6: Establish a mechanism for maintaining emergency awareness and CRG participation.	Discussion forum for daily interactions; frequent updates of emergency-related information on the home page.
G7: Maintain a balance between protecting user privacy and ensuring authentic identity.	Except for publicly available information such as name and affiliations, other information about the user may be concealed through editing “My Profile.”
G8: Ensure that the CRG functions in conjunction with existing emergency reporting systems.	Important contact numbers listed across multiple pages; in “Report Incident” section, advising users to report <i>urgent, life-threatening</i> incidents directly to the police using 911.

Table 1: Mapping between CRG Goals and Web Components

The current interface mock-ups resulted from iterative evaluations. We presented versions of the mock-ups to university officials and police in our meetings and interviews with them. After several rounds of brainstorming and modification, we showed color printouts of the mock-ups to two UMD students in two interview sessions. Interviewees’ suggestions ranged from changing the font color to the main functionalities of the interface and were integrated in the current interface design. In the future, we plan to conduct more rigorous user testing on the interface with more users across different stakeholder groups.

Figure 3: Home page of the UMD CRG

Status	Requested by	Situation	Time & Location
Offer help	 A. Lee UMD Movie Club	My car is dead at the parking lot. It's almost midnight now and I'd rather deal with AAA and towing tomorrow morning ... (read more)	Time of Request: Oct 21, 2007 Sun 11:25 pm Location: Parking Lot #1
Offer help	 Dr. Smith iSchool	There seems to be an outbreak of flu virus. We need someone in each dorm to report infection status ... (read more)	Time of Request: Oct 21, 2007 Sun 11:10 pm Location: N/A
Helped by	 J. Wang CSSA	I'm in McKeldin right now. Can anyone walk me back to my apartment located near the university bookstore ... (read more)	Time of Request: Oct 20, 2007 Sat 11:55 pm Location: McKeldin Library

Figure 4: “Offer Help” page

FUTURE STEPS

This CRG is still in development. Many challenges must be addressed before the UMD CRG will be ready as a full-fledged, cell phone and mobile device accessible emergency response system. In our future research, we will explore solutions to issues such as:

- Information organization and filtering. Since the UMD CRG provides multiple tools for users to contribute information, it is important to determine how to organize, synthesize, and filter the information so that it is useable to both community members and professionals. Our current design partially address these issues. For example, we visualize reported incidents on a Google Mashup so that users can see what is happening on campus by looking at the map. On the “Offer Help” page, we provide options of sorting requests by status, time, location, and requester. For the discussion forum, we plan to experiment with collective filtering and sanctioning by deploying a reputation mechanism similar to that of Slashdot and Digg.
- Human moderating. Besides computer-assisted information organization and collective filtering, it is also necessary for human moderators to constantly monitor CRG-based activities, provide technical assistance, and disseminate information from and transmit information to authorities. We will rely on the UMD community by recruiting students, staff, and faculty to serve as volunteer moderators. These volunteers will perform daily maintenance tasks. In times of emergency when there is a large amount of reports or requests, however, university officials need to have designated personnel work with community volunteers to gather valuable information and facilitate community response.
- Security, privacy, and integrity of information. As in many publicly accessible information systems, CRGs have to deal with issues regarding users’ privacy, data security, and information integrity. Nevertheless, CRGs tend to be susceptible to these issues due to its impact on the community’s everyday life and the vulnerability of victims during an emergency. For example, a false alert of a campus shooting may cause widespread panic that could seriously disrupt the routine order of the community. One way to prevent such abuses is to link CRG user profiles with the UMD directory so that every registered CRG user can be tracked down if needed. We will continue to explore the avenue and experiment with other security methods.
- Functionality and interface design of mobile CRG. As discussed earlier, a robust CRG should incorporate multiple communication channels to ensure redundancy of emergency communication. Battery driven mobile devices are especially useful in emergency situations when Web access is often not available or bandwidth is limited. We will survey more undergraduate students at UMD and start to plan a mobile CRG that provides the same vital functionalities of Web-based CRG but fit the smaller screen of handheld devices.

CONCLUSION

The research detailed in this paper represents the early stages of a long-term research effort. We have involved different stakeholders – students, faculty, staff, administrators, and professional responders – in the design process to constitute a comprehensive picture of user needs and design requirements. The prototyping of a CRG for UMD demonstrates the potential of social network-based community participation in emergency response. We have identified some challenges raised by professional responders and potential CRG users, and refined our design accordingly. We have conducted some preliminary evaluations and interviews with potential users and will continue throughout development and testing. We will continue to situate CRGs within the big picture of emergency preparation, response, and recovery so that community participation may supplement professional emergency response.

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