Supporting "Everyday Analysts" in Safety- and Time-Critical Situations

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1. Leysia Palen [CORRESPONDING AUTHOR]
Department of Computer Science
University of Colorado at Boulder
palen@colorado.edu
http://cs.colorado.edu/~palen/

2. Sarah Vieweg
Alliance for Technology, Learning and Society Institute
University of Colorado at Boulder
sarah.vieweg@colorado.edu
http://www.sarahvieweg.com/

3. Kenneth Mark Anderson
Department of Computer Science
University of Colorado at Boulder
kena@cs.colorado.edu
http://cs.colorado.edu/~kena/

CORRESPONDING AUTHOR:

Prof Leysia Palen, palen@colorado.edu
430 UCB
Department of Computer Science
University of Colorado
Boulder, CO 80309-0430

ABSTRACT. The need for quick, timely and accurate information is critical in emergency events. People assemble information from both official and unofficial sources. As digital access expands, people will increasingly incorporate digital sources into decision-making and assess it against the local circumstances they experience. If we extrapolate to what such behavior means for the future, we argue that information management under emergency conditions will need to become increasingly socially distributed. A natural point of contention in such a view is the matter of how to assess the quality of information: how "good" or "bad" it is; whether it is "misinformation" or "disinformation." Borrowing from Simon's *satisficing*, we consider the matter of the assessment of information helpfulness and credibility as a function of the "everyday analytic" skills that people use to take action during mass emergencies. We discuss steps in a research agenda for the development of analytical support tools.

KEYWORDS: Computer Mediated Communication, Crisis Informatics, Citizen Response, Disasters, Widescale Interaction

INTRODUCTION

Access to timely and accurate information during times of mass emergency is the means by which those in affected areas may reduce or even avoid the impact of devastating events. Emergency management personnel try to convey the best information possible to members of the public, as those residents in turn assemble information from multiple sources to make decisions (Sorenson & Sorenson, 2006).

In times of emergency, people supplement information from official sources with information from friends, family and neighbors but also, increasingly, through on-line official and grassroots sources (Drabek, 1986; Schneider & Foot, 2002; Hagar & Haythornthwaite, 2005; Sorenson & Sorenson, 2006; Mark & Semaan, 2008; Hagar, 2009). Intensified information search (Turner, 1990; Dynes & Tierney, 1994) is one of the characteristics of disaster and mass emergency conditions. Complementarily, offerings of assistance and the rise of an "altruistic community" (Drabek & McEntire, 2003) during times of disaster are other characteristics of large-scale, unexpected disruption.

The expansion of the digital world and digital access through a growing array of personal information and computing technology (ICT) that include "Web 2.0" or social media services and applications means that resources for seeking information and providing help during mass emergencies have also blossomed. Though accessing digital sources of information is undoubtedly growing, use of digital sources and digital communications is difficult to measure both during and across many mass emergency events: The pace of the events; diffuseness of affected populations; the vastness of the attendant, interested but geographically remote populations; the differences in features across events; and rapid technological change itself make it difficult to know precisely to what degree social media is incorporated into on-the-ground decision-making by members of the public.

However, based on many indications of digital expansion (mobile telephony diffusion, continued website proliferation, social networking site (SNS) growth and end- user innovation) and—critically—the socio-technical innovativeness of CMC interactions, the use of digital media will continue to expand its role in emergency response activity. It is critical that we understand the

nature of these information-sharing activities to shape the future where mass coordination will be more commonplace so that such observations shape innovation, policy and practice.

Objective

Here we consider the matter of assessment of information credibility and helpfulness as a function of the "everyday analytic" skills that people must employ to assess and take action in the face of emergency. We discuss how helpfulness is constructed between multiple actors in emergency situations as mediated through CMC. In safety- and time-critical situations, the major concern with respect to yielding some authoritative control to "crowd sourcing," for example, is an unrealistic attachment to the ideal of *accuracy.* (Even in research communities that are attuned to the realities of human behavior in practice, we find this to be the case). Our claim is that if we do not attend to our assumptions about information quality in time-, safety-critical, and information-impoverished situations, we restrict opportunities to work toward far better solutions than we otherwise could, and we impede progress in technical innovation, practice and policy. These opportunities include supporting the "everyday analyst."

HELP & COMPUTER MEDIATED COMMUNICATION

Related Research

"Help" has been a prevailing theme in computer-mediated communication since the dawn of the internet (Kollock & Smith, 1996). Pre-web environments like Gopher and Usenet; the pre-web rise of the practice of FAQ creation; as well as other environments that thrived regionally such as Zephyr (Ackerman & Palen, 1996) indicate that question-and-answer type interactions were important to the earliest forms of computer-mediated communications.

In the CHI and CSCW literature, the notion of "help" has examined such exchanges under non-emergency conditions, and have centered on matters of expertise location (Ackerman & Malone, 1990; Ackerman & McDonald, 1996; Ackerman & Palen, 1996; McDonald & Ackerman, 1998; McDonald, 2001; Zhang et al., 2007); recommender systems (Herlocker et al., 2004); suggestion systems (Cosley et al., 2007); collaborative filtering (Amento et al., 2003); collaborative and remote help-giving (Twidale et al., 1997; Twidale & Ruhleder, 2004; Crabtree et al., 2006; Nam et al., 2009) and help in the achievement of knowledge management (Halverson et al., 2004).

Online social support is another means of offering CMC-based help. People have long turned to the internet as a place to show and find support. They come together online to participate in social support communities for reasons that including sharing experiences and offering advice (Farnham et al., 2002; Pfeil, 2007; Pfeil & Zaphiris, 2007, Preece, 2000). Similarly, in the mid-90s, Wellman (1996) explains how CMC environments support question and response exchanges, and, with colleagues in (Wellman et al., 1996), also points out that "despite the limited social presence of CMC, people find social support, companionship, and a sense of belonging….even when they are composed of persons they hardly know" (p. 220). In addition Maloney-Krichmar and Preece (2005) reported on a multi-year study that examined aspects of a popular online health community. Their work led to recommendations for those who develop, manage and design such sites as they "improve the lives of people as they seek to cope with illness, disease, injuries and health concerns" (Maloney-Krichmar & Preece, 2005). This sample of work on CMC-based help—whether for purposes of knowledge management, content or product recommendation, or seeking health and emotional support—summarizes how features of online forums can assist through enhanced knowledge, words of encouragement or pointers to sources. However, a central matter is how we come to call these conditions "helpful."

"Helpfulness" is not an inherent quality of information. Helpfulness is instead constructed by context, where consumers—and even providers—recognize, explicitly or otherwise, that it is often *relative to what is needed*. It is this point that is central to our understanding of helpfulness of information in mass emergency settings, and positions how we might design for "everyday" analytical support for navigating and sifting through large amounts of quickly-generated CMC-based information sprawled across the net.

CMC Help in Emergencies

In mass emergencies, help comes from a variety of sources (including government agencies, public and private groups, and volunteers) and in both material (child care, food, medication) and situational (directions, warnings) forms.

The roles served by members of the public will shift and change in quality because of changes in speed and reach of information production through ICT (Palen & Liu, 2007). CMC-based emergency-behavior has not yet become normative; rather, it is clearly evolving across disaster events (Liu et al., 2008; Palen & Vieweg, 2008; Vieweg et al., 2008), with users of photo repository sites, microblogging applications, social networking sites, texting applications, blogs and plain vanilla web pages continuing to adapt and expand the tools and their behaviors over time.

We are at a critical juncture in our society: "social media" and Web 2.0 interest will approach critical mass (if it hasn't already).[1] In the emergency response arena, grassroots efforts are numerous (Schneider & Foot, 2002; Hagar & Haythornthwaite, 2005; Palen & Liu, 2007; Shneiderman & Preece, 2007; Sutton et al., 2007; Torrey et al., 2007; Liu et al., 2008; Mark &

[1] According to Quantcast.com on September 15, 2009, Twitter.com receives over 28 million hits per month, Facebook.com over 95 million hits, and MySpace.com over 58 million hits.

Semaan, 2008; Meier & Brodock, 2008; Qu et al., 2008; Shklovski et al., in press; Shklovski et al., 2008; Wu et al., 2008; Mark et al., 2009; Palen et al., 2009). We can expect ICT-abetted assistance to continue to grow at rates similar to the growth of Web 2.0 and social networking activity. In addition, in terms of formal inclusion, government agencies are beginning to seriously consider how to incorporate the use of the web and social media services and applications in their public communications, though they struggle with what it means to do so for current and uncertain future situations. One example of current, new uses of social media by government agencies include the US Center for Disease Control's social media tool suite for information about the H1N1 (swine flu) virus (CDC, 2009).

CMC Helpfulness: What's the Good, the Bad & the Ugly?

However, an overarching concern about CMC-based communications in the emergency space remains: for information to be helpful, it must have some reliable degree of accuracy. But how does one judge information accuracy, especially under dangerous and threatening conditions, where the source might be something not immediately recognizable as authoritative? How do we—in practice and in theory— judge peer-generated information to be "good?" To what degree do we worry about "misinformation" or even "disinformation," and how do we identify it, lest it damage our trust in the "good?"

These are questions at the core of all aspects of emergency response, and indeed, for any kind of inquiry about matters where answers are uncertain, but where individuals are in a position to nevertheless take some kind of action or remedy. For this particular domain of investigation, an understanding of "helpfulness" contributes to a range of concerns: individual behavior, agency behavior, and—critically to the matter of human-centered computing development concerns—design of technical solutions that assist people to sift through and make *satisficing* (Simon,

1996), or locally optimal, judgments about information under pressures of uncertainty and time criticality—a clear case of bounded rationality in operation.

Our contribution in this paper focuses on a discussion of higher-order features of CMC-produced information created under conditions of mass emergency, when the need for help is at a premium. With this, we take the discussion away from "good" and "bad" and show how actionable helpfulness is achievable through a range of features with respect to information and source. This also helps us think about how to collate information for future ICT systems, how to inject metadata into CMC sources that makes these attributes more obvious to the everyday person, and in general lends power to people by enhancing their abilities to be "everyday analysts."

APPROACH

The discussion here is the result of having engaged with qualitative and quantitative matters of information generation and seeking over multiple mass emergency events in recent years including 2005's Hurricane Katrina, the April 2007 Virginia Tech shootings, the October 2007 Southern California Wildfires, the February 2008 Northern Illinois University shootings and the March/April 2009 US Red River Valley floods (Palen & Vieweg, 2008; Shklovski et al., 2008; Palen et al., 2009; Starbird et al., 2010; Vieweg et al., 2010).

We restrict discussion to matters of mass emergency, rather than crises in general. "Crisis" includes a large number of events, both personal and shared, many of which we do not include in a research program on *crisis informatics* (such as a personal crisis or an economic crisis). In this discussion on helpfulness, it is necessary to restrict ourselves to events that have constrained

temporal and geographical extent (even if they are lengthy or broad) that affect large numbers of people, and bring everyday life to a standstill. Pandemics, as we are learning in other related but still preliminary research, appear to have different information production and seeking activities, perhaps in part because of the stigma attached to embodying the invisible agent (the H1N1 virus for example); because of the prolonged latency of the hazard; and because much of social life is still running under so-called "normal" conditions. Therefore we restrict our consideration here to mass emergencies—large-scale events that affect a broad population; cover a focused geographical region; result in extensive damage to people and/or the built environment; and have sustained disruption to the social order. They can occur naturally, or be accidentally or deliberately instigated.

SHIFTING AWAY FROM "ACCURACY" AS A GOLD STANDARD

The task for a person affected by a regional emergency is one of assembling information from multiple sources (Sorenson & Sorenson, 2006). This task has become increasingly burdensome—though possibly produces higher yield (Sutton et al., 2008)—because people now attend to traditional media while often navigating new and information-flooded CMC forums under pressures of time and risk.

This is, needless to say, a difficult problem upon which socio-technical solutions for critical situations rest. The consideration of the issue of helpfulness that we examine in this paper is in response to design needs; it is also in response to visceral reactions—even by those who are otherwise technology/social media enthusiasts—to the idea *that emergency response will need to move away from framing information as something to control and carefully disseminate*. We instead need a fundamentally different perspective, which is that *information activities must be*

more socially distributed. People, capitalizing on already built-in traits of analysis (Shapiro, 1994) will be able to have enhanced means (that is, technological support of existing social processes) to arrive at the most optimal solutions for their individual situations.

The core basis for this shift in perspective lies in the argument that, even in matters of emergency, people behave—and can only behave—to optimize within a bounded rationality (Simon, 1996). The mistake often made when considering matters of *technology solutions in the emergency space* is the presumption that the standard for helpful information must be "accuracy."

This is an impossible standard to attain under conditions of mass emergency, when broad swaths of populations, the ecology and property are often affected. This is true not only for members of the public, but also emergency management. Emergency managers are reluctant to release information that they cannot deem accurate. The risk in doing so is obvious; no one wants to be wrong and put people at additional risk. The problem is that emergency managers know that they themselves can only reach standards of satisficing when situation reporting and making determinations about the quality of information. It is an illusion to believe that anyone has perfectly accurate information in mass emergency and disaster situations to account for the whole of the event. If someone did, then the situation would not be a disaster or crisis.

The whole information arena in mass emergency events is one that can only satisfice because, as Simon explains, the "complexity of the environment is immensely greater than the computational powers of the adaptive system" (Simon, 1996, p. 190). This bounded rationality is true for all aspects of human life; the problem in disaster is that we tend to resist the idea even more. Such a view might be no surprise to those who study human computer interaction issues for so-called "normal" conditions. We have found, however, that people who otherwise understand the

challenges of managing uncertainty nevertheless apply different standards when planning for—and designing technology for—times of crisis. We would rather that someone know what to do to better limit the terrible outcomes that might ensue. When circumstances are dire and tragic, the desire to find knowledgeable and accurate sources runs deep.

So then, when we imagine the inevitable world to which we are moving, where ubiquitous technology and rapid generation and movement of CMC information fundamentally constrains permissive reasoning about information control, we quickly run aground with the presumption that "accuracy" can be the gold standard by which concession to the social cognition (Hutchins, 1995) and collective intelligence (Hiltz & Turoff, 1993) of the public is made. Even then, we have reason to believe that information produced by members of the public has the potential to be more accurate than we might presume (Palen et al., 2009). Therefore, it is not so much a question of accuracy, but a question of *ascertaining helpfulness* that is the primary operational issue.

CONSTRUCTING HELPFULNESS: INFORMATION OR SOURCE AS POINT OF ENTRY

Before helpfulness can be offered, judged and acted upon, people involved in mass emergency situations must first assess their situation. A prevailing aspect of mass emergencies is lack of knowledge about the circumstances, which leads to ambiguity about what decisions to make and actions to take. As Landgren (2007) explains in his extension of Weick's (1988) writings, people must overcome this sense of ambiguity if they are to act, and they do so by "actively transforming ambiguity into risk." Seeking and using CMC-based sources does two things: it goes toward translating ambiguity in the system into some form of risk assessment. In turn, the

assessment of risk arms the seeker of knowledge in the heterogeneous array of CMC information with something to measure "found" information against, and to make local decisions of helpfulness of that information.

The Seeker's Orientation to Information vs. Source

Historically, people have sought information from what we might call conventionally trusted sources; sources such as local emergency personnel or local media outlets, as well as from their neighbors and area friends and family (Sorenson & Sorenson, 2006). With the advent of web search, and the generation of CMC-produced information (though not necessarily "data") from several and unknown sources, seekers often find that they have access to information first—rather than source first—and have to make differently engineered judgments about its viability.

The power of online search, where users can plug in a search query, results in numerous possibilities to investigate. People might search on source name such as "Federal Emergency Management Agency," in which case they might be led to FEMA's official page. But they will also investigate based on partial information that they have at hand, to locate, for example, where they can find goods and services, as happened here during the run up to Hurricane Gustav:

UserX City Network, August 30, 2008 16:42: Which Home Depot has the generators? Thanks!

UserY NearbyCity Network, August 30, 2008 16:49: I know Home Depot in Slidell has generators, or at least they did last night.

The orientation of the seeker here is to the information, with an apparent willingness to field answers from unknown sources. People will also look for information about details of impending

hazards, such as the eyewitness location of a "fireline" or other situational indicator. For example, an analysis of Twitter activity during the March/April 2009 Red River Valley flooding in North America shows Twitterers who referenced area buildings in their information relay:

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I heard earlier that Hjemkomst Center had gotten water in the
lowest level.
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With such answers from unknown sources (who possibly cite other unknown sources), seekers must decide if they will trust the information and/or the source, and what risks would be incurred if the information is incorrect.

Trust is a component involved in assessing the credibility and riskiness of information and/or sources and its achievement is a pursuit of the "everyday analyst." Grabner-Kräuter, Kaluscha and Fladnitzer write that "the need for trust only arises in a risky situation, therefore trust would not be needed if actions could be undertaken with complete certainty and no risk" (2006). When considering emergencies, stakes are often quite high, so credibility must be established quickly, though often only partially, before one decides what to do (or not to do) with it. The achievement of trust is again a satisficing goal for the everyday analyst, especially without benefit of additional support to further verify information (see Discussion for elaboration on this point).

Provider-Seeker Relationship in Trust Building: Seeker Inference and Recipient Design

The achievement of trust in such settings is done through a variety of means. Seekers must look for indicators that go toward some satisficing achievement of trust: they must often make *inferences* from indicators that would suggest trustworthiness. Providers, if aware that they have an audience and understand the relationship between what they write and how it might be consumed—"recipient design" (Sacks et al., 1974)—might provide explicit indicators of credibility.

Trust is achieved through a number of ways borne by both the seekers and the providers, and not always simultaneously or with awareness of the relationship between those in the information exchange. Though CMC-based providers and seekers may not have intersubjective understandings upon which information exchange can depend, some interplay exists between how information is understood and negotiated by both seekers and providers.

Therefore, in striving to make decisions, information seekers may rely upon socio-technical affordances that lend themselves to displaying both direct and indirect offers of credibility. Sometimes the onus is on the reader or receiver of information to make inferences about the postings of others, particularly when those who post information do not (or cannot) take a larger audience into account. Information displayed in a public place may be of interest to the reader, or relate to his/her situation in some way, but it remains up to the reader to assess its credibility.

On the other hand, some providers of information convey their awareness of the larger audience through the way in which they "design" their communications for their known, unknown or anticipated future recipients (Sacks et al., 1974). Word choice, reference to sources, and other tactics can all serve as indicators of credibility.

CHARACTERISTICS FOR JUDGING HELPFULNESS

In this section, we discuss how features of computer-mediated communications are used to establish source-level credibility and information-level credibility as input to the everyday analyst. We also discuss how temporality figures into the assessment of helpfulness, especially in times of crisis. Finally, we consider how the absence or presence of unexpected information are characteristics of helpfulness.

Establishing Source-Level Credibility

Throughout our research, we see instances of people displaying trust-inducing behavior in the form of credentialing, as seen in the examples above. Such behavior can be comprised of several components, which may be inferred by the audience or designed by the information provider. Examples include identifiable network affiliation; presentation of local knowledge; self-correction or hedging (i.e. stating information is uncertain, but believed to be correct) and words of support and/or encouragement.

Existing Credentials

Information might be considered "good" as a starting point if it is provided by a source that is previously deemed credible by a seeker. Some providers of CMC-based information have pre-existing credibility, such as police officers, emergency personnel, local media personalities, and weather forecasters, among others. For example, during the Red River floods of March/April 2009, certain locally-known media personalities posted information via Twitter:

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Public works director says a leak was found in one of the
temporary dikes in Wahpeton. It's been repaired. A backup
dike's been added.
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Fargo Red is climbing a tenth of a foot per hour, now over 40.1
to 40.2, about to set a new record, surpassing 1897.
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Both of these messages provide readers with information relating to the flood threat, and carry with them a degree of information trust because both sources are previously credentialed. However, we know that information seekers will continue to incorporate this information into the bricolage of information they are gathering, but the work that they must to do to verify the source in this information class has, in a sense, been done for them.

Offering of Credential-Worthy Information

Active credentialing on the part of the provider is also at work. Some providers are aware that they are communicating with a (sometimes) large audience and write to suggest credibility. People will do this by providing links to proffered information as a reference; mention connections to already credentialed organizations and people; and refer to other indicators of status and access. An excerpt from recent research on the Red River Floods (Starbird et al., 2010) illustrates this last point, where, in a Twitter post, "riverfisher" (usernames are pseudonyms) credentials fishermen as an authoritative source in this kind of event:

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more red river floods pics from anglers on the front line
http://tinyurl.com/anonymous
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In the earlier generator example, UserY offers information that presumably could be understood best if one had local knowledge. She mentions a Home Depot in Slidell, a town about 30 miles from New Orleans: this demonstrates local knowledge. This author also self-monitors when she writes "at least they did last night;" indicating that she is uncertain about the present status of generator stock, and UserX should be aware of the possibility that the generators may be sold out. UserY's response to UserX's question is designed such that credibility is invoked.

Credentialed Through Information Activity

However, what is also at work more than ever before in CMC is the ability to make inferences about credibility through other CMC features. Many CMC authors during mass emergencies are not previously credentialed. They instead emerge as sometimes sudden information providers. The burden is upon the seeker to assess credibility; one of the ways to do this is to construct the credibility through the provider's information activity. Some providers will anticipate the need to offer credentials through such means.

There are a number of ways an information seeker will verify the credentials of providers: from network affiliation, audience indicators, frequency of postings, demonstration of local knowledge, willingness to self-correct, evidence of cross-verification among others.

Network Affiliation. In social networking sites, for example, users display a network affiliation by city, workplace or institution. When seeking information about an emergency in a specific location, affiliations—which can serve as an indirect offer of credibility—can be one basis for inferring credibility through proximity to the event.

For example, during the aftermath of the 2007 Virginia Tech (VT) shootings, a Facebook participant affiliated with VT acted as the unofficial moderator of a discussion group that focused on compiling a list of the 32 victims. He self-selected to manage posts to the discussion by making sure sources were cited and information was accurate (Vieweg et al., 2008).

Audience Indicators. Another indication of credibility originates with the audience. Large audience size can act as an indication of credibility. Sites with many participants, or people with many followers or connections might be judged as being trusted by more people. Additionally, when large audiences converge online, there is more opportunity for receiving answers to questions and information correction and corroboration.

Posting Frequency vis-à-vis Content. The rates at which people post information can be used as part of the credibility composite. Consistency and frequency might carry value, if the source aims to be a hub. However, frequent posting alone does not indicate credibility; some simply regurgitate information that adds additional noise. Others establish competence through not only posting frequently but also offering reliable, pertinent information.

Self-Correction and Cross-Checking. An additional example taken from SNS activity that occurred after the Virginia Tech shootings displays credentialing through cross-checking. Once list-building activity began in earnest, people quickly realized there was a need to offer sources for proffered information. An emergent norm began whereby participants posted sources along with victim names (Vieweg et al., 2008; Palen et al., 2009).

In another example, a Twitterer who eventually gained popular attention during the 2007 Southern California Fires would correct information that he had previously posted in his high-frequency tweet stream. Self-correction—which might arise in response to a listener who read and corrected or added new information—adds credibility. This, in turn, if we rely on market-based theory, should gain more listeners. The larger audience should result in better overall system correction (Sutton et al., 2008).

Significance of Credibility as Trust

Throughout the process of establishing credibility, the onus may fall on both the seeker and the provider of information differently. If one is already a local authority, he or she assumes a burden of being as responsible as possible informationally. However, the burden remains a constant on the seeker because as everyday analysts, they assume a degree of risk in whatever resulting actions they take. It is through both socio-technical affordance and direct communication that people construct situational measures of helpfulness.

Establishing Information-Level Credibility

The web in its entirety serves as a means of getting information in uncertain situations. Many people have the ability to come together around a common cause or need, and gather and disperse information quickly, but they do it across many forums and services. The problem at

any one point in time—especially for sudden, unexpected events—is knowing where on-line to look for it.

This problem was highlighted by users of a social networking site during the 2009 Red River floods in the US (Starbird et al., 2010). A specialized Ning forum was started specifically for the event, and within it, one participant began a discussion thread that asked others what websites they were regularly checking. She listed her own choices, which spurred others to respond by posting additional sites and references. In response, another participant posted about her frustrations about the need to sign in to the site and navigate the digital world:

> This signing up business is ridiculous – in the event of a real emergency and/or need for info – no ones nerves can take what it took to get into here. I'm in <local city> and already mine are shot. The ins and outs of the web are enough.

This example emphasizes not only the need for people to have access to more streamlined information that is easy to navigate, but that social networking sites and other online places where people can find user-generated content will serve critical roles as legitimate stop-offs for those seeking information in emergency situations.

However, access to information does not automatically imply utility. Determination of helpfulness of CMC information where the sources are numerous and uncertain requires some sort of corroboration from multiple sources for verification. Nevertheless, sifting through the myriad of sources to do so is no small task, yet is at the core of today's everyday analyst's work. In studies of social media use in mass emergency, people do emerge to perform focused analytic services, which includes aggregation, redistribution and synthesis (Shklovski et al., 2008; Vieweg et al., 2008). These people are in positions to relieve some of the burden of seekers.

Once the information brokers are identified as trustworthy and credible, they provide a way to systematize and focus the information seeking process for others.

The everyday analyst must also corroborate information found elsewhere with the situation they are experiencing at hand. Information that is helpful to one person may not be for another. In disasters that occur even over an extended geographical area will result in situational that is particular to locale. Even distances as a little as mere miles apart can result in the need for quite different information. In the September 2010 Fourmile Fire in Boulder County, residents in the mountainous area were under direct threat, but those only mere miles away were mostly assured of their safety. Information that is helpful to one person could also be damaging to another.

Absence & Unexpected Presence of Information

In critical situations in which time is of the essence, what is not known can be just as significant as what *is* known. If questions are asked in multiple on-line places and/or to multiple people, and answers are not forthcoming, this can be a telling indication of what is known. This is what the sheer volume of participation can do to the analytic space. We turn to the Virginia Tech shootings for elaboration. At one point after the shootings and before the official release of the victims' names, people came together on a group in Facebook to let others know they were safe. There were also questions about the well-being of others. One person was asked about repeatedly on the site, as his whereabouts were unknown; no response was ever received to support his presence in other places on-line and elsewhere. The person was tragically a victim of the shooting; the lack of information about him and his digital inactivity suggested this news before official information was released (Vieweg et al., 2008).

Going on-line can provide also unexpected help and information. During the 2009 Red River floods, some Twitterers innovatively created bots to automatically gather data from a United

States Geological Survey sensor that monitors river levels. The sensor records the water level, updates a data table available on the web, and then, in this case, user-generated scripts read that data and broadcast it via Twitter each time the table was updated (Starbird et al., 2010).

Temporal Viability: Timeliness & Currency

The establishment of credibility and trust is not something unique to mass emergency; it is an analytic process that takes place elsewhere. However, one factor that separates the trust and credibility building process in mass emergency from other situations is that of timeliness: those experiencing an imminent flood or approaching wildfire do not have the ability to spend a lot of time ascertaining if a source and/or information is credible and trustworthy. When a hurricane hits land or a river spills over its banks and puts residents at risk, information about the emergencies is at a premium. Those in affected areas may need information about evacuation, risk to their homes, the status of friends and family, whether the area emergency personnel are equipped to provide services and much more.

However, during a mass emergency, information is constantly changing. Information that was previously helpful might no longer be so a short time later. The currency of information is a factor to consider in mass emergency; indications of information aging are important signals that can help people reach satisficing decisions.

IMPLICATIONS FOR SUPPORTING "EVERYDAY ANALYSIS"

The considerations and framework presented above have implications for software design and implementation. We envision a suite of software services to aid the everyday analyst in sifting and sorting through the deluge of changing digital information generated during a mass

emergency. The scholarly basis for these ideas appears in an extended "visions" piece elsewhere (Palen et al, 2010); here we offer a pointed summary of design implications and ideas.

Our framework offers a series of characteristics by which people can judge "helpfulness" of information. We know that "accuracy" is the ideal, but not the measure, by which people take information and make use of it even—and especially—in disaster. Their goals can only be ones of satisficing. Therefore, our goals as designers of socio-technical solutions are to process the heterogeneous and diffuse CMC-generated information in a manner that does not claim to produce the "right" answer. Instead we aim to collate information using indications of credibility that are benefited and made more powerful through automated synthesis and extrapolation. Here we present items for a research agenda that pursues these goals.

Locating CMC Activity

Software services that quickly identify the places on the web—social networking media and other on-line forums—where content about a particular emergency is actively being created are needed as a first order step to support navigation within and across multiple information sources. In a mass emergency, where information is first concentrated geographically, activity location services will likely need to first identify active local sources (media and other locally emergent CMC sites), as larger aggregators (such as Google) may not be able to update their indexes quickly enough for rapid response. In addition, these CMC location services must rely on what is known about people's digital behavior for different types of crisis events. Ultimately, the output of these services point people quickly to the forums they need to analyze to start making their own decisions about how to respond to the emergency.

Filtering and Sorting of CMC Content

Services are also needed that can rapidly analyze the activity of a CMC forum and then present filtered and annotated data back to users. This assists in assessment of trustworthiness and helpfulness of the information found there. Such services look for and reveal the distribution of repeated information across people, time and sites. Annotated posts can be ordered using criteria and known situational factors supplied by the analyst, e.g. asking that posts be ranked by the number of times it was replicated or ordering the posts of trusted users before the posts of unknown users.

Automated Synthesis of Credibility Indicators

Another service required by the everyday analyst is one that assists with the ongoing task of assigning credibility to the members of a CMC forum. For instance, a service can use heuristics about the posting behavior of trustworthy individuals from past events to infer credibility about the posting behavior of unknown members acting within a current forum. In addition, it may be useful to have a service rapidly construct a "trust dossier" about a given member by searching for instances of trustworthy behavior by that person in other CMC forums in the past. It can also determine, for example, whether a person has a blog where they post regularly and thus has an on-line reputation to maintain. With this trust dossier, an analyst can assign a mark of trust (or non-trust), which then can propagate and alter previously filtered and sorted CMC posts.

Information Corroboration

Support for corroborating information across forums is also critical, and may require switching to secondary sources to confirm. For instance, confirmation that a cited street near a wildfire actually exists and is accurately geo-located can be cross-checked with public records. This helps

the analyst infer that there is local knowledge on display in the CMC post; this contributes to an assessment of credibility.

Data Age & Comparison with Current State

An additional service that will be needed is one that allows users to judge the validity of previously posted information based on updates to the current state of a crisis event. Thus, a post during a wildfire stating that a house is still standing needs to be judged based on information about where the fireline was when the post was generated and where it is when the post is being viewed at a later point in time.

Constraints & Feasibility

As we continue to develop our framework and identify heuristics that will be of use to everyday analysts, we will start to build experimental prototypes that investigate the tradeoffs and utility of the services described here. However, there are interesting software engineering and user interaction challenges to overcome to produce such services. These challenges include 1) deep integration of these services into web browsers, feed readers and other devices used to access CMC content and 2) the need to search social networking sites and microblogs in real time when these services impose restrictions on clients either via their terms of service or by rate-limiting the number of requests that can be made by user, application, and/or IP address. Other challenges include how to store this information and for how long: Twitter, for instance, cannot store all the information that flows through it. If they cannot store everything, how should third-party tools retain enough information to enable the services discussed above? New techniques will be needed to summarize past information in a compact fashion before space limits require that the original information be deleted. Finally, this research agenda will require new research in fields

such as natural language processing and network security/identity to make feasible some of the proposed services. We are actively working on all of these challenges.

CONCLUSION

The unifying theme of the framework for the assessment of "helpfulness" and the associated services proposed is clear: In highly contextualized situations where time is of the essence, people need support to consider the content across multiple sources of information. In the on-line arena, this means assessing the credibility and content of information distributed across CMC forums. Technical support can go a long way to help collate and inject metadata that makes explicit many of the inferences that the everyday analyst must make to assess credibility and therefore helpfulness. However, our view is that the everyday analyst stays in control: It is not the job of the services and tools to make decisions but rather to allow their users to reach a decision as quickly and confidently as possible.

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