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6A.4 A Cooperative Pilot Project on Weather and Emergency Management Decision Support

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1. INTRODUCTION

The emergency management (EM) community, which we are broadly defining as people that make critical decisions that have a societal impact before, during, and after a hazardous event, can struggle to find appropriate weather information. If they do find it, they can have trouble understanding it and translating it to their network of decision makers; and if they do understand it, they may not be certain how to take proper actions based upon it. In response to this struggle for weather information that can impede an EM's decision making, a cooperative pilot project on decision support for the emergency management (EM) community was established between the Renaissance Computing Institute (RENCI), East Carolina University, National Weather Service (NWS) Offices of Science and Technology and Climate, Water, and Weather Services, local NWS offices, and NOAA's Earth System Research Lab, Global Systems Division.

Through rapid prototyping, our goal is to understand the potential impact of NWS products and services on critical EM decisions by examining EM processes, collaborations, and product and services utilization. Rapid prototyping is applied to both the social science aspect of the project involving the understanding of the EM knowledge network, as well as the technological side that focuses on products and services development.

The project stemmed from another in North Carolina developed by RENCI called NC-FIRST (Proud and Galluppi, 2008). NC-FIRST is a weather information web portal and training program for North Carolina EMs that reorganizes NOAA/NWS products in an easy to find way and then trains users on how to use these products. It was modeled after the OK-FIRST program (Morris, et al., 2001), which is an outreach project of the Oklahoma Climatological Survey and Oklahoma Mesonet. Since its inception in 2007, NC-FIRST has trained over 700 users and has become a standard tool in the North Carolina emergency management community. Although NC-FIRST has helped EMs access weather information, the challenge of truly understanding weather information and relating it to decisions and impacts still exists.

2. KNOWLEDGE NETWORKING PROTOTYPE

The first step in the project was to establish the knowledge network of the EM community following Skyrme's (1999) model. This model can be thought of as a triangle with the three points representing technology, virtualization, and knowledge. Technology and knowledge are connected by electronic networks; technology and virtualization are connected by collaborative strategies; and virtualization and knowledge are

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connected by human networks. We applied this model in several steps to the EM community to learn about their actions during a hypothetical winter weather event.

The first step was to establish a basic understanding of the EM community and learn who talks to whom, what type of weather and other information they need, how this information gets passed, and where bottlenecks in the process exist. Three focus groups, each with four participants, were held to gather this information. We are defining the EM community as those groups which fall under one of the 15 Emergency Support Functions (ESFs) that were established by FEMA's National Response Framework (2008). A listing is given in Table 1. Representatives from 11 of the ESFs participated in focus groups, including representatives from transportation, emergency medical services, a school, agriculture, Red Cross, a power company, a hospital, public health, and a county EM director

Table 1: Emergency Support Functions

#1: Transportation	#9: Search and Rescue
#2: Communications	#10: Oil and HazMat Response
#3: Public Works & Engineering	#11: Agriculture and Natural Resources
#4: Firefighting	#12: Energy
#5: Emergency Management	#13: Public Safety and Security
#6: Mass Care, Emergency Assistance, Housing and Human Services	#14: Long-term Community Recovery
#7: Logistics Management and Resource Support	#15: External Affairs
#8: Public Health and Medical Services	

The focus groups were conducted using an adapted form of the Class, Responsibility, and Collaboration (CRC) card methodology created by Beck and Cunningham (1989). Originally used for object-oriented software design, CRC cards are a simple and consistent way to collect information from small groups in response to given scenarios. Each person is given an index card on which they write their job title, responsibilities, and collaborators (person or technology) in response to a scenario that is read to the group. In our case, five scenarios that occurred before, during, and after a hypothetical winter storm were read to the participants. Additional information, such as what weather data is used, is written on the back of the card. After participants write down their information, they read it to the group. This generates discussion within the group and questions from the facilitator. The information on the cards establishes a record of what the EM is thinking about during an event in their own words. Montz, et al. (2011) discusses detailed results of the three focus groups.

Using the information gathered during the focus groups, we were able to establish a rudimentary knowledge map showing who talks to whom 48 hours before the hypothetical storm (Figure 1). The knowledge map shows that the network of communication is large and complicated, allowing for many opportunities for information to be miscommunicated. We are currently working on gleaning more robust knowledge networking information from the map, but we were able to use it in combination with other focus group information to pull out three critical sub-groups: schools, transportation, and power companies. These sub-groups make decisions during winter weather events that have a major societal impact on a community. From these three, we narrowed down our focus to schools because they appear to struggle most with finding and using weather information.

Using the network of county EM directors established through NC-FIRST, we began reaching out to schools to learn about their inclement weather decision process. A group of nine schools with varying geographies and student populations across central and western North Carolina became our feedback and testing group. Initial contact with the schools was a

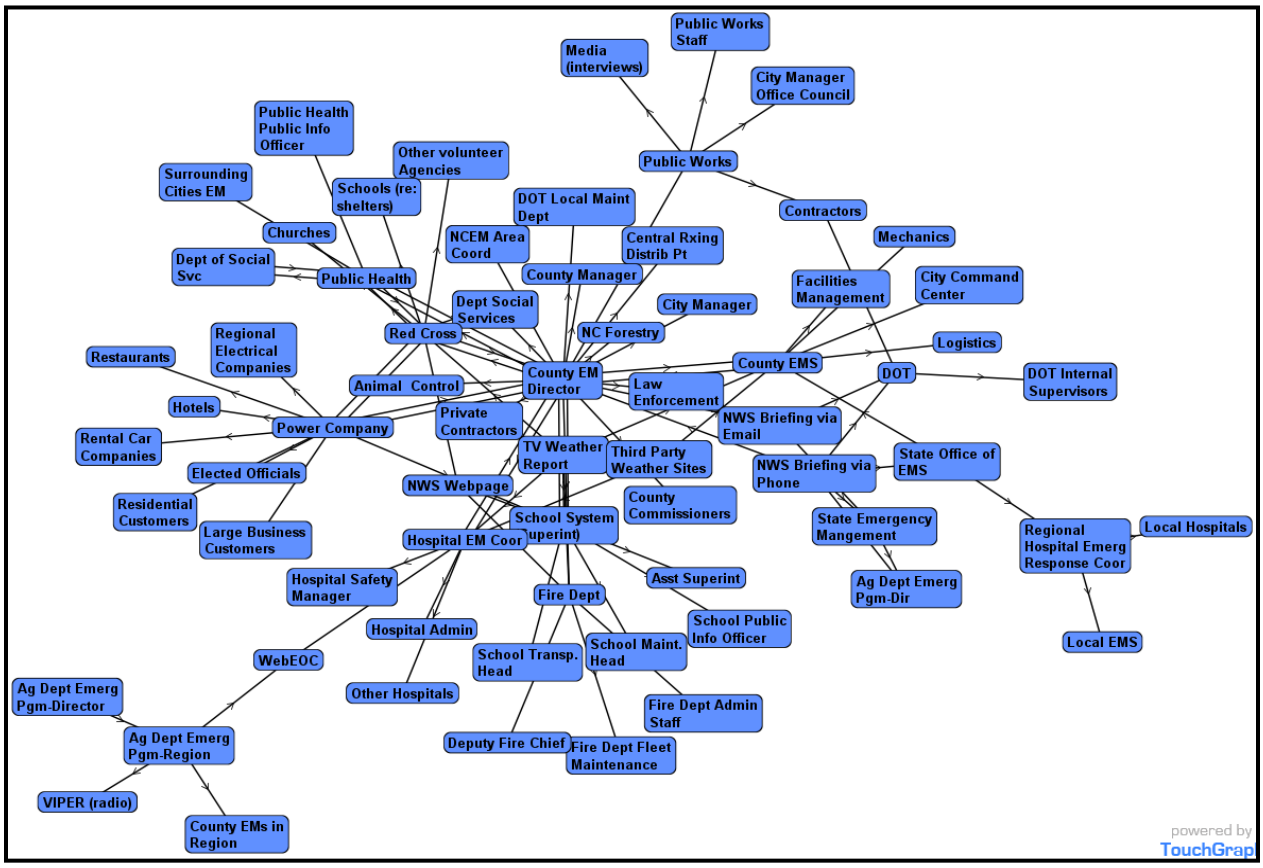

Figure 1: Knowledge map showing who talks to whom during a winter weather scenario for 48 hours before a storm.

phone interview during which we asked questions about who makes the recommendation to close or delay school, what information – both weather and non-weather - is needed, how it passed within the school, and their decision process timeline. We found that the schools all follow a similar routine to gather information. For example, when closing schools the day of an event, transportation officials will "ride the roads" beginning as early as 3:30am looking for ice or snow covered roads. This road information is gathered informally either through note taking by a person stationed at the transportation office or in someone's mind with no recorded notes. All look to multiple sources of weather information (TV, NWS, etc.) to determine how they vary and then try to make a decision based on these sources. Most schools use some amount of NWS data. One school does not actively use any NWS data. The two most important pieces of information that a school rep is looking for are road conditions and the onset time of precipitation. Precipitation type, accumulation, duration, forecasted temperatures, and sky cover are also important.

Building upon the first round of interviews, we talked with several of the school reps after an actual winter weather event occurred. We focused on establishing a timeline of their process and on specific weather products they used to make their decision. All of the school reps use their local TV station's forecast information in their decision. Most school reps used some combination of NWS products that could include the area forecast discussion, point-and-click forecast, hourly weather graph, warnings and watches, and radar. A small number of school reps initiated contact with their local NWS office to discuss the forecast. One

school rep relied only on his TV station forecast and a third-party vendor radar image to make his decision.

The third round of interviews with several of the school reps entailed testing them to determine if they correctly interpret NWS products and introducing existing NWS products that they may be unaware of. We found that they interpret the products correctly most of the time, but struggle understanding some aspects. For example, no one could correctly answer what was meant by the probability of precipitation in the forecast text and hourly weather graphs. Also, two reps thought that underlined words in the area forecast discussion were important terms they should devote attention to, when they actually are underlined because they are hyperlinks to glossary definitions. Finally, on the hourly weather graph, no reps knew what the "SChc, Chc, Lkly, Ocnl" probability of precipitation verbal descriptions meant or were aware they existed on the graph, and one misinterpreted how to read accumulation totals. While discussing these topics, we also asked school reps to tell us what they would change on various products. One rep noted that making the Forecast at a Glance icons more representative of probability would be beneficial, while another felt that having a radar display colored by precipitation type would be very valuable.

The next round of interaction with the school reps will occur over the next six weeks as we begin to introduce products and services prototype ideas to them for feedback.

3. PRODUCTS & SERVICES PROTOTYPE

All of the information gathered during the ongoing knowledge networking prototyping is fed to the technical products and services prototyping team at RENCI. The team takes this information and works with the knowledge networking team to develop various prototype ideas that can range from a different way to convey onset time of precipitation on a map to a modified Area Forecast Discussion with relevant words for school reps highlighted to an interactive, online map conferencing system that all participants can collect and share weather and road information on in real-time. While these ideas have been developed over the course of the project, they are refined with details gathered from each round of interviews with school reps. Over the next six weeks, when an idea of any magnitude is ready for testing, three school reps in our testing group will receive the prototype and will be asked a series of objective and subjective questions aimed at measuring the usefulness of the prototype and how well testers interpret the information. In keeping with the rapid prototyping model, we will receive and analyze their feedback, discuss development priority, and move on to the next development iteration if necessary in the span of a several days. We anticipate that about 15 iterations will occur over the course of six weeks.

4. NEXT STEPS

After the rapid prototyping cycle a week of testing and exercises with schools will begin using the suite of products and services we learn that school reps find most useful to their decision making process. This suite could include a mix of current NWS products and services as well as prototype ideas that test well with schools. Once this week of exercises is complete, we will take what we have learned about the EM community network and begin to apply it to tropical weather decision making for the remainder of the first year of the project.

5. CONCLUSIONS

Although the first phase of this work is not complete, some preliminary conclusions have been made. First, it was reinforced through interviews that most decision makers struggle to find and understand weather information. Virtually none of the people making decisions to close or delay school have any weather training, but they are expected to make high impact decisions based on weather information they do not completely understand. Providing weather information in a way that makes a school rep feel more confident about their understanding, and therefore their decision, is a critical need. Also, information that is available to them is not

always pertinent to the decisions they need to make. Finally, the EM social networks are working, but they are not optimal for sharing complicated weather information.

6. **REFERENCES**

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