Managing Peripheral Interactions in Emergency Response Environments

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Abstract
In this paper, we discuss how personnel in emergency operation centres (EOC) use peripheral interactions in the context of emergency response planning where multiple devices are concurrently updated with information from different sources both from inside and outside the EOC. We present ePlan Multi-Surface, our multi-surface prototype for emergency response planning which relies on the use of different devices and peripheral interactions to manage information during emergency response planning. We also present our research questions on the direction of peripheral interactions in emergency response planning.

Author Keywords
Emergency Response Planning; Multi-surface environments; Peripheral Interactions

ACM Classification Keywords
H.5.2 [Information interfaces and presentation]: User Interfaces— Input Devices and Strategies; Interaction Styles.

Introduction
EOCs from governments and the private sector rely on information from numerous sources when conducting emergency response planning and when dealing with a live event. These sources may include their own

personnel (e.g. firefighters, police, emergency medical services (EMS), or armed forces), or third-party sources (e.g. news channels or citizens) that use different protocols before exchanging information.

The source of information determines whether it enters the EOC via video, audio, or text. A traffic or incident camera could live-stream into the EOC, tweets could arrive via text, and information from ground-personnel may arrive via text messages or by word-of-mouth. EOC personnel need to ascertain the importance, authenticity, and accuracy of the information as device screens update. Emergency personnel report through their chain-of-command, reporters (print, television and radio) have their information fact-checked before broadcast, while citizens may live-tweet, post, or send emails while the event unfolds. When the EOC receives these information updates from the three sources (their personnel, reporters, or citizens), they also need to peripherally monitor developing traffic congestion, incident cameras, and operational decisions that are being updated on a large wall display.

Multi-surface environments (MSE) provide an environment amenable to emergency response planning and peripheral interactions by separating and segmenting areas for information triage. For example, iPads are personal workspaces from which personnel can privately communicate with colleagues, tabletops serve as a collaboration and cooperation area, and large wall displays can aggregate information from multiple sources – movement of personnel, traffic and incident cameras, and tweets.

Related Work

Detecting and monitoring emergencies and managing the deployment of resources and communication are important tasks in emergency response planning [1]. Emergency response planning is inherently a peripheral process [2], as critical information about an emergency can arrive from numerous sources (e.g. first responders, reporters, or online sources) and information processing and analysis are typically done in parallel with the primary emergency response-planning task [2] typically with interruptions [3]. In the research literature, emergency response planning is a well-explored area, with several different technologies (e.g. tabletops [1]) being used to assist in these tasks, as well as information management, collaboration, and efficiency [4].

While many of these systems utilize single tabletops or other devices and show immediate benefit in emergency response situations [1], they do not properly consider peripheral interaction scenarios (e.g. multiple-users interacting with each other on tabletops, who may also be concurrently analyzing or receiving different sources of information) in emergency response planning situations. This may be due to interface design or physical constraints such as orientation or screen size. This gap provides an opportunity for exploration in using MSE – environments containing multiple heterogeneous devices (e.g. tablets, wall displays, tabletops) – which allow for a variety of different tasks and interactions (e.g. "flicking" to different screens) [5]. Leveraging the concepts of MSE and their interactions in emergency response planning and its peripheral nature provides the basis for our preliminary implementation of ePlan Multi-Surface that we present in this paper.

ePlan Multi-Surface Design

Figure 1. *ePlan Multi-Surface* Emergency Response (a) A digital tabletop is used as the hub of communication and collaboration. (b) A large high-resolution wall display provides an overview of the emergency situation and contains information updates for which all EOC personnel are required to be aware. (c) A personal laptop is used as a private workspace (in addition to digital tablets). (d) A Microsoft Kinect is used to track users to facilitate multi-surface interactions such as flicking and pouring.

In collaboration with an emergency response simulation software company, C4i Consultants Inc.[1], located in Calgary, Alberta, Canada, we designed *ePlan Multi-Surface* Emergency Response. As shown in Figure 1, the environment consists of a large high-resolution wall display, digital tabletop, Microsoft Kinect, a personal laptop and multiple iPads (not displayed). The system was built using C4i's ePlan desktop software to drive the emergency simulation, as well as MSE-API [6], which provides inter-device communication and multi-surface interactions.

Peripheral Multi-Surface Interactions

To highlight the role of peripheral interactions in our multi-surface prototype, we will describe the typical usage scenario during an emergency response-planning scenario used by our industry partner:

Step 1: *Emergency Alert Issued*. In the first stage, the emergency response operation controller receives information in different mediums (text, email, and phone) from various sources (fire, EMS, and police) about an emergency. The EOC then determines the type of emergency that is occurring and issues a state of emergency to a city or municipality. During this time, EOC personnel are continually receiving and analyzing information on their iPads, in addition to analyzing the situation globally on the large wall display that showcases information from live traffic and incident cameras, and Twitter. The EOC is often interrupted or doing tasks simultaneously due to the evolving nature of an emergency.

Step 2: *Response Representatives Assemble.* After the alert has been issued, the response personnel assemble in the *ePlan* multi-surface emergency response-planning environment. Depending upon the severity of the event, these representatives may include the fire department, EMS, and police. Representatives have iPads containing relevant information that is either shared at their discretion or used in their own assessment for allocating their resources during the emergency. Representatives can share information from their iPads using gestures (one or two-finger flicks, or a pour gesture) to send information to other devices in the room (wall display, tabletops, or iPads). The wall display allows everyone in the room to see the information; the tabletop is used to assist in collaborative emergency response planning; or other iPads are used to facilitate communication between different representatives. These multi-surface interactions are typically done in parallel with planning or analysis tasks in the EOC, and visual notifications that can been seen in the user's periphery are used to prompt representatives when new data arrives on a device. Also, since there are many representatives in EOC, it is possible to peripherally see someone using gestures when sharing new or updated information.

Step 3: *Emergency Response Planning.* During the emergency response-planning scenario, which lasts

[1] http://www.c4ic.com/

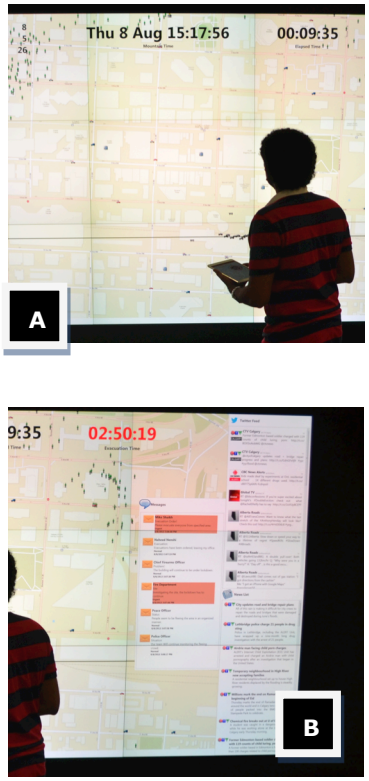

Figure 2. Example of peripheral interaction in ePlan. (a) An EOC personnel is examining the overview map of an emergency on a large wall display (b) The EOC personnel must also be peripherally aware of live twitter, messages and news

until the end of an emergency situation, numerous types of interactions occur. This session is the most critical component of emergency response planning, as significant coordination and planning are done. In *ePlan* multi-surface, emergency response personnel are continually collaborating and consuming new information rapidly using iPads, while also simultaneously trying to keep track and manage the emergency through the wall display and digital tabletop. At the end of an emergency response-planning scenario, a report is typically generated that summarizes the emergency and the contributions of the emergency response representatives.

Discussion

In this work, we have presented our multi-surface emergency response-planning prototype, *ePlan Multi-Surface*, and have discussed the role of peripheral interactions. In particular, we highlighted the information hierarchy in emergency response planning situations that were incorporated into the prototype and impact the peripheral interactions in the EOC. Overall, feedback from preliminary discussions with personnel from the Alberta Emergency Management Agency has been positive; however, one common theme in their feedback has been a request for consideration of paper-based interactions. This leads to an interesting question of the consideration of mixed-fidelity peripheral interactions in emergency response planning and their role in the design of multi-surface interactions. We plan to explore the following research questions in our next prototypes:

- How do we incorporate hierarchy in the design of peripheral interactions for multi-surface environments?
- How scalable are peripheral interactions for multi-surface environments, and what types of devices are more amenable to them?
- Are multi-surface interactions a viable solution to managing peripheral interactions in emergency response situations and other application scenarios?

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