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Designing a tangible interface for manager awareness in wilderness search and rescue

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Figure 1: The SAR tangible-interface prototype.

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Abstract
We present a tangible interface for supporting wilderness search-and-rescue (SAR) managers in maintaining awareness of a large SAR incident, where there are numerous field teams searching for a lost person in a wilderness area. This interface consists of physical and digital representations of the search area and elements of the search activity (e.g., the locations of search teams, weather information, and clues from the field). It is intended to allow SAR managers to inspect information about the response and search area from different perspectives and aid them in planning by allowing them to physically manipulate the representations and explore the data through touch.

Author Keywords
Search and rescue; outdoors; wilderness; tangibles; tabletops; situation awareness

Introduction
Wilderness search and rescue (SAR) involves the search for and extraction of one or more lost subjects (e.g., hikers) from a wilderness area. In a typical scenario (in Canada, at least), one or more SAR groups (usually from local communities) would respond to a call for a lost person, and each group would work from

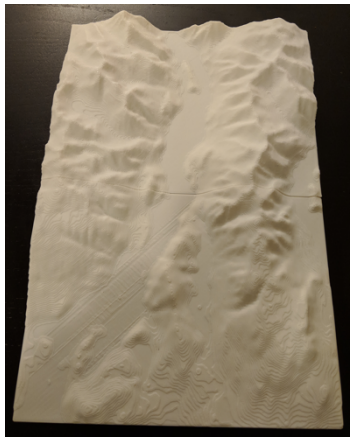

Figure 2: The 3D terrain model.

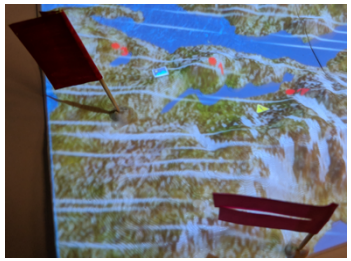

Figure 3: Lines move across the terrain to represent the speed and direction of wind.

its own staging area (a mobile office near the search area) [5,6]. A management team (which consists of a manager and personnel in charge of logistics, communications, and other operations) would then deploy one or more field teams to search assigned areas in the field [5,6].

SAR requires managers to build and maintain high situation awareness [2] and use that awareness to carefully plan and coordinate field teams [6]. From preliminary interviews with SAR workers [4], one of the main problems we encountered is that, as a search progresses and more workers become involved, the bigger-picture awareness that managers need becomes more difficult to maintain. This is because the management team needs to keep track of more people, work with more information from the field, and often work with a search area that has increased in size. As a result, this can cause the potential for logistical errors to increase. For example, location, status, and activity awareness of field teams and members, as well as awareness of environmental information (e.g., weather, snow accumulation, clues about the subject) are common challenges. Logistical errors and delays can have high stakes in SAR, tying up valuable resources and risking the lives of the missing subject(s).

In this paper, we present a tangible interface (Figure 1) designed to support SAR managers in building and maintaining awareness of an ongoing search. Consisting of a terrain model of the search area, as well as physical and digital representations of information important to SAR managers, the interface is intended to allow SAR managers to inspect the statuses of the search area, field teams, and search activity through visual observations from multiple viewpoints as well as through touch and physical manipulation of objects.

Background

In large SAR incidents, a lot can happen in a short time frame. Members of the management team need to communicate carefully with each other to ensure that they are working efficiently as a team, and that their collective actions are helping advance the search response. Thus, the team has to maintain a high level of *team awareness* [1] and *distributed cognition* [8].

Rogers [8] defines *distributed cognition* as being the bringing together of each team member's unique knowledge, skills, and perspectives into one overall system, which is supported by artifacts and representations in the environment [11]. In SAR, management-team members use physical maps (e.g., with markings indicating the areas that have been searched), pins, charts, sticky notes, and whiteboards, as well as some digital tools (e.g., mapping software indicating the locations of teams) to collaborate with each other and offload cognition [5,6]. While SAR groups generally use physical and digital tools separately, there could be a benefit in mixing both to support distributed cognition. As an example, interactive topographic maps show promise in supporting exploration through both touch and sight via multiple perspectives, and they are generally easier to read than 2D topographic maps [7].

Many SAR management activities fall within the realm of spatial planning and problem solving. Tangible interfaces could help support these activities, as they have shown potential to do so within the contexts of other domains [10]. In addition, tabletops show

promise in supporting teamwork and group sensemaking, as they can support multiple users and provide a section of workspace for each user [9].

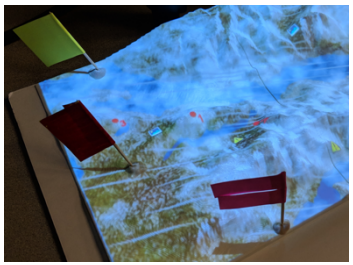

Figure 4: Representations of cloud cover and wind over the terrain.

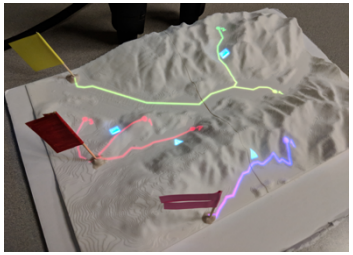

Figure 5: Basic viewing mode.

System Design

We designed a tangible interface (Figure 1) to support SAR managers in maintaining awareness of an ongoing search. For this early prototype, we chose to represent some of the most important information that SAR managers need to plan their actions; information such as the makeup of the search area, locations and activities of field teams, and weather. This interface consists of a 3D topographic map of the search area as the central point of interaction, a projector projecting digital dynamic information over the terrain map, and physical props placed over the terrain to represent static (or infrequently-changing) information.

This system is intended to be placed in the middle of a SAR command office and left on during a response. Throughout, the system would update with new information, and members of a management team would approach the system and interact with it to update their knowledge about the search status and to collaborate on planning activities. While the prototype shows only one geographic area, the idea is that each SAR agency, which in Canada typically handles its own area of jurisdiction, would use a model of its own jurisdiction. For instances in which agencies need to work in varying search areas, one could consider (for example) a model that changes shape (e.g., [3]).

Physical Representations. The 3D-printed base (Figure 2) is a topographic map of a mountainous wilderness area near Vancouver, Canada. The model is about 32 x 21 cm in size, printed in polylactide (PLA), and represents an area that in reality is approximately 16 x 11 km in size. Placed on the model are small flags representing information that changes infrequently. In the case of the current iteration of the prototype, the flags indicate the location of the staging area of each SAR group responding to the current ongoing search. Each SAR group has its own management team at its staging area, as well as one or more teams in the field looking for the lost subject(s).

Digital Representations. The digital representations of frequently-changing information were implemented in Unity and run on a single application sending a video feed to a small projector projecting onto the terrain model (Figures 3-5). The representations depict the locations of each field team, the paths taken by field teams, clues from the field, the makeup of the terrain (e.g., snow, grass, water, etc.), water current, and various weather patterns such as wind and cloud cover.

Interaction and Viewing Modes. A viewer can use a set of buttons to toggle between different viewing modes, allowing them to choose what dynamic information to see and what not to see. This allows a manager to filter out information that is not needed at a given time. For example, the user can choose to see wind flow (Figure 3), all weather information (Figure 4), or just basic information about the field teams and clues from the field (Figure 5).

Usage Scenario. Amelia, a manager for a local SAR agency, is called to take over for another manager, Joan, who had been on duty for the past 10 hours. This is the first time that Amelia has been exposed to this particular response, so she needs to familiarize herself with the status of the search and the teams. Along with the usual briefing, Amelia approaches the terrain

interface and interacts with it to familiarize herself with the search area, the statuses of the teams, and other important information from the search area. Joan also uses the interface to help demonstrate the key points she describes in her briefing to Amelia. She does this by gesturing to key areas where teams are dispatched and areas that are dangerous to traverse due to weather. She also uses the interface to describe the terrain makeup in certain areas and the equipment needed to handle those areas.

Future Work

We plan to work closely with SAR managers to both iterate on the design and use it as a research-through-design [12] instrument to understand how tangibility and other emerging technologies can help support distributed collaboration in SAR. We also plan to build a larger version to better support multiple collaborators, and incorporate touch detection and object tracking to improve interactivity. To evaluate a more-refined version of this prototype, we will run field trials, akin to wilderness-SAR scenarios, and observe how SAR teams use it in comparison with current technologies.

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