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# Designing for Distributed Collaboration in Wilderness Search and Rescue

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**Abstract**

Wilderness search and rescue (SAR) is a critical operation that requires careful team collaboration. Even with current technologies, SAR workers still face communication difficulties when working outside in challenging conditions. The goal of my thesis work is to understand how communication and collaboration interfaces can be designed to better support wilderness-SAR teams while distributed in an outdoor environment with challenging terrain and conditions.

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**Author Keywords**

Search and rescue; outdoors; team communication; distributed collaboration; situation awareness

**Introduction**

Wilderness SAR is a critical operation that requires careful communication and collaboration between field workers and managers, as well as high levels of situation awareness [1]. In a typical wilderness-SAR scenario, a group of volunteers would be called out to search for a lost person (e.g., a hiker) in a wilderness area. This team would be coordinated by one or more SAR managers from a command post (a trailer set up near the search area), and team members would form into one or more smaller teams of field workers who would each be tasked to search a different part of the search area for the lost subject [3].

Even with extensive training in team communication [3], SAR workers still face communication difficulties when distributed in the outdoors in challenging terrain and conditions (e.g., mountains, storms, etc.). For example, it is difficult for managers to fully understand what field workers may be experiencing, as they are limited in the information they can communicate and are fully invested in the acts of searching and navigating the space [3]. Today, field workers use two-way radios to communicate [3], while SAR managers



**Figure 1:** Wilderness-SAR groups around the world are beginning to use drones to assist with search tasks.

use physical materials (e.g., paper maps, whiteboards, etc.) to build bigger-picture awareness of the search task [3,4]. Some SAR organizations are gradually adopting new digital technologies such as GIS software, GPS devices, and smartphones (for messaging). However, many of these technologies were not designed with SAR in mind, as they do not consider the unique challenges that SAR workers face or the unique ways they interact, share information, and work together as a team. New technologies such as video communication, augmented reality (AR), and drones (e.g., Figure 1) could potentially better support distributed collaboration in SAR, just as they can support other outdoor activities [2,5]. However, the ways in which they could do so are not yet well understood. The research question that drives my work is "How can we design technologies to support richer forms of distributed collaboration in wilderness SAR?"

To address this question, I have divided my thesis work into three phases: *Investigation*, *Prototyping*, and *Evaluation*. I am currently in the *Investigation* phase, in which I am interviewing SAR workers and observing SAR training activities and mock searches. The goal here is to understand SAR communication and collaboration practices and the real-world challenges that SAR workers face, in order to derive a set of design guidelines for distributed-collaboration tools for SAR. For the *Prototyping* phase, I will iteratively design and build prototypes, based on these design guidelines, to explore the different types of emerging-technology designs that can effectively address common SAR collaboration challenges. For the *Evaluation* phase, I will evaluate these prototypes through both simulated trials (mimicking real SAR scenarios as closely as possible) and longer-term deployments for real SAR

training activities, to understand their uses in different contexts, the new opportunities and challenges they introduce, and to understand how SAR practices would have to evolve to adjust to new technologies.

My work will provide the following contributions:

1. A framework for understanding how distributed-collaboration interfaces should be designed to better support wilderness SAR.
2. Prototype tools for distributed collaboration in wilderness SAR, utilizing emerging collaboration technologies such as video communication and AR.
3. Recommendations for how wilderness-SAR work practices should evolve to adjust to new distributed-collaboration technologies.

### **Investigation Study: Preliminary Findings**

Through one-on-one interviews with SAR workers and observations of SAR training exercises, I am looking to understand how SAR workers communicate with each other and maintain situation awareness, as well as to understand the challenges they face in doing so. I am conducting this study with SAR members and organizations in British Columbia and Alberta, Canada. I plan to interview a total of about 10-15 SAR members (for one hour each), including both managers and field workers. In addition, I plan to observe at least 2-3 SAR training exercises and mock searches. So far, I have interviewed six SAR members, including one manager. The initial results and early analysis so far have led to four preliminary themes of design implications:

- 1. Design to help management build a bigger-picture awareness of the response.** SAR managers need a high-level awareness of a search incident, and

this becomes more difficult to maintain as a search goes on and the response becomes larger. The things that the management team needs to remain aware of include (but are not limited to): who is assigned to which task, where each field team is located, what each team member is doing, what skills each team member has, and what challenges each team member is facing.



**Figure 2:** A prototype of a tangible interface for supporting SAR managers in building and maintaining a bigger-picture awareness of a search response.

**2. Design to allow field workers to effectively share and receive information relevant to them.**

Field workers are generally concerned only about information that is relevant to them. Given the complexities of teamwork in SAR, field workers need to remain highly focused on their own duties. Thus, collaboration technologies for field workers should primarily present information that is relevant to them.

**3. Design to allow field workers to understand their contributions to the 'bigger picture'.**

While field workers are generally concerned only about their own duties, many also want to know how their actions contribute to the search response as a whole. This can potentially help for three reasons: (1) it can boost a field worker's morale, (2) it reminds them that they are doing the right thing, and (3) seeing their contributions in relation to those of everyone else involved helps field workers feel less isolated and reminds them that they are working together in a team, even if they cannot see or interact with all of their team members (which is especially important when in an isolated, and potentially hostile, wilderness environment).

**4. Design to not detriment the situation awareness of field workers.**

Field workers need to be constantly aware of their surroundings in the environment, and they need to have their hands free to

use tools and move objects. Any technologies that they use should keep all of this in mind and allow them to communicate and share information hands-free and with few distractions. Tools such as head-mounted displays and wearable cameras are possible solutions.

**Current Prototype: Terrain Interface**

To explore how we can support wilderness SAR managers in building and maintaining a bigger-picture awareness of a search incident, I designed and built a tangible-interface prototype (Figure 2) consisting of four basic components: (1) a physical representation of the search area (in the form of a 3D-printed topographical map), (2) physical representations of information that is static or infrequently changing (in the form of flags), (3) digital representations of information that is constantly changing (projected over the terrain model by a small projector), and (4) basic interaction for changing viewing modes (via toggling switches). This prototype, while small in size, serves as a proof of concept for a tool that would be the size of a large tabletop, in order to support team collaboration and territoriality [6]. This design is still in its early stages, and I plan to work closely with SAR managers to both iterate on the design and to use the prototype as a tool to spark discussions with SAR managers to understand how tangibility and other emerging technologies can help support team awareness in SAR.

**Future Work**

**Prototyping:** Working with SAR members in a co-design process, I will continue to build prototypes, provide demos of their usage (e.g., live demos and videos) to SAR workers, and use their feedback to continue iterating on those designs and develop new design ideas. The goals of this process are to (1) arrive

at a set of real design ideas and working prototypes that adhere to the design guidelines derived from the previous phase, and (2) to have a set of prototypes ready to test with SAR members and other users in simulated scenarios and SAR training exercises.

**Evaluation:** To evaluate the prototypes I build, I will first run field experiments with them. The purpose will be to test how well they support distributed collaboration in semi-controlled outdoor team activities related to SAR scenarios. The prototypes will be used by teams of participants conducting search and navigation tasks in outdoor spaces. As a further evaluation, I will conduct longer-term studies with SAR groups, where I deploy the prototypes for use in training activities and mock searches. Here, I will seek to understand how SAR teams use these tools over longer periods in varying conditions. While I will not be able to deploy these tools for use in real searches, their use by SAR teams in training activities can provide an understanding of how they might be used in real situations. I will also work with SAR groups to understand the issues these tools still have, as well as to understand how SAR practices would have to evolve to adjust to new technologies.

### Benefits of Participating in the CSCW DC

I believe I would benefit from participating in the CSCW Doctoral Colloquium (DC) for three main reasons:

1. I am entering a crucial period in my work in which I will have a lot of data that I will need to analyze. Thus, I now need to gain feedback on appropriate theories to apply and understand how others have analyzed similar data. The CSCW DC would be an excellent venue for me to receive this feedback.

2. I am inspired by the work of others in the CSCW community. I think it would be beneficial for me to learn more about how others conduct research in CSCW, particularly within domain-specific contexts, and to understand the different perspectives that other researchers come from and the ways they put those perspectives into practice.
3. Participating in the DC would allow me to build a cohort with other researchers. This is important for me professionally, as these will be my intellectual peers who I will be able to seek advice from or collaborate with, both in the context of my work and their work. In addition, as I am strongly considering continuing my career in HCI and CSCW research (and potentially academia) after I finish my PhD, I believe that establishing and maintaining this network is important for me in the long term.

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