

# Human-Computer Interaction Techniques in Firefighting

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**Abstract:** This thesis investigates the design of human computer interaction techniques for ubiquitous computing solutions in firefighting.

**Research Area:** Human-Computer Interaction Design for Safety Critical Ubiquitous Computing

## 1 Research Problem

For HCI, research on interaction techniques is a core concern. A human-computer interaction technique provides users “a way to carry out an interactive task” [1]; or, as [2] put it, an interaction technique “represents an abstraction of some common class of interactive task”; it can be classified as a primitive element of an interactive system. Lacking the same means of input and output, ubiquitous computing systems do not support desktop computing interaction techniques; they demand for novel interaction techniques tailored for the specific use [3].

Tailored interaction techniques are crucial for ubiquitous computing systems supporting people who work in hazardous, safety-critical environments. Interaction techniques need to closely match on-site situation as the mixture of cognitive and physical load, protective clothing and special equipment leaves very little space for human-computer interaction.

For the domain of firefighting, such restrictions are imminent. Fighting fire is a multi-faceted task in a hazardous environment that changes dynamically during an intervention. The work on the first line of intervention is complex and requires a set of very specific skills and tools [4]. It is often conducted in buildings full of smoke, which can only be accessed by crawling on the floor due to heat distribution. To cope with an ever-changing environment, firefighters rely on intensive training, high levels of improvisation and teamwork [5].

Current HCI research targeting the firefighting domain, proposes systems to support navigation, health monitoring or communication [6-10]. While some researchers avoid the constraints of the first line of intervention by focusing on the

work that takes place in relatively safe and less restrictive environments [11], research projects targeting the first line of intervention often use firefighting scenarios as a motivation or explanation for the need of a certain technological development [12, 13]. Here, the approach is to adapt interaction techniques designed for everyday mobile technology [12] or to rely on relatively novel means of interaction such as head-mounted displays [13] without evaluating their fit with real-world conditions. The work that specifically focuses on interaction techniques for firefighting [14] focuses on certain aspects of firefighting practice but does not consider the overall firefighting practice such as the collaborative nature of the job.

Firefighting practice is, however, very sensitive to technological change and likely to be disturbed by systems that do not take into account the full complexity of the task [5]. As of today, firefighting on the first line of intervention remains an activity with almost no IT support [4], lacking human computer interaction techniques that are able to cope with the challenging setting.

Recent HCI research shows that a situated perspective provides means to study social, situated actions in dynamic use contexts and that interaction design needs to respect the underlying role of embodiment in interaction [15]. While [15] provides a research paradigm covering the relevant aspects, the existing methods have been mainly applied in far less restricted environments [16] leaving unanswered the question if and how such open methods can be applied for the design of interaction techniques to be used in highly dynamic, safety critical environments.

## 2 Working Hypothesis

Design methods of the situated perspectives HCI research paradigm provide meaningful contributions to the challenge of designing interaction techniques for ubiquitous computing systems that support people working in highly dynamic, safety critical conditions.

## 3 Methodology

This research applies an action research method [17] and an phenomenologically situated research paradigm [15].

The *initial diagnosis* motivating this research was conducted in form of a study that introduced a triggering artifact [18] in firefighting practice by means of a wizard-of-oz prototype of an indoor navigation system. A full account of the findings can be found in [5].

The *actions* to be taken were planned using a broad set of methods following the situated perspectives research paradigm. They comprise empathic studies [19], workplace studies, design probing [20], experience prototyping [21] and qualitative in-field evaluations of prototypes:

- To build empathy, studies to allow forming an embodied understanding of this work are set up, as firefighting is essentially different from daily experiences. The work-studies take place in professional firefighting training apartment buildings

that simulate typical interventions and in training facilities that allow experiencing real fire conditions. First results of this empathy building approach can be found in [5] and [22].

- Workplace studies of the equipment used by firefighters analyze tool support in firefighting and extract the qualities that make the existing tools fit the challenging environment. Empirical material for this study has been conducted and initially analyzed as presented in [4].
- Design probes [20] of consumer interactive systems featuring novel interaction techniques used by firefighters in their private life help to join the expertise of firefighters with their usage experience of novel interaction techniques. For this activity, jackets with interactive textiles have already been handed out to firefighters.
- Experience prototypes [21] of novel interaction techniques allow to gain results early in the design process. An initial experience prototype for visual feedback inside the SCBA mask has been constructed and evaluated with firefighters.
- Qualitative in-field evaluations of prototypes will analyze critical incidents and feedback by firefighters to learn about the fit of interaction techniques within firefighting work practices.

To *specify learning* the results from individual studies will be reflected in terms of their contribution and value for the design of interaction techniques.

## 4 Proposed Solution

A broad set of methods, inspired by ethnographic and design research of the situated perspectives HCI research paradigm, provides the means to design interaction techniques for ubiquitous computing solutions to be used in hazardous environments. This methodological foundation supports the design of interaction techniques for ubiquitous computing solutions in firefighting scenarios.

## 5 Expected Contributions

Scientific contributions to the HCI research community are expected to be twofold:

- On a theoretical level, the research will provide an understanding if and how design research methods following the situated perspective research paradigm can be applied and for the design of interaction techniques for ubiquitous computing solutions to be used in highly dynamic, safety-critical environments.
- On a practical level, a set of interaction techniques will be developed and evaluated to support firefighters working inside burning buildings.

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