

Practice-Centered Support for Indoor Navigation: Design of a Ubicomp Platform for Firefighters

Dissertation

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Leonardo Ramírez Zúñiga

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*"A bright light is not necessary; a taper is all one needs to live in
strangeness, if it faithfully burns."
Samuel Beckett.*

Abstract

Quickly building a reliable assessment of an incident is very important in the work of firefighters. Indoor reconnaissance missions are an essential part of this work. In a reconnaissance mission, firefighters must enter an unknown building and conduct a systematic inspection to assess the situation, look for victims or attack the fire. Because of the heat and fumes, firefighters have to wear breathing protection equipment which provides support only for restricted periods of time. The work under such conditions is a very complex agency in which experience, training and intuition play a central role. Finding a way out of the danger area before complete exhaustion of the air supply can be a matter of life and death in some situations. In these conditions, getting lost is an important cause of accidents in firefighting. Currently, the role of information technology to prevent these accidents is very limited.

Inspired by Weiser's vision of Ubiquitous Computing, the last 20 years have seen a progressive emergence of a new wave of computing, one that fosters the proliferation of tiny networked computers embedded in the human environment, distributed among objects and people. The new paradigms conveyed by Ubiquitous Computing placed in the context of the work of firefighters and, in particular, in the context of indoor wayfinding, create an important opportunity space where ubicomp technology can enhance wayfinding practices of firefighters. In the tradition of Ubiquitous Computing, indoor wayfinding has been commonly equated to the question of

precise position information indoors. However, this technical focus disregards the complexity of wayfinding, missing the fact that navigation of unknown spaces is a skill where technology is only one of many relevant pieces.

This dissertation presents the results of my work in designing and developing ubicomp infrastructure to support the indoor navigation work of firefighters in poor-visibility conditions, part of a long-haul effort of more than five years working as an interaction designer with two firefighting brigades in France and Germany. The guiding theme of my work is a practice-centered perspective for the design of navigation support technology, which moves the focus from the technical question of providing indoor location to the socio-technical question of co-developing technical artifacts and new navigation practices. Contrasting to the automatist approaches of ubicomp, I propose in my work the construction of a platform that support firefighters in augmenting the environment, in this way creating richer contexts that help them to discover their own paths. The concepts informing the platform and the reflection around the design process represent a contribution in three interrelated levels:

- It proposes a novel change of perspective for the design of ubicomp systems in general and of indoor navigation support in particular; and explores the implications of this perspective by means of the design and evaluation of a specific platform inspired by it.
- It provides new insights into the logic of the work of firefighters engaged behind the line of danger in a fire, from the perspective of a designer of interactive systems.
- It uses and evaluates different design strategies in the domain of firefighting, a domain in which they have been tested only to a limited extent.

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Along my work, I had the chance to meet a great group of colleagues and friends both at Siegen and at Fraunhofer FIT: Andrea Bernards, Matthias Betz, Alexander Boden, Sebastian Denef, Jan Gerwinski, Bernhard Nett, Tobias Schwartz and many others who with their friendship created a cheerful and exiting work environment. I owe special thanks to my colleague and friend Tobias Dyrks, who worked with me side by side not only in the construction of navigation systems for firefighters, but also in developing my appreciation for Germany, the German language and particularly the German humor.

I want to express here my gratitude to all the firefighters and instructors that worked with us in Cologne, Münster and Paris, for their invaluable support and great engagement in the projects that framed this thesis. In particular, a sincere thanks to Hans-Willi Kehr, Thomas Dziggle and Thomas Stollenwerk

for their generosity in sharing their experience and knowledge. I also want to thank the people working in the Landmarke project, and in particular Markus Scholz for his support in designing and building prototypes.

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List of Publications

The following list presents in reverse chronological order the papers published in the frame of my dissertation work.

- Ramirez, L., Dyrks, T., Gerwinski, J., Betz, M., Scholz, M. & Wulf, V. (2011). Landmarke: an ad hoc, deployable ubicomp infrastructure to support indoor navigation of firefighters. *Personal and Ubiquitous Computing*. London: Springer. Doi: 10.1007/s00779-011-0462-5
- Ramirez, L., & Dyrks, T. (2010). Designing for high expectations: Balancing ambiguity and thorough specification in the design of a wayfinding tool for firefighters. In O. W. Bertelsen & P. Krogh (Eds.), *Proceedings of the ACM conference on Designing Interactive Systems DIS2010*. New York, NY: ACM Press.
- Ramirez, L., Denef, S., & Dyrks, T. (2009). Towards Human-Centered Support for Indoor Navigation. *Proceedings of the 27th international conference on Human factors in computing systems - CHI '09* (pp. 1279-1282). New York, NY: ACM Press.
- Denef, S., Ramirez, L., & Dyrks, T. (2009). Letting tools talk: interactive technology for firefighting. In *Proceedings of the 27th international conference on Human factors in computing systems - CHI'09*. New York, NY: ACM Press.
- Dyrks, T., Ramirez, L., Denef, S., Meyer, D., & Penkert, B. (2009). Designing for Firefighters—Building Empathy through Live Action Role-Playing. In J. Landgren & S. Jul (Eds.), *Proceeding of the 6th International ISCRAM Conference*. Gothenburg, Sweden.
- Habscheid, S., Gerwinski, J., Dyrks, T., Denef, S., & Ramirez, L. (2009). Artikulationsarbeit und mediengestützte Ortserkundung. Multimodale und multilokale Kommunikation in Notfalleinsätzen. In Institut für Deutsche Sprache (Ed.), *Konferenzband der 45. Jahrestagung des Instituts für Deutsche Sprache*. Mannheim. Germany.
- Denef, S., Ramirez, L., Dyrks, T., & Stevens, Gunnar. (2008). Handy Navigation in Ever-Changing Spaces - An Ethnographic Study of Firefighting Practices. In *Proceedings of the 7th ACM conference on Designing interactive systems DIS '08* (pp. 184-192). New York, NY: ACM Press. doi:10.1145/1394445.1394465
- Ramirez, L., Dyrks, T., Denef, S., & Stevens, Gunnar. (2007). Context as a Resource for Diagnostic Work. IST Palcom Workshop: CSCW, Technology and Diagnostic Work. European Conference on Computer Supported Cooperative Work (ECSCW 2007), Limerick, Ireland. Retrieved from: <http://publica.fraunhofer.de/documents/N-75110.html>

Foreword by the Institute Director

At the Fraunhofer Institute for Applied Information Technology FIT we investigate human-centered computing to optimize the usefulness of information and cooperation systems in their interplay with human work practice and organizational processes.

The emergency management domain is a typical example. It is characterized by its complex requirements and—to a large extent—the absence of IT support on the frontline. As one key example, Fraunhofer FIT has taken up the challenge to support first responders in firefighting. The European project WearIT@Work has performed research on wearable computing systems for this domain, and developed both planning methodologies and initial artifacts for navigation. The BMBF project 'landmarke' has expanded the design towards a navigation support system for frontline firefighters. The European project SOCIONICAL investigates larger-scale firefighting settings, and BRIDGE aims to support large-scale crises across national and organizational boundaries.

Based on experiences in these projects, several doctoral theses at Fraunhofer FIT have been investigating firefighter work practices with different methodologies, and developing methodologies and specific solution proposals for advanced technologies.

The thesis by Leonardo Ramirez – awarded the exceptional grade “with highest distinction” at the University of Siegen under guidance of Professors Gunnar Stevens and Volker Wulf – follows a Grounded Design approach. After an in-depth analysis of the state-of-the-art in firefighter navigation support and the grave shortcomings of present solutions in this respect, a four-year longitudinal ethnographic study in two fire departments of large cities (Cologne/ Germany and Paris/France) is reported from which the requirements for a novel kind of navigation aid called “landmarks”, a kind of intelligent communicating door-stopper firefighters can distribute in a burning building while exploring it for victims and/or fighting the fire. In essence, landmarks constitute a method for distributed annotation of physical space, analogous to what we are doing in the Web 2.0 in the virtual environment. The particular strength of this research results from the continuous interaction of technical design and firefighting practice during the design. The impressive final evaluation reported in the thesis is but one step in this participatory design process.

In summary, the reader of this book will not just gain deep insights in the design history of a successful piece of new firefighter navigation technology, but also see an excellent pioneering example of the Grounded Design methodology as an approach to better understand and design new technology for very weakly structured and ad-hoc collaborative emergency management processes which gain increasing importance in many domains today. I wish all readers the same fascination I had when reading this book.

Matthias Jarke, Fraunhofer FIT
Aachen and Sankt Augustin, February 2012

Die Institute des Fraunhofer-Verbunds Informations- und Kommunikationstechnik (IuK) entwickeln gemeinsame Strategien für die anwendungsorientierte Forschung.

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