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Department of Informatics

Transient Cooperation in Mobile Information Systems

Accessibility mapping by sharing traces of activity

Ph.D. thesis

Harald Holone

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For Oskar Linus and Oliver Thelonius.

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ABSTRACT

In this thesis I present a study of a route planning system within the field of Computer Supported Collaborative Work (CSCW), based on a case within the Accessibility field. A route planner client running on mobile phones has been developed and tested in a close to real world setting. Users provide feedback about accessibility along routes suggested by the route planner, and this influences the route planning algorithm running on a server, providing improved routes over time.

From a CSCW perspective, the work focuses on the individual users' perspective, and how they interact with the system, how they make their decisions, and their reflections on own activities. I take an interpretative approach to describe and understand user rationales for action, and the negotiation of meaning of the traces left behind from use.

The case is that of wheelchair users navigating built and urban environments. The thesis includes work describing existing practices for planning and undertaking such trips, as well as potential consequences of introducing new technology to an already challenging task. The project is based on the OurWay concept of accessibility mapping, where users get a central role in providing the accessibility information based on which the route planning is performed. This contrasts with the established top-down approach to collection and use of this type of information.

The main theoretical contribution of this thesis is the development of a theory of Transient Cooperation*. To do this, I build on the concepts of* groups*,* cooperation*, and* negotiation*. First, I review these concepts and how they are applied within the CSCW and Accessibility literature, before I discuss how the same concepts apply to observed use of the OurWay prototype. Further, I promote the extension of the term* cooperation *to include ad-hoc and implicit forms of co-activity, and argue that this perspective has applications not only in the specific case of accessibility mapping, it can also be applied to other aspects of systems involving user generated content.*

Negotiation, in particular, is central to the discussion of Transient Cooperation. Relationships between individuals, groups, technology, information, and the meaning of action is continuously negotiated by the users. Generalization of the concept of Transient Cooperation is discussed, and practical implications following this idea are presented, both specifically in the case of accessibility mapping, and in the more general case of cooperation through the use of (mobile) ICT.

The aim of proposing the theory of Transient Cooperation is to present ideas to inform design, deployment and situated use of ICT, particularly in the mobile ICT and social web era, and generally to the use of ICT in cooperation between individuals.

PREFACE

This thesis is submitted as a partial fulfillment of the requirements for the degree of Philosophy Doctor (Ph.D.) at the Faculty of Mathematics and Natural Sciences, University of Oslo, Norway. The work has been conducted at the department of informatics in the research group for Information Systems, as well as at the Faculty for Computer Sciences at Østfold University College, Halden, Norway.

The thesis consists of five papers as well as an introduction. The papers, as listed below, are included as appendices. The numbers correspond to the section numbers in the Research Findings chapter and the sequence of the appendices.

1. Holone, H., Misund G., and Holmstedt, H. (2007), "Users Are Doing It For Themselves: Pedestrian Navigation with User Generated Content", In: Al-Begain, K., and Bohnert, T. (editors): *Proceedings of the 2007 International Conference on Next Generation Mobile Applications, Services and Technologies* (NGMAST 2007), Cardiff, Wales, UK, September 2007.

2. Holone, H., Misund, G., Tolsby, H., and Kristoffersen, S. (2008), "Aspects of Personal Navigation with Collaborative User Feedback", In: Gulz, A., Magnusson, C., Malmborg, L., Eftring H., Jönsson B., Tollmar K. (editors): *Proceedings of the Fifth Nordic Conference on Human-Computer Interaction* (NordiCHI 2008), "Building Bridges", Lund, Sweden, October 2008.

3. Holone, H. (2009), "Retrospective Altruism and Transient Cooperation in Accessibility Mapping", In: Mihalaş, G., Saka, O., Blobel, B., Gülkesen, K. H., Mazzoleni, C., Pharow, P. (editors): *Selected Papers from European Federation for Medical Informatics Special Topic Confer-*

ence (EFMI STC 2009), "Travel Health Informatics and Telehealth", Antalya, Turkey, November 2009.

4. Holone, H., and Herstad, J. (2010), "Transient Cooperation in Social Applications for Accessiblity Mapping", In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A. (editors): *Proceedings of the 12th International Conference on Computers Helping People with Special Needs* (ICCHP 2010), Vienna, Austria, July 2010.

5. Holone, H., and Herstad, J. (2010), "Negotiating Privacy Boundaries in Social Applications for Accessibility Mapping", In: Blandford, A., Gulliksen, J., Hvannberg, E. T., Larusdottir, M. K., Law, E. L-C., Vilhjalmsson, H. H. (editors): *Proceedings of the Sixth Nordic Conference on Human-Computer Interaction* (NordiCHI 2010), Reykjavik, Iceland, October 2010.

CONTENTS

CHAPTER 1

INTRODUCTION

Email is fantastic. A standardized, cross-platform, distributed, personal, text-based form of communication with any number of usages and possibilities for adaption. It enables communication between other people and me, one to one and one to many. And by using email lists, it supports many-to-many communication as well. I can access email from any of my computers, using a number of different client applications, stationary and on the move. Through encryption, I can keep email content secret from anyone but the intended recipient. With a digital signature, I can ensure that the recipient knows the email comes from me, and that it has not been tampered with by a third party.

Many regard email as old-fashioned. After all, it has been with us since the introduction of the networked computer. Many are frustrated with the information overflow resulting from a huge number of emails. However, in my view email still forms the backbone of communication on the Internet, also in the context of new, web-based communication platforms such as Twitter and Facebook. I get updates over email, I get invited to new services over email, and I get my password and account information sent over email.

What is it, then, that makes me regard email as so powerful? Being text based, it has several properties that makes it fit into my own work flow. I can copy and paste information from emails to any number of other tools, without worrying about proprietary formatting or export routines. When co-writing with others, collecting information into my personal wiki, or producing written material to be published in any number of formats, pure text is the common denominator across all the tools

I use. It works with version control systems such as Subversion, I can copy and paste to micro blogging systems, and I can produce beautiful typeset documents with LaTeX[1]. In fact, I'm writing this text in emacs in a terminal window on one of my GNU/Linux machines [2], and through a sequence of loosely coupled steps, out comes a finished typeset version as part of a book (this thesis).

I can set up multiple email accounts to reflect my different roles (e.g. private and professional), and I can even use automatic filtering based on keywords and headers to help me work with the amount of information I receive over email. In this respect, email becomes a brilliant example of how standardized, distributed electronic communication can take place. I have the power to customize my interface to this information in any number of ways, and to negotiate both privacy and the security and trustworthiness of the communication. Pure text accounts for the interoperability between the different, loosely coupled components in my electronic information work flow.

In summary, the technologies I choose to use are loosely coupled in standardized ways, and this makes it possible for me to define, or negotiate, my own approach to dealing with electronic information. As will become apparent throughout the rest of the thesis, the technological and philosophical aspects of interoperability and negotiation available through pure text and email have influenced the concepts and the theoretical work i present.

So what does this have to do with the work presented in this thesis, which deals with communication of accessibility information about the physical world? I will argue that key to successful cooperation through ICT, complementary communication channels are required for negotiating meaning of the shared content. Negotiation, according to Hedvall [54], is also central to the experienced physical accessibility of any situation in the real world. Supporting this negotiation requires opportunity for users to appropriate technology, and to *reach outside the system* to negotiate the meaning of information with other users. The system, in turn, must be open to the *result* of this negotiation, again stressing the point about interoperability.

Groups have been central to much research in the Human Computer Interaction (HCI) and Computer Supported Collaborative Work (CSCW) fields, and one of the more successful groupware/CSCW systems in the

[1] `http://en.wikipedia.org/wiki/LaTeX` - Interestingly, the originator of TeX, Donald Knuth, stopped reading his email in 1990, citing the reason was information overflow.

[2] GNU is a recursive acronym for "GNU's Not Unix!

history of the networked computer is, indeed, email [48]. The idea of a group can however be hard to define, and the relationship between individuals is itself a case of continuous negotiation depending on context. Within the Accessibility field, the concept of groups is found in the legislative and regulatory work undertaken by interest organizations, and these groups tend to represent the common denominator of any subset of people with special needs.

In recent years we have seen the rise of mobile computing and the social web in what is turning out to be a very powerful combination. It enables communication between people across geography and time in ways that was considered science fiction only a decade ago. The new opportunities for communication have been, and continue to be, adopted for all kinds of activities, including tools for sharing pictures with family and friends, status updates, running political campaigns, reconnecting with old school mates and finding new friends on-line. Modern mobile phones are equipped with positioning technologies (GPS), cameras, sound recorders and Internet connectivity. In this sense, they are veritable networked mobile multi-media centers, a perfect technological fit for the read/write web.

1.1 Problem Setting and Motivation

Today we see a rapidly increasing level of attention to the principle of *Universal Access* in society as a whole. Ranging from urban planning to website design, recommendations and regulations are created to ensure that everyone in our society can get access, be it to public places or technology like computers. Most often associated with disabled people[3] with special needs, the case for universal access is, as the name suggest, universal. In many ways, it applies in similar fashion to the heterogeneity of devices we use to access the web, from mobile phones and public terminals to set-top boxes, gaming consoles, netbooks and desktop computers. Work in the accessibility field then, can be seen as a special case of general accessibility, and work in the two different approaches to accessibility has much to learn from each other. Work in general accessibility can be found for instance in HCI and CSCW, as well as in standardization of protocols and services on the technical side.

In 2007, I became involved with a project at Østfold University College in cooperation with the National Association of Disabled (Norges Handi-

[3]Disabled by society, not disabled as an inherent quality.

capforbund, NAD), Oslo Municipality, and Norkart. The project goal was to create a mobile client for viewing accessibility information on a digital map. Information about accessibility in the built and urban environment is collected as an initiative coordinated by NAD, and there was already a web based viewer, in addition to the traditional paper maps. The purpose of these maps is to enable disabled people to plan trips, taking into consideration accessible venues and ways to get there. For example, information about curb heights, door widths, ramp angles, elevators and toilets is provided to support planning of travel with wheelchairs. Østfold University College was providing the technical expertise on programming of mobile devices.

The project, started in 2006, was an exploration of the technological possibilities emerging with mobile Internet, GPS positioning, digital maps and mobile phones with the computing power equivalent to that of desktop PCs only a few years earlier. The project was inspired by work in cooperation with, amongst others, the National Association of Disabled. Earlier work with these technologies had been used to create a web-based read-only accessibility map, where users could pan around in a map and get accessibility information about shops, theaters, public buildings and the urban landscape in general. In many ways, this was a digital version of the paper maps that were already in use.

As an extension to the mobile, digital accessibility guide, our team subsequently decided to introduce the opportunity to *add* information to the map, not simply view what was already there. This in turn lead to the idea of using this accessibility information for route planning, and the *OurWay* concept was born. The idea is that users are not only consuming accessibility information gathered through a centralized initiative, they are contributing back to the system through traces of their activities. Users can attach accessibility ratings to segments of the routes suggested by the route planner, and over time the route planner learns and provides better routes for subsequent users.

This thesis describes an attempt to bring the promises of Web 2.0 to the negotiation of accessibility in the urban and built environment. To do this, I combine existing work in the accessibility field with that coming from Computer Supported Collaborative Work (CSCW) and social software. Both these fields are introduced in the first part of Chapter 2, in Section 2.1.1.

1.1.1 The resource challenge

There are two main approaches to universal access in the physical world. The first, and the most prominent one within the accessibility field, is work with rules, regulations and legislation to ensure access for all to new built and urban environment. The second is about identifying and negotiating accessibility of already existing environments.

The typical approach to the latter is through sharing information about accessibility between peers, typically based on personal connections and respective trust and knowledge of individual needs and preferences. More formalized initiatives include projects to document the environment according to standardized criteria. Often this involves measuring everything from curb heights and ramp angles to toilet seat heights and door widths. In Norway, these initiatives are taken by interest organizations, such as the Norwegian Association of Disabled (NAD), where members of the organization are trained to collect the information according to standardized criteria.

After the information is collected, it is approved by NAD, and disseminated, traditionally on paper maps, now also on digital maps, to facilitate planning of trips to public areas such as shops, hotels and tourist attractions. The approach is top-down, meaning that the initiative is taken by the organization, volunteers are collecting information, and the dissemination is performed under the quality seal of the organization. I refer to the process of collecting and organizing accessibility information as *accessibility mapping*.

This approach has obvious benefits, such as presenting an objective view of the level of accessibility, related to specific standards. It also has challenges, such as the fact that it is difficult to standardize accessibility information. Needs and preferences evolve, and individuals *negotiate* the experienced accessibility in every situation. Another big challenge is the scalability of this approach. By using a top-down approach, and relying on selected individuals in the community to do the field work, there are limitations to how many places can be mapped out, and this is further emphasized by the need for continuously maintaining the information, once collected and disseminated. Prioritizing the areas to map out will often be a case of finding the most popular areas, the places where most people would benefit from available accessibility information.

A parallel story can be found in geographical mapping in general. National mapping agencies produce detailed and high-quality maps, but this information is often available with a license fee which is high enough to discourage use by the general public. Licensing issues often pre-

vent end users from modifying or augmenting the geographical information, a typical effect of the top-down approach. One project that aims to create an open alternative source of geographical information is the OpenStreetMap (OSM) project [4], founded by Steve Coast in 2004. OpenStreetMap can be thought of as the Wikipedia of geographical information. By letting every user be a potential contributor of information to the project, thousands of users have contributed their GPS traces, meta data, time, and drawn roads and other geographical entities to create an impressive, freely licensed source of geographical information. This stimulates creative use and new services which would typically be prohibited with map data sourced from national mapping agencies. Additionally, since the users are making the priorities with regards to what areas (and what details) to map out, the OpenStreetMap project can maintain good coverage also in less populated areas, and with focus on details that might not be of interest to the larger population.

In other words, new data can be added to the core OSM data set, or additional services can be set up to augment the core OSM data set. Numerous examples exists for this, including services specific to bicyclists [5] and ski tracks [6]. In addition to the data itself, the OSM project has created an infrastructure with servers, API's, communication platforms and tools to facilitate the collection, modification and dissemination of geographical information. In the OurWay prototypes, both data and infrastructure from OSM has been used as core components in the project, and data has been contributed back to the OSM project where applicable.

One of the first questions we tried to answer in the OurWay project was if the ideas from collaborative undertakings like Wikipedia and OpenStreetMap could be used to alleviate some of the challenges posed by the traditional top-down approach to accessibility mapping.

1.1.2 Accessibility mapping rethought

A possible solution to the resource problem mentioned above is to apply the insight gained from CSCW, the social web, and the field of accessibility to think about accessibility mapping from a fresh angle. By involving the users as contributors of accessibility information, as *Citizen Sensors* [41], updates to the accessibility database can be made more frequently, based on traces of activity from each individual user. These updates are

[4] `http://openstreetmap.org`
[5] `http://opencyclemap.org`
[6] `http://openpistemap.org`

subjective three-level ratings of accessibility, and as such is a significant simplification compared to the traditional approach of measurements and standard requirements. This involvement of the users is the core idea behind OurWay, what I throughout this thesis refer to as the OurWay concept. Included papers present promising results from indoors and outdoors tests of OurWay prototypes.

1.2 Positioning and Theoretical Motivation

This thesis concerns the cooperation between individuals for sharing information about urban and built environment accessibility through mobile ICT. Central to the theoretical part of the presented work are the ideas of groups, cooperation and negotiation. Most of my research in this project has been in the intersection of the HCI, CSCW and Accessibility fields. Through the various papers, related literature from these fields have been brought to the table. The selection of literature has also, of course, followed the evolution of the project and the turn towards the third paradigm of HCI [52] towards the later stages of the project.

Within the CSCW literature, the majority of research has concerned cooperation through technology in workplace settings. I build on this discourse to suggest the application of insight to systems in non-traditional settings, where explicit cooperation and shared goals are not prominent. The case on which the thesis builds is set in the accessibility area, where negotiation of built and urban environments is the primary goal. The theoretical contribution to this field consists mainly of bringing insight from CSCW to the Accessibility field, and one of the central concepts I bring in from the CSCW literature is negotiation, which I elaborate on in Chapter 2.

1.3 Research Questions

This thesis consists of five papers published over the last few years. These clearly reflect the evolution of my own work, from a technological prototype focus to a human centered focus. When I started my PhD project, it was loosely defined around the use of mobile devices and geographical information. The first paper published as part of my project was indeed focused on technology and was positivist of nature, and in particular investigated to which extent the selected mobile equipment and routing algorithms were effective for accessibility mapping. In this respect, my

project started out in what Harrison calls the first and second paradigms of HCI research [52]. Throughout the project, the focus has become more interpretive, shifting focus towards the human perspective, and my recent papers have discussed social applications for accessibility mapping, and privacy issues emerging from change of existing practice.

What follows are four research questions addressed in this thesis, partially in the included papers, and partially in Chapter 4, 5, and 6.

1.3.1 RQ1

> In what ways are opportunities for cooperation changed by the introduction and use of mobile ICT systems?

With the emergence of smart phones and mobile Internet access in the late 1990's, online computer activities were no longer restricted to desktop computers and wired networks. This opened up for IP-based communication away from the desktop computer, "anywhere, anytime". Early on, this technology was predominantly used by business professionals in early adopter vertical markets, due to pricing of both phones and Internet access. Over the last decade, technology has grown more sophisticated, with more capabilities and computing power being added to mobile phones. Simultaneously, phone prices and data access plan pricing have declined. With the introduction of phones and application store ecosystems like the Apple iPhone and Android phones from various manufacturers, these handheld, networked computers have become a natural part of many people's daily lives. This development, combined with blurring of the borders between work activities and leisure activities may also introduce questions about the role of structured work as the framing for cooperation through ICT systems.

With this research question, I seek to explore ways in which cooperation can be supported by mobile, networked technology. The empirical case I use is collaborative route planning aimed at wheelchair users, however the insight gained could be generalized to account for a more general description of cooperation through mobile ICT. Being firmly rooted in the empiric findings in the first two papers included, the question provides the technological anchor of this thesis. The first included paper gives a thorough description of the first OurWay prototype, which was the starting point for a complete re-write of the client and server software which I performed before the indoors trials as a preparation for the second included paper. The second paper also provides a bridge from the technological perspective to aspects of use of the system.

1.3.2 RQ2

> How can these forms of cooperation be described in the context of existing HCI literature on cooperation?

Mobile ICT seems to support ad-hoc forms of cooperation "anywhere, anytime", blurring the boundaries between work and leisure activities. Structured organization and a traditional work context is perhaps no longer a required framework for cooperation to take place through mobile ICT. In the existing CSCW discourse, the term *cooperation* mostly refers to co-activities in traditional work settings, where roles and responsibilities are usually well understood.

With this research question I aim to position my work in the context of existing CSCW literature. The goal is to leverage the knowledge accumulated in the field over the last 25 years, and to problematize the concepts of cooperation, groups and negotiation with background in the insight from my work with cooperation through mobile ICT.

In particular, I propose the theory of *Transient Cooperation*, where shared benefits from traces of individual activities left from pursuing individual goals are viewed as cooperation.

1.3.3 RQ3

> What motivates users to cooperate through and contribute to OurWay-like systems?

The question of motivation for contributing user generated content has been addressed by many, particularly with focus on popular on-line services such as Wikipedia and Flickr. In systems like OurWay, *content* is perhaps a misleading term to use for describing the information contributed by users in the pursuit of their own goals. "Traces of activity" might be a more precise phrase. The nature of the ad-hoc forms of cooperation covered by *Transient Cooperation* leans towards non-formalized forms of co-activity. Activities involved in achieving self-oriented goals leaves behind traces that can contribute to a greater good, such as a service based on aggregate traces from multiple users.

With this research question, I use the OurWay case to discuss how motivations for use seems to change before, during, and after use of such systems. Involved in the dynamics of motivation is also the negotiation of group identity, representativeness and the meaning of own activities. I draw upon some psychology theory and economics theory to elaborate

on these findings. Additionally, I point to use cases different from the "typical" use case I have studied, to suggest how the context of use has an effect on motivation.

1.3.4 RQ4

> What privacy issues might emerge with the introduction and use of these kinds of systems?

Introducing new technology into existing practices inevitably changes those practices. With systems based on traces of activity, such as OurWay, persistence of traces of activity is of particular importance. In our daily lives, without mobile ICT, we're accustomed to ephemeral conversations and the forgiving mind with respect to prior activities by our self and others. In fact, we're to a large extent depending on our ability to forget and to re-interpret fragments of prior activity to form a consistent image of our selves. With the introduction of ICT systems to facilitate communication and coordination between people, what was once ephemeral might suddenly be persisted in detail, for others to view and interpret at a later stage. To a certain degree, this limits our opportunities to negotiate our identity and the meaning of action at the time of interpretation.

With this research question, my goal is to look at how an existing practice changes with the introduction of mobile ICT, and to problematize privacy issues that might arise with it. To do this, I once again turn to the OurWay case, with focus on route planning for wheelchair users. Existing practice is established through interviews with wheelchair users. Observed changes in practice are reported from my own studies, and privacy concerns are raised both by participants in the studies, and by myself as an extrapolation of the findings. I use an established privacy framework proposed by Palen and Dourish to structure the discussion, which can be found in the fifth included paper.

1.3.5 A project is a journey

My own background is in the technology focused tradition, and the project I started doing was also primarily technology oriented. Through my involvement with the group for Design of Information Systems at Ifi, University of Oslo, my scope broadened, and my interest evolved into a fascination for the use of technology, rather than the technology itself. The OurWay project also paved the way for me into the field of Accessibility, which has shaped the content and themes for the papers in this thesis.

Obviously, through a journey like this, several cases of profound hindsight have occurred. One notable such case is my "discovery" of Social Navigation of Information Space, which I became aware of after publishing the paper "Aspects of Personal Navigation with Collaborative User Feedback" (included in this thesis). Prior knowledge of this and related literature could have informed both the design and development of the prototypes and the approach our research. On the other hand, the evolution of the project has been a great learning experience, and is of course difficult to assess the outcome of an alternative progression.

1.4 Theoretical Framework

Developing a theory has long been an elusive prospect for me. It is only in the later stages of my project that I've realized that the concepts I have identified, and the observed use of technology as part of cooperation merits a theoretical framework, based on the very concepts I have spent time with. According to Silverman's model of research [94], the most basic stance in research is that of the *model*. Basically, this describes the way we observe and reflect about reality, e.g. in a positivist or relativistic sense. Within this model of reality, we discuss *concepts*, and the combination of concepts used to describe some phenomena is referred to as a *theory*. With this background, the idea of building a *theory* is less intimidating, and comes across as a practical way to frame a discussion of a phenomena in the real world.

1.4.1 Transient Cooperation

During testing of the OurWay prototypes it became apparent that users often did not have an explicit goal of cooperating with others, rather they were focused on solving their own tasks at hand, i.e. achieving their own goal [62]. Nevertheless, the accumulation of traces of their interaction with the system gradually had benefits for the other users, in the form of better and more accessible routes based on feedback from the users. Through observations and interviews, this phenomena was investigated further, and has culminated as the the theory of *Transient Cooperation*. Here a definition put forward in one of the published papers included in this thesis:

> "Transient Cooperation is a form of cooperation which does not require an existing community, or explicit participation

> other than a shared benefit from use. The interaction is asynchronous and limited in time, and the users might be unaware of their cooperators or the benefit they have from cooperation." [63]

Transient Cooperation attempts to capture the fleeting nature of groups, how members associate with groups, and how they can cooperate in this context. Wenger's [119] third group of participants in a Community of Practice, the *peripheral group,* is an example of where the idea of Transient Cooperation likely is applicable. The group consists of the majority of the members of the community, and people in this group are mostly passive, unlike participants closer to the core of the community. They participate in, and associate with the community to a varying degree.

In the OurWay case, may be problematic to talk about a Community of Practice, mostly because there is no pre-existing community in the described case, and second because the duration of the case have been to short for one to be formed by the participants. There are also elements of the system design which did not cater well for the building of such a community. I will return to the details of the case in Chapter 3. I prefer to view these limitations as important factors that helped tease out the idea of Transient Cooperation. Precisely because of the short period, the non-existence of prior community and the limitations in the technology, the form of cooperation became obvious. It might be tempting to dismiss the idea because of these limitations, however the subsequent interviews and review of our observations clearly suggests that the users first and foremost concern themselves with achieving their own goal, despite the fact that they were (or rather, we intended for them to be) fully aware of the other users, and their shared benefit of interaction with the system.

This touches on some interesting questions related to goals. It is obvious that in our experiments, focused on the use of the OurWay prototype as a navigational tool, the goal of reaching the assigned destinations soon became appropriated by the participants, and the focus was, with few exceptions, on getting there with the use of the technological aid. The concern for the other participants was, generally, absent. In another, more coordinated setting, for instance in a accessibility mapping campaign (this is a common way for organizations to gather accessibility information for an area or a type of public places), it would be expected that the goal would be more clearly defined and shared across the participants of the group. Of note here is that the coordination and formation of the shared goal would happen *outside* of the ICT system. This would also shift the focus from "what is accessible for me" to "what is accessible to us".

Participation in and identification with groups evolve, too. For instance, a disabled user can have different wheelchairs available for different occasions, which accordingly influence which "group" the user "belongs" to. The setting in which gathering accessibility information is happening also plays an important role. Is it driven by a personal goal, or a goal defined by a defined group or organization? In previous work, we have identified different stakeholders in a system using mobile ICT for accessibility mapping [60], and different stakeholders would most likely have different objectives, and the objectives would also likely be diversified within the different stakeholder groups. Further, it is important to recognize that negotiation will take place both at the time of producing the information (who do I represent now, who do I want to share with etc), and at the time of interpretation (Who was this information created by and for? Is it relevant for me? Do i trust the source? etc).

A dilemma related to negotiation in networked ICT can be found in Palen and Dourish' *temporal* boundary [83]. By persisting activity, conversation or other pieces of communication, the opportunity for negotiating the meaning and context of that piece of information is to a large degree abandoned. In the evaluated prototype implementation of OurWay, the cooperation between users can be considered "blind", that is, similar to "Monitoring and adjusting the state of the machine" [10]. The cooperation between users has indeed been indirect, and other user's activity has only been available as part of the aggregate leading to the route suggested by the route planner. This is critique we have put forward earlier, when re-framing OurWay as a social application [59].

Transient Cooperation is discussed in more detail in Section 2.2.6.

1.5 Structure of the Thesis

In this chapter I have presented background and motivation for the work on which this thesis is built. The chapter started with a personal story about email to highlight the flexibility and interoperability provided by this successful CSCW system. Further, Universal Access and Accessibility studies were introduced, and the background for the OurWay project was presented. The chapter continued with a description of the resource challenge related to collecting and maintaining accessibility information, and suggests social accessibility mapping as a potential solution to that problem. The research going into this study was placed within the CSCW field, with a case set in the Accessibility field. Main research questions were introduced, and a brief overview of Transient Cooperation closed

the chapter.

The remainder of the thesis is structured as follows. Chapter 2 provides a review of relevant research fields, and frames the OurWay work within existing discourse. Further, the theory of Transient Cooperation is developed based on the concepts groups, negotiation and cooperation. In Chapter 3, the case is presented in greater detail, as is the research approach applied in the studies. Research findings from each of the included papers are presented in Chapter 4. Theoretical contributions and practical implications of the work is discussed in Chapter 5, before the thesis is concluded in Chapter 6. Following that, the papers included in the thesis can be found as appendices.

CHAPTER 2

THEORY

> Good for you! My word, yes. Well, Chris, what is it, that it is, this theory of mine? Well, this is what it is: My theory, that I have, that is to say, which is mine . . . is mine.
>
> Anne Elk (Miss)

This thesis is built on the journey of the OurWay project, which is described in detail in Chapter 3. Initially, the project was mostly inspired by technological curiosity and possibilities. However, the focus soon changed towards different aspects of the user experience, and we sought a theoretical foundation in the HCI field. This chapter serves two main purposes. First, it aims to present my way into the HCI field, and to highlight the main sources of inspiration and theory relevant to my work. Further, it incorporates other research fields than HCI, to form the theoretical platform on which the later stages of my project has been carried out. The second goal for this chapter is to introduce my theoretical contribution of my thesis, the theory of Transient Cooperation (TC).

In OurWay, the core idea is that users can collect information about accessibility in the physical world trough use of a server based, mobile route planner, and share this knowledge with other users through the same system. In the project we soon became interested in how our users interact with the OurWay system, and how they relate to each other through the use of the route planning service.

In the first section, Review and Positioning, I identify relevant fields of research, and position my work in relation to existing discourses. My interest in the project has been the collaborative aspects of use, and in particular how users cooperate with each other, explicitly or implicitly. Three central concepts have emerged from this research focus, helpful to describe this phenomena: *Groups*, *Cooperation,* and *Negotiation*. I point out the relevance of these terms in related work, as a background for my discussion of these concepts and how they relate to the theory of Transient Cooperation. In the second section I present the TC theory, starting with a rationale for developing the theory, and a discussion of the core concepts and their relations, which finally is formulated as the theory of Transient Cooperation.

2.1 Review and Positioning

In this section, I review the research fields most relevant to my work with OurWay. Following the review, I discuss the role of the key concepts *Groups*, *Cooperation*, and *Negotiation* as they appear in this literature.

2.1.1 Relevant fields of research

Several fields of research have inspired and influenced the work in the OurWay project. I start out with a general introduction to the HCI field, with a brief history and an indication of where my work belongs in this large and many-faceted field. Then I move on to Computer Mediated Communication (CMC), Computer Supported Collaborative Work (CSCW) and social applications, and position them in the general HCI field. I highlight activities within the CSCW sub-field *Social Navigation of Information Space* (SNIS), a field that has special relevance to the OurWay concept and our research findings. I then look at work concerning collective production of content such as encyclopedias and digital maps, before introducing the accessibility field and its role in the OurWay project.

Human Computer Interaction

The field of Human Computer Interaction (HCI) encompasses the study of various aspects of interaction between computers and people. From my perspective, HCI is a general term covering many sub disciplines, which has evolved along with advances in technology. It has roots in the origins of Human Factors (HF) research dating back to the industrial

revolution. The discipline established itself in the 1960's with seminal works like Douglas Engelbart's *oNLine System* (NLS) [32] in 1968, Ivan Sutherland's *SketchPad* [104] in 1963, the proposal of user interfaces with overlapping windows by Alan Kay in his doctoral thesis *The reactive engine* [66] in 1969, and Carmody et al.'s *Hypertext Editing System* [19] in 1969.

The diversity of the HCI field is supported by established work in many other areas of research, including various fields of psychology, computer science, artificial intelligence, and anthropology. By applying principles, theories and practical experience from these other fields, the HCI field has been able to progress rapidly with contributions supported by discourses in other fields.

Several detailed historical accounts of the evolution of the HCI field exist, including work by Carrol [20], Grudin [45, 46] and Myers [78, 79]. The description of the evolution of HCI as a research field (and, indeed, the definition of the HCI field) will vary depending on the describer. One approach that I find fruitful for getting a birds eye perspective on the field of HCI is the discussion of three paradigms of HCI identified by Harrison et al. [52].

Harrison breaks down the evolution of the HCI field into three paradigms. The paradigms are not laid out in a chronological sequence, although they have appeared at different times in the history of HCI. Neither are they mutually exclusive, that is, research is still performed within each of the three paradigms. The first paradigm is characterized by pragmatic solutions to issues concerning the fit between humans and machines. Research within the second paradigm is more focused on cognitive aspects of HCI, typically using measurable phenomena related to optimized communication between man and machine. The third paradigm is defined by the use of multiple perspectives, and an phenomenological approach to understanding and designing for interaction.

Jonathan Grudin takes a slightly different approach to make an overview of types of HCI research [44], where he identifies five levels of interface design, ranging from hardware (the first level) to work settings (level five). Levels three, four and five maps quite nicely to the paradigms suggested by Harrison.

The first published paper from the OurWay project can be considered to belong to the first and second paradigms of HCI, in that it is applies a pragmatic research approach ("can this technology be used for this type of navigation or can it not?") and also tries to establish the efficiency of the applied technology ("how quickly can users generate better and accessible routes?"). Later papers in the OurWay project fall clearly in the third paradigm of HCI research, as identified by Harrison. This is char-

acterized by focus on the context of use, and the interest in collaborative aspects of interaction with and through the system.

CSCW, CMC, and mobility

CSCW and CMC Computer Supported Collaborative Work emerged from the HCI field after years of focus on interaction between computers and people. With networking technologies came the ability to communicate human to human *trough* computers. The study and development of technology taking advantage of this ability is often referred to as Groupware (see for instance [45, 48]).

In 1984, a workshop on Computer Supported Collaborative Work was initiated by Irene Greiff and Paul Cashman, followed two years later by the first ACM conference on the same subject. With CSCW, the focus expanded from small work groups to collaboration in larger groups, directed towards the work that people do *with* technology, in stead of focus on the technology itself. The CSCW community attracted researchers from many fields, and for different reasons. There has been (and continues to be) disagreements about the status of the field [10, 9, 2, 92].

One area of interest in CSCW is the concept of *awareness* [27, 91]. When working with others, awareness of colleagues' whereabouts and activities is important. In the physical world, this awareness is available to us implicitly. In the electronic world, however, with cooperation over distance and over computer networks, work context (or parts of it) must be recreated to enable awareness. An example of awareness related to editing and reading documents is Edit Wear and Read Wear [56], where inspiration from traces of activity on physical documents (such as notes in the margins, worn pages from reading etc) is used to create awareness about activity on shared electronic documents.

Another area that interests CSCW researchers is the distinction between the concepts places and spaces [26, 4, 53]. A place is a physical or virtual arena where activity *can* take place (for instance, a classroom, a public square or an online chat room). A *space* is a place which is inhabited by activity (the classroom can be used for teaching a class, or it can be used for a staff meeting). Depending on the activities and people that occupy the space, the rules and expectations for the same place might change.

The CSCW field attracts researchers and methodology from many different disciplines. Ethnography plays a special role, in that observation of work places, activities taking place, meaning of these activities, artifacts in use and cooperation are central to CSCW research. The field also has,

from its beginning, a bias towards studies of work places, i.e. activities within the context of companies and organizations.

The related field of Computer Mediated Communication (CMC) typically revolves around the effects of use (such as the difference between face-to-face communication and on-line chat), and the technologies involved in on-line communication. It differs from CSCW both in the focus on non-work related situations, and in the lack of focus on content of and purpose of communication and collaboration [7].

With the introduction to the public of the World Wide Web in the early 1990's [15], collaboration between people across the globe, and often without any sort of formal organization of work, was enabled. Most prominent from the early days of the publicly available Internet is perhaps Usenet, where newsgroups on almost any kind of topic attracted users from different locations and situations to create communities for broader or narrower interests.

In the early days, the amount of information produced was still somewhat manageable, however it soon became difficult to keep up with topics of interest, even for the most dedicated person (See for example "The future of ignoring things", [25]). In addition to the wast amount of content posted online, the varied quality of newsgroup postings, including junk messages and trolling behavior made it desirable to introduce technology to help track and extract the most valuable information in the groups. This inspired some researchers in the CSCW field to study collaboration, content creation and navigation on the web, shifting the focus from group work and organized collaboration to larger scale collaboration without the same degree of formal coordination.

Recommender systems is a general term applied to systems that can act as a filter of information. It can, for instance, be based on profile information, where users indicate interests of specific themes. Collaborative Filtering (CF) is a specific type of Recommender System where the filter is built collaboratively (and often invisibly) through individuals' use of systems, based on the traces left behind from use of the system. The mechanism is simple at the core, and basically consists of various ways of voting for the quality of content found on-line. Content that receives votes from many people is regarded more relevant or of higher quality. Combining voting with rating systems for the raters themselves provides a way to collaboratively identify worthwhile content.

GroupLens [86] is an early example of a collaborative filtering system that allows users to rate news articles found on Usenet. The ratings are distributed in the Usenet infrastructure, and are used for two purposes: to match users with similar interests or preferences, and to predict whether a

new article is interesting to a particular user based on other users' ratings.

For an overview of different types of recommender systems, including discussions and an outline of challenges, see Terveen et al. [106].

Mobility In my thesis, the role of mobile technology is pronounced. It is what enables route planning on the spot, and what allows the blend of online communication and locations in the physical world, for instance related to obstacles for traversal of urban environments.

In CSCW, being focused mainly on workplace settings, the mobility aspect has often concerned the mobility of work, that is how coordination of work activity taking place in different physical locations can be achieved with the help of networked technology. As an example, Bellotti et al. identifies *micro mobility* in a workplace settings [14], and describe challenges related to awareness and coordination introduced by people moving around in their working environment, e.g., between offices and desks, away from their computers.

Early work on mobility not only for people, but also for technological artifacts used in collaboration, includes Luff et al. [73]. Three different work settings are described, and aspects of micro mobility and mobile artifacts are discussed. In particular, they call for more focus within the CSCW community on investigations into support for collaboration away from desktop computers, and the interaction between people using mobile devices.

There are several studies on work mobility carried out in hospital settings, on the basis that these environments involve a lot of distributed work, across different people, situations and technological artifacts. Further, the work is not (always) tied to the desktop, it often involves moving around in the hospital. This type of work is dubbed *mobility work* by Bardram and Bossen [11]. González et al. [40] later use Bardram's and Bossen's work, as well as Bannon's and Bødker's *Common Information Spaces* [8] as the basis of a theorectical understanding for the support of ubiquitous computing technology in distributed work spaces.

Still, the term *work* mostly refers to activities within an organization or traditional workplace. With the advent of powerful mobile phones and mobile internet connections comes opportunities for new forms of collaboration and coordination, often outside of the traditional work context. What *work* constitutes in the CSCW acronym has been debated [10], nevertheless the majority of CSCW research revolves around the traditional workplace. Mobile phones with the ability to be online any place at any time allows for coordination of more mundane tasks, and collaborative

activities related to physical location and other contextual information. The mobile phone is a personal device, which often blurs the boundaries between one's private and professional activities, and the locations at which activities take place (see for example [4]).

Designing technology to support collaboration and coordination requires an understanding of the processes to be supported. Ackerman [2] argues that there is a clear gap between the social requirements that the systems need to support, and the technological solutions designed to support them. By pointing to what he calls the *social-technical gap*, he calls for a refocus of CSCW research to better support the nuances in human social interaction in CSCW systems. His insight is valuable, and perhaps even more pertinent now with the plethora of online communities for social interaction, and the ubiquity of networked devices, including the social computer we call the mobile phone.

Social Navigation of Information Space

Social Navigation of Information Space (SNIS) is a term which refers to a number of different approaches to supporting information searching and sharing in the networked world. Sometimes referring simply to publishing lists of WWW links or sharing of URLs [23], it more often includes collaborative filtering and other forms of recommender systems [28, 24, 55].

Metaphors from social navigation in the physical world are often used as inspiration for methods of social navigation of information space [120]. One example is the way we tend to judge the popularity of venues such as restaurants based on the number of people already at the venue. Further, if we identify positively with the people at the venue, the implied recommendation of the place grows stronger.

I discovered the existence of the social navigation literature about half way into the OurWay project. Had I been aware of it earlier it is likely that some of the design decisions that were made would be different. Social navigation builds on two main pillars in the CSCW research field; awareness and information spaces. In the OurWay project, the prototypes were not designed with emphasis on these two facets of collaborative systems. It is perhaps the lack of direct support for mediated awareness that stands out as a missing feature. In OurWay there is only indirect awareness provided, in the form of route suggestions based on aggregated accessibility feedback from previous users. This might be regarded a weakness of the design, however as some of the OurWay findings suggests, it might have helped uncover interesting aspects of personal navigation in collaborative

systems.

SNIS systems are often characterized along two dimensions of capabilities. The first dimension describes the temporal aspect of the system, in other words if the communication between different users of the system is taking place synchronously or asynchronously. For instance, a book review or a posted list of favorite WWW links is a form of asynchronous communication. An on-line chat room would be an example of synchronous communication. Interestingly, services such as Facebook and Twitter could fall in both categories, depending on how the users appropriate the technology.

The second dimension characterizing a SNIS system is describing aggregated or non-aggregated information. Accumulated (and perhaps averaged or weighted) information, such as book ratings or Digg "votes" is an example of an aggregating system. Book reviews would be an example of a non-aggregating system. Adding votes to the reviews would produce a hybrid system where the non-aggregated recommendations (the reviews) would be highlighted by the aggregated votes collected for the review.

OurWay would fit in the asynchronous/aggregate category of Social Navigation systems. Traces left from use of the system is stored on the server and aggregated (averaged) for the route planning algorithm to use. There is no direct "real-time" communication between the users through the system.

A third aspect of Social Navigation systems regards the intentions of the users. In some cases, sharing traces of activity is deliberate, such as sharing WWW links. In other cases it can be traces left as a by-product of use, such as online stores where the purchase of an item also leaves behind information that allows the online store to subsequently recommend items to users based on what other "similar" users have purchased. OurWay falls into the latter category, since the traces left behind from use can be considered by-products of navigating with the help of the system [62].

In Social Navigation of Information Space metaphors from social navigation in the physical world are used as inspiration for design. With OurWay, one can consider that the metaphors are brought back to the physical world, supporting social navigation of the physical world through the use of a route planner. Another implied feature of OurWay is the kind of "inverted recommender system" feature it supports. Initially, all routes are considered navigable by OurWay, and feedback from users in practice (mostly) removes obstacles from the initial geographical network, thus sharing information about where *not* to go, different from the traditional

recommender system approach.

Most of the (early) work in Social Navigation of Information space is related to navigating on the web, and mobility of technology and users is not often considered explicitly. One early exception to this is work by Herstad et al. [85], contemplating the role of wearables (mobile devices) in social navigation.

Collective content creation

The emergence of web logs (blogs), social networking sites, mash-ups, and the statusphere has had a profound impact on how people interact on "the web". The power of loosely organized individuals using relatively simple technology to communicate, organize, and collaborate has been described vividly by many, including Clay Shirky in his book "Here Comes Everybody: The power of organizing without organizations" [93] and Howard Rheingold in "Smart Mobs: The Next Social Revolution" [87]. Cost and amount of effort required for collaboration across distance and time have been reduced to the point where everybody can have the opportunity to voice their opinions, and coordinate activities to influence society.

It is difficult to escape Wikipedia as an example of the collective creative power of individuals on the internet. A case for many research projects on motivation and collaborative content creation (see for example [82, 122]), this online encyclopedia stands out as one of the most successful and well-known examples. Issues of conflict and mischievous activities are also numerous, and have been studied by many. Viegás et al. created and evaluated ways of visualizing changes to pages in Wikipedia over time [112], an example of how to make editing activity visible. Special attention was paid to so-called edit wars, where two or more groups of people have different opinions on a matter, and take turns editing large portions of material to reflect their particular view. Priedhorsky [84] has later built on this work, identifying types of damage and introducing metrics for evaluating the impact of such damage. Another method for visualizing activity was suggested by Adler et al., who came up with a strategy for assigning trust and colorize words and phrases in a Wikipedia article based on a number of sources, including the accumulated trust of the editors [3]. A related approach is found in Kramer et al., who present metrics for assigning trust to Wikipedia pages based on phrasal analysis of the article revision history [68]. Another related approach is suggested by Suh et al. [102]: WikiDashboard, a tool for visualizing the social dynamics and context of a Wikipedia page.

Serving as an example of collective content creation in a different domain is the OpenStreetMap[1] (OSM) project, which was initiated by Steve Coast in 2004. There were at least two reasons for starting the project. Partly, it was motivated by the steep pricing of map data from Ordnance Survey, Britain's national mapping agency. Secondly, the typical usage restrictions on licensed commercial map data prohibited many innovative usages.

More than 100.000 individuals have contributed to the OSM project, resulting in an impressive, worldwide database of geodata [50]. Within the existing Geographical Information Sciences (GIS) community, this form of geodata collection is referred to as Volunteered Geographic Information (VGI) [41]. Coverage and accuracy [6, 77], and credibility [37] in VGI have been studied, and promising findings have been presented in support of the value of collective content creation. The relationship between VGI and the similar concept of Public Participatory GIS (PPGIS) is explored by Tulloch [108]. Collectively creating content as in Wikipedia and OpenStreetMap also faces challenges, ranging from participants' different cultural reference points [111], to engaging bureaucratically organized entities [16] (however, the issue of resistance towards introduction of new systems in organizations is not new [74]). Some middle ground solutions have been proposed (see for instance [99, 18, 69]) in order to bridge gaps between different approaches to information gathering and dissemination.

An extra advantage of open content such as the OSM data set is that the core geographical information is available, which enables alternative applications of the data, such as customized map rendering, route planning, and other calculations based on the data sets. The OSM data set and tools have been central in the OurWay project.

Mobile phones get increasingly powerful processors, larger screens and more features. Geographic positioning, typically implemented as a GPS receiver, is found in most most modern phones. The rapid growth of the smart phone market (with Android and iOS devices as two significant players) and related software markets suggests more and more users possess devices with these capabilities. New services such as FourSquare, GoWalla and Facebook Places are Location Based Services (LBS), that is, the position of the user (and the position of other users in the social network) is the decisive factor. See Reno [97] for an early example of LBS research. Location also naturally plays an important role in navigation, and search engines and other web services are also starting to use the

[1] `http://openstreetmap.org/`

user's location for providing customized services.

The rapid technological development of mobile equipment and the service infrastructure now being built around it caters for online collaboration and other cooperative activities away from the desktop computer. These promises of the technology was what initially prompted the start of OurWay as a project.

Accessibility

The *accessibility* field can be regarded as a subset of the more general field of disability studies. Disability studies in general are concerned with understanding and describing life in society for people with impairments. According to Gleeson [39], the disability discourse emerged in the 1950s, and grew through the rise of the civil rights movement in the United States in the 1960s. For the most part the discourse was, and to a large extent still is, concerned with policy issues, such as employment and benefit rights. The practical and political themes of the discourse reflect the backgrounds of most of the contributors to the field, namely as practitioners and advocates. This also partly explains the lack of a solid epistemological approach in the field.

The United Nations Convention on the rights of persons with disabilities aims to "promote, protect and ensure the full and equal enjoyment of all human rights and fundamental freedoms by all persons with disabilities, and to promote respect for their inherent dignity." [81]. This is one of many current initiatives on the political level.

The accessibility sub field is concerned with access to physical environments, technology and information. This is also a practically oriented field, as it shares many of its contributors and history with the general disability discourse. Accessibility covers a wide range of topics, such as the accessibility and usability of ICT, as well as physical accessibility in urban and built environments. In current work with OurWay, the primary focus is on physical accessibility and the use of mobile ICT for sharing information relevant to moving around in the physical world.

Physical accessibility When applied to the physical world, the term *accessibility* can refer to different phenomena. For instance, in results from the AUNT-SUE project [33], social aspects like *fear of crime* are mentioned as important factors when users assess the overall accessibility of an area. Similarly, the AMELIA project [107] identify surrounding factors such as places to rest and public toilets as important in the overall accessibility

picture. Völkel et al. [114] describe requirements for accessibility annotation of geographic data, with the aim to collect detailed information about the physical environment for different needs and preferences.

The proportion of elderly people in the population is growing. The needs and preferences found in this group provides another example of the many-faceted area of accessibility. For instance, Ståhl et al. [98] reports from a Swedish project in which accessibility and safety in the outdoors environment is surveyed in the age group 65+ to provide guidelines for urban design. Risk factors reported by participants includes "poor snow removal", "behavior of cyclists" and "too few benches".

Access to information Universal design is receiving increased attention, as can be seen for instance in programs within the European Union regarding accessible technology. The European Union's focus on eAccessibility and eInclusion [110], the 2006 Riga declaration [109], and The World Wide Web Consortium's Web Accessibility Initiative (WAI)[21] (including the Web Content Accessibility Guidelines (WCAG)) all address issues related to accessible ICT and information.

Existing literature on ICT accessibility focuses mostly on the interaction between a single user and a computer system, with some notable exceptions, e.g. [121] and [54]. Hedvall [54] argues that the accessibility field is lagging behind the HCI field, focusing mostly on regulations and influence on the political level.

Hedvall's work bridges work in the HCI field and the accessibility field [52, 46], and by comparing the evolution of the two fields, he suggests that the accessibility field has much to learn from the work in HCI and CSCW. In particular, the focus on the individual is key to Hedvall's argument, in what he calls *experienced accessibility*.

Assessing accessibility and planning routes through built and urban environments can be seen as a special case of navigating by interest. In this respect, physical disability dictates some interests and requirements. The same argument can be made for eAccessibility, where physical impairments like blindness impose requirements on the technology and infrastructure. This is in many ways similar to the different requirements different computer terminals (desktop computers, laptops, mobile phones etc.) impose, with variations of operating systems, screen sizes, input devices and other capabilities.

Working towards accessibility for all is a complex task, ranging from work with technologies and standards to license agreements for content that determine the amount of adaption allowed at different stages in the

content management process. ÆGIS is a project with the aim to create a platform for embeddable technology to ensure accessibility for all [67]. In this project, Korn et al. describes an Open Accessibility Framework upon which interfaces, applications and accessibility toolkits can be built.

Access to information about physical accessibility My own research primarily relates to the parts of the accessibility literature that deals with navigation in built and urban environments. The OurWay concept uses mobile ICT to enable sharing of experiences (in the form of accessibility ratings) in the physical world. Universal design of the OurWay prototypes and interfaces has not been a particular focus of the project.

Organized collection and dissemination of accessibility information has traditionally been a top-down approach with a long update cycle. With rapid developments in mobile technology, and inspiration from collaborative content creation initiatives and recommender systems, new possibilities arise. Online interaction with information systems, instant communication with others, and access to accumulated information is possible from the field.

Assistive technology and universal design We surround ourselves with technology which was originally designed as assistive technology, that is technology which is made specifically to help disabled people to cope in their daily lives. Hearing aids and wheelchairs are well known examples, however there are plenty of examples of assistive technology becoming part of the daily lives of all people, not only for people with special needs. One such example is the TV remote control, which was once developed to help movement impaired people operate their television set. Other examples include the typewriter, which was invented i 1808 by Pellegrino Turry to help a blind friend write letters. Alexander Graham Bell's work on the telephone came out of work with hearing impaired people.

In other words, much of what we regard as assistive technology may eventually become household items to the benefit of all people, not only for people with special needs. An example from urban planning where design for all (Universal Design) may be a better approach than specifically designing for a particular user group is the development of curb cuts to distinguish sidewalks from roads. The benefit of raised curbs is for visually impaired people to easily identify the extent of the sidewalk by the use of a white cane. This does, however, provide challenges for wheelchair users, who have problems getting onto sidewalks with raised curbs. With curb cuts, both visually impaired people and wheelchair

users can make use of the same facilities. And most importantly, the curb cuts also are a benefit to bicyclists, baby strolling parents and others not typically considered in assistive technology development.

The move towards universal design as a primary goal is an important one. Work on web standards is a good example from the ICT community, where the separation of content and presentation on web sites is key not only to visually impaired people, but to users with different types of terminals, e.g. mobile phones and tablets. The work with the OurWay concept presented in this thesis is not exclusively meant for wheelchair users, however this is the selected case, and some discussions of OurWay does tend to gravitate towards assistive technology. That said, the concept can just as well be applied to bicycle trails, tourist scenarios and car drivers.

Psychology and economy

In later stages of the OurWay project, two theories from other fields have become relevant. These are not used extensively in the discussion of my findings, however they do provide insight and support relevant to my observations and discussion. From the field of cognitive psychology, Cognitive Dissonance can help explain rationalization observed among participants in the retrospective interviews in the OurWay project. Bounded Rationality is a theory from the field of economics dealing with decision making, and this is relevant to the *in situ* decisions some OurWay participants make.

Cognitive Dissonance Humans are story telling animals, and we have an inherent desire to make sense of our surroundings and our own actions. Situations in which the story we would like to tell about our self is self contradicting or contains conflicts can lead to a state psychologists refer to as Cognitive Dissonance. The theory describing this was first put forward by Leon Festinger in 1957 [34], and has since been the subject of much research and debate within the social psychology field.

One example of Cognitive Dissonance is found among cigarette smokers. The dissonance is typically caused by smoking despite the knowledge that it might be dangerous to one's health, combined with a self-image as a sensible person who makes rational decisions. There is a conflict between the self-image and the activity, and this causes a state of cognitive dissonance. The inclusion of self-image as part of the theory was proposed by Aronson [5] in 1969.

The theory suggests that the state of cognitive dissonance is uncomfortable, and people will try to minimize the level of dissonance through a number of different strategies. These include rationalization ("Lung cancer only affects heavy smokers") and blame ("I was fooled into smoking, and now I'm addicted. It's not my fault.").

Cognitive Dissonance is relevant to observations in the retrospective OurWay interviews. There are several examples of participants viewing themselves on video making decisions which conflict with their self image (e.g. the idea of themselves as helpful, responsible people). I submit that rationalization of own behavior can be described as negotiation of the meaning of prior activities. Cognitive Dissonance as a theory can in my view be applied to describe what I in an earlier paper called Retrospective Altruism [63].

Bounded Rationality When we make decisions, they are based on information available and circumstances under which they are made. Parts of the economics literature propose a fully rational decision making process, where all available information is taken into account to enable an optimal solution to a decision problem.

Bounded Rationality, originally put forward by Simon [95], proposes that the limitations in cognitive processing power and the time constraints under which decisions are made prohibits an optimal solution. This applies even if optimal decisions are theoretically attainable, which often is not the case because of the complexity of available information and the difficulty of assessing potential consequences. Simon refers to these non-optimal but sufficient decision processes as *satisficing*. The theory of Bounded Rationality suggests that decisions are made with a subset of the information available, and that heuristics are used to arrive at a decision, as opposed to detailed analysis. Inherent limitations in human cognitive resources often forces us to make satisficing decisions.

As an example of Bounded Rationality, assume a person is about to purchase a new car. There is an abundance of information available about available cars, for instance from manufacturers, reviews in magazines, suggestions from friends, and personal experience. Types of information ranges from technical specifications to extra equipment, price, warranties and promotional images.

In addition, the buyer might have a deadline (real or imagined) for the purchase, and might have a predisposition towards a particular brand before the purchasing process, as well as peer pressure to go for a specific brand or type of car.

All of this creates a situation in which a search for the optimal decision requires more objective and comprehensive analysis than the scope of the process allows, and the buyer is reducing the complexity of the process by limiting the number of factors to consider, using heuristics and making a "gut" decision.

Bounded Rationality is relevant to the OurWay observations to help understand the decisions participants make about providing feedback to the route planning system. This includes a "short-sightedness" in terms of the effects of a particular annotation, such as when ignoring to annotate an obstacle, or annotating to achieve immediate personal goals without reflecting on the long term consequences of the action.

Cognitive Dissonance and Bounded Rationality together is useful for understanding the situation within which a decision is made, and the retrospective rationalization of that action.

2.1.2 Key concepts in existing discourse

In the previous section I reviewed literature of relevance to my work in the OurWay project. Next, I examine the use of *Groups*, *Cooperation*, and *Negotiation* as concepts in the literature I refer to. The purpose of this exercise is to establish prior use of the terms, as a background for my own use of the terms in Transient Cooperation.

Groups

According to the Merriam-Webster's Online Dictionary, a group (when referring to people) is defined as *a number of individuals assembled together or having some unifying relationship* [2]. From this perspective the question remains: what defines this unifying relationship?

The idea of a group is difficult to define exactly, as pointed out by Bannon and Schmidt [10]. They use the informal definition by Hans Paul Bahrdt: a group is defined as a set of people who refer to themselves as "we". Pragmatically this makes sense, and has some merit, although it is not difficult to challenge this definition. For instance it is problematic to apply it for analytical purposes, especially since who we refer to as "we" is constantly negotiated (along the Identity Boundary [83]). Studying groups in organizations, then, becomes even more difficult, since "group" as an analytical unit is indeterminable, or at least constantly changing and negotiated, and what constitutes a group seen from the outside (by

[2] `http://www.merriam-webster.com/dictionary/group`

the researcher) is most likely different from the groups identified (and constantly negotiated) by the organization members.

Wenger introduced the theory of *Communities of Practice* (CoP) in the late 1990's [119], following his work on Legitimate Peripheral Participation (LPP) together with Jean Lave [70]. CoP is by origin a theory of learning, and as such not directly related to the CSCW field, or the use of ICT. However, it does touch on the concept of groups to a large extent. A community of practice, typically described in workplace setting, is concerned with solving a common problem or reaching a common goal. What defines a Community of Practice is how participants are engaged in a common practice, and that they learn through participation in the practice they belong to. Legitimate Peripheral Participation (LPP), concerns how members are recruited to the practices and assigned tasks that have meaning, but are not instrumental, to the process they are taking part in. By gradually working their way towards the core of the community, they acquire new and more specialized skills, and become experts in their communities. These experts, then, guide novices through the same process of gravitating towards the core of the community. Bryant applied LPP as a framework to discuss how people get involved with creating and maintaining Wikipedia content and the Wikipedia community [17]. It is worth paying attention to how, according to LPP, the core of the community is also under constant evolution, shaped by the members at the core, and adjusted goals shared by the community.

Wenger identifies three levels of participation in a Community of Practice, and they are all related to the concept of a group. First, the *core group* consists of very active participants, taking part in discussions and information exchange with vigor. This group often represents the "experts", or leaders who help novices become future experts. Second, Wenger describes the *active group* as containing members who are active, but not with the same vigor and to the extent of the core group. Finally, the third group is the *peripheral group*, consisting of rather passive members, still benefiting from the Community of Practice. This is the group from where novices are recruited, and according to Wenger typically represents the majority of the Community. These definitions of groups can be viewed as externally imposed, and does not necessarily reflect how the individual members identify with the community at large or groups therein.

Fischer has proposed the term *Communities of Interest* (CoI) [35, 36] to describe group constellations of a more temporal nature, such as project teams consisting of consultants from different departments or companies during a product development process. Bridging of company cultures and vocabularies are among the issues discussed in the CoI literature.

Blurring of the group concept is perhaps increased, or at least made more visible, through the prevalence of ubiquitous computing [49] which diminishes the relationship between location and activity [96].

Within the field of Accessibility, much work has concerned creation of rules, regulations and legislation to ensure universal access. In this process, according to Hedvall, the focus has been almost exclusively on groups, that is distilled constellations of special needs. There has been little focus on the individual, or the individual's identification with groups. We see more awareness concerning this in current Accessibility work, where the question if design for all is actually design for none, that is, one size fits one, rather than one size fits all. For all the merit of the political and organizational work within Accessibility, the dynamic concept of a group has no proper place. Further, the huge efforts put into these formal processes have a tendency to be self-conserving, in that they maintain the view of accessibility as something applying to groups and sub-groups, without taking into consideration the constant change of needs, preferences, and contexts, and the negotiation of experienced accessibility [54] taking place in a situation.

In summary, the term "group" does not have one, unified meaning, and the Merriam-Webster's definition is maybe as close as we can get. The implied meaning of the term depends to a large degree on the context in which the term is used, nevertheless the idea of a group of people sharing some common properties is useful for the discussion of cooperation, which I take on next.

Cooperation

Turning to Merriam Webster's Online Dictionary again, the definition for cooperation is "the action of cooperating, common effort", where cooperating is defined as:

> "**1** : to act or work with another or others : act together or in compliance <refused to cooperate with the police> **2** : to associate with another or others for mutual benefit <nations cooperating in a trade agreement>"

After over 25 years of Computer Supported Cooperative Work, there is still discussion about the interpretation of the second 'C' in the acronym CSCW, representing cooperation. Intertwined with the interpretation of "group", cooperation in some form describes activity within a group to achieve or produce something together. This activity doesn't necessarily

have to be motivated by some common goal, although that is often the premise taken in the development of CSCW applications for workplace and organizational use. The 'W' in CSCW stands for work, which reflects the research focus on the support of cooperation in workplace activities. In the evolution of CSCW into the domain of the social web, however, the notion of work is of a more evasive nature, and can be regarded as the efforts put into producing the product or service, regardless of this is within a classical work setting or not.

Shirky argues that one of the main contributions of the new (mobile) information technology is that it enables rapid and low cost forms of cooperation, through coordination [93]. An in-depth analysis of coordination is provided by Ling [71], where he establishes the idea of hyper-coordination, by looking at the use of mobile phones among teens in Norway. According to Ling:

> "Moving beyond [micro coordination], "hyper-coordination" encompasses instrumental coordination and adds two other dimensions to this. The first is the expressive use of the mobile telephone. That is, in addition to the simple coordination of where and when, the device is employed for emotional and social communication. People chat with each other. The Short Message System (SMS) function is used to send chain letters, and personal messages that can range all the way from innocent and over-sweet greetings to vulgar pornographic images. One sees the integration of the group via the use of the mobile telephone." [71]

In other words, mobile ICT enables forms of coordination, group formation, and cooperation not available before its introduction. Schmidt [90] cites Holt to show that coordination as a theme was identified early in the history of CSCW:

> "The new capabilities at which coordination technology aims depend on finding and installing appropriate conceptual and structural units with which to express tasks, their diverse relations to each other and to the people who ultimately bear responsibility for them." "To be useful, this must be done in a flexible yet well-integrated manner, with plenty of leeway for the unpredictability of real life." [65]

The point of "plenty of leeway for the unpredictability of real life" will be returned to in the next section, on negotiation. Cooperation through

technology, however, doesn't need to be explicit from the perspective of the individual, it can also manifest itself through interaction with the technology without direct regard for others involved in the same process:

> "The workers operating a rolling mill in a steel plant, for example, cooperate by monitoring and adjusting the state of the machine system. They are often not constituted as a "group" and they often interact without communicating in the sense of symbolic interaction." [10]

This point is given more attention with the advent of the CSCW sub field Social Navigation of Information Space (SNIS). Here, one of the core ideas is that traces left behind by interaction between humans and technology can benefit other users in the long run. One classical example of collaborative filtering, one of the mechanisms covered by SNIS, is GroupLens [86]. GroupLens is a distributed system for sharing ratings of Usenet articles to enable navigation and filtering of interesting content. One user's activity (ratings) is shared with others through the collaborative filtering system. Others both benefit from this and contribute back with their own ratings. This type of cooperation, where the notion of work is not clearly defined, is also recognized by Bannon:

> "In other cases, groups have a quasi-permanent character like, for instance, project teams. While such situations do belong to the problem situations addressed by CSCW, we certainly do not want to restrict the scope of CSCW to those cases where the responsibility of performing a task has been allocated to or assumed by a relatively closed and fixed collective." [10]

In other words, the phenomena studied under the CSCW umbrella are pertinent also to the online, social, networked world. Some areas of CSCW, such as Social Navigation of Information Space, has indeed moved the focus from workplace settings to other, looser forms of cooperation in the networked world.

Further, the meaning of *work* has implications for how we interpret cooperation. Work, loosely, is any effort put into creating a product or service. In a workplace setting the product or service is often "planned or rather premeditated"[10], for instance defined by the employer as part of a company's or organization's overarching goal(s). On the net, however, the end result might be less tangible, and often shaped during the process through less formal organization like grassroots movements.

Bannon and Schmidt conclude their discussion of cooperative work like this:

> "In sum, the term "cooperative work" is the general and neutral designation of multiple persons working together to produce a product or service. It does not imply specific forms of interaction or organization such as comradely feelings, equality of status, formation of a distinct group identity etc. Hence, unlike research areas like Artificial Intelligence and Office Automation, the name of our field is quite pertinent."[10]

Cooperation in the Accessibility field, on the other hand, has not been a significant focus, with some exceptions (e.g. by Winberg's work on the cooperation in computer use between blind and sighted people[121]). The idea of cooperation, and the individuals resulting *experienced* accessibility is central in the work done by Hedvall. He argues that the focus on regulatory and legislative work should be extended to take the individuals seriously, that is, to take into account the individual's perspective on accessibility, for instance through cooperation with other people. Indeed, this has been the core idea in OurWay from the start, as will become clear in this thesis' chapter on the case and research settings. Looking beyond the use of ICT for cooperation, there are obvious instances of cooperation between individuals to negotiate the accessibility of built and urban environments. For instance, sharing accessibility information between friends and trusted parties who have a common understanding of needs an preferences plays an important role in the daily activities for many disabled people.

As can be seen from the review, the term "cooperation" can be interpreted as having different meanings, from organized workplace activities to more loosely bound forms of collective action. In this thesis, the theory of Transient Cooperation is developed to facilitate a discussion of the looser, ad-hoc forms of cooperation that can take place through the use of mobile ICT. Cooperation often happens in the peripheral groups of a community[119], and acknowledging this can lead to insights valuable in the design of mobile ICT system for cooperation.

Negotiation

The origin of the word "negotiation" is the Latin word "negotium", literally meaning "lack of ease". It took on the meaning "doing business", and later was generalized to mean "bargaining about anything". Merriam-Webster's Online Dictionary defines "negotiation" as:

> "the action or process of negotiating or being negotiated"

and "negotiate" as:

> "to confer with another so as to arrive at the settlement of some matter".

It is widely recognized in the CSCW field that motivations for cooperation (such as shared goals) and group memberships (in the loose definition of "group" addressed in the previous section) are not static and do not merely involve pre-defined and planned activities. The idea of articulation work, that of making work visible, is argued for by many, including Suchman [101]. Schmidt and Rodden identifies challenges pertaining to the support of cooperation in CSCW applications:

> "Precisely because of the dynamic and distributed character of cooperative work arrangements, mechanisms of interaction are not executable code but rather heuristic and vague statements to be interpreted and instantiated, maybe even by means of intelligent improvisation. They are local and temporary closures with a limited area of validity and they are by necessity underspecified." [89].

The situatedness of action, and the role of plans in activity is treated by Suchman in her seminal book "Plans and situated action":

> "plans are resources for situated action, but do not in any strong sense determine its course. While plans presuppose the embodied practices and changing circumstances of situated action, the efficiency of plans as representations comes precisely from the fact that they do not represent those practices and circumstances in all of their concrete detail." [100]

In other words, the situation and the task at hand is constantly *negotiated* based on a number of factors. The very notion of a group, or the form of cooperation taking place can be described as a continuous negotiation. Palen and Dourish, drawing on work from Altman, use the notion of negotiation for discussing privacy in the networked world [83]. Specifically, they identify three boundaries along which negotiation is constantly taking place: the *identity* boundary, the *disclosure* boundary and the *temporal* boundary. In face to face communication, argues Altman, we constantly negotiate who we are, what we represent and what we reveal; privacy is a process, not a static set of rules. Put into the context of digital communication, argues Palen and Dourish, the ability to negotiate is changed,

especially along the temporal boundary, because of persistence of communication in networked ICT systems.

The challenge of interpreting shared information without direct access to the situation in which the information was created is also recognized by Schmidt:

> "Now, what happens if the information object accessed by one actor is produced by another and vice versa, that is, if the set of information objects are produced and accessed by multiple actors? At the level of the objects themselves, shareability may not be a problem, but in terms of their interpretation, the actors must attempt to jointly construct a common information space which goes beyond their individual personal information spaces." [88]

The requirement for the act of "jointly construct[ing] a common information space" requires negotiation between multiple actors.

Within the field of Accessibility, there is not an abundance of material on negotiation, with Hedvall as a noteable exception. He argues for the notion of *experienced accessibility*, which in many ways is has the connotations of situated action, put into the context of negotiating accessibility. Hedvall writes:

> "Accessibility today is under-theorized and lacks methodological sensitivity to the particular conditions for access and participation in concrete activities. The field has yet to account for several of the characteristics of and impacts on individually experienced and activity-tied accessibility." [54]

Hedvall draws a parallel between the regulatory and legislative work undertaken in the field of Accessibility with Suchman's concept of planned activities, implying the inevitable deviation from and improvisation in carrying out planned activities. Further, he suggests that the *experienced accessibility* is parallel to situated action. The negotiation of accessibility in the situation takes into account both prior experience, available help, access technology, and other factors. Note that one of the etymological roots of the term *negotiate* ("not with ease"), seems to fit well within the context of accessibility. Through the OurWay concept, we have aimed to provide a mobile ICT solution to help in negotiating the experienced accessibility, and to share this experience with others to help them negotiate similar situations.

In summary, negotiation in constituent to most processes in our daily life, from participation in concrete tasks to managing identity and choosing a group membership. There is a need to take this phenomenon seriously when designing CSCW applications, and the theory of Transient Cooperation attempts to address this issue in a tangible and practical way.

2.2 Theoretical Framework

Through observation and interviews in the OurWay project, certain recurring themes have been identified which seem useful for characterizing the form of cooperation we have witnessed. This section describes the emergence of three central concepts presented in the previous section. First I discuss my motivation for developing the theory of Transient Cooperation, before methodology, data collection, and analysis are described. Following that, I review each of the three central concepts *group*, *cooperation*, and *negotiation* in the context of the OurWay project. Finally, I end the chapter with the three concepts combined in the theory of Transient Cooperation.

2.2.1 Rationale

The indoors experiment was primarily designed to measure the rate at which the route planning system could go from a neutral network (without any associated accessibility information) to a state where most of the obstacles were removed from the route suggestions. Additionally, we wanted to learn about motivation for annotation among the participants, and the way they reflected on their use of technology. When preparing each participant for the tasks ahead, we emphasized the existence of the other users, and explained how input from previous users influenced the routes they were suggested, and how their own feedback on accessibility could affect users following them.

Despite the emphasis on the cooperative idea behind the route planner in the introduction, most of the participants soon forgot about or ignored the other users, and rather focused on completing the experiment tasks (soon appropriated as their own goals) of getting from one place to the other. In retrospective interviews conducted a few months later, many of the users would claim to have had the interest of other users in mind, despite documentation suggesting behavior of a more self serving nature, such as tricking the system to suggest a route desired by a participant.

It became apparent from observations during the experiment and later from the interviews that there was no obvious goal shared among the participants, despite the introductory description of the route planner as a system that learned from the collective efforts by the users. This is perhaps not surprising, given the nature of the tasks each individual was given. However, it serves to highlight the focus each participant had on his or her own effort. The users held a variety of "theories" about what was happening with their feedback (some thought we just collected the data, others thought a janitor was monitoring the system for possible amendments to the campus building, and some thought we were collecting information to identify types of obstacles).

Further supporting the idea that the participants were mostly concerned with their own business was the type and amount of feedback coming from the users. The majority of the votes cast in the experiments identified absolute obstacles (tagged as *inaccessible*). Very few instances of *good* were used, and the use of *uncomfortable* was unpredictable. This all indicates that the main (and only predictable) purpose of providing feedback to the route planner was to get an alternative route upon encountering a non-negotiable obstacle.

Despite the individual focus of each participant, the overarching goal (from the system designer's point of view) of collaboratively collecting accessibility data to be able to calculate more accessible routes was to a large degree accomplished. The aggregated feedback from users did lead to better and more accessible routes over time, and quite rapidly, too. Details about this aspect of the study can be found in [62].

By developing the theory of *Transient Cooperation* (TC), I attempt to capture the observation that explicit cooperation is not a prerequisite for successful cooperative output. The evolution of the system's ability to provide accessible routes comes as a result of the activities carried out by users frequently lacking the concern for other users (in the moment of interaction with the system). The phenomenon is related to parts of the Social Navigation of Information Space literature. However, Transient Cooperation looks at the phenomenon from a cooperation perspective, and less from the system perspective. It also takes into account insight from interviews with disabled people pertaining to their activities in the organized disability movement, their views on technology, and the politics of accessibility work.

Thus, the rationale for developing the theory of Transient Cooperation is to frame the discussion of the observed phenomenon in context of cooperation, drawing on existing literature in fields such as CSCW and Accessibility.

2.2.2 Data collection and analysis

Five research papers constitute the main bulk of this thesis. The cases and research foci are described in Chapter 3. Details for each paper is described in Chapter 4.

The development of the theory of Transient Cooperation came to a certain degree as an afterthought, inspired by findings from the indoor experiments (see for example [62]). One particularly interesting observation was the participants' apparent lack of awareness with regards to other users. In retrospective interviews with participants, they sometimes expressed a concern for the other users which was not observed during the experiment itself. For instance, some participants would claim engagement on behalf of other users despite observations and debriefing interviews suggesting lack of such engagement.

Two sets of interviews have been analyzed for the purpose of investigating this phenomenon further. The first is a series of interviews with seven participants from the indoors experiments. In these interviews, we talked about their experiences from the experiment. To do this, we also showed video footage from the experiments (most of the time of the participant being interviewed and sometimes, because of technical problems with video equipment, of other participants). Notes from observations and debriefing interviews were also used. The participants were encouraged to comment on their own and others behavior. The interviews were transcribed in entirety. An open coding process was employed to extract recurring themes from the interviews.

The second (chronologically speaking the first) set of interviews was conducted in an earlier phase of the OurWay project. Three interviews with experienced wheelchair users were held to investigate initial thoughts about the usefulness of a collaborative route planning system such as OurWay. Emphasis was put on existing practices related to planning and carrying out trips with wheelchairs, privacy concerns, and motivation for or against the use of such a system. These interviews were fully transcribed and analyzed through the use of an open coding process.

Results from the analysis of the two sets of interviews suggest the three concepts (or terms) useful to describe the phenomenon I have dubbed Transient Cooperation. These three concepts, *groups*, *cooperation*, and *negotiation*, are discussed next.

2.2.3 Groups

Introduction

What is a group? In my review of existing literature earlier in this chapter, the conclusion is that the term has many meanings, and perhaps the definition best covering the term is "a group is who we refer to as *we*". Now, who we refer to as *we* varies from situation to situation, and over time. In the case of a wheelchair user, one can imagine that other people in wheelchairs would be a likely group to associate with. Sometimes it is. However, in some cases the type of wheelchair one uses could influence this association with others. For instance, when assessing whether a door is wide enough to accommodate a wheelchair, it makes a difference if you're in a large electric chair, a narrow electric chair, or in a smaller manual chair. And many times, of course, the wheelchair is *not* the confounding factor, for example when discussing music, science, or taking a political stance - when being part of society at large. Further, in certain situations, the group one associates with will depend on factors such as the desire to represent a specific group (e.g. electric chair users), or the expectation that others will, at a later stage, interpret one's activities as if they are representing a certain group.

Groups in background interviews

It is fair to question whether the aspect of groups, and how people associate with and form groups can be discussed with basis in observations and interviews from the OurWay project. The prototypes developed and tested did not expose features to facilitate association with one or more user groups, not to mention creating new groups. In the background and retrospective interviews, however, there are many examples of the dynamic association with groups to be found. Several examples from the background interviews are presented in [64], and provides an insight into existing practices for planning and carrying out trips involving wheelchairs. The following quote is from a man who's reflecting on the possible consequences of accepting a goods lift as a means of transport to reach a desired destination:

> "This is very dangerous. Because, as you say, this system could also be used by the municipality. If it [the use] in any way reflects that the group that I represent [when annotating the lift] accepts goods lifts as equally good alternatives to ordinary lifts, they might conclude that they won't bother about

> [installing] an ordinary [accessible] lift."

This quote comes from a man with many years of experience from organized work in an interest group for disabled people. His concern aligns with the idea of the Temporal Boundary identified by Palen and Dourish [83]. For instance, what we're used to think about as ephemeral communication (e.g. talking face to face) changes through the introduction of information technology that persists elements of the communication. The interpretation of meaning can happen at a later time in a different context by other people, without the source's knowledge or possibility for influence.

In other words, it would perhaps be OK to accept the goods lift "here and now" to gain access to the desired destination. The concern, however, is that when the same acceptance is persisted, it allows for other (perhaps non-intended) recipients, to interpret the meaning of that acceptance, including its representativeness (e.g. that it represents a consensus within a group). If taken as a statement made on behalf of a group (say all wheelchair users), the consequences could be undesired, both for all wheelchair users (the property manager sees no reason to invest in a proper persons lift) and for the user who originally accepted the use of the goods lift (his reputation might be damaged among his peers).

Groups in retrospective interviews

There are also examples of dynamic group association to be found in the retrospective interviews conducted with the participants in the indoors experiment. This is especially apparent in the way many participants in the interviews reflect differently about their association with groups when they look back at their activities in the experiments. For instance, even when their behavior seems to be obviously self serving at the time of the experiment, participants tended to argue that they *did* have other users in mind when providing feedback to the collaborative route planner. In other words, their idea of association with a group does not only depend on the context of the activity at the time, but also on the context in which the activity is discussed and reflected about at a later time. As an example, here is one participant answering a question about whether he was concerned for the others at the time he annotated an obstacle:

> "I don't think so, really. Maybe now, later, when I'm going over it again. But not in the situation."

According to the participant, it was his own frustration that triggered him to annotate in the first place:

> "I must be irritated with the obstacle ... [for instance if] it is an unnecessary obstacle which is easy to remove. That is probably the worst."

This retrospective concern for the other users (a phenomenon I dubbed *Retrospective Altruism* in one of the included papers [63]) is interesting. It serves to illustrate the issues introduced with persistence of information, and the role the individual has (or wants to have) in interpretation of action. It also suggests that people have a *desire* to be considered helpful and concerning by their peers. Who we refer to as "we" is a dynamic relationship between individuals, which depends on the situation, individuals' experience, and time. This "retrofitting" of history to meet one's own self image seems to fit well with the theory of *Cognitive Dissonance* [34] from the field of social psychology. This theory and its relation to my findings is briefly discussed in Section 2.1.1.

In the case of OurWay, we have typically seen re-telling that put participants in favorable light as thoughtful and community oriented people. This might reflect reality, however it is also possible that this in turn reflects the setting of both the experiments and the retrospective interviews. In other words, if the participant thinks we expect to observe "good citizens", she might try to re-tell her actions in a way that fits with that expectation. When reflecting upon own actions alone the re-telling might be different.

Groups during experiments

In the background interviews and in the retrospective interviews, references and reflections about groups and relationships are numerous. This is, however, not typically the case during the actual experiments.

One way to view this is that the "group" in the moment of action is limited to the person himself. Some of our observations fit with this interpretation, including the finding that most participants seem to be rather self-centered users of OurWay [62]. The decisions made at the time of action is likely to be affected by the *bounded rationality* [95] people apply in decision making. See Section 2.1.1 for an overview of this theory and how it relates to OurWay observations.

Groups in summary

The way we think about and relate to groups seem to depend on the circumstance, clearly illustrated by how this changes before, during, and after the navigation exercises in the OurWay experiments. The background interviews reveal a reflected consideration about other people and group relations. Prior experience and future expectations form the viewpoints at this stage. During the experiments, participants are more self-centered, and the choices made are affected by bounded rationality, both with regards to time and the current goal (task at hand). In the retrospective interviews, cognitive dissonance influence the way participants reflect about their prior use of the navigation system.

Designing information systems to support this dynamic poses an interesting challenge to the CSCW community. I will return to this challenge in Chapter 5, Contributions and Implications.

2.2.4 Cooperation

Introduction

Most participants in our indoors study displayed little or no concern for the other users at the time of the experiments. Where then, does *cooperation* come into the equation? In the CSCW literature, the term cooperation is most often used for describing coordinated activities in a workplace setting. In other words, there is an idea of a shared goal (or set of shared goals), and there exists an implicit group within which this activity takes place.

In this section, I will argue for my view that if the *outcome* of action looks as if it comes from cooperation, then the action which produced the outcome should be regarded as cooperation. Individual goals, self-centered activities and the lack of explicit groups notwithstanding.

In the following section I will use the terms *explicit cooperation* and *implicit cooperation*. The terms have been used in economics and robot/agent literature (see for instance [51] and [1]), however I have not found the terms to be in common use in the CSCW literature. My use of the terms are colloquial, and only intended to distinguish between cooperation as reflective action and cooperation as a consequence of individual action.

Explicit cooperation

One answer to the relevance of cooperation in the OurWay case can be found by considering the associations users have to groups before, dur-

ing, and after the navigational tasks. Looking at the background interviews, many examples of such associations can be found, ranging from close friends, to fellow wheelchair users, to the disabled movement in general. Two of the three wheelchair users have long-term experiences with organized work in the disability movement. In this context, cooperation to achieve shared goals seems common.

During the experiments, "in the moment", most participants seem to be mostly concerned with their own goals and doings. However, in the retrospective interviews, it seems that the concern for others and the desire to credit activity to the benefit of a community becomes more prominent. Explicit cooperation requires awareness, which was neither well supported in the prototype being tested, nor did it seem to be of great interest to the participants during the experiments.

Implicit cooperation

Implicit cooperation, on the other hand, does not require awareness in the same way. Participants in the OurWay experiments have collectively influenced the route planner to provide better routes, not only for the user providing feedback, but for other users as well. This despite the focus on their own task at hand. The beneficial outcome is the result of a collective process, one that later often will be claimed as deliberate by the participants. In other words, not only does the association with *groups* change depending on context and time, so does the idea of *cooperation*.

One could perhaps argue that "implicit cooperation" is an oxymoron. My intention of describing this observed collective activity as cooperation is to be able to position it within the context of existing discourse on cooperation (e.g. CSCW). What makes it interesting is precisely that it is not an explicit form of cooperation between users, rather it is an implicit form of cooperation made possible partly through the design of the system, and partly by the "selfish" behavior of the users. It is worth mentioning that this was not a deliberate aspect of the design of the OurWay prototype. Rather, it can be argued that the (unintended) *lack* of support for awareness in the prototype helped tease out this aspect of user activity, thus demonstrating *Transient Cooperation*.

Judging cooperation from outcome

I argue that if the outcome of accumulated interaction with or through a system by more than one person has the appearance of cooperation,

it makes sense to describe the activity as cooperation. By taking this approach, it becomes possible to discuss and design systems supporting this form of interaction by looking at existing discourse, for example CSCW. Although this literature typically has workplace focus and explicit goals as corner stones, the work on sharing information spaces and awareness seems relevant to the ad-hoc form of cooperation described by Transient Cooperation.

With the growth of on-line, informal forms of interaction, it also seems relevant that more CSCW work should focus on non-traditional forms of cooperation. This includes different interpretations of *work* and *collaboration* than the typical approaches in existing discourse.

Cooperation in summary

As a thought experiment, consider the same technology (the OurWay route planner) applied in a slightly different setting. Imagine it being used in a campaign context (a typical way for interest groups to cover an area to gather accessibility information). A group of people, associated on several levels (predominantly perhaps, in this context, by the fact that they're representing the same organization), uses the technology in an explicitly cooperative effort to map the accessibility of an area. It is the same technology, however it is used in a different context. With explicit goals and intentions shared among the participants, the sense of cooperation would likely be more consistent when discussed before, during and after the event.

Further, the observed *desire* amongst participants to be seen as cooperative may have implications for the design of such systems. For instance, better support for awareness of other users and their activities in the system could perhaps inspire more explicit cooperation. How this would affect the individual users' interaction with the system would be an interesting aspect to investigate. How can we alleviate cognitive dissonance through system design?

In conclusion, *cooperation* in the context of the OurWay experiments is not an explicit form of cooperation, in that participants are typically focused on their own tasks, not thinking much (if at all) about other users and their role. Participants still seem to consider it a system for cooperation (in retrospect), however their direct interaction with the system does not necessarily reflect that.

2.2.5 Negotiation

Introduction

Negotiation plays a role in both the dynamic association between users and in the varying degree of deliberate cooperation as discussed in the two previous sections. Perhaps most prominently along the *Identity Boundary* [83], negotiation is constantly applied in most situations of our daily lives. Who we represent, what our goals are, how we reflect about previous activities and what we decide to share with others is all continuously negotiated depending on the situation. In this case, *negotiation* is mostly an internal process, and it can be more or less deliberate.

Negotiation before experiments

The relationship between a user and assistive technology, such as wheelchairs, is also subject to negotiation. For instance, some users will have different wheelchairs for different situations, perhaps a manual chair for light transport and a motorized chair for longer trips. What equipment to choose is part of negotiating the physical environment, and planning ahead. Deliberation about using additional tools, such as a route planning systems, can also be described as negotiation in the planning phase.

Negotiation during experiments

In the case of OurWay, negotiation also takes place when a user decides whether to annotate an obstacle or not. The most predictable type of feedback in the experiments was *inaccessible*, which was given by users who were faced with an absolute obstacle such as a stair case. However, when deciding about an *uncomfortable* obstacle (e.g. a high door sill), several factors come into play. These include the perceived level of hindrance, the focus on solving the navigational task at hand, the level of (prior) irritation about the obstacle, and previous experience with the obstacle:

> "... it was especially annoying, and I knew that door from before so to speak. I already had a negative relation to that door"

The participant subsequently annotated the door she had successfully entered as *uncomfortable*. In other cases, we see people clearly struggling to pass similar obstacles, clearly expressing their frustration, without pausing to provide feedback to the system.

Deciding to provide an annotation sometimes involve deliberate negotiation along both the identity boundary and the temporal boundary. One example of this is the goods lift quote mentioned in the section on Groups.

Negotiation after experiments

Interestingly, the reason for annotating or not annotating the obstacle is often interpreted differently by the same user at a later time. By retrospectively describing his activities as motivated partly by the potential benefits for other users, the participant seeks to *negotiate* the meaning of his own activities. The cognitive dissonance experienced by the user when viewing his prior (selfish) activity leads to re-telling the story about the events to better fit a consistent self image as a cooperative and concerning person.

Negotiation in summary

When reflecting on the *potential* use of technology, people have ample time to consider consequences of utilizing it. Ranging from previous experience, history, personal motivation (and ideology), to group membership assessment, representativeness and future interpretation of action, many aspects of use are part of the decision making process for the individual. Explicit negotiation along the identity boundary and temporal boundary are obvious at this stage.

Our experiment participants had of course agreed to use the technology, perhaps without taking the time to reflect upon the consequences of use, as the people in the background interviews did. When using the system, it seems that users allow less time to pay attention to aspects outside of the situation at hand, and their decisions are based more on the individual goal at the time, than what benefits (or drawbacks) their activity may have on others or themselves in the future. In other words, less negotiation takes place with the system, more negotiation is taking place with the physical environment.

Later, when reviewing their use of the system during the navigational tasks, there is once again more room for reflection. When their observation of activity at the time conflicts with their more reflective, "ideal" view of action, they enter a state of cognitive dissonance. In the process of relieving this tension, negotiation of the meaning of action takes place.

2.2.6 Transient Cooperation

In the previous sections I have discussed the concepts *groups*, *cooperation*, and *negotiation* in the context of the OurWay system. Although the scope of the experiments has been somewhat limited in size and carried out in a semi-controlled environment, I suggest the observations can be generalized and the findings be extrapolated and applied to other systems and usage scenarios. I have presented the insight from Altman who argues that the way we relate to other users through groups, and how we negotiate meaning and relationships is a dynamic, continuous process. Further, I have argued that when accumulated traces of activity involving use of a system results in what appears to be the outcome of cooperation, it makes sense to regard the activity itself as cooperation.

In this section my aim is to capture these dynamics in the theory of *Transient Cooperation*. What follows is a review of the meaning of the term *transient*, a discussion of the elements of Transient Cooperation, and finally a summary of the proposed theory.

The meaning of *transient*

The use of the word transient to describe the ad-hoc form of cooperation observed during the OurWay experiments is a deliberate choice. It aims to capture both the time span during which the co-activity takes place, and the prolonged effect traces of this activity can have on the shared service, in my case the qualities of routes suggested by a route planning system.

Turning once again to the Merriam-Webster online dictionary, we find the following definitions for the word *transient*:

1. **a)** passing especially quickly into and out of existence

   b) passing through or by a place with only a brief stay or sojourn

2. affecting something or producing results beyond itself

The Online Etymology Dictionary has the following description of the origin of the word:

> c.1600, from L. transiens (acc. transientem) “passing over or away,” prp. of transire “cross over, pass away,” from trans- “across” (see trans-) + ire “to go” (see ion). The noun is first attested 1650s; specific sense of “transient guest or boarder” first recorded 1880.

In physics, *transient* refers to a short-lived peak, like an oscillation in an electric system. Physical transients are important in many areas, including music and sound. For instance, the *attack transient* refers to the initial part of a sound, for instance the plucking sound of a guitar or the tongue sound at the beginning of a trumpet tone. The transient is short-lived, but may influence the perception of the quality of the sound, and even help distinguish between otherwise similar sounds. There is also a *decay transient*, which describes the rate of fading to the "normal" level of the sound, the sustain level. The attack and decay transients may be described not only in loudness (volume), but also in frequency. It is the combination of different attack/decay/sustain/release envelopes that makes up the signature of a sound we recognize as coming from a particular instrument. Conversely, without knowing exactly what waveforms and envelopes that went into the construction of the final sound, it can be very difficult to identify the individual contributions to the sound. From the user perspective, the same can be said to be true for OurWay. The effects on the route planner of all the accumulated ratings are only visible to the user in the form of a route suggestion, much like the final waveform of a complex tone.

The definitions mentioned above fit well with the way *transient* is used in this thesis. Users take part in a collective effort only briefly (often for their own direct benefit), perhaps unknowingly. The traces left behind through use of OurWay can lead to "results beyond itself" when accumulated and used by the system to provide a better service to subsequent users. In other words, the brief interaction with the system may influence the parameters of the route algorithm in the system for a period of time after the interaction took place.

In the following section I will start with a previously published definition of *Transient Cooperation*, and then elaborate on it with a basis in the discussion of *groups*, *negotiation*, and *cooperation* earlier in this chapter.

Components of Transient Cooperation

I have been referring to the idea of *Transient Cooperation* in previous papers, without theorizing it to any extent. Here is a definition from one of my earlier papers [63]:

> Transient Cooperation is a form of cooperation which does not require an existing community, or explicit participation other than a shared benefit from use. The interaction is asynchronous and limited in time, and the users might be unaware

of their cooperators or the benefit they have from cooperation.

This was an intentionally open definition of TC. At the time, the general idea of ad-hoc cooperative work was recognized, however there was still work to do on the foundation of the theory. In fact, it was not clear at the time that I would develop a theory based on these observations. What follows is an elaboration of the components in the initial definition of Transient Cooperation, including theoretical insight from the later part of my project.

The breakdown of the previous definition into different components was done in two steps. First, I selected the key words and phrases from the definition, and then I combined and restructured them to allow for a discussion without too much repetition of key points.

A form of cooperation I make the argument that if the outcome of collective interaction with a system has the properties of explicit cooperation, then it makes sense to consider that activity cooperation. This differs from the typical definition of cooperation in the CSCW literature, where (more or less) shared goals in a work setting defines the context within which cooperation takes place. The benefit of regarding the accumulation of activity traces as cooperation is that it allows for discussion of the phenomenon within the existing literature. This enables leverage of existing knowledge pertaining to important issues such as awareness, negotiation, and the difference between places and spaces.

In some ways, Transient Cooperation has obvious similarities to cooperation in more traditional work contexts. For instance, people seldom has complete overview of the complex interactions between different goals and own activities in such work processes. They are, however, mostly performing activities as part of their role in that organization, and they are aware of this organization and their role within it. With Transient Cooperation, this awareness of a role or the commitment to an organization or group is not required. The relation to others, and the intention of action is, however, often negotiated retrospectively.

Prerequisites It can be argued that Transient Cooperation takes place on a micro level in any established organization. This is often the case in Communities of Practice, where alliances and work practices emerge from within the organizational setting, without being captured by the formal structure of the organization. With Transient Cooperation, the requirement of an existing community or organization is non-existent, at

least there is no need for the individual to be aware of it. Of course, some entity must enable the Transient Cooperation, for instance through establishing infrastructure, to support the individual activities from which traces are accumulated to provide a benefit to other actors.

There is, however, no conflict between Transient Cooperation and established organizations or awareness of a community. Still, from our experiments it seems that people *in situ* often neglect their role in a larger context, and perform their activities with self-serving goals in mind. Further, as opposed to e.g. Legitimate Peripheral Participation, the goal is not necessarily to end up with the identification with a larger group or community. In fact, I would argue that Transient Cooperation describes a form of activity that is detached from the larger context of a group or community, if it exists at all.

Implicit participation In what is traditionally considered cooperation, the participant is aware of her own role in the group or community, and recognizes that activities performed in this context has a certain contribution towards shared goals. Opposed to explicit cooperation, Transient Cooperation describes implicit cooperation which happens as a by-product of self-centered activities.

In this respect, one might consider contributions to data harvesting by internet corporations (such as Google or Facebook) to be examples of Transient Cooperation as well. Some of this data harvesting can be viewed as unethical, especially when it happens without the user's acknowledgment. It is therefore tempting to include informed (meaning intelligible) consent from the user as a prerequisite for Transient Cooperation. Being more of a ethical and ideological standpoint, this requirement falls outside of the concrete findings from the experiments on which the theory is built. However, going back to the typical understanding of what cooperation is, it seems reasonable to demand user access to information about how the accumulated traces of activity will be used.

Shared benefits and effects beyond itself For self-serving activities to add up to cooperation, there must exist outcomes of accumulated traces of activity which can be viewed as contributions towards a common good, such as an improved route planning system. This outcome is typically defined by the design of the system, and dictates what information is collected in what situations and for what purpose. In the OurWay route planner, individual ratings of accessibility are collected at the time users actively mark a specific part of a route, for the purpose of influencing

the route planning algorithm. Typically, this action is detached from the larger context of the system, and is performed to serve the user's immediate goal. Later, however, the users often attempt to re-negotiate the meaning of their actions to better fit with their self-image as taking responsibility for others in their community. This phenomenon is well captured by the theory of Cognitive Dissonance.

In the OurWay case, the shared benefit is a route planning system which uses previous individual experiences as a factor in suggesting the best route between two points. From the user's perspective, what happens is that she tells the system that a specific part of the route does not work *for her*, and the system responds by providing an alternative route from the current location to the destination. What the user often seems to be unaware of (or neglect) is that this input not only influences *her own* route here and now, but also has an impact on the routes suggested to *other users* at a later point in time. The decision process involved in making (or not making) an annotation about accessibility involves a limited set of information, and is made on the spot. In this regard, the decision is carried out as a Bounded Rationality process.

This means there are two layers of effect: the immediate effect of an activity is an outcome that serves the individual user at the time of interaction. The longer term effect is one that is shared by other users at a later stage, based on the accumulated activities of multiple users. In other words, the interaction with the system leaves traces which have effects beyond itself (the immediate provisioning of an alternative route), which in turn leads to shared benefits for other users (improved routes for subsequent users).

Interaction and time In OurWay, the fact that users interact with the system asynchronously implies that no direct interaction is required between the users. Further, no information about the other users' individual activities is presented to provide group awareness. It is not unlikely that this design contributes to the observed self-centeredness of use.

Interestingly, despite a design which discourages explicit cooperation, the aggregation of traces from asynchronous interaction by multiple users does show a positive outcome overall in the form of improved routes from the route planner. This is not to say that designing for collective awareness would not influence (or improve) the outcome, however it does illustrate that this awareness might not be *necessary* for the result to regarded as the outcome of cooperation.

Transient Cooperation implies cooperation over short time spans. It is

only the short moments of interaction with the system that tie one user's activities together with activities of other users. Since no common goal shared by a group is *required*, these short periods of interaction does not necessarily reflect any consistent set of preferences or requirements by the users. Still, the aggregated result displays properties that seem to imply an existing shared goal. The outcome can perhaps be described as an illusion of a collective effort put in by a dedicated and coordinated group of users.

Of course, the users relation to the system is not limited to the time of interaction. As previously discussed, the reflections users have about their own and others use of the system is negotiated over time. In the planning stage (when deciding whether to use the system or not), concerns of misuse and perspectives on group relationships are obvious. Reflecting on one's own use of the system retrospectively seems to include a certain amount of cognitive dissonance, especially in the cases where the observed activity does not match one's own standards or self-image. However, in the moment of interaction, bounded rationality comes into play, and the promise of an immediate reward (a new route) apparently is the main factor when the user decides how to interact with the system. The interplay between the bounded rationality decision and the resulting cognitive dissonance sometimes encountered is interesting, and might give clues towards design for these kinds of systems.

Transient cooperation in summary

The theory of Transient Cooperation is developed from observations made during experiments with a prototype of the OurWay system. This section has elaborated different aspects of this form of cooperation, and linked it to observations from the OurWay experiments, as well as to prior theoretical work.

The findings, however, are recognizable from many situations in our everyday lives. By using insight from the fields of social psychology and economics, findings in a limited size study are supported and better understood.

Transient Cooperation is not proposed as a contribution to psychology. Rather, it is proposed as a contribution to the CSCW community and through that also to the field of Accessibility. This is further elaborated in Chapter 5 , Contributions and Implications.

CHAPTER 3

CASE AND RESEARCH APPROACH

> It is a mistake to think you can solve any major problems just with potatoes.
>
> Douglas Adams

This chapter serves two main purposes. First, the case that forms the basis of the research is presented. A brief history of the development of the OurWay project and my involvement in it is presented as an introduction to this account. Secondly, it outlines the approach applied in the research leading up to the publications that constitute the body of this thesis. The end of the chapter contains a discussion of the potential contribution of this thesis, and its generalizability.

3.1 Case

There are three distinct activities that constitute the case that forms the basis of my work with this thesis. First, there is the technological evaluation of an early prototype in an outdoors environment. Following that, a few interviews with wheelchair users, potential *ultimate* users, were conducted. The final activity is the indoors evaluation of a newer prototype, with focus on the human and social aspects of use, including observations and interviews. Before describing these activities in more detail, however,

the OurWay idea, or *concept*, and related work is reviewed, along with a presentation of the Norwegian Association of Disabled (NAD), a central partner in the initial stages of the project.

According to Flyvbjerg, case studies are well suited to discover contextual knowledge related to human affairs [38]. Further, he argues convincingly that proper selection of a case often well can support generalization, hypothesis testing and theory building, contrary to many oft-perceived notions:

> The advantage of the case study is that it can "close in" on real-life situations and test views directly in relation to phenomena as they unfold in practice. [38].

In the OurWay project, the situations studied are constructed, in the sense that where new technology is involved, the context of use is to a certain degree dictated by the researchers. However, the value of testing the prototype as it appears in the hand of the users, allows the opportunity for in-depth studies of the relationship between the users and the technology, and between the users *through* technology.

To further strengthen the theoretical work with this case, interviews with *real* potential users have enabled elicitation of knowledge and perspectives on technology and people that *"close in" on real-life situations*, to use Flyvbjerg's words. In addition, the views and concerns expressed by the users in our more controlled experiments arguably allow for deeper understanding of the users *beyond* the experimental context, especially through the post-hoc interviews performed after some of the experiments.

3.1.1 The OurWay concept

When I was first associated with what would become the OurWay project, it was the core of an ongoing master thesis project by Håkon Holmstedt [58]. Holmstedt's system, dubbed the "Ranger", was aimed at pedestrian navigation, using mobile phones, GPS and mobile Internet access.

In 2004, The Norwegian Mapping Authority (Statens Kartverk) started a pilot project to map the physical accessibility in the center of Oslo according to universal design principles. The collected information was disseminated first through paper maps, then made available in an online web portal. A team (including Holmstedt) from Østfold University College was recruited by the project in 2006 to develop a mobile phone application for viewing the same data.

A framework for geotagging, called OKAPI, had already been developed by members of this team, and it was a natural extension of the formal mobile accessibility map viewer project to open up for user participation through accessibility-related geotagging of locations in the urban environment. Positions were provided by GPS, and the geotagging information (including pictures, location, textual and rating information) were sent back to a server over a mobile Internet connection.

The next extension of the idea was to use a variety of the geotagging information to inform route planning decisions. This was the starting point for Holmstedt's master thesis, and the foundation for what was to be dubbed the *OurWay* concept [1]. It is easy to see the inspiration from collaborative undertakings on the (social) web, such as Wikipedia and OpenStreetMap. Indeed, Holmstedt identified OpenStreetMap as a valuable source (and destination) for geographical information in his thesis, and later experiments and prototypes have used OpenStreetMap as the main source for geographical information, as well as for tools and infrastructure to store, manipulate and present this information.

Interestingly, the experienced accessibility is not yet part of the current instantiation of the original project. In fact, in a 2008 guideline document [2] from the Norwegian Mapping Authority, the following statement is found:

> "Registrations of the users' appreciation of the areas are not taken into consideration in this work."

This statement is more than just a curiosity, it serves to illustrate the difficulty of marrying a traditional top-down approach with a grassroots or bottom-up approach. The project in question is driven by the Norwegian Mapping Authority, and is concerned with standardization, data formats, procedures, and objective, authoritative quality measurements. A grassroots effort, on the other hand, typically will require a more relaxed and simpler approach to collecting and using data, and OurWay is aimed at supporting that aspect of accessibility mapping.

The core idea of OurWay is simple. Users can provide information back to a route planning server about the experienced accessibility at a location by using their mobile phone. Images and textual descriptions did not make it into the first prototypes, even though it is likely they

[1] A concept in this context refers to the underlying idea or mechanism, not to the concept as in Silverman's model of research.

[2] `http://www.statkart.no/nor/Land/Fagomrader/Temadata/Universell_utforming/`

can have a role in communicating context and details to other users. The feedback provided by the user consists of a geographical location (most frequently identified by using a GPS receiver, or by manually pointing on a digital map), and an *accessibility rating*. The rating is currently given on a three-level Likert scale, representing *Inaccessible*, *Uncomfortable* and *Good*. The reasoning behind the scale is related to the perceived threshold for contribution, and an unobtrusive user interface.

The geographical network used by the route planning server consists of all kinds of roads and paths. No information is kept about the *nature* of the network segments, such as highway or footpath information. This decision was made early on to be able to study the rate at which the "blank" network would adopt according to user feedback. The rating system and the reasoning behind the blank network is elaborated in Chapter 4.

Once the feedback is in the route planning server, it is attached to the closest segment of the geographical network. The numerical rating is used for weighting the network segments, so that for instance an *inaccessible* segment will seem like an impossibly long segment, and thus be avoided by the route planning algorithm. The algorithm employed is a standard shortest path algorithm. Conversely, *good* segments will seem shorter than their "real" length and thus be preferred by the route planner. *Uncomfortable* segments will seem longer, but not prohibitively long.

When a user asks for a route from an origin (typically current location) to a destination, a request is passed from the mobile client application to the server. The server then calculates the shortest path between the two points, taking the accumulated user supplied weights into consideration, and sends back a route suggestion to the mobile client. The route is presented on a digital map display, and the user can navigate along the route. Should the user encounter a situation where feedback is required (or desired, although it turns out that users typically provide feedback only when they have to), the current position along with the accessibility rating is sent back to the server.

In addition to inspiration from existing systems, it was also apparent from the original accessibility project that a major challenge was to identify the right people to collect accessibility information, to train them, and to get them into the field. A system based on the OurWay concept is one possible way to partly overcome this challenge. Of course, the nature of the information collected through OurWay is different from the more formalized and standardized information format suggested by the Norwegian Mapping Authority. However, by viewing the two approaches as complementary, both rigid, formalized, timely and updated information can be collected and disseminated to the public.

3.1.2 Related work

Literature from different fields can be considered related to the OurWay idea. As a route planning system OurWay is related to car navigation and pedestrian navigation in general. Further, the field of user generated geodata, or Volunteered Geographical Information (VGI), as it is dubbed by the geospatial community, is of relevance because of the user intensive nature of the concept. Finally, within the accessibility discourse we also find approaches to collection and dissemination of accessibility information.

The field of navigation reaches far outside of the realms of the OurWay prototype, often focusing on best practices for communicating directions to people (see for instance [57] for an account of similarities and differences between route directions from humans versus those coming from machines). Primarily a field with a focus on in-car navigation, projects started appearing at the end of the 1990's where pedestrians were the target groups.

Increased stability and bandwidth of mobile Internet connections opened up the possibility for client/server based route planning from the field, for instance by using up to date traffic information (e.g. [105], [76], [13]). In [13], Bederson et al. presents a framework that allows for subjective experiences (automatically through logging of travel and additionally with explicit annotations) to be captured and utilized for navigational purposes in an in-car GPS navigation system.

Ludford et al. introduces *PlaceMail* and *ShareScape* [72], two systems that together allows people to receive place-based email reminders, and to share information with other users about the places they have identified and used. Not specifically used for navigation, their research focuses on the types of places that are created and shared, how people decide to share, and if the shared information is useful to other users. The research team is partly coming from the same research environment that created GroupLens [86] in the early 1990's, and as such forms a bridge from the field of Social Navigation of Information Space to current research on location based services.

Within the geospatial community, the traditional focus is on data quality, adherence to standards and precision. It typically follows a top-down approach with strict guidelines and formal standards that help assure the quality, objectivity, and trustworthiness of the geographical information. Initiatives like OpenStreetMap, or other projects aiming at collecting and sharing information among end users was eventually described by Goodchild in 2007 as Volunteered Geographical Information (VGI) [41, 42, 43].

In Goodchild's view, the citizens (or users) can be considered sensors that collect geospatial information of various kinds.

The concept of VGI has been further explored by many, and Elwood goes into great detail about it from a GIS perspective, taking a critical, methodological, participatory and feminist approach to the issue [29, 30, 31]. One key question that remains, in particular in the geospatial community, is that of the credibility of information created by grassroots participants. Flanagin et al. compares the traditional approach followed by the established GIS community with that of emerging, participatory approaches. Research from related fields, such as co-writing of on-line encyclopedias, are drawn upon to suggest methods and tools for quality assurance and reliability. Sui takes a similar approach, in what he calls the *wikification* of GIS [103].

A concrete comparison of the quality of geographical data created by the OpenStreetMap project with similar data sets from the British Ordinance Survey reveals an 80% overlap between most of the road objects investigated [6]. This result is encouraging in that it indicates the viability of the idea and practice of VGI.

Pedestrian navigation for the physically impaired is receiving growing attention. The approach to creating the needed data set to support route planning for specific user groups is mostly comparable to the traditional GIS approach. For instance, Beale et al. presents a system where minute details are key to the design [12]. Digital Elevation Models (DEM),, calculation of rolling resistance, surveys, classification of "urban barriers" such as steps, gravel surfaces, narrow pavements and street furniture is collected in advance to form the basis for route suggestions for wheelchair users in an urban environment. A similar approach can be found in Völkel et al. [113, 114, 115, 116].

The OurWay approach combines the idea of pedestrian navigation for physically impaired users with that of Volunteered Geographical Information. Additionally, the approach taken is pragmatic, and not focused on details in the environment, rather on the subjective experiences of the users. In this respect, OurWay combines the VGI approach with ideas from Social Navigation of Information Space.

3.1.3 Norwegian Association of Disabled

According to the NAD (Norges Handicapforbund) web pages,

> The Norwegian Association of the Disabled (NAD) is an independent advocacy organization working for equal rights and

> social participation for the disabled. Our main target group is people with physical impairments[3].

NAD works for equal rights and opportunities, a no discrimination society where all people are included, despite physical or cognitive impairments. They are in line with the current academic disability studies discourse in claiming that disablement is imposed upon the individual by society, it is not inherent in the impaired person. Thus, much of the effort in NAD is related to political activities, through regulatory work and lobbying for equal rights and juridical rights for impaired people.

The organization has many branches, and a strong presence in the local communities. It is among its members we find volunteers who invest time and resource to take part in and contribute to projects such as the Norwegian Mapping Authority accessibility project mentioned above.

3.2 Research Approach

The previous section outlined the background and the setting for my research. As the project has evolved from technological to social, the research focus has changed as well. This is also reflected in the research design and methodology chosen in the different phases. In this section, I present the three distinct research activities, and detail the design for each of them.

3.2.1 Outdoors evaluation

There is a tradition at the Faculty of Computer Sciences at Østfold University College to produce publications based on good masters projects, in cooperation with the master students themselves. My involvement in the OurWay project started with planning the evaluation of the prototype system for a paper we were writing based on Holmstedt's master thesis.

The approach we took falls into both the first and second paradigms of HCI as identified by Harrison [52]. We were curious about the impact interaction from the users had on the underlying system (its ability to provide improved routes), and the impact on distance. Little or no effort were put into understanding how the users reasoned or responded to these changes.

[3] `http://www.nhf.no/index.asp?id=61240`

The outdoors evaluation was a direct follow-up to Holmstedt's masters thesis, and was designed primarily to assess the technical and algorithmical feasibility of the OurWay concept. The main goal was to investigate the rate at which a "neutral" network could be populated with user feedback to provide accessible routes, thus indicating the feasibility of the core idea. The evaluation was also designed to reveal the maturity of the underlying technology, such as the mobile devices, GPS precision, mobile Internet access, and related infrastructure.

Setup and data collection

The core geographical data (the geographical network), coming from and created for the OpenStreetMap project, was stripped of all existing meta data, such as the type of road or path. Keeping this information would be a good starting point for accessible routing (for instance, it would be an obvious choice to avoid all highways). However, we decided to test the extreme case where no such meta data existed. Buildings and other non-traversable geographical features were removed from the data set.

In order to evaluate the feasibility of the OurWay idea, we constructed a case in which people with baby strollers would use an OurWay prototype to navigate through the streets of Halden, Norway. Ideally, we would have liked to recruit wheelchair users for this, however it being an early stage of research, and knowing the demand put on the relatively few volunteers from the relevant user groups, we opted for a pragmatic solution. By using baby strollers to approximate the accessibility requirements of a wheelchair, we could explore the concept without exhausting the potential *ultimate* users.

We as researchers took the role of users ourselves, and iterated through a handful of navigational tasks, which together made a round-trip of Halden. Prior to the recorded experiments, we did a few test runs in the Halden area, and decided that feedback on a three level Likert scale would be sufficient for the time being. This was a simplification of the original five level scale we were using, and the decision was made because it seemed difficult to consistently differentiate between five different levels of accessibility. How we appreciated the accessibility of a certain stretch of road seemed to be relative, that is the *change* in accessibility was what we noticed, not necessarily the absolute accessibility. Later stages in our projects have documented how people tend to leave feedback only when the have to in order to get an alternative route, which suggests that our decision was sound.

We complemented the field walks with simulated walks in the lab, ap-

plying our knowledge of the local geography as we "walked" the routes on the computer screen, providing feedback as if we were in the field.

Most interaction with the prototype was logged automatically on the server side to allow for subsequent analysis and "playback" of events. This allowed us to visualize changes to the suggested routes over time (more about that in the following section on analysis). We captured notes on paper or using a dictaphone during the walks, and discussed aspects of the prototype as we went along.

Analysis

Our primary focus during analysis was the rate at which the suggested routes from the systems *converged* as stable, in other words how quickly the system was able to provide accessible routes. To answer this question, we looked at the number of iterations necessary for each of the navigational tasks to end up with a route suggestion that didn't require or invite further feedback.

We then compared the difference in geographical distance for the shortest path possible with the *converged* path, and calculated a ratio number we dubbed the *penalty factor*.

3.2.2 Interviews with potential users

Having performed the initial evaluation of the OurWay idea, with positive results, it was natural to investigate how this technology might be perceived by the ultimate users. Three interviews with wheelchair users were conducted to provide insight into existing practice, attitude towards new technology and privacy issues related to the introduction of new technology.

Setup and data collection

Two active members in the Halden branch of the Norwegian Association of Disabled were recruited, as well as one person living in the Oslo area. A semi structured interview was planned, including the main themes and general questions we wanted to discuss. A scenario was included to facilitate the conversation. We prepared an interview guide based on the scenario and questions to ensure the interviews were conducted in a comparable fashion. The interviews took place either in the home of the subjects or in their work environment. The interviews were recorded on audio tape, and notes were made during the interviews.

Analysis

All three interviews were transcribed in entirety. The text was then coded using an open coding approach, where main themes that occurred during the interviews were identified, and refined through comparison with the other interviews and iterations of this process. The resulting themes were then used as the basis for describing the existing practice, attitude towards the idea and technology, and privacy issues.

3.2.3 Indoors evaluation

To further explore the usage of OurWay, an indoor experiment was set up. Prior to this, a new OurWay prototype was developed, from server to client. This was done to easier facilitate changes and extensions to the prototype when needed. It also enabled us to move from the proprietary Windows Mobile platform to an open Java platform.

Setup and data collection

Nine users (two male, seven female, age from 29 to 60) were recruited among students and staff at the Østfold University College (ØUC). Six navigational tasks were created, spanning the campus building of ØUC in Halden. As in the prior outdoors experiments, the tasks together formed a round-trip of the geographical area. Because of the indoors setting, use of GPS for automatic positioning was prohibited. The users would scroll the map on the mobile phone and move a cursor to indicate their current position when providing feedback to the system. Infrastructure and tools from the OpenStreetMap project was accommodated to produce a complete geographical network for the interior of the campus building.

At least two observers followed each participant. Video and audio was recorded, and notes were made along the way. As in our previous work, we logged most of the user interaction with the system to allow for playback of events, and to be able to correlate video and notes with specific obstacles or events. After each of the six task, the participants were given a short structured debriefing, where they rated the quality of the route, the usefulness of the service and the quality of the prototype. They also elaborated on their ratings, and their responses were recorded using a dictaphone.

The first user started with a geographical network devoid of accessibility ratings. Each subsequent user had the benefit of the aggregated ratings produced by previous users.

A few weeks after the round trips of the campus building, we arranged semi structured post-hoc interviews with the participants. During these sessions we used video and feedback events from the previous session as a basis for a conversation about the activities that took place during navigation, and to explore the rationale behind the user actions. These interviews were audio recorded, and notes were made during the interviews. The interviews were later transcribed in their entirety.

Analysis

Feedback provided by the users during navigation was analyzed using descriptive statistics. We did this to see the rate at which the routes *converged*, and to account for the number and type of route segment ratings produced by each user.

The intermediate debriefings were analyzed using descriptive statistics, supported by the user elaborations on the ratings. We did this to provide insight into how the perceived route quality changed over time (from participant to participant), and similarly for the development of the usefulness ratings.

The transcribed post-hoc interviews were analyzed using an open coding approach, where key themes were identified in an iterative fashion.

In summary, the research approach has shifted along the course of the OurWay project, from a fairly pragmatic and technologically focused start, to the current explorative, human centered focus.

3.2.4 Use of Theory

The start of the OurWay journey can be described as pragmatic and technologically focused. The use of heuristics in design and descriptive statistics to evaluate the core idea falls into the first and second paradigms of HCI, as suggested by Harrison [52]. In this phase of the project, algorithms for route planning and GIS-related research formed the theoretical basis of the work. The nature of analysis was primarily quantitative, although some methods from qualitative research were applied to establish heuristic guidelines for the design, for instance by applying ideas from *rapid ethnography* [75].

Gradually, the focus of research moved into the interpretative domain, where methods such as interviews, questionnaires, observation (video/audio/photo) were applied to gain understanding of *how* the technology was used, and how this use was reflected upon by the users. Walsham [117, 118] and works in the seminal collection "An introduction to

qualitative research in information systems" [80] was an inspiration during this transformation of the projects focus.

In summary, the project's research approach can be described as a "mixed methods" approach [98, 22], utilizing the strengths of qualitative and quantitative approaches where they best applies to the primary research questions.

When it comes to theory building, this was (as I suggest in the theory chapter) an elusive goal for a long time. Finding support in the introductory work on qualitative research by Silverman [94], his structured view on research (Model/Concepts/Theories/Hypothesis) made it easier to break down the task of building a theory into manageable sub-tasks.

The relatively low number of participants in each of the activities constituting the OurWay case could be viewed as a limitations of the work, especially from the quantitative methods perspective. However, as we have demonstrated, the numbers have yielded sufficient results also in the earlier stages of the project. Moreover, as the research was gradually focusing *inward* on the users and their interaction with the technology, the richness of material produced compensates for the lack of a larger scale experimental setup. That said, the knowledge we have gained on this level can be used to inform design of such a larger scale deployment, and a longitudinal study of both technology and its users.

3.3 Type of Contribution and Generalizability

The main contribution of the research conducted in the OurWay case has produced types of contributions that mirror the development of the project itself. First, we have demonstrated the technical feasibility of the idea of collaborative accessibility mapping. Second, we have provided an in-depth view of the users relationship with technology and the cooperation (or lack thereof) that takes place through the technology. This includes implications for design, and brings work from Social Navigation of Information, Volunteered Geographical Information, and Accessibility together to propose a solution to a real life problem: that of creating, disseminating and applying information about physical accessibility in the real world.

The case is small in scale, however it can be argued (as does Flyvbjerg [38]), that the insight provided by the research of a good case can be generalized despite of (and precisely *because of*) the contextual setting. The theory of Transient Cooperation developed in this thesis is built on findings from the OurWay case. Applying insight from this theory to

other collaborative undertakings, such as Wikipedia or OpenStreetMap can serve as an example of such generalization.

CHAPTER 4

RESEARCH FINDINGS

> The most exciting phrase to hear in science, the one that heralds the most discoveries, is not "Eureka!" but "That's funny".
>
> Isaac Asimov

Included in this thesis are five selected research papers that together reflect the evolution of the OurWay project, and the corresponding change of research focus. The papers are presented in chronological order; two from the accessibility field (papers 3 and 4), one from the mobile technology field (paper 1), and two from the HCI field (papers 2 and 5). The papers can be found in the appendices to the thesis.

This chapter focuses on the findings in the included papers, and does not directly reflect the four research questions presented in the introduction to the thesis. For theoretical contributions put forward in this thesis, see Chapter 2, 5, and 6.

The first paper is the most technologically focused, and where the viability of the initial OurWay idea is tested. The second, third and fifth papers concentrate on the user perspective, for instance by looking at motivation for contribution, and privacy concerns. The fourth paper is concerned with discussing the OurWay concept as a social application, changing the perspective from a description of a prototype implementation to a discussion of the underlying OurWay idea.

The journey of my PhD project is well represented by these selected

papers. Together they form a thorough exploration of the idea of collaborative accessibility mapping, based on field tests of working prototype systems, spanning from technological assessment to user-centered reflection. The paper not only reflects the change of focus in the project, it also illustrates a gradual change in methodological approach.

4.1 Users are Doing it for Themselves: Pedestrian Navigation with User Generated Content

4.1.1 Reference

Holone, H., Misund G., and Holmstedt, H. (2007), "Users Are Doing It For Themselves: Pedestrian Navigation with User Generated Content", In: Al-Begain, K., and Bohnert, T. (editors): *Proceedings of the 2007 International Conference on Next Generation Mobile Applications, Services and Technologies* (NGMAST 2007), Cardiff, Wales, UK, September 2007.

4.1.2 Abstract

This paper describes the initial tests of the idea that information about physical accessibility for route planning can be created by and shared by users, over Internet-enabled mobile devices. A working prototype, based on Holmstedt's masters thesis work [58] was populated with a geographical network representing the city of Halden, Norway. All non-traversable geographical features, such as building outlines, were removed. Other meta data indicating the type of traversable geographical features such as roads and paths were removed too, leaving a neutral network consisting only of edges and nodes.

The experiments took place in Halden during the spring of 2007, as a continuation of Holmsted's work, to produce the first peer-reviewed paper based on the OurWay idea.

For the initial rounds of testing, we as researchers took the role of users ourselves, and followed up the field experiments with walk-throughs in the lab. For the field work we used a baby stroller as a way of emulating a consistent set of requirements with regard to accessibility.

Two main findings are presented in the paper. First, the *rate of route convergence*, that is, how quickly an accessible route between two locations

can evolve. This is measured by the number of annotations (user feedback) required for the route to reach a state where no more feedback is required from the users. Second, the *impact factor* is described as the relative increase in length of the converged route compared to the shortest possible path between the two locations.

The paper concludes that surprisingly few annotations are needed for routes to converge, and that the impact factor is low. The latter mostly because of the urban environment in which the tests took place, since there are many alternative routes to choose from. Further, the mobile technology and the supporting infrastructure is considered mature enough to suggest that the idea is viable also from a technological perspective.

4.2 Aspects of Personal Navigation with Collaborative User Feedback

4.2.1 Reference

Holone, H., Misund, G., Tolsby, H., and Kristoffersen, S. (2008), "Aspects of Personal Navigation with Collaborative User Feedback", In: Gulz, A., Magnusson, C., Malmborg, L., Eftring H., Jönsson B., Tollmar K. (editors): *Proceedings of the Fifth Nordic Conference on Human-Computer Interaction* (NordiCHI 2008), "Building Bridges", Lund, Sweden, October 2008.

4.2.2 Abstract

The second paper addresses the user perspective, with special attention paid to the user's appreciation of the prototype as a supporting technology, and to the relationship to the other users mediated through the technology. A geographical network was created for the interior of the campus building of Østfold University College (ØUC) in Halden, Norway. A new prototype based on the OurWay idea was developed for this set of experiments, to allow easier modification and extension of the system, and to facilitate manual positioning in the indoors environment.

The experiments took place in Halden in late 2007. This time, we recruited nine participants from students and staff at ØUC. Each participant was provided with a wheelchair, and presented with the scenario that they had been through an accident that required its use. The first participant started out with a neutral network (as in the previous outdoors tests), and each subsequent user had the benefit of the feedback

provided by previous users. They were also informed about the collaborative aspects of the system, and told about immediate benefits from providing feedback (i.e. an alternative route), and long-term benefits for themselves and other users (i.e. a route planner which provides more accessible routes over time).

Six navigational tasks, together forming a round trip of the campus building, was presented to each participant. Observations (recorded on video, photo, audio and paper), debriefings (using questionnaires) and logging of interaction with the route planner formed the basis for analysis.

We found that ratings of route segments, contrary to our expectations, were not primarily a result of explicit collaboration between the users, rather it was the immediate "selfish" goals of the users that provided feedback to the system. Typically, feedback was provided by a user when faced with an absolute obstacle, e.g. a staircase. Other forms of feedback (good and uncomfortable) were sparse and unpredictable.

4.3 Retrospective Altruism and Transient Cooperation in Accessibility Mapping

4.3.1 Reference

Holone, H. (2009), "Retrospective Altruism and Transient Cooperation in Accessibility Mapping", In: Mihalaş, G., Saka, O., Blobel, B., Gülkesen, K. H., Mazzoleni, C., Pharow, P. (editors): *Selected Papers from European Federation for Medical Informatics Special Topic Conference* (EFMI STC 2009), "Travel Health Informatics and Telehealth", Antalya, Turkey, November 2009.

4.3.2 Abstract

Based on the NordiCHI 2008 paper, and a subsequent appearance at the European eAccessibility forum in 2009, I was invited to write a paper for a special topic conference by the European Federation for Medical informatics on travel health. The paper is based on the earlier published papers on OurWay, and additionally on post-hoc interviews with the participants from the indoors experiments.

The paper introduces the terms *Retrospective Altruism* (RA) and *Transient Cooperation* (TC). Retrospective Altruism refers to the tension be-

tween how users *do* behave (i.e. oriented towards their personal goals, largely neglecting the long term benefit for self and others), and the way they *explain* their desires to be taking action also on behalf of and to the benefit of other users. Transient Cooperation, which is developed further in this thesis, refers to the brief, often unintended form of cooperation taking place through the interaction with the system.

A review of related work in geomatics and collaborative writing, with additional emphasis on data quality, validity and trust is presented. Along with our findings pertaining to the OurWay case, the collaborative approach to accessibility mapping is put forward as viable. To build the case for RA and TC, related literature on cooperation is reviewed: Communities of Practice, Communities of Interest and Social Navigation of Information Space.

In summary, the paper stands as a position paper based on empirical findings from our previous research and other literature in related fields of work.

4.4 Transient Cooperation in Social Applications for Accessibility Mapping

4.4.1 Reference

Holone, H., and Herstad, J. (2010), "Transient Cooperation in Social Applications for Accessiblity Mapping", In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A. (editors): *Proceedings of the 12th International Conference on Computers Helping People with Special Needs* (ICCHP 2010), Vienna, Austria, July 2010.

4.4.2 Abstract

ICCHP is a conference specialized on the topic of assistive ICT technology for people with special needs. This paper address the OurWay idea and our experiences with it from an accessibility perspective.

Two main research questions are posed: 1) *What characteristic features do we find in the collaboration taking place in OurWay as a social application?* and 2) *What implications can this have for accessibility mapping?* The paper builds on another paper where the OurWay idea is discussed as a social application [59], where Grudin's characteristics of such systems [47] are used as a facilitating framework.

A brief summary of literature on cooperation is presented, before the characteristics put forward by Grudin are covered. The discussion is divided into three parts. First, the accessibility field is related to cooperation literature, for instance by invoking Hedvall's notion of *experienced accessibility*. Second, an answer to the first research question is presented as a positioning of Transient Cooperation within the existing literature on cooperation. This positioning is performed in light of the type of non-explicit cooperation we have observed through the OurWay case. Finally, suggested implications for accessibility mapping are covered, including the importance of applying lessons learned in HCI and CSCW, and the insight provided through the notion of Transient Cooperation when designing systems for this purpose.

4.5 Negotiating Privacy Boundaries in Social Applications for Accessibility Mapping

4.5.1 Reference

Holone, H., and Herstad, J. (2010), "Negotiating Privacy Boundaries in Social Applications for Accessibility Mapping", In: Blandford, A., Gulliksen, J., Hvannberg, E. T., Larusdottir, M. K., Law, E. L-C., Vilhjalmsson, H. H. (editors): *Proceedings of the Sixth Nordic Conference on Human-Computer Interaction* (NordiCHI 2010), Reykjavik, Iceland, October 2010.

4.5.2 Abstract

Semi-structured interviews with three wheelchair users were performed to get feedback on the OurWay idea and to elicitate existing practices in the community for planning and making trips in urban environments. This included a focus on their initial thoughts about introducing such a route planner as assistive technology, and privacy concerns that might arise as a consequence of using such a system.

The paper focuses on the privacy concerns raised by the informants. It reviews relevant literature in the fields of accessibility, social software and privacy, and summarizes the discussion of OurWay as a social application.

The paper makes two main contributions. First, it establishes existing practice by which wheelchair users plan and make trips in the urban environment. The interviews are central in this part of the work, and

several concrete examples provided by the informants are presented in this section.

The second contribution is the discussion of potential consequences of introduction of a collaborative route planner as assistive technology. To frame this discussion, we invoke the privacy framework proposed by Palen and Dorish [83]. By tying the existing and identified changes of practice to the privacy framework, we are able to conclude with implications for design of social systems for accessibility mapping.

4.6 Findings in summary

The selected papers have addressed different stages of the OurWay project, using different perspectives as the project has evolved. There is a certain overlap between some papers, however they have provided input to different fields through different publication channels, and the focus has changed accordingly.

The technical part of the project has documented the viability of the core idea, both when it comes to the maturity of mobile Internet services and handsets, and the use of pragmatically selected levels of feedback to inform the route planning algorithm. The field tests with technology in hand were performed in 2007 and 2008, and the power and capabilities of smart phones and the stability of mobile Internet connections have improved since then.

From the perspective of use of the prototypes, the main observation is the individual user's focus on his own navigational task at hand, and how the thought of "the others" largely is absent during use. However, the system still works and improves over time through the accumulated feedback provided by individual users. This observation leads to the notion of *Transient Cooperation.* Second, our participants typically express a *desire* to behave to the best of a "community", and this observation leads to the notion of *Retrospective Altruism*. Transient Cooperation in particular is theorized in Chapter 2, where additional literature from the field of economics and social psychology is invoked to better understand these observations.

Finally, an attempt has been made at identifying potential privacy concerns that might arise as a consequence of the introduction of new assistive technology in an existing practice. Based on interview material, and using an interpretative approach, a rich case was built both for the existing practice and the potential privacy issues that might emerge.

CHAPTER 5

CONTRIBUTIONS AND IMPLICATIONS

> It is the peculiar and perpetual error of the human understanding to be more moved and excited by affirmatives than negatives.
>
> Francis Bacon

It is now time to review the theoretical and practical work put forward in this thesis, and to put it in the context of the main research areas it is aimed to contribute to. The purpose of this chapter is to assess contributions in each of the fields, and to argue how these contributions together may help to bridge research in the CSCW field and the Accessibility field.

In Chapter 1, I presented the research questions addressed in this thesis. In the introduction to the current chapter, it is relevant to re-visit these questions, and point to where the relevant discussions can be found.

5.1 Research questions

What follows are the individual research questions, with a brief summary of where the relevant findings and contributions can be found. For more background and motivation for these questions, see Chapter 1.

5.1.1 RQ1

> In what ways are opportunities for cooperation changed by the introduction and use of mobile ICT systems?

This questions is addressed primarily in the two first included papers [61] and [62]. The first paper is the most technology-oriented of the included papers, and describes the OurWay concept in detail. The second paper serves as a bridge to more interpretative research, and recognize the importance of traces left from use as a starting point for ad-hoc cooperation. Summaries of the two papers can be found in Sections 4.1 and 4.2.

5.1.2 RQ2

> How can these forms of cooperation be described in the context of existing HCI literature on cooperation?

Positioning of Transient Cooperation within the existing literature is found in Chapter 2. Here, the terms *group*, *cooperation* and *negotiation* are reviewed as they appear in CSCW discourse, and discussed with respect to the empirical findings in my own research. Together, this constitutes the development of the theory of Transient Cooperation. A short review of Transient Cooperation can be found in Section 5.2.2. The Transient Cooperation idea was first presented in the third included paper [63], summarized in Section 4.3.

5.1.3 RQ3

> What motivates users to cooperate through and contribute to OurWay-like systems?

In the initial stages of my project, user motivation was hypothesized to come from shared goals and responsibilities, and the feeling of community. However, as reported in the second included paper [62], a recurring theme was that motivation came from opportunities to solve ones own tasks, often neglecting the implications for other users of the system. A summary of this paper can be found in Section 4.1. The findings about motivation are developed further in Chapter 2, and summarized in Section 5.3.1.

5.1.4 RQ4

> What privacy issues might emerge with the introduction and use of these kinds of systems?

Again, the case of route planning for wheelchair users is used to establish existing practice, and to discuss changes in practice as a result of introducing mobile ICT. By leveraging the privacy framework proposed by Palen and Dourish [83], issues raised by participants and extrapolated from the interviews led to the fifth included paper [64], summarized in Section 4.5. Privacy is also covered in the contributions to CSCW in Section 5.3.1.

The rest of this chapter is structured as follows: First, I present a brief summary of the theory of Transient Cooperation, including a discussion of the generalizability of the theory. Second, I propose contributions and practical implications for the CSCW and Accessibility fields, before I conclude the chapter with a summary of the main contributions.

5.2 Transient Cooperation

In this section I present a brief review of the theory of Transient Cooperation. To put the work in context, I include a summary of related fields of research, and the OurWay study on which the work is based.

5.2.1 Background

Cooperation in CSCW

Computer Supported Collaborative Work has over the 25 year history of the field been mostly concerned with work place centered studies. This is not surprising, given the origins of the field. With roots in Groupware in the early 1980's, CSCW has followed the development of new information technology with networking capabilities, video and audio communication and technologies specifically designed to enable cooperative work through information technology. With the explosive growth of on-line activity following the introduction of the commercially available Internet, some CSCW researchers has looked beyond the desktop computer paradigm. Opportunities for distributed work supported by mobile technology has a place in the literature, and some researchers has also looked into non-work related activities on the Internet.

Still, the primary focus has remained workplace settings, both distributed and co-located. These settings are often characterized by a number of shared goals, imposed by the formal structure of the organization in which the work takes place. Even though employees rarely have a complete picture of information flow and decision making in an organization, each employee knows about their responsibilities in relation to their immediate colleagues or department, and in performing their work they have a fairly clear idea of how it contributes to the shared goals of the department or company as a whole. Being employed imposes an explicit cooperation with other workers in the organization, and whether or not one achieves the shared goals has a direct impact on the success of the organization or department.

In this work, I have looked at a non-work related setting, where the relations between individual users are not necessarily pre-defined, neither is there a requirement for a shared goal among the participants. Still, there is much to learn from the work-centered literature of CSCW, with regards issues like awareness and the creation of common information spaces to allow for cooperation.

One of my proposed contributions to the CSCW literature is to extend the definition of cooperation with the inclusion of non-work related, distributed individual activities which produce *outcomes* that have the properties of cooperation. I will return to this topic later in this chapter.

Accessibility in urban and built areas

Designing urban and built environments to include all users has become an important topic in regulatory and political work. Although in many places, new buildings and areas are required to satisfy standards of universal design, substandard buildings and areas will continue to exist. The efforts required to map the accessibility of such areas are considerable, and often unrealistic. When different requirements for different users depending on abilities and assistive equipment are taken into consideration, it does pose the question if traditional top-down approaches for collecting, maintaining and disseminating such information is the optimal way to go.

One of the core ideas of the OurWay concept is to involve the end users in the collection and maintenance process. This may have at least two effects: contributions towards solving the resource challenge mentioned above, and empowering the individual user.

Accessibility is relevant to the OurWay project as the frame within which the case has been studied. In the beginning of the project, wheelchair

users and interest organizations were involved, and results from the study has been presented in conferences relevant to the Accessibility field. I also hope to contribute to the Accessibility field with ideas for reflection about the end users' opportunity for participation and empowerment, in addition to practical ideas for accessibility mapping.

The study

The study consisted of background interviews with prospective users, experiments involving technology in hand in an indoors environment, and retrospective interviews for reflection on use of the system. Going into the study, we presented the participants in the indoors study with an overview of the route planning system, and how their own feedback to the system would help the system provide better routes for all users over time. We had no intention of building a community among the participants, however we were assuming that their awareness of other users and the shared goal of improving the route planner would be maintained throughout the experiment to a certain degree.

What we found, though, was that most participants rapidly ignored or forgot what we had proposed as a shared goal, and did not pay much attention to other users, or the influence their actions might have on the usefulness of the route planner for subsequent users. In particular, users seemed to quickly be immersed in their own immediate goals, which were to find routes between predefined points in the building, using the system. The result was what can be described as self-centered action, both with regards to feedback they *didn't* provide when they had overcome an obstacle, or feedback they *did* send in order to "trick" the system into providing a desired route.

Retrospective interviews with these participants involved viewing video footage from the experiments, and a reflective discussion about the users' interaction with the system. In this setting, the concern for other users was more prevalent, and they often attempted to rationalize away any inconsistency between what they *had* done and what they *would like to have* done.

Theorizing the findings

In the early stages after the indoor experiments and retrospective interviews, these observations resulted in the coining of the term *Retrospective Altruism*. This alluded to the tension between actual and desired behavior

mentioned above. At this stage in the project, the idea of developing a theory was somewhat elusive, and it was only towards the end of the project where the prospect of theorizing the findings further really emerged.

After analysis of interview transcripts and other material, a few concepts became central in explaining the changes in attitude towards the system, other users, and the act of cooperation. The theory of Transient Cooperation is summarized in the next section.

Towards the end of the project, two theories from other fields became relevant to further explain and support the validity of the observed phenomena. First, *Cognitive Dissonance* from the field of Social Psychology provides insight in the tension of actual and desired action. Second, *Bounded Rationality* helps explain the limitations in reflection about consequences of decisions at the time of action.

5.2.2 A Review of Transient Cooperation

Definition

Transient Cooperation was coined as a term based on the observations from the indoor experiments and subsequent interviews. This was, however, before I decided to develop a theory based on the findings in my work. After a process of theorizing the findings, the initial definition of Transient Cooperation still stands, with elaborations which can be found in Chapter 2:

> Transient Cooperation is a form of cooperation which does not require an existing community, or explicit participation other than a shared benefit from use. The interaction is asynchronous and limited in time, and the users might be unaware of their cooperators or the benefit they have from cooperation.

What follows from this definition is an extension of the typical view on cooperation to also include activities which are not coordinated or inspired by shared goals or communities. Transient Cooperation attempts to capture the dynamic relationships between people, groups, and technology. If the outcome has the appearance of cooperation, the activity itself is considered an cooperative effort. The aggregation of individually motivated activities from multiple users leads to benefits beyond the immediate reward given to the individual at the time of interaction with the system.

Negotiation is key to Transient Cooperation in that the relationships between people and technology, and the meaning of activity is constantly

subject to change. This is how we intuitively relate to our surroundings, however it is a challenge to capture these dynamics in a technological system.

5.2.3 Generalizability

With a limited number of participants in the study, it is important to raise the question of generalizability of the findings. This section addresses this question, by taking a look at the case, data collection and analysis.

Case

The background interviews were performed with three individuals with many years experience as wheelchair users. Two of them also had significant experience as active individuals with roles in organized activities in the disabled movement. Their combined experience and reflections on the issues from their own standpoint and also from the viewpoint of others provides a major contribution to the project in terms of understanding the daily lives of disabled people, in particular with regards to wheelchair users and trip planning.

The indoors navigation experiments where performed with nine people, none of which had previous experience as wheelchair users. The experiments where conducted with a working prototype of the OurWay concept, with full route planning and user feedback functionality in place.

The subsequent interviews with the indoors participants were conducted a few months after the indoor navigation experiments, and were conducted as semi-structured interviews based on video footage of the participants themselves and/or other participants.

Data collection and analysis

Both the background interviews and the retrospective interviews were fully transcribed. Additionally, video material, server logs and questionnaires from the indoor experiments were available for analysis.

The transcribed interviews were analyzed using an open coding approach over several iterations. By re-playing the server logs, we could look at the instances where users provided feedback to the system, and correlate that with video material and observations. This was also used in the interviews, to identify interesting situations to discuss with the participants.

The different sources of material has allowed for multiple angles of analysis, which together forms a thorough picture of activity during the experiments. Allowing the participants to reflect on their own actions has been a key source of insight into the decisions made during use of the system, and has contributed significantly to the theory of Transient Cooperation.

Support from other theories

The CSCW field in general has a broad focus on people using technology for cooperative efforts. Some research within CSCW has also looked at non work related use, however it is my impression that this work often gets a technological focus, as is the case with Social Navigation of Information Space (SNIS). This sub-area of CSCW originated with the introduction of Internet access to the general public in the mid 1990's. Collaborative filtering and recommender systems was a recurring topic within SNIS, and ideas from these has influenced parts of the OurWay project. Findings within SNIS suggests that the idea of aggregating traces of activity from multiple users can be used as a method for sharing popular content. Indeed, many existing successful systems are using these kinds of technologies, including on-line book store amazon.com (since 1995) and more recently Facebook's "Like" button.

The introduction of Cognitive Dissonance and Bounded Rationality in the later stages of my work provides support from other fields for the observations of participants' decisions and reflections about own activities. This support is valuable, since it allows for a more general interpretation of the observations than is supported firmly by the data from the OurWay experiments alone.

Generalization validity

The combination of a multiple rich sets of data from interviews and experiments and the support from other theories regarding central observations suggests that valid generalizations can be made to a certain extent beyond the scope of the OurWay prototype. However, this is still an exercise which should be handled carefully.

In the rest of this chapter I take on this challenge, and bring forward potential contributions to the CSCW and Accessibility fields.

5.3 Contributions and Implications

The following sections discusses theoretical contributions and practical implications from the work with OurWay. The contributions are based both on the theory of Transient Cooperation and the experiences from working with the OurWay concept throughout the project.

The contributions are focused towards the fields of CSCW and Accessibility. First, separate contributions to each of the fields are presented, before I argue how CSCW and Accessibility might be brought closer to each other through the contributions in each separate field.

Although theories from psychology and economics are used to support some of the suggested contributions, it is important to note that I am not attempting to contribute to these fields specifically. The frame of reference is cooperation between people through mobile technology, and how this can be viewed from the perspectives of CSCW and Accessibility.

5.3.1 Computer Supported Collaborative Work

Judging cooperation from outcome

Cooperation is typically defined as an explicit participation in work towards a shared goal. This is also the traditional view in Computer Supported Collaborative Work. In Transient Cooperation, the notion of cooperation is extended to also include activities which does not require a shared goal, or even awareness of other users. The reason for extending the definition of cooperation is twofold. First, it allows for the discussion of distributed, asynchronous systems such as the OurWay route planner within the field of CSCW, drawing on years of experience and literature pertaining to cooperation, awareness and shared information spaces. Second, it proposes to extend the focus of the CSCW field to a class of systems which is more often found in ad-hoc leisure activities on the Internet rather than in organizations and their established work settings. Interestingly, these ad-hoc systems are gradually introduced to traditional work settings as well, making then inclusion of them into CSCW relevant, and suggests a research direction for the field.

Mobile and non-workplace settings

Considering mobile work contexts is not new to CSCW. However, the area of leisure type activities utilizing mobile technologies has not received much focus within the field. This is partly due to the traditional CSCW

focus on established work settings. With more activities spanning personal and work life, participation in cooperative activities and dedication to tasks can become fragmented, and this poses interesting challenges for the design of cooperation support.

Transient Cooperation proposes a view on cooperation which relaxes the requirements for awareness support and shared goals. With traces from activities performed in the users' self interest, aggregations can create long lasting effects for other users with the appearance of explicit cooperation.

Discussing these kinds of applications (previously described in Social Navigation of Information Space) as devices for cooperation allows for application of knowledge from CSCW, as well as an extension of the CSCW field to include this class of applications. Discussing cooperation from the end-user perspective may also provide valuable insight back to more traditional work settings.

Design implications

The theory of Cognitive Dissonance has previously been applied to interaction design to discuss mental models of interaction and how the underlying system works. To the best of my knowledge, it has not been applied to the use of a system as a whole, to describe users' relationship to the system, other users and their own activity over time.

One of the lessons learned from the OurWay project is that users tend to rationalize their own activities, as when explaining why they did or didn't annotate an obstacle when it was encountered. There are at least two general design implications to take away from this. First, design to support this rationalization (negotiation of the meaning of activity) as part of the system. This includes allowing for editing and deleting information at a later time. Second, design for minimizing cognitive dissonance in the first place. More focus on awareness support is one possible outcome of this.

Awareness, however, does not seem to be required to make the system work. After all, in the OurWay experiments, practically no awareness information was available to the users, yet the system did improve rapidly over time to the benefit for all users. It is possible that a more awareness-centered design of an OurWay client would help minimize the tension between ideal and actual activity (as seen from the user's perspective). Other examples of systems which can be described by Transient Cooperation may include peripheral members of the Wikipedia community or similar systems.

Participants in the Wikipedia project come in many flavors, from the dedicated individuals at the core of the project (the *Wikipedians* [17]), to the peripheral users who mostly consume, but sometimes adds a link or fixes a spelling mistake. I propose that Transient Cooperation can be applied for discussing these peripheral users. In relation to the discussion of awareness, it is interesting to note that Wikipedia as such does not enforce much awareness of other users, even for those editing pages. Discussion pages and the others in the community has to be sought out specifically by the interested contributors. Of course, the same is true for individuals who only read Wikipedia content. In fact, this is one of the main criticisms of Wikipedia: the lack of reminders that the content is in fact user generated.

In ICT systems, users and groups are typically represented as in static relationships. This does not reflect our everyday relationships to other people, which are dynamic and continuous processes, not static properties. As has been demonstrated through the OurWay case, these dynamics not only describe relationships between individuals and groups, but also the relationships between users, technology and physical environments. Supporting negotiation of this kind is an important design challenge, relevant to many current technologies, including massively popular social networking sites. At the very least, the systems we design should be open to *outcomes* of negotiation happening outside of the technological systems.

Privacy

Trusting information in most cases comes down to trusting the source of information. The source can gain trust in many ways, including through authority, reputation and personal relationships. In the OurWay case, we've seen that existing practice for planning trips is typically based on personal relationships, directly or indirectly. One implication of this is that these personal relationships must be captured by the ICT system, in order to provide the necessary foundation for trust based decisions.

The flip side of this is that personal information about where and when users provide accessibility information to the system must be persisted to allow the system to improve over time. Partly, these conflicts can be solved by using nick names or other forms of anonymizing approaches.

On the other hand, most people do not seem to be very concerned with leaving behind amounts of traces of their own activities, whereabouts and other information using their full name. One obvious example of this is

Facebook. Facebook is interesting because it gives value to participants by providing a platform for communication and socializing on the net. At the same time, Facebook harvests information in order to tailor advertising to users and their networks. A brief look at the evolution of Facebook's privacy regulations clearly shows a shift from the focus on the individuals right to privacy towards an advertising and data harvesting centered model.

Still, one could invoke Transient Cooperation to discuss Facebook and other data harvesting services such as Google. Every single user performs activities in their own interest (posting on a Facebook wall, chatting with a friend, using a search engine, updating their calendar, using email), and gets immediate reward from the system corresponding to their activities. However, traces of these activities are left behind, and provides the service providers valuable information to enable user profiling, social network analysis, and other forms of data mining. Applications of this information comes in different forms, including targeted advertising and suggestions for new people to befriend. The problematic side of this is when users are not informed about (or even has the opportunity discover) what their traces are used for.

The balance between information trust and the need for privacy and negotiation is a major challenge to the information system design community. Even if many users seems to think that no harm can come from the dissemination of their activity traces, it doesn't mean that privacy concerns in design can be neglected. On the contrary, I would argue that it emphasizes the need for careful privacy design, and visualization and awareness related to these issues. Storing activity traces are key to many of the services we have come to rely on, and users' trust in these services is key to their continued success.

New questions

Transient Cooperation is developed on the findings from a specific case of route planning with mobile technology. However, the core of the theory can likely be applied to other cases, involving mobile and desktop technology, and existing systems we encounter on the Internet. For instance, it would be interesting to apply Transient Cooperation as a discussion framework for services such as Wikipedia and Twitter.

Further, a longitudinal study which extends the indoors OurWay study could be valuable. This would be a good opportunity for elaborating and refining Transient Cooperation, as well as a real life test of the OurWay concept. The latter could provide more insight into the potential use for

the system as a practical route planner, as well as an opportunity for a focus on making the technology itself more accessible to heterogeneous user groups.

5.3.2 Accessibility

My contributions to the accessibility field are more practical than theoretical. The field of accessibility consists to a large degree either of practitioner based research or politics and regulatory work. My goal is that this thesis can contribute with a slightly different perspective on what accessibility can mean, in two ways. First, I bring in Computer Supported Collaborative Work and accumulated knowledge from the CSCW field as a means to understand a form of cooperation between individuals through mobile technology. Second, I propose a potentially more active role for the individual with regards to negotiating the physical environment and to helping others in similar situations. In particular, I present a system which aims to empower the individual user to negotiate physical accessibility in built and urban environments through the use of mobile technology. Through the use of this system, each user is also potentially helping other users negotiate accessibility in the same environments.

Lessons learned from CSCW

Following Hedvall's recommendation to learn from research in HCI and CSCW and apply insight from these fields to accessibility, the OurWay concept is an attempt to implement "Accessibility 2.0" [54].

Negotiation of physical accessibility is a complex matter, involving the physical environment, the user's physical ability, use of assistive technology and support from others. Adding to this complexity is continuous variation of these factors. Physical environment changes with season, weather and construction work. Different wheelchairs might be chosen for different activities. You might be with a friend or an assistant, or you might be alone. An objectively speaking accessible route is difficult if not impossible to define, precisely because of this complexity.

With a route planning tool which allows the user to query for alternative routes based on the situation at hand, the user can make use of other peoples experience, and get alternative route suggestions, helping to negotiate the physical environment. Whilst getting the direct benefit of these alternative routes, the user also contributes by sharing new information with other users through the system.

Empowering users

In stead of being pure consumers of accessibility information gathered, approved and disseminated by an authority, each user can take an active role and contribute with information to the shared information system. In other words, individuals can be empowered to shape their own and others' ability to negotiate physical environments.

Additionally, the OurWay concept is a proposed solution to the resource problem related to collecting, disseminating and maintaining accessibility information. The traditional way of doing this is to engage selected users in a process which is controlled by an organization. Good initiatives exist to standardize requirements for accessibility, however there are still great variations in needs and preferences not necessarily reflected in such objective measures of accessibility.

Taking negotiation of accessibility seriously, and considering the individual user as a potential resource, accumulated subjective experiences available through a route planner may have the power to change how trips are planned and carried out. There is still a need for further development and testing of the OurWay concept to achieve this, however the initial findings are promising. Looking at other cooperative undertakings on the web, it is difficult not to be optimistic about the promises of such an approach.

There are, of course, remaining challenges related to privacy and trustability in a model based on user generated content. However, these challenges are not unique to the accessibility application of on-line cooperation, as similar challenges are being handled in other prominent on-line systems. There is much to learn from existing research on these issues.

The OurWay project has received positive response from the accessibility community, and there seems to be a general shift in the way user generated content is considered as a valid source of information. It is my hope that the concept will be developed further and be available as a tool for people to use, both within and beyond the field of accessibility.

Remaining challenges

If a system built on the OurWay concept was to be made available as an assistive technology through regular channels, it would undoubtedly also introduce new challenges. First, assistive technology is typically provided through a support network or organization. All new technology requires training of support personnel, and it is not likely that introduction of

new mobile technology with an emphasis on user participation will be an exception. Another question to address is where and who should host the required technical infrastructure. This is not only a technological question, it also raises issues related to ownership, quality of service and decision making. One possible solution is to host the server software within an established interest organization, thus granting the route planning system with a sense of approval by a trusted authority.. On the other hand, it may be a challenge to get traditionally organized communities to accept responsibility for a user driven solution, without having control over the information provided. The challenge of balancing top-down organizations with bottom-up solutions is an interesting one, and it needs to be addressed to get a system based on the OurWay concept available as an assistive technology provided through established channels. See Section 2.1.1 for a brief background on assistive technology and universal design.

One aspect of the of the OurWay prototypes which has been overlooked to a large degree is the interaction design with respect to users with varying abilities. The prototypes have simplistic designs, as they were intended to test the OurWay *concept* rather than the interaction between the user and the mobile phone. With current smartphones gaining better support for speech technologies and multimodal interaction, good opportunities exists for universal design of future OurWay clients.

5.3.3 In summary

This chapter has presented the main contributions put forward in this thesis. I have presented contributions and implications for both the CSCW and Accessibility fields. The main theoretical contribution to the CSCW field is the theory of Transient Cooperation as a means for understanding and discussing ad-hoc cooperation between people using (mobile) technology. The more practically oriented contribution to the Accessibility field is the proposal of a route planning system for accessibility based on user generated content from the users themselves.

By submitting these proposals to the two fields of research, I hope to bring knowledge from CSCW into the realm of accessibility research. Conversely, by demonstrating a collaborative route planning system tested in an accessibility context, I hope to highlight an interesting field of further explorations of technology to support cooperation between people.

CHAPTER 6

CONCLUSION

> Astrology is as vacuous as the space it worships.
>
> Perry DeAngelis

In this thesis I have presented my work in the cross section of Computer Supported Collaborative work and Accessibility research. By combining experiences from user-driven systems on the web with the challenge of negotiating the physical environment, my aim has been to contribute both to the CSCW field, as well as to the Accessibility field. The research has had a practical foundation, and both theoretical contributions and practical implications have been proposed.

The main research questions introduced in Chapter 1 was addressed directly in the previous chapter, as well as in Chapter 2 and in the included papers. The individual research questions from the included papers are discussed in the respective papers, and are summarized in Chapter 4. Findings from these papers have informed the theoretical contributions and implications put forward in the thesis.

I have presented the OurWay concept, which was the starting point for the research going into this thesis. The OurWay concept is taking a new approach to the well-known challenge for wheelchair users to plan and carry out a trip in built and urban environments. Users typically rely on "official" accessibility information, combined with accessibility assessments from other trusted parties such as family and friends.

The established approach to accessibility information gathering emphasizes centralized, coordinated and standardized methods, and typi-

cally regard the user as a consumer of such information, rather than an active user who can add value to the system. The OurWay concept takes the approach that the end user is the main source of information, and lets users provide subjective feedback through the use of the system as a route planner. Over time, the system's ability to suggest accessible routes improves, and published results from tests of the OurWay concept shows the idea to be promising.

The research constituting the work behind this thesis can be divided into three stages. First, a series of background interviews have been conducted with wheelchair users to better understand the challenge of planning and carrying out trips, and to establish existing practices involved in these activities. Second, prototypes of the OurWay concept have been developed, and tested in a real world setting both indoors and outdoors. Third, findings about cooperation from the indoors experiments have been theorized to form the theory of Transient Cooperation.

Key concepts in Transient Cooperation are Negotiation, Groups and Cooperation. These are all dynamically related concepts, and the insights provided about dynamic group relationships and aspects of cooperation before, during and after interacting with the shared system helps outline requirements for new cooperation systems.

The main theoretical contribution proposed in this thesis is the extension of the concept of cooperation to include Transient Cooperation. This is an ad-hoc form of cooperation where users are not necessarily aware of how their use of a system affects other users, and the users do not necessarily have to be part of a community or even share common goals for a cooperative effect to take place. I have argued that if the result of aggregated traces of self-centered activity has the properties of a cooperative effort, then it makes sense to regard these activities as cooperation. At least for the purpose of being able to describe these activities within the literature of cooperation.

My contributions to the accessibility field is mainly in the form of practical implications. The OurWay concept has been shown to be promising, and will hopefully inspire future work. One such implication is the suggestion to involve the individual as an active and empowered participant in the use of technology for negotiating the physical environment. Further, by considering individual users as resources, a potential solution to the overwhelming task of gathering and maintaining accessibility information has been suggested.

Finally, the concept of negotiation is a recurring theme in this thesis. Ranging from the navigation in physical environments to group affiliations and the meaning of action, negotiation is always an implicit and

important factor. Taking this insight seriously has implications for how we design, deploy and use technology, and how we deal with our environments in our daily lives.

BIBLIOGRAPHY

[1] Y. Abe and M. Yoshiki. Collision avoidance method for multiple autonomous mobile agents by implicit cooperation. In *Intelligent Robots and Systems, 2001. Proceedings. 2001 IEEE/RSJ International Conference on*, volume 3, pages 1207–1212. IEEE, 2001.

[2] Mark S. Ackerman. The intellectual challenge of CSCW: the gap between social requirements and technical feasibility. *Hum.-Comput. Interact.*, 15(2):179–203, 2000.

[3] B.T. Adler, J. Benterou, K. Chatterjee, L. De Alfaro, I. Pye, and V. Raman. Assigning trust to Wikipedia content. In *WikiSym 4 rd Intl Symposium on Wikis*, 2008.

[4] P.E. Agre. Changing Places: Contexts of Awareness in Computing. *Human-Computer Interaction*, 16(2, 3 & 4):177–192, 2001.

[5] E. Aronson. The theory of cognitive dissonance: A current perspective. *Advances in experimental social psychology*, 4:1–34, 1969.

[6] A. Ather. A Quality Analysis of OpenStreetMap Data. Master's thesis, University College London, 2009.

[7] L. Bannon. Perspectives on CSCW: From HCI and CMC to CSCW. In *EW-HCI'92: Proc. Int. Conf. on HCI, August 1992, St. Petersburg, Russia*, pages 148–158, 1992.

[8] L. Bannon and S. Bødker. Constructing common information spaces. In *Proceedings of the fifth conference on European Conference*

on Computer-Supported Cooperative Work, pages 81–96. Kluwer Academic Publishers, 1997.

[9] L.J. Bannon. CSCW: An Initial Exploration. *Scandinavian Journal of Information Systems*, 5:3–24, 1993.

[10] L.J. Bannon and K. Schmidt. CSCW: Four characters in search of a context. In *Proceedings of the First European Conference on Computer Supported Collaborative Work*, 1989.

[11] J.E. Bardram and C. Bossen. Mobility Work: The Spatial Dimension of Collaboration at a Hospital. *Computer Supported Cooperative Work (CSCW)*, 14(2):131–160, 2005.

[12] Linda Beale, Kenneth Field, David Briggs, Phil Picton, and Hugh Matthews. Mapping for wheelchair users: Route navigation in urban spaces. *Cartographic Journal*, 43(1):68 – 81, 2006.

[13] B.B. Bederson, A. Clamage, and C. Plaisant. Enhancing in-car navigation systems with personal experience. *Transportation Research Record: Journal of the Transportation Research Board*, 2064(-1):33–42, 2008.

[14] V. Bellotti and S. Bly. Walking away from the desktop computer: distributed collaboration and mobility in a product design team. *Proceedings of the 1996 ACM conference on Computer supported cooperative work*, pages 209–218, 1996.

[15] T. Berners-Lee and M. Fischetti. *Weaving the Web: The original design and ultimate destiny of the World Wide Web by its inventor*. Harper San Francisco, 1999.

[16] Borchorst, N.G. and Bødker, S. and Zander, P-O. The boundaries of participatory citizenship. In *ECSCW 2009: Proceedings of the 11th European Conference on Computer Supported Cooperative Work, 7-11 September 2009, Vienna, Austria*, page 1. Springer, 2009.

[17] Susan L. Bryant, Andrea Forte, and Amy Bruckman. Becoming wikipedian: transformation of participation in a collaborative online encyclopedia. In *GROUP '05: Proceedings of the 2005 international ACM SIGGROUP conference on Supporting group work*, pages 1–10, New York, NY, USA, 2005. ACM Press.

[18] N.R. Budhathoki, B.C. Bruce, and Z. Nedovic-Budic. Reconceptualizing the role of the user of spatial data infrastructure. *GeoJournal*, 72(3):149–160, 2008.

[19] S. Carmody, W. Gross, T.H. Nelson, D. Rice, and A. van Dam. A hypertext editing system for the/360. *Pertinent concepts in computer graphics: proceedings*, page 291, 1969.

[20] John M. Carroll. Human computer interaction (hci), 2009.

[21] World Wide Web Consortium. Web Accessibility Initiative (WAI), 2011. [On-Line; accessed 2011-01-12] `http://www.w3.org/WAI/`.

[22] J.W. Creswell and V.L.P. Clark. *Designing and conducting mixed methods research*. Sage Publications, Inc, 2007.

[23] A. Dieberger. Supporting social navigation on the World Wide Web. *International Journal of Human-Computers Studies*, 46(6):805–825, 1997.

[24] A. Dieberger, P. Dourish, K. Höök, P. Resnick, and A. Wexelblat. Social navigation: techniques for building more usable systems. *Interactions*, 7(6):36–45, 2000.

[25] C. Doctorow. *Content: Selected essays on technology, creativity, copyright, and the future of the future*. Tachyon Publications, 2008.

[26] P. Dourish, A. Adler, V. Bellotti, and A. Henderson. Your place or mine? Learning from long-term use of Audio-Video communication. *Computer Supported Cooperative Work (CSCW)*, 5(1):33–62, 1996.

[27] P. Dourish and S. Bly. Portholes: supporting awareness in a distributed work group. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 541–547, 1992.

[28] P. Dourish and M. Chalmers. Running Out of Space: Models of Information Navigation. *Short paper presented at HCI*, 94, 1994.

[29] S. Elwood. Grassroots groups as stakeholders in spatial data infrastructures: challenges and opportunities for local data development and sharing. *International Journal of Geographical Information Science*, 22(1-2):71–90, 2008.

[30] S. Elwood. Volunteered geographic information: future research directions motivated by critical, participatory, and feminist GIS. *GeoJournal*, 72(3):173–183, 2008.

[31] S. Elwood. Volunteered geographic information: key questions, concepts and methods to guide emerging research and practice. *GeoJournal*, 72(3):133–135, 2008.

[32] D.C. Engelbart and W.K. English. A research center for augmenting human intellect. In *Proceedings of the December 9-11, 1968, fall joint computer conference, part I*, pages 395–410. ACM, 1968.

[33] G. Evans. Accessibility, Urban Design and the Whole Journey Environment. *Built Environment*, 35(3):366–385, 2009.

[34] L. Festinger. *A theory of cognitive dissonance*. Stanford Univ Pr, 1957.

[35] G. Fischer. Communities of Interest: Learning through the Interaction of Multiple Knowledge Systems. In *24th Annual Information Systems Research Seminar In Scandinavia (IRIS'24), Ulvik, Norway*, pages 1–14, 2001.

[36] G. Fischer. External and shareable artifacts as opportunities for social creativity in communities of interest. *Computational and Cognitive Models of Creative Design V (Heron Island'01)*, pages 67–89, 2001.

[37] A.J. Flanagin and M.J. Metzger. The credibility of volunteered geographic information. *GeoJournal*, 72(3):137–148, 2008.

[38] B. Flyvbjerg. Five misunderstandings about case-study research. *Qualitative Inquiry*, 12(2):219, 2006.

[39] BJ Gleeson. Disability studies: a historical materialist view. *Disability & Society*, 12(2):179–202, 1997.

[40] Víctor M. González, Mónica E. Tentori, Elisa B. Morán, Jesús Favela, and Ana I. Martínez. Understanding mobile work in a distributed information space: implications for the design of ubicomp technology. In *CLIHC '05: Proceedings of the 2005 Latin American conference on Human-computer interaction*, pages 52–63, New York, NY, USA, 2005. ACM Press.

[41] M.F. Goodchild. Citizens as sensors: the world of volunteered geography. *GeoJournal*, 69(4):211–221, 2007.

[42] M.F. Goodchild. Citizens as sensors: web 2.0 and the volunteering of geographic information. *GeoFocus (Editoral)*, 7:8–10, 2007.

[43] M.F. Goodchild. Commentary: whither VGI? *GeoJournal*, 72(3):239–244, 2008.

[44] J. Grudin. The computer reaches out: the historical continuity of interface design. In *Proceedings of the SIGCHI conference on Human factors in computing systems: Empowering people*, page 268. ACM, 1990.

[45] J. Grudin. Computer-supported cooperative work: History and focus. *Computer*, 27(5):19–26, 1994.

[46] J. Grudin. Three Faces of Human–Computer Interaction. *IEEE Annals of the History of Computing*, pages 46–62, 2005.

[47] J. Grudin. Enterprise knowledge management and emerging technologies. In *Hawaii International Conference On System Sciences*, volume 39, page 57. IEEE Computer Society, 2006.

[48] Jonathan Grudin. Groupware and social dynamics: eight challenges for developers. *Commun. ACM*, 37(1):92–105, 1994.

[49] Jonathan Grudin. Group dynamics and ubiquitous computing. *Commun. ACM*, 45(12):74–78, 2002.

[50] Mordechai (Muki) Haklay and Patrick Weber. Openstreetmap: User-generated street maps. *Pervasive Computing, IEEE*, 7(4):12–18, Oct.-Dec. 2008.

[51] A.H. Hallett, European Commission. Directorate-General for Economic, and Financial Affairs. *Coordination without explicit cooperation: monetary-fiscal interactions in an era of demographic change*. European Commission, Directorate-General for Economic and Financial Affairs, 2008.

[52] S. Harrison, D. Tatar, and P. Sengers. The three paradigms of HCI. *Proceedings of Alt. CHI*, 2007.

[53] Steve Harrison and Paul Dourish. Re-place-ing space: the roles of place and space in collaborative systems. In *CSCW '96: Proceedings of the 1996 ACM conference on Computer supported cooperative work*, pages 67–76, New York, NY, USA, 1996. ACM.

[54] P.O. Hedvall. Towards the Era of Mixed Reality: Accessibility Meets Three Waves of HCI. In *HCI and Usability for E-Inclusion: 5th Symposium of the Workgroup Human-Computer Interaction and Usability Engineering of the Austrian Computer Society, USAB 2009, Linz, Austria, November 9-10, 2009, Proceedings*, pages 264–278. Springer-Verlag New York Inc, 2009.

[55] J.L. Herlocker, J.A. Konstan, L.G. Terveen, and J.T. Riedl. Evaluating collaborative filtering recommender systems. *ACM Transactions on Information Systems (TOIS)*, 22(1):5–53, 2004.

[56] William C. Hill, James D. Hollan, Dave Wroblewski, and Tim McCandless. Edit wear and read wear. In *CHI '92: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 3–9, New York, NY, USA, 1992. ACM.

[57] S. Hirtle, K.F. Richter, S. Srinivas, and R. Firth. This is the tricky part: When directions become difficult. *Journal of Spatial Information Science*, 1(1):53–73, 2011.

[58] Håkon Arneng Holmstedt. Experience augmented pedestrian wayfinding. Master's thesis, Østfold University College, 2007.

[59] H. Holone and J. Herstad. Social software for accessibility mapping: challenges and opportunities. In *Unitech 2010, Oslo, Norway*. Tapir Forlag, 2010.

[60] H. Holone and G. Misund. People Helping Computers Helping People: Navigation For People With Mobility Problems By Sharing Accessibility Annotations. In *ICCHP*. Springer, 2008.

[61] H. Holone, G. Misund, and H. Holmstedt. Users are doing it for themselves: Pedestrian navigation with user generated content. In *Next Generation Mobile Applications, Services and Technologies, 2007. NGMAST '07*, pages 91–99, Sept. 2007.

[62] H. Holone, G. Misund, H. Tolsby, and S. Kristoffersen. Aspects of personal navigation with collaborative user feedback. In *Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges*, pages 182–191. ACM New York, NY, USA, 2008.

[63] Harald Holone. Retrospective Altruism and Transient Cooperation in Accessibility Mapping. In *Travel Health Informatics and Telehealth,*

EFMI Special Topic Conference, Antalya, Turkey 2009. European Federation of Medical Informatics, 2009.

[64] Harald Holone and Jo Herstad. Negotiating privacy boundaries in social applications for accessibility mapping. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*, NordiCHI '10, pages 217–225, New York, NY, USA, 2010. ACM.

[65] A. Holt. Coordination technology and petri nets. *Advances in Petri Nets 1985*, pages 278–296, 1985.

[66] A.C. Kay. *The reactive engine*. PhD thesis, The University of Utah, 1969.

[67] P. Korn, E. Bekiaris, and M. Gemou. Towards Open Access Accessibility Everywhere: The ÆGIS Concept. *Universal Access in Human-Computer Interaction. Addressing Diversity*, pages 535–543, 2009.

[68] M. Kramer, A. Gregorowicz, and B. Iyer. Wiki trust metrics based on phrasal analysis. In *WikiSym 4rd Intl Symposium on wikis*, 2008.

[69] A. Krowne and A. Bazaz. Authority models for collaborative authoring. *System Sciences, 2004. Proceedings of the 37th Annual Hawaii International Conference on*, pages 18–24, 2004.

[70] J. Lave and E. Wenger. *Situated learning: Legitimate peripheral participation*. Cambridge University Press, 1991.

[71] R. Ling and B. Yttri. Hyper-coordination via mobile phones in Norway. *Perceptual contact: Mobile communication, private talk, public performance*, 2002.

[72] Pamela J. Ludford, Reid Priedhorsky, Ken Reily, and Loren Terveen. Capturing, sharing, and using local place information. In *CHI '07: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 1235–1244, New York, NY, USA, 2007. ACM.

[73] P. Luff and C. Heath. Mobility in collaboration. *Proceedings of the 1998 ACM conference on Computer supported cooperative work*, pages 305–314, 1998.

[74] M. Lynne Markus. Power, politics, and MIS implementation. *Communications of the ACM*, 26(6):430–444, 1983.

[75] D.R. Millen. Rapid ethnography: time deepening strategies for HCI field research. In *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*, page 286. ACM, 2000.

[76] G. Misund and M. Lindh. Annotating mobile multimedia messages with spatiotemporal information. *Journal of Geographic Information Sciences*, 2005.

[77] L.N. Mummidi and J. Krumm. Discovering points of interest from users' map annotations. *GeoJournal*, 72(3):215–227, 2008.

[78] B.A. Myers. A brief history of human-computer interaction technology. *interactions*, 5(2):44–54, 1998.

[79] Brad Myers, Jim Hollan, Isabel Cruz, Steve Bryson, Dick Bulterman, Tiziana Catarci, Wayne Citrin, Ephraim Glinert, Jonathan Grudin, and Yannis Ioannidis. Strategic directions in human-computer interaction. *ACM Comput. Surv.*, 28(4):794–809, 1996.

[80] M.D. Myers and D. Avison. An introduction to qualitative research in information systems. In *Qualitative Research in Information Systems - A Reader*. Sage, 2002.

[81] The United Nations. Convention on the Rights of Persons with Disabilities, 2006. [On-Line; accessed 2011-01-12] `http://www.un.org/disabilities/convention/conventionfull.shtml`.

[82] O. Nov. What motivates wikipedians? *Communications of the ACM*, 50(11):64, 2007.

[83] L. Palen and P. Dourish. Unpacking" privacy" for a networked world. *Proceedings of the conference on Human factors in computing systems*, pages 129–136, 2003.

[84] Reid Priedhorsky, Jilin Chen, Shyong (Tony) K. Lam, Katherine Panciera, Loren Terveen, and John Riedl. Creating, destroying, and restoring value in wikipedia. In *GROUP '07: Proceedings of the 2007 international ACM conference on Supporting group work*, pages 259–268, New York, NY, USA, 2007. ACM.

[85] O.W. Rahlff, R. Kenneth Rolfsen, and J. Herstad. Using personal traces in context space: Towards context trace technology. *Personal and Ubiquitous Computing*, 5(1):50–53, 2001.

[86] P. Resnick, N. Iacovou, M. Suchak, P. Bergstrom, and J. Riedl. GroupLens: an open architecture for collaborative filtering of netnews. *Proceedings of the 1994 ACM conference on Computer supported cooperative work*, pages 175–186, 1994.

[87] H. Rheingold. *Smart mobs: The next social revolution*. Basic Books, 2003.

[88] K. Schmidt and L. Bannon. Taking CSCW seriously. *Computer Supported Cooperative Work (CSCW)*, 1(1):7–40, 1992.

[89] K. Schmidt and T. Rodden. Putting it all together: Requirements for a CSCW platform. *HUMAN FACTORS IN INFORMATION TECHNOLOGY*, 12:157–176, 1996.

[90] K. Schmidt and C. Simonee. Coordination mechanisms: Towards a conceptual foundation of CSCW systems design. *Computer Supported Cooperative Work (CSCW)*, 5(2):155–200, 1996.

[91] Kjeld Schmidt. The problem with 'awareness': Introductory remarks on 'awareness in cscw'. *Computer Supported Cooperative Work (CSCW)*, 11:285–298, 2002. 10.1023/A:1021272909573.

[92] Kjeld Schmidt and Carla Simone. Mind the gap! towards a unified view of cscw. In *In The Fourth International Conference on the Design of Cooperative Systems COOP*, pages 23–26. IOS Press, The, 2000.

[93] C. Shirky. *Here Comes Everybody: The power of organizing without organizations*. New York: Penguin Press, 2008.

[94] D. Silverman. *Doing qualitative research: A practical handbook*. Sage Publications Ltd, 2005.

[95] H.A. Simon. A behavioral model of rational choice. *The quarterly journal of economics*, 69(1):99, 1955.

[96] M.M. Skeels and J. Grudin. When social networks cross boundaries: a case study of workplace use of facebook and linkedin. In *Proceedings of the ACM 2009 international conference on Supporting group work*, pages 95–104. ACM New York, NY, USA, 2009.

[97] I. Smith, S. Consolvo, J. Hightower, J. Hughes, G. Iachello, A. LaMarca, J. Scott, T. Sohn, and G. Abowd. Social Disclosure of

Place: From Location Technology to Communication Practice. *Proceedings of International Conference on Pervasive Computing (Pervasive)*, 2005.

[98] A. Ståhl, G. Carlsson, P. Hovbrandt, and S. Iwarsson. "Let's go for a walk!": identification and prioritisation of accessibility and safety measures involving elderly people in a residential area. *European Journal of Ageing*, 5(3):265–273, 2008.

[99] S.L. Star and J.R. Griesemer. Institutional Ecology,'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, 19(3):387–420, 1989.

[100] L.A. Suchman. *Plans and situated actions: The problem of human-machine communication*. Cambridge Univ Pr, 1987.

[101] Lucy Suchman. Making work visible. *Commun. ACM*, 38(9):56–ff., 1995.

[102] B. Suh, E.H. Chi, A. Kittur, and B.A. Pendleton. Lifting the veil: improving accountability and social transparency in Wikipedia with wikidashboard. In *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*, pages 1037–1040. ACM, 2008.

[103] D.Z. Sui. The wikification of GIS and its consequences: Or Angelina Jolie's new tattoo and the future of GIS. *Computers, Environment and Urban Systems*, 32(1):1–5, 2007.

[104] I.E. Sutherland. Sketch pad a man-machine graphical communication system. In *Proceedings of the SHARE design automation workshop*, pages 6–329. ACM, 1964.

[105] W. t. Balke, W. Kießling, and C. Unbehend. Personalized services for mobile route planning: A demonstration. In *In Proceedings of the Int. Conf. on Data Engineering (ICDE 2003*. IEEE Computer Society Press, 2003.

[106] L. Terveen and W. Hill. Beyond Recommender Systems: Helping People Help Each Other. *HCI in the New Millennium. Addison Wesley*, 2001.

[107] HJ Titheridge, R. Mackett, and K. Achuthan. From footway design to the street environment: removing the barriers to walking. In *Proceedings of the 10th International Conference on Walking and Liveable Communities*, 2009.

[108] D.L. Tulloch. Is VGI participation? From vernal pools to video games. *GeoJournal*, 72(3):161–171, 2008.

[109] The European Union. Riga Ministerial Declaration, 2006. [On-Line; accessed 2011-01-12] `http://ec.europa.eu/information_society/events/ict_riga_2006/doc/declaration_riga.pdf`.

[110] The European Union. i2010 - A European Information Society for growth and employment, 2007. [On-Line; accessed 2011-01-12] `http://www.un.org/disabilities/convention/conventionfull.shtml`.

[111] M. van der Velden. Design for a common world: On ethical agency and cognitive justice. *Ethics and Information Technology*, 11(1):37–47, 2009.

[112] F.B. Viégas, M. Wattenberg, and K. Dave. Studying cooperation and conflict between authors with history flow visualizations. *Proceedings of SIGCHI*, pages 575–582, 2004.

[113] T. Völkel. Personalized and adaptive navigation based on multimodal annotation. *ACM SIGACCESS Accessibility and Computing*, 1(86):4–7, 2006.

[114] T. Völkel, R. Kühn, and G. Weber. Mobility impaired pedestrians are not cars: Requirements for the annotation of geographical data. In *Proceedings of the International Conference on Computers Helping People with Special Needs (ICCHP'08)*, pages 1085–1092. Springer, 2008.

[115] T. Völkel and G. Weber. A New Approach for Pedestrian Navigation for Mobility Impaired Users Based on Multimodal Annotation of Geographical Data. *LECTURE NOTES IN COMPUTER SCIENCE*, 4555:575, 2007.

[116] T. Völkel and G. Weber. RouteCheckr: personalized multicriteria routing for mobility impaired pedestrians. In *Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility*, pages 185–192. ACM, 2008.

[117] G. Walsham. Interpretive case studies in IS research: nature and method. *European Journal of Information Systems*, 4(2):74–81, 1995.

[118] G. Walsham. The emergence of interpretivism in IS research. *Information systems research*, 6(4):376–394, 1995.

[119] E. Wenger. *Communities of Practice: learning, meaning, and identity*. Cambridge University Press, 1999.

[120] Alan Wexelblat and Pattie Maes. Footprints: history-rich tools for information foraging. In *CHI '99: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 270–277, New York, NY, USA, 1999. ACM.

[121] F. Winberg. Supporting Cross-Modal Collaboration: Adding a Social Dimension to Accessibility. In *Proceedings of Haptic and audio interaction design: first international workshop, HAID 2006, Glasgow, UK, August 31-September 1, 2006*, pages 102–110. Springer-Verlag New York Inc, 2006.

[122] X.M. Zhang and F. Zhu. Intrinsic motivation of open content contributors: The case of wikipedia. In *Workshop on Information Systems and Economics*, 2006.

APPENDIX A

NGMAST 2007

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Users Are Doing It For Themselves: Pedestrian Navigation With User Generated Content

Harald Holone, Gunnar Misund and Håkon Holmstedt
Østfold University College
Mobile Applications Group
Halden, Norway
{harald.holone, gunnar.misund, hakon.a.holmstedt}@hiof.no

Abstract

Route planning has over the few past years become common in the context of driving cars and other vehicles. However, with the advent of powerful mobile devices, such as smart-phones, systems helping pedestrians finding their way in complex urban environments have emerged. We present a prototype system for mobile pedestrian navigation, called OurWay*, based on user generated maps and collaborative annotations of network segments. We are particularly concerned with users with various permanent or temporary disabilities, like wheelchair users, or parents pushing baby strollers. By letting users rate the accessibility of locations, the system will compute bespoke routes matching their abilities and preferences. We explore the potential of the concept through a combination of field work and lab trials, using real life data. We also demonstrate that collaboratively collected geodata has promising properties as a foundation for innovative geospatial applications. Initial results indicate that few user annotations are needed to produce good routes.*

1 Introduction

Pedestrian navigation is a challenge in complex urban structures, in particular in unfamiliar territory. For the physically impaired, like wheelchair users or parents with baby strollers, finding and following a reasonable route from one place to another may become difficult, not to say impossible, when encountering barriers like stairways, steep hills and missing sidewalks. Contrary to the related field of car navigation, with its abundance of tools, services and content providers, tools for pedestrian wayfinding are scarce. Notable exceptions can be found in Japan, where the availability and usage of pedestrian mobile route planners in larger cities, such as Tokyo [26, 17], is rapidly increasing. The reason for this, in addition to the widespread use of advanced mobile services, might be the relatively low market penetration of cars, and the comparatively high reliance on public transportation.

Pedestrian wayfinding diverges from car navigation in mainly two aspects:

- Pedestrians are not strictly bound to follow designated roads, paths and sidewalks, but may walk through parks, or take short-cuts through shopping malls. Hence, the underlying transport network becomes more complex, both to generate and to maintain.
- Pedestrians are a more heterogeneous group than car drivers, as car drivers usually are only limited by whether or not there exists a road between given waypoints. Pedestrians may be categorized according to a wide set of criteria, reflecting physical abilities and personal preferences. User profiles also depend on context: a father becomes temporarily disabled when pushing a baby stroller. Accordingly, route planning tools should be able to cope with a variety of user profiles.

Our main strategy for resolving these issues, is to turn to the users themselves. Inspired by the rapidly growing community efforts in phenomena such as wikis, media sharing services and open source software development, we have built a prototype system, called *OurWay*, that enables pedestrians to grade road segments with regards to accessibility, for subsequent use in route planning. Using this mechanism, knowledgeable users, for example people that live and spend time in a particular area, can create feedback and essentially map out their neighborhood. Using this mechanism, users, can draw upon each other's knowledge to quickly find the better paths through town.

We have also leveraged principles and tools for collaborative mapping, by using the OpenStreetMap [22] infrastructure to build the underlying geographic network. The

users generate the content in the field by using off-the-shelf mobile devices, such as smartphones and Bluetooth GPSs.

The purpose of the paper is twofold. First, we want to explore, on a proof-of-concept basis, how members of a group could benefit from using a collaborative system, such as OurWay, to find good routes in urban environments. Second, we will use this case to demonstrate the potential of user generated mobile content, as the geographic network of streets, sidewalks and paths, along with the individual ratings of accessibility, is built by collaborative efforts in the field, and shared among all users.

In the next section we briefly review a selection of related work. The OurWay prototype is presented in Section 3, and results from the preliminary experiments are given in Section 4. We discuss our findings and propose modifications and extensions of our concept in Section 5, before giving some final remarks in Section 6.

2 Related Work

Route planning for pedestrians is emerging from where classic vehicle routing meets the increased power and versatility of mobile devices. Early commercial efforts include the pioneering DoCo-Navi [26] and the later KDDI's EZ Navi Walk [17]. Karimanzira et al. [15] have looked at using machine learning techniques to generate routes tailored for disabled pedestrians, although the majority of the work in the field has been aimed towards tourist guides and similar [14].

Personalized route planning means that the route planner adapts to the user's specific needs and desires, such as Balke et al.'s prototype [3]. Kawabata et al. propose a context dependent metadata layer over the physical space to generate optimal routes according to the users' preferences [16]. Wuersch and Caduff point out that pedestrians are not confined to the underlying network of streets and sidewalks, but may use open areas like parks and squares. As a consequence, they explore aspects of treating routes as a sequence of waypoints [28].

Collaborative route planning is a variation of personalized route planning that has received little attention from researchers, although research into collaboration in recommender systems has matured (such as [11]). Still, some headway has been made using multiple agents sharing experiences to create a distributed case based reasoning system [20]. Others have looked at collaboration through users offering each other clues, either through direct participation [6] or more indirectly through photographs in geoannotated wikis [5].

To personalize routes, one must somehow capture the user's preferences. Haigh et al. suggest letting users rate routes using an *efficiency* β value to decide whether to reuse old solutions or explore new territory [10], while Akasaka and Onisawa have looked at using fuzzy measures to capture users' preferences, and assign roads sets of attributes based on detailed user input [1, 2]. Rogers and Langley, however, point out that an explicit user model may be too costly to develop and give too few assurances of accuracy to be worthwhile [23]. Examples of explicit pedestrians models are found in [24] and references therein.

Level-of-service (LOS) is a common term in transportation planning and research, and describes systems and methods for modeling suitability, efficiency and other aspects of vehicle transportation. The LOS concept has also been applied to pedestrian domains. Unfortunately, due to regional variations and lack of standards, pedestrian LOS frameworks differ substantially, as evident when comparing for instance the work reported in [19] (US) and [9] (Australia).

In the *MAGUS* project, a comprehensive LOS model for wheelchair users is developed, based on questionnaires, interviews, observations and physical measurements of starting and rolling resistance [4]. The final system is a GIS application, aiming to assist new users and enable better navigation for existing users, and as a means for planners. However, Sobek and Miller point out that the detailed LOS model would be extremely costly to establish and maintain, and that the application requires too much time from the users [25]. MAGUS is implemented with an expensive and proprietary GIS system, and they are of the opinion that this may further limit the practicality of the application.

Based on these observations, Sobek and Miller present an alternative system for route planning for disabled pedestrians, called *U-Access*. They propose simplified models of both level-of-service and users, claiming that this still generate good results. The implementation of the concept is web based, and leverages open geodata standards, thus providing access for users without specialized and expensive software.

In our work we propose an even simpler approach. First, we allow the users to organize themselves based on self-identification, creating groups we can assume share abilities and preferences. Second, we let the users collaboratively generate a simple LOS model based on shared user annotations. Finally, we leverage open standards and open geodata, and implement the prototype as a modular system with open source components.

3 The OurWay Prototype

We have developed a prototype to explore our concept of collaborative pedestrian route planning [12]. The OurWay system is a loose coupling of server and client-side components communicating over the HTTP protocol and exchanging XML formatted data. Figure 1 shows the basic architecture of the system.

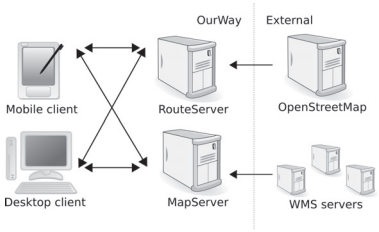


Figure 1: OurWay architecture

3.1 Implementation

OurWay is comprised of two clients and two servers.

Clients The two clients are nearly identical; One is implemented on a smartphone/PDA device, running the Windows Mobile 5 operating system, the other as a desktop C# based application. Their main functionality is to provide a map based user-interface for route planning and user rating of the quality of the streets, sidewalks and paths. In addition, both clients allow the user to create new segments for the underlying geographic network, either semi-automatically by GPS tracking, or manually by drawing on the map.

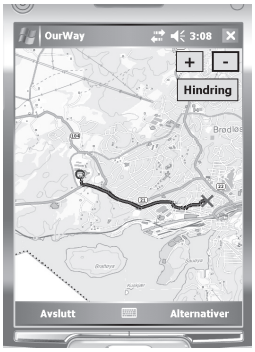


Figure 2: Screenshot of OurWay prototype, running in an emulator

A screenshoot from the mobile client is shown in Figure 2. The buttons labeled plus and minus zoom in and out of the map, while the third button lets the user report feedback. Most other functionality is available throught the two menues at the bottom of the screen. Note that the GUI has not been the focus of this project, and we have therefore not applied any HCI techniques to its design.

Servers The two servers are responsible for providing maps and calculating routes, respectively, in addition to administrative services. The map server is implemented in PHP, while the route server is a Java Servlet.

The Map Server's task is to deliver background maps to the clients, in the form of image tiles. The server transforms the map requests into appropriate calls to a specified geodata provider. We use the Web Map Service (WMS) protocol, initially developed by the Open Geospatial Consortium, and an international standard (ISO) since 2005 [8]. By leveraging this widely used specification, the server can access any WMS based map provider, without changing the implementation.

To reduce the number of WMS calls and speed up delivery, the server maintains a local tile cache based on the clients' positions. In our case, we used both aerial imagery and topographic maps.

The Route sERVER is responsible for calculating and delivering routes based on the supplied user group, start point, and end point. It delivers the routes as an ordered list of geographic points. It also handles ratings from users and assigns these to the relevant edges in the road network during the route calculation. The underlying geometric network is imported from the OpenStreetMap (OSM) server. We explain the route calculation process in some detail in the following section.

3.2 Route Calculation With User Ratings

The central collaborative feature of our prototype application is the rating of accessibility of geographic areas, and the sharing of these ratings inside user groups. Users are able to change groups at any point, and create new groups if they wish. In the current implementation, user groups do not share information, even if the user groups have similar needs.

Users can rate the network used for route planning by pointing out good, bad, or inaccessible points along a route. For instance, if a wheelchair-user comes across a stretch of road where he must get off the sidewalk to circumvent an obstacle, he could mark this point as bad. Even worse, if the wheelchair-user is lead up a road that is simply too steep for him, he could mark the spot inaccessible, and the route planner would never again attempt to route a wheelchair user up that road.

User feedback causes roads to appear shorter or longer than they really are, by applying weights to the corresponding edges in the underlying road graph. This way, the search algorithm will attempt to avoid stretches of road that have received negative feedback. Roads marked as inaccessible will appear prohibitively long and thus never be used by the route planner.

The user feedback is represented as floating point weights. When a route is calculated, an edge in the network is assigned a value equal to its geographic length multiplied

with any prevailing user feedback assigned to it. Currently, the most negative feedback an edge has been given is the one that is used, although other modes can be imagined, like having the last feedback count, or calculating some average between all user feedbacks.

We have chosen the three weights 0.5, 4.0, and 42000.0. We arrived at the first two weights through informal experimentation, where we found that these worked well for us. The final weight is an arbitrarily large number that effectively renders a road untraversable.

For the purpose of route planning, we consider an edge to be a stretch of road or path or otherwise between two intersections, such that the stretch itself does not contain any intersections. This means that the geometry of the road is not considered when creating the graph of the map, only the topology. Furthermore, it means that negative user feedback offered at the bottom of a very long, winding path up a hill, will make the hill nigh insurmountable, while similar negative feedback for a short road in an urban setting will have a much smaller effect.

The actual search algorithm is the classic A* algorithm for finding an optimal route through a network.

4 Prototype Evaluation

The OurWay prototype was evaluated in an incremental study where we simulated users interacting with the system while we observed the behavior of the prototype. We limited the study to one single user group: normally fit parents with baby strollers. This study was an initial proof-of-concept exercise, focusing mainly on technical aspects.

The study was split into three parts. We first created the geographic network we would use for route planning by gathering map data using the OpenStreetMap infrastructure, as explained in the next section. Then we engaged in a field test, before carrying out systematic lab trials.

4.1 Street Map

The OurWay framework relies on a detailed map of available roads, sidewalks and paths. The clients provide functionality for adding new nodes and edges, however, this is primarily intended for minor updates. Hence, in a practical situation, the system has to be bootstrapped with an initial map with a reasonable level of detail.

However, developing and experimenting with applications depending on real life geospatial data is not trivial. Access to geodata is often expensive[1], and sometimes complicated and cumbersome, due to for instance inefficient distribution systems and problems with interpreting formats and converting data. In particular, the challenge may become overwhelming when trying to integrate data from multiple sources in one single application.

These problems are widely recognized, and several initiatives have emerged to deal with them. On an interoperability level, the perhaps most prominent effort is the Open Geospatial Consortium, which has developed and promoted a family of specifications, some of which have become ISO standards (see e.g., [18] and references therein for details on semantics and interoperability of geodata).

On a content level, the Digital Chart Of The World (DCW), published by United States Defense Mapping Agency (DMA) in 1992 [7], has been, and still is, the most comprehensive dataset with global coverage. The Global Mapping Project is working on product similar to DCW, free for non-commercial use. It is a joint effort, with contributions from national mapping agencies [21].

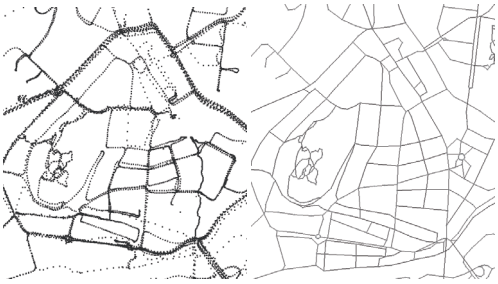
However, the mentioned open sources provide data on coarse scales, typically 1:1 million, and is unusable for applications dealing with street level problems. During the past years, many initiatives in collaborative content generation, often in the form of wikis, have emerged. The most outstanding example is Wikipedia, which from its start in 2001 has grown from a modest experiment to a highly respected and frequently cited information source on a global scale, outrivalling many traditional encyclopedias.

The Wikipedia concept has as a parallel in the geospatial domain, the OpenStreetMap (OSM) project [22], founded in 2004. OSM provides a complete infrastructure supporting collaborative map making on a global scale, including tools for mobile data acquisition, editing applications, administrative and storage services and browsing and downloading facilities. The OSM data is distributed under a Creative Commons license, which in practice allows any kind of use, as long as OSM is attributed, and that new products are shared under the same conditions.

At the time of writing, OSM has approximately 7500 contributing users, and close to 70 million uploaded GPS points. Several areas and cities, in particular in Great Britain, have reached a coverage making the data usable in various kinds of applications. As an example, the Britain based property search engine Nestoria is providing OSM content as an alternative to Google maps.

For the reasons stated above, OSM became the data provider of choice in the OurWay project. Our main test area was Halden, a small town in Southern Norway, with a population of around 28000. When starting the project, the OSM coverage of Halden was not complete. The authors and a couple of students undertook the task of supplementing the network. We used both GPS tracking, with cars, bikes, and on foot, and tracing on top of high resolution aerial imagery, provided by the local municipality. Figure 3 illustrates the mapping process. The resulting geographic network is a relatively complete map of downtown Halden

[1] A notable exception is US geodata, which, due to legislation on public sector information, is freely available for usage in most applications.



(a) GPS tracks (b) Final geographic network

Figure 3: Mapping Halden the OSM way

(approx. 2 km^2).

The OSM infrastructure provides functionality for categorization of the road networks, in order to enable applications to distinguish between for instance foot paths and highways. However, the OurWay server discard this information, thus treating all parts of the network equally. In this way, all additional information on the usability of the components of the network is provided by the users themselves as feedback in the field.

4.2 Field Work

For the field tests, the main objective was to gather experience as users of the prototype. The authors brought a PDA type smartphone with the prototype installed and a baby stroller. Using OurWay to generate routes, we pushed the stroller through the city-scape, including a fairly hard-to-navigate park with poor trails and steep climbs.

Although the researchers have substantial local knowledge of the test area, the field excursions taught us more about the precise obstacles facing people with baby strollers. We improved our understanding of the local geography and gained some insight into what sort of obstacles would matter to the baby strolling user group.

During the tests, we learned that as a user, it was reasonable to distinguish between only three kinds of accessibility: what was uncomfortable, what was completely inaccessible, and what was experienced as good. The first category would include anything where we felt it was uncomfortable to maneuver. This could include steep climbs as well as roads with poor or confusing sidewalks. By inaccessible, we meant places we were forced to carry the baby stroller, or roads that lacked sidewalks altogether. Positive feedback was given when we came across places we experienced as a relief from the roads around, or where it was especially easy to maneuver.

Further, the field tests provided insight into how to estimate the values of the weights associated with the three categories. Conceptually, these weights are supposed to reduce or increase the actual distances in order to reflect the users' positive and negative experiences. After some trial and error, we decided on the weights 0.5 for a good review, 4.0 for uncomfortable areas, and 42000.0 for an inaccessible point. Estimating parameters like this is notoriously difficult, however, these values yielded satisfactory results in our tests.

An obvious question to ask is under what circumstances users will find themselves motivated to annotate their environment. In a parallel study, we have started to look into different aspects of motivation for use and contribution to this kind of system [13]. Preliminary findings indicate that people are more likely to react to and annotate negative experiences, thus possibly leading to less use of the "good" category of feedback. Further, within some groups, such as those organized in associations for physically disabled, the shared goal of universal access can be a strong motivational factor. Ensuring system trust and information trust is another topic which is key to motivate use of such a navigational tool.

4.3 Lab Trials

The final part of the study was performed in the lab where we used the desktop version of the route planner. Apart from being a technical system test, the main objective was to study how user feedback affected the quality of the proposed routes.

We performed a set of tasks, where we simulated finding and following routes between two waypoints, and giving feedback during the "walks". The simulated user was supposed to belong to a user group with normally fit persons pushing baby strollers.

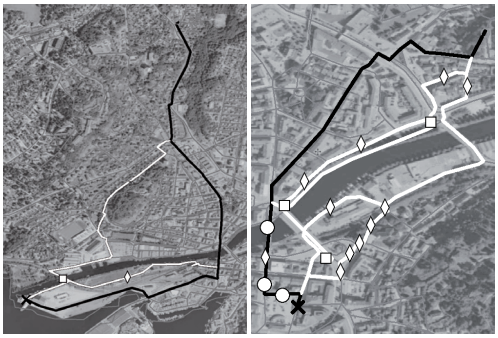
During each task, we performed a number of iterations, where a route between the given waypoints was generated, based on existing user feedback. We then "walked" the route, and used our local knowledge of the geography and the experience garnered earlier to identify and report comfortable, uncomfortable and inaccessible areas.

The first iteration of each task was carried out with a neutral network, i.e., one that had not received any prior user feedback. We stopped the iterations when there were no need for more feedback, in other words, when the process converged on a stable solution.

4.3.1 Results

The following results are drawn from experimenting with four navigation tasks. The trips were estimated to be in the range of ten to thirty minutes pushing a stroller at normal speed. The area covered included pedestrian streets, paths

in parks and sidewalks on local and regional highways. In the following we describe each case in some detail.



(a) Task 1 (b) Task 2

Figure 4: Final routes (black) and intermediate routes (white). Inaccessible, inconvenient and good spots are marked with squares, diamonds and circles, respectively. OpenStreetMap network (thin gray lines). Background aerial imagery courtesy of Halden Municipality.

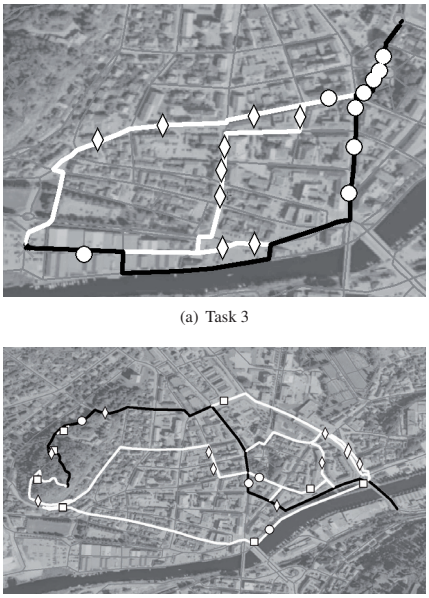
Task 1 The trip starts in a residential area, crosses the town center and ends up in the harbor area. Tista river has to be crossed, see Figure 4(a). The first proposed route mainly follows sidewalks and footways down to the shopping area at the river bank, and then uses a path leading to a bridge that is too narrow for a stroller. Hence, this part of the route is rated inaccessible.

The next route uses another bridge, designated for bikes and pedestrians, resulting in a slightly longer route. It follows a rather cumbersome footway along the river out to the harbor, and this segment is rated uncomfortable.

In the final iteration, the last leg of the route follows sidewalks and crosses open harbor areas. Interestingly, this route is identical to one frequently used by one of the authors. The solution converged after three iterations, including feedback consisting of only two ratings, one on an inaccessible segment, and one on an uncomfortable path.

Task 2 This is a typical 10 minutes walk, from the town square on the south side of the river, to the Porsnes highschool on the other side of the river. The ground between the two waypoints is quite heterogeneous, from dedicated footways to industrial areas and busy streets with sidewalks, as seen in Figure 4(b). To reach a satisfactory route, we made five iterations, with 16 feedbacks, three inaccessible stretches, eleven bad segments and two good parts.

Task 3 This trip is also fairly short, from one shopping mall to another, in a relatively homogeneous mixed shopping/residential city area, with no major obstacles. A good solution was achieved after three iterations. No inaccessible areas were identified, however five segments were rated comfortable, and nine stretches were considered uncomfortable. See Figure 5(a) for details.



(a) Task 3

(b) Task 4

Figure 5

Task 4 This is the most challenging case, estimated 20 minutes through a highly diversified area. It starts in a park with a labyrinth of dirt paths, continues through residential and shopping areas and crosses a regional highway and the river. There are many potentially inaccessible constructs, such as stairways and narrow footpaths in uneven terrain. Not surprisingly, this case needed more iterations to converge than the other tasks. After eight passes, eight reported major obstacles, ten uncomfortable parts and two good ratings, an acceptable route emerged. However, the final solution included one bad segment, marked in the first iteration. The intermediate solutions varied substantially, probing rather a large area all together, as seen in Figure 5(b).

To further analyze the test results, we introduce the *penalty factor*, which is the ratio between a given route between two waypoints and the shortest path computed without user feedback. The penalty factor reflects the additional cost of choosing an alternative route to avoid obstacles and

unpleasant stretches. Table 1 shows how the penalty factor increases over the iterations in each of the four tasks.

	Iterations							
Task	1	2	3	4	5	6	7	8
1	2554m	1.14	1.16					
2	927m	1.04	1.06	1.09	1.09			
3	770m	1.08	1.10	1.17				
4	1307m	1.07	1.10	1.10	1.10	1.10	1.11	1.12

Table 1: Penalty factor: For each task (row), we give the length in meters of the initial shortest path (first column), and then the computed factor for the following iterations.

It's worth noting that the penalty factor is a conservative measure of the overhead of choosing more comfortable alternatives, considering that avoiding obstacles and inconvenient segments may indeed yield an all together faster route. With this in mind, the penalty factors in our cases seem surprisingly low, in the worst case the best alternative is only 1.16 times longer than the shortest path without user feedback.

One reason for the low penalty factors, is that the urban test area is relatively dense with respect to the underlying network, i.e., there are many and short edges, resulting in a generous solution space, where the algorithm is able to find many alternatives that are relatively similar.

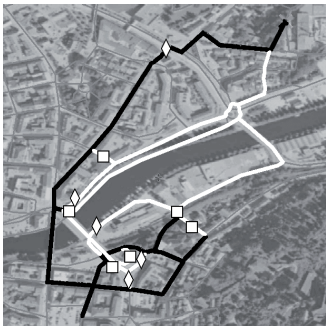


Figure 6: Navigating by trial and error. The ground covered is marked as black, and the proposed, but not used, segments are in white. Annotations are indicated as in Figure 4.

This could lead to the hypothesis that it would be easy for a newcomer to find a good route just by trial and error. To pursue this aspect, we performed an additional experiment, based on Task 2, to simulate this kind of user behavior. We started out with a neutral network, calculated an initial shortest path route, and followed the route until we found an inaccessible or uncomfortable segment. We then reported the point, and asked for a new route, from the current location to the final destination. The procedure was repeated until we reached the target. Not surprisingly, this resulted in a route with numerous backtracking elements, see Figure 6. The penalty factor reached 1.83, significantly higher than the converged route in the corresponding previous experiment (1.09).

The results will be further discussed in the following section.

5 Discussion and Future Work

We chose to carry out the initial round of field testing of the prototype ourself for a handful of reasons. It allowed us to gain first-hand experience as users, giving us valuable insight for the design of a larger study with independent users. Also, it gave us the opportunity to discuss the number of feedback levels and weighting of user feedback, both prerequisites for a larger scale study. Furthermore, as the group consisted of representatives of the case user group, we were able to realistically judge accessibility, giving our findings real value. Finally, continuing the experiments in the lab was made easier and more realistic, since we had our own experiences in mind whilst in the lab.

Our field and lab experiments have led us to several discoveries we consider worthwhile for further research, and some of these will be highlighted the following section.

5.1 Algorithmic Issues

Route distance and the number of iterations to reach route convergence are not correlated, rather the homogeneity and lack of obstacles in an area are determining factors.

It is worth mentioning that a fast convergence of a route planning iteration does not necessarily indicate a high quality route. If there are few alternative routes, a negatively rated segment might be unavoidable, as seen in Figure 5(b), where the final route takes the user through three segments rated as inconvenient. This is of course related to the choice of feedback weights, and a subject for further research.

Proper handling of multiple user feedback on road segments will be crucial to the adaptiveness of the system. In the current prototype, only the most negative feedback on a segment is considered. This leaves the system vulnerable to malicious annotations, since a more positive feedback on the same segment has no effect. Fortunately, experimenting with different ways of handling multiple user feedback is easily achieved by changing the cost function in the route planner. Inspired by wikis, one obvious alternative is to use the last feedback on a segment when calculating the adjusted length. This allows for a more dynamic network, where corrections from users have an immediate effect. This also leads to interesting issues such as edit-wars and malicious edits found in wikis .

In order to enable changes in the underlying road network, it is vital to separate user feedback from the network itself, and rather keep the feedback as point annota-

tions, associated with network segments at the time of use. Further, this separation allows for points of interest (POIs) from different sources to be integrated in the system. Objectively measured accessibility for street crossings, sidewalks, and roads could be mapped to our pragmatic user feedback model. Further, interest points such as parking spaces, toilets and shopping centers with accessibility information could be included, and allow for route planning with POIs as intermediate goals in a route.

The current prototype handles each user group separately, i.e., there is no sharing of user feedback across the groups. Also, the concept of discrete user groups is open for questioning, since there obviously are differences in perceived quality of the routes between individuals in the group. Alternative ways of handling this include dynamic user groups based on trust networks, and hierarchical groups where some feedback is considered to apply to all groups, with additional feedback within the groups. Using universal access information as a backdrop, each user group could augment and tailor the information to their specific needs.

The experiment results are achieved on a neutral network with no extra information for distinguishing car roads from sidewalks, bridges or stairs. In fact, the prototype will ignore additional metadata information even if provided. Utilizing such information could clearly impact the route planner positively, however the complexity involved in maintaining an unambiguous set of attributes, combined with the positive results of our tests makes our pragmatic approach very attractive.

5.2 Usage Patterns

It is highly likely that the users' perception of the quality of a route segment is linked with the *change* in quality, rather than the objectively measured quality at any given point. Coming from a foot path, it is easier to appreciate a paved sidewalk as good, than if the route generally consisted of paved sidewalks. For this reason, we anticipate that user feedback will tend to appear at points of change in road quality, and to a lesser degree in homogeneous stretches of road.

This is well illustrated by the special case of an inaccessible route segment, where the user will give feedback on the point where it becomes inaccessible, and not have the opportunity to explore the route beyond that point.

In a related study, we are taking on the issue of users' motivation for contributing to a system such as OurWay. Inspired by research on wikis (especially Wikipedia), we are curious to see if users will take responsibility for geographical regions, in the same way that Wikipedia contributors take responsibility for Wikipedia pages on their *watchlist* [27]. This also brings up the need for a visualization method to display changes in an area over time. The non-linearity of geotagged information makes this an interesting issue for further research.

6 Conclusion

In this paper, we presented a collaborative navigation system for pedestrians with varying physical abilities and personal preferences. The OurWay infrastructure enables users to find bespoke routes matching the specific profile of their group.

User participation plays a vital role on two levels in the system. The street network on which the route planning takes place is collaboratively created by OSM contributors. Further, user feedback on route segments makes the route planner adapt to perceived accessibility by users in distinct user groups. The feedback is immediately available for the community using the OneWay services.

Technically, we found the prototype to behave as expected, from each individual component, to the system as a whole. However, our main research objective was to explore the effect of collaboration in route planning, utilizing map making and route feedback tools.

The OpenStreetMap infrastructure enabled us to generate a complete geographic network of the test area with surprisingly small efforts. We used various techniques for creating the OSM data, from field based GPS tracking to tracing features from freely available aerial imagery.

We were able to demonstrate that a relatively small number of annotations was sufficient to generate good bespoke routes, even when starting out with a completely neutral network. This was confirmed both in the field and in our lab trials.

The preliminary findings are promising, and inspires our future work in the direction of user experience trials, studies on user motivation for contribution and use, and issues such as sharing of ratings across user group boundaries, estimation of feedback weights and integration of different data sources.

Part of our initial motivation for creating OurWay was the different requirements for navigation posed by pedestrian users as opposed to car drivers. Nevertheless, it seems obvious that the type of user involvement utilized by OurWay has numerous potential applications, including route planning for different groups of vehicle users. Letting users plan routes along attractive stretches of roads, where attractiveness is defined by a peer group seems to follow naturally from the OurWay concept.

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References

[1] Y. Akasaka and T. Onisawa. Pedestrian Navigation System Reflecting Users Subjectivity and Taste. *Proc. of Intl Conf. on Control, Automation and Systems*, pages 995–1000, 2003.

[2] Y. Akasaka and T. Onisawa. Individualized Pedestrian Navigation Using Fuzzy Measures and Integrals. *IEEE International Conference on Systems, Man and Cybernetics*, 2:1461–1466, 2005.

[3] W. Balke, W. Kießling, and C. Unbehend. Personalized Services for Mobile Route Planning: A Demonstration. *Proceedings of the 19th International Conference on Data Engineering (ICDE 2003)*, pages 771 – 773, 2003.

[4] L. Beale, K. Field, D. Briggs, P. Picton, and H. Matthews. Mapping for Wheelchair Users: Route Navigation in Urban Spaces. *The Cartographic journal*, 43(1):66–81, 2006.

[5] A. K. Beeharee and A. Steed. A Natural Wayfinding - Exploiting Photos in Pedestrian Navigation Systems. In *MobileHCI '06: Proceedings of the 8th conference on Human-computer interaction with mobile devices and services*, pages 81–88, New York, NY, USA, 2006. ACM Press.

[6] N. J. Bidwell, C. Lueg, and J. Axup. The Territory is the Map: Designing Navigational Aids. In *CHINZ '05: Proceedings of the 6th ACM SIGCHI New Zealand chapter's international conference on Computer-human interaction*, pages 91–100. ACM Press, 2005.

[7] D. M. Danko. The Digital Chart Of The World Project. *Photogrammetric engineering and remote sensing*, 58(8):1125–1128, 1992.

[8] J. de la Beaujardiere. OpenGIS Web Map Server Implementation Specification. Technical report, Open Geospatial Consortium Inc, March 2006.

[9] N. Gallin. Quantifying Pedestrian Friendliness–Guidelines for Assessing Pedestrian Level of Service. In *Conference Proceedings: Walking the 21st Century*, Perth, Australia, February 2001.

[10] K. Z. Haigh, J. R. Shewchuk, and M. M. Veloso. Exploiting Domain Geometry in Analogical Route Planning. *Journal of Experimental and Theoretical Artificial Intelligence*, 9:509–541, 1997.

[11] J. L. Herlocker, J. A. Konstan, L. G. Terveen, and J. T. Riedl. Evaluating Collaborative Filtering Recommender Systems. *ACM Trans. Inf. Syst.*, 22(1):5–53, 2004.

[12] H. A. Holmstedt. Experience augmented pedestrian wayfinding. Master's thesis, Østfold University College, 2007.

[13] H. Holone. Collaborative mapmaking: Motivations for contribution and use. To be submitted to CHI2008.

[14] C. Huijnen. Mobile tourism and mobile government - an inventory of European projects. Technical report, European Centre for Digital Communication (EC/DC), April 2006.

[15] D. Karimanzira, P. Otto, and J. Wernstedt. Application of machine learning methods to route planning and navigation for disabled people. In *MIC'06: Proceedings of the 25th IASTED international conference on Modeling, indentification, and control*, pages 366–371, Anaheim, CA, USA, January 2006. ACTA Press.

[16] M. Kawabata, R. Nishide, M. Ueda, and S. Ueshima. Graph-based Approach to Context-adaptable PNS and its Application Scenarios. In *Proceedings of the 21st International Conference on Data Engineering Workshops (ICDEW '05)*, Los Alamitos, CA, USA, 2005. IEEE Computer Society.

[17] KDDI. KDDI to launch EZ Navi Walk, a full-scale navigation service for pedestrians. [Online]. Available: `http://www.kddi.com/english/corporate/news_release/2003/1006/index.html` [Accessed March 21, 2007].

[18] W. Kuhn. Geospatial Semantics: Why, of What, and How? *J. Data Semantics III*, pages 1–24, 2005.

[19] B. Landis, V. Vattikuti, R. Ottenberg, D. McLeod, and M. Guttenplan. Modeling the Roadside Walking Environment: A Pedestrian Level of Service. *Transportation Research Record 1773*, pages 82–88, 2001.

[20] L. McGinty and B. Smyth. Shared Experiences in Personalized Route Planning. In S. M. Haller and G. Simmons, editors, *FLAIRS Conference*, pages 111–115. AAAI Press, 2002.

[21] T. Okatani, H. Maruyama, H. Sasaki, H. Yaguchi, T. Nagayama, S. Kayaba, M. Abe, and N. Kishimoto. Progress of Global Mapping Project since Johannesburg Summit in 2002. *Bulletin of the Geographical Survey Institute (ISSN 0373-7160)*, 53:7–16, 2006.

[22] OpenStreetMap. OpenStreetMap Wiki. [Online]. Available: `http://wiki.openstreetmap.org/index.php?title=About&oldid=10739` [Accessed March 22, 2007].

[23] S. Rogers and P. Langley. Personalized Driving Route Recommendations. In *Proceedings of the AAAI Workshop on Recommender Systems*, January 1998.

[24] N. Ronald, L. Sterling, and M. Kirley. A conceptual framework for specifying and developing pedestrian models. In *Proceedings of the 16th Biennial Conference of The Modelling and Simulation Society of Australia and New Zealand (MODSIM 2005)*, 2005.

[25] A. Sobek and H. Miller. U-Access: A web-based system for routing pedestrians of differing abilities. *Journal of Geographical Systems*, 8(3):269–287, 2006.

[26] Telecom Tribune. NTT DoCoMo To Launch Navigation Service for Pedestrians Using Enhanced GPS Technology. *Telecom Tribune*, 14(10):2 – 2, January 2000.

[27] F. Viégas, M. Wattenberg, and K. Dave. Studying cooperation and conflict between authors with history flow visualizations. *Proceedings of SIGCHI*, pages 575–582, 2004.

[28] M. Wuersch and D. Caduff. Refined Route Instructions Using Topological Stages of Closeness. In *Proceedings of Web and Wireless Geographical Information Systems, 5th International Workshop*, volume 3833 of *Lecture Notes in Computer Science*, Lausanne, Switzerland, December 2005. Springer.

APPENDIX B

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APPENDIX C

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Retrospective Altruism and Transient Cooperation in Accessibility Mapping

Harald Holone

Østfold University College, Halden, Norway

Abstract: A central agency attempting to collect detailed accessibility information for users with different and constantly evolving needs and preferences faces a practically insurmountable challenge. Inspired by the social web revolution, the OurWay concept of a collaborative route planner was created a few years ago. Its main contribution is to let users share subjective opinions about accessibility by rating segments of routes suggested by the system. It is now time to review the concept, and draw on different fields of research to highlight challenges, experiences and outlook for this approach to harvesting accessibility information. The concept seems feasible, although it works not because users engage in active cooperation and with the explicit desire to help each other, rather it works by producing feedback as a *by-product* of navigation. When faced with an obstacle, users provide feedback to get an alternative route, and this accumulated feedback is what helps provide improved routes to subsequent users. I introduce two terms, *Retrospective Altruism* (RA) and *Transient Cooperation* (TC), to further illustrate the type of cooperation we observed when studying OurWay. The contribution of this paper is three-fold: 1) A presentation of what seems to be a viable concept for accessibility mapping, 2) our preliminary experiences with use of the system, including RA and TC, and 3) a brief survey of other fields experiencing related types of challenges with regard to trust and credibility with user generated content.

1. Introduction

Collecting huge amounts of detailed, subjective information is nearly impossible without involving the end user. Base map data from big vendors is primarily targeted towards car usage, and there is little or no focus on other user groups with different needs, such as bicyclists, baby-strolling parents or people in wheelchairs or visually impaired users. The more closely one looks at the needs and preferences of individuals, the more one realizes that one size does not necessarily fit all, even within (falsely) presumed homogeneous groups, e.g. wheelchair users. In fact, this might also be true for car drivers, although the rules and regulations governing roads and the car as an proxy to the environment helps a bit. Consider being an avid bird watcher or to have an intrinsic fear of tunnels. Your car navigator won't really help you here, despite route alternatives such as "scenic routes"

and “shortest time”.

And consider for a moment the humongous task of collecting all the required information to cater for bespoke routes based on individual needs and preferences. It is one thing to collect data for “normal” car navigation (and it is financially viable, too), it is something completely different to collect information according to an open-ended, ever-changing and subjective specification.

Accessibility information is detailed and personal, not a general purpose, objective set of measurements. Initiatives to standardize types of accessibility measurement are well-meant, however at some detail the system is bound to break down as a consequence of the wast amount of information to be harvested by selected and trained members of the community, and the attempt to fit this information into rigid and ontology-based schemes.

Traditionally, accessibility information has been provided by central rauthorities, e.g. interest organizations such as the Norwegian Association of Disabled (Norges Handicapforbund). They have been the trusted source of (amongst many other things) accessibility information, and have run a number of projects to collect and disseminate this information to its users. Interestingly, they often (if not always) rely on selected members of their community to collect and verify information on the local and specialized level.

The OurWay concept tries to solve parts of this dilemma by involving end users as central contributors of information. Crowd sourcing has its challenges, perhaps must noticeably when it comes to trust and credibility. At the very least, this is often the main concern of the authorities that once had a monopoly on collecting and disseminating information. The main problem though, might not be that information is created at the edges of the network, by the end users. Although this requires thoughtful consideration when reading and applying acquired information, this is not something unique to user generated content. As Douglas Adams so adequately puts it in his 1999 essay *How to Stop Worrying and Learn to Love the Internet*:

> Working out the social politics of who you can trust and why is, quite literally, what a very large part of our brain has evolved to do. For some batty reason we turn off this natural scepticism when we see things in any medium which require a lot of work or resources to work in, or in which we can’t easily answer back – like newspapers, television or granite. Hence “carved in stone”. What should concern us is not that we can’t take what we read on the internet on trust – of course you can’t, it’s just people talking – but that we ever got into the dangerous habit of believing what we read in the newspapers or saw on the TV – a mistake that no one who has met an actual journalist would ever make [1].

And while we can be fairly certain that basic map data from a national provider is reliable for everyday use, the same can not be said e.g. for accessibility data only partially collected, outdated and stale. Not only because of the sheer amount of information to be collected, but also the temporal aspects of such information and the subjective nature of accessibility.

This introduction presents the motivation for user-driven accessibility mapping, and the reminder of this paper is laid out as follows: Section 2. reviews some related fields where user generated content is applied, and I point to similar challenges and remedies with regard to trust and credibility. The OurWay concept is reviewed in Section 3., and

Section 4. reviews the understanding of cooperation, and places TC and RA in a theoretical context. Finally, Section 5. contains a brief discussions and suggests themes for future research on the OurWay concept.

2. Related fields of work

Five years after the first Web 2.0 conference held by O'Reilly Media and MediaLive, user contributed information is found everywhere. In the blogosphere, statusphere, discussion forums, encyclopedias, street maps and health information systems to name a few. It is hardly surprising that all of these areas share some challenges, especially concerning trustworthiness and credibility of information.

The recurring theme is that the traditional model which alludes to credibility through authority is put to the test when users are involved as active, and in some cases, the main contributors to the information flow. Concerns about trust, credibility and sharing of information and experiences is of course not unique to health informatics (or any other discipline). Here's a brief look at two other fields and how they are discussing the same issue.

Geomatics

The OpenStreetMap [1] project was started by Steve Coast in 2004, motivated by the fact that the Ordnance Survey, Britain's national mapping agency, charged so much for their content that it prevented ordinary people and organizations to make creative use of it. Since then, more than 100.000 individuals have contributed to make an impressive worldwide geowiki [9]. Both the coverage and accuracy [3] and credibility [7] of Volunteered Geographic Information (VGI) [8] have been studied, and provides an interesting background for discussing related issues in the field of health informatics.

Flanagin [7] argues that local knowledge is best found, identified, and described by locals. This applies in an obvious way to accessibility information. The collaborative route planner is itself (at least when discussed in the context of use by disabled users) in the cross between geomatics and health informatics.

Collaborative writing

The most well-known collaborative undertaking on the web is probably Wikipedia. It has built-in features (watch lists, history pages, discussion pages etc) that allows for ad hoc peer review and community engagement. A cornerstone of Wikipedia is the principle that all articles should be written from a neutral point of view (NPOV) [2].

However this is not necessarily a desired feature or goal for a collaborative accessibility mapping approach. Here, a multi-faceted, subjective view of the world is encouraged, and the challenges become how to identify, associate with and trust the providers of accessibility ratings that meets ones own needs.

When there is much controversy around a theme on Wikipedia, so called edit-wars can break out, whereby sections of text are rapidly changed from one version to another to reflect different points of view. At IBM, Viegás [17] has demonstrated tools and tech-

[1] http://openstreetmap.org/
[2] http://en.wikipedia.org/wiki/NPOV

niques for visualizing page edits over time (history flow), a concept that could also be applied to changes in accessibility ratings (or rather, opposing views among users in a group or between groups) in collaborative accessibility mapping.

Two current projects that aims to raise the public awareness about the trustworthiness of Wikipedia articles are WikiDashboard [16] and the WikiTrust [2] initiatives. WikiDashboard provides an easy-to-navigate overview of article editors, number of edits, and history for each article and editor. In WikiTrust, each word in a Wikipedia article is color coded with respect to the trust value assigned to it, based on metrics that takes the authors computed reputation and the history of the text into account.

Finally, the work of Priedhorsky et al. on the impact of damage and types of damage in Wikipedia articles is worth mentioning [15]. It provides a thorough set of tools and metrics for understanding just how vulnerable Wikipedia articles are to erroneous edits, and on how rapidly most of the damage is corrected by the community.

In the field of Health Informatics, Moturu et al. outlines challenges of trust and credibility with the advent of health applications inspired by the Web2.0 revolution [14] . The challenges and remedies outlined here are more specifically addressed within Health Informatics, however the underlying challenges are shared across many fields, including those mentioned above.

3. OurWay overview

The OurWay concept

The OurWay concept is simple. It consists of a route planning server containing the geographical network (roads, paths, corridors etc), and a routing algorithm (Weighted shortest path) which takes into account user supplied ratings on route segments according to accessibility. The OurWay concept differs from traditional accessibility mapping efforts in two important ways:

1. End users create and share accessibility information with their peers instantly, and are not passive consumers of centrally provided information.

2. The information collected is simply a subjective rating (good, uncomfortable or inaccessible), as opposed to a more rigorous and objective measurement approach based on ontologies.

In our experiments, we have used relatively homogeneous groups of people, although the concept includes ideas for multiple (self-identified) groups of people who share information with each others just by the very fact that they're members of the same group. We created a prototype implementation of the OurWay concept that runs on a mobile phone. The prototype presents the user with a map and the ability to ask for a route to take them from place A to place B. The suggested route is rendered on top of a base map. The user follows the route just as a car driver follows a route on a car navigation system.

By allowing end users to rate segments of the route (and request alternative routes based on these ratings), the system "learns" about obstacles and tries to avoid these in new route suggestions. It is key to keep this process as unobtrusive as possible, and in the earliest version of the prototype we used a five degree Likert scale for accessibility ranging from "impossible" to "excellent". We have since made it even simpler, by using a

three degree Likert scale where the user can choose between *inaccessible*, *uncomfortable* and *good* when providing feedback to the system.

It is worth mentioning that the only time the user really *has* to provide feedback (if they decide to play by the "rules", i.e. choose to use the navigator) is when they encounter an absolute obstacle, say for instance when facing a staircase when using a wheelchair. To continue using the system, they must rate the route segment where the obstacle is found, and if required they can ask for an alternative route from their current location. In fact, the only predictable type of rating from the users is *inaccessible*, the use of *uncomfortable* is not used often (or consequently), and *good* is seldom if ever used.

I'm not arguing that the traditionally detailed and objective information is of no use, I'm simply pointing to the fact that collecting this level of detailed information is an extremely resource demanding endeavor, and one that is likely to have severe limitations with regards to coverage and update cycles. Indeed, the OurWay approach does not attempt to capture *why* something is accessible or not, this is left to the users and groups discretion. This is comparable to how tagging of images on Flickr or bookmarks on delicio.us is a free form of content meta-data, yet yields tremendous opportunities for individuals looking for pictures or links they have an interest in.

Feasibility

In our first round of OurWay experiments, we wanted to see if the concept itself seemed viable, and whether mobile internet and GPS technology had reached a maturity that made OurWay seem like a worth-wile approach. Our findings in this respect were positive, and we also found that the routes *converged* quickly, that is, relatively few ratings (and thus few users) were necessary for the system to provide obstacle-free route suggestions [11].

We later identified three possible usages that could benefit from the OurWay concept: *Route finding*, *Surveying* and *Accessibility verification* [10] . Route finding is the primary application of the concept, and forms the basis of our research so far. Using OurWay as a surveying tool, say in a campaign setting, would most likely produce different dynamics with regards to collaboration and motivation.

We have since looked at how users relate to the route planner and the way in which they provide feedback during use. An indoors experiment was conducted where users were to solve a set of pre-determined navigational tasks in our campus building. The users were video recorded and briefed after each task. Our findings made clear that feedback from users did not come primarily at instances when they wanted to actively share experiences with others, but rather as a *by-product* of using the navigator. Especially in the case of absolute obstacles, as in the example given above [12].

The by-product-of-use type of feedback is so prominent that it might be worthwhile replacing the three degree Likert scale with one button for the user to request an alternative route. Keeping in mind that this is mostly relevant for the end users, and not necessarily for the surveyors, campaign users or other user groups. I acknowledge that our studies so far have been limited in size, however this has allowed us to focus on detail and do in-depth interviews with participants that have provided us with insight which I present in the next section.

4. Cooperation

Through our studies we have looked at how the users relate to the tools and technology, and how they relate to each other. To describe this in a context, I want to start with a short introduction to important work on groups and cooperation. This is by no means an extensive evaluation of previous work, but it helps frame the discussion of how we interpret the usage patterns displayed by the participants in the OurWay studies. They are also mentioned because they promise to form a solid basis for understanding user actions in more full-scale deployments of the OurWay concept.

Communities of Practice

Coming from the work by social scientists to understand learning processes, the term *Communities of Practice* (CoP) refers to ways in which apprentices learn from taking part in a communities that share a common goal [18]. To quote Etienne Wenger, one of the originators of the term:

> Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. [3]

Later, Lave and Wenger described situated learning in CoP's as Legitimate Peripheral Participation, LPP [13]. The main contribution of LPP is an understanding of how the learning process gradually turns an apprentice into an expert. Starting out with important although non-critical tasks, the apprentice is introduced to the Community of Practice. Step by step, the importance of the tasks and the responsibility is increased, until the apprentice has acquired expert skills within the community.

There are several reasons why the OurWay end users (the route finders) cannot be considered a Community of Practice. Firstly, there is no established practice, or a pronounced community. In fact, there are no experts that can take on apprentices. How this would play out over time is difficult say, however what interests me is the type of invisible cooperation that takes place in our current tests of the concept. That said, looking at the type of usage we envision for *surveyors* and *verifiers* of accessibility information it is easier to apply the insight from CoP.

Communities of Interest

Building on Communities of Practice, Gerhard Fischer has introduced the term *Communities of Interest* (CoI) to focus on cross-domain collaboration [6]. The main concern here is the communication between groups from different domains, the challenges introduced by different cultures and vocabularies and how to capture this in knowledge management systems.

Communities of Interest often have a more temporal nature than Communities of Practice. CoP's are typically long-lived (although not static), and the learning that takes place within the community can take a long time.

[3] `http://www.ewenger.com/theory/`

The temporal and cross-community aspects of CoI makes it an interesting candidate for shedding light on the OurWay users. Again, this is perhaps more applicable to interaction between the different types of stakeholders involved in accessibility mapping. The problem remains, however, that it is difficult to use for understanding interaction between the end users.

Social Navigation of Information Space

Dourish and Chalmers introduced the concept of social navigation in 1994. They described it as

> ... navigation towards a cluster of people or navigation because other people have looked at something [5].

Social navigation takes an information centric approach, whereby information left behind by users because of their activities form 'places' where people interact. Sharing of information then, is not (necessarily) a result of participation in a Community of Practice, rather it is a by-product of use, which might well be without any thought for other users.

Social navigation of information uses the way we navigate in the real world, e.g. by visiting restaurants with many customers and avoiding the ones without them, as a metaphor for navigating information places on the web. This way of thinking about interaction fits very well with the way users of OurWay share their experiences. They leave traces of their use, which in turn is used (behind the scenes) to provide better quality routes for other users. Curiously, OurWay takes the metaphor of navigation back to the physical world — it is tempting to dub it *Sociogeographic Navigation of Information*.

Paul Dourish describes Social navigation of information as a type of awareness system, with some significant differences compared to "traditional" CSCW awareness technologies. The information can be aggregated over time from the use of many different users, which means that communicating awareness can be asynchronous. The decoupling of the activity that produces the information and the situation in which this information is used (perhaps as part of an aggregate) poses challenges to the design of these systems, e.g. for presentation of awareness information [4]. The OurWay concept also differs slightly from these ideas, by the fact that it is the *removal* of obstacles, not identification of non-obstacles which is key to the concept.

This insight provided by Dourish and others can help in the design of future implementations of the OurWay concept, which up till now has not focused on the communication of awareness information (the aggregated ratings). Rather, only the consequence of aggregated ratings, i.e. the suggested route, has been provided to the user.

Transient cooperation

Social navigation of information describes systems, technology and use that facilitates sharing of awareness information across time and space. The type of cooperation that takes place between the users of such a system (including the OurWay concept) is what i refer to as *Transient Cooperation*:

> Transient Cooperation is a form of cooperation which does not require an existing community, or explicit participation other than a shared benefit from

use. The interaction is asynchronous and limited in time, and the users might be unaware of their cooperators or the benefit they have from cooperation.

This is a phenomena we have observed during tests of the OurWay concept. Users with different backgrounds, goals, preferences and needs are brought together through the use of an OurWay prototype system to solve navigational tasks. The users typically quickly disengage from the idea of "the others", and focus on solving their own task at hand.

One could argue, of course, that the design of the OurWay prototype does not encourage or invite to more explicit cooperation between the users. If we were to follow the design ideas for awareness coming out of the CSCW community, we might well be able to inspire more direct cooperation between users. The interesting point, however, is the observation that despite the lack of outspoken cooperation, the system works and improves over time.

Retrospective altruism

When preparing participants in our indoor exercises, we presented them with the OurWay concept, and told them they were part of a group of people who would all share and benefit from each others annotations.

Very quickly, however, most users "forget" the other users, tend to adopt the navigational tasks we gave them as their own, and focus almost exclusively on solving the task at hand. This leads to some interesting behavior, such as one user tricking the system into providing an alternative route by tagging a closed door as inaccessible. We often see users ignoring the opportunity of rating a door sill as uncomfortable even though they really have to struggle to pass it.

Thus, our participants are, with few exceptions, using the navigation system in an egoistic fashion. They are seldom concerned about other users, and usually annotate only when they have to in order to get an alternative route around an absolute obstacle.

During in-depth interviews, however, they are often convinced that they were in-fact concerned citizens and did have other users in mind during use. Even when confronted with video evidence that shows their self-centered activity they will maintain that they did reflect on other users and their potential benefits during annotation. This phenomena is what i have called *Retrospective Altruism*:

> Retrospective Altruism describes the tension between selfish activities that takes place at one time, and the attempt (or desire) to describe those very same activities as altruistically motivated at a later time.

This observed phenomena can be helpful in the design of future implementations of the OurWay concept. Most users seem to *want* to appear as concerned citizens, and this might be an argument for visualization of aggregated ratings, users etc. in order to help them achieve that. The tensions in the Retrospective Altruism phenomena is anyhow a potential for improving the collaboration of and awareness shared between users of the system.

5. Discussion and conclusion

The OurWay concept of collaborative accessibility mapping seems promising. Our studies range from a technology-centered proof-of-concept to user-centered evaluations of use, and our results suggests that it forms a solid base for further exploration of "Accessibility 2.0".

The concept separates from the rigid, objective and detailed accessibility measurement approach which is the hallmark of centralized, authority-controlled information collection and dissemination. The end user is closest to the experience (geographical or accessibility-wise), and functions as a "citizen sensor" to use a term from the field of VGI.

Segment rating as a by-product of navigation takes us back fifteen years to the ideas of Social Navigation of Information Space. Since then, mobile phones have become powerful computers with embedded location technology, which gives us the opportunity to bring the navigation metaphor back into the physical world. OurWay is a simple, almost to the point of being naive, approach to the challenge of collecting accessibility information. It seems to work, and it works in ways predicted by the CSCW community in the mid 1990's.

We observe that users tend to behave selfishly and how the concept works despite of the selfishness. Users are not actively engaging in cooperation, nevertheless they do cooperate through the shared use of a navigational system. I use the term *Transient Cooperation* to describe this phenomena . I have dubbed the way users tend to apply post-hoc rationalization to describe their selfish actions as altruistically motivated *Retrospective Altruism*. Within these two terms lies a great potential for enhancing future implementations of the OurWay concept to foster trust, credibility and cooperation.

The issue of trust and credibility is central to widespread deployment of the OurWay concept, as it is for any system which utilizes user generated content for decision making. The consequences of errors might be different across applications in different domains, however the general problem is shared amongst many fields of work, and there is plenty of published material to learn from.

We don't know much about how the OurWay concept scales if released to consumers. On the other hand, the centralized model has its own challenges with regard to scale. We look forward to testing the OurWay concept over a longer period of time, across many users in different user groups.

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7. References

[1] D. Adams. How to Stop Worrying and Learn to Love the Internet, 1999.
[2] B. Adler, J. Benterou, K. Chatterjee, L. De Alfaro, I. Pye, and V. Raman. Assigning trust to wikipedia content. In *WikiSym 4 rd Intl Symposium on Wikis*, 2008.
[3] A. Ather. A Quality Analysis of OpenStreetMap Data. Master's thesis, 2009.

[4] P. Dourish. *Where the footprints lead: tracking down other roles for social navigation*. Springer-Verlag London, UK, 1999.
[5] P. Dourish and M. Chalmers. Running Out of Space: Models of Information Navigation. *Short paper presented at HCI*, 94, 1994.
[6] G. Fischer. Communities of Interest: Learning through the Interaction of Multiple Knowledge Systems. In *24th Annual Information Systems Research Seminar In Scandinavia (IRIS'24), Ulvik, Norway*, pages 1–14, 2001.
[7] A. Flanagin and M. Metzger. The credibility of volunteered geographic information. *GeoJournal*, 72(3):137–148, 2008.
[8] M. Goodchild. Citizens as sensors: the world of volunteered geography. *GeoJournal*, 69(4):211–221, 2007.
[9] M. M. Haklay and P. Weber. Openstreetmap: User-generated street maps. *Pervasive Computing, IEEE*, 7(4):12–18, Oct.-Dec. 2008.
[10] H. Holone and G. Misund. People Helping Computers Helping People: Navigation For People With Mobility Problems By Sharing Accessibility Annotations. In *ICCHP*. Springer, 2008.
[11] H. Holone, G. Misund, and H. Holmstedt. Users are doing it for themselves: Pedestrian navigation with user generated content. pages 91–99, Sept. 2007.
[12] H. Holone, G. Misund, H. Tolsby, and S. Kristoffersen. Aspects of personal navigation with collaborative user feedback. In *Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges*, pages 182–191. ACM New York, NY, USA, 2008.
[13] J. Lave and E. Wenger. *Situated learning: Legitimate peripheral participation*. Cambridge University Press, 1991.
[14] S. Moturu, H. Liu, and W. Johnson. Trust Evaluation in Health Information on the World Wide Web. In *Conference proceedings:... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference*, volume 1, page 1525, 2008.
[15] R. Priedhorsky, J. Chen, S. T. K. Lam, K. Panciera, L. Terveen, and J. Riedl. Creating, destroying, and restoring value in wikipedia. In *GROUP '07: Proceedings of the 2007 international ACM conference on Supporting group work*, pages 259–268, New York, NY, USA, 2007. ACM.
[16] B. Suh, E. Chi, A. Kittur, and B. Pendleton. Lifting the veil: improving accountability and social transparency in Wikipedia with wikidashboard. 2008.
[17] F. Viégas, M. Wattenberg, and K. Dave. Studying cooperation and conflict between authors with history flow visualizations. *Proceedings of SIGCHI*, pages 575–582, 2004.
[18] E. Wenger. *Communities of Practice: learning, meaning, and identity*. Cambridge University Press, 1999.

8. Address for correspondence

Harald Holone — *harald.holone@hiof.no* — `http://www.it.hiof.no/~haraldh/`

APPENDIX D

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Transient Cooperation in Social Applications for Accessibility Mapping

Harald Holone[1] and Jo Herstad[2]

[1] Østfold University College, Norway
[2] University of Oslo, Norway

Abstract. Collecting, disseminating and maintaining accessibility information about the physical world is a daunting task. Through the *OurWay* concept, end users are involved to provide feedback on suggested routes in a route planning system, thereby solving both their own navigational tasks at hand, and helping other users by leaving behind traces of their activity. We define and explore *Transient Cooperation*, the type of cooperation we have observed in a prototype evaluation of the concept. This exploration is undertaken in the light of established research on accessibility, cooperation and social software. We also suggest implications this type of cooperation can have for for accessibility mapping.

1 Introduction

Accessibility is a wide term, which applies in different ways to a wide variety of resources, be it information and communication technologies or physical access in public areas. In this paper we're concerned with sharing of location-based accessibility information in the physical world. We pay special attention to the forms of cooperation that take place when sharing such information. Accessibility information is frequently shared between users, either directly through friends or contacts, or indirectly through formalized initiatives undertaken by organizations. Collecting, verifying and distributing accessibility information is a formidable task.

Through OurWay we have introduced a concept in which end users play a central role in creating and maintaining accessibility information. The OurWay concept is described in more detail in the Research Setting section. Involving the end users makes sense both from a resource perspective and maintenance perspective. After all, these are real *citizen sensors* [6] experiencing the urban accessibility issues on the street level, day by day.

In this paper, our main research questions are: 1) *What characteristic features do we find in the collaboration taking place in OurWay as a social application* and 2) *What implications can this have for accessibility mapping?* The paper is organized as follows: First we review relevant work, then we describe the OurWay concept and prototype, and present a summary of OurWay as a social application. In the discussion we take on the main research question about cooperation in accessibility mapping. Finally we conclude the paper with implications for social applications in accessibility mapping.

2 Related work

2.1 Accessibility

Accessibility has different meanings in different situations. For instance, in results from the AUNT-SUE project [5], social aspects like *fear of crime* are mentioned as important factors when users assess the overall accessibility of an area. Similarly, the AMELIA project [15] identify surrounding factors such as places to rest and public toilets as important in the overall accessibility picture. Völkel et al. [17] describes requirements for accessibility annotation of geographic data, with the aim to collect detailed information for different needs and preferences.

Existing literature on accessibility focuses mostly on the interaction between a single user and a computer system, with some notable exceptions, e.g. [20] and [8]. Hedvall [8] argues that the accessibility field is lagging behind the HCI field, focusing mostly on regulations and predictability.

2.2 Cooperation

Human Computer Interaction is about making the computer usable and accessible. A shift of focus within HCI came with the emergence of CSCW. Whereas traditional HCI has focused on human-computer interaction, CSCW concerns how computers facilitate human-to-human communication. Groupware and CSCW represent a paradigm shift in computer use. Human-Human interaction, rather than human-machine interaction is the primary focus; the computer facilitates human communication rather than acting as a purely computational device [2].

Hedvall [8] compares the evolution of the accessibility field with three waves of HCI, and concludes that the accessibility field has much to learn from the focus on individuals found in the third wave of HCI. He, as we, does not argue that the efforts with regards to rules and regulations to ensure universal access is misplaced, however there is a need to extend the accessibility field and take the perspective of the individual user, the situatedness in use of technology into serious consideration when designing tools and technology.

The term Social Navigation of Information Space was coined by Dourish and Chalmers in 1994 [4] to to discuss information sharing on the Internet (as opposed to collaboration in work environments, which had so far been the main focus of CSCW). Social Navigation takes an information centric approach, whereby information left behind by users from their activities form *places* where people interact. Sharing of information then, is not necessarily a result of participation in a Community of Practice, rather it is a *by-product of use*, which might well be without any thought for other users.

By regarding the traces of activity as an opportunity for a shared information space [12], it becomes paramount to allow users to negotiate the the interpretation of this information. In other words, it is not sufficient to collect and share the information; alternative communication channels must be available for the users to make sense of the traces.

Initiatives to make user activity and information validity in Wikipedia more visible include WikiDashboard [14] and WikiTrust [1]. Both of these efforts are working to make Wikipedia more socially transparent, by visualizing author credibility and article revision history. Part of the Wikipedia guidelines dictates that care must be taken to reflect a balanced view on every topic. The Wikipedia concept of a Neutral Point of View is being challenged, for instance by van der Velden [16], who argues for multiple points of view and ways of representing knowledge, and what she and others call *Cognitive Justice*. Coming from the work by social scientists to understand learning processes, the term *Communities of Practice* (CoP) refers to ways in which apprentices learn from taking part in a communities that share a common goal [19].

2.3 Social Software

Jonathan Grudin, although not using the term social software, puts forward four characteristics he considers key in these kinds of technologies [7]: ... they 1) can be extremely lightweight, 2) make information and activity highly visible, 3) provide individual and group benefits, and 4) are grassroots, self-organizing phenomena. Grudin refers to studies of using project blogs and wikis as well as the use of hash tags for coordinating and maintaining project-related content and activities. We use Grudin's characteristics for discussing OurWay as a social application.

3 Research setting and methodology

3.1 Methodology

The research approach from the IS tradition adopted for this paper is the interpretive approach to a case study [18,11]. Interpretive research aims at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context [18]. The use activity is always in a particular context or situation, and not seen as an abstract activity detached from specific users and specific technologies within an interpretive case study.

Interviews and direct observation has been conducted in order to understand the use of the OurWay prototype. The main basis for the current analysis is eight in-depth interviews conducted with users, following nine sessions (consisting of six navigational tasks each) with observation of the activity of use. The observational data includes video, audio and field notes. The interviews and observations have been transcribed, analyzed and interpreted. In addition, data has been recorded and analyzed by investigating the logs from the use activities.

3.2 Previous work with OurWay

OurWay is a collaborative route planner, where users are providing feedback on accessibility through their interaction with the system. Users are equipped

with mobile phones running a client application, which connects to a central route planning and feedback server over a mobile Internet connection. The client displays a map of the area, and allows the user to ask for a route between two locations, which is then displayed on the map. The user can at any time provide feedback to the central server about the part of the route being traversed. To keep the threshold for contribution low, we have used only three levels of feedback: *good*, *uncomfortable*, and *inaccessible*. The submitted ratings are attached to route segments, and are used as weights by the route planning server when calculating new routes.

Viewing OurWay as a social navigation tool, several design limitations become obvious, especially with regards to awareness of other users, their actions and identities. This gives us an incentive to attempt to re-frame OurWay as a social application, and re-assess some of the design choices made in the current prototype.

3.3 Accessibility mapping as a social application

Using Grudin's four characteristics, we now summarize our discussion of accessibility mapping with social applications [10].

3.4 Lightweight

From the end user's perspective, OurWay can be considered extremely lightweight. The feedback mechanism is a vast simplification of the typically form based inquiry taking place in traditional accessibility mapping. It also contrasts with the requirements suggested by Völkel et al. [17]. We do not propose that the OurWay concept should replace such detailed approaches, rather that the information generated by users can *augment* existing information. One obvious challenge is the use of mobile phones for people with special needs. Although mobile phones are ubiquitous among all user groups, the necessary HCI challenges related to use in the field must be considered carefully. One key argument for using an open, lightweight infrastructure for a social accessibility mapping application is that the opportunities for adaption to different needs and requirements are moved away from the core of the system and towards the end user.

Information and activity made visible A tool which provides accessible routes must adhere to high standards when it comes to dependable information and social transparency. There is little doubt that allowing the user to see the ratings and context which is used to calculate the routes is important. Some suggestions can be found in the WikiTrust and WikiDashboard projects mentioned earlier, where exposing the source and history of information is a key point. Perhaps the main drawback of the current OurWay prototype is that it only indirectly provides this information, through the *resulting* route suggested to the user. In other words, there are no clues provided as to who provided the annotations that led to the suggested route, or what context they were captured in.

Individual and group benefits Some individual benefits of a social software system for accessibility mapping are obvious, such as the opportunity to provide feedback on suggested routes and get immediate reward in the form of an alternative route from the system. The benefits for the group(s) are, as we have shown through the work with OurWay, more accessible routes over time. Another benefit for the group as a whole, is that this way of collecting and maintaining accessibility information is a potential resolution to the resource challenge mentioned in the introduction of this paper. Further, by utilizing existing social software infrastructures, the social awareness of mobility challenges and special needs can be raised, also outside of the group of core users.

Self-organizing grassroots phenomena There is obvious value in the networks, agendas and political power represented by established interest organizations. At the same time, parts of what make social applications work is the ability for users to rapidly form groups and processes, often to influence the organizations or establishments they are taking part in. There should be a mutual interest from institutions, individual users and user groups to make use of social software tools, however the suitable balance of initiative and power remains to be established. See for instance Borchorst et al. [3], where they look at the application of Web 2.0 technology in the interaction between citizens and municipalities in Denmark.

4 Discussion

4.1 Accessibility and cooperation

The accessibility of technology, information and other people are prerequisites for cooperation. Cooperation provides the opportunity for sharing experiences in the world, in our case information about accessibility in the urban landscape. It is important to remember that not all parties are approaching this cooperation on the same terms [20], the individual needs and preferences combined with the situation at hand provides a context within which the artifacts and meaning of information is negotiated. This is what Hedvall describes as *activity-tied and experienced accessibility* [8].

Keeping in mind the heterogeneity of users, it becomes obvious that providing access to systems for cooperation demands a multitude of ways for interaction. This demand can be covered in part by designing for *all*, however the result must not be a least common denominator of technology, rather it should be taking the individuals seriously and allow for appropriation close to the end user.

Even when we take the individuals into consideration, it is important to remember that users are not static. They change over time, and can and will negotiate the situation depending on contextual information, such as available assistance, tools, and weather conditions. We can use the Wikipedia concept of a *Neutral Point of View* (NPOV) as a contrast to this insight. Both Wikipedia and OurWay captures facts about the world around us, however it would be

meaningless to attempt to agree on a neutral point of view regarding physical access. The same argument has been made against Wikipedia's NPOV, see for example van der Velden [16] about Cognitive Justice.

4.2 Transient Cooperation

In all the simplicity of the OurWay concept, an important question arises: *What constitutes a group of users?* In the groupware and CSCW fields, groups of users are mostly regarded as organized groups in a work setting. The 'W' in CSCW is work, which reflects the origin of the term. We choose to interpret cooperative work as *any activity that provides input to a process*, which makes it possible to describe OurWay as a CSCW system. However, the groups of people interacting with the system are not necessarily organized, and the way they interact with the system would rarely be regarded as 'work' by the users. Further, any group consists of individuals with their own preferences, needs, practices and tools.

In Communities of Practice we also find that the organizational setting is dominating the discussion. Our view is that organization is not a prerequisite for cooperation, rather that cooperation can, through discussion and negotiation, lead to organization. Through the work of individuals, value can be provided to groups of varying sizes, where the number of shared needs and preferences diminishes as the groups grow in size. At the larger end of the scale, we find interest organizations who lobby and work with political processes and regulations. These are very important, however it should not be the only focus in accessibility work, since the results tend to play a conservative role [8].

Transient Cooperation [9] is not carrying the organizational connotations of CSCW or Communities of Practice, rather it suggests a way to look at cooperation as any activity that involves multiple users of an information space [12]. As users coordinate, it is perhaps more fruitful to talk about loyalty towards peers than group membership in the traditional sense. It becomes clear with the insight from CSCW [12] and accessibility [8] that there is a need for additional forms of communication channels to allow for negotiation of the situation at hand. It is also important to remember that the system is part of the world, the world is not captured in its entirety within the system. Negotiation of the situation happens with the system as a tool or medium, and involves communication outside of the system as well.

Transient Cooperation is not suggested as a naïve idea about automatic capture of activity traces that can be applied through information sharing alone. Rather, it attempts to capture the ephemeral nature of interaction between individual users through the use of an information system which does not require a long-time commitment or shared goal by the users. This form of ad hoc cooperation becomes important in activity-tied accessibility, and involves negotiation of the situation at hand.

4.3 Implications for accessibility mapping

It should be clear from our discussion so far that we argue strongly for the individual's role in the field of accessibility in general, and in the process of collecting, sharing and interpreting information about physical accessibility specifically. We agree with Hedvall in his view that the accessibility field has much to learn from decades of work in HCI and CSCW. This is especially true with recent cross-domain research into social applications in the age of Web 2.0. OurWay is an example of a concept that is inspired by successes on the social web to involve the end users and take individuals seriously.

The *Transient Cooperation* we observe in OurWay gives further insight into how these systems can be designed. We see that the cooperative effort by individuals provides value to others even when the primary use of the system is for personal navigational tasks. Also, even though the idea of "the others" is presented to users, they soon focus purely on their own activity, disregarding the potential benefits (or other consequences) for other users. In light of the CSCW literature, it becomes obvious that there is a need to provide good support for visualization of user activity, as well as communication channels for negotiation.

Experienced accessibility is the "real" accessibility, a sum of the accommodation of the physical environment and the situation in which the individual acts. Design of new solutions for accessibility mapping requires attention to this, by enabling flexibility and interpretation, both in information capture and interpretation. Creating social applications for accessibility mapping requires balancing the role of the organizations and the individuals. The individual perspective, the experienced accessibility, can only be negotiated and described by the individual or small groups. Other issues, such as regulatory work and political processes are better handled by the organizations. However, one must not disregard the collective power of individuals [13]. Using ideas from social applications in accessibility mapping seems to be a promising way to put focus on the individual.

5 Conclusion

We have reviewed literature from accessibility, cooperation and social software. Further, we have presented a re-iteration of the OurWay concept as a social application, to frame a discussion of accessibility mapping as a topic for social applications. By discussing accessibility and cooperation and defining the concept of *Transient Cooperation* we have suggested implications for the design of new systems for accessibility mapping. Truly putting focus on the individual in this context is inspired by successful social applications in other domains. Balancing the power of the individuals and established organizations has its challenges, however both ends of the scale has much to gain from the insights provided by decades of research in HCI and CSCW.

References

1. B. Adler, J. Benterou, K. Chatterjee, L. De Alfaro, I. Pye, and V. Raman. Assigning trust to wikipedia content. In *WikiSym 4 rd Intl Symposium on Wikis*, 2008.
2. R. Baecker. *Readings in groupware and computer-supported cooperative work: Assisting human-human collaboration*. Morgan Kaufmann, 1993.
3. Borchorst, N.G. and Bødker, S. and Zander, P-O. The boundaries of participatory citizenship. In *ECSCW 2009: Proceedings of the 11th European Conference on Computer Supported Cooperative Work, 7-11 September 2009, Vienna, Austria*, page 1. Springer, 2009.
4. P. Dourish and M. Chalmers. Running Out of Space: Models of Information Navigation. *Short paper presented at HCI*, 94, 1994.
5. G. Evans. Accessibility, Urban Design and the Whole Journey Environment. *Built Environment*, 35(3):366–385, 2009.
6. M. Goodchild. Citizens as sensors: the world of volunteered geography. *GeoJournal*, 69(4):211–221, 2007.
7. J. Grudin. Enterprise knowledge management and emerging technologies. In *HAWAII INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES*, volume 39, page 57. Citeseer, 2006.
8. P. Hedvall. Towards the Era of Mixed Reality: Accessibility Meets Three Waves of HCI. *HCI and Usability for e-Inclusion*, pages 264–278, 2009.
9. H. Holone. Retrospective Altruism and Transient Cooperation in Accessibility Mapping. In *Travel Health Informatics and Telehealth, EFMI Special Topic Conference, Antalya, Turkey 2009*. European Federation of Medical Informatics, 2009.
10. H. Holone and J. Herstad. Social software for accessibility mapping: challenges and opportunities. In *Unitech 2010, Oslo, Norway*. Tapir Forlag, 2010.
11. H. Klein and M. Myers. A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly*, 23(1):67–93, 1999.
12. K. Schmidt and L. Bannon. Taking CSCW seriously. *Computer Supported Cooperative Work (CSCW)*, 1(1):7–40, 1992.
13. C. Shirky. *Here Comes Everybody: The power of organizing without organizations*. New York: Penguin Press, 2008.
14. B. Suh, E. Chi, A. Kittur, and B. Pendleton. Lifting the veil: improving accountability and social transparency in Wikipedia with wikidashboard. 2008.
15. H. Titheridge, R. Mackett, and K. Achuthan. From footway design to the street environment: removing the barriers to walking. 2009.
16. M. van der Velden. Design for a common world: On ethical agency and cognitive justice. *Ethics and Information Technology*, 11(1):37–47, 2009.
17. T. Völkel, R. Kühn, and G. Weber. Mobility impaired pedestrians are not cars: Requirements for the annotation of geographical data. In *Proceedings of the International Conference on Computers Helping People with Special Needs (ICCHP'08)*, pages 1085–1092. Springer, 2008.
18. G. Walsham. *Interpreting information systems in organizations*. John Wiley & Sons, Inc. New York, NY, USA, 1993.
19. E. Wenger. *Communities of Practice: learning, meaning, and identity*. Cambridge University Press, 1999.
20. F. Winberg. Supporting cross-modal collaboration: Adding a social dimension to accessibility. *Lecture notes in computer science*, pages 102–110, 2006.

APPENDIX E

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