Pers Ubiquit Comput (2004) 8: 135–143
DOI 10.1007/s00779-004-0263-1

ORIGINAL ARTICLE

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Understanding mobile contexts

Received: 5 December 2003 / Accepted: 10 March 2004 / Published online: 24 April 2004

Abstract Mobile urban environments present a challenge for context-aware computers because they differ from fixed indoor contexts such as offices, meeting rooms, and lecture halls in many important ways. Internal factors such as tasks and goals are different—external factors such as social resources are dynamic and unpredictable. An empirical, user-centred approach is needed to understand mobile contexts. In this paper, we present insights from an ethnomethodologically inspired study of 25 adult urbanites in Helsinki. The results describe typical phenomena in mobility: how situational and planned acts intermesh in navigation, how people construct personal and group spaces, and how temporal tensions develop and dissolve. Furthermore, we provide examples of social solutions to navigation problems, examine mobile multitasking, and consider design implications for mobile and context-aware human–computer interaction.

Keywords Mobile context · Mobility · Ethnography · Ethnomethodology · Context-aware computing · User-centred design

1 Introduction

Mobile technologies can be seen as new resources for accomplishing various everyday activities that are carried out on the move. People have tremendous capabilities for utilizing mobile devices in various innovative ways for social and cognitive activities. For example, there are services for arranging ad hoc face-to-face meetings with friends, finding driving directions, fixing blind dates, playing games, and even chatting with unknown people.

In its complexity, mobile lifestyle presents a challenge for context-aware computing. Context-aware devices are supposed to monitor the changing contexts of the user and adapt appropriately through interpreters, aggregators, and services [1]. Mobile computers need "awareness" of several contextual factors including social, psychological, physical, and the like. What these factors are, and how they should be interpreted and acted upon, are questions addressed in this study. Having deep social roots and involving a dynamically changing environment, mobile context is a difficult concept to define. It is problematic to decide from an armchair which attributes are relevant. In order to be *socially acceptable and useful*, context-aware technology must be based on empirical knowledge of the context analysed from the perspective of the end-users. In this paper, we show how different aspects of mobile contexts are created and maintained by *situated actions in everyday life*. Furthermore, we examine various implications that our findings pose for the design of context-aware computing.

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2 Previous research

What a context comprises is a widely debated and controversial issue. A wide philosophically oriented body of literature exists within HCI about the nature of "context" [2–7]. In addition, attempts to create a standardized definition of use context have been made (e.g. ISO 13407, [8]). However, some researchers consider the present definitions of context too vague and general to be adapted to any specific design processes. The following objection is common [4, 5]: because context is tightly intertwined with users' internal and social—continuously changing—interpretations, it seems difficult to capture context in any general sense that would

support design. Consequently, there have been doubts about whether the entire concept is of any use [5, 7].

The demand for a new, empirical approach has been noted. For example, Dourish distinguishes between two strands of empirical context-aware computing research. The first is informed by research on physically based interaction and augmented environments. The second attempts "to develop interactive systems around understandings of the generally operative social processes surrounding everyday interaction" [4, p. 231].

The majority of empirical research falling under the first strand has mainly been concerned with fixed indoor contexts (e.g. offices, meeting rooms, and lecture halls). Perhaps because such settings appear to be static, the researchers have tried to create rigid taxonomies and general "all-embracing" definitions of context—with negligible success. Technological advances have largely driven this branch of research. As a result, the viewpoint of the end-users has been ignored (see [9]). When research has been carried out in a user-centred way (Dourish's second branch), it has focussed on different kinds of *work contexts* and *mobile workers*. For example, Luff and Heath's [10] analysis of different kinds of mobilities and their relations to collaborative work together with Perry et al.'s [11] study of the everyday nature of mobile businesspeople's work point out several problems and possibilities related to mobility and mobile contexts. However, it seems that considerations on how context-aware mobile devices might make their place in mundane actions of *everyday life outside work settings* have been forgotten. The present study falls under the second line of empirical research; we try to understand particular interactional processes related to mobile contexts outside work settings. As there is a rich variation with situated actions in mobile contexts, they do not lend themselves to rigid general definitions or static taxonomies. However, even if mobile contexts are created by particular actions performed while moving, they also contain regularities that can be captured by context-aware devices.

3 Our approach

Our starting point is that contexts are always determined by their specific use situation loaded with different action resources: motives, plans, other people, mobile computers, and the like. By analysing trivial actions, we focus on the interactional and situated nature of mobile contexts. Thus, rather than trying to give a working definition for mobile contexts, we believe that, by explicating the subtle actions and resources by which people manage their mundane doings in particular mobile circumstances, we can gain insights on how mobile contexts "get done" and to what extent these doings could be proactively recognized by mobile and ubiquitous devices.

This paper contributes to user-centred empirical attempts by trying to understand how context-aware computing might make its place in mobile activities, especially in the rapid change of *contexts in everyday urban navigation*. How are mobile contexts actively created and upheld by people's interactions with other people, with available technology, and with the outer surroundings of their actions? In addition to the user-centeredness, this study emphasizes two points. First, our interest is confined specifically to context changes occurring on the move in urban public and semi-public places (typically, somewhere between home, leisure activities, and work). In contrast to previous work, which has concentrated on restricted areas such as museums, offices, or university campuses, we are interested in the interplay between dynamic context-changes, moving people, and their actions. Second, unlike previous research on mobility, e.g. [10, 11], we are specifically interested in the majority of people—the elderly, single mothers, and youngsters—instead of focussing on businesspeople or researchers as usual.

3.1 Background of this study

This study was part of a strategic design research project that envisioned new concepts for selected target groups. Understanding their typical ways of moving around the city and providing general design ideas for context-aware mobile technology was one of its goals. Journeys in the city of Helsinki are typically done by public transportation, like in most European cities. In Helsinki, the average annual amount of boardings per capita is 371, in Western Europe 202 [12][1]. Thus, this study analyses the activities taking place in present-day urban environments. We do not try to predict the future on the basis of present-day technology. Instead, we believe that an understanding of the present-day activities is necessary for gaining an insight into how future devices and applications could support, or even challenge, the present interactions in mobile contexts[2]. However, at this point, we are *not suggesting any particular ideas for interaction design*. The aim is simply to point out some general aspects relating to the urban navigation and mobile contexts. These general aspects provide a way of understanding the challenges and possibilities of the user-centred (interaction) design that apply for different kinds of new context-aware devices and services.

4 Method

The data was gathered by ethnographic participant observation and analysed from an ethnomethodological standpoint [13, 14]. Ethnomethodology is interested in

[1]Although public transportation is used frequently in Europe, it is common in other parts of the world too. For example, in New York, the same annual figure was 152 boardings per capita in the years around 2000 [15].

[2]Discussions about this kind of "Technomethodology" can be found from [16].

how people make sense of their social world, on how everyday life gets "done" with the help of different trivial actions and resources that are available to people in a given situation.

Twenty-five adults (names changed in the following) were observed while moving from place to place during their normal days in the Helsinki metropolitan area. Altogether, 25 people from five different user groups participated in our user research. They included the elderly, young singles, journalists, amateur actors, and middle-aged apartment house neighbours. All participants received a small monetary compensation.

The study took place during the summer of 2001. Five researchers spent 1–3 days with each participant. Video cameras, digital cameras, and field notes were used to document the observations. The focus of the observations was on subjects' everyday activities, especially activities related to their urban everyday journeys (see [17]). For the analysis of the mobile context, observations were transcribed and represented in a notepad-like format. Photographs were presented on the left side of the notepad, and explanations of the pictures and the storyline were on the other. The storylines were in the form of a thick description, including all of the details that could be observed and documented. These documents were then divided to *travel episodes*. A travel episode consists of temporally organized (i.e. it has a beginning, middle, and end) action patterns depicting a meaningful journey between two places. "Meaningfulness" here means that actions were performed in sequences in order to carry out a culturally recognizable doing. A special emphasis was given to finding nodal events (e.g. see [18]), that is, events where an action transformed the present context into another recognizable context. A good example of such a nodal event is the space claiming act (see Sect. 5.2). These nodal events, if reoccurring throughout the data and carried out on the move by our subjects, were then analysed further.

5 Characteristics of mobile contexts

We describe five characteristics of mobile contexts. The characteristics can be seen as the sum of different resources and actions by which the mobile contexts are situationally constructed and upheld. They were selected on the basis of three criteria: (1) diagnosticity (specific to mobile contexts, but rare to fixed contexts), (2) generality (recurring in many travel episodes), and (3) concreteness (specific enough to be taken into account in the design of context-aware computers). We present the characteristics as closely linked to the constituting activities and illustrate them with examples.

5.1 Situational acts within planned ones

When moving, people usually have a mental plan on how to navigate from place A to place B, and what actions must be performed on the way in order to fulfil the plan. However, several actions can be performed in a situational, ad hoc manner during the journeys. One important aspect of mobile navigation seems to be that unplanned context changes lead to unplanned situational acts. Our participants often popped in somewhere or bumped into acquaintances on their way to their primary destination (see Fig. 1a, b).

Suchman's [19] notion that plans do not simply determine action, but provide *resources* through which individuals organize their own actions and interpret the actions of others in certain situations, is useful here. People keep their main target in mind while simultaneously doing something else, which is usually some minor-scale activity. Thus, the pattern of the modern urban journey can be similar to those of Gladwin's [20] native Polynesian navigators, who do not forget their final target, even they are constantly reacting to their immediate environment, such as the waves and winds of the ocean.

Fig. 1 **a** Semi-planned sidestepping. Jane was on her way to a café to meet with her friend. She got off the tram in front of another café that provided internet access and dropped in to read emails, and then carried on to meet her friend. **b** Popping in to a store. After missing her bus, Anne was walking home from work. She noticed some nice postcards in the bookstore window and decided to go into the store to have a closer look at the cards. She realized that she needed to buy one, since she was going to a party the following day. **c** Ad hoc. Unplanned sidestepping triggered by a change in social context. Jane was riding in a tram on the way to visit her friend. While talking on the phone, she noticed her friend, Albert, stepping in. Jane finished the phone call and went to Albert. They started to chat about latest happenings

Certain contexts enable people to perform actions that are significant only at that specific moment. These actions do not necessarily replace the ''main'' plan; rather, they are little sidesteps on the way to the goal. However, the threshold for doing sidestepping has to be low if they are to be performed while still adhering to the main plan—otherwise the sidestep could become the main plan.

Furthermore, unplanned acts are often social in nature. Sometimes, it takes time for people to recognize old acquaintances from a crowd. But after mutual recognition, people usually stop to chat about their latest happenings—it would be impolite to act otherwise (see Fig. 1c).

5.2 Claiming personal and group spaces

People need space for themselves and for the actions they are about to take. For this reason, they create at least two kinds of spaces around themselves; personal and group spaces. According to several psychosocial studies, the upholding of personal space is a universal need—only the dimensions of this space are culturally dependent [21]. These spaces both constitute and indicate the nature of the social interaction at hand in a given situation. People regulate their involvement in social interactions [22] by different situational resources (e.g. by turning away from others in conversation). Even if the phenomena of space claiming and privacy in social interactions have been recognized in the field of social psychology decades ago, they have emerged as research topics in the HCI area only recently [23, 24]. Spatial considerations, and space claiming in particular, are a central issue in the study of mobile contexts, as we demonstrate below. The space claiming in our everyday journeys was done in various ways. For example, space claiming on a bus was achieved by picking up a newspaper, watching out of the window, talking on a mobile phone, or with similar actions. In our example (Fig. 2a), free newspapers were read when travelling alone. With the newspaper, the reader claims a personal space [25] and signals off a private sphere in the midst of other passengers. The number of people in the group is an important factor affecting *how, and what kinds of spaces*, are claimed, as well as the actions carried out in the created context. An example from our data shows a group of friends sitting around a table and sharing a newspaper, turning their backs to other people, and, that way, isolating from them. In this situation, a territorial group space is claimed. The group in another example takes a territorial group space by indicating that it will not yield to others while roaming ahead (see Fig. 2b).

What is apparent in these examples is the way public places are transformed to personal and group spaces by using the resources available. The free newspaper on trams and the circling act in groups provide physical resources to mark the place socially as *a relevant space*. With these actions, the actor manifests themselves as a participant or as an outsider of the ongoing social activity.

5.3 Social solutions to problems in navigation

Navigation in urban spaces is difficult for a number of reasons. Maps are complicated and hard to remember, streets and buildings resemble each other, exact addresses are difficult to keep in mind, and complicated bus routes are difficult to envision. These problems are usually solved with interaction with other people. When people on the move come up against obstacles, or are simply feeling unable to navigate their routes correctly, they often seek help via their social channels.

In our data, problems were solved with the help of a mobile phone. For example, when people realized that a bus had already gone, mobile phones were quickly picked out of pockets. This does not suggest that people would have been totally lost in navigation, rather, the telephone connection was invoked mainly for two reasons: to announce that the schedule has changed, and to negotiate what to do next (see Fig. 3). In our example, missing the bus affected not only Kaarina's and her children's schedule, but also the schedule of her friend.

Fig. 2 **a** Newspaper marking a boundary of personal space. Jane was riding alone on a bus. All of the passengers were reading a similar free newspaper. So did Jane. There were no discussions among the passengers. **b**Gathering in a circle as a sign of claiming group space. Anne and Maija met Jaana at a metro station. They got together in a circle to talk about the clothes that Jaana had bought. They share a territorial group space

Fig. 3 Missing a bus triggers social navigation. Kaarina was on her way to meet a friend with her children. They missed the bus they had planned to take and she called her friend in order to ask when the next bus leaving. She preferred to call even though the timetable was in front of her

Fig. 4 a Hurrying. Kaarina needed to run with her children to catch a bus. Before running, they were in a fast-food restaurant and the children didn't eat fast enough. **b** Waiting. Maikku was swimming with her grandson. She rushed to the bus stop in order to go home in time, but after checking the timetable, she noticed that she would have to wait for the next bus. After a while, she decided to call her son (the father of the grandson) to let him know that everything went well in the swimming hall

This episode underlines the complex relationship between navigational procedures and possible disruptions in the socially organized and co-ordinated schedules. Disruptions in these actions require re-negotiation of both the next navigational action as well as shared schedules. Generally, Kaarina's action in the situation shows orientation towards social awareness: she manages her relationship to the other person indirectly involved in her journey. In future, this mundane, but still rather complex, re-negotiation procedure could probably be recognized and assisted by proactive devices and services.

5.4 Temporal tensions

Time plays a crucial role when moving through urban areas. It has been argued that mobile devices free people from the limitations of time and place. Our data, in agreement with previous work, e.g. [26], firmly disagrees with this. In fact, time and place are overemphasized in mobile contexts. Fluctuations in the importance of time and space as contextual factors are called *temporal tensions* here. Temporal tensions refer to situations where time becomes problematic in relation to the action at hand and where, at the same time, the temporal aspect of a situation is actively used to orient action (making temporal tensions in actions visible). Analytically, temporal tensions could be classified into four stages: acceleration, normal (anticipated) proceeding, slowing down, and stopping. Some situations get *accelerated* so that multiple tasks should be performed more or less simultaneously, and some prepared tasks may become impossible at that very moment. They can be carried out only if events unfold as anticipated. Sometimes, everyday life gets "*slower*", or even "*stops*"—for example, because of a suddenly cancelled appointment or a misunderstood timetable of a public transport vehicle. The two important tensions emerging from our data are *hurrying* and *waiting*. When hurrying, people are actively orienting to the temporal aspects of their actions. They are managing their current doings to fit in a time frame—the planned action is not unfolding as anticipated, and more "doings" must be squeezed into a same amount of time than in a normal situation to keep up with the original plan. When moving in a hurry, physical and social surroundings change rapidly, but attention is directed mainly to space (e.g. shortest route) and time (e.g. monitoring time). Amidst human and inhuman moving actors, finding the fastest route becomes important (Fig. 4) and co-ordinating the hastening requires all of the attention of the person. Activities that need constant monitoring involve route selection, checking timetables, informing related persons, and anticipating changes in the surrounding environment.

Sometimes, people simply hurry too much, which results in waiting. When *waiting*, the relationship between time and action is stretched. Temporal aspects of the situation are again a main orientation in the situation as an anticipated action is about to happen (Fig. 5). The waiting time can then be made use of by various time-killing activities (e.g. by calling somebody, see Figs. 3 and 4b).

5.5 Multitasking

The fact that navigating through an urban environment requires paying constant attention to surroundings means that attentional resources available for interacting with a device are limited. The navigator must actively position and reposition him/herself in the social context of other people and physical objects. Social conventions reduce some of the cognitive load in navigating through a mass of other people (e.g. in Finland, people use the right side of the pavement), but not all actions can be as streamlined and may require socially coordinated sequencing—turntaking—with other people to achieve the goal (e.g. turntaking is required among people whose lines of walk are crossing). Furthermore, finding the way from the starting point to the goal

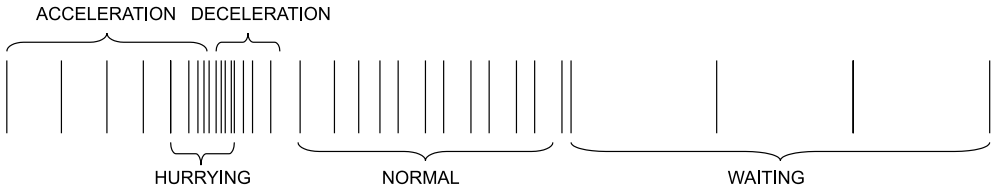

Fig. 5 Temporal tensions: acceleration, deceleration, hurrying, normal (or balanced), and waiting. The *horizontal axis* denotes objective time in the task and the *vertical bars* show task-related actions

requires monitoring performance and reasoning whether the goal is getting closer or not.

Navigating while moving obviously restricts multitasking. As discussed in Sect. 5.1, people seem to have a longer-term plan of navigation (e.g. "to go and visit parents") divided into sub-goals (e.g. "turn left at the next corner"). Therefore, monitoring the environment to notice whether a sub-goal has been reached requires attentional resources from other tasks. The requirement for attention is higher in situations involving more uncertainty, such as when getting closer to a signal that indicates the fulfilment of a sub-goal (e.g. "the street corner"). Another attention-demanding task is manipulating or creating sub-goals "on the move" (e.g. inferring the shortest route when coming to a street-crossing). These are likely reasons why our participants tended to have less multitasking while moving than whilst waiting. It is also known that navigation in an urban environment places heavy demands on working memory, the visuo-spatial resources in particular [27]. However, when the route is familiar and navigation is more automatic, and working memory is not as taxed, more multitasking can be carried out. An extreme example is given in Fig. 6.

While waiting, people tend to engage only in the kind of multitasking that does not hinder them from noticing the signal in the environment that indicates the end of waiting. This signal constitutes a nodal event that must be noticed. For example, making a call with a mobile phone while waiting for a bus does not interfere with the demand of seeing the bus as it comes closer. In contrast, writing an SMS message or email would interfere with capturing this nodal event (since it requires eye gaze and hands).

6 Design implications

The purpose of the following suggestions is not to advocate a certain specific technological platform or infrastructure, but to direct designers' attention to higher-level issues in mobility and mobile contexts. The suggestions below fall into four broad categories: navigation, mobile communication, mobile games, and general user interface issues.

6.1 Navigation

Monitoring sidestepping The phenomenon of occasional sidestepping, for example, reading one's emails in an Internet café on the way to meeting friends (Fig. 1a), creates a challenge for route-guidance systems. These systems could monitor and learn information about recurring sidestep destinations (and activities performed therein). This information could be utilized, for example, in a busy-alerting service that would watch a person's timetable and warn if the ongoing process might make him or her busy in the next phase. Thus, understanding temporal tensions caused by sidestepping would be important in creating this kind of service. This is also relevant from the viewpoint of affective computing [28], as temporal tensions are usually accompanied by changes in the emotional moods of the users (e.g. frustration caused by missing the bus).

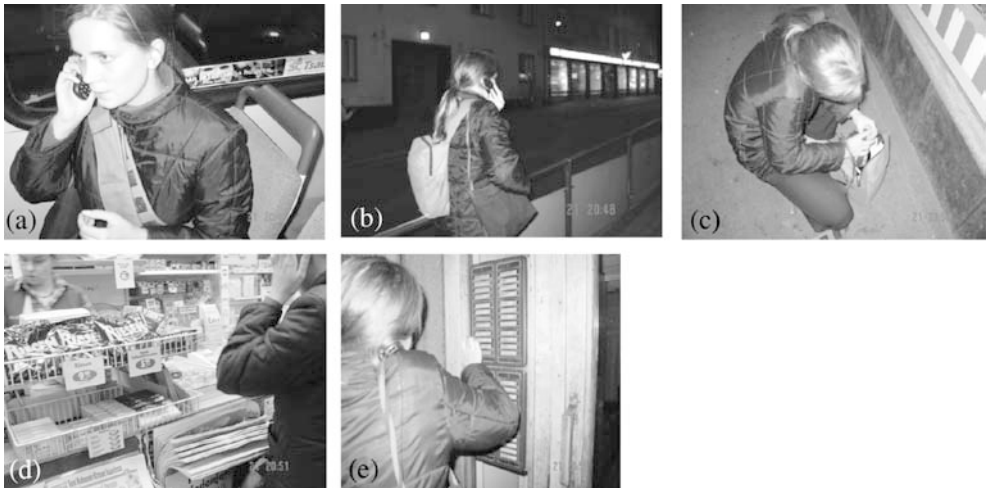

Fig. 6a–e Mobile multitasking. **a** After her work shift, Jane took a tram to visit to her friend. On the tram, she received several phone calls. **b** She continued talking while stepping out from the tram, crossing the street, walking to a kiosk, **c** grabbing some money out from her bag, **d** actually buying the tobacco, and **e** trying to manipulate malfunctioning door bell buttons. We noticed that moving and waiting pose somewhat different demands on how the environment on the one hand, and the task itself on the other, are attended

Adapting to sidestepping The notion of situational acts within planned acts implies that it is important to allow users to choose or create a route that is not necessarily the shortest or fastest, but otherwise rewarding. Sidestepping is relevant because travelling should not be understood only as moving from place A to place B. Collected information about sidestepping could be used to support more flexible, customized routes that are not based only on minimizing distance. Ideally, routes would represent possibilities for beneficial sidestepping such as popping into a store (Fig. 1b). On the other hand, sidestepping can be explicitly supported by visualizing the resources available and close to the route (e.g. gas stations for drivers). Sidestepping calls for adaptation and flexibility on the part of the system that aims to support navigation. The system may need to re-adjust its navigation suggestions after sidestepping from the proposed optimal route has occurred, as is done in many of the current in-car route-guidance systems.

Predicting navigation problems Agents could benefit from observations of common problems in navigation. When facing an obstacle, such as not finding the way to a meeting place or missing a bus, people tend to find a social solution. In our data, problems were solved, for example, by calling to the friend (Fig. 3). Navigation could be supported by a digital or live agent as in route-guide services (direct social navigation), or by a representation of a history of solutions other people have made in the same situation (indirect social navigation). Proactive agents are already in use in some in-car navigation devices that create a direct connection to a live person, who advises the driver about the route, or even gives advice in the case of a car accident. Another example illustrating this kind of service could be a mobile agent, triggered by a bus station, that would be available to people who have missed their bus.

Enhanced awareness of navigation-related changes in remote contexts To address the problems of waiting for environmental signals (Fig. 4b) that indicate an important forthcoming context change, we suggest devices that "boost" these signals. For example, the vibration of a mobile device could indicate that one's bus is approaching the bus stop. This service would free resources for other, potentially more interesting, activities. Our analysis of multitasking implies that it is important that interacting with the device does not interfere with the noticing of the signal in the environment that indicates the transformation from one context (e.g. waiting) to another (e.g. getting on the bus).

6.2 Social awareness in mobile communications

Communication of context information As humans are inherently social beings, our actions are always directly or indirectly linked to other people (e.g. Fig. 3). Context-aware technology should, thus, be designed to consider not only one person's doings, but also the doings of other relevant people. Simple implementation of this idea would mean, for example, crosschecking of a user's schedule or conversation history with one of their friends and to compare it to their past or current physical location. On the basis of these crosschecks, the systems could provide information to the user about their social contexts and networks of communication (social awareness), and also use this knowledge to proactively infer the user's next action. Another implementation could consider the fact that, at the beginning of mobile phone conversations, it is very common to both ask about and describe one's own contextual situation [29, 30]. Context-aware technology could provide additional representational tools for the presentation of user environments (e.g. what kind of resources are present in the present or remote context, how easily available other social contacts are, or how likely they are to know an answer to the problem). During the temporal tension of hurrying (see Fig. 4a), contextual information would be useful in preventing an unnecessary waste of time caused by calling a busy or inaccessible person. Prototypes of contextual information of others communicated to and represented in a mobile device do exist (e.g. [31]), but field tests have not focussed on the aspect of what contextual information would be useful for a mobile person to know about another mobile person. Wizard of Oz studies in the mobile context could be carried out in the future, similar to the study performed by Hudson et al. [32] in the office environment to address this question.

Recognition of personal and group spaces The observation that people actively create personal and group spaces (see Fig. 2a, b) points out that issues of space claiming and privacy in social interaction are important in mobile contexts. Many of the markers of changes in personal and group space could be used as starting points in the recognition of new mobile contexts. Space claiming indicates the nature of the interaction at hand in relation to other people situated in the vicinity. Thus, context-aware devices could recognize acts of space claiming because they are important indicators of the user's activity and willingness to use different types of services (e.g. single/multi-user). It would also be fruitful to consider services that could extend the claiming of personal or group space to the (shared) virtual space. At the present moment, there are prototype services [33] that can be used to overlap physical and virtual worlds, and to turn a virtual space into a location-dependent social place. In addition, virtually shared group spaces pose challenges for the design of shared displays and of privacy in interaction.

Representation of nearby associates Ad hoc meetings among acquaintances (Fig. 1c) could be arranged easily (also in virtual space) if people on the same route, or on routes close to another, were aware of each other's movements (e.g. [31]).

6.3 Mobile games

Mixing reality with the virtual world It is possible that, in the future, mobile users can be connected to a multiplayer online game whilst moving around in the real world. Such games could utilize the real world contexts presented in this paper in at least three ways. First, a group of people sharing a group space in the real world could be given more "power" in the game than those not in the space, or the people in the same group space could be given a bonus task to be solved together. Second, people playing a game featuring challenges or problem could be given a possibility to call and ask for help from their friends in the real world to solve the problem. And third, temporal tensions in the real world could be part of the game. For example, when the player stops, the game world could become more demanding, or it could create tensions in the real world by providing time-limited tasks that are connected to certain routes in the real world (e.g. catching a certain person or bus).

6.4 General user interface issues

Modality selection Our participants rarely just "walked" or "waited" but instead, engaged in multiple activities simultaneously (Fig. 5). Multitasking naturally gives rise to multi-modal interfaces. Traditional PDAs, for example, require both hands and visual attention to operate, which is clearly inappropriate for mobile contexts in which some modalities are preserved for other tasks. On the other hand, nomadic user interfaces (designed for interaction while walking) might be too clumsy and awkward for situations where all modalities are available, such as during a longer waiting period. Context-sensitive selection of modalities can be achieved by recognizing prototypical "modes" of mobility, such as walking, waiting, hurrying, navigating, or sidestepping, and choosing the interaction channels according to the resources that are typically free in that mode. Recent developments in context management and recognition in mobile devices point out that this may not be a distant dream (e.g. [34]).

Interruption management Mobile computing devices that filter the information flow (e.g. incoming emails, SMSs, phone calls, etc.) need to select and intensify task-relevant information, and inhibit task-irrelevant information. From the point of view of the user, irrelevant information proves to be an interruption, no matter how elegantly it is conveyed. We propose that markers of context-change also provide indirect indications of the interruptability of the person. Space claiming acts, for example, signify a transformation of context to where certain information is attended to (e.g. newspaper), and other information is ignored. In the office environment, talking to another person in the last 15 s is a very good predictor of the interruptability of a person [32], but in a mobile situation, the best predictors may differ. Temporal tensions, such as acceleration, make certain kinds of information important (e.g. estimations of speed), and other information irrelevant. Moreover, as sidestepping introduces breaks and pauses into the use of the system, its user interface must incorporate effective reminders of the stage of the interrupted task.

7 Conclusions

If context-aware devices and services are to find their way into everyday mobile life, careful reconsideration of the analytical level and role of "context" in the studies of technology and human action should be taken into account. Social acceptability of new context-aware technologies is dependent on how well they fit into the routinely carried out mundane processes of everyday life. The results of our study describe interactional social and psychological restrictions and resources in mobility: how situational and planned acts intermesh in navigation, how people construct personal and group spaces, and how temporal tensions develop and dissolve.

The results of our data are geo-culturally bound to Helsinki, Finland. The everyday journeys made by the selected target groups could look different outside Scandinavia, or Western Europe in general. Thus, the study could be replicated in other cultural settings to assess the generalizability of our findings. However, even with these reservations, the viewpoint and analysis of everyday journeys presented in this paper demonstrate one way of dealing fruitfully with the concept of mobile context within the HCI tradition, and of incorporating the findings into the design process as design implications. The studies of mobile settings based on an empirical, human-centred approach offer interesting possibilities that allow us to see the future of context-awareness in a new and innovative light, and offer a rich source of innovation for new context-aware services and for the design of underlying context-recognition mechanisms.

Acknowledgments We thank Salla Hari, Sauli Tiitta, Tomi Kankainen, and Esko Kurvinen, and our industrial partners Alma Media, Elisa Communications, Nokia, Sonera, and SWelcom. The second author acknowledges a grant from the Academy of Finland.

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