Determining Requirements for Supporting Mobility

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Abstract

This paper identifies the importance of context and emergent needs to mobility and notes that current approaches to specifying and designing mobile technologies pay little attention to users' needs. We sought to overcome some of the shortcomings of established methods for determining requirements for stationary information systems in the TramMate project. A user-centred approach was employed, incorporating methods that are sensitive to the highly contextual and emergent nature of mobility. The TramMate project has provided insight into the strengths and weaknesses of these methods for determining the requirements for mobile technologies.

Keywords

Mobility, mobile technologies, determining requirements, user-centred design

Introduction

Mobility challenges established methods for determining requirements for stationary information systems (for example Davis 1993, Kotonya & Sommerville 1998). Issues of context and emergence are critically important for mobile technologies: devices and applications. While these issues have received some attention in relation to stationary systems (see Beyer & Holtzblatt 1998, Iacucci, Kuutti & Ranta 2000, Kensing & Munk-Madsen 1993), they are more significant and complex when applied to mobility.

Mobile technologies facilitate connection with diverse people, objects, technologies and data sources from any place at any time. All or some of the people, devices and data may be mobile. If we accept that human action is situated (Suchman 1987) then any examination of mobile technologies must take into account multiple contexts of use and transition between these contexts. However, methods for determining requirements for stationary information systems and devices do not have a strong contextual focus nor are they sensitive to the transition between different contexts. In addition, technology use may emerge in unexpected ways from the interaction between the human user, the user's activities, the contexts of use and the technologies (Carroll & Tobin 2003). Such emergence is compounded by the novelty of mobile technologies: users are uncertain of the possible activities and contexts of use supported by mobile technologies and will only understand these possibilities through actual experience. For example, Palen, Salzman and Youngs (2000) found that novice users were unable to envision their use of mobile devices. As a result of the importance of emergence,

forecasting the use of innovative mobile technologies is an intractable problem and necessitates the development of new requirements methods or novel combinations of existing methods (see Howard, Carroll, Murphy, Peck & Vetere 2002).

To date, there appears to be little consideration of context and emergence in practice. The specification and design of mobile technologies have focused on technological capabilities rather than use. Infrastructure issues (3G networks, bandwidth and protocols), form factors and usability of mobile devices (including power, data input and output) are receiving much attention (for example, Dix et al. 2000, Pirhonen, Brewster & Holguin 2002). These are critical issues that provide the necessary foundations for implementation of mobile technologies but are not sufficient to ensure successful use. An alternative, user-centred approach involves examining the ways that mobile technologies can add value to users' lives and then designing technologies to meet their needs.

This paper explores the relationship between mobile technologies, context and emergence. It describes a user-centred approach to determining the requirements for mobile technologies that incorporates methods that are sensitive to the contextual and emergent nature of mobility. The approach was devised as part of the TramMate project. The innovative combination of requirements methods used in the TramMate project is evaluated and some suggestions for further research are outlined.

Mobile Technologies and Context

Human action is situated: "*every course of action depends in essential ways upon its material and social circumstances*" (Suchman 1987:50). The way that a technology is used is worked out through a process of exploration, evaluation and adaptation by different users in their situations of use (Carroll, Howard, Peck & Murphy 2002). 'Situation' includes all the rich detail of the actor's circumstances; we need to abstract away much of this detail in order to focus on those aspects of a situation that are significant to our purpose (Lueg 2002). We can achieve this through the concept of 'context'. Context operationalises the significant aspects of a situation of use. In this paper, we are interested in the use of mobile technologies and therefore have selected and classified four types of context that represent significant aspects of their situations of use:

- Spatial context refers to place (location, either virtual or physical) and the characteristics of that place including such environmental details as weather conditions and noise levels. It also refers to space (areas, either virtual or physical) such as meeting rooms and cyberspace.
- Temporal context includes both absolute (9am) and relative (before, faster) time and events scheduled (that are outstanding, current or pending) or past (history).
- Technological context refers to the telecommunications infrastructure, accessible applications and information systems and other devices (Dix et al. 2000).
- Social context refers to the people (and collections of people) that are accessible including such characteristics as their purposes and activities as well as more abstract qualities such as trust, politics and culture. If we are looking at the context of a mobile device, we must also include the user (identity, characteristics, preferences and needs).

Some aspects of the user's situation, operationalised by these four contexts, are exemplified in Table 1. Note that the virtual/physical dimensions are orthogonal to absolute/relative dimensions.

Characteristics / Context	Virtual	Physical	Absolute	Relative
Spatial	On-line Chat room	Swanston St Raining	27^0N, 43^0E 23^0C	Familiar/unfamiliar Noisy/quiet
Temporal	Scheduled	Current	9am EST	Before/after
Technological	Voice mail Accessible network	Mobile phone	Synchronous communication	Working/ not working
Social	On-line community	Jennie & Sonja	3 person group	Hostile/ friendly

Table 1. Four contexts significant for mobility

Users will interact in some purposeful way with the mobile technology in these contexts. Therefore, when determining the requirements for mobile technologies it is essential to examine users and their activities, purposes, characteristics and needs in relation to these contexts. This has a number of implications of the selection of requirements methods and their desired characteristics.

Firstly, we need to examine users' needs and preferences in relation to each of these four contexts. For example, examining a user's requirements in the temporal context involves understanding the time of activities ('at 9am I have a briefing with my manager'), the sequencing of events in the day ('I prepare for a meeting before meeting my support staff'), scheduling a day's activities ('there are two meetings in the city centre so I will schedule them both for the morning') and actual events ('I have arrived 15 minutes early so I need to locate a café'). It is not sufficient, however, to determine users' requirements solely in relation to each of the four contexts. The very nature of mobility implies transition: users can move fluidly from one context to another, from synchronous to asynchronous communication, from application to application while communicating with other individuals and groups. Requirements methods must be developed or combined to cater for multiple contexts and the impact of different and changing contexts on use.

Secondly, we need to broaden the concepts and methods used to determine requirements. Mobile devices facilitate interaction outside organisational or office environments and allow social, personal, leisure and organisational use in different contexts (Carroll, Howard, Vetere, Peck & Murphy 2001). For example, a mobile phone allows a business worker to be accessible at any place (having network coverage) at any time; conversely, the same worker is accessible at any time to family and friends while physically located within the organisational environment. As a result, the distinction between work and leisure, business and private, group and individual use are becoming increasingly blurred. This means that traditional methods for determining organisational requirements need to be expanded to account for use in multiple, poorly differentiated, non-organisational contexts. New concepts and theories for understanding these blurred contexts and their influences on human interaction are also required.

Thirdly, contextual requirements methods – where the interaction between analyst and user occurs in the contexts of the user's everyday activities – are needed. In particular, it is necessary to observe users in context. Mobile technologies facilitate ad hoc behaviour (Carroll et al. 2001). Planning is becoming less important because users are increasingly accessible at different times in different places to arrange meetings or joint activities. Consequently, asking users what they will do in the future (that is, focusing on their intentions or asking them to predict their ad hoc behaviour) has limited usefulness. Ad hoc behaviour involves a gap between intentions and action; mobile technologies allow users to modify their goals or plans in response to contextual triggers. Therefore it is necessary to examine users' actions by observing them in context, where ad hoc behaviour may be triggered by environmental or social forces.

Fourthly, non-contextual requirements methods (for example, interviews by telephone or in a meeting room) are necessary. The combination of personal, social and business use in multiple and changing contexts suggests that mobile devices may only receive partial attention. This has implications for analysts determining requirements. Although it is important to collect data in context, there is also a place for non-contextual data collection where users can give the full attention to envisioning their future needs and reflecting on past experiences.

In conclusion, the importance of context necessitates understanding of the spatial, temporal, technological and social contexts that are significant to the use of mobile technologies. In addition, new concepts are required to deal with the blurred roles and transitions between contexts that mobility entails. Innovative contextual methods are called for, to help to build understanding of users' actions and needs; these should be supplemented by existing contextual methods such as observation. There is a place, also, for non-contextual requirements methods, where users' full attention is devoted to envisioning future needs rather than demonstrating current practices.

Mobile Technologies and Emergence

The use of technology is not determined by its characteristics or those of its user cohorts but emerges over time from the interaction of the users in context and the technology (Markus & Robey 1988). Forecasting the use of mobile technologies is more complex than that of stationary information systems due to the influence of multiple, changing contexts of use outlined above as well as the novelty of mobile technologies. Users are still exploring the possibilities of mobility and the activities and contexts of use that mobile technologies afford. Initially, the mobile phone was viewed as an extension of the home phone with the added ability to make calls at any place. However, over time it has been used for totally different activities such as ad hoc group decision-making (Carroll et al. 2001), alerting subscribers of the proximity of drug 'sniffer dogs' (Lebihan 2002) and blind dating (Loken 2001). There is a reciprocal relationship between these different activities and contexts that may lead to further, emergent activities and contexts.

Dealing with emergence and approximating future users, activities and contexts of use of yet-to-be-developed mobile technologies is difficult. Some insights have been gained from an envisionment process called Acting Out that was constructed from scenario-based design, participatory design, and theatre performance (Howard et al. 2002). Scenarios are 'acted out' by participants. Performance of scenarios immerses participants in a range of everyday

situations as a prelude to envisioning possible future needs and situations of use (Carroll & Tobin 2003). A focus on technology is enhanced through the use of props or bare representations of candidate technology forms. The participants use props to overcome contextual constraints such as limited time, noisy environments or a rescheduled meeting. Both theatre spaces and participants' everyday contexts are used for Acting Out performances.

Table 2 summarises the implications that the importance of context and emergence have for the requirements methods employed in relation to mobile technologies.

Issue	Implications for requirements methods
Mobile technology use in, and between, multiple contexts	Development of new requirements methods or novel combination of existing methods
Blurred distinction between organisational, social, personal & leisure use in poorly-differentiated, non-organisational contexts	Development of new concepts, theories and methods for non-organisational contexts
Ad hoc, unplanned behaviour results in a need to interact with users in everyday contexts	Use of contextual methods especially observation
Mobile devices receive only partial attention in multiple, changing contexts	Use of non-contextual methods
Use of mobile technologies is emergent and poorly understood	Use of envisionment techniques such as Acting Out

Table 2. Mobility issues and their implications for requirements methods

The TramMate Project

The TramMate project was initiated to determine the informational and functional needs for a location-aware mobile device that would encourage employees, where appropriate, to use trams when travelling to and from the city. The headquarters of a major technology company are located on the outskirts of Melbourne, Australia (population 3.5 million). Many of the company's employees travel to meetings in the city and its suburbs, principally by car although frequent trams heading for multiple destinations pass by the company headquarters.

The research team designed the project in four phases: determining requirements, design, prototype development and evaluation. The focus of this paper is the first phase where requirements methods were employed that heed the contextual and emergent nature of use of mobile technologies. The practices of a number of the company's employees—called 'users' in the paper—were studied, including senior managers, sales and technical middle managers and a cognitive engineer. Data were collected using different requirements methods (detailed in the following section) and recorded by video and audio tapes and field notes. The data were analysed to describe users' current practices, needs and desires. Issues were identified through individual and cross-case analysis, broad themes were noted and then classified. Needs and opportunities for technological support were identified and the implications for

possible functions and form factors for mobile technologies were analysed. In this way, requirements for future mobile technologies were induced from current and envisioned future practices rather than from the beliefs, assumptions or theories of technology designers and marketers.

The Requirements Methods

When selecting the requirements methods for the TramMate project, we sought to address the implications of context and emergence summarised in Table 2. Also, we combined methods in order to construct a rich understanding of the users' practices, needs and future desires. Spradley (1979:8) suggests that sources for learning about others are what people say; the way that people act; and the artifacts that people use. No one source is complete in itself but together they lead to rich understanding. Thus, we used a combination of three requirements methods: interviews, Contextual Interviews (Holtzblatt & Beyer 1993) and Acting Out in Context (AOiC). All three methods involve users talking about their perceptions, activities and needs; in Contextual Interviews and AOiC users carry out their everyday activities. In Contextual Interviews we observed the artifacts used by users in their activities while in AOiC we provided props to assist users in imaging their future needs and desires. Together, these methods provide understanding of the users and their current needs, some indications of their future needs and provide a mix of contextual and non-contextual data. The methods used and their outcomes are described in the following sections.

Interviews

Four users who travel frequently into the city centre were interviewed at their place of work. The aim of the interviews was to provide demographic information, an overview of the organisational situation, descriptions of current work practices and the interviewees' perceptions of travel by car and public transport.

All users were adamant that punctuality is crucial: "*we must be on time*". All had a clear idea of expected travel times to meeting locations or would leave very early if travelling to a new location. If running late, users would take a taxi to avoid parking problems. Punctuality has such importance that one user sets his watch 5 minutes fast to ensure that he is on time. Arriving a little early was not perceived as a problem as they could have a coffee, review their notes or use mobile technologies to complete work so that the time is not wasted.

Technical employees tended to carry multiple laptops for demonstrating multiple applications and their interoperability. All users carried a mobile phone as well as a PDA. These are used for different functions (the phone for coordinating with others: "*meet here*" and the PDA for a calendar, addresses and daily tasks). The mobile devices are synchronised regularly with a personal computer at company headquarters. A strong desire to integrate or converge these technologies was expressed by the users.

The users were receptive to using public transport. Environmental issues were important to two users. However, using a mobile phone on the tram raised issues of privacy, confidentiality and courtesy to other passengers. Paying for the tram trip (having to find coins) was a nuisance although the company provided an easily-accessed jar of petty cash for this purpose. Regardless of the mode of transport, users had to locate streets and specific numbers; on-line street directories are used. However, working out a public transport route was an important issue: "*What trams do I need to take to get from A to B? Are trams integrated with other forms of public transport? Are estimated travel times (maximum and*

minimum) provided?" Convenience is essential to these users: they want few changes of trams because they viewed wasted time between connections as more important than overall travel time: "*hanging around doing nothing is the worst*"; also, walking between connecting trams was inconvenient, especially when carrying multiple laptops.

A car was viewed as more flexible so that users could move on to subsequent meetings at different locations. Often several users travel to the same meeting so it is more efficient to travel together in the one car. The car is quieter for rehearsing a presentation en route, it provides a private space or 'mobile office' so that "*I'm in control*". However, "*parking is painful and expensive*".

Contextual Interviews

The interviews were followed by two contextual interviews with users travelling by car (the first involved a sole user, the second involved two users travelling together to a meeting). The aim was to provide understanding of current practice: contextual interviews involve interacting with users as they carry out their everyday activities (Holtzblatt & Beyer 1993). Contextual interviews rather than participant observation were used as they involve more active intervention by project team. Team members were not just participating in users' everyday activities in order to see them 'through the users' eyes' (Nardi 1997) but were questioning the users as they undertake their everyday activities in context. This has advantages of time savings and tighter focus on project aims.

Two quite different views of technology and its place in the users' lives resulted; the first user was a very senior manager, highly experienced and organised. To him, technologies were inserted into his working day at discrete yet critical times: he accessed 'islands of technology' to resolve issues or answer clients' questions. His working day was quite predictable so he organised his day rather than just a meeting. The second contextual interview involved a junior sales executive and a technical support representative. Their working day was more unpredictable (involving cancelled or changed meetings) so more improvisation with meeting schedules was required; being on time and prepared was critical. The pair used the car as a mobile office, planning the meeting and making phone calls (both social and work-related). For these users, mobile technologies were more closely woven into their working schedule. Like the senior manager, the sales executive carefully discriminated between manual and technological support for appropriate tasks; one key issue for both was the corporate image projected by writing notes (acceptable) or typing into a laptop (unacceptable) while meeting with clients. Written notes, however, cannot be accessed while driving a car so meeting follow-up must be delayed until the user returns to headquarters.

The contextual interviews provided understanding of the business people's everyday routines and their current practices in travelling to off-site meetings; this extended the interview data as it occurred in context. The project team members agreed that *experiencing* was more powerful than just *hearing* about users' practices, especially where two users were interacting in the car. The contextual interviews highlighted some of the advantages and disadvantages of travelling to business meetings by car and use of technology when travelling. This enabled us to determine some of the users' desires or wishes for additional technological support while in transit.

Acting Out in Context

Data from the interviews and contextual interviews were used to plan and implement an innovative method that we have called Acting Out in Context (AOiC). The aim was to extend and validate our understanding of current practice and to envision future technological functions that would support the users. We have been exploring the use of theatrical methods in envisioning future needs for technology through Acting Out (Howard et al. 2002). We have revised and extended this to overcome identified shortcomings (Tobin & Carroll 2002) and to meet the TramMate project aims more closely. AOiC is an experimental method and was used twice in the project. For each AOiC session, a user travelled by tram to city meetings accompanied by members of the project team. One team member facilitated each session, one video-recorded slices of the interaction and another made extensive notes on the process.

In the first session the aims of the project and the acting out were explained to a sales leader and a range of props were presented in order to focus her discussions of technology needs and desires. Each prop indicated a different medium for interaction: reading, writing, looking, listening and speaking (tablet and PDA-sized blocks of wood, sunglasses, earphones and a mouthpiece). The user selected a tablet-sized prop then set off for the tram stop, caught a tram and travelled to her meeting.

The outcomes can be delineated into meeting-related tasks and the themes that are 'wrapped around' these tasks. The meeting-related tasks were preparing for the meeting, communicating with those involved and then following-up after the meeting. However, surrounding these tasks were a number of themes: privacy, accessing information (about travel arrangements, other meetings that day and the general work or economic situation) and entertainment/leisure (social issues, music to relax on the way to the meeting). The user expressed the need for convergent technologies (she carries a paper notebook, mobile phone and a PDA). Weaknesses of this session were that the user appeared uncertain about our expectations of her and rapport was only established between the user and project team members towards the end of the session.

The second session incorporated learning from the first and achieved incremental improvements by focussing more closely on future needs in context and technology. We worked with a user who had participated in an initial interview so rapport had already been established. We spent more time explaining the acting out process and two project team members 'acted out' a brief (but unrelated) scenario to demonstrate the type of interaction desired. The same range of props was presented and again the tablet-sized prop was selected. The user's trip was complex, involving multiple trams on different routes as well as a short walk. In this case the prop was the focus of the user's attention and triggered much discussion about possible technological support while in transit.

The AOiC provided specific information relating to technology use in context and the emergent requirements that arise from the interaction of the user with the prop in context. The surrounding environment acted as an additional prop in the performance: the interaction between the bare mobile prop and the context triggered discussions of users' needs and wants: "*I'm here and I have this problem and would like this information accessed from our corporate database …*" In particular, location-specific information needs were identified (the information needed in the office is different to that at the tram stop and on the tram). AOiC gave users an active role in the requirements process: it involved the users doing everyday activities and showing their needs – using a finger, pretending to push buttons or pointing at an external information system – for informational and technological support while

travelling. The props helped to constrain these supports to plausible technological options rather than science fiction (see Howard et al. 2002).

Discussion

The company's suggested solution to choosing a mode of transport was a location-aware mobile device to provide tram route information to users. The requirements determined by the TramMate project team included:

- the need for a convergent device that could be tailored for individual's preferences in different contexts
- access to multiple technologies while mobile (including the company's database, email, on-line newspapers, music, text messages and voice)
- functionality for completing work-related meetings, and
- a broader 'wrapping' around work activities, of which location-aware information for route planning was a minor part.

The users' problems when in transit to meetings did not focus merely on selecting a mode of transport. Consequently, their requirements identified in the TramMate project were far broader than the company realised. Users wanted mobile technologies to provide them with a 'mobile office' including communication via voice, email and text messages; daily or weekly scheduling, current tasks and client addresses; social and leisure activities including music, text (newspapers and books), personal development (often accessible via the internet) and a private calendar. The requirements methods employed in the TramMate project enabled the project team to identify a mismatch between the suggested technological solution and users' needs.

In Table 3, the requirements methods used in the TramMate project are classified as contextual or non-contextual in relation to Spradley's three sources of learning (Spradley 1979). Contextual methods, those that are applied in contexts of users' everyday activities, were particularly valuable in the project. Studying users in context provides access to their actual, minute-to-minute experiences rather than their analysed, summarised and recollected accounts of what they do (Beyer & Holtzblatt 1998:47). Contextual methods are more likely to reveal routine or 'invisible' activities. They also enable analysts to examine the impact of context on users' activities and their needs in particular contexts. For example, it was only when travelling on the tram that the issue of a noisy environment was raised: the context triggered a response from the user who suggested that listening to music through earphones would help to block out noise while she worked.

	Non-contextual	**Contextual**
Saying	Interviews	Contextual interviews
Doing	-	Contextual interviews
Doing with artifacts **Doing with props**	- -	Contextual interviews Acting Out in Context

Table 3. Classification of the requirements methods used in the TramMate project

A tighter focus on context was achieved in the second AOiC session where all four types of contexts significant to mobility were investigated. A matrix was constructed to identify instances of the spatial, temporal, technological and social contexts (examples are shown in Table 1) and these were then injected into the acting out process. For example, the user was asked to demonstrate his actions when the location of his meeting was changed to an unfamiliar address; he used the prop to locate the street and street number, access tram timetables and map out a new route. The matrix enabled a comprehensive examination of the user's actions and needs in, and between, different contexts. The outcomes from use of the matrix illustrate the value of the classification of context shown in Table 1.

Only one non-contextual method, interviews, was employed in the TramMate project. In interviews the users articulated their needs out of their everyday working context; this was balanced by use of Contextual Interviews. However, users acted in context to demonstrate their needs and desires and this was not balanced by an acting out method that occurred out of context. AOiC involved users carrying a prop, being observed and filmed by strangers and drawing attention from other passengers while trying to demonstrate and articulate their needs and imagined future needs. Clearly the envisionment process, where possible uses of yet-to-be-developed mobile technologies are forecast, could receive only partial attention (from both the user and the project team members). Therefore, context can be a limitation when trying to forecast emergent needs and practices.

This suggests that there is a place for acting out in theatre spaces, where full attention on envisionment is possible and team members can have greater influence on the acting out process, as outlined by Carroll and Tobin (2003). An insight during the second AOiC session supports this: it was noted that the user's envisionment was limited by his knowledge of current technology and infrastructure and, as a result, possibilities for support were overlooked. This could be overcome by more thorough preparation of the user by presenting some of the imminent and likely technological innovations that relate to mobility (see Howard et al. 2002; Tobin & Carroll 2003) that are then applied in non-contextual spaces.

Finally, Acting Out in Context is a variant of Acting Out (Howard et al. 2002). Work is needed on developing other variants for different situations, fidelity of props and technologies (for one example, see Carroll & Tobin 2003). Also, given the labour-intensive nature of Acting Out, there is a need to develop 'lighter', less-intensive contextual methods.

Conclusion

This paper has identified the importance of context and emergent needs to mobility and noted that current approaches to specifying and designing mobile technologies pay little attention to users' needs. In the TramMate project we sought to overcome some of the shortcomings of established methods for determining requirements for stationary information systems. A user-centred approach was employed in the TramMate project, incorporating methods that are sensitive to the highly contextual and emergent nature of mobility, to determining the requirements for mobile technologies. An innovative method, Acting Out in Context was devised and a novel combination of contextual and non-contextual methods was used. The TramMate project has provided insight into the strengths and weaknesses of these methods.

One implication of using contextual requirements methods is that users can only give partial attention to the task at hand while simultaneously monitoring and responding to other people,

technologies and tasks in their situation. Consequently, we suggest that a balance of contextual and non-contextual requirements methods is valuable.

In addition, difficulties of understanding and forecasting emergent use of mobile technologies remain. Moving beyond understanding of current practices is necessary because rapid changes in mobile technology and users' deployment of this technology quickly render current practices obsolete. However, there are few requirements methods for dealing with these difficulties. Acting Out in Context, devised for the TramMate project and described in this paper, is a product of ongoing work on acting out. There is a need for further research to refine variants of Acting Out (including AOiC), the impacts of the fidelity of props and the development of less labour-intensive, contextual methods. This work, along with the user-centred approach employed in the TramMate project, contributes to information systems theory and practice in providing requirements methods that are tailored for the specific nature of mobile technologies.

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References

Beyer, H. and Holtzblatt, K. (1998), *Contextual Design: Defining Customer-centered Systems*, Morgan Kaufmann, San Francisco.

Carroll, J. and Tobin, D. (2003), 'Acting Out the future: a process for envisionment', *Proceedings of 11th European Conference on Information Systems (ECIS 2003)*, (forthcoming).

Carroll, J., Howard, S., Vetere, F., Peck, J. and Murphy, J. (2001), 'Identity, power and fragmentation in cyberspace: technology appropriation by young people' in G. Finnie, D. Cecez-Kecmanovic and B. Lo (eds), *Proceedings of the 12th Australasian Conference on Information Systems (ACIS 2001*), Vol. 1, 95-102.

Carroll, J., Howard, S., Peck., J. and Murphy, J. (2002), 'A field study of perceptions and use of mobile telephones by 16 to 22 year olds', *Journal of Information Technology Theory and Application (JITTA)*, vol. 4, no. 2, pp. 49-62.

Davis, A. M. (1993), *Software requirements: objects, functions and states*, 2nd ed., McGraw-Hill, New York.

Dix, A. et al. (2000), 'Exploiting space and location as a design framework for interactive mobile systems', *ACM Transactions on Computer-Human Interaction*, vol. 7, no. 3, pp. 285-321.

Holtzblatt, K. and Beyer, H. (1993), 'Making customer-centred design work for teams', *Communications of the ACM*, vol. 36, no. 10, pp. 93-103 (Oct).

Howard, S., Carroll, J., Murphy, J., Peck, J. and Vetere, F. (2002). Provoking innovation: acting-out in contextual scenarios. X. Faulkner et al. (eds), *Proceedings of HCI 2002 (BCS-HCI)*, Springer-Verlag, London, 175-192.

Iacucci, G., Kuutti, K. and Ranta, M.(2000), 'On the Move with a Magic Thing: Role Playing in Concept Design of Mobile Services and Devices' in *Proceedings of DIS 2000*, ACM.

Kensing, F. & Munk-Madsen, A. (1993), 'PD: Structure in the toolbox', *Communications of the ACM*, Vol. 36, No. 4, pp. 78-85.

Kotonya, G. & Sommerville, I. (1998), *Requirements engineering: processes and techniques*, John Wiley & Sons, Chichester.

Lebihan, R. (2002), 'Sniffer dog site', zdnet.com, June 11 (accessed 13 June 2002).

Loken, S.B. (2001), *SMS babies on the way*, WAP.com, August 1 (accessed 3 September 2001).

Lueg, C. (2002), 'Operationalizing context in context-aware artifacts: benefits and pitfalls', *Informing Science*, vol. 5, no. 2, pp. 43-47.

Markus, M.L. & Robey, D. (1988), Information technology and organizational change: causal structure in theory and research, *Management Science*, vol. 34, no. 5, pp. 583-598.

Nardi, B.A. (1997). 'The use of ethnographic methods in design and evaluation', in M. Helander, T.K. Landauer and P. Prabhu (eds), *Handbook of Human-Computer Interaction* (2nd edn), Elsevier Science.

Palen, S. Salzman, M. and Youngs, E. (2000), 'Going wireless: behavior and practice of new mobile phone users', *Proceedings of the ACM Conference on CSCW*, ACM, Philadelphia, pp. 201-210.

Pirhonen, A., Brewster, S. and Holguin, C. (2002), 'Gestural and Audio Metaphors as a Means of Control for Mobile Devices' in *Proceedings of CHI2002*, Minneapolis, Minnesota, ACM.

Spradley, J.P. (1979), *The Ethnographic Interview*, Harcourt Brace Jovanovich, New York.

Suchman, L.A. (1987). *Plans and situated actions*. Cambridge University Press, Cambridge.

Tobin, D. and Carroll, J. (2003). 'Successful envisionment: augmenting the process of Acting Out'. *Department of Information Systems Working Paper*, available at http://www.dis.unimelb.edu.au/staff/jcarroll/JC Working papers.html