

Fluid Interaction in Mobile Work Practices

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1. Introduction

Our recent history has seen an upsurge in Information and Communication Technologies (ICT) supporting the mobilisation of computer-mediated interaction in general and during the past decade the mobilisation of organisational actors in particular. The ongoing mutual adaptation of work practices and such mobile and wireless technologies has both resulted in new work and technology practices and in the need for re-appreciating the perception of these practices. Everyday working life is increasingly constituted of a heterogeneous mélange where people, work objects and symbols as well as their interactions are distributed in time, space and across contexts. When we then consider interaction where participants, work, and interactional objects are mobile, the challenges of supporting the fluidity of interaction in collocated settings are immense. Many years of research and commercial efforts has sought to establish technological means by which interaction can be conducted with the same ease, or in the same fluid manner as collocated interaction. However, as argued by Olson and Olson (2000), distance does matter.

This paper addresses one particular aspect of organisational life for mobile workers, the constant negotiation of fluid work, based on the assumption that an essential aspect of mobile work is the negotiation of desirable versus disruptive interaction. We here take a closer look at mobile interaction in the locus of the individual meeting the others. The purpose of the paper is to initiate a broader discussion of fluid mobile work by drawing upon social topology, the study of ICT use in organisations, as well as experimental research constructing and testing innovative interaction management technologies. In order to initiate the debate we ask the question: *What are the pertinent issues involved in individuals negotiating mobile work?* This is based on the assumption of temporary asymmetry between individual mobile workers in terms of fluid mobile work – what for one person is a perfectly justifiable request can for another be a disruption.

Previous research has demonstrated the richness of means by which people working “at arms length” negotiate fluid ongoing interaction (Heath and Luff, 2000). However, the increased mobilisation of work activities across temporal, spatial and contextual barriers has placed localised technology practices at the centre of the constant negotiation of fluid ongoing interaction. The need to seek advice, inquire, co-ordinate, delegate, arrange and sort out implies that mobile workers critically rely on ICT support for negotiating their interdependencies. There is also a rich body of literature demonstrating new and interesting ICT-mediated interaction practices, but mostly in so-called “stationary” settings, i.e., where participants primarily work from a stationary computer.

The paper reflects upon the theoretical implications of advanced mobile work practices for the ways in which we understand contemporary ICT use. The numerous claims that we are entering an “*always-on*” society where people will interact “*anytime*” and “*anywhere*”, is far too simplistic a notion. Mobile work is often temporally, spatially and contextually dependent. Even when it is not, the asymmetry of situated interactional needs and preferences implies, for the individual mobile worker, an ongoing struggle to obtain fluid work practices. It is concluded that the specific and theoretical study of mobile work practices simultaneously highlights the relative poverty of current technologies in supporting fluid mobile interaction and the need for rich detailed management of interaction.

Section 2 outlines mobile interaction. Section 3 characterises mobile interaction in terms of the fluid topological metaphor. Section 4 outlines a framework characterising interactional asymmetries. Section 5 analyses the dimensions of struggling with fluid mobile interaction, and Section 6 discusses the findings and concludes the paper.

2. Mobile Interaction

It is obvious that during the latter half of the last century, our ways of living in general has been transformed considerably. Among many vital drivers of the transformation, information and communication technologies (ICTs) are perhaps the most conspicuous in terms of the widespread impact upon our social lives as a whole. There is no doubt that because of their pervasiveness and our intensive use of them, ICTs have changed ways of living in virtually all realms of our social lives.

Mobile work is clearly one of the emerging phenomena induced by the diffusion of ICTs in our modern lives. Traditionally, ‘work’ has been conducted in fixed formal places such as an office in a building, a factory and a laboratory, based on clear division of labour. However, we are now able to do our job flexibly largely beyond geographical and temporal barriers and contextual constraints by effectively using various ICTs such as the internet, e-mail, personal data assistants (PDAs), mobile phones, short messaging service (SMS) and instant messaging (IM) along with traditional technologies such as fixed telephones and fax machines. In particular, contemporary ‘office’ workers are not just working in an office in a building, but also moving out from it and doing their job remotely at various sites. We can also see the increasing number of workers who do their job at home. It is this kind of work style, often called telework, telecommuting or SOHO (small office, home office), that has emerged since 1990s clearly resulting from the wide spread and a rapid decline of the cost of ICT options for individual workers. As seen in these examples, ICTs have diversified our working modes, not only working inside the offices but also working remotely and flexibly.

Here, it is crucial to look at mobile work more carefully. In spite of the upsurge of interest in mobile work in our social lives, current research perspectives into it and, more specifically, the notion of ‘mobility’ have been quite narrow, dealing with it exclusively in terms of humans’ geographical movement. Much of literature characterises mobile work as its flexible geographical movement of people (e.g. Makimoto and Manners, 1997; Dahlbom and Ljungberg, 1998; Fagrell et al., 1999; Kopomaa, 2000). Conventional understanding of the notion of mobility has been clearly confined to the corporeal characteristic of humans freed from geographical constraints thanks to mobile computing technologies such as mobile phones and PDAs. However, in order to grasp the significance of mobile work in our modern lives in general and work settings in particular, we need to take a broader perspective and rethink the fundamental aspects of human interaction and the transforming notion of mobility, looking beyond human movement (Kakihara and Sørensen, 2002).

In addressing mobile work supported by various ICTs, we need to look also at *temporal* aspects of human interaction. In a face-to-face meeting of two or more people, for example, they do and need to share the same, constantly proceeding, linear clock time. In a sense, the people are forced to ‘synchronise’ in a face-to-face meeting. Yet, using ICTs, especially Internet technologies such as emails and instant messaging, people no longer need to share, not only the same space, but also the same time; their interaction can be ‘asynchronous’ with regard to efficiently using their time in their interaction. It is reasonable to say that such a temporal shift, from synchronous to asynchronous, resulting from using the Internet technologies, increases the mobility of human interaction in work settings, since the people using such internet technologies in their work become largely freed from temporal constraints such as necessity of sharing the same time and different national time zone. In this sense, mobile work clearly signifies not just humans’ flexible movements but also the temporal transformation of human interaction in work settings.

The contextual aspect is a further important aspect of human interaction, which needs to be considered in the debate of mobile work. Human action and interaction with others are inherently situated in particular contexts that frame and are reframed by his or her performance of the actions recursively. Such contextuality, or situatedness, of human action is critical for capturing the nature of human interaction. Suchman (1987) argues: “*The coherence of situated action is tied in essential ways not to individual predispositions or conventional rules but to local interactions contingent on the actor’s particular circumstances*” (p. 28). In this sense, it could be argued that in addition to spatial and temporal aspects discussed above, contextual aspects where the action occurs are of equal importance in organising human interaction. In considering mobile work, such contextual aspects of interaction are significant. We then could argue that contextuality plays a critical role in constituting human interaction just as spatiality and temporality do. Contexts in which people are immersed continuously reframe their interaction with others, including people’s cultural backgrounds, particular situations or moods, degrees of mutual recognition, exchanges of facial and bodily expression. Thanks to various ICT applications and mediated communication, people nowadays can easily interact with others largely freed from such contextual constraints, interacting with people in largely different contexts. In this sense, the relationship between interaction among people and contexts in which they are is becoming mobilised in terms of flexible patterns of interaction across different contexts. It is also clear that such contextual, or relational, aspects of human interaction are increasingly ‘uneven’ among interacting people beyond neat time-space conditions of interaction. Hence, when considering human interaction in mobile work settings, we need to deal with contextual as well as spatial and temporal aspects of human interaction.

Increasing mobility of human interaction in terms of special, temporal and contextual aspects, does not necessarily imply that our interaction becomes *completely freed* from spatial, temporal and contextual constraints of our everyday activities. Many scholars, especially in computer science and engineering, tend to offer the simple proposition that using mobile ICTs, we are now able to interact with others “*anytime, anywhere*” (e.g. Kleinrock, 1996; Agre, 2001). This is valid in the sense that ICT, especially email and mobile phones, help us interact with those who are in different location either synchronously or asynchronously. However, as Wiberg and Ljungberg (2001) clearly show, this does not necessarily mean that we can interact with others “*every time, everywhere.*” In their analysis of mobile work at Telia Nära, mobile workers’ activities are in most cases dependent upon particular place and time, sometimes significantly. As we have seen in the discussion of contextuality above, every human action and interaction is inherently situated in a particular context; so is it in the case of mobile communication and interaction ensured by ICTs including mobile technologies (Kim et al., 2002). Thus it is clear that the notion of mobile work itself is not such a simple concept as signifying working remotely or “*anytime, anywhere.*”

As we have discussed in this section, the emerging debate of mobile work has been discussed from quite a narrow perspective, almost only dealing with humans’ geographical movement intensified by effective utilisation of ICTs in work settings. From a wider perspective we take, mobile work is not just about a working mode or style to be done remotely from various sites; much more importantly, it also signifies *the increasing mobilisation of human interaction* in work settings in terms of spatiality, temporality and contextuality. What has been freed by various ICT options, particularly mobile technologies, in our modern work style, is not humans’ corporeal movement but interactional pattern they perform (Kakihara and Sørensen, 2002), which we may call *mobile interaction*.

3. Fluidity of Mobile Interaction

In order to capture the complex and diversified nature of mobile work, or more specifically mobile interaction in work settings, it might be beneficial to conceptualise the significance of mobile interaction itself to contemporary work environments. Here we want to take a metaphorical approach with ideas from social topology.

Topology is a branch of mathematics that deals with various geometrical properties and spatial relations. However, it is not restricted by Euclidean three-dimensional geometry; it localises objects in terms of a variety of co-ordinate systems. In topology the three standard axes, X, Y and Z, are no longer a fixed or concrete geographical frame of reference. Applying the basic ideas of topology, Mol and Law (1994) propose three distinct “social topologies” drawn from their investigation on the spatial properties of the medical condition anaemia in which there are too few red blood cells in the blood; namely. First, the *region* is a distinct topology whereby objects are clustered together and boundaries are drawn around each particular regional cluster. In short, this topology can be characterised by “boundary.” Second, the *network* is a topology whereby relative distance is a function of the relationship between components constituting the network. Complex patterns of connected nodes create the whole network structure. This topology can be characterised by “relationship.” Third and most important for our discussion, the *fluid* is a topology whereby “neither boundaries nor relations mark the difference between one place and another. Instead, sometimes boundaries come and go, allow leakage or disappear altogether, while relations transform themselves without fracture. Sometimes, then, social space behaves like a fluid” (p. 643). This is a particular image of the topology of anaemia discussed by Mol and Law. Anaemia, like blood,

can be seen as flowing in and out of different regions, across different borders, using diverse networks.

Applying these metaphors from social topology, we can appreciate the nature of mobile interaction in work settings more properly. The *region* metaphor can be clearly applied to the traditional, geographically dependent human interaction in the pre-ICT age. Even in the early computing era, the region metaphor is pertinent to characterise that computational support then was limited to mainframes with connected terminals. The *network* metaphor can characterise modern life styles. Interaction among people via various media networks such as telephones and the internet has been relatively mobilised in terms of symbolic travel of data, images, sounds and so on. Computer installations comprising of local- and wide-area networks are precisely characterised as networks, and the metaphor can also be expanded to characterise the socio-technical mesh of humans and technologies in organisational settings.

However, given the rapid diffusion and domestication of various ICT applications including mobile phones, SMS, PDAs, laptop computers, and awareness technologies such as ICQ into our everyday lives, a network metaphor seems increasingly insufficient to explain our social activities in general and work mode in particular. In the environment where people can interact with others by using such emerging technologies as mobile phone, SMS, pagers, email, laptops, PDAs, ICQ, relational disposition of human interaction is becoming ambiguous and transitory. Such a social topology can be a *fluid*. According to Mol and Law, a fluid world is “a world of mixtures” (p. 660) and “variation without boundaries and transformation without discontinuity” (p. 658). A fluid world ensured by multiple mobilisation of interaction can be characterised as “the remarkably uneven and fragmented flows of people, information, objects, money, images and risks across regions in strikingly faster and unpredictable shapes” (Urry, 2000: p. 38). This is clearly the world of the contemporary mobile work mode. Mobile workers engage themselves in getting their job done not only at their formal offices but at various sites such as home, clients’ offices, hotels, moving vehicles and so on. Looking at their nature of work, there is no rigid boundary that determines whether inside or outside the office: anywhere can be their office. They permeate across “regions” and “networks.” In this sense, we can argue that mobile work is the fluid mode of working.

Fluidity of mobile interaction raises a variety of new issues to be addressed. For example, due to increasing flexibility in interacting with others with various ICT supports, people tend to be exposed to “interaction overload” (Ljungberg and Sørensen, 2000), which inevitably provides them with various unwelcome consequences. Whereas high degree of fluidity of interaction in work settings offers workers a wide range of benefits such as interacting with people remotely and flexibly, it also creates interruption and disturbance in their actual work environment. By having a mobile phone, for instance, you can be disturbed by anyone who knows your number regardless the level of your busyness. Although e-mail is basically an asynchronous communication medium that does not require you immediate response, if you keep storing emails without any reply then you are “overloaded” by e-mail. PDAs enable workers to check and send e-mail outside their offices, but colleagues who know that you have PDAs would expect that you *always* check and reply to their e-mail. As seen in these immediate examples, high fluidity of mobile interaction offers us a practical issue to be solved: *the asymmetry of interaction* (Nardi and Whittaker, 2000), which will be discussed in the following.

4. Asymmetries of Interaction

In order to initially analyse aspects of mobile interaction, we intersect one level further down from the notion of human interaction understood as a *fluid* where attention and expressions in emerging patterns shift across time, space and context. In this section we project this topology onto the operational level of the individual desiring to interact or to be left alone. The overall goal is to analyse the elements affecting the fluidity of interaction from the perspective of one actor, acknowledging the inherent asymmetries of everyday organisational interaction (Nardi and Whittaker, 2000) as well as the fact that much work cannot be accomplished independent of temporal, spatial and contextual constraints (Wiberg and Ljungberg, 2001). It, therefore, makes sense to take a closer look at how individuals manage their interaction with others. This is exclusively viewed from the perspective of understanding the struggle to maintain fluid mobile interaction. The asymmetry of interaction occurs when “*the time and topic are convenient for the initiator, but not necessarily the recipient. This asymmetry arises because while initiators benefit from rapid feedback about their pressing issue, recipients are forced to respond to the initiator’s agenda, suffering interruption.*” (Nardi and Whittaker, 2000). A distinct focus on issues related to establishing fluid mobile interaction, will inevitably place some significance on the initial phases of interaction, which in particular can be characterised as *outeraction*, i.e., negotiating the communication (Nardi and Whittaker, 2000). Current research characterise organisational conversations as mostly being between two people, spanning brief periods of time, opportunistic, containing multiple concurrent threads, and ongoing rather than one-shot (Whittaker et al., 1997), furthermore emphasises issues of personal desire as opposed to only studying organisational or functional rationality. This leads to the inclusion of concerns for individuals improvising and allowing their emotional disposition affect decisions as to how they interact and with whom. This concurs with Ciborra’s call for better understanding of the role of improvisation and moods in meetings between people and contemporary technologies, and to acknowledge these as a basic tenet for analysing the relationships (Ciborra, 2002).

Interactive versus Interpassive

In order to analyse more closely the issues related to an individual maintaining fluid mobile interaction in organisational conversations, we initially distinguish between an individuals desire at a given point in time to be *interactive* or *interpassive*. Being *interactive* implies communication and collaboration between two or more people around a shared object (Dix and Beale, 1996) whereas *interpassive* is a state in which a person is passive in relation to others. This distinction is essential since it precisely characterises desire to interact versus desire *not* to interact. It does, however, not characterise the distinction between being active and being inactive. A person can be interpassive whilst immersed in his or her own individual activities. We can then for a given person and at a given moment analytically characterise the interactional asymmetries (Nardi and Whittaker, 2000) in terms of the individual’s desire to be interactive or interpassive, versus the preferences of every potential interactor to be interactive or interpassive in relation to this particular individual in a particular moment of time. An interactor characterises a person that can initiate interaction or respond to a request for interaction. The model, therefore, analytically distinguishes between “you” and “them”.

Managing Interaction

The first scenario covers situations where there at least instantaneously are no interaction asymmetries. Here both the person at the centre as well as the surroundings are interpassive

— they are left on their own, undisturbed, and for example involved in individual activities or reflecting. This relates to the distinction between action and reflection (Schön, 1983), or Norman's (p. 15, 1993) distinction between experiential and reflective cognition: "*There are many modes of cognition, many different ways by which thinking takes place. The two modes particularly relevant to my analyses are called experiential cognition and reflective cognition. The experiential mode leads to a state in which we perceive and react to the events around us, efficiently and effortlessly. This is performance. The reflective mode is that of comparison and contrast, of thought, of decision-making. This is the mode that leads to new ideas, novel responses. Both modes are essential for human performance, although each mode requires very different technological support.*" It is, therefore important to be able to configure technology so as to allow for sustained interaction, but also for non-interaction, to provide support for both the experiential mode as well as the reflective mode of cognition (Wiberg and Ljungberg, 2001).

Secondly, in instances where the person at the centre, in order to maintain a fluid work pattern for example need to get hold of another person by the use of a mobile phone, the person instantiates a potential interaction asymmetry when contacting a person who may be interpassive. This invokes the subsequent issues of managing the interaction, of session management and of the problems of the central actor potentially by means of an obtrusive technology (Ljungberg and Sørensen, 2000), forcing him or herself into the fore.

Thirdly, the opposite instance is characterised by the asymmetry being evoked from outside and the interpassiveness of the person at the centre being broken by someone who request interaction in order for that particular person to maintain fluid mobile work. Here, the issue, from the point of view of the central actor is managing temporary interruptions of one session for another or engaging in interaction from being interpassive. From the point of view of the person at the centre, maintaining fluid mobile work can be an issue of dealing with interruptions (O'Conaill and Frohlich, 1995), even to the extreme where work can be characterised in terms of constant interruptions (Rouncefield et al., 1995).

The fourth situation covers instances where the asymmetry of interaction is resolved in interaction. Both the actor at the centre and people in the surroundings desire to interact. If this is the case, then one of the primary issues will be to prioritise between different strands of interaction. This implies that interaction can lead to meta-interaction, or "outeraction" (Nardi and Whittaker, 2000): "*Outeraction is a set of communicative processes outside of information exchange, in which people reach out to others in patently social ways to enable information exchange.*" The negotiation of interaction here also involves thread swapping where decisions to hold or wait relate to discussion and negotiation of availability and relative importance of different threads involving different configurations of involved actors.

Viewing the analytical distinctions between attempts to negotiate the interactional asymmetries over time leaves us with a potentially ever-changing configurations and negotiations. These changes can lead to fluctuations between symmetry and asymmetry with potential consequences for the central actor being engaging in both fluid and disruptive mobile work. From the perspective of the central actor, the challenge is to manage the configuration so as to actively encourage interaction when it either serves the purpose of contributing to fluid mobile work, or when disruptions are deemed desirable by the actor in order to establish interpassive situations at a later stage (Ljungberg and Sørensen, 2000).

If certain configurations between the central actor and others persist over some period of time, or if the same configurations of interactors frequently experience recurrent asymmetries, this

in itself can raise essential issues of interaction management. In the case of both the central actor and others remaining interpassive, then there may be an absence of interaction over a prolonged period. If the central actor persistently over time instigate interaction despite others' preferences for interpassiveness, the result can be fragmentation of work activities on their part. To some extent, the work of the central actor can in this situation be conceived as fluid. In the opposite asymmetry, the central interactor constantly being interrupted, can result in fragmentation of the mobile work activities, but equally in perceived fluid work on the part of the instigators of the interaction. However, if an asymmetric pattern is reiterated over time, participants who constantly are disrupted and therefore may not experience fluid work, could desire to proactively affect the situation and for example control it by switching off their mobile phones or avoiding reading email for a couple of days. In the case where interactiveness is the primary preference of all parties, it raises the issue of balancing the participation of all involved and the need to maintain awareness of the interaction, its status and results.

5. Struggling with Fluid Mobile Interaction

This section outlines and reviews the issues involved when a central actor manages interactional asymmetries in order to be able to engage in fluid mobile work. Firstly, we must recognise that distance matters (Olson and Olson, 2000), and that a host of issues related to the struggle for maintaining fluid mobile work emerge from the mobilisation of interaction and from the fluidisation of work activities across temporal, spatial and contextual boundaries. Many of the issues discussed below are also interesting to study and discuss in settings where the interaction is "at arms length", but here the main objective of such a study could be the opposite - demonstrating the richness of means by which collocated interactors manage fluid interaction (Goffman, 1982; Heath and Luff, 2000; Olson and Olson, 2000). Studies show that collocated office workers spend between 25% and 70% of their time on face-to-face conversations. Collocated synchronous interactions can be characterised in terms of (Olson and Olson, 2000): Rapid feedback, multiple channels, known identity of contributors, shared local context, impromptu interactions on arrival and departure, easy establishment of joint references to objects, free individual control of attention and participation, implicit peripheral cues, and the spatiality of reference. As outlined previously, empirical studies have characterised most interpersonal interaction as dyadic (involving two people), brief, opportunistic, synchronous, focused on shared objects, ongoing rather than one-shot, and containing multiple threads (Whittaker et al., 1997). Conversations are typically brief, synchronous and opportunistic interactions with multiple concurrent threads, thus leading to issues of context regeneration and conversation thread tracking (Whittaker et al., 1997).

The first issue to consider relates to the relevance of the interaction. Although much of the contemporary discourse on the application of ICTs seems to focus on the increased ability to interact anytime and anywhere, and that this apparent ability is translated into a subsequent necessity of interacting anytime and anywhere, studies of actual work activities demonstrate that by far all work can indeed be conducted anytime and anywhere (Wiberg and Ljungberg, 2001). Distance matters not only in terms of geographical distance but also in terms of temporal and contextual asymmetries between interactors. The initiator may be in one frame of mind, focused on for example getting a meeting schedule finished, whereas the person he or she contacts on a mobile phone in order to clear some details may be in the middle of an important meeting, or concentrating on writing a memo. In the case of the telephone engineers studied by Wiberg (2001), their work depend critically on travelling to where the fault has been reported. They must therefore negotiate access with the house owner. Wiberg (2001)

found examples of lack of mutual awareness of what the status of the cases were at a given time, such as in the example where the engineer had travelled quite far only to find out that rebooting the telephone switch had solved the problem remotely, rendering the long trip unnecessary. We here have a potential deepening of the interaction asymmetries, when at the one hand mobile work is conducted in certain spatial, temporal and contextual circumstances and on the other hand pervasive mobile communication technologies offers an apparent stability of dissolving temporal, spatial and contextual barriers - the mobile worker can be reached no matter where and when they are and irrespective of what they are engaged in (Agre, 2001).

Generally, interaction modalities can be characterised in terms of their degree of obtrusiveness and ephemerality (Schmidt and Simone, 1996; Ljungberg and Sørensen, 2000). Interaction can be perceived as more or less obtrusive in terms of how the interaction forces upon the participants the need for them to devote their attention towards the interaction. Ephemeral interaction unfolds in time and space without leaving behind external traces, whereas persistent interaction is characterised, precisely by traces being sedimented from the interaction. Both modes of interaction offer continua and not distinct categories. Interaction can be perceived as more or less obtrusive to the fluid accomplishment of mobile work dependent on the actor's subjective perception. Mackay (1988) showed that different actors experienced different levels of stress coping with email overload. Similarly, the degree of persistency can depend on the actual technology used and the specific way in which it is appropriated and combined with other technologies. Whilst a face-to-face conversation clearly can be characterised as ephemeral since it only verbal, and an email clearly is persistent in that it leaves a trace behind that can be inspected at a much later stage, then instant messaging such as ICQ and MSN message Service clearly can be viewed as both asynchronous persistent interaction as well as synchronous ephemeral interaction. Although the streams of interaction may be stored at the server for later retrieval as digital traces of human activity (Sørensen et al., 2000), the situated use can equally be viewed as real-time conversation where the trace only serves a highly temporary primary purpose. When investigating the struggle to obtain fluid mobile work, interesting insights can be gained from investigating configurations of the two interaction modalities. Using a traditional stationary phone with no caller ID displays, results in a fairly obtrusive and ephemeral interaction. Modern mobile phones, on the other hand, offers increasingly advanced ways of setting the interaction requests as unobtrusive, so only the acceptance of an incoming call will lead to obtrusive ephemeral interaction. It is not unrealistic to assume that mobile ICTs will support more sophisticated awareness, filtering and notification mechanisms (Ljungberg and Sørensen, 2000), for example by allowing the semi-automatic filtering of incoming requests for interaction and subsequent conversion of a request for a conversation to a reply by SMS explaining the interactional preferences of the receiver of the request. Generally, the current mobile ICTs primarily support interaction modalities that are not ephemeral and unobtrusive - the aspects of human interaction which have been demonstrated handled in very sophisticated ways when interactors are collocated and working at "arms length". We will below discuss the related issue of mutual awareness further.

Taking a closer look at the relationships between ephemeral and persistent modes of interaction, then work studies have illustrated how actors actively will make ephemeral interaction persistent for example by audio or video taping conversations, by photographing whiteboards, or simply by taking notes during meetings or during telephone conversations (Ljungberg and Sørensen, 2000). Since it is associated with considerable transaction costs for example to transform audio notes to written text, some research has looked into enabling easy

retrieval of passages in audio material such as voice mails (Whittaker et al., 2000). In a sense, these activities partly can serve the purpose of crystallising work activities, for example by making discourses and discussions publicly known for others to inspect and comment. Written documents, audio or video notes, email trails, voice mails, SMS messages etc, therefore provides a common and shared, although fragmented, awareness of dyadic interrelationships for later inspection and reference. Such awareness is at least to some extent quite crude since they can not be assumed to be synchronous, nor can they be assumed to reveal significant information of the other part's willingness or readiness to be interrupted.

Increasingly technologies offer ways of managing fluid mobile interaction by offering the receiver of the request for interaction to postpone or stack the interaction. These technologies are either asynchronous such as the basic email that can be accessed from a mobile phone or PDA, or can be gateways between synchronous and asynchronous technologies, for example allowing a telephone conversation to be postponed by having the number stored in a "missed calls" register or by allowing the caller to leave a message to be picked up at a later point. These mechanisms of postponing synchronous interaction can be combined with various filtering and awareness mechanisms (Ljungberg, 1999; Ljungberg and Sørensen, 2000), such as a discretely vibrating phone, which from the users trouser pockets alerts of an incoming call, or the more advanced awareness filtering of assigning different groups of callers to different ring tones. The ability to translate a synchronous attempt to interact into an asynchronous trace can obviously lead to severe consequences for everyone involved. Establishing fluid mobile work in the short-term by disconnecting and stacking all interaction requests, clearly may result in others' struggling to maintain fluid mobile work. Around 60% of workplace phone calls have been reported to fail to reach the recipients (Nardi and Whittaker, 2000). In the case of networked mobile workers, this can of course be assumed to change, but against an increasing intensification of interaction, it may still be a significant problem. Wiberg (2001) reports of telephone repair engineers with three mobile phones for each engineer. Furthermore, not all problems may go away by being transformed from synchronous to asynchronous requests for interaction. Postponing implies spending time at a later stage retrieving the information and subsequently attempting to contact people who has attempted to contact. Easy access to the available interaction threads is therefore important (Nardi and Whittaker, 2000).

Given the increase in available means for communicating with others and the general increased technical sophistication of mobile ICTs, maintaining fluid mobile work is also increasingly a matter of managing multiple ongoing conversations over multiple technologies. Here, mutual awareness comes to the fore as a crucial issue. In cases of single synchronous technology scenarios, such as the traditional office with one stationary telephone, others will immediately be aware of essential interactional aspects of the owners behaviour - if the phone is busy, the person is on the phone. However, with an increased fragmentation and mobilisation of interaction across multiple ICTs, lack of mutual awareness can lead to increase in the interaction asymmetry. Establishment of mutual awareness of location has been promoted as an important element of mobile interaction (Mäenpää, 2001), but also conflicting accounts of the awareness of activities as the primary element has been promoted (Weilenmann, 2001). However, in both cases, a generalised notion of location awareness is being negotiated since Weilenmann argues that the awareness of activity infers awareness of location. It can, therefore, be argued that the use of mobile phones, for example, socially constructs a location based services, both in terms of allowing constant update mutual awareness of locations, as well as in bringing the interaction to the location. Much research has discussed applying specific awareness technologies, AwareWare (Nilsson et al., 2000).

The most common of these technologies is a stationary interaction technology in its own right, namely Instant Messaging, where platforms such as ICQ allow participants explicitly to declare the interactional status. Other systems, such as the one reported by Nardi et al. (2000) supported implicit awareness by monitoring user keystroke rates and therefore enabling others to gain an impression of whether or not the person to be contacted is situated by their desk, or alternatively they perhaps is too busy to be contacted at all. Tang et al. (2001) demonstrate a multi-platform mobile awareness system with implicit location logging. Dix et al. (2000) suggest a generic systems architecture for mobile awareness technologies that integrates the technologies technical "awareness" of internal state with the inclusion of the external context to support mutual awareness between users.

The extent to which ICTs model the properties and behaviour of the interactors can greatly affect both the degree of sophistication to which the ICT can support the establishment of mutual awareness, as well as the extent to which the people involved will find the technology a breach of their privacy and more serve as a surveillance technology. Here, we would assume as a first hypothesis, the same interrelationship as argued by Schultze & Vandenbosch (1998) concerning the perceptions of information overload when using Lotus Notes. It was demonstrated that although there were initial reports of information overload as a result of implementing Lotus Notes, then a subsequent study showed that the actors had adapted and therefore did no longer experience information overload. Similarly Nardi et al. (2000) discuss how the introduction of the Instant Messaging system led to initial discussion of how people felt observed since everyone else could inspect their key-typing rate constantly. However, this concern was subsequently forgotten and a positive stance had prevailed — people saw the immediate benefits of gaining awareness of the typing speed of the person they would wish to interact with in order to know if they were busy or not. This mechanism is an example of an awareness mechanism, where information pertaining to the interaction is provided others in order to facilitate their decision as to whether or not they still wish to interrupt.

In terms of managing fluid mobile interaction in situations where a number of participants are engaging in ongoing interaction, traditional CSCW issues pertaining to session management and floor control are brought to the fore. Clearly most organisational conversations have an ongoing character as opposed to the traditional view of sessions discretely organised in time (Whittaker et al., 1997). Participants will need to engage in prioritisation of competing conversation threads, and the generally poor support for ephemeral and unobtrusive modes of interaction, which are essential for obtaining fluid session management (Whittaker et al., 1997; Olson and Olson, 2000), implies significant challenges.

We have based the analysis of fluid mobile interaction on the assumption of proactive actors exercising their judgement in the situation as to who they wish to interact with, for how long and if they choose to turn on the answer machine and email instead of engaging in a telephone conversation. Here, we therefore critically emphasise the role of the individual's subjective preferences as opposed to organisational or task rationality in terms of purpose, duty, or need. We acknowledge that there of course exist systems of power, domination, division of labour and so on.

6. Discussion

This paper has, through theoretical inquiry, aimed at outlining the main challenges for understanding fluid mobile interaction from the perspective of the individual actor constantly

faced with detailed decisions as whether or not to engage in interaction with others. Our discussion in this paper has been based on the explicit choice of attempting to integrate theories from social topology, sensitising how we generally can characterise changes to work practices, with theories emerging from detailed operational studies of how new technologies can be integrated within organisational practices. Traditionally the former strand of research retains great distance to discussions of actual technologies and work practices, whereas the latter almost exclusively focus on how concrete technological innovations integrate with the performance of specific tasks. We find that both perspectives ought to be called upon when attempting to address some of the most important issues organisations are faced with at the moment. One of the reasons for this relates to a particular discourse we have not related to in this paper, but which naturally would be a key subject for further consideration, namely the issue of the relationship between modes of organising and the mobilisation of interaction.

Rapidly adopted technologies such as email, mobile phones and instant messaging can be characterised by their interpretative flexibility in terms of the individual user locally defining the patterns of use. They basically provide a backbone mobilising conversations, and relative little else. Thereby, they support the individual actor in engaging in encounters with others whilst retaining emergent processing of information, thus enabling the individual user effectively to cope with tasks of relatively low complexity but relatively high degree of uncertainty (Mathiassen and Sørensen, 2002). The local application of locally conditioned microprocedures (Lanzara and Patriotta, 2001) are used as a means of coping with conflicting interactional requirements. The individual actors specific configuration and application of a single ICT as well as the specific patterns of use and portfolio choice of multiple technologies can be viewed as locally conditioned improvisation to resolve the local messiness (Ciborra, 2002).

Some of the unintended consequences of the flexibility and immediacy of these technologies are then their flexibility to be applied for example for tasks of high complexity and low degree of uncertainty. Here, simple mobilised conversation representing emerging information processing could, for example, be replaced by a systematisation of the information processing, thus reducing the risk of participants experiencing interaction overload (Mathiassen and Sørensen, 2002). Imagine the slightly silly proposition of having to replace Amazon.com's automatic order handling system with a call centre. However, in order to comprehensively analyse the mobilisation of interaction and the struggle to obtain fluid mobile work, we cannot exclusively look at the overall social or managerial issues of rational ways of organising work. The individual actor's intentions, desires, moods, local dispositions etc will greatly affect the microprocedures they employ for managing their own availability and interactivity (Ciborra, 2002). Here, one of the key issues pertaining to the individuals experience of fluid work will be the daily unfolding of both interaction and outeraction, where the latter characterise communicative processes employed solely to establish and discuss connections with each other, as opposed to actually communicating (Nardi and Whittaker, 2000). When, for example mobile voicemails only containing the message "*ring me at...*" are served in a ping-pong fashion between people, all they do is outeraction. If there are constantly discrepancies between individual actors' desire to be interactive or interpassive, the increased mobilisation of interaction can lead to dramatic increases in this "co-ordination of co-ordination work" (Ljungberg and Sørensen, 2000). The recursive relationship between interaction and outeraction, does, however, not stop after the first recursion, and a question for further empirical and theoretical investigation is the changes to the ways in which individuals and organisations manage interaction in general. When all members of an organisation has mobile phones, then there need to be both general as well as highly specific discussions of

how these can be used to facilitate fluid mobile work. However, the organisation may also need to discuss how to co-ordinate and discuss the use of new interaction technologies.

Neither can we exclusively study these phenomena in a bottom-up fashion. The mobilised interaction always takes place within a social and perhaps even an organisational context. This raises socially conditioned issues of power, influence, domination, culture, privacy, surveillance etc. It may, for example, be a very good idea for mobile workers to know what close colleagues are doing and where they are located, such as discussed from a technical and operational perspective by (Tang et al., 2001). However, in some contexts it will be considered surveillance of work if the information is shared with others in the organisation (Ciborra, 1996). Similarly, if the project team members are distributed and highly mobilised, it is probably not acceptable from an organisational point of view if a key member of the project decide that maintaining fluid mobile work involves sustained periods of disconnectedness.

There are, in our view, significant methodological consequences of the mobilisation of interaction. When studying CSCW systems, it is a significant challenge to sufficiently cover and understand the roles, opinions and detailed actions of distributed interdependent actors (Grudin, 1994). Even more distribution and mobilisation of interaction will potentially imply even more methodological challenges for fieldwork design. The mobilisation of interaction also brings novel approaches to the fore, such as conducting virtual ethnographies, studying mediated interaction patterns (Hine, 2000).

Summarising, it is clear that a host of research results from varied fields can inform the discussion of fluid mobile work, and that this research at the same time must be appropriated to situations where the interaction as well as the actors are highly mobilised. The state-of-the-art technologies we have seen so far show us interesting glimpses of the future, but it is evident that the real issues in contemporary working life radically changing and that the current technologies being used does not sufficiently address the main issues.

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References

- Agre, P. E. (2001): Welcome to the Always-On World. *IEEE Spectrum*. pp. 12-13.
- Ciborra, C. U., ed. (1996): *Groupware and Teamwork: Invisible Aid or Technical Hindrance?* Chichester: John Wiley & Sons.
- Ciborra, C. U., ed. (2002): *Information Complexities (Forthcoming)*. Oxford: Oxford University Press.
- Dahlbom, B. & F. Ljungberg (1998): Mobile Informatics. *Scandinavian Journal of Information Systems*, vol. 10, no. 1&2, pp. 227-34.
- Dix, A. & R. Beale, ed. (1996): *Remote Cooperation: CSCW Issues for Mobile and Teleworkers*. London: Springer-Verlag.
- Dix, A., T. Rodden, N. Davies, J. Trevor, A. Friday, & K. Palfreyman (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.
- Fagrell, H., F. Ljungberg, & S. Kristoffersen (1999): Exploring Support for Knowledge Management in Mobile Work. In *Proceedings of the 6th European Conference on Computer Supported Cooperative Work (ECSCW '99), Copenhagen, Denmark*, ed. S. Bodker, M. Kyng, and K. Schmidt.
- Goffman, E. (1982): *Interaction Ritual : Essays on Face to Face Behavior*. New York, NY: Pantheon Books.
- Grudin, J. (1994): Groupware and social dynamics: Eight challenges for developers. *Communications of the ACM*, vol. 37, no. 1, pp. 93-105.
- Heath, C. & P. Luff (2000): *Technology in Action*. Cambridge: Cambridge University Press.

- Hine, C. (2000): *Virtual Ethnography*. London: Sage.
- Kakahara, M. & C. Sørensen (2002): Mobility: An Extended Perspective. In *Thirty-Fifth Hawaii International Conference on System Sciences (HICSS-35), Big Island Hawaii*, ed. R. S. Jr. IEEE. <http://www.hicss.org/>
- Kim, H., J. Kim, Y. Lee, M. Chae, & Y. Choi (2002): An Empirical Study of the Use Contexts and Usability Problems in Mobile Internet. In *35th Hawaii International Conference on System Sciences (HICSS-35), Big Island, Hawaii*.
- Kleinrock, L. (1996): Nomadicity: Anytime, Anywhere in a Disconnected World. *Mobile Networks and Applications*, vol. 1, pp. 351-7.
- Kopomaa, T. (2000): *The City in Your Pocket: Birth of the Mobile Information Society*. Translated by T. Snellman. Helsinki: Gaudeamus.
- Lanzara, G. F. & G. Patriotta (2001): Technology and The Courtroom: An Inquiry into Knowledge Making in Organizations. *Journal of Management Studies*, vol. 38, no. 7.
- Ljungberg, F. (1999): Exploring CSCW Mechanisms to Realize Constant Accessibility Without Inappropriate Interaction. *Scandinavian Journal of Information Systems*, vol. 11, pp. 25-50.
- Ljungberg, F. & C. Sørensen (2000): Overload: From Transaction to Interaction. In *Planet Internet*, ed. K. Braa, C. Sørensen, and B. Dahlbom. Lund, Sweden: Studentlitteratur, pp. 113-36.
- Mackay, W. E. (1988): Diversity in the Use of Electronic Mail: A Preliminary Inquiry. *TOIS: ACM Transactions on Office Information Systems*, vol. 6, no. 4.
- Mäenpää, P. (2001): Mobile Communication as a Way of Urban Life. In *Proceedings of the Workshop on "Mobilize!: Interventions in the Social, Cultural and Interactional Analysis of Mobility, Ubiquity and Information and Communication Technology"*, UK. Digital World Research Centre, University of Surrey.
- Makimoto, T. & D. Manners (1997): *Digital Nomad*. Chichester: John Wiley & Sons.
- Mathiassen, L. & C. Sørensen (2002): A Task-Based Theory of Information Services (Forthcoming). In.
- Mol, A. & J. Law (1994): Regions, Networks and Fluids: Anaemia and Social Topology. *Social Studies of Science*, vol. 24, pp. 641-71.
- Nardi, B. & S. Whittaker (2000): Interaction and Outeraction. In *Proceedings of Computer Supported Cooperative Work, Philadelphia, USA*, ed. W. Kellogg and S. Whittaker, pp. 79-88.
- Nilsson, S., L. Svensson, F. Bengtsson, & C. Johansson (2000): Exploring Awareware. In *Doing IT Together: Proceedings of the 23rd Information systems Research In Scandinavia (IRIS 23) Conference, Lingatan*, ed. L. Svensson, U. Snis, C. Sørensen, H. Fagerlind, and T. Lindroth. Laboratorium for Interaction Technology, Trollhättan Uddevalla University, Sweden, vol. 2, pp. 1019-1029.
- Norman, D. A. (1993): *Things That Make Us Smart. Defending Human Attributes in the Age of the Machine*. Reading, Mass.: Addison-Wesley.
- O'Conaill, B. & D. Frohlich (1995): Timespace in the workplace: Dealing with interruptions. In *Proceedings of CHI'95 Human Factors in Computing Systems, New York*. ACM Press, pp. 262-263.
- Olson, G. M. & J. S. Olson (2000): Distance Matters. *Human-Computer Interaction*, vol. 15, pp. 139-178.
- Rouncefield, M., S. Viller, J. Hughes, & T. Rodden (1995): Working with constant interruption: CSCW and the small office. *The Information Society*, vol. 11, no. 4, pp. 173-188.
- Schmidt, K. & C. Simone (1996): Coordination Mechanisms: An Approach to CSCW Systems Design. *Computer Supported Cooperative Work: An International Journal*, vol. 5, no. 2&3, pp. 155-200.
- Schön, D. A. (1983): *The Reflective Practitioner: How Professionals Think in Action*. New York: Basic Books.
- Schultze, U. & B. Vandenbosch (1998): Information Overload in a Groupware Environment: Now you see it, now you don't. *Journal of Organizational Computing and Electronic Commerce*, vol. 8, no. 2, pp. 127-148.
- Sørensen, C., H. Fagrell, & P. Ljungstrand (2000): Traces: From order to chaos. In *Planet Internet*, ed. K. Braa, C. Sørensen, and B. Dahlbom. Lund, Sweden: Studentlitteratur, pp. 113-136.
- Suchman, L. A. (1987): *Plans and Situated Actions: The Problem of Human-Machine Communication*. Cambridge: Cambridge University Press.
- Tang, J. C., N. Yankelovich, J. B. Begole, M. Van Kleek, F. Li, & J. Bhalodia (2001): ConNexus to Awarenex: Extending awareness to mobile users. *CHI 2001*, vol. 3, no. 1, pp. 221-228.
- Urry, J. (2000): *Sociology beyond Societies: Mobilities for the Twenty-First Century*. London: Routledge.
- Weilenmann, A. (2001): "I can't talk now, I'm in a fitting room": An initial investigation of the ways in which location features in mobile phone conversations. In *Proceedings of the Workshop on "Mobilize!: Interventions in the Social, Cultural and Interactional Analysis of Mobility, Ubiquity and Information and Communication Technology"*, UK. Digital World Research Centre, University of Surrey.
- Whittaker, S., R. Davies, J. Hirschberg, & U. Muller (2000): Jotmail: a voicemail interface that enables you to see what was said. In *Proceedings of CHI2000 Conference on Human Computer Interaction*, pp. 89-96.
- Whittaker, S., J. Swanson, J. Kucan, & C. Sidner (1997): TeleNotes: managing lightweight interactions in the desktop. *Transactions on Computer Human Interaction*, vol. 4, pp. 137-168.

- Wiberg, M. (2001): *In between Mobile Meetings: Exploring seamless ongoing interaction support for mobile CSCW*. PhD Dissertation, Umeå University, Sweden.
- Wiberg, M. & F. Ljungberg (2001): Exploring the Vision of "Anytime, Anywhere" in the Context of Mobile Work. In *Knowledge Management and Virtual Organizations*, ed. Y. Malhotra/Idea Group Publishing, pp. 157-69.