DESIGNING FOR MOBILE AND DISTRIBUTED WORK: TECHNOLOGY USE IN REMOTE SETTINGS.

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WORK AND COLLABORATION IN MOBILE SETTINGS

1.1 Introduction: Mobility and Mobile work

In terms of mobile work, mobility has long been a contested notion. What does it really mean to be mobile while working? In the literature for example, Luff and Health(1998) have gone to the extreme of talking about micro-mobility, highlighting, for example, doctors and their use of patient notes. When designing an electronic replacement for written patient notes, Luff and Heath point out, the way that a doctor moves and shifts the paper notes in his workspace during a patient-doctor consultation session is an important aspect of patient-doctor collaboration - one that is in danger of being lost in a straightforward electronic representation of the notes on a computer screen due to the inflexibility of the desktop PC to replicate and allow such subtle opportunities for collaboration and co-operation.

Likewise, Kakihara and Sorensen have sought to develop a conception of mobility which rejects the traditional view that it should be seen "in terms of humans' independency from geographical constraints" (Kakihara and Sorensen, forthcoming). Instead they maintain 'being mobile' is not just a matter of people travelling but relates more to the *interactions* they perform - the way in which they interact with others in their social lives. By relating mobility to interaction, they expand and deconstruct the concept to embrace spatial, temporal and contextual mobility (Lee & Perry, forthcoming). While such a fine-grained focus on what mobility is and how it relates to collaboration is refreshing in HCI, the majority of commentators in the literature prefer to conceptualise and examine mobility at a lower grade of magnification. Instead their focus is on local, remote and distributed mobility as traditionally understood and the part technology is (or should be) playing to support the activities mobile workers wish to perform on the move. Even at this level of analysis though, mobile work is a varied and formidable design space for those seeking to design new technologies to support it. For example, Perry et al. point to mobile workers describing their activities involving working at multiple (but stationary) locations, walking around a central location, traveling between locations, working in hotel rooms, on moving vehicles and in remote meeting rooms (Perry *et a*l, forthcoming). Each of these working environments have their own challenges in terms of resources for/and constraints on communication and collaboration. These challenges demand the attention of those that participate in the design process because only by meeting such challenges can they hope to conceptualise and build mobile communicate that are flexible enough to meet the true needs of mobile users.

The purpose of this first section of the report is to outline some of the key research on mobility and mobile work with a view to identifying any organisational, technological, social and other factors affecting the use and deployment of mobile technologies in mobile work. By examining the available literature we shall have a glimpse into some of the key factors that must be taken into consideration when designing for people in real life mobile

situations, as well as appreciating how designing for mobility has gone awry in the past - when inappropriate areas have been identified to be supported by technology.

Much of the research on mobility, until fairly recently, has dealt with purely technology issues such as limited battery life, unreliable network connections, risk of data loss, portability and location discovery (Wiberg and Ljungberg, 1999). However, with the explosion of mobile telephony in the western world - and with it the realisation that mobile devices can no longer be seen in isolation but must be viewed as parts of larger systems used by a variety of users in heterogenous locations - user-centred research into collaborative mobile work has now come to the fore and it is this research our review of the literature shall focus on.

1.2 FACTORS AFFECTING THE USE AND DESIGN OF MOBILE DEVICES

A) Difficulty in identifying features of mobile work practices to support

While discussing at length the notion of micro-mobility in their paper, *Mobility in Collaboration*, Luff and Health (1998) also find space to discuss an interesting example of when designing for mobile work went wrong. The example given from their research is of the introduction of an electronic notebook record-keeping system in a building site to replace a paper allocation sheet used to record the amount of time that workers spend on anyone particular aspects of the job. The system *was* meant to act as a mobile resource for the foremen as they wandered around the site to help them monitor problems as they were encountered and to support in situ discussions with other people on the site. However, in actual use, things turned out differently. Instead of being used as a communication tool in support of the mobility of the foremen around the site, the laptop record keeping system quickly became a tool used primarily as a stationary record-keeping device. So, although useful to the work as a whole, the notebook was not useful for its intended support of the mobile dimension of the work practices on the site. This occurred because the laptop actually impeded certain of the crucial features of the collaborative work practised by the foremen and the other workers. For instance, when using the existing paper-based version of the allocation sheets, there would be a brief hand-over of documents and a simultaneous discussion about the problems on site. During these discussions, the paper documents would be positioned to render them "accessible" to the participants as the needs of the conversation dictated. With the new electronic mobile system, the characteristics of the notebook, such as its size, shape and screen intensity made it difficult for such subtle shifts of "accessibility" of information between collaborating participants. In practice, then, the system actually hindered mobile collaboration rather than supporting it because the wrong features of mobile work were chosen to be supported.

B) Facilitating awareness of both co-located and distributed colleagues

Another study of local and distributed mobility is found in Bellotti and Bly's paper *Walking away from the desktop computer: distributed collaboration and mobility in a product design team* (1996). This paper focused on the local mobility of a distributed design team across several buildings in a local area. They found that local mobility was critically important in supporting communication and awareness activities in the work practises under investigation. Bellotti and Bly observed that collocating with a colleague allowed a richer level of access to co-workers than was possible using telecommunication tools from the desktop. Local mobility, also facilitated access to colleagues that provided workers with an awareness of what was going on elsewhere in the workplace - with notably numerous 'ad hoc' informal meetings taking place throughout the day. However, the cost of such local mobility came in the form of limiting the telephone access to co-workers for remote colleagues - since the co-workers they wished to talk to were often not at their desks when they phoned.

The notion of awareness in the workplace and the problematic nature of capturing it with mobile devices also featured in Luff and Heath's 1998 mobile studies. They highlight the

difficulties of awareness through their discussion of staff and management conditions at the London Underground. Here they found much of the information and communication resources that were required for the staff to perform their work were located in the Operations room (Ops room). Thus, when a member of staff was mobile and away from this room dealing with problems, they were unable to access this rich seam of information, and any update of it, because they no longer had visual and auditory access to colleagues - and information which manifests in such events as inadvertently overhearing activities in conversations and phone calls. The access to this information was ongoing and unplanned when in the Ops room and would be impossible to replicate with currently used devices, such as a mobile phone, when away from the room.. Wiberg and Ljungberg's (1999) ethnographic study of mobile telecommunication engineers in Sweden also identified that knowledge sharing amongst mobile workers was problematic. Since the mobile engineers studied in the research worked alone in their cars for most of the day, they faced the intractable problem of finding out about ongoing developments in other projects.

C) Designing around social and organisational factors

This section examines the problem of designing technology that allows mobile workers to work within acceptable social/organisational norms (or developing tools to work around them.). On a day- to-day basis even if a particular technology is available for a mobile worker they may be reluctant or unable to use it in some situations. In the main this may be due to the social/organisational norms of the situation (restaurants, meetings etc.) or it can be a legally imposed restriction, such as on a plane or when driving. There is also the grey areas of use - such as in movie theatres or in ' forbidden mobile phone use' train carriages (which have been introduced in some British train routes) where using the device, although legally not banned, would be extremely frowned upon and would usually elicit a request for the user to remove themselves from the vicinity.

Ling's studies into mobile telephones and manners in Norway, mainly focusing on telephone use in restaurants, discusses in detail the social constraints on the use of mobile telephones in public. He notes that "the adoption of new technology is a conservative process but once accepted the user "cannot go back home and life changes with the object nudging their way into the daily life of the user although those around him may not be so willing to accept the new technology."(Ling,1999). Ling also points to the schizophrenic nature of someone on the phone while engaged in another activity, such as eating at a restaurant, and the resultant disruption this can cause for those around them. For example, the language and topic of the call may differ substantially to the "cosy and intimate chat" that the participant was engaged in before taking the call and he highlights the "stressful" and "suspended status" of those that are asked to wait while the call is in progress (Ling,1999). More importantly, he highlights the problem of eavesdropping and the stress this can cause to both the phone user and those around him.

Many of Ling's findings are echoed in Nelson et al.'s (2001) *Quiet calls: Talking Silently On Mobile Phones,* where they identify several ways people attempted to deal with the situation of having private conversations in public places such as - talk quietly, move the conversation elsewhere, do not take the call (by using voice mail instead) and lastly switch modality to use inaudible technology such as a text pager (although SMS texting on mobile phones seems to have taken over this role among the youth of today). In their research they noted several instances where observers could not help but overhear personal information they shouldn't have had access to (such as names, telephone numbers and addresses) but also they identified the competing need that mobile phone users have to be responsive to others in their daily routines - both their livelihoods and the health and safety of other depending on them leaving their phones on in places that typically would not be acceptable. As a design solution to the problems identified in their research, they prototyped and tested a device that allowed the receiver of a call to continue using the phone but switch mediums of input - so they could respond to a caller by using a quiet mode of communication such as a keyboard button or touch-screen (and the information typed into this would then be transferred to synthesised speech heard by the caller) and a headset for hearing the call.

Whether such novel design solutions will take foothold in society is debatable. Palen et al, building on Ling's earlier work examined novice users first tentative steps of using the mobile phone. They found that these people often initially bought phones for business or security purposes only. However social use became more apparent among these users so that despite "clearly articulated feelings about improper uses of mobile phones initially", the participants of the study very quickly changed their views after a short time of using the mobile phone to more favourably viewpoints about the use of mobile phones in public places (Palen et al, 2000).

D) Strategies and resources

This section looks at the utilisation of strategies by mobile workers to take advantage of people's natural tendencies to find solutions and workarounds to poor resource environments. Laurier's 1999 ethnographic work into mobile work discusses the phenomenon of the "mobile office". He relates some of the socio-material practises that allow a car-based mobile worker to achieve "the office" on the road. For example, overcoming geographical boundaries by using the mobile phone to 'team build' with co-workers or using a switched off phone, voicemail and caller ID display as a substitute for a 'meeting in progress' sign on a fixed office door and a Receptionist. In a similar way, Perry et al (forthcoming) show that mobile workers made use of the resources they had available to them in their impoverished mobile environments to retain links with their fixed offices. For example, the mobile phone was a key feature in this behaviour since mobile workers need to keep up with their ongoing background work activities, rather than only working when they had a complete office infrastructure at hand. The flexibility of the mobile telephone allowed them to disperse their workload and to work in otherwise 'dead time'. The mobile telephone also allowed its users to operate other technologies by proxy. When mobile workers were in resource-poor surroundings, the mobile workers used the mobile telephone to access external devices such as faxes and emails as well as urgent documents.

They could also use the mobile telephone when they were away from their home base to monitor activities back in their main offices - something that they tended to do in 'dead time'. Perry et al also showed that mobile workers planned ahead to take things with them that they may require. This phenomenon they termed "preplanning for contingency" and was identified as an essential feature of a mobile workers' on-the-job practices. They argue that technologies could be built to support these strategies more effectively, linking the different technologies and integrating them more closely with their work practices.

E) Access and Mobility - the blue-collar dimension

Up until now our examination of previous research into mobile work has focused primarily on white-collar workers (with the exception of Heath and Luff's and the Victorian Institute's studies). Specific research into the informational and communicative needs of mobile blue-collar workers appears to be, for the most part, overlooked by the literature. This lack of interest in blue-collar worker research is despite the lessons learned in, for example, Orr's study (1996) into mobile photocopy repair technicians, where he identified that the shared "war stories" of these technicians had a critical role to play in supporting their daily work practices. This lead to his recommendation that members of this 'community of practice' (Wenger, 1998) should be given radio equipment to enable them to remain in contact throughout the day to support each other in their repair tasks.

Ignoring the needs of mobile blue-collar workers can be argued to be extremely problematic in the design of new mobile technology. Not only can it be viewed as discriminatory (in the sense that increasing technological power is invested in the hands of managers, and not the workers), but also because it is ignoring a potentially large corpus of users. In the UK, it would be rare to find a self-employed blue-collar worker who did not use a mobile telephone for work. However, the kinds of mobile technologies currently on offer in the market place are extremely limiting for this group of workers - supporting as they do the building of

contact lists, diaries and other forms of document management traditional associated with knowledge work (Brodie & Perry, 2001).

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