ADOPTING A FRAMEWORK FOR COLLECTING AND ANALYSING MOBILE AND DISTRIBUTED WORK DATA

1. Introduction: "workers of the world unite, the mobile revolution is here and you have nothing to lose but your desktop chains".

"Let the ruling classes tremble at a Communistic revolution. The proletarians have nothing to lose but their chains." (MARX & ENGELS 1872, Manifesto of the Communist Party)

The mobile computing revolution, like the Russian Revolution of 1917, should not be interpreted as an end in itself. Instead, it should be seen as a necessary milestone on the path to an ubiquitous computing future for the world's nations; just as the social, economic, and political revolution of 1917 was conceived as the first step in the long - although never achieved - path towards a true Communist world order. While it was envisaged in socialism that there would be a "Vanguard" of the "proletariat" to protect and lead the masses during this intermediate stage towards Communism; there is lacking in our fledgling mobile revolution a similar "Vanguard" of the "mobile worker". Instead our mobile workers must do "battle" for mobile connectivity hindered by complex devices[1] and facing the Goliath's of "chaos" in device standards; incompatibility of devices and usability problems which range from "limited battery life" to interface navigational difficulties (Johnson, 1998; Perry et al, unpublished). Several companies, like Symbian and Microsoft have tried to hoist their banners for the mobile masses to follow their EPOC or Microsoft CE mobile platforms but, for the moment at least, mobile workers are still finding it near impossible to unite in Cyberspace and, thus, cannot lose their Ethernet chains and gain freedom from the dogmatic inflexible nature of the desktop machine (Perry et al, unpublished). While the aims of this PhD are modest, both in terms of content and scope, one of its central tenets will be that just as Marx and Engels envisioned that the Communist state could not come about without the levelling out of differences of resources between town and country that, similarly, mobile[2] computing cannot succeed without addressing the current imbalance of collaborative resources between desktop machines and mobile devices.

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[1] Kyocera Smartphone released in the United States recently, has a "reboot" button because of its sheer complexity.
(http://www.zdnet.com/zdnn/stories/news/0,4586,2711249,00.html) Norman (1990) labelled such developments as "creeping featurism".

[2] At the outset we must admit that a definition of what it means to be mobile is hard to pin down. For the purpose of this PhD though mobility can be seen as related to resources and so our mobile workers are seen as mobile when they are away from the collaboratively rich resources of their usual desktop office environment.

2. Cobbling together cut down versions of desktop applications does not a solution to mobile computing make

Of course it is not just the amount of resources that is the key to the solving the mobile workers' problems. The HCI literature is littered with devices that users never took to, the Dvorak keyboard is as an infamous example of this (Beyer & Holtzblatt,1998:7). As Beyer and Holtzblatt point out, "Traditionally new products were most often defined by an engineer getting a bright idea, building it then looking for a market for it". But in today's economic climate "new products will not be accepted" if they do not fit in with "customer's other systems and existing ways of working " (Beyer & Holtzblatt, 1998:1). Thus, we need to overcome our myopic focus on the component aspects of mobile devices, such as handwriting recognition speed or screen real estate and go further to picture our mobile devices and their software applications in a holistic light. Our final goal in CSCW research must be to offer designs for improving the overall performance of mobile devices as collaborative tools and not on any individual element of a system, such as physical portability. Such a short-sighted viewpoint has been shown to, if anything, lead to the development of devices with negative side effects for our mobile users in terms of opportunities for collaboration (Luff and Heath, 1998).

We must begin, therefore, by accepting that there are deeper issues to be addressed when looking at the design of software and hardware for mobile workers than the up to now focus on low-level performance criteria apparent in HCI research, for example, focusing on text entry speeds or handwriting recognition (Pascoe *et al.*, 1998; MacKenzie&Chang1999). To date, with a few exceptions, mobile device creation has been technologically driven and the research into mobile devices has, by and large, failed to fully comprehend how mobile workers operate and the kinds of activities they perform while on the move (for exceptions see Bellotti & Bly 1996 Luff & Heath, 1998; Perry et al, unpublished). Yet such research, we can argue, is essential if we are to create technology which will enable and empower the mobile masses in their quest for full collaborative-resource equality. The underlying research problem we face then is to establish where and when our mobile workers *may* need technological support in their daily activities and where traditional low cost materials such as paper and pen, for example, will *suffice*. As Beyer and Holtzblatt explain, to be successful " those who define and build hardware and software systems must know how to fit them into the fabric of everyday life". (Beyer & Holtzblatt,1998:1) and we can appreciate that the only way to do that is to know what the "fabric" of the everyday "life" of our users is, (while, in addition arguing also for an inherent flexibility in our mobile device creations since these devices and software applications may well lead to the adoption of new working practices by our workers, when combined with other devices for example, and so lead to a change in this existing "fabric"). With this in mind we turn to look at the traditional HCI techniques used for identifying the technological requirements of users. Our purpose will be to see if we can establish if these methods provide a suitable framework for analysing and investigating the activities and work practices carried out by mobile workers. The quality of the data to be collected will be crucial since it will not only be used to evaluate the current situation for mobile workers in terms of

technological resources and existing work practices but also provide us with an initial first pass sweep at requirements capturing for a prototype software application to further enhance mobile workers' opportunities for collaboration.

3. The problem with traditional HCI methods

There have been many methodologies and methods used in traditional HCI research to collect data as regards users' needs and wants. For example, laboratory experiments usability interviewing, questionnaires and usability focus groups. However, it has been widely accepted in the CSCW community, for quite some time now, that these methods produce insufficient data in respect to the "real life" of the users involved because these methods are unable to accomodate the fact that human activity is highly "flexible", "nuanced", and contextualised" (Suchman1987; Ackerman 2000). The problematic nature of these methods are exacerbated even further when we look at mobile work. Mobile work can be viewed as "heterogeneous" with a large "versatility of usage patterns" and "usage contexts"(Kristofferson & Ljungberg,1999; Väänänen-Vainio-Mattila and Satu Ruuska, 1998). Thus, mobile communications technologies need to support a range of different types of work, between the mobile user and their office and several workers and several devices. Such complex phenomena cannot, it can be argued, be successfully replicated in a laboratory setting or even be fruitfully observed outside a "real life" backdrop.

4. Ethnography: the solution to the decontexualised nature of traditional hci research techniques?

After establishing the inappropriateness of traditional HCI methods for data collection of mobile work practices, since these methods' analytical frameworks are not designed to incorporate contextual issues, we turn our attention towards ethnography, an array of methods for collecting data in real world settings, as a likely candidate for providing us with appropriate techniques to carry out our research. Ethnography, traditionally associated with anthropology and sociology, has for many years now been adopted by CSCW researchers in studies of underground control rooms, air traffic control rooms and other large organisational settings, like the IMF (Hughes et al, 1992; Luff & Heath 1998; Harper, May 2000). By spending time with workers observing what they *do*, rather than what they *say they do*, ethnographers can arrive at a rich understanding of the work under investigation. The ethnographic methods employed in such studies include, field observation and diary techniques which have helped ethnographers identify the organisational, social and political constraints of the work activities under investigation. Significantly, also, the language of the data collected mirrors that of the participants own language. Initially, the CSCW research community embraced ethnography with open arms as *the* solution to the decontexualised world of the traditional HCI laboratories:

" We expect that field research to be more extensively used in product and tool development. The methods will become more standardized widely shared and better understood… The documentation of success cases such as the origins of Word Perfect…will provide an incentive for adoption. If the decade

from 1985 to 1995 could be called "the decade of the usability lab" the decade from 1995 to 2005 may become the "decade of field research". (Ramey & Wixon, 1996:10)

However, there are problems that have subsequently been identified with ethnography when it has been adapted for use by those in system development: the time it traditionally takes (which can often span years in a setting under investigation); the fact the results produced are often not in a form which are easy to communicate to others and the lack of shared language between the anthropologists/sociologists carrying out the research and the software engineers who are expected to build systems on the basis of the research results. There is also the question of abstraction, which for so long has been the focus of software development, and yet how do you extract what you want to develop from techniques that deliberately generate data focused on the context of a particular situation? There is also the additional problem that there is a "lack of systematic approach to carrying out ethnography "making the technique dependent on the individual ethnographer's skills" (These issues are discussed in Viller & Sommerville 1998:2). Yet, despite all its faults, in terms of expense and difficulties of process ethnography is stilled viewed by those in the CSCW community as necessary if we are to create systems that truly reflect the needs of the users since it has undoubtedly improved understanding of the way in which work is socially organized, and how, for instance, seemingly ordinary tasks can play a vital role in the successful accomplishment of the work under study (Harper, 2000) .

5. COHERENCE: combining ethnography with system design a solution?

In order to overcome ethnography's fatal flaws in relation to informing system design CSCW researchers have looked to combine and integrate ethnographic methods into the design process. The first methodology we shall look at is Coherence. Its developers view it as a way of systematising the experience gained from performing ethnographic studies in system design. This methodology was developed at Lancaster University by Sommerville and Viller and in the past has had input from both software engineers and sociologist (Viller & Sommerville, 1998). Coherence as it stands at present has eradicated the traditional role of an ethnographer. Instead, the designer/developer does the work analysis on their own and are backed up by ethnographic guidelines, which help the software engineer/designer model the existing system under analysis while highlighting the social dimensions of the work under scrutiny. By using an extended form of the Unified Modelling Language (UML) to undertake the modelling of the existing system this enables the software engineer/designer to work in framework familiar to them from which to draw out design requirements for a new system.

In the Coherence methodology Viller and Sommerville use what they term “concerns” to drive the analysis of the work under scrutiny. “Concerns“ directly reflect the goals of the organisation and are global requirements of the existing system that must be satisfied when designing a new system (for example, a concern such as safety in air traffic control). Once concerns have been established then Villers and Sommerville

employ the technique underlying their work, viewpoint-oriented requirements engineering, which they call PREview. IN PREview "viewpoints are encapsulations of information about a system or process i.e. about some aspect of the workplace under analysis."(Villers & Sommerville,200:173). Each viewpoint is a partial analysis of the workplace and a complete analysis of the workplace is obtained through both integrating and reconciling multiple viewpoint analysis. Viewpoint, as defined in PREview, consists of the following components:

- Name. An identifier, used to refer to the viewpoint, and usually chosen to reflect the focus of the viewpoint.
- Focus. A statement of the perspective adopted by the viewpoint.
- Concerns. The organisational goals and constraints which drive the analysis process.
- Sources. The sources of information associated with the viewpoint. The sources may be people, documents, requirements, other viewpoints, and so on.
- Analysis (requirements/model description). The analysis of the system or process as seen from the focus of the viewpoint.

(from Viller & Sommerville, 2000)

However, this is not the end of the story. After establishing viewpoints in their analysis the software engineers/designers go on to encapsulate the "concerns" identified into questions and these questions must be asked of every viewpoint to collect information about the system which will apply across all viewpoints. Coherence initially deals with three social viewpoints, these are Distributed coordination; Plans and procedures; and Awareness of work. Likewise, several concerns are also built into Coherence's framework, these are paperwork and computer work; skill and the use of local knowledge; spatial and temporal organisation; and organisational memory (although these will be adapted or not used depending on the situation under investigation). By adopting the viewpoints framework, Coherence provides a means of integrating analysis of the social aspects of a workplace with the typically more technical concerns for the design of a system to support the work that takes place within it. After conducting their social analysis of the situation this is then modelled in (an extended version) of a UML sequence diagram and following on from this, use cases can be generated. (These are meant to be the starting point for more detailed object-orientated analysis and the design of the new system.)

On initial reflection, although quite a complex methodology Coherence does seem to answer a lot of the problems that have been identified in ethnographically informed system development. The first thing to note is the absence of an ethnographer in the method, instead " the locus of ethnography is no longer in the ethnographer's head but

embodied in in the system itself" (Viller & Sommerville, 1998:2). This, neatly rules out any clash of culture in terms of language or perspective between those analysing the old system and those designing the new - because they are one and the same in the Coherence method. The method, on the surface, also seems to have all the benefits of existing ethnography such as allowing those conducting the analysis to see the work in "context" and appreciate the social concerns of the actors involved as well as being able to witness at first hand if apparently mundane tasks are in fact crucial to the work being investigated. Another benefit of the method is that it does not interrupt the flow of the work under investigation, which is important in areas such as medicine or air traffic control, where it would be inappropriate to interrupt a doctor or air traffic controller for clarification of an action during the middle of an operation or landing of a plane. Similarly, by using an extended version of UML notation the developers of this technique are allowing software engineers/designers a familiar framework from which to both analyse the old system and generate the new. For my own part I feel that the very fact that the Coherence methodology sees as important the social concerns of actors in the system and tries to incorporate them in to system development is an important step in the right direction.

However, despite the apparent benefits of this methodology on closer inspection there are obvious problems for what we are trying to do in our investigation (i.e. collect and analysis data to develop a prototype for mobile workers). Firstly, The Coherence methodology is undoubtedly suited for systems with fixed procedures, which are often repeated but, as noted earlier, there are many different "usage patterns" and "context" changes that we want to accommodate when looking at mobile device and software design, so modelling an existing system would not only be difficult but of little use to us since mobile activities may be done once and not again or done in completely different ways each time by our diverse mobile users. In terms of modelling a system the Coherence methodology leaves itself open to all the criticisms usually levelled at modelling notation techniques. For example, that the life expectancy of a notation tool like UML is short because of its dependency on the kind of programming languages that it is designed to support, namely, objected oriented which could well be replaced with new styles of programming (as procedural programming was replaced by object oriented programming in the not too distant past.)

The Coherence methodology also seems to encourage a slow evolution of those systems under investigation, with its focus on initially modelling the existing system to see what concerns are apparent. Although this is in keeping with large organisations like air traffic control and banks who want to change their working practices very slowly over time (and so change few of those social concerns at a time) with mobile devices we want to design and encourage new working practices that are more flexible than the Coherence model would seem to allow. We can also question the demands placed on one type of individual in the Coherence methodology e.g. the software engineer/designer has to both analyse an old system and develop a new one. With the loss of the cross-functional teams in the Coherence methodology we can argue that the process (and perhaps the results) of system development using this methodology will

be impoverished since it loses out in terms of the blending of different skills and experience that typically occur in a cross-functional development team. Similarly, it can be argued that the "tacit" knowledge of a skilled ethnographer, cannot become "hard" knowledge in the form of guidelines for analysing a work situation, as easily as the developers of this method would like us to believe. Perhaps the Coherence method could have, instead of getting rid of the ethnographer, embraced an apprenticeship model for system design, which could go some way to alleviate this problem. Under this scenario system designers would shadow for a short period of time (at least) a traditional ethnographer at work before being allowed to conduct the work study on their own. In the final analysis, when examining Coherence, a methodology for system development that seems to guarantee the slow evolution of systems over time, its developers have made a large leap of faith by abandoning the ethnographer in ethnography and may well have thrown out the 'baby with the bath water'.

At the end of our look at Coherence it seems clear that we need to continue on our search for a suitable framework of analysis and techniques to conduct our mobile worker's study because despite its strengths Coherence is just not suited to our needs. Thus we turn to look at our second methodology for integrating ethnography in system design, Contexual Design, to see if that can provide us with more appropriate techniques to conduct our investigations.

6. The contextual design solution - a better alternative?

Contextual design is an interpretive field research methodology used to gather and to understand qualitative data with respect to users in real life settings. Contextual Design's key aim is to bridge the gap between the complex open world of work and the closed world of software design. It seeks to overcome the problems identified in traditional ethnography such as time scales, lack of structure in the work model and usability of the ethnographic record as a design document. Its designers view it as:

> "as an approach to define software and hardware systems that collects multiple customer -centered techniques into an integrated design process."(Beyer &Holtzblatt, 1998:3)

Contextual design begins with Contextual Enquiry, which is an approach to work study that seeks to optimise the usability of envisioned products by involving end users in the design process, thus in that sense it can be seen as embracing an element of participatory design in its structure. As a backlash to traditional laboratory based usability engineering the main aim of contextual inquiry is to avoid the de-contextualisation of the user and allow them to voice their concerns about existing/new products in context.

The data collected using contextual inquiry can be used in gathering system requirements and/or evaluations of prototypes. Data collected in contextual design is always gathered in context: during conversations and observations of current and potential users in their natural setting, preferably while the activity is still happening because:

"No job, even one as simple as printing a label is accomplished with a single tool. Design has become difficult because systems now support almost every aspect of work life. It's up to the design team to understand the environment their tool will be used in because it is the combination of tools that controls their customer's work practice." (Beyer &Holtzblatt, 1998:7)

If an interview regarding work is retrospective, the interviewer must query the participant further to actively encourage the participant to recall concrete details of the work being related in the interview. Thus, it is just as important in this instance what the user does not say as what they do say because the interviewer must ask questions that lead to the filling in of the "holes" in the user's account (Beyer & Holtzblatt, 1998:49).

In contextual inquiry there are several key concepts that are essential to the success of the method. The first is context, which relates to understanding users' needs while they are actually working. The second key concept is partnership, which views the user and interviewer as partners in the inquiry at hand, and the third is the notion of *focus*, which enables the interviewer to listen and explore from a 'clear perspective'. In Contextual Design there are several different types of focus the first and foremost is the project *focus* which gives the design " team a shared starting point and this is "agumented by each person's entering focus so they each bring their unique perspective to bear". (Beyer &Holtzblatt, 1998:62) Focus is critically important to Contextual Design as Holtzblatt explain:

"First, we set the focus deliberately to give the team a common starting point, an initial way to see the work, allowing them to build their own distinctions and interpretations on that base. Then we use group interpretations in the cross functional team to allow team members to learn and take on each other's focus over time and bring their own focus to bear on each other's interviews." Beyer & Holtzblatt, 1998:62)

During individual interviews the initial project focus will be expanded by paying attention to both things that are not said and things that are said but do not make any sense to the interviewer.

Once data is gathered in contextual design, using the methods of contextual inquiry the data is analysed during the interpretation sessions. As Beyer and Holtzblatt point out the interpretation off the data is as critical, if not more so, as the data collection to the success of good design:

"A clear understanding of the customer doesn't guarantee any kind of useful system gets designed and delivered. Design depends on being able to see the implications of data… Contextual design… is intended to help designers see design implications in customer data… The design isn't inherent in the data…Designers have to make a leap from fact to implication for design". (Beyer &Holtzblatt,1998:16-17)

Interpretation of the data begins during the interview because facts are checked and validated as they are mentioned. However, most interpretation takes place during a team analysis of the data following the interview. This cross team analysis is considered to elucidate better data than data coming from one perspective. Data in contextual design is not only what the interviewee says and does, but also the

interviewer's interpretation of the work under investigation. During this team analysis the data that has been collected are built into diagrammatic representations called 'the work models'. Work models attempt to consolidate and represent contextual inquiry interview data in a way useful to designers. For each interview five types of work model are constructed. The flow model which represents the communication and co-ordination necessary to make the work happen. The sequence model which shows the work steps followed towards achieving an intent (purpose or goal). The cultural model which reveals attitudes and constraints resulting from the policy and values inherent in the work environment. The artefact model which shows the artefacts used to support the work and reveals any breakdowns in use and, finally, the physical model which reveals the important physical dimensions of the workplace and the movement of people and artefacts in the workspace. After creating individual work models the design team work together to consolidate the models into a single set of more generalised work models. During the interpretation session the design team also construct an affinity diagram.

Affinity diagrams are created using the statements from transcripts of users sessions and a re-iteration of the research question. Then the question is put whether the statement given is relevant to the focus of the research project. If information is found to be relevant it is recorded and further analysed using affinity diagramming. Affinity diagramming can be viewed as structured brainstorming supporting lateral thinking, creativity and innovation. Beyer and Holtzblatt view it as "bringing individual points captured during interpretation sessions together into a wall sized, hierarchical diagram showing the scope of issues in the work domain." (Beyer and Holtzblatt,1998:25).. Beyer and Holtzblatt argue that affinities do not just make a category explicit they aim to identify themes of patterns and allow lateral thinking of possible design solutions to the problems raised. The relationship between items in affinity diagramming may not necessarily be apparent but after brainstorming the user can begin to see key patterns emerging. As Holtzblatt and Beyer point out the affinity diagram organises the individual notes captured during an interpretation session into a "heirarchy revealing "common issues" and "themes" (Beyer &.Holtzblatt, 1998:154) The affinity diagram shows the scope of the customer problem "revealing in one place, all the issues, worries and key elements of work practice relevant to our research focus". It also helps define the key quality requirements of the system such as reliability etc. (Beyer &Holtzblatt, 1998:155). When looking at an affinity diagram a designer not only learns the key issues but can see the exact data that contributed to identifying an issue in the workplace. Affinities are built "bottom up" by " raising common structures and common themes out of individual notes. Beginning from a set of categories reduces building an affinity to a sorting task. Instead the builder of an affinity diagram must allow individual notes to suggest categories they might belong to. Building an affinity diagram is seen as "inductive reasoning at its purest." (Beyer& Holtzblatt,1998: 156). Two post-it notes have an affinity if they are saying similar things about the work as it relates to the design focus, that is they are expressing a "similar intent, problem or issue in the users work"(Beyer, Holtzblatt, 1998:156). When notes are collected together they are given a name to represent the group. A

good group name states the work issues that holds the individual notes together. It is a succint “phrase” that summaries the content of the group.

Following on from affinity diagramming and consolidation of the workflow model the designers, users and other interested parties are encouraged to 'walk' the consolidated models and affinity diagram. This is carried out by reading through each and suggesting design ideas or changes as appropriate. In this way the interpretation diagrams become an arena for an exchange of ideas and the first stage of the work redesign. Usually the diagrams are displayed in a physical space, however, they can be made available on-line (see Curtis et al, 1999 for an indepth account of an 'online' and 'physical' affinity diagram success story). The next stage is to develop a vision of the new system in the work context. This is achieved by the use of both metaphors to help see the underlying structure of the work situation by exploring parallel work domains and also structured brainstorming allowing the creation of future visions for the work under investigation. The highlights of each vision are then synthesised as a new solution incorporating the best of the individual visions. The goal during synthesis should be a vision that is "coherent and clean and that supports the work issues everyone identified".(Beyer&Holtzblatt:1998: 287) The designers then move on to capture their vision in storyboards. Storyboards show how how specific tasks will be achieved in the "new world" envisioned by the designers and follow the structure of a consolidated sequence model but also include implications from other models as required. However, Beyer and Holtzblatt believe that designing a system based solely on storyboards would optimise each sequence of use at the expense of the system as a whole so an element of structure must be included in the design. To do this the technique of User Environment Design (UED) collects the system functionality described in each of our storyboards and organises it into focus areas (which are merely a place in the system). Each focus area has specific functions in the system and are linked to other focus areas by arrows, which indicate how the user can move through the whole system. The UED in its early stages describes the system functionality and each focus area provides the designer with a checklist of functions provided and not provided to the user in the focus areas under consideration. As the UED is developed though, the overall structure of the system become apparent and keeps the design at the "right level" (Beyer&Holtzblatt, 1998: 310). Beyer and Holtzblatt state that the UED has much to offer over traditional use cases since the use case is task-oriented, telling one story of use for one task, but it does not reflect a coherent view of the system which they argue UED modelling does by being neither task oriented nor object oriented but focused on "the structure of work in the system it is work oriented which makes it powerful". (Beyer&Holtzblatt, 1998, 312).

Contextual Design also goes on to provides guidance on how to conduct iterative paper prototyping interviews and feed the data gathered back into the UED and the creation of new prototypes. These prototyping interviews are different from traditional usability testing because, as Beyer and Holtzblatt note usability tests typically seek to measure users' performance on set tasks to ensure they can be done fairly efficiently. But the goal for their testing is to discover a better system structure for the UED so together "user and designer can explore how the system will impact

the work and how work is likely to change in the future as a result."(Beyer and Holtzblatt, 1998:375). They emphasise, once again, the ideas of context, partnership and interpretation during this stage of development. Eventually, after prototype testing has finished the UED is translated into the User interface by using the UED and the work models to inform the final design decisions made by the programmers of the system.

On reflection Contextual Design does seem to address most of the problems we found with traditional HCI testing, ethnography and The Coherence methodology. For instance, it analyses the users work activities in context, but uses the notion of an entry focus to limit the time needed to do the work analysis and subsequently the data generated. The 'trick' Beyer and Holtzblatt see of overcoming the traditional drawbacks of ethnography is to:

" give the team tools that let them see the breadth of data without being overwhelmed to see the common structure and pattern without losing the variation and to understand the wealth of detail without losing track of its meaning." (Beyer & Holtzblatt, 1998:4)

As a methodology Contextual Design still maintains cross functional teams to do the design and development of the system and actually emphasises the benefits of different background and experience when analysing an old system and building a new ones, particulary with respect to the notion of focus. Having a project focus also facilitates good communication between different team members. Unlike the Coherence model with its emphasis on "task analysis" Contextual design highlights the structure in the work under investigation and captures this in its 'models' particularly the UED, which is seen as crucial to the designing of a system that will benefit the overall work under investigation, as well as potentially aiding the success of innovation in design:

"Innovative designs that succeed are those that offer new ways of working and new advantages while maintaining enough continuity with people's existing work that they can make the transition. …what makes an optimal fit…no absolute right answer. In customer-centered design we seek a framework for the discussion so that the decision is based on customer data and a way to check the decisions with the customer." (Beyer & Holtzblatt, 1998: 8)

Another positive reason for using contextual design when designing for mobile workers is the fact that it has already been successfully used in the design of the Nokia 9000 Communicator . In this instance, the affinity diagramming of contextual design was exploited, "in early design phases to get input e.g. for the requirements formation and task analysis, and especially to gather insight and create basis for design ideas. (Vaananen-vainio-mattila and Ruuska,1998).

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It is also a good methodology to use because it accommodates iterative prototyping. This adds additional validity to the design process, as well as continuing the partnership between user and designer throughout the design process and checking the design developments at key stages with the people who matter the most the users without undue pressure on them to come up with design solutions on their own

(which is often a drawback of other methodologies which embrace participatory design principles).

But like all methodologies there are drawbacks to be seen in adopting Contextual Design wholesale. It's a complex methodology, which demands many skills from its designers/interviewers. One obvious example is a reliance on the skill of the user of the methodology and their memory for details: they must keep a lot of facts in their head at one time to guide the processes through to its conclusion. A lesser complaint but none the less valid is the commercialism of this methodology with its focus on the notion of the "customer". Customer and user are often not interchangeable concepts in industry.

On the positive side though Beyer and Holtzblatt do recognise that their system does not need to be used in its entirety and even if it is used wholesale there will be adaptations along the way in the methodology because " as you take it and use it, in whole or part, you will change it again" (Beyer &Holtzblatt).

7. Conclusion

Our goal in this chapter was to find a framework for analysing the work practices of mobile workers and discover techniques for doing this, so that we could discover in real life complex settings what they need and want from mobile technology. We have in this chapter explored traditional HCI methods, critically examined the Coherence methodology used at Lancaster University and ended with an in depth look at Contextual Design. In Contextual Design, it can be argued, we have found a methodology that, although not perfect, does provide us with useful techniques and a framework from which to analysis our mobile works technological needs.

Despite our enthusiasm for Contextual Design as a complete methodology, it was felt that rather than plunging head first into contextual inquiry to generate our data in our initial pilot interviews, that more tried and tested techniques, in the form of reconstructed diary studies and analysis of artefacts used during specific business trips, would be used (Perry et al, unpublished). These methods have been used successfully in earlier studies of mobile professionals and the combination of these techniques has many of the same characteristics as contextual inquiry, however, by using these tried and tested methods, instead of contextual inquiry, we would be free ourselves to focus primarily on the data coming through from the interviews (which would eventually shape the direction of any future work) rather than concentrating on getting the interview style just right (which may have been the case in any initial attempt at using contextual inquiry).

However, to maintain our commitment, and also to develop our skill, in Contextual Design affinity diagramming was adopted for the analysis stage of our pilot study because this, it was felt, would allow us to identify coherent overriding themes in the large amounts of data generated, while also helping us to appreciate what further areas needed further investigation when we came to carry out our larger study.

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