Managing Information on the Move:
A Study of the Information Needs
of Mobile Professionals

Kenton O'Hara, Mark Perry, Abigail Sellen, Barry Brown
HP Laboratories Bristol
HPL-1999-123
14th October, 1999*

mobile phones,
documents,
mobile professionals,
mobile technology,
wireless
communications

Many IT companies recognise the importance of wireless communication in the development of new technologies. In order to better inform this development of these technologies this paper describes a study of mobile professionals focusing on their communication and document activities. The findings indicate the particular importance of verbal communication for these people and hence the value of the mobile phone. The study also brings to the fore the relationship between their use of the phone and their document activities. The findings have allowed us to develop a taxonomy of this relationship that provides a useful resource for thinking about design implications and new technology supporting mobile work.

Managing Information on the Move:

A Study of the Information Needs of Mobile Professionals

Kenton O'Hara, Mark Perry, Abi Sellen, Barry A. T. Brown,

{Kenton_Ohara;Abi_Sellen;Barry_Brown }@hplabs.hp.com; Mark.Perry@brunel.ac.uk

Appliance Design Group	Dept. of Information Systems & Computing
Hewlett-Packard Labs	Brunel University
Filton Road, Stoke Gifford	Uxbridge, Middlesex,
Bristol, BS34 8QZ, UK	UB8 3PH, UK
+44 117 922 9520	+44 1895 274 000 x 2395

ABSTRACT

Many IT companies recognise the importance of wireless communication in the development of new technologies. In order to better inform this development of these technologies this paper describes a study of mobile professionals focussing on their communication and document activities. The findings indicate the particular importance of verbal communication for these people and hence the value of the mobile phone. The study also brings to the fore the relationship between their use of the phone and their document activities. The findings have allowed us to develop a taxonomy of this relationship that provides a useful resource for thinking about design implications and new technology supporting mobile work.

KEYWORDS

Mobile phones, documents, mobile professionals, mobile technology, wireless communications

INTRODUCTION

The last five years have seen a startling boom in the uptake of mobile phone technology. Sales have far exceeded even the most optimistic predictions. They are now an indispensable tool for the mobile worker as well as widespread within the consumer space.

The success of not only mobile phones but other kinds of portable devices such as the PalmPilot have motivated IT companies to want to learn and profit from these experiences. Some aim to invent new categories of mobile technology for themselves. Others seek to take advantage of infrastructures or devices that already exist, and to leverage these through invention of new products and services.

In the process of doing this, most IT companies have recognised that wireless communication can be central to

innovation. It suggests classes of technology that can keep mobile workers better connected to one another, and to networked information. Not only does wireless communication allow people to talk anywhere, anytime, it also offers the ability for them to remotely access, send or receive information through a mobile device. For example, there are many new devices coming on to the market which allow remote access to email, to the internet, and to electronic document repositories.

It is tempting in this new world of wireless communication to add cellphone capabilities to any mobile device which allows user to create, display or manipulate information (such as a laptop or a PDA). Equally, it is tempting for cellphone developers to incorporate data processing or document handling features into their cellphones. Some of these efforts will result in useful features, and others will not. Some will create successful new kinds of mobile technologies and some will not.

Studying Mobile Technology in Use

We believe these efforts can be helped by a better understanding of the use of mobile technology. In particular, this paper looks at the use of mobile technology by mobile professional workers. Not surprisingly, as we will show, most of the findings centre on their use of mobile phones as well as their use of documents (be they paper or electronic). In their reliance on talk and on text, mobile workers are no different from any of the other kinds of workers we have studied over the years [e.g., 8]. Mobile professionals are heavily dependent on their mobile phones in all kinds of interesting ways as we will discuss. They are also constantly engaged in the gathering, creating, managing and distributing of documents in the course of their work. They rely on many different tools to do this, including laptops, PDAs, fax machines and even paper.

What we hope to show in this paper is that this kind of study provides a more systematic way to think about the kinds of mobile devices that mobile professionals might find useful. In particular, we will show that the ways in which mobile professionals combine their use of the cellphone with document-related activities suggests new directions for the design of mobile devices.

PREVIOUS RESEARCH

The use of mobile technology is an important area of research still waiting to be mined. For example, so far there is surprisingly little in the published literature on mobile phone use with a few exceptions [6,10]. Although there is some literature covering choice of communication media (email vs. fax vs. phone), virtually all of this has been investigated in people's office environments dealing with a fixed and familiar technological infrastructure [e.g. 2,9].

With regard to mobile professionals, many marketing and IT companies rely on a now well known segmentation study which describes and classifies mobile professionals' activities (carried out by BIS consulting). However, this is a large scale study based mainly on questionnaire data which provides generalisations rather than in depth description of their activities. More in depth observational and interview studies of mobile professionals do exist, but look mainly at document use, and not at the other tools they use [e.g., 1,7].

Our Approach

Our research is different from previous work in that it looks in particular at how mobile professionals manage information through documents and through mobile communication technology.

In doing so, we felt it important to gather many different kinds of situated data. By this we mean that we wanted to gain our understanding, as far as possible, from observation and interviews in the actual work settings of these individuals. We also wanted to gather a comprehensive set of data so that we could understand the full range of communication and document activities these mobile professionals were engaged in. Interviews alone often do not suffice, as people are necessarily selective in what they tell you or think is important to tell you. Our solution was to use a combination of diary techniques, interviews, and analysis of the technologies and documents used during specific business trips. This allowed us to ground the study in real activities and to use trip diaries and existing artefacts to unearth the detailed context of their information and communication activities.

Another important aspect to the approach was to gather data both before and after business trips so that we could gain a longer term understanding of what happened during travel: what kind of preparations were made prior to travel, and what actually transpired during the travel episode. This helped to give a deeper understanding of the context surrounding the mobile professionals' activities.

Finally, on the basis of previous work such as segmentation studies of mobile professionals, we were well aware that there is great diversity in the nature of the work they do, the ways in which they travel, and their document and technology use. Thus we also felt it important to recruit a sample of mobile professionals which were representative of these differences.

METHOD

Subjects

A screening questionnaire was designed to provide a varied set of profiles for participants along these two main criteria:

- *Mobility* - Frequent air travellers to destinations outside the country vs. regular road/train travellers (both within local area and other parts of the country).

- *Collaboration* - Those who spend a high proportion of time working with others vs. those who spend a large proportion of their time working alone.

A pool of participants was collected from which 14 mobile professionals were chosen to provide a representative sample across the two main criteria. All but one regularly used a mobile phone. They were as follows:

1. Regional manager for a market research company;

2. Corporate relations manager for a communications firm;

3. Regional operations manager for a telecoms company;

4. Software sales manager;

5. Managing director of an Italian import company;

6. Account development manager for a major brewery;

7. Business and sales manager for a lab equipment supplier;

8. PR consultant;

9. Medical research co-ordinator in a large hospital;

10. International customer services manager for a telecommunications company;

11. International marketing director;

12. Civil servant (Executive Officer for Procurement);

13. Sales and marketing manager for a software company;

14. Production manager for a television company

Procedure

Each participant was interviewed twice. The first – the Pre-travel interview – was conducted as close as possible prior to the departure date for the next upcoming business trip. The second – the Post-travel interview – was conducted as soon as possible after returning.

Pre-travel interview - This was divided into two parts:

The first part was to gain some general background about the nature of the participant's work and home lives. This included: information about their position and responsibilities in the workplace; who they worked with and the nature and frequency of this collaboration; descriptions of typical days, both office and travel based; frequency and type of travel; information about family and social networks; technology infrastructure at home and office; and technologies used while mobile.

The second part of the interview focussed more specifically on the upcoming business trip. This included: the purpose of the trip; trip duration; where they were going; who they were going to meet; what kinds of information were they expecting to gather; preparations they had to do, such as

slide creation; what documents they would be taking with them and why; what technologies they would be taking with them.

Finally, subjects were asked to bring with them to the second interview any materials (e.g. emails, paper, and electronic documents) generated or collected while away.

Post-travel interview - This was divided into three parts:

The first part of the interview focussed on gaining an overview of what had happened during the whole trip.

In the second part, the interviewers used the overview to decide on a typical day in the trip to unpack in more detail. A "diary" of this day was then constructed from the beginning of the day when the participant awoke right through to the end of the day when the subject retired to bed. For each "diary day" subjects were asked to give detailed descriptions of their activities throughout the course of the day including any communication episodes, dealings with documents (paper or electronic), meetings, and travel. Any information that was gathered or distributed (e.g. documents or photographs) was then photographed or photocopied. These artefacts were discussed in relation to the daily activities and the goals and motivations of the participants. Subjects were asked what they planned to do with this captured information upon their return from travelling.

Finally, subjects were asked about any particular problems that they experienced in relation to their document-related and communication activities while travelling. Specifically they were asked whether there had been times when they *would have liked* to have been able to carry out some action but did not have the means.

Analysis
A total of over 35 hours of interviews was conducted in all. All were tape-recorded and later transcribed. From these, 2 kinds of "inventory" were compiled:

- *Document Inventory* – A list was compiled of information used prior to travel, during the diary day, and during the rest of the trip. (e.g. text document scribble, sound, scene), how it was acquired or produced, and how it was used (e.g. read, distributed).

- *Communications Inventory* – This recorded work-related communication episodes (phone calls, email, fax) during the diary day, the purpose and nature of the communication, and use of anything captured.

In addition, these inventories were analysed to discover the extent to which documents were used in conjunction with communication episodes.

RESULTS AND DISCUSSION
In this section, we investigate the pattern of communications activities across participants, and then look at their document-related activities. A final, third section brings these together to look at the interaction between the two, and presents a taxonomy with illustrative examples of participants' activities when they were mobile.

Communication Activities
The communication activities during the diary days for our 14 subjects can be subdivided into incoming and outgoing communication episodes. Starting with *incoming* communications, we analysed the frequency of received messages (e.g., phone calls, email messages) from our inventory of each participant's diary day (see Figure 1).
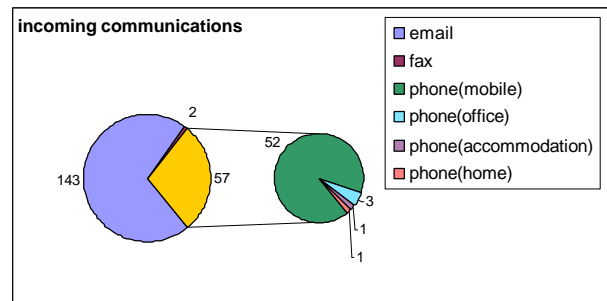

Figure 1. The frequency of incoming communications in terms of technologies used. The smaller circle provides a further breakdown of telephone use by telephone type.

Figure 1 shows that approximately two thirds of incoming communication (in terms of number of messages) was via email. However, this needs to be interpreted in view of the fact that only 4 of the participants used email facilities while mobile (receiving between 30 and 40 emails in the diary days we focussed on). In addition, this figure also includes many email messages which constituted junk mail or messages which were relatively unimportant to the receiver. The true utility of email relative to other means of communication is thus idiosyncratic and hard to measure.

Reliance on the phone for communications was much more consistent across the sample of participants, with subjects receiving on average 5 phone calls a day. These incoming calls relied most heavily on the mobile phone with about 85% percent of calls being received this way.

Fax, while an important communication device for a some of the participants in office-based work, did not play a signficant role for incoming communication while mobile. It was regarded by some of the participants more as a back-up mechanism in case, for example, they had left an important document behind.

In terms of outgoing communications, Figure 2 shows that even relative to email (which again is subject to problems in interpretation), the phone was the most important technology for these mobile professionals. On average, subjects reported that they made approximately 10 phone calls a day, although this varied widely, with some subjects making up to 19 calls a day and others making only a single call. Of these, 55% of outgoing phone calls were made on a mobile phone.

One of the implications of this is that these business travellers were much more likely to be the initiators of communication than to be receivers. We found this particularly to be the case for more senior managers. Some
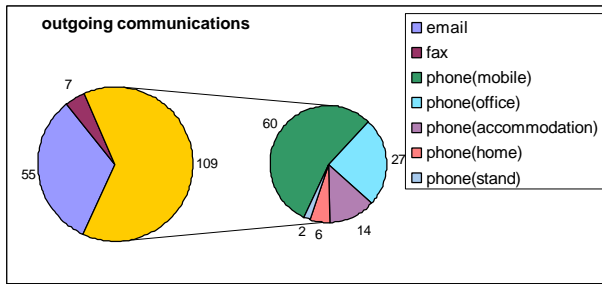
Figure 2. The frequency of outgoing communications in terms of technologies used. The smaller circle provides a further breakdown of telephone use by telephone type.

of the senior managers saw outgoing calls as the major role for their mobile phone and made deliberate attempts to avoid incoming calls by, for example, switching off their phone or deliberately not giving out their mobile telephone numbers.

The data thus confirm the dependence of these mobile workers on their mobile phones. As our television production manager described it:

"If you're in a studio then yes there's more of a routine but if I'm on location then I'm anywhere and then basically my tool is my mobile, that's my number one thing."

As the data indicate, mobile workers rely strongly on the ability to communicate synchronously with others. For the television production manager (and for others in our study), the mobile phone made it possible to efficiently clarify issues and negotiate with others making it the technology of choice especially in urgent situations. Being able to talk anywhere, anytime allowed him the possibility to take action and reach closure on issues which he otherwise would have found difficult while on the road. This can be constrasted with having to leave messages via email and fax leaving issues unresolved.

Another important aspect of the mobile phone was the coupling of the technology with the person. Without the mobile, it would have also made contact much more difficult for those trying to reach him. As he indicates, life on the road is unpredictable.

Finally, the mobile phone allowed an easy way for our participants simply to "touch base" with others and to keep informed on events going on while away - a form of remote background monitoring activity. Participants found it useful to phone the office "just in case" there was anything urgent and also to keep abreast of general issues that might impact their understanding of situation and therefore their job. This was seen to be important not just for dealing with issues while away but also to help with the catch-up period on returning to the office. Much of this seemed to be entangled with social banter:

"... we've always had a habit keeping ourselves, keeping one another up to date as the day goes on... if he's down in London I would say you know OK we've had a brilliant day or we've had a bad day you know we've just got a habit of doing that so... I suppose sometimes it's just social banter you know he'd say he had a good day, he had a bad day that type of thing, and by the way I bumped into so and so, do you remember him you know we saw his project a year ago when it crashd."

Email was used less for outgoing than it was for incoming communication and was not used for managing urgent situations in the way that the mobile phone was. For the small group of participants who did use email, it was generally something that was done only when they had sufficient time available, making it less opportunistic and reactive in its use than the phone. The typical scenario of its use was in the evening at a hotel, for the purpose of keeping on top of a build-up of messages that would otherwise have to be dealt with upon their return to the office - a case of more evenly distributing their workload over time.

As with incoming communications, the fax was used relatively infrequently for outgoing communications (see Figure 2). When it was used, it was typically for the purpose of conveying information that was difficult to accomplish verbally, for example information that the receiver would need to read and reflect on. It was also a means of avoiding time-consuming conversation that might take place with a phone call.

Document Use Activities

The second kind of activity we looked at in more detail was our subjects' use of documents, both paper and electronic. Most of these workers' activities were centred on use of paper documents. This was true of the documents these workers gathered to take away with them, the ones they used during travel, and the documents they brought back with them.

For example, whilst a few of the participants took electronic documents with them (e.g. a PowerPoint presentation or a work schedule) the documents they assembled prior to travel were typically in paper format. These included things like printed agendas, faxes, printed emails, printed reference and discussion documents "just in case" they were needed, printouts of documents to read during free time, and working customer information documents.

Very few electronic documents were also used during travel. In fact we found only two instances of explicit electronic document use in the diaries: In one instance, a laptop-based presentation was used for a meeting, and in the other, a working schedule was updated on a laptop. The only other electronic document work was email activity.

It is also interesting to note that some of the paper documents these workers took with them and used they could easily have accessed via electronic means at their travel destinations. It is therefore important to understand why they were also carried in paper form. One reason was that paper documents were frequently organised into project files, and the paper provided a means of allowing different documents to be physically collated within these files. The documents could then be browsed as a group or

quickly searched as needed. These documents were also used for meeting support either as an object of discussion or for quick reference of information. Paper was also carried because it could be relied upon in a wide variety of situations without being affected by the technology infrastructure constraints of locations such as meeting rooms, hotel rooms or in cars.

Like the mobile phone, paper was thus offering versatility for the mobile worker both in terms of the activities it supported and in where and when it could be used. For example, an important aspect of the work of mobile professionals is their activities during free time, either on trip or non-trip related work. As with the mobile phone, the flexibility of paper allowed more opportunistic exploitation of these free moments. Our equipment salesman was a prime example of this. He would frequently use free time between meetings to deal with a briefcase full of paper customer files that provided him with quick access to (trip unrelated) information while on the phone calls to clients.

In addition to what they took with them and what they used, these business travellers also gathered documents. Again, these were mainly paper documents. While they occasionally requested electronic documents, delivery of these documents was generally deferred until their return to the office. Likewise, emails received during the course of travel were generally not for the immediate purposes of the travel episode. Conversely, gathered paper-based documents such as promotional materials, handouts, agendas, and discussion documents were deliberately prepared for the purposes of the meeting, and to be used *during* the meeting. Paper was recognised as the best medium in support of face-to-face talk, a topic that has been written on extensively by others [3].
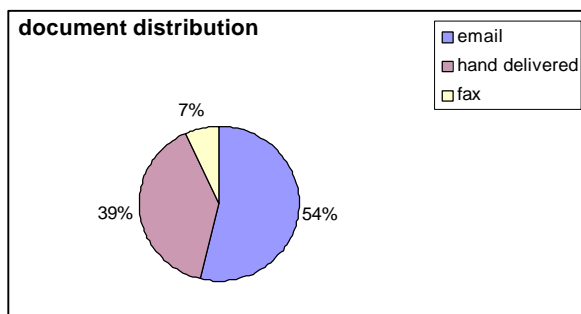

Figure 3. Document distribution by type.

Document distribution was also a feature of activity whilst travelling, although less so than gathering, with only half as many documents distributed as received. As can be seen from Figure 3, distribution was by email, fax or hand delivery. Email distribution was larger in terms of number of distributions but, as has been discussed earlier, is limited in terms of its spread across subjects when compared with hand delivery of paper documents. Unlike email, hand

delivery was used to support the immediate needs of the situation and the work to be done around the document.

The final important document-related activity to mention is note-making. All of our subjects at some point made notes or annotated documents. Both took place both within meetings and during phone calls, to record action items, clarifications, contact details and discussion issues, as well as reflective reading during free time.

Communications and Document Interaction

We have described both the communications and document-related activities of our 14 mobile workers. However, one of the most striking findings was the degree to which mobile telephone and document use went hand-in-hand for these mobile professionals. Often this meant that talk was followed up with documents, sometimes talk surrounded documents, and sometimes documents sparked the initiation of a conversation. It is interesting to look more closely at the ways in which these workers made use of the tools available to them to accomplish these activities. Similarly, in many instances, the technological resources that they had limited what they could do, making conversation around documents problematic. In this section, we elaborate on the ways in which talk and text were combined in the diary data.

We found that the episodes in the data involving communication and document interaction could be split into two groups: docucentric and telecentric interactions. Docucentric interactions were those where a document was the primary focus of the episode whereas telecentric interactions were more focussed on the talk as the means of accomplishing the work. We found that the relationship between documents and telephone use took 9 main forms:

Docucentric interactions

Documents Triggering Phone Calls
Phone calls were sometimes triggered by the caller reading a document. In certain cases, this behaviour was necessary to the sender for the purposes of clarification:

"Sometimes it would be much clearer with a 'phone call because sometimes you find you've done six e-mails back and forth when one 'phone call would have got it all."

In other cases, these documents were messages or queries that required a verbal response from the person being called. Often these document-triggered conversations involved a great deal of back and forth activity:

"I have a blue book that I write, it's my book that I use, my bible basically that I write everything down on and then I speak to so and so over the phone, put a pencil on something, then I have to go back to the director, my producer and then things roll on from there and then usually I'll confirm it, write down on the fax all the details of what I need and then they'll send me a fax through for costs of exactly what I've got because I quote for everything, they send you a quote through. You might have to get back to them then and saying this quote's too much and they come back and give you another quote and then finally everything's sorted."

Phone Calls to Confirm Delivery of Documents

The telephone was sometimes also used to check whether a fax had been received and acted upon. This stems from the difficulty of ensuring both that the document (e.g. fax or email) has been accurately sent, and that the recipient has received it or been able to access its content. This knowledge is important to the sender: it is not enough to know that they have sent a document, but that they must also know that it has been retrieved by the recipient. Document sending when making hotel bookings is a typical instance of this: callers need to know that their booking information has been received so that when they arrive at the hotel, they do not need to worry that they have somewhere to stay.

Phone Calls to Elaborate on Documents

Phone calls were sometimes used to build a context around the purpose of a document and any actions associated with it. Documents often do not refer directly to an activity, or they may be incomplete and require further explanation, and this additional information can be easily conveyed over a telephone call. In the case of the mobile professionals, the mobile telephone was a critical technology for this purpose. The interview with the managing director of the Italian import company illustrates this:

"Often if it's a major fax, I'll call after the fax and go through it with them…Check they've got <it> and check they're going to do something about it and check that they understood it fully."

The mobile phone was also used as a back up technology, as in the case of problems with the fax with transmission quality. In the following instance, use of the phone and the fax provided a combined solution to the problem of following directions to a hotel, the telephone adding a degree of flexibility to communication:

"I was a bit concerned that she might get a bit lost so I said I'd leave my mobile on, ring me any time – because the fax I sent through to her, she didn't get the information on time. It was last minute, she needed a hotel, so I faxed it through."

Phone Calls to Access Remote Documents

In some cases, people made calls to access information on or about documents that they did not have direct access to whilst they were away from their home office base. In these instances, they would call up the owner of the document, or someone who had access to the document, and get them to read out or forward the information from that document to them. In one instance, an interviewee said he occasionally forgot key documents and was often asked for information that he did not have on him, and that he asked his office to fax the document to his hotel's fax machine: "the fax solves a lot of problems".

Telecentric interactions

Document Discussion During Phone Calls

As with face to face conversations, many of the telephone calls were based around some form of document discussion. These would range from a simple quick glance to reference information in support of the conversation to more in-depth document discussion that could also involve some form of annotation:

The importance of this activity can be seen through the difficulties experienced when not being able to view documents in mobile situations such as in the car.

"You do need to see the information, if I could see it myself it would be a lot easier… I'm asking so many questions, is it this, is it that, can you see this, can you see that?"

Note-Taking During Phone Calls

People frequently needed to make notes when they were telephoning either for recording contact details, action items or information that needed to be discussed there and then. Often such note-making made use of whatever was to hand in order to avoid disrupting the conversation.

"Did I make any notes, yes I made some notes on the newspaper because she called me so I made it on the back of a newspaper, two points,… just so that I could again capture the thoughts as she was going through it…the numbers that I had in there I would be able to play with them and look down at them and reference them"

Although not a novel finding, this activity was particularly problematic for mobile professionals because of their limited resources for writing or scribbling. Within the car this characteristic of telephone behaviour would sometimes cause difficulties for drivers, who regularly made and received calls whilst on the move:

"No it is a problem when you're driving, the mobile phone and the messages and remembering things, writing things down. I haven't managed to solve that problem yet."

Some important information was retained in the technology, such as the number of the caller being retained by the mobile telephone. For other, and particularly for complex information, many people had to resort to scribbling notes down whilst they were driving, or pull over to the side of the road.

Documents to Elaborate on Phone Calls

In certain instances, verbal communication in itself was not sufficient to convey all the information necessary for the task situation. Additional follow up material, such as fax, email or posted documents would sometimes need to be distributed to elaborate on the information in some way. In the cases of people faxing documents on the move it followed on from a phone call in over 40% of occasions. For example, one of the participants was in his car where he had a free hour available so made a phone call to a customer using his mobile about some equipment for he was trying to sell. While he was able to give the customer enough overview information to get them interested, they wanted full written details to peruse before they would commit to buying. The phone call was not sufficient in itself to make the sale because the customer needed time to look through the details more closely and in his own time. There was therefore a need to support the verbal telephone communication with paper based visual information that

would support the customers needs. This required that some information be faxed to the customer in support of the phone call. Because he did not have access to a fax in the car and did not readily have access to the information in document form, he made a call on his mobile phone to his office requesting that they find the necessary document and fax the full details to the customer.

Documents as Records of Phone Calls

In some cases, people needed to have records of telephone calls. These were required for a number of reasons, including the recording of telephone numbers or client names for later archiving and retrieval. Sometimes they contained detailed information that was drawn from the telephone call to use later (an example being telemarketing surveys). Other follow-up documents confirmed the details of the call as an official record of the conversation. In the example below, the TV production manager was asked how he made a booking for film stock. He used a paper record so that he knew exactly what he had ordered:

"Just being on the phone basically, being on the phone, speaking to people over the phone and then putting something down on a fax to confirm it...I've got to get everything down on paper so I know in my mind what I've got, what I've got coming, who I've got coming and then basically slap it in lists."

IMPLICATIONS FOR MOBILE TECHNOLOGIES

The findings have highlighted the particular importance of verbal communication for those on business travel as well as the kinds of document activities they perform. More importantly, the findings point to an interesting interelationship between these two aspects of mobile professional work practices that has hitherto been underplayed. By categorising this relationship between mobile communication and mobile document activities in this way provides us with a useful framework within which think about new technologies. The categorisation helps highlight existing problems and can suggest new opportunities. Such a framework can also be used to provide a basis on which some initial assessments about emerging technologies can be made in terms of their role within the work practices of the mobile professional.

When thinking about the design implications of these findings it is important to consider the particular need of the mobile professional for technologies that can flexibly accommodate their information needs across the wide range of unpredictable circumstances and contexts. One of the reasons why artefacts such as the mobile phone and paper are so useful to these people is precisely because they respect this need. They offer "lightweight" solutions that allow creative use on the fly rather than trying to predict all problems and throwing technology at each and every one. Design implications should leverage these artefacts and build upon existing widespread technology infrastructures.

Bearing these issues in mind let us consider some potential technologies that are suggested by the taxonomy. A logical starting point for us to consider would be a potential relationship between scanning technologies and mobile phones. Scanning technologies integrated with mobile phones might offer an number of opportunities to integrate phone and document use. For example, in the case of *documents triggering phone calls,* small scan heads within a mobile phone could be used to access contact information from document cover pages. By tethering the scanner to the phone, software could even convert these marks on paper into phone numbers which could be immediately dialled at the press of a button. Furthermore, replying to queries in particular sections of text might be made easier by allowing callers to scan in the relevant sections and send them on for the call recipient to look at during the phonecall. Taking this further, larger scan heads might be used for the purposes of scanning in whole documents. This would help in the sharing and clarifying of documents as we discussed in *Documents to elaborate on phone calls.* It would also allow for quick follow-up to phone calls for notes and records taken during a conversation (i.e., as in *Documents as records of phone calls).* Such solutions could be based around integrating scan head technology within mobile phones or around tethering portable scanning appliances with mobile phone technology. These can then allow document distribution through fax and internet channels.

There are also implications around technologies that more closely integrate access and distribution of electronic documents with mobile phone technology. Web-based document repositories may provide some benefit here by offering widespread accessibility to documents. Xerox's Satchel system [5] is designed to confer these sorts of benefits by allowing remote access to electronic document repositories through the internet using simple document "tokens". Tokens can be beamed to "Satchel-enabled" devices for printing or viewing. These kinds of technologies are important because they leverage the ability of the mobile phone to access documents which can then either be printed out or viewed on laptops. Mobile workers can then more easily send documents promised in conversations, or even jointly discuss them while talking. However the success of these activities depends to some extent on the mobile worker's surrounding infrastructure, the ability to connect to the Web, for example, or the availability of Satchel-enabled printers or laptop displays. In many respects it is good that such systems employ existing technology infrastructures that can be exploited when available. But as we have seen, part of what the mobile worker needs is freedom to work without infrastructure. Thus their dependence on these additional technologies may mitigate their value.

Other technology options to be considered within this framework are shared displays for the purposes of discussing documents during phone calls. This kind of approach has been explore extensively in the CSCW literature [e.g., 4]. There have also been there have even been commercial systems such as HP's Omnishare. Such systems have not achieved widespread success because they are cumbersome in their approach and depend heavily on

new technology infrastructure. This is not suitable for the unpredicatable circumstances of the mobile professional. Cameras on laptops or mobile phones may offer some solution in this area that deserve some consideration and investigation though as with the shared display technologies are probably ultimately too cumbersome for these circumstances.

The audio facilities of mobile phones could also be exploited for various categories within the taxonomy. Recording audio snippets such as contact details and action items during a phone call could support activities within the *Note-making during phone calls* category especially for in-car conversations where other forms of note-taking are difficult. The legal implications of this are perhaps preventative but other audio recording facilities could be integrated within the phone for after-call recording of action items and contact details. Such audio recording facilities might also be used in support of activities within the *Phone calls to elaborate on documents category.* Providing context in the form of a short verbal message that can be attached to documents both paper and electronic. For example audio annotations could be created and played back using mobile phone technology. Audio files could be attached to emails or linked with paper documents and accessed through a URL or barcodes link.

Finally, techniques for using PDAs for viewing and annotating documents while using the mobile phone provides interesting possibilities. For example, by tethering a mobile phone to a PDA or by incorporating PDA functionality into a phone, *Note-making during phone calls* could be supported. Callers could make notes which are then automatically tagged with information about the phone call such as details about where, when and who was called. This could provide records of phone calls. Callers can also make notes about action items which are then sent to one's ToDo list. This could be augmented by having an automatic ToDo button which records a snippet of the conversation as a reminder to future action.

CONCLUSION

In conclusion the findings have shown the importance of the mobile phone for the work of mobile professionals. In contrast to the laptop, the flexibility, versatility and convenience of the mobile phone have made it a ubiquitous device in terms of who owns one, whether it is taken on trips and where it is subsequently used. As such it is rather like paper, and the link between paper documents, and indeed documents in general, provide an important leverage point for thinking about new technology ideas. While providing some descriptive analysis of how mobile workers use both communication technology and documents to manage

information on the move, we hope to have demonstrated that looking at the relationship between talk and text offers new insights for mobile technologies.

REFERENCES

1. Eldridge, M., Lamming, M., Flynn, M., Jones, C., & Pendlebury, D. (1999). Research methods used to support development of Satchel. *Proceedings of INTERACT '99.*

2. El-Shinnawy, Maha and Markus, M. (1997) "The Poverty of Media Richness Theory: Explaining People's Choice of Electronic Mail Versus Voice Mail." *International Journal of Human Computer Studies, 46*, 443-467, 1997.

3. Luff, P., Heath, C. & Greatbatch, D. (1992). Tasks in interaction: Paper and screen-based documentation in collaborative activity. *Proceedings of CSCW '92.*

4. Ishii, H. (1992). Clearboard: A seamless medium for shared drawing and conversation with eye contact. *Proceedings of CHI '92*, 525-532.

5. Lamming, M., Eldridge, M., Flynn, M., Jones, C., & Pendlebury, D. Satchel: Providing access to any document, any time, anywhere. Submitted for publication in January 1999.

6. Laurier, E. (1999). Conversations in the corridor. *Second Workshop on HCI for Mobile Devices,* Glasgow, Scotland, May 1999.

7. Puuronen, S. and Savolainen, V. (1997) Mobile information systems - executive's view. *Information Systems Journal, 7*, 3-20.

8. Sellen, A. and Harper, R. (1997) Paper as an analytic resource for the design of new technologies. In *Proceedings Of Chi 97: Human Factors In Computing Systems*. New York: ACM Press, 131-137.

9. Trevino, L.K. (1987) Media symbolism, media richness and media choice in organisations: a symbolic interactionist perspective. *Communications Research, 14*, 5, 553-574.

10. Vanaanen-Vainio-Mattila, K. & Ruuska, S. (1998). User needs for mobile communication devices. *First Workshop on HCI for Mobile Devices,* Glasgow, Scotland, May 1998.