



On the Use of Mobile Tools in Everyday Life

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ABSTRACT

This paper explores how mobile tools are used in everyday life and investigates the issues surrounding their usage, or indeed, their *lack* of usage. Personal computers support us in a wide range of our desk-bound activities, but there is still relatively little use of computer-based tools in other parts of our day-to-day lives. We hypothesise that this is because certain barriers-to-use exist that discourage their use in everyday environments, namely that the tools are not readily to hand at the time of need and/or that they distract the user's attention too much from the surrounding environment or main task at hand.

We briefly present our concept of a Smartwatch – a wrist-worn form of a general-purpose wearable computer – that aims to overcome these barriers. However, we strongly believe that a prerequisite to the successful development of this, and other types of mobile devices, is a better understanding of the use, or disuse, of mobile tools in everyday life (including traditional and paper-based solutions). To gain this understanding we conducted a diary study in which a group of twelve volunteers recorded their usage of mobile tools over a period of 2 days. With the large volume of data that was collected we performed a qualitative analysis based on grounded theory techniques, resulting in a comprehensive and detailed picture of the use of mobile tools in everyday life. From this understanding we have drawn out nine key themes which we present in some detail in this paper, including: situational versus portability strategies, the mobility of information, new behaviours derived from mobile phone usage, the importance of creative expression, concern over privacy and security issues, and the demonstrated existence of the barriers-to-use.

Categories and Subject Descriptors

H.5.2 [Information Interfaces & Presentation]: User Interfaces - Evaluation/methodology, user-centered design.

General Terms

Design, Experimentation, Human Factors.

Keywords

User centred design, user study, diary study, usability, mobile, mobility, context-aware, ubiquitous computing, ubicomp, pervasive, wearable, wrist-worn, barriers-to-use, Smartwatch.

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OzCHI 2007 Proceedings, ISBN 978-1-59593-872-5

1. INTRODUCTION

The conference theme proposes that “the computer is no longer a workstation but an entire lifestyle portal.” Indeed, computers are being employed in increasingly diverse aspects of our lives, from viewing and arranging holiday snaps to finding and listening to music, from online banking to online encyclopaedias. There are few aspects of our lifestyles in which helpful computer applications cannot be not readily employed.

Until recently though the focus has been on creating hardware and software for desktop and laptop computers, with the in-built assumption of a static environment of use. Thus limiting the use of the “entire life style portal” to a relatively small part of our lives, i.e. when we are sitting at a desk. However, with the evolution of mobile phones and PDAs into smartphones and small computers in their own right, computer-based tools are increasingly moving off of the desktop and into our everyday lives, and it is these mobile tools for everyday life that interest us.

But first, what exactly do we mean by *Mobile Tools for Everyday Life*? We use the term “mobile” because we are interested in tools that people carry with them to perform tasks while on-the-go or in different places. We use the term “tool” because we are interested in studying the use of many different types of existing mobile technologies, not just computer-based ones. Finally, we use the term “Everyday Life” because we are interested in the whole range of scenarios in which people employ mobile tools throughout their daily life, not just when sitting in front of their desktop computer or while engaged in one specific task.

We suspect that current computer-based mobile tools are succeeding in only a very few specific domains (an issue that this paper explores) such as messaging and voice calls, and that they remain far from being usable as true mobile lifestyle portals. Our long-term research aim is to remedy this situation with a new type of mobile computing tool, and to do this successfully believe it is first necessary to gain a comprehensive understanding of the current use of mobile tools in everyday life.

This understanding, and the methods we employed to obtain it, is what we present in this paper. Firstly, we give some background information on our concept for a new type of mobile tool (the underlying motivation for this research) and then we describe the methods that were chosen to explore the use of mobile tools in everyday life. The remainder of the paper presents our findings in detail and ends with our conclusions and future work.

2. BACKGROUND

We are working on a concept for a wrist-worn form of a general-purpose computing device that we call the “Smartwatch”. Our

interest in this concept stems from our observation that although computers in the form of PDAs and Smartphones are increasingly being taken with us everywhere, they still spend the majority of their lifetimes buried in our bags or pockets and are often not readily accessible at the time of need.

This is a significant problem for existing applications as we believe it often acts as a barrier-to-use, inhibiting the use of a mobile device in favour of using another more convenient tool, or causing the delay of a task until a time in which the device is more readily to hand, or resulting in the abandoning of a task altogether. For example, we can probably all recall a time where we have used a pen and piece of scrap paper to jot down an idea rather than using one of our mobile computing devices. Or perhaps, whilst walking to the train and curious of the schedule for our day, we have postponed a check of our agenda until we are seated on the train rather than attempt to find our PDA, activate it, and switch to the calendar application whilst on the move. And perhaps whilst hearing a song on the radio while engaged in another activity we have tried to remember the name of the song rather than jot it down, and have subsequently forgot it.

For new types of mobile computing applications such barriers-to-use can prove even more detrimental. For example, context-aware applications [1] often offer up information and services to the user based on their physical surroundings and other types of current context, such as the oft-cited electronic tourist guide that offers information on the attractions the user is currently approaching or passing. Using a current PDA or Smartphone device for this purpose leads the user to either (a) keep the device in their hand so they can quickly see the new information pages as they pop up, or (b) retrieve it from their pocket or bag every time they hear a beep or vibration that signals the availability of new information. Neither case is practical or sustainable for extended periods of use or, indeed, for applications intended for constant everyday use. Perhaps it even prevents new types of applications that require such a continual usage from even being conceived of.

The problem can be simply summarized in that current mobile tools – smartphones, PDAs, etc. – are often *not* conveniently accessible or usable at the time of need.

Although research has progressed in some specific areas such as the one-handed usage of devices [2] (an ability now commonly found in many mobile phones), the general form and function of today's mobile computing devices has changed little from their forerunners of the late 1980s; they have simply grown smaller, faster, and cheaper. We believe a more radical re-think of the form and function of our mobile devices is required in order to rectify this situation. In particular we think a mobile computing device should:

- (a) be continually and readily accessible and usable.
- (b) not unduly distract or hinder the users in carrying out their everyday activities.

Research into wearable computers [3] has successfully addressed the former issue of continual access to computing resources by employing wearable apparatus that is constantly at the user's disposal. However, this has come at the cost of donning specialised equipment, such as head mounted displays, which people tend to find disagreeable or socially unacceptable, and can lead to distraction and hindrance in the course of the wearer's

daily activities. We believe a more subtle form of wearability such as the wrist-worn Smartwatch concept may be able to combine the benefits of a continual and readily accessible computing presence with a more socially and fashionably acceptable form that does not unduly distract or hinder the user.

There have been some previous attempts at building wrist-worn computing devices but these have not proven to be long-lived. Those which were truly general-purpose computing devices include Fossil's range of PDA watches that ran the Palm operating system (commonly found on PDAs and Smartphones) and IBM's research into a Linux-based watch [4]. The Fossil device suffered from re-packaging a PDA platform into a much smaller physical form without much thought for redesigning the user interface and methods of interaction. A short battery life also did not help matters. And although IBM's Linux watch efforts did explore some user interface issues [5] the project's initial thrust was more concerned with demonstrating the ability of Linux to run on small footprint platforms. Neither projects explored in depth what existing or new types of activities people would really want or need to do with such an extremely mobile and personal device. More recent research into wrist-worn devices has tended to concentrate on developing tools with very specific functionalities (e.g. a wrist-worn device aimed at improving communication within a social group [6], or Sony Ericsson's MBW-100 Bluetooth Watch for remote control of your mobile phone). However, our interest lies in a more general-purpose computing device that would be more suited to filling the role of mobile lifestyle portal.

3. THE PROBLEM

We believe that the Smartwatch can overcome the barriers-to-use that we consider to be inherent in existing mobile tools. However, this belief in the widespread existence of barriers-to-use in existing devices, and the Smartwatch as an effective solution, is founded solely on the personal and ad-hoc observations of the use of mobile tools by friends, colleagues and ourselves. Furthermore, we have only the vaguest idea of what the Smartwatch is: a wrist-worn general-purpose computing device. We have no concrete notion of an appropriate form or of the functions it should offer.

We therefore need to gain a more comprehensive understanding of the wider public's use of mobile tools in everyday life. In gaining this understanding we would like to not only verify if the barriers-to-use of current mobile tools do widely exist, but also to identify other common themes that may influence the design of the Smartwatch or, indeed, other types of mobile tools.

4. METHOD

Our study into the use of mobile tools in the present and their potential forms and uses in the future took place in three phases, all of which took place at Waikato University. Firstly, we conducted a diary study in which 12 volunteers recorded their use of mobile tools over the course of 2 days. Secondly, we held a brainstorming session [7] of HCI researchers from the University of Waikato to discuss the implications of the diary study findings in the design of new mobile tools. Finally, we organised a creative workshop in which a number of volunteers from the general public participated in a creative process of imagining future forms and functions of their ideal mobile tool(s).

In order to be able to present our findings in the level of detail we feel will be most useful, we have chosen to concentrate in this paper on the diary study, exploring the current use of current mobile tools in everyday life. We intend to present our findings from the brainstorming session and creative workshop (both of which focus on ideas for new mobile tools) in a future paper.

4.1 The Diary Study

To investigate the current use of mobile tools in everyday life we decided on a diary study rather than a focus group or questionnaire, as we wanted to gain an accurate-as-possible understanding of how people really use their mobile tools and not simply how they perceive their use of them. This view was vindicated when some volunteers expressed surprise at the behaviours they had recorded in their diaries.

We designed the diary to be a pocket friendly size (13 x 7.5 centimetres) in which each page is used to record an instance of an observation, with predefined fields displayed to record the date, time, place, and tool(s) being used. We also added plasticized, waterproof front and back covers with an attractive colour and design, all with the intention to make it both as practical and attractive as possible to continually carry around and record activities in situ. The first six pages were also pre-completed with some examples that could remind the volunteers of the type of information we would like them to record.

The volunteers were found through adverts placed in the local paper and through posters placed around the campus. The adverts stated “Volunteers who own at least one mobile technology needed for a research study.” Mobile technology was defined in a footnote as a “Smartphone, PDA, camera phone, electronic organizer, pocket computer, etc.”. The advert also offered a twenty-five dollar book voucher as thanks for their efforts.

We wanted to consider both computer and traditional or paper-based mobile tools in our study as we felt that computer-based ones would give only a small view onto the use of mobile tools in everyday life. However, we requested that volunteers have at least one mobile technology so that (a) we could be sure to have a group that was open to technological solutions even if the majority of tools they used were paper-based, and (b) that we had a good sample with which to identify any the common themes of computer tool usage in particular.

Approximately 40 volunteers replied to the adverts from which we selected 6 female and 6 male participants for the study. The majority of participants fell in the 20-35 age group category, and the remainder fell in the 36-50 age group. Our selection process was quite random, though where possible we did try to get a diverse selection of volunteer backgrounds and tools. Note that the study was conducted in the town of Hamilton, New Zealand, but we suspect we would find no significant variation in mobile tool usage in any other modern towns with a westernised culture.

4.1.1 Briefing Session

Each participant was invited into the Usability Laboratory, a purpose-built usability testing facility at Waikato University, for an initial briefing session that was recorded on DVD. In these and subsequent sessions just the interviewer and the participant were present in the room. In this briefing session we did *not* mention the Smartwatch concept, only that we were interested in how people were using different mobile tools in their daily lives.

We took care to define a mobile tool in general terms such as “something you carry around with you in order to help in some tasks or activities during your daily life”, and gave examples such as a paper notepad for jotting down notes and a mobile phone for texting friends, etc. We also discussed with them what they viewed as a mobile tools in their own lives. This was followed up with a more structured approach where we asked them to complete a questionnaire in which they were asked to list their mobile tools. They were then asked to rate each of the tools they had listed on a scale of 1 to 5 for the following criteria:

1. Is it easy to use?
2. Do you use it very often?
3. Is it important to you?
4. Do you take it with you?
5. Are you confident in using it?

Participants were then asked to list the tasks they used each tool for and, where appropriate, select the most important task and explain why they use that tool for that task. The questionnaire concluded with an open-ended question to consider “Is there a common theme or motivation behind your use of mobile tools in general?”

The participants completed the questionnaires by themselves and afterwards the interviewer went through it with them in order to discuss any points of interest or comments that needed clarification.

We hoped that the questionnaire would lead their thinking from an initial concept of what a mobile tool is, to what tools they have, how they use them, and finally to the more philosophical consideration of a general theme or motivation underlying their use of mobile tools.

The participant was then presented with a blank diary and an instruction sheet, which the interviewer went through with them. They were asked to take the diary around with them for two full days; if possible and appropriate or relevant, for one workday and one leisure day. The instructions clearly re-stated in detail the types of tools we were interested in and that we liked them to record their usage of both electronic and traditional or paper-based tools. They were also asked to record even trivial uses they may not view as important, such as using their mobile phone to check the time. Further examples of tools and activities were given for both electronic and traditional tools, and the participant was told to record the use of all mobile tools they employed during the two days, even if they had omitted to mention a particular tool on the original questionnaire.

For each entry they made in their diary they were asked to record the date, time, tool(s) being used, and a description of the activity. Where appropriate they were also requested to record any thoughts related to:

- Things they found particularly helpful and/or enjoyable with the tool.
- Things they found frustrating, difficult to do, inconvenient or time-consuming with the tool.
- Any ideas for improvements/additions to existing tools, or for new types of tools.

They were also asked to record when they would have liked to use a tool but didn't. For example, perhaps they would have used their paper notepad if it were not for the hassle of having to find it in their bag, or perhaps they would have used their phone's notepad application if it were easier to get at, use and organise.

We were careful to balance our requests in terms of both positive and negative aspects of their mobile tool usage, leaving the participants to decide what tools and tasks they liked and disliked and thought were good or bad.

The instructions also requested the user to record any other related thoughts or opinions they may have, and we stated that if they were in doubt they should record it as we would rather have too much information than not enough.

4.1.2 Debriefing Session

After completing their two-day study the volunteers were invited back into the Usability Laboratory to discuss the observations that they had recorded in their diaries. These sessions were also recorded on DVD.

Before starting on the diary the interviewer asked the participant if there were any interesting highlights of the study that they would like to talk about, or other things that stood out for them or that they would like to mention. After discussing these issues the interviewer went through each page of the diary with the participant to ensure we had a good understanding of what they had written and, more importantly, to allow the opportunity for more in-depth discussion of any interesting points or issues that were raised from their diary entries.

In conclusion we asked if there were any changes in their opinions as expressed in their initial questionnaire answers, and if the observations recorded in their diary had closely approximated what they had expected. We also explored any ideas they had during the course of the study regarding new mobile tools or improvements to existing ones that they believed they would find beneficial. And we particularly questioned the issue of any barriers-to-use they experienced in their mobile tools.

4.1.3 Diary Analysis

We amassed a significant amount of data from the diary study. For each of the 12 volunteers we have a completed questionnaire, a diary with up to 40 pages of entries, and approximately 2 to 4 hours of video footage from the briefing and debriefing sessions.

After some unsuccessful experiments of how to analyse the data we returned to the original goal of the study: to build a comprehensive understanding of mobile tool use in everyday life. That is to build a relatively complete picture of this domain rather than to provide quantitative statistical measurements. We therefore chose an approach similar to grounded theory [8] in order to conduct a qualitative analysis the data. The approach we took was to create a separate document for each volunteer and then sequentially work through each of the original source materials: the questionnaire, the diary, the briefing video, and the debriefing video. Each atomic comment, observation, idea, or issue that contributed to the understanding of the use of mobile tools in everyday life was written down in this document along with a coded reference that linked it to the original source material.

The completed set of documents spans approximately 150 pages and provides a comprehensive 'snapshot' of the current state of

mobile tool usage in everyday life. However, it is not in a particularly useful or wieldy form to be of use to other practitioners in the field. Therefore, the final part of the diary study was to comb through this set of documents looking for natural groupings and order in the individual points. This naturally leads to a process of identifying themes of importance and/or that were shared by a number of individuals. It is these themes that we hope will provide a useful and comprehensive knowledge of the current use of mobile tools in everyday life, and it is a selection of the most important ones we describe in the following findings.

5. FINDINGS

Here we present what we regard to be the most interesting themes that have emerged from the diary study. The list is by no means complete, but consists of those themes that we feel are of most importance or relevance to designers of new mobile tools.

5.1 Situating Information and Tools

As we had anticipated, volunteers experienced a clear need for tools to access services and information in a wide variety of locations and situations throughout the day. Though interestingly this was not always achieved with what we would traditionally think of as mobile tools. Rather, they would often employ methods of situating the information or tools in the location in which they would be needed.

Prime examples of this are paper notes (often self-adhesive Post It notes) that are attached to the places in which the information they hold will be needed. The tool itself is not mobile in the traditional sense but is placed in, or even dispersed throughout, the environment in which it is needed. Given the correct placement of the tool, its close proximity at a time of need is assured.

We were surprised to discover how widely and often this situation strategy was used. A majority of the volunteers frequently situated information or reminders, and sometimes did so in quite elaborate ways. For some volunteers, it even formed the large part of their use of mobile tools. For example, one volunteer stuck important reminders near their cat feeding area, knowing she would see it every morning. She placed bills and other items for discussion with her partner on the coffee table, where she knew they would both be present in the evening. She placed doctors appointment cards on the car dash board, where she knew she would see them driving to and from work. She spread work-related to-do's around her desk, knowing she would see them whilst carrying out her work activities. And for the most urgent and important actions she would write a note on her hand so that she would constantly see it and be cued into action throughout the day. Her environment was practically littered with information and reminders, and to some degree this was common among most of the volunteers.

There is clearly a strong affinity between the aims of this situated information strategy and those of ubiquitous computing [9]. Both attempt to offer seamless and transparent use of information or services throughout our environment. However, it is worth pointing out that it is the situation of the information that we found to be important rather than the tool. Therefore, if the information were digital, one could readily imagine equally functional solutions employing ubiquitous, mobile or wearable technologies.

There is also a strong connection with context-aware research, which has often explored the attaching of digital information to

the physical environment (and has even used a Post-It note metaphor to do so [10]). Indeed, many volunteers can be seen to simulate context-aware behaviour with their current tools. For example, by placing information on the coffee table the aforementioned volunteer was really trying to express that “this is information that I would like to have available when I am relaxed with my partner”. Another volunteer often had to carry out specific tasks at a particular locations and would remind himself to do so by setting an alarm on his mobile phone at a time at which he thought he would be there. However, what he really needed was a form of location-based alarm. Such examples were common in our study and would clearly benefit from a technological solution because the simulated forms of context-awareness were often prone to error. For example, there were many other times when the partner was present in a relaxed situation, not just while at the coffee table, and one can also imagine that a time-based alarm simulating a location-based one is susceptible to error unless one keeps to a very rigid timetable.

A digital solution also appeals in that physical notes can soon clutter-up an environment and gradually cause it to slip into an unorganised mess. Indeed, many volunteers reported such occurrences and even had strategies in place to cope with this, ranging from ad-hoc spring-cleans to demarking sections and drawers of a desk into areas dedicated to specific categories or priorities of information.

In our study there was virtually no sign of computer-based tools used in the situation of information and services.

5.2 Portability of Information and Tools

The strategy of situating information and services breaks down when they are needed in a variety of places (though potentially a computer-based solution could handle this to some degree) or, indeed, if they are needed anywhere and at anytime. In such cases a mobile tool is often carried around, assuring its close proximity at a time of need.

A need for such portability was strongly exhibited across all volunteers. A common example of the portability strategy was the constant companionship between a person and their mobile phone, enabling calls and messages to be received whenever and wherever they may be. In several cases the phone even spent the night next to the person on their bedside table.

A major challenge with the portability approach is how to ensure that the mobile tool is really with you for at least the time in which you will need it. For something other than clothing this requires some amount of conscious effort. Volunteers had a number of approaches to this, though putting things in a bag or pocket was the most common. Indeed, some volunteers carried a bag with them wherever they went specifically to ensure that their collection of mobile tools was always nearby. Though it was often the case that they would (a) leave their bag in a fixed place whilst wandering around a local environment, and so not always have their mobile tools directly to hand, or (b) face a not insignificant degree of effort in finding and retrieving the tool from the bag. Those who chose to use a pocket in their clothing had a better degree of portability but also had a much more restricted amount of space in which to transport things (and one could imagine a possible loss of comfort too). One volunteer stated that every pocket is now full with a particular tool, so if he buys a new one then it has to warrant taking the place of another.

Both pocket and bag based approaches suffered from the problems of having to remember to put the tool inside in the first place, and in the case of reminders and similar kinds of information, to remember to occasionally retrieve and look at the tool in order to see it and so be reminded. A novel solution to the former problem that two volunteers employed was to attach a mobile tool (in this case a mobile phone and a USB memory stick) to their key rings to ensure that it was with them whenever they left the house (provided, of course, that they did not forget or lose their keys). In essence, they were employing what could be described as a *parasitic portability*.

Similarly to places holding situated information, a problem commonly encountered was that with the addition of every new piece of information, pockets and bags would gradually slip into an unorganized mess that required the occasional clean-out.

Computer based tools fared better in the portability strategy than in the situated strategy, with mobile phones and music players, and to a lesser extent laptops and PDAs, being commonly employed as mobile tools. Though being in a bag or pocket subjected them to the same problems that traditional solutions face in that they are not necessarily to hand at the time of need. We should also note that they were often the only means of achieving the task, e.g. portable music playing, mobile text messaging, etc. In cases where there was a choice of tools, such as note taking for example, traditional paper-based approaches were chosen in the vast majority of cases. We discuss more about why this is the case in a later section.

As could be expected, volunteers often employed a combination of both situation and portability in their use of mobile tools, selecting the one which best fit the task or information at hand.

5.3 The Mobile Nature of Information

Although we had anticipated a high degree of mobility of information in the sense of a person carrying around a mobile tool to have some information available in different places, we also discovered that it was very common for information to move between different mobile tools for a number of different reasons.

One common reason for the movement of information was in the transition of a potentially temporary piece of information into a permanent one. It was often the case that people initially wrote a piece of information, such as a phone number, onto a scrap of paper. These scraps were normally by their very nature a temporary storage mechanism, and some of the information on them was also temporary; after their usefulness had expired (e.g. the person whose phone number was written down had been contacted) the piece of paper was thrown away. However, if the information turned out to be of a more permanent value then it would be transcribed to a different mobile tool that was dedicated to keeping such permanent records. For example, if the phone number was of a person that may be contacted again in the future then it may be transcribed to an address book. There were also systems with not just binary temporary/permanent states, but varying degrees of permanence and corresponding sets of mobile tools.

In effect, this behaviour is like having a scratchpad or holding bay into which new incoming information is placed and temporarily stored before being either thrown away or filed in its correct location. This can serve several purposes. Primarily, it keeps the new information readily to hand (the scratchpad or holding

bay is usually a scrap of paper or equally mobile and quickly accessible medium) at the time when it is most likely to be needed (just after its created). But equally it serves to retain the quality and order of the permanent place of storage by waiting to see if it's a genuinely useful piece of information before recording it. Finally, there are also those pieces of information that are not readily categorised, and to which there is no apparent permanent storage area. Such cases are kept in the scratchpad until such time as there is. Some people also had separate areas for this purpose (such as a desk drawer or plastic tray) so as not to clutter the rest of their tools or cause a mental "information overload". Placing it in the drawer or tray effectively made it 'invisible' without actually throwing it away. They would then occasionally dip into this store to rediscover information and either use it, throw it away, or leave it in there for another time.

Interestingly, most computer-based tools do not have these abilities. For example, when adding a phone contact to an electronic organiser it is either entered into the address book or not at all. I cannot add a contact into a temporary store "just for a while".

Prioritisation of information is another cause of its movement. For example, one volunteer kept her household bills on the coffee table during the week as a peripheral reminder, and then placed them in the seat of the car as a more active reminder on the day payment should be made. Other volunteers would transcribe important appointments from their agendas or memories onto notes on a desk on the day of the appointment, or even onto their hands. These more directly visible tools would give them continual cues throughout the day. However, at least one volunteer commented that they would often get too involved in their work and overlook the cue. In such cases computer-based tools can more effectively alert a person (through an audible alarm, for example) and some volunteers did use the alarmed agenda on their mobile phones, though we suspect many more would do so if it were not for other barriers-to-use.

There were other more consciously deliberate movements of information. For example, several volunteers transferred files between home and work or shared files with friends using a USB memory stick or an iPod (in fact, the iPod was as frequently used as a portable harddrive as much as it was a music player). A less commonly observed example was the synchronisation of contact and calendar information between a mobile phone and a PC. The connection, installation, and integration of computer-based tools required was often deemed by volunteers as too complicated or difficult or time consuming.

5.4 Communication and Presence

Communicating was the most commonly occurring activity across most, but not all, of the volunteers (note taking was the other widely seen activity). This was the only area in which mobile computing devices were widely deployed and used.

Most volunteers used their mobile phones primarily for text messaging (and seldom for calling, probably due to cost considerations) and generally enjoyed both the instant and potentially on-going nature of communications. The minute chunks of time needed to write or reply to a text message and the almost zero impact to the surrounding environment, also allowed for conversations during circumstances or in situations in which

other forms of communication would be impossible or socially unacceptable.

In addition to straightforward text messaging, new social behaviours were seen to be emerging such as the increasing fluidity of meetings due to the ability to quickly and easily communicate changes to planned times right up until the last minute. Meetings were also often arranged on a spontaneous basis by sending a text message to a friend to suggest a meeting when they happened to be in the neighbourhood or passing by. Couples also often employed novel uses of text messaging, such as checking up on each others safety when travelling home or even holding arguments over text messages so that there was time to think in between responses and so that the argument could have already "moved on" by the time they physically met again. But the most commonly employed use of texting (perhaps almost as much as direct communication) was of sending messages with little in the way of meaningful content. The aim with these 'non-messages' was not to communicate facts or information but to simply serve to let someone know that another was thinking of them. There would often be sequences of these messages throughout the day, forming a kind of virtual presence between people.

5.5 Managing Availability

Many volunteers also experienced some negative aspects of these new communication possibilities. The primary complaint was that they felt obligated to reply to messages at once. Even if circumstances at work or other tasks currently at hand had led to a genuine delay in replying, there was often a feeling of guilt on the part of the receiver and a feeling of frustration on the part of the sender. This is mainly attributable to a lack of information on the other's status and the fact that the default expectation built into text messaging is that the person being contacted is always available.

Some people felt strongly enough about this issue that they engaged in particular measures to combat it. For example, one volunteer only turned on her phone during an hour-long interval in the morning and a similar interval in the evening, during which time she would receive and reply to her messages. However, such behaviour strongly negates the benefits many perceive in being constantly available (such as being contactable in the case of an emergencies or, as one volunteer put it, simply "being available in an increasingly competitive and globalised world"). Most were content to deal with the occasional pang of guilt felt on a slow reply and to adapt or tolerate the replying behaviours of their fellow texters. Perhaps it is to be expected that a closer connection to others will necessitate a greater adaptation in oneself, though one can certainly imagine simple technological solutions being able to improve the situation. For example, if the sender were informed of the receiver's status (if they are busy, at work, etc.) then they could adjust their expectations of a response accordingly.

The issue of availability is also applicable to the wider social environment, and there were several cases of volunteers expressing negative and positive feelings about the use, for example, of headphones to provide a "personal bubble" of social exclusion. Without exception those who viewed it as positive were the wearers of headphones and those who viewed it as negative were those without headphones who had observed their use by others in immediate vicinity.

Social context also governed the choice of some technologies, with one volunteer commenting that he felt at ease scribbling on a paper pad - even if it had nothing to do with the ongoing meeting - but felt uncomfortable scribbling on his Smartphone - even if it were recording important ideas from the meeting - because of the perception he knew others had of the typical respective uses of those tools. Volunteers widely recognized and appreciated the social and physical context in which they were operating and what use of mobile tools they felt was acceptable.

5.6 Writing as a Thought and Memory Aid

Writing was one of the most important activities that people used mobile tools for, and the one in which computer-based tools were used least.

The two main reasons for writing were as an aid to thinking and as an aid remembering. Considering the former, most volunteers expressed a need to make notes and scribbles on paper in order to explore their thoughts and so help them in thinking about a particular issue or problem, and even in generating new ideas. The resulting piece of paper was often of little importance in itself, rather it was an aid just during the process of achieving an understanding in their own minds.

Regarding writing as an aid to memory, there were three classes of this behaviour that we observed. Firstly, a kind of journaling in which ideas, thoughts, inspirations, reflections, poems, etc. were written down in a book for perusal at a later date. This formed a historical record that could be used for practical purposes (such as recording a PhD journal and looking back at a later date to see what approaches to a problem had already been taken) or for keepsake and enjoyment, or a combination of these factors. Some volunteers used journaling extensively, with one volunteer even annotating personal diary entries from previous weeks with his current thoughts on the matters discussed.

Writing reminders or to-do lists formed the second class we observed, and these simply served as a memory aid to what had to be done, when it had to be done, and possibly the priority or order in which a set of tasks should be done. In a few cases the act of writing the task down would enforce it in their memory to the extent that the paper would no longer be needed. In both journaling and reminders, some volunteers felt the tool also acted as a kind of motivating force for them by enabling them to look back and see accurately what they had achieved or to look forward to see clearly what they must do.

The final form of writing as a memory aid involved the noting down of reference material that would need to be recalled at a later date, such as an address in an address book.

One volunteer noted that he was “kind of a head mobile tool person” meaning that he preferred to use his own brain and memory. Indeed, mobile tools that assist in improving or assisting our own brain’s functioning is an interesting research avenue we would like to explore in future work.

5.7 Emotion, Expression, Freedom & Fashion

Mobile tools by their very nature become an intimate part of our lives and so raise emotional considerations that should not be overlooked. Several volunteers expressed the importance of form as well as function, with one female volunteer stating she would only use beautiful things, and one male volunteer buying only black or silver mobile tools to match his personal colour scheme.

It appears that mobile tools are taking on the quality of jewellery, and in some cases the ornamental value of the tool took precedence over all else, such as in the selection of a watch.

Although the look of the mobile tool is clearly important the issue runs much deeper than this. Volunteers often developed a strong emotional attachment to their mobile tools, especially to their paper notebooks or diaries. The thoughts inside were no doubt precious but so was the book in itself, which would often exhibit curious designs (some hand-made) in which the owner sought to express their own feelings or identity. This desire for expression and the freedoms with which to explore it was documented many times in our study. For example, in paper notebooks there was a tremendous variety of pens, colours, cutting & pasting, diagramming, and free-form drawing being employed. Such creative freedoms made the notebook an ideal tool for thinking with, and even the most technology-focused of the volunteers shared the notion that paper offered “a more direct connection to the brain”. There was also a certain physical satisfaction experienced when using the material. For example, some volunteers expressed they felt a greater satisfaction on completing a task if they crossed it out on a paper to-do list rather than ticking a checkbox on an electronic to-do list. The desire for creative freedom and expression was also demonstrated in the customisation of tools. For example, one volunteer decorated a tool with personal photos and another performed quite extreme customizations, such as physically chopping a paper notebook in half to give it a more convenient size. Sometime tools were even “re-purposed” or adapted for uses that they were not originally intended for. In summary, there was a strong desire for the freedom of creative expression and customisation.

Although mobile tools such as phones have become much more fashion conscious, they still fall far behind other traditional tools in terms of their customisability and the creative freedoms that they offer within their functionalities.

5.8 Concern over Safety, Security & Privacy

Many volunteers expressed concerns regarding safety, security and privacy of information across the whole range of mobile tools, from paper notepads to smartphones.

Some information being recorded in these tools was of a very personal nature, with privacy being of paramount concern. One volunteer commented that she would rather have her journals burnt than read by someone else. Security is also an issue with other types of personal data, such as PIN numbers and other identify information that volunteers sometimes stored in their mobile tools. One would imagine that computer-based tools had an advantage in this area through, for example, password-controlled access to information, but this benefit was often countered by the perceived risk of information “being hacked”. And where computer-based solutions were viewed as particularly weak was in safety, in the sense of preventing accidental loss of information. Most volunteers felt secure in having information recorded on paper because they felt there was no way short of a major event, such as the loss or destruction of the physical tool itself, that the information could be lost. But there was widespread insecurity expressed about computer-based tools, and many personal anecdotes told of accidental deletions, computer crashes, harddisk failures, and so on. It appears that its just too easy to delete information in computer-based tools.

5.9 Barriers to Use

One of our initial beliefs in this study was confirmed by numerous cases of volunteers documenting that a tool was not readily to hand at a time of need. In many cases this discouraged a tool's use altogether. Volunteers also commented that they would use some tools more often if they were easier to hand. For example, one volunteer who carried a notebook around in his bag to record interesting thoughts decided on one occasion against using it to record a poem because it was right at the bottom of his bag.

Such barriers were seen across different types of mobile tools, but so were more positive observations that also supported the case for an always-to-hand tool such as the Smartwatch. For example, several volunteers wrote important reminders on their hands so that they would serve as a constant visual cue, and many others scattered notes around their work area so that they were in their peripheral vision whilst engaged in the main task at hand. It is this instant accessibility or "glanceability" that we would strive to achieve with the Smartwatch.

That a mobile tool surmounts the problems of instant and continual accessibility does not necessarily imply usability. Volunteers in our study documented a whole catalogue of barriers-to-use experienced with mobile phones even after the device was in their hands, due to poor user interface design and ergonomics. Most common were complaints that text entry was difficult or clumsy, that the menu of functions or options was confusing, and that besides the basic tasks of messaging and calling it was hard to find the things that they wanted. Volunteers also complained that there were restrictions of functionality at the level of individual user interface elements (e.g. an unnecessarily small character limit on a contact name) and also at the level of applications as a whole (e.g. the notepad being just a place to enter a string of characters without any creative freedom whatsoever). It is perhaps a testament to the degree of benefit people perceive in text messaging that they use their phones so much. But other than for extremely minimal functions, such as setting an alarm, those tasks which could be accomplished with another tool typically were. For example, none of the volunteers stored anything but the name and numbers of contacts in the address book of their phone, and there were just one or two isolated occasions in which a notepad on a phone was used (e.g. to record some brief reference information such as a ticket number).

There were also some positive demonstrations of instant usability. For example, one volunteer liked the ability to deactivate his phone's alarm by pressing any key, so that so he didn't have to expend much effort on it whilst still snoozing in bed.

Of course, for paper notepads and similar traditional tools there was never an issue with usability, as long as there was also a pen or pencil to hand. Such traditional tools also had a lead over technological solutions in that they required no cables, software, or battery charging (all of which were complained about to some extent by our volunteers). They also better met the expressed needs of many of the volunteers for a robust tool that can also be used outdoors (the computer-based ones tended to be more fragile and often had screens that were difficult to read in sunlight).

6. CONCLUSIONS AND FUTURE WORK

Returning to our thoughts at the beginning of this paper regarding the conference theme's proposition of the computer as an entire

lifestyle portal, we can see that there are numerous challenges to be overcome before this is successfully accomplished within a mobile computing tool available throughout our everyday lives. In detailed user studies we found that barriers-to-use, such as mobile tools not being readily-to-hand at the time of need, proved to be major obstacles. We also found that computer-based mobile tools fared particularly poorly in their user's estimations. This was due to a variety of factors, ranging from the lack of support for creative freedoms and commonly employed mobile strategies (such as the situation of information) to more basic concerns over consistently poor user interfaces and the fear that data is more easily accidentally deleted or lost on a computer-based tool. Application areas of mobile tools that were of particular interest to our study volunteers were also identified, such as communicating, projecting a virtual presence, managing availability, organising time and information, and, in particular, tools that aided thought processes and retrospective and prospective memory.

We believe that the wide array of issues we have documented here on the use of mobile tools in everyday life (all based on detailed observations across a number of study volunteers) lends support to our argument for a more radical re-think of the design of mobile computing devices. We have begun this re-think by conducting a brainstorming session of usability experts and by holding a creative workshop with a further group of volunteers, the results of which we look forward to presenting in a future paper. Using the results from our various studies as a guide, we intend to create one or more prototype mobile tools for everyday life, such as the Smartwatch. We then plan to test these prototypes and refine or reject them through further user studies.

We also intend to further refine the large volumes of diary study data into a more structured and easily digestible form, perhaps as a hierarchy of issues broken down into atomic detail, or as a set of guidelines for those involved in the creation of mobile tools.

7. ACKNOWLEDGMENTS

Our thanks to the FCT in Portugal in funding both the Smartwatch research project and the travel costs that enabled this collaboration between the University of Minho and the University of Waikato.

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