RESEARCH METHODS USED TO SUPPORT DEVELOPMENT OF SATCHEL

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INTRODUCTION

Over the last five years, our group has been developing ways of supporting the document work of mobile professionals. At the outset of our research, we knew little about the work practices of mobile professionals, in particular, we knew little about their document activities. We also knew little about how to study the document activities of this mobile group. In trying to gain this understanding, we carried out a number of studies and designed many scenarios. As we began to develop prototype systems, we also designed scenarios to illustrate how our prototypes would affect the way people carried out their document activities. As our prototypes matured, we carried our more extensive user trials of our systems. This paper describes the various studies and trials used during our research and development activities. The aim is to illustrate the range of methods we used, not to describe the results of studies and trials in any detail. We will, however, provide a few results to illustrate the contribution of each method.

Each of our prototypes was called "Satchel", and one of our latest prototypes is described in two recent papers (Lamming et al., submitted for publication; Flynn et al., submitted for publication). Satchel supports mobile document work by providing streamlined access to remote documents and document services. The user carries around a wireless mobile device and accesses documents and services provided out on the network. To the user, it seems as though they are "carrying around" their electronic documents in their mobile device, though this device only stores references to remote documents. On the mobile device, the user can select document references and invoke various services including printing, faxing, emailing, scanning, and exchanging documents with other users. The mobile device communicates to other devices (e.g., printers, fax machines, or other mobile devices) using either infra-red or radio communications.

The paper is divided into two major sections. The first section describes general studies of mobile document activities. The aim of these studies was to gain an understanding of the range of document activities carried out by mobile professionals and to gather support for some of our early ideas about related problems. The second section describes a set of trials carried out using Satchel technology. The aim of these trials was to gather input for the iterative design of our Satchel prototypes.

GENERAL STUDIES OF MOBILE DOCUMENT ACTIVITIES

The following methods were used to study mobile document activities in general. They provided us with useful data to support many of our initial thoughts about problems in mobile document work. Although not always rigorous, they gave us valuable background knowledge about the range of document activities carried out by mobile professionals. Some of these studies focus on mobile document work while travelling outside of the organisation; others focus on document work carried out while moving around within one's own building.

Studying Document Use in Meetings

Meetings are a pervasive part of the life of mobile professionals, and many of these meetings occur within the person's own building. Our earliest study was carried out as a student project in the summer of 1994. The meetings of a group of software auditors during a one-month period were observed. The meeting participants were interviewed before the meetings about the documents they took with them, and during the meetings, notes were taken on which documents were used.

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Although only qualitative results were obtained from this study, several interesting observations were made. For example, the closer the meeting to the person's office, the more willing they were to carry paper documents. In addition, people do not have required documents with them for a variety of reasons including: an unwillingness to take bulky documents just in case they're required; unanticipated requests from others during the meeting; or relying, sometimes quite optimistically, on someone else at the meeting bringing the document. We were interested in some of these issues; in particular we were interested in reducing the need for people to carry around heavy briefcases full of paper. We decided to follow up on these results by creating a questionnaire to gather more quantitative data.

Mobile Professional Survey

Following on from the study of meetings, we distributed a short questionnaire survey to 197 Xerox managers in October of 1994. It included questions about frequency of meetings (both within and outside of the building), numbers of paper documents carried and frequency of paper document exchanges. It also asked people whether they preferred to exchange paper or electronic documents and why. Another purpose of this survey was to identify people for future studies who were particularly mobile and who frequently used and exchanged documents.

The data from 96 returned questionnaires were useful in providing some preliminary information. For example, although more respondents said they preferred to exchange electronic documents (59% vs. 21%), there were clear reasons for people preferring paper (e.g., easier to annotate, easier to review with others, easier to read). We thus felt it was important to try to make exchanging electronic documents as easy as exchanging paper, while providing easy ways to transform electronic documents into paper ones. We also found that 83% of the respondents said that they found themselves without a needed document at least once per week and nearly one-third of these said this occurred more than five times per week. This confirmed our belief that, despite carrying around many paper documents, people still fail to have the ones they require.

One-on-One Interviews

From February to July of 1995 we carried out individual interviews with 11 "mobile document workers" who had been identified via the survey results. The purpose of these interviews was to identify some specific examples of problems with mobile document work, partly to provide input to our early scenarios, and partly to get a better understanding of those problems. We also hoped to identify people who would be willing to be shadowed in a more extensive study at a later date.

For example, one interviewee reported that while travelling abroad in Milan, she was asked by her manager for the most recent monthly report, quite a long document including many activity logs and sales figures. After many repeated attempts to pull the electronic document onto her PC from her home office network, she gave up. After this trip, she decided to create a mini-version of this report and carry it around in paper form. Stories such as this allowed us to refine our scenarios with real examples; they also provided us with concrete examples of the sorts of problems we were interested in.

Shadowing a Mobile Professional

Although the interviews had provided us with useful information, we felt we needed some first-hand knowledge about the sorts of activities carried out while travelling, and the range of documents encountered. At the end of July of 1995, one mobile professional who had been interviewed agreed to be shadowed while travelling overseas to attend two meetings in the Paris metropolitan area (see, for comparison, Vaananen-Vainio-Mattilo & Ruuska, 1998). He was shadowed in many different contexts: while preparing for the meetings the day before his trip, while travelling to and from Paris (by airplane and taxi), and while collaborating in formal and informal meetings. During the observations, all of his document activities were logged, and preparations and meetings were video and audio recorded.

In these two days, he encountered 74 documents, 68 paper and six electronic. About half were collected during his travels (e.g., taxi receipts, documents from others at meetings, newspapers). The other half were taken with him on his trip. These included documents that were essential for the meetings (e.g., his presentation), some that were taken just in case they were required (e.g., older reports), and some that were taken mostly out of habit (e.g., emails detailing plans for the meetings). Of these, only about half were actually used, adding evidence to our belief that many documents are carried unnecessarily. We also noted that, after his presentation at the first meeting, he threw out his

slides, only to find he wanted to refer to them at his second meeting. Once again, more good examples for scenarios, and evidence of the wide range of document activities carried out while on the move.

Studying Document Use in Hallways

Our earlier studies tended to focus around document use and meetings. Although meetings were of interest to us, since they involve local mobility, we were interesting in understanding what other reasons people might have for carrying around paper documents. In January of 1995 we carried out a study in the hallways of the Xerox headquarters office in the U.K. We positioned ourselves near coffee machines and in other well-travelled corridors and stopped 68 people who were carrying documents. We asked them a few questions about the reasons for their trip and also about why they were carrying documents.

Unsurprisingly, many reasons for carrying paper centred around using them at meetings. For example, 26 people carried the documents to refer to during conversations or meetings; 11 reported that the focus of their discussion was the document itself. Other reasons, though, were more surprising. For example, eight people said that they were carrying paper either because it was urgent or that they wanted to be convinced that the document had been delivered; they did not trust sending these documents electronically. This wish to be able to both ensure and confirm the delivery of important documents was immediately built into our scenarios. We also built feedback and security mechanisms into our prototypes partly as a result of this finding.

Diary Studies of the use of Paper versus Electronic Documents

Several diary studies have been carried out by people within our lab over the last few years. Although they were carried out primarily by other groups, one of us (Eldridge) was involved, partially to collect information relevant to our interests in mobile working. The most extensive diary study was carried out on 25 workers at the International Monetary Fund (IMF) in May of 1995. In this study, workers kept daily logs of their activities for one week, recording in particular their use of both paper and electronic documents.

Many of the results from this study are reported in Sellen and Harper (1997). Of particular interest for our project was the finding that electronic documents were only rarely used in face-to-face collaborative work, while paper documents were used in the majority of these encounters. The importance of paper in such mobile, collaborative settings yields yet more evidence for providing easy access to document services that can easily convert documents from electronic to paper form. Of interest, too, was the finding that many economists in the IMF wanted to deliver important documents personally as paper documents; once again pointing to the importance of confirming document delivery (see Sellen & Harper, 1997).

The IMF also played a role in our scenario development. Many detailed examples of the work of the economists, both from our study and earlier ones by Richard Harper (1998) helped us to further refine our scenarios. In a follow up meeting, we described Satchel to them and presented them with scenarios based specifically on some of their document activities. Having scenarios of such relevance to their work helped us evaluate some aspects of our design without going to the expense of running an actual user trial.

TRIALS USING SATCHEL TECHNOLOGY

The studies carried out above occurred in parallel with prototyping activities within our group (see Flynn et al., for descriptions of these early prototypes). As a brief history, the first prototype, based on the Xerox PARCTab (Want et al., 1995), was implemented in 1993, before any of the above studies were carried out. This was very much a "proof of concept" prototype. Starting in 1994, we implemented Satchel on off-the-shelf Apple Newtons, mainly because the PARCTab required a local infrastructure and was not commercially available. At this stage in our prototyping activities we wanted evidence to support our early ideas, and in the summer of 1994, we started the series of studies described above.

By 1996, we were ready to start testing the Satchel technology itself, primarily because we felt our technology was ready for commercial exploitation. We carried out a series of trials of Satchel, starting with a very small-scale in-house trial using somewhat inappropriate subjects, and ending with a large-scale trial with salespeople at an external customer site. These trials are summarised below.

Small-Scale Internal Trials

The first tests of the Satchel system were run in 1996 using the Apple Newton as the mobile device; it communicated via infra-red to other Newtons that were logically connected to various devices around the lab to enable access to local services. We started by running a trial in August of 1996 using ourselves as subjects, not typical mobile professionals by any means. Although this first trial was brief (only about two weeks) and half-hearted (only two of us really used the system!), it enabled us to unearth a number of system bugs, design flaws, installation problems and also problems with the trial method itself.

The second trial started in October of 1996 and ran for about three weeks; six colleagues in our own lab were used as subjects. These people, too, were not "mobile professionals" and we therefore devised a number of game rules to force them to use the system. For example, people were not allowed to email documents to one another, they were forced to "beam" them from Newton to Newton using infra-red. Once again, many issues were raised (a total of 112!), most of which were concerned with the functionality of the system. For example, lack of feedback (particularly audio) during infra-red transmissions proved problematic; many additional features were desired (e.g., the ability to "beam" presentations directly to a screen); and many provided features, designed to streamline the interaction, were found to be confusing (e.g., one-step "beaming"). These results were fed into the design of the next prototype system. One surprising result was that supporting these six users during the trial required much more effort than we had anticipated. This was a particularly valuable lesson for our future trials.

Paper-and-Pencil Walkthroughs

By the end of 1996, we were ready to run a large-scale internal trial. This necessarily required us to consider other mobile devices, since the Apple Newton did not have convenient wide-area network communications and we wanted people to be able to use Satchel easily outside of their local buildings. The Nokia 9000 Communicator was now available; it provided local area wireless communications via infra-red and wide-area wireless via GSM. It also had built-in PDA functions.

Re-designing the user interface for the Nokia 9000 required many changes. In the new time pressures of a rapidly-emerging development project, we needed feedback on ideas quickly and without waiting for a re-implementation on the Nokia 9000. Two of our colleagues who had participated in the earlier trial of Satchel were walked through a series of tasks using a paper-and-pencil prototype of the new design of the Nokia-Satchel user interface. We were mainly interested in testing the basic structure of the dialog, as well as nomenclature. These early results, requiring no implementation effort, provided us with a first step in the iterative design of the user interface.

Large-Scale Internal Trial

In 1997 we ran a large-scale trial of our Satchel technology on 26 Xerox employees located at three different sites within southern England. The goals of this trial were to convince others within Xerox (and ourselves!) that this technology was actually deployable and that it was useful. Some of the employees were "mobile professionals"; others were not. The members of the group were working together to launch a Xerox product within Europe, thus we expected a reasonable amount of interaction among them. They were selected because of their intra-group interactions, their mobility across the three sites (and elsewhere), and because they were willing to spend the time and effort helping us with this trial.

Each person was given a Nokia 9000 Communicator running our Satchel software. In addition, Satchel systems supporting services (e.g., printing, faxing, scanning) were installed at each of the three sites. People were trained, but were given no particular tasks to do; there were no game rules devised to force usage. Rather, they were "let loose" with the technology and asked to use it to support their normal work activities. Results from the trial were collected from electronic logs of all service requests, observations, individual interviews, questionnaires, and group feedback sessions at the end of the seven-week trial.

Our design goals and the results of this trial are described in Lamming et al. (submitted). In summary, we found overwhelming support for providing access to documents and document services. There were problems, however, providing ubiquitous access, primarily because of lack of GSM coverage at a few of the sites, and also in the United States. One major lesson learned from this trial was the degree of time and effort required to prepare and support the users' current, rather out-dated, technology for

the requirements of the Satchel system. New operating systems were installed (changed from Windows 3.1 to Windows NT), often necessitating hardware upgrades. Installing Satchel itself was simple; preparing the technology for it was not.

Large-Scale External Trial

In the autumn of 1998 our Satchel technology was transferred to a Xerox business group. In conjunction with the business group, we set up a trial with an external customer. A group of 22 national account salespeople for a wireless carrier in the U.K. were provided with Nokia 9000 Communicators. These people could confidently be called "mobile professionals". The trial started in late 1998 and the salespeople are still using it. Plans for future customer trials are now underway, and our involvement as a research group has ended.

CONCLUSIONS

We have presented a brief overview of the different methods that have been carried out in the course of our five-year research and development project. Each of the early general studies contributed to our understanding of mobile document work; no one study by itself would have provided us with the necessary information. They were useful in helping us to refine our design requirements and increased our confidence that we were ready to submit our prototypes to extensive user testing.

Our early studies were also invaluable in enabling us to design scenarios that were realistic and persuasive. Initially our scenarios were dreamt up by us sitting around a whiteboard, with little evidence from the real world to support them. In the early days of the project before we had prototypes that were easily demonstrated, we used the scenarios to illustrate Satchel's functionality to other people within Xerox. They played a powerful role in persuading the corporation to continue funding our project.

The later trials were considerably more time-consuming and expensive; they were invaluable in successively refining our prototypes. Even the early small-scale internal trials, though short and small, provided a vast amount of data to feed into later designs. Of course these early trials focused on user interface and system design problems. The later trials, particularly the two large-scale trials, also provided important information on installation problems, business models and marketing strategies.

Taken together, this program of research leading from early concept to early product relied on knowledge gained from all of our activities. Many of the early studies were "quick-and-dirty" and were carried out by just several people over a day or two. The later trials were extremely time-consuming, required additional funding, and involved sometimes up to ten people. Many studies yielded only a few snippets of useful data; others provided vast quantities of data. We believe now that each played a role and contributed to the final success of the project.

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