Opportunities and Barriers to Portable Document Scanning

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Abstract: While electronic documents are increasingly prevalent in the workplace there are many texts – such as books, magazines and letters – which are not easily available in an electronic form. Since many electronic document systems depend upon documents existing exclusively, or at least predominantly, in electronic form, this suggests an opportunity for document scanning technology. However, conventional scanners are limited by their large size and relatively cumbersome usage. Using a diary-based methodology, this study investigated the use of a new portable document scanning technology. In this paper we explore the need for document scanning, and how this portable device was used by our study participants. Document scanning is shown to be a goal-driven activity – individuals did not scan just to have an electronic version of a document, but to do something with electronic documents, in particular, distributing documents to others, archiving documents and reusing documents. The small design of this device also enabled a mode of usage distinct from that of conventional flatbed scanners. Its size meant that the device was a personal, rather than shared technology; that it could be easily stored when not being used; and that the scanner could be carried to the materials to be scanned, rather than the materials brought to the scanner. We discuss this interaction with the local environment as a case of "local mobility" – this is less to do with portability but with how a device's small size can make it fit better into work environments.

Keywords: Diary studies; Digital documents; Information appliances; Mobile devices; Paper use; Scanning

1. Introduction

Scanners are now one of the most popular add-on devices sold for the PC. Second only to the printer, sales reached 14 million units by 1998 [1], and the market currently shows no sign of abating. Despite this popularity, there has been very little published research looking at document scanner use. With a few notable exceptions, scanning – be it in the home or the office – has had little attention. This is unfortunate, and not just for the gap in our knowledge that it presents. Many discussions of document technology depend upon a notion of one's documents existing exclusively, or at least predominantly, as electronic documents. For example, a recent paper by Buscher et al. describes a system (called "manufaktur") where documents are manipulated and shared in a virtual environment [2]. There is an implicit assumption that documents that are only available in paper form (such as books, magazines and other externally produced materials) will be scanned as a matter of common practice. There is no discussion of the laborious, low-status work which is needed to scan in documents. To reach their full potential, these mixed reality environments or electronic document systems depend upon document scanning to make paper documents available electronically. These sorts of assumptions can also be seen in other work involving the use of documents in virtual environments [3–5].

In our own research group, we were confronted with these issues in relation to our research with a new kind of document scanner, a handheld document scanner known as the "Capshare 920" (Fig. 1). The Capshare handheld scanner is an untethered appliance that can be used to scan and store 50 A4 or US letter-sized pages. Capshare works by tracking the grain of the page as it is dragged over the page in a "swipe" motion. The device then stitches the page back together and displays it on an LCD screen on the back of the device where it can be viewed before sending it to a PC or printer. Capshare can scan greyscale or black and white pages up to flipchart in size. Capshare's mobile nature makes it a radically different sort of device from existing flatbed scanners. It can be used in situations where one does not have access to a PC or a network, and it can be easily carried in a briefcase or bag. The researchers who worked on its design and production conceived of it as a "casual capture" device – one which would be used for the ad hoc capture of documents in situations outside conventional office environments.

Since Capshare is a very different kind of scanner than conventional flatbeds, we were interested in how its use would be different. In this

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Fig. 1. The Hewlett-Packard Capshare 920.

paper, we discuss research which we have done looking into how the small size of Capshare has implications for its use. The design of Capshare is such that in the process of scanning, one takes the Capshare to the object to be scanned, rather than the other way round (as with flatbeds). Capshare can also be stored in a desk drawer or easily kept on a desktop without taking up much space. Its design also makes it possible to scan surfaces which are pinned to walls, which are in situ, and which are encountered in an ad hoc way. These issues are related to the size of the device and its physical mobility, but are not about "mobility" or "portability" in the way the terms are normally used.

In addition to looking at how Capshare is used, and the relationship of its use to its size and mobility, we also wanted to be able to identify potential user needs which Capshare failed to support, and to discover what the barriers were to its use. To accomplish these goals, we developed a methodology involving a modified diary elicitation technique. Diary methods are a popular data collection technique in sociology, but are still relatively rare in technology studies. We have been developing our own form of this methodology, with some success in the areas of reading [6], paper use [7], and the research behaviour of library users [8]. The methodology we used in this study incorporated digital cameras as a tool to log users' activities, giving us the ability to capture naturalistic details of work practice without the large overhead of an observational study. In this case, cameras were used as a diary tool for the first phase of the study to uncover what initial "needs" participants saw for a document capture device. This was followed by a second phase where participants actually used the Capshare device. This gave us a view of what individuals desired to scan, in contrast to what they actually scanned with our new handheld scanner.

2. The Literature

Perhaps because it is viewed as a mundane technology, scanning has mostly appeared implicitly in the literature rather than being addressed as a topic in its own right. It is often taken for granted as a prerequisite and simple activity. As we have already mentioned, many new prototype document systems often assume that documents will be available on-line, despite the reality that there is a vast paper legacy that most organisations have to deal with.

Most research involving scanning systems has avoided discussing how they are used, or how they fit into existing practices. Technical descriptions of scanning technology are the norm, e.g. [9–11]. This is perhaps acceptable in situations where scanning is used in the archiving of large corpora of documents, such as digital libraries. In these settings, archiving and integrating media are the primary organisational goals [12]. Issues concerning the incorporation of scanning into work practice are less pressing, since scanning and maintaining the scanned archive is the main task for those concerned. However, these situations represent the minority of scanning sales. Most scanners are bought for use in different situations, where scanning is only one activity amongst many – there is little in the literature which deals with the use of scanners in these complex situations.

One exception can be found in research by Trigg et al. [13]. This paper discusses the use of a scanning system by an urban rail engineering team. It highlights in detail the work which is required when keeping paper and digital documents, and the problems that arise in managing the boundary between the two. The engineering team studied used the scanning system for archiving reports and documents which were generated by their project work. In this case, the reports were catalogued when they were written, and the scanning system used to archive the documents. These documents could then be searched via the web, and printed by team members and other members of the organisation.

Much of Trigg et al.'s paper discusses the categorisation schemes that were developed by the

team, and how they adopted and modified standardised schemes for use in their own archiving. This discussion gives an interesting view of archiving practices, and the problems of maintaining and using standardised categorisations. However, the paper also addresses how scanning was incorporated into the work practices of the team. For various reasons to do with the experimental nature of the project, records were also kept in a paper archive along with the digital archive. Keeping the paper and the digital records in step proved to be problematic for staff. Some engineers used the paper records, and would then annotate, change, or recategorise them when needed. These changes would not normally be transferred over to the electronic copy, causing problems with mapping between the digital and the electronic versions. Scanning in this setting also became something of a "chore", in that it satisfied no short-term goals for getting the work done; instead it was part of maintaining records so that files could be found in the future – a long term goal. This sort of work is likely to be of low priority and status. Indeed, in the situation Trigg et al. investigated, the documents to be scanned were put into a pile to be fed through by the group's administrator. This paper highlights the utility of scanning to cross the digital–paper boundary, but also shows some of the problems which arise from the time-consuming nature of existing scanning technology.

3. Method

In this study we wanted to look at scanning practices across a diverse range of settings and professions, in particular with reference to how a mobile scanning device could be used. It was not an aim of the study to produce statistically generalisable data. Instead, we were looking for a way of understanding how scanning fits into different occupations and work practices. Moreover, our aim was to collect in-depth data on each individual by interviewing them over the course of many consecutive days. Accordingly, we designed and used a three-week-long diary study with a relatively small sample of participants. This study was an attempt to understand both the new situations in which a mobile "capture" device such as Capshare could be used, and the design barriers to its further use.

The study was carried out in two parts. The first part elicited document capture requirements by using a modified diary method. The aim here was to understand what possibilities existed for portable document capture devices. The second part of the study equipped participants with Capshares, and a similar methodology was used to uncover details about the scanning which they actually did.

3.1. Choice of participants

In choosing our participants, we were particularly interested in settings where there was potentially high demand for devices such as Capshare. This led us to choose participants who worked in paper-intensive occupations. Also, perhaps unusually for a study concerned with mobility, we chose to focus on participants who were mainly desk-bound rather than mobile. Part of our rationale for this was practical: we were looking for future markets for the device and Capshare had already been well researched (internal to HP) in the context of mobile professionals. The other reason, however, was that we were interested, not necessarily in Capshare as a device that was only used "on the move", but rather whether the unique, compact design of Capshare might find its place in an office environment. In other words, we were interested in whether the design of Capshare as a mobile device would offer different affordances for scanning in a conventional office setting than flatbeds do. The issue of interest, then, was to do with the mobility of the device rather than the mobility of the people who used it[1].

Eleven participants were chosen in a sample of paper-intensive occupations, covering both professional and administrative jobs (Table 1). The screener we used selected for participants who were PC users, received or collected information from documents more than 10 times a day, and were at their desk (or main work site) more than 80% of the time.

3.2. Procedure for Stage 1

Participants were equipped with digital cameras, and asked to use them to record their paper capture activities. The participants were asked to imagine that the camera could capture documents by just taking a photograph of the first page. This "magic camera" could then be used to email the document,

[1]Having said that, we fully expected that these mainly desk-bound individuals would sometimes be mobile both locally within their work settings and outside of them. These situations were also of interest.

Table 1. Participants and their occupation.
(Pseudonyms have been used for participants' names)

Subject	Occupation
Jane	Office administrator in small financial services firm, responsible for activities such as distributing the post, answering the telephone and keeping track of the company's correspondence.
Ewan	Sub-editor of an entertainment magazine, doing jobs such as opening and organising correspondence, making sure people get information at the right time and keeping an eye on the supplements which go in the magazine. He works from home three days a week, where he is also a book author.
Susan	Teacher in local school. Responsible for teaching "special needs" children, producing specialised material and monitoring their progress.
Ken	Head buyer of supermarket chain. Manages his staff who do the actual buying and maintains the contacts between suppliers and stores at the senior level.
Jennifer	Trainer in supermarket chain, dealing with arranging training sessions and working out what material to put into new training sessions.
Lenny	Stockbroker who takes buying requests from his clients, carries them out on the stock exchange and advises clients on the best time to make financial investments.
Matt	Management consultant who spends a lot of his days in meetings, and often works from client sites. Roger University researcher who spends a lot of time interviewing people working in government agencies.
Tim	Logistics manager in Hewlett Packard. Lots of work in meetings discussing new manufacturing processes, and bringing together plans for new products.
Sam	Financial administrator working in Hewlett Packard. Manages the purchasing of equipment and chasing purchase orders.
Geoff	Lawyer in firm dealing with patent issues. Frequently distributes information to other people in the company, and keeps large archives of information.

print the document, or to carry out any actions possible electronically. The emphasis was placed on participants using their imagination as much as possible. No limit was put on how documents could be captured, allowing individuals to specify their "dream document capture device". Participants were told that every time they came across a document they would like to capture and do something with, they were to take a photograph of the document. The camera in this way worked as something of a diary tool, helping them record all the documents they wanted to capture throughout the working day. Documents were described as being anything which was on paper or acetate, including posters, letters, post-it notes, photos, and so on. It was emphasised that we were interested in how they would use the documents they were photographing.

Participants had the cameras for 1.5 weeks, during which time they were interviewed three times for between 30 minutes and 1 hour, using the photographs they had taken as material on which to base the interview. Since we had used digital cameras, the photographs could be reviewed on the camera's built-in LCD screen. These photographs were also archived and used later in our analysis.

The interviews we conducted allowed us to build up considerable data on what documents individuals wanted to capture, where they wanted to capture them, and what stopped them doing the capturing with the existing infrastructure. Standard questions were asked during the interviews for each photograph taken including:

- Where were you when you photographed this?
- Did you know what you wanted to do with it?
- Would you have liked to have shared this?
- Would you have liked to have used this on your computer?
- How do you normally capture this sort of thing?
- How do you currently archive/send/re-use these things?

3.3. Procedure for stage 2

In the second stage of the study, the same participants were equipped with a Capshare device. Software was loaded onto their PCs and participants were equipped with a connection between Capshare and their PC. This allowed them to use Capshare when away from their PC, to capture documents which could then be sent to their PC and stored as TIFFs, a standard format for scanned pages. Participants were shown how to use the scanner, how to get documents onto their PC and how to view, edit, and send TIFF documents to others.

The aim of this second stage was to investigate how participants used Capshare to capture documents. The same methodology was used as in Stage 1: three in-depth interviews per participant

were carried out over 1.5 weeks, based around the documents which they had scanned. Similar questions to those listed in Stage 1 were asked about each scanned document.

Together, the two stages of the study gave us first a view of people's desires for document capture (using the camera), followed by their actual document capture behaviour (using Capshare). In all, 66 interviews were conducted with participants to collect the data for this study. The interviews for both stages were tape recorded and fully transcribed, producing a large corpus of information about document capture scanning and its relation to work practice.

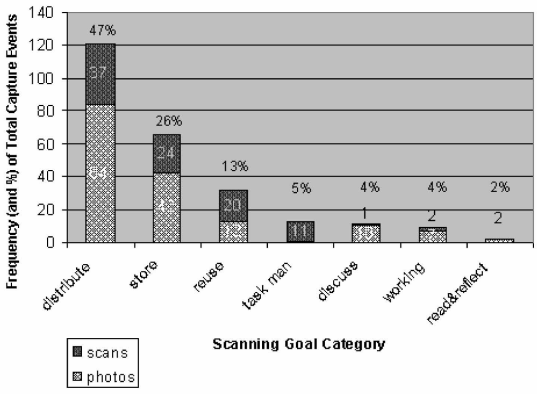

Fig. 2. Scans and photographed categorised by the goal behind their capture.

4. Findings: Scanning Goals and Document Types

During the study, participants took 162 photographs and carried out 98 successful scans – an average of 15 photos and 9 scans per participant. A first observation is the difference in the frequency of photographs and scans. This shows that participants indicated they wanted to capture documents more than they actually did capture documents. There are many reasons why this might be. One reason could well have been that participants' motivation declined over the course of the study. Another is that Capshare was simply not suited for the types of things that the participants wanted to scan in. Finally, another possible reason was that scanning a document with the Capshare and carrying out subsequent activities required more effort than just taking a photograph and telling the interviewer about it later. By looking in more detail at the reasons why participants captured documents (their goals), and the kinds of documents they captured, these issues become clearer. We will return to this marked difference in the frequency after describing the basic findings.

4.1. Scanning goals

One of the first findings from the data was that scanning was a highly goal-driven activity. For the study participants, scanning documents was something which was done only if there was a definite benefit to having the documents in electronic form. Participants' time was too valuable to scan documents merely to have them electronically available. Instead, there had to be some work goal of which scanning was one part. So, for example, handwritten notes would often be scanned to send to colleagues. The goal for this activity was not scanning itself, but rather was sending the note to a colleague. While this may seem an obvious point, the implication is that we cannot assume that documents will consistently be made available electronically, unless scanning plays a part in achieving work goals.

To understand the goals which were achieved with document scanning, we categorised the photographs and scans by the capture goal. We used a list of categories which we developed from our related work on information capture [14]. There were seven categories in total which we used to classify each capture incident with both the camera and the scanner. A quantitative categorisation of the data according to these goals is shown in Fig. 2. It should be emphasised that with such a small sample size, it is not possible to draw any strong conclusions from these numbers. However, some important inferences can be drawn. Firstly, there was a wide range of different activities within which document capture occurred. So, while a scanner such as Capshare may be characterised as a single-function device, it is certainly not a single-use device. Second, the fact that the three most frequent capture goals covered 86% of all documents which were captured indicates something about the needs of these individuals. These particular participants frequently came across documents which they wanted to distribute, store or reuse. Furthermore, participants saw some real advantage in doing these activities electronically, for reasons which we shall discuss.

In an attempt to understand these findings better, we looked in more detail at each of the different activities starting with the most frequent category first.

Distribute: The "distribute" category covers cases where documents were scanned to be distributed or sent to someone else, either a group or an individual. This category was the goal behind 47% of the captures. Participants were enthusiastic in the interviews about being able to scan documents for electronic distribution them. This was particularly the case with participants who spent much of their time receiving and redistributing information. For example, both Jane (office administrator) and Tim (logistics manager) received a lot of paper documentation through the post which they would then need to distribute to groups of people in their organisations:

Interviewer: Was using Capshare quicker than photocopying it and sending it out to people?

Jane: Yes, much quicker and also it means I don't have to tramp around everywhere you know I can actually do it from here. (Jane, Office Administrator)

Tim: These are more notes from a meeting we had today. This is basically an action plan for setting up the returns process. So now I have to send that out to people. I could send that out handwritten, as it's all internal. I'm going to type it up in an email … It would have been marvellous if I could have scanned it in and emailed it out. (Tim, Logistics Manager)

With electronic documents, one obvious advantage is their ability to be quickly distributed. This activity can be time-consuming with paper, especially if there is a large recipient list, as one has to photocopy and send or fax individually each copy of the document. With electronic mail, documents can be simply scanned and emailed, saving time and effort. The high frequency of this activity suggests that supporting distribution is an important need for all scanning devices. Our participants had a real need for distributing paper documents electronically to others that was not currently well met with existing technologies.

Store: This category refers to documents captured for medium-term storage or longer-term archiving. This includes documents which are captured and kept "just in case", as well as documents which are stored for a specific purpose. This category was the second most frequent in our study. Some participants who maintained large collections of documents were enthusiastic about keeping electronic archives:

Ewan: I and most people who do my kind of job consume immense quantities of print and we tear things out of newspapers for filing away and thinking I would like to write something about that … so in that sense perhaps when in a few years time I will have on my hard disc a whole sort of archive of newspaper clippings that have been scanned in as opposed to sort of half a dozen folders of various sort of wedges of yellowing news print that I never bother looking at. (Ewan, Magazine Editor)

However, other participants were less enthusiastic. There were various reasons behind this hesitancy to store documents electronically, ranging from legal reasons or a lack of trust in computer technology. For example:

Interviewer: You've got a lot of files, do you think you could file them on the computer, all the bits of paper on the computer or is it easier just have it in folders?

Jane: We've got to keep them on paper for legal reasons, we've got have it on paper, you know they don't want it on the computer because we don't trust it. (Jane, Office Manager)

One recurring reason centred around the effort which would be involved in scanning the documents. Jane, who maintained a large body of records, felt that it would have been cumbersome to have to scan each record compared to placing it into the paper archive she kept. This emphasises that the effort of scanning to file may outweigh any potential benefits. This is therefore a barrier to scanning. One relevant issue here is that electronic records lack the tangibility of paper records. In some ways this makes them harder to arrange and sort in a flexible manner. However, electronic document archives have advantages in that they can be searched (if OCRed) and that they can be accessed by geographically diverse groups. For example, Roger (university researcher) collected a large archive of documents from his interviews with government officials. Roger often found that he wanted to distribute these documents from his archive with other researchers – in this case he needed to resort to photocopying the documents and putting them into the post. To Roger, scanning these documents into an archive would have been worthwhile, since he often needed to take them out of the archive and redistribute them to others.

Reuse: This category covers documents which are captured in order that they can be reused in the production of something else (usually a document). This was third in terms of frequency. In this case, participants often wanted to take snippets from other documents, so they could reuse them in their own documents. One participant in particular, Susan, a teacher in a local school, found the scanner useful for scanning in diagrams which she then included in her own documents. These diagrams were specially modified for special needs children, who needed text around diagrams to be simplified, or diagrams to be enlarged. Another participant, Tim, a logistics manager, found it useful

to scan in handwritten process diagrams, which he would then distribute around different groups for comment. Tim found that drawing these diagrams on the computer using PowerPoint was fairly laborious, and particularly time consuming. With Capshare, however, he found he could just sketch out the diagrams on a piece of blank paper, scan it in and include it in his word documents.

One relevant issue to the r-use of scans is whether these documents were to be converted into computer text – "if they were to be OCRed". In our study, in many of the cases where participants indicated that they wanted to OCR scans, conventional OCR software would have been unlikely to produce useful results. For example, a number of participants wanted to scan handwritten notes, or complex tables of numbers and have this converted to text. It is unlikely that conventional software would be able to do this with any level of accuracy. This suggested to us that OCR would have had limited applicability to our participants.

Task management, discussion, working, reading and reflection: These four categories together were the least frequent in our study, accounting for only 15% of captures. However, they do demonstrate the wide range of activities for which people want to capture documents:

- Task management covers situations where documents are captured in order to remember things that you have to do, or have them organised for future tasks. One participant, Lenny, was responsible for nearly all the capture events in this category, as he used Capshare extensively for scanning letters and attaching them to tasks in his diary.
- Discussion covers documents which were captured to have a synchronous discussion around – documents to be used in face-to-face interaction. For example, one participant took a photograph of a slide from a presentation, that he wanted to be able to use in a group meeting with his team, having a discussion using the captured slide.
- Working was where documents were captured to be annotated as "working documents". This category covered cases where documents are modified in an ongoing way, and act as repositories for information.
- Reading and reflection covers documents which were captured to be read later, by printing them out for reading or by reading them on-screen.

Since these activities are of low frequency it could be argued that there was little need for participants to carry them out. Indeed, the interview data suggest that participants saw very little need to carry out these sorts of activities in the electronic realm. For example, one participant (Ewan, magazine editor) discussed a document which kept the magazine's important dates. This document would be distributed to magazine section editors, and annotated as it came closer to production time. This document was therefore a "working document", in that it was continually being changed and updated. Ewan distributed photocopies of this document as he knew this fitted its purpose better than an electronic one:

> Basically it contains a whole load of listings of dates … but you know it would be have been easier to photocopy it. (Ewan, Magazine Editor)

Ewan explained that the documents would be annotated and posted up on office walls – and it was better to distribute this document by photocopying it and manually handing it out. In this case, having the document held electronically would not support the incidental viewing of the document on office walls, and annotations and modifications which would be made to the document in different magazine departments. Data such as this suggest that rather than these kinds of activities being rare, they are instead activities which are not well supported by electronic documents. Electronic documents are less than ideal for supporting discussion, and reading and reflection, when compared to paper documents.

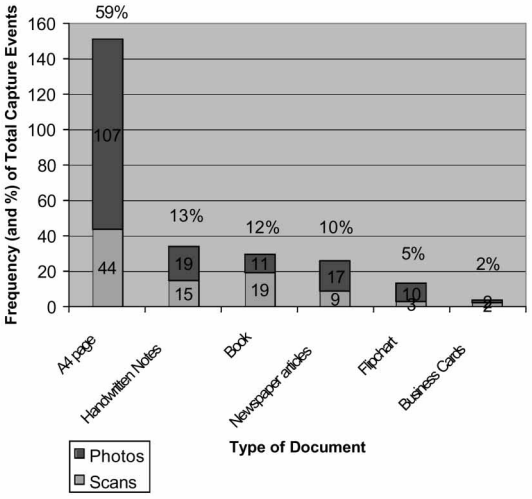

Fig. 3. Document capture by type of document.

4.2. Analysis by document type

A second aspect of document capture in which we were interested was the *type* of document that was captured. Participants photographed and scanned a wide range of documents, from newspapers to handwritten notes. To understand this diversity we carried out a second categorisation of the data in terms of the type of document scanned.

Breaking down our data by the goal of capture gave us an idea of the different workplace activities scanning was part of. However, we were also interested in what sorts of documents participants wanted to capture. This would be important in shaping the requirements for future scanning technologies. This is shown in Fig. 3. Documents were categorised into A4 pages, handwritten notes, book pages (which includes all bound documents), newspaper and magazine articles, flipcharts and business cards.

The data showed that A4 pages were the most commonly-scanned document type. Moreover, the majority of documents scanned were one page: 76% were one page or a section of a page; 16% were 2–3 pages; 7% were 4 pages or more. While A4 documents were the most common type of document captured, the type of A4 document varied. For example, they included résumés, application forms, legal documents, letters, faxes and handouts from meetings. Since this bias towards A4 pages existed both with the camera and the Capshare, this suggests that it was not due to a peculiarity of the technology but rather that the majority of documents participants wanted to scan were A4 pages (or the equivalent, such as letter or legal paper).

However, the data also show that there was a large variety in the remaining 41% of documents, including book pages, handwritten notes and newspaper articles. From the interviews, the participants emphasised the value they got from scanning handwritten notes:

> Matt: I realised at the end of the meeting, someone said did you happen to know what those questions were and it was sort of ideal if I could have just photocopied the page out of the book or emailed the page out of the book rather having to write, what I actually had to do was laboriously type it out and email it round to all concerned which took some time. (Matt, Management Consultant)

> Interviewer: Do you sometimes get it where they just want to send handwritten notes?

> Jane: Yes quite often, John quite often just writes faxes, especially if it's to someone he knows in a company. (Jane, Office Manager)

Participants emphasised the value of distributing handwritten notes, in that they could avoid having to type their notes up for emailing. However, if participants were dealing with individuals outside their own work group, there was more hesitancy in sending handwritten documents:

> Interviewer: You said that you'd want to type it up for people outside the company. What about people outside your part of the company but still inside the company?

> Tim: It depends on the team structure. I mean, if it's internal to a project team it can be in any format. If you're working with people in a foreign language, it's sometimes better to type it up so you can clean up the language. Yeah, so anything outside the department. Outside the company, I'll make it a bit slicker. (Tim, logistics manager)

5. Scanning as an "Effort Bargain"

Having covered the basic findings, we now return to the observation that participants took almost twice as many photographs as scans. Previously, we had conjectured three reasons for this: first, that participants' motivation may have waned over time; second, that the materials they wanted to scan were unsuited to the design of Capshare; and third, that the time and effort required to scan far outweighed that of taking a photo. Although we have no strong support for the claim, it is likely that participants maintained motivation for the study simply by the frequency with which we interviewed them over the course of the three weeks. With regard to the issue of the unsuitability of materials scanned, there were certainly some kinds of documents that Capshare was not ideally suited for scanning (such as business cards). However, according to the analysis by document type, it was clear that the majority of materials were in fact unproblematic for Capshare. For example, Capshare has a "flipchart mode" designed to handle large pieces of paper. Further, the distribution of document type is very similar for both photos and scans, suggesting that document type was not the main factoring influencing Capshare's use.

What seems most likely, and what was indeed clear from talking extensively with the study participants, was that the reason for the small number of scans was the effort involved not only in scanning, but also in achieving the range of goals which we have outlined. In this respect, scanning was in competition with other more conventional processes – such as photocopying or obtaining an original electronic file – which also achieve those goals. In this way, scanning is an effort bargain. By this we mean that participants would only scan if the potential

benefits they could gain justified the effort required. So if participants thought that they could work around the barrier between paper and electronic documents, and that this would be quicker and easier than scanning, they would do this rather than scan the document. If the goal was editing a document, for example, then an individual might ask the author for an electronic copy, rather than attempt to scan the document in, OCR it and then edit the OCR'd copy. In this way, Capshare sometimes "failed" the effort bargain:

Ken: Again it's back to this "the thought goes through your mind" and you just dismiss it almost immediately, it's not worth the effort. (Ken, Manager)

This effort bargain exists in the use of many types of technology. Sharrock and Anderson, for example, discuss it with reference to the design of photocopiers [15]. It is an explicit trade-off between the use of a new type of technology, such as Capshare, and the use of existing processes. At its heart it involves a consideration of the effort which will be involved in meeting a goal. Two aspects of Capshare's design reduced its ability to win this "effort bargain". Capshare was designed as a contact scanner. That is, it was swiped over the page making contact with the page to scan its contents. In use this meant that Capshare was very sensitive to being lifted off the page during scanning. Indeed, bumps in the page, such as paperclips, or creases, would be enough to stop the scan, which would then have to be repeated from the beginning. This meant that, in practice, Capshare had a high scan failure rate for participants.

Moreover, this failure rate was increased by the difficulty participants had in finding suitable flat surface areas where they could use the scanner in a hurry. Participants' desks were often crowded and covered with documents. There would simply be no suitable flat surface for scanning a document in, meaning that an area would have to be cleared before a document could be scanned. It could be thought that this small addition to the scanning activity might have little effect on scanning behaviour. However, it increased the amount of effort needed to scan, influencing the effort bargain. As the bother involved in scanning increased, a number of marginal scanning activities became quicker and easier to do with existing paper technologies. However, some participants were more tolerant of some of these problems such as page clipping, because of the advantages a portable device gave them:

This was useful because I've been missing college quite a lot lately so I've scanned in all these notes. All these college notes – but they don't always capture it all. It depends on the paper – it crops the edges of the page. When I got them back here I printed them off and put them in my file. It saved copying them all out or photocopying them, I just did it there and then. It handy because you don't have to borrow and take things away. It's been pretty valuable for that sort of use. (Tim, Logistics Manager)

A second aspect of Capshare's design which influenced the effort bargain can be seen if we look at how Capshare is used to reach a goal. For example, to send a document to a colleague with Capshare would involve a number of steps. First, one would need to scan the document, then check the document to see it had scanned properly, rescanning if necessary. Then the Capshare would have to be attached to the PC, and the document sent using the buttons on the PC. Finally, a new email message would need to be created, addressed and the file attached to the email message.

Obviously, these steps take some time and cognitive effort. To the participants, this effort would often be more than using other ways of completing the task, such as putting a photocopy into the internal mail. The configuration of Capshare and its software on the PC produced little assistance in completing common tasks. This made using Capshare to reach goals unnecessarily complex. One example from the study illustrates this clearly. Jane, the office manager, found Capshare to be easier to use when she wanted to photocopy documents. Rather than walking round the building and waiting for the photocopier to warm up, she could copy the document from her desk using her printer, Capshare and PC. This also had the advantage of keeping a copy of any documents that she photocopied on her PC. However, due to the failure rate of scanning with Capshare, and the effort involved in completing the task, she eventually gave up on using the Capshare and went back to photo-copying documents:

There were times when I went to get it and then thought no I haven't got time. You know that sort of thing because quite often since I'd maybe take three attempts to get it how I wanted it. (Jane, Office Manager)

In this way it was the small amounts of effort caused by technical and design problems with Capshare which forced individuals to revert to conventional technologies.

6. Capshare as a Personal and Mobile Technology

A second theme which ran throughout the findings has to do with the implications of Capshare's small size and mobile design. Our data suggest two aspects

of Capshare's small design which affected its use, neither of which have to do with portability in a conventional sense. First, there were clear differences between Capshare's use as a personal technology and the usage of shared infrastructure in office environments. Being a small device, Capshare did not have to be shared like photocopiers or fax machines, avoiding allocation problems. Secondly, Capshare's mobility made it fit spatially better into non-mobile settings. Thus, Capshare supported "local-mobility", in that it could be kept on a desk, put away in a drawer when space was needed, or carried to a meeting room on site. Both these findings show the non-obvious advantages which mobility can give to a device in non-mobile settings.

6.1. Personal vs. shared technologies

To those who took part in the study, Capshare offered a key advantage over existing parts of the office infrastructure since it did not have to be shared with others. Participants saw clear advantages in not having to go across the office to use a shared device, such as an office photocopier or a fax machine, which might be in use, or take time to set up.

Interviewer: Did you do any photocopying today?

Tim: Yeah I had some documents other people wanted.

Interviewer: Would you have wanted to do that at your desk?

Tim: Absolutely, the photocopier takes about 10 minutes to warm up. It's two corridors over. (Tim, logistics manager)

Roger: I don't like faxing, that's one thing I don't, I don't like fax because it means I have to get up from here and walk along the corridor and then hang around waiting for the opportunity to use the faculty fax and then input it and I tend to put it in upside down or something. (Roger, University Researcher)

The fact that Capshare was seen as a personal device generated enthusiasm from participants since they could see the value of replacing a shared technology with something they could use individually. Above we gave the example of Jane, who used Capshare instead of her office photocopier. Other participants talked about how Capshare could save them time by replacing shared technologies:

Geoff: That'd save the walk to the photocopier. It's all a time thing really, if you can save me some time. (Geoff, Lawyer)

In our introduction we discussed the sales of scanners as a peripheral for the PC. This market is dominated by the sales of flatbed scanners (around 90% of the market). We were interested, therefore, in how Capshare compared to these scanners. Due to the large size, flatbed scanners were viewed as shared devices by the study participants. None of the participants discussed flatbed scanners as something they would personally own in an office environment:

Interviewer: Have you ever thought about buying a scanner?

Tim: Well… I wouldn't have though it's worth it. I think we're getting one in for the department, but I wouldn't suggest it individually. (Tim, Logistics Manager)

This appears to have little to do with the cost of flatbed scanners (relatively low), but rather their size. Indeed, the size pressure on most offices is tight. The working environments of the participants who took part in the study were all fairly crowded. Even the smallest of flatbed scanners would take up an equivalent space to a PC – unworkable on most peoples' desks. The shared nature of scanners also makes them particularly difficult to use as you have to transfer scans from a shared PC to your own. This is a problem addressed with the recent introduction of network scanners. Market research by HP also suggests that as few as 22% of scanners which are purchased are used in the office for work activities, the rest being sold into the home.

The difference with Capshare, then, is not so much that it is a portable device, but that it is a personal device. Being personal, Capshare could be used to lower the effort involved in using a shared device such as a fax machine or a photocopier. However, to be able to make this distinction effectively, it was clear that the effort of using Capshare – both in terms of its scanning success rate and in the ease of using scans – had to be lower.

6.2. Micro and "local" mobility

The portable nature of Capshare also showed up in the way in which Capshare supported "local mobility". In one of the first papers to discuss mobility and technology in depth, Luff et al. [16] contrasted the conventional notion of mobility (meaning portability) with something they called "micro-mobility". In this case, they referred to micro-mobility as the extent to which an artefact could be jointly viewed, referred to and interwoven into a face-to-face conversation. This micro-mobility is something which paper documents support very well, but which technological alternatives often fail to support. So, the fact that

a device is small and lightweight not only affects where such devices can be carried physically, but also affects the ways in which the devices support local aspects of the interaction with those devices. In this case, Luff et al. had in mind the ways in which a PC-based tablet was used in conversational situations. In our study, this issue did not come to the fore since Capshare did not support this kind of "micro-mobility" in that its small screen was unsuitable for document sharing in a conversation. Even increasing the screen size on the device would not have avoided the interactional problems (such as limited viewing angle and cumbersome design) which Luff et al. discuss.

However, this study did suggest that Capshare had the advantage of offering support for a different aspect of interaction in a local environment – one which we have tentatively named "local mobility". Capshare's small size allowed it to be stored easily on a desk or in a drawer. Unlike a flatbed scanner it did not demand desk space which could not be reused when it was out of use. Added to this, the device was locally portable in that it could be taken to meetings on-site, or to other staff offices. For one participant this meant that the device could be used to scan in meeting notes immediately after they had been taken. Moreover, if the device was routinely carried about on the local site, one could use it to scan documents in unexpected situations. In one example, a participant found himself scanning slides in a meeting where he unexpectedly wanted copies of a few key slides. In this way, Capshare's small size helped it to better support activities in a fixed, limited geographic area (i.e. an office), without strictly being used as a portable "mobile" device. This local mobility was seen as a key advantage of the device by the users who took part in this study.

What this points to is that the advantages of mobile devices may not come just from their portability, but in the way that their mobility makes them fit better into our working and personal life. This may take a number of different forms, rather than just the conventional notion of mobility as portability, ranging from how devices can be used to better support workplace interaction, to how a device can fit better into crowded office environments.

7. Design Implications

The aim of our research work was to recommend changes to the Capshare product. However, a number of more general design implications can be drawn for the design of scanning devices per se, and other information appliances. The discussion of capture goals emphasises that the design of technology must centre around satisfying the goals of the user. Of course, with many developing technologies, those goals are ill-defined, although our study shows how diary methodologies can be used to explore and understand what these goals may be.

The participants in our study scanned when it was easier to complete their goal with an electronic as versus a paper document. In the study, the key advantage of electronic documents appeared to be the ease with which one could distribute digital documents to others. This took the form of emailing documents, but it could include sharing activities such as scanning to web pages. This suggests that an important feature of scanning technologies is that they should support the distribution of scans in as easy a way as possible. The analysis of the type of document scanned has a similar lesson. A4 documents accounted for 59% of what was captured. This seems to indicate that there may well be high value for a scanning device which is suited to the scanning of single pages of A4 paper. However, this analysis also showed that people wanted to capture handwritten notes, books and newspaper articles (together accounting for a further 35% of the data). This implies there are advantages to a device, like Capshare, which can easily capture a wide range of document types. Devices that only address one type of capture may be less successful than devices which attempt to scan a wide range of document types.

Focusing on the use of Capshare highlighted two other important findings. First, that the use of devices such as Capshare is part of an effort bargain and, second, that the small size of Capshare had other implications for how it was used (such as the fact that it could be used as a personal device, and that it was locally mobile in some useful ways). With regard to Capshare, the first observation about the effort bargain had a special resonance. We recommended two design changes to lower this barrier. Firstly, we recommended that Capshare be sold with a cradle with one button on it which would synchronise the Capshare with the PC. This simplifies the connection of Capshare to a PC. Secondly, we prototyped the assignment of actions for documents on the Capshare device itself. In this model of use the document is scanned and then the action (such as sending to a colleague) entered on the device itself without having to go to the

PC. The action is then completed when the device is put into its cradle. The aim of both these design recommendations was to reduce the effort involved in completing the scanning activity for the most frequent types of activities and goals that our participants talked about. The cradle solution reduced the complexity of completing a particular part of using Capshare, whereas the ability to address email from the Capshare reduced the number of steps involved in achieving the goal. Together these lower the barriers of learning how to use Capshare and barriers to its adoption.

These observations can be carried across to the design of other devices. The study suggests that lowering of the complexity of completing simple tasks can greatly increase usage. The dynamics of this are based around the competition these devices have with existing processes. Should the effort of the new device be more than existing processes, they will not be used. This effort barrier takes the form of the complexity of individual actions with the device, the number of steps involved in its use, and the barriers in learning how to use the device.

However, our observations regarding the design of shared versus personal devices, and "locally-mobile" devices, gives encouragement to the design of devices such as Capshare. If devices can be better designed so that they fit into individuals' personal work practices, rather than having to be shared either for economic or space reasons, then they are likely to be successful. This is an interesting addition to the recent interest in mobile technologies [17], in that utility of these devices may not come just from their mobility, but from the fact that their small size allows them to become personal technologies. With Capshare, this opened our eyes to new markets outside that of mobile professionals, since the small size of the device allowed it to fit into the static office context as much as it enabled use on the move.

8. Conclusion

This paper has discussed a study looking at the usage and opportunities for a new type of scanning device, the Capshare 920, and, more generally, the opportunities for ad hoc document scanning in the office. The results from the study emphasised the importance of goals in scanning activity. When participants captured documents, it was with some usage in mind. The top goals for capture were distribution, archiving and reuse. A similar categorisation of the documents which were captured by document type highlighted the prominence of A4 documents. Capshare's use by the study participants was part of an effort bargain. Participants would only use Capshare if they estimated that it would save them time and effort. While this is not a new observation, it was particularly relevant to the design of Capshare. Two issues with Capshare – problems with getting reliable scans, and the effort required to transfer scans to the PC – increased the effort required in using Capshare. This lowered the device's usefulness.

However, a number of features of Capshare's design made it useful to our participants, in particular, how Capshare's mobility was useful in distinctly non-mobile settings. Since Capshare was small and portable it was used as a personal technology, rather than being shared. Participants saw real advantages in this. When using shared devices, such as photocopiers or fax machines, participants would have to walk across their building, turn on and wait for the device to initialise, and often wait until other people had finished with the device. Although seemingly trivial, this added to the effort involved in using shared devices. Alternatively, personal devices such as Capshare lower the effort involved in faxing or copying a document. Capshare's personal nature made it more useful.

A second finding concerned the ways in which Capshare's small size made it fit into conventional, non-mobile work environments better. Since Capshare was small it could easily be stored when not used, either on a desk or in a desk drawer. This is in contrast with conventional scanners which take up a large amount of desk space. Moreover, Capshare was locally portable in that it could be taken to meetings on-site, or to other local places. This meant that, with Capshare, the scanner could be taken to the document to be scanned, rather than the document being brought to the scanner. This "local mobility" implies that the advantage of mobile devices, such as Capshare, may not come from just their portability, but in the way that their mobility makes them fit better into our working and personal life. This may take a number of different forms, rather than just the conventional notion of mobility as portability. In terms of future research directions, this interaction between different form factors for conventional devices and their usage is a promising one. Within our own lab we have been investigating this in the case of devices such as miniature web servers [18], and Swatch watches which can access the internet [19].

In conclusion, we present this study as an attempt to understand better the divide between

paper and electronic documents. Rather than assuming that documents are all available electronically, we have looked at how individuals cross this divide with one type of scanning device, and the problems which they encountered. As the importance of electronic documents increases, and the prominence of electronic document management systems increases, we believe that how this divide is managed is a topic of increasing importance.

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