

## **Does a Video Diary Help Recall?**

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# *Does a Video Diary Help Recall?*

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**The purpose of this paper is to determine the value of video recording in aiding the recall of work activities. A Video Diary System is described and the results of a preliminary evaluation of the system are presented. The memory experiment provided subjects with several different memory aids. The use of a Video Diary increased the number of activities which were recalled compared to using only a written diary. People and objects were particularly valuable cues in aiding the recall of work activities. Although the Video Diary was very useful, it clearly does not completely capture the events of the working day.**

**Keywords:** Memory, multi-media, video

## **1. Introduction**

The purpose of this paper is to determine the value of video recording in aiding the recall of work activities. We have designed a Video Diary System which uses low resolution time-lapsed video, with no audio recording. In this paper we will describe this system and discuss some preliminary results on its utility. Before we begin the description of the system itself, we will present some related work which is being carried out at EuroPARC.

### ***1.1. The Human Memory Prosthesis***

People at work deal with a vast amount of information. Information is passed to people in informal conversations or in formal meetings; information is contained in electronic or paper documents; and information is communicated over telephone networks. This information explosion necessarily increases the load on the human memory at work, and although the computer enables vast amounts of information to be stored, it does little to help the retrieval of this stored information.

The aim of a research project at EuroPARC called “Activity-based Information Retrieval” (AIR) is to use technology to support human memory by increasing the ability to recall or retrieve information [Lamming & Newman, 1992]. The essential idea of this project is to automatically collect contextual information about human activities, and to use this

contextual information to help the later recall of past activities. As part of this project, we are working on the development of a “human memory prosthesis”, which will be implemented as an application running on a light-weight wireless notepad-style computer.

For each user of the human memory prosthesis, a detailed personal autobiography will be maintained by the AIR system. This autobiography will include information about events in the user’s working life: phone calls, workstation activities, meetings attended, papers read, and so on. Each of these activities will be time-stamped, and thus information about one activity can be used to cross-index to other activities. For example, suppose you want to remember which document you were working on when you had a phone conversation with someone last week. By posing a query concerning an aspect of the past that you do remember (i.e., the phone call last week), you can find out more information about the aspect of the past that you do not remember (i.e., the particular version of the document). Thus, a user’s knowledge about the context of activities can be used as an input to the human memory prosthesis, and the AIR technology can be used to help retrieve information that might otherwise be difficult, or impossible, to retrieve.

The importance of contextual information in assisting the recall of activities is well known in the human memory literature [e.g., Smith, Glenberg & Bjork, 1978; Tulving, 1983]. There is also evidence that time-based contextual information is important in the way that various memories are structured; for example, Barsalou [1988] describes a theory of memory in which temporal cues link various memories. We are basing our design of the human memory prosthesis on research findings and insights derived from studies about how human memory behaves in the recall of everyday activities.

### ***1.2. Early Experiments***

One of our first experiments with collecting information about work activities used a system called Pepys, a program designed to make inferences about people’s activities based on automatically-collected location data [Newman, Eldridge & Lamming, 1991]. These location data are gathered via an Active Badge System [Want, Hopper, Falcao & Gibbons, 1992], which is part of the technical infrastructure at EuroPARC. Active badges are small security-tag devices which are worn on the clothing. Each badge emits a unique identification code using infra-red signals. The code is repeated approximately every 15 seconds and is picked up by wall-mounted sensors located throughout the building. Sensors are connected to a UNIX-based badge monitoring service called the Badge Server which keeps track of which badge has been observed by which sensor, and thus deduces the location of each badge wearer. The Badge Server is also responsible for notifying Pepys and other authorised client applications whenever a location change is observed.

These location data are processed by Pepys, and the descriptions of work activities are presented to users in the form of a diary (see Figure 1). The episodes are time-stamped and include such activities as conversations and meetings with other people, and periods spent alone in the office. Although these diaries were presented to users via e-mail, this implementation was a prototype, and the plan is eventually to build an interactive version and incorporate it into the human memory prosthesis.

<b>Diary for Tuesday, October 30, 1991</b>	
14:14	In office [50 mins]
15:04	In and out of event in Nathan's office; with W. Nathan, R. Hatton [45 mins]
15:50	In office [10 mins]
16:00	In Conference room [4 mins]
16:05	Attended part of event in Commons; with B. Andrews, M. Morton, R. Hatton [7 mins]
16:13	Mostly in office [44 mins]
16:57	Attended event in Wright's office; with P. Wright [7 mins]
17:04	Looked in on event in Morton's office; with I. David, M. Morton [1 min]
17:05	Mostly in office [2 hr 3m]
17:05	In office [5 mins]
17:11	In event in office; with P. Wright, I. David [1h 2mins]
18:13	In office [36 mins]
18:50	Meeting in office; with W. Nathan [13 mins]
19:03	In office [5 mins]
19:09	In 2nd floor rear area [2 mins]
19:11	Last seen

**Figure 1. An example of a Pepys diary**

Although the overall accuracy of the episode descriptions generated by Pepys was found to be very high [Newman et al., 1991], there are some problems regarding the utility of the information that is presented to the users. One problem is that for long periods spent alone in one's office, there is no additional information provided in the diary that might help a user recall what he or she was doing. In addition, for meetings which repeatedly involve the same people, there is no additional information provided which can help distinguish one meeting from another.

To overcome this lack of information in the Pepys diary, we have started looking at capturing data related to other activities. We are currently pursuing the capture of information related to workstation activities [Lamming & Newman, 1992] and paperwork activities [Newman, 1991; Newman & Wellner, 1992] which should add much richer information to the periods spent alone in one's office. We are also looking at note-taking and white-board activities [Lamming & Newman, 1992] to augment the information concerning meetings.

Another approach is to video record a user's activities. Although this would undoubtedly help distinguish the many similar episodes in the Pepys diaries, this method is not without its problems. For example, can these video images be captured automatically; and, perhaps more importantly, can the resulting information be browsed and searched efficiently on a personal workstation?

## **2. The EuroPARC Video Diary System**

Our goal was to create a system capable of storing many days or months worth of video images, and which would provide users with rapid, random access to the video recording.

There were several reasons why we did not want to include audio recording. First, although it is possible to increase the speed of a video recording and still make sense of the images, if audio recordings are increased to correspondingly high speeds, the signal is no longer intelligible (hence video cassette recorders do not play audio when using fast forward). Second, we felt that people would object to audio recording over such a long period of time. And, third, we knew that there were technical problems with recording audio in addition to video (e.g., problems of synchronisation of the two signals, additional storage requirements, etc.).

Capturing video images of people engaged in their day-to-day work activities posed two initial problems: how can a person remain in camera shot throughout the course of his or her activities; and can the potentially large amount of video information be reduced to manageable yet useful proportions? These problems are addressed by the various components of the Video Diary System. Figure 2 shows a diagram of the system, and each of the components is described below.

### ***2.1. The Video Network***

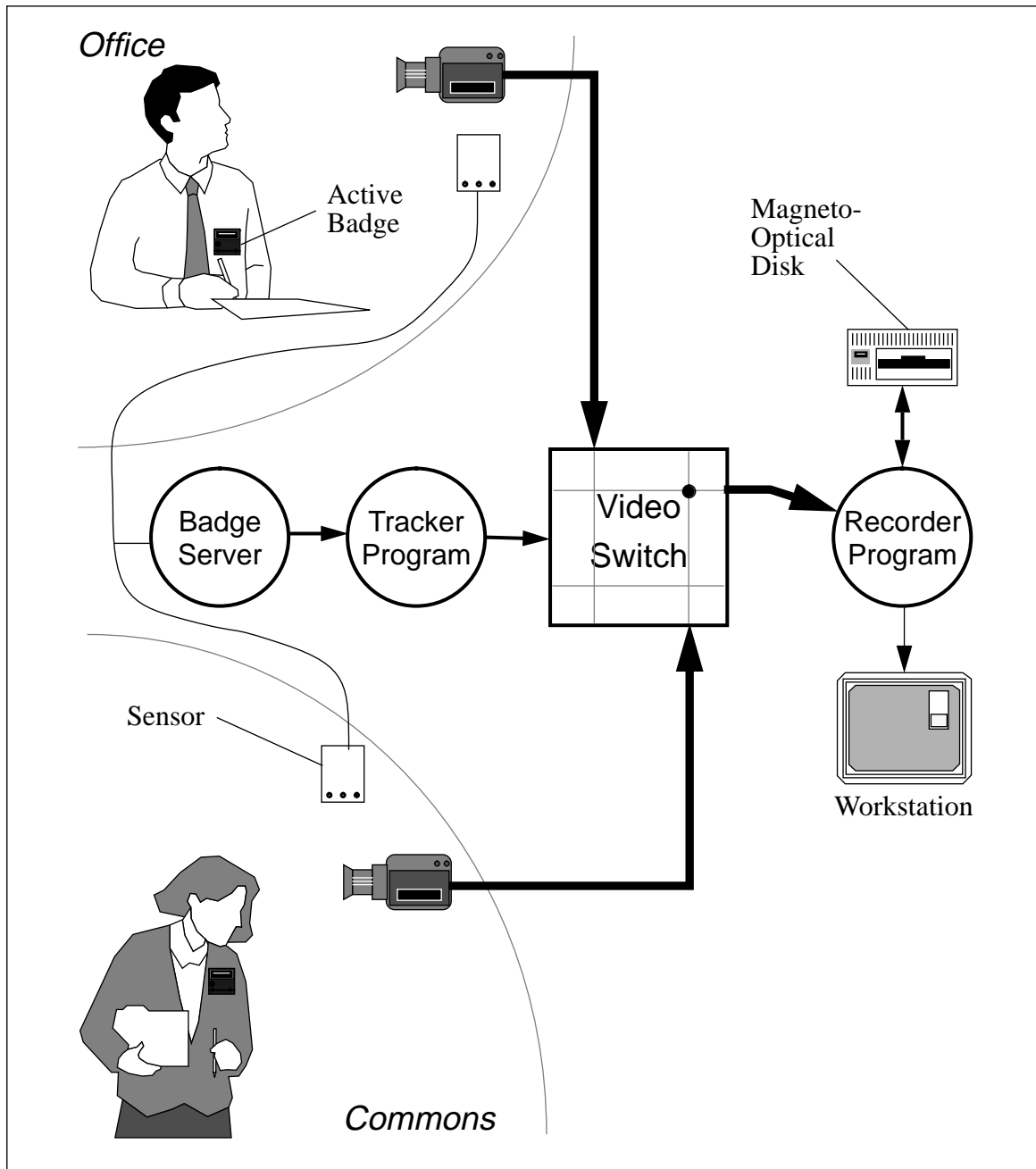
We are fortunate at EuroPARC in having a technical infrastructure which greatly helps in addressing the problem of how to keep a person within camera shot. In addition to the Active Badge System, described in the Introduction, the technical infrastructure includes a computer-controlled switched analogue audio/video network. For the purposes of the current project, only the video links in this network will be described, since no audio recording takes place with the Video Diary System.

Each office and open space within EuroPARC contains a video camera which is aimed at the region where the majority of the activity occurs. Each camera is connected to one input of a crossbar video switch (i.e., a switch where any input can be connected to any number of outputs). The outputs of the switch are connected to a variety of video sinks, usually monitors. The crossbar switch is under the control of a UNIX-based switch control server [Buxton & Moran, 1990] which is responsible for making and breaking video connections in response to user or program requests. This Video Switch allows each video source to be connected to more than one sink. Requests arrive at the Video Switch via an Ethernet LAN; the switch then checks to see that the requestor has permission to make the desired connection and either executes or rejects the request. This authentication step is necessary to prevent accidental or unauthorised video snooping. With this system it is possible to switch cameras as the need arises to ensure that an individual is almost always kept in shot, in a manner analogous to that of a television director.

### ***2.2. The Tracker Program***

We wanted to provide a way for the cameras to be switched automatically without the intervention of a human “director”. This switching is accomplished using a custom-built client of the Badge Server called the Tracker Program.

When a person starts the Tracker Program running on his or her workstation the program first obtains the person’s login credentials. The program then registers with the Badge Server for information about that person’s movements, and the movements of other active



**Figure 2. The Video Diary System and Related Infrastructure**

badge wearers are private. As the person being tracked arrives at a new location, the Tracker Program is notified and in turn formulates a switch request which is passed on to the Video Switch. The resultant video signal is passed to the workstation where it is fed to a frame grabber, digitised and displayed on the workstation display. A person can thus ensure that an almost continuous display of his or her working day is presented on the workstation. To remind other people in the building that still images are being recorded, a sound effect of a camera shutter clicking is played periodically at background volume into the room where the person is located.

### **2.3. Recorder Program**

Our aim was to store many days or weeks of data. An uncompressed video source would normally generate an unmanageable amount of data, both because human intervention would be needed several times a day to change disks or tapes as they became full, and because random access and fast playback would be difficult to achieve. Compression technology can reduce the storage requirements considerably, but such technology was not available to us.

The Recorder Program captures low resolution images at a much reduced frame rate and stores the results on exchangeable magneto-optical disks. An early prototype of this program showed that acceptable performance and quality could be achieved with quarter-size frames (one sixteenth of the area) recorded at the rate of a frame every five to ten seconds. An eight bit-per-pixel colour dithering technique was used which resulted in a frame size of about 25 kilobytes. As a further refinement, the Recorder Program compares consecutive frames for differences at the pixel level. If fewer than 1% of the pixels change between frames, then the frames are deemed to be the same and the later frame is discarded. With this relatively unsophisticated scheme, and under normal operating conditions, two weeks worth of data easily fits onto a single 650 megabyte magneto-optical disk.

The Recorder Program also provides playback facilities for a day's worth of data or more. Figure 3 shows the main control panel of the Recorder Program. The user of this program first specifies a day by using the "Open..." button; this brings up a panel which allows the user to choose a particular file which contains a day's worth of video data. The user can then play back the recording at various speeds by using the "Control..." button; this brings up a panel which allows the user to adjust the wait between frames, to a rate up to 60 times normal. To begin the playback, the "Go" button is pressed. This button is a toggle which allows the user to start and stop the playback at any time. The user can move a horizontal slider control to provide instant random access to the recording; the frame currently being viewed is displayed in the "Frame" field. Using the slider control, a whole day can be reviewed in just a few seconds, or a sequence can be repeatedly reviewed by gently "jiggling" the slider left and right over a segment of particular interest. To step through the recording one frame at a time, the user operates the up and down arrows to the right of the "Frame" field.

### **3. Evaluation**

The Video Diary System is a proposed component of the human memory prosthesis. We would like to know whether the visual information provided by this system will be useful in helping people recall information related to events in their working lives. Given that a Video Diary is found to be useful, we would also like to understand what aspects of the Video Diary are most important in aiding this recall.

We conducted a preliminary evaluation of the utility of the Video Diary System by running a memory experiment using several people at EuroPARC as subjects. From some previous work undertaken as part of the AIR project, we knew that people forget many activities in their working lives, even after periods as short as one week. We therefore wanted to see whether or not the Video Diary System could improve a person's ability to recall work





**Figure 3. The main control panel of the Recorder Program**

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activities, and also whether or not it provided more useful retrieval cues than those provided in the Pepys diary (see Figure 1).

### ***3.1. Method and Experimental Design***

Three subjects were recorded using the Video Diary System for five consecutive days. During the recording period, each subject wore an active badge and a tag which reminded other people at EuroPARC that they were being recorded. Some initial adjustments were made to the cameras located in each of the subject's offices to ensure that the captured images would include as much of the work area as possible.

Each subject was given a recall test after four different intervals: one day, one week, two-and-a-half weeks and four weeks. During each of the four recall tests, subjects were asked to recall their work activities of one of the previously recorded days, with a different day being recalled at each of the four recall sessions. At each recall session, subjects were asked to recall their activities under three different conditions. These conditions were always

presented in the following order for all subjects: (1) Free Recall condition, where the subjects used no external memory aids; (2) Pepys condition, where they were asked to recall additional activities while reading sequentially through their Pepys diary; and (3) Video Diary condition, where they were asked to recall additional activities while using the Video Diary System.

In the Video Diary condition, the experimenter started the Recorder Program, and the subject viewed the Video Diary from the start to the end of the day. The playback was set to show about three frames per second. This speed was judged by the subjects and the experimenter as being slow enough to allow changes in the scene to be viewed, but fast enough so that a day could be viewed within about 15-20 minutes. Subjects were allowed to stop and start playback at will, and were also allowed to “rewind” the video to have a closer look at a particular scene. In some cases, a portion of the video was studied in detail by stepping through the recording one frame at a time.

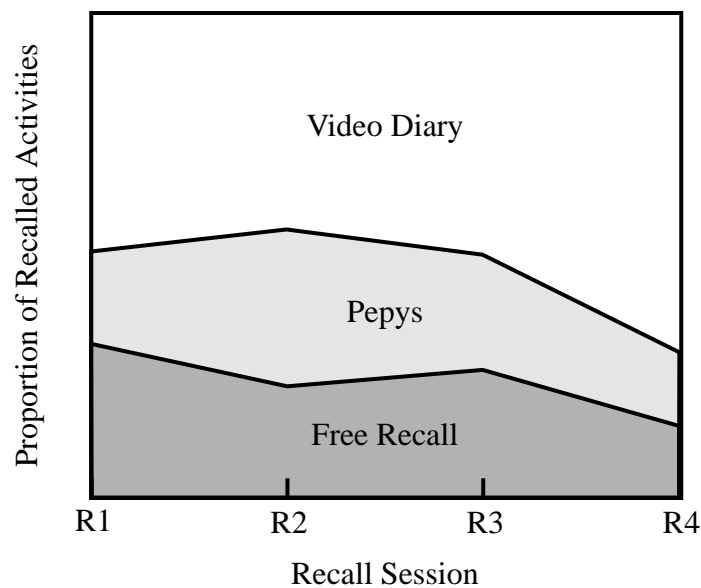
The recall sessions were audio taped, and later transcribed.

### ***3.2. The Number of Activities Recalled***

It should be pointed out that the results reported here are preliminary, and several cautions should be made before these results are interpreted. First, only three subjects were run in this experiment, and thus a fully counterbalanced design was not possible. Second, although an attempt was made to balance the days of recording, so that a different day was used for each recall interval across subjects, this proved to be impossible because of the need to juggle recall sessions to fit in with the subjects’ busy work schedules. Third, there were some technical teething problems with both the infrastructure and the Video Diary System itself, so that some days of recording were cut short.

The measure of recall used was the number of activities mentioned during the recall sessions. Activities were scored for each condition by underlining phrases in the transcripts; activities included: conversations, meetings, reading documents, making telephone calls, etc. For the Pepys and Video Diary conditions, only new activities were counted; that is, any activity that had been recalled in an earlier condition was not scored. It should be pointed out that an activity was only scored as “recalled” if the subject provided enough content information to convince the experimenter that the activity was actually being remembered. Thus, for example, if the Video Diary showed the subject in conversation with another person, the subject was required to provide the experimenter with the general topic of the conversation, and not just report that the activity had occurred. This same criterion regarding content information was also used for scoring in the Free Recall and Pepys conditions.

The average number of recalled activities decreases as the length of the recall interval increases. In the Free Recall condition, the average number of activities recalled for the four recall intervals drops from about 15 recalled after one day, to just over two after four weeks. Averaged across all three conditions, the number of activities recalled drops from an average of 35 after one day, to 12 after four weeks. Thus, there is evidence that more activities are forgotten after longer recall intervals, although we have no control over the true number of activities that actually occurred on each of these days.



**Figure 4. The proportion of activities recalled in each condition**

A useful way to view the overall results from this experiment is to count the total number of activities that are recalled during each recall session summed over the three conditions. We can then look at the proportion of activities recalled in each condition. Figure 4 shows the proportion of the total number of activities recalled in each condition for the four recall sessions, averaged across the three subjects. It is clear that both the Pepys and the Video Diary conditions lead to the recall of additional activities; in other words, if Pepys and the Video Diary were not useful memory aids, we would expect to see a very small, or even non-existent, area representing the proportion of activities recalled in these conditions. In fact, more activities were recalled in the Video Diary condition than in either of the other two conditions; approximately half of the total number of activities were recalled in the Video Diary condition for the first three recall sessions, and nearly three-quarters of the total were recalled for the last recall session (after four weeks).

The Video Diary also served to confirm activities that had been recalled in the earlier Free Recall or Pepys conditions. For example, one subject recalled in the Free Recall condition that she had pinned notices on a noticeboard, and then later this activity was observed and confirmed in the Video Diary condition. There was often a tendency for the subjects to make confirming comments during the Video Diary condition; for example, “See, that’s where I was doing ...”, or “That’s the conversation with ...”.

Not only did the Video Diary condition confirm activities, it also occasionally disconfirmed activities that had been “recalled” in earlier conditions. For example, one subject commented in the Free Recall condition after two-and-a-half weeks, that her boss had phoned her to say he would not be in until lunchtime, and she said that this was cutting down on the time they would have available to get things ready for his business trip planned for the following day. Many of the activities recalled for this day hinged around this belief that her boss arrived late. However, when the Video Diary was viewed, and her boss appeared in the morning, she said:

Oh, he came in much earlier than I thought he did—I thought it was lunchtime. It was this time [a later trip] that he came back from America he got in at lunchtime—it wasn't the time before when he got back from his holiday—he came back at the right time! So you see, you remember it wrong! So we had a whole morning together. Yeah, I got it wrong. You do forget, you forget.

Another subject recalled in the Free Recall condition a series of activities that centred around a telephone call informing him of a minor accident with his new car. But later in the Video Diary condition, he comments:

No. I didn't do what I thought I did. Ah, I know why. Because I've got my days mixed up. What I thought was Friday the 13th wasn't Friday the 13th—So the set of events that I thought happened on Friday the 13th, didn't.

Thus, not only was the largest proportion of activities recalled in the Video Diary condition, but the Video Diary also proved useful in confirming and disconfirming other activities that had been recalled in earlier conditions.

### 3.3. Cues Used in Recall

Because we are interested in contextual information related to activities, we wanted to understand what aspects of the Video Diary were important in aiding the recall of activities. In other words, we wanted to determine what cues the subjects were using from the Video Diary to aid their recall. For each of the activities recalled in the Video Diary condition, the visual cues used were identified. It should be noted that the cues that were identified were those that the subjects made explicit in their recalls; there are almost certainly additional cues, some from the Video Diary and some generated by the subjects internally, which are implicit, and thus are not identified.

The two major classes of cues used were objects and people. For about half of the activities recalled in the Video Diary condition, a physical object served as a cue for the recall of the activity, and people served as cues for about one-third of the activities. In addition, the physical location of an activity was occasionally useful in aiding recall; for example, seeing oneself in the seminar room, cued the recall of attending a seminar on a particular topic. This location cue was also available to the subjects in the Pepys condition, since the Pepys diary provides location information (refer to Figure 1). Thus most of the activities involving changes in locations were recalled in the earlier Pepys condition, and were therefore not counted again as being recalled in the Video Diary condition.

Paper documents, books or folders were often commented on by the subjects in their recalls, as is shown in the following example where seeing an orange folder in her outbasket cued the recall of three separate conversations (the activities recalled are shown in italics):

That was the folder of things I was giving to John. Ah, yeah, I remember some more things—*Mark came in because he wanted John to take—you know the staff satisfaction surveys with him to America*, and he left it with me and I said, “well, I'll ask him”. And *he [John] said, “no, I won't—I've*

*got enough paper to take,” and made me give it back to him, or he gave it back to him I can’t remember which. Bill came up with a video, which you’ll see later, he’ll come in and give me a video. I remember that. But all these things were things to go, in that orange folder... [these three activities are later confirmed in the Video Diary]*

In other cases, both the presence of a person and a physical object served as recall cues. For example, after seeing a person and seeing a pad on which the subject was writing, she recalled:

Peter—Yes, I do remember why he was there. Because *we were talking about the library system*—We’re writing something—I’ve got a pad here and I was writing some stuff out, just deciding what to say—I was designing something with him.

Other objects that were used as cues included: workstations, telephones and cameras, as well as several other miscellaneous objects (including a plastic carrier bag from Waitrose!). In some cases, the object itself was being manipulated by the subject; for example, seeing himself on the telephone reminded one subject of a specific telephone conversation. One subject recalled, after being asked if he remembered who called:

There may have been two phone calls, in fact. *One of them was Susan* who we’ll be working with a few months early next year. In fact—I think *she phones back later on* [this is later confirmed in the Video Diary].

There are also examples where the lack of a certain object or person helped the subject decide about the content of an activity. For example, one subject recalled, after being asked if she knew why someone had come to her office:

She—no, not on that occasion. I was thinking of an occasion when she asked me where some paper was, but I was talking to Joan—but Joan isn’t there, so that’s different.

This last excerpt is a good example of how contextual information can help people discriminate between a number of different conversations, a problem that was mentioned in the Introduction concerning the utility of the Pepys diary.

### **3.4. Location of Recalled Activities**

We were also interested in knowing where most of the recalled activities occurred. One of the problems identified with the Pepys diary was the lack of detailed information about the activities that occurred in one’s own office. Thus we wanted to know whether or not most of the additional activities recalled in the Video Diary condition occurred in one’s own office, or in other places throughout the building.

It should be pointed out that we do not know the true number of activities that occur in different locations around the building. We do not know, for example, whether or not more activities occur in one’s own office versus other people’s offices or other areas of the building. Thus, although we can identify where the recalled activities occurred, we do not know what the proportion of recalled to true activities is for various locations. However, we

can still conclude that the Video Diary is useful in particular areas if there is an increase in the number of activities recalled in those areas in the Video Diary condition. What we cannot conclude is that the Video Diary is most useful in a particular location, because we do not know the true number of activities that occurred.

For each of the activities recalled in the Video Diary condition, the location of that activity was determined. About half of the activities recalled occurred in the subject's own office, about one-sixth occurred in other people's offices, and the remainder occurred in other more public areas. Thus nearly three-quarters of all the activities recalled occurred in offices, which are relatively private areas.

This finding is important for two other reasons. First, if a Video Diary System similar to the one described here is implemented at other sites, it may be easier and cheaper to have the system operate in only specific locations. Since many of the recalled activities occur in the subject's own office, even a scaled-down system where a camera only operates in an individual's own office will be useful. Second, having cameras in private places (e.g., offices) rather than in public places (e.g., common areas and reception areas) may be seen as more acceptable to other people in the building.

#### **4. Conclusion**

Although the evaluation described here is preliminary, we have clearly shown that a Video Diary can help people recall activities in their working lives. It is also useful in confirming and disconfirming what people think might have happened. The most frequently used cues are people and objects, and often the conjunction of these cues leads to the recall of new activities. Not surprisingly, a Video Diary helps the most after long periods of time, when the likelihood of recalling activities with no memory aids decreases.

It is important to note that even though the Video Diary has clearly been shown to increase the recall of work activities, it by no means completely captures the events of a working day. The inclusion of audio signals would undoubtedly improve one's ability to recall activities, for example, by revealing the content of conversations or meetings. Despite the problems with recording and playing back audio signals, there might be specific occasions where recording audio would be both acceptable and useful (e.g., formal meetings). In addition, capturing workstation activities would undoubtedly improve recall, since seeing oneself sitting at a workstation does not generally provide enough cues to completely reconstruct one's activities.

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