Unobtrusive But Invasive: Using Screen Recording to Collect Field Data on Computer-Mediated Interaction

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ABSTRACT

We explored the use of computer screen plus audio recording as a methodological approach for collecting empirical data on how teams use their computers to coordinate work. Screen recording allowed unobtrusive collecting of a rich record of actual computer work activity in its natural work setting. The embedded nature of screen recording on laptops made it easy to follow the user's mobility among various work sites. However, the invasiveness of seeing all of the user's interactions with and through the computer raised privacy concerns that made it difficult to find people to agree to participate in this type of detailed study. We discuss measures needed to develop trust with the researchers to enable access to this rich, empirical data of computer usage in the field.

Categories and Subject Descriptors

H.5.2 [User Interfaces]: Evaluation/methodology

General Terms

Human Factors, Experimentation, Design.

Keywords

Screen recording, video-based observation, field studies.

1. UPDATING VIDEO OBSERVATION

Video-based observation methods have become commonplace for studying how people interact with technology (e.g., [7]). However, current work practices can be hard to capture using conventional video-based methods. Today's work often involves collaborating with others, switching quickly among various projects, and moving among a number of different work settings, enabled by laptops and other mobile devices. These attributes make it hard to capture the work activity of interest by positioning video cameras and recording at just the right times. Thus, we explored using software-based computer screen recording as a new approach for collecting empirical data on everyday, collaborative computer usage in the field.

This empirical study was part of our research on understanding how people use their computers to accomplish collaborative work. We wanted to gain insights into users' current work practices and identify new design opportunities. Two central areas of inquiry are around how people integrate their activities across computer applications, and how they coordinate with others to accomplish their shared activities. To investigate these areas, we planned a study in the tradition of video-based observation [7]. Since prior research described the fine-grain nature of collaborative activities [4, 2], we sought to collect a rich, empirical record for study.

Instead of setting up video cameras, we explored using screen recording software, which has come into common use for usability studies in the laboratory [3]. We extended the use of screen recording software to collect data *in the field* for longer stretches of time. Current video compression algorithms reduce several hours of screen recording to a manageable file size, and portable mass storage devices afford conveniently collecting these data from the field for analysis.

In this paper, we describe and reflect on our experiences in using screen recording to collect empirical data in the field. This approach captures users' everyday interactions with and through their computers. We discuss the advantages and privacy concerns related to this method.

2. COMPUTER SCREEN RECORDING

For our study, we wanted to capture data of how team members use their computers to accomplish their work and coordinate with others on shared tasks. We used Camtasia Studio screen recording software from TechSmith [1]. As with several other similar products, the recording parameters in Camtasia can be configured to create high quality screen recordings with minimal impact on computer performance to enable recording for long durations (several hours) within manageable file sizes.

We conducted three rounds of data collection where we observed teams of knowledge workers as they planned for a specific event. They were engaged in ad hoc, shared activities (e.g., co-authoring papers, revising slides, updating budgets) involving synchronous and asynchronous collaboration around one or more projects. Our study of each team lasted about one week, including pre- and post- interviews with each individual participant. We recorded several days of computer activity from two or three team members as they collaborated on their planning work. Since we were interested in how the members coordinated with each other on their shared work, we recorded data during concurrent spans of

time to capture interactions *among* the participants. We timed our observations to occur before a shared deadline, increasing the likelihood of witnessing coordinated interactions among them.

During the pre-interview, we installed Camtasia on their computer and used it to record the interview on their machine. We asked them to describe their current activities and projects and show us how they organized their work information on their computer desktop (e.g., file folders, email folders). We also asked them whom they would expect to work with and what applications they would use. Essentially, we wanted to become familiar with their work context so that we could understand the screen recordings.

The pre-interview also allowed us to show them how to start and stop recording in Camtasia. We configured hotkeys for the record/pause and stop functions to make it easy for them to manage the recording. This setup enabled users to have complete control of when their computer activity was being recorded. We also attached a sign onto the computer indicating that it was being recorded, both as a visual reminder to the participant and to notify others who might come near the recording computer.

Camtasia was configured to record the entire computer screen at 5 frames per second. We found this frame rate to adequately capture users' interactions while also keeping the video files a manageable size. We added a timestamp to the video recording to make it easier to index for later analysis. We also recorded "cursor sounds" (a click when the mouse button was pressed).

We also recorded audio from a microphone which captured the sounds of the area surrounding the computer, even though it almost doubled the amount of digital data generated and increased the privacy concerns of the participants. We found that recording the surrounding audio provided context and clarification for some of the work being recorded. For example, the sound of visitors entering the office often explained interruptions in participants' computer activity, and phone conversations often provided a context for using their computer to find information related to those conversations. We did not obtain audio recordings from three of our eight participants, however, due to sensitivities in recording the audio of an office mate and problems in connecting a working microphone to two computers.

Participants then controlled the recording of their computer interactions for a few days. We typically visited the participants daily and used a portable mass storage device (30GB Apple iPod) to collect recordings from their computers. We did not want these large files to decrease their hard disk space significantly, and we wanted to collect the data for immediate review.

While the participants continued to record data, we reviewed the recordings collected so far to select clips to view with the participants during the post-interview. Since we were interested in how team members coordinated with each other, each researcher reviewed the recordings across all the team members for the same time interval (e.g., a half day) to reveal any interactions that occurred among them during that time. For this initial pass in reviewing the data, we entered time-stamped notes in a spreadsheet to help index episodes of interest to our research. We also collected clips for which we wanted to elicit the participants' perceptions and clarifications through the post-interview. After a few days of collecting data, we asked them to stop recording and we un-installed Camtasia from their computers.

We generally scheduled the post-interview within a few days of ending the data collection so that the participants could easily reconstruct what happened. We asked specific questions that arose in our review of their videos, and we played selected clips to elicit their perspective on the activity. We again screen recorded the interview, using our computer to both play the selected clips and record participants' commentary on them. Besides providing closure for the study, the post-interview also gave them a sense of what kind of clips would be used in our research presentations.

Over the three rounds involving eight participants (seven females, one male), we collected 67½ hours of recording, which translated into 13.67 gigabytes of data. On average, the pre-interviews took about 19 minutes per person and the post-interviews lasted about one hour. Our aim was for most of the data collection to be done unobtrusively; the researchers appeared only about once a day for about 10 minutes to transfer data from the participant's computer.

3. UNOBTRUSIVE BUT INVASIVE

While using screen recording is *unobtrusive* (no one is physically present), it is unavoidably *invasive* (all computer interactions and surrounding conversations are recorded). Collecting a detailed record of users' interactions with their computers raises obvious privacy concerns on how these data could be used. Screen recording captures a permanent record of the users' email and IM interactions in addition to any artifacts they create or view on their computers. While this is a valuable data source to us as researchers, it is important that the participants understand and are comfortable with how the recordings of their work would be used. In our studies, we took several measures to give participants control over how the data would be collected and used:

- Participants always had the option of pausing and restarting the screen recording at any time, so they had complete control over when data was being recorded.

- We committed to deleting any data that (in retrospect) the participants would rather not have recorded.

- We negotiated with the participants about which researchers (from a list of eight) would have access to the recorded data.

- We committed to reviewing any clips from the data with the participants and anonymizing them before showing them in public research presentations.

Each group that we studied required some negotiation around how the data would be used. For example, some teams requested restricting access to their data to a smaller set of researchers than our proposed list of eight. All participants exercised their ability to pause and restart the recordings during the studies, and one team requested some materials to be deleted after the fact. Before showing any video clips publicly, we will use an internal review process to help ensure that the selected clips are appropriate for public presentation. Clips shown publicly will be anonymized by blurring so that the text (and any names or information) cannot be read, but the user interaction can still be observed.

3.1 Advantages

Perhaps the most important advantage in using screen recording in the field is that it unobtrusively collects rich, empirical data on users' interactions with their computers without physical video equipment in participants' work environments to intrude in their normal work practices and interactions with others. Unlike direct observation or shadowing [6], there is no physical presence of an observer. It also creates a permanent record for later analysis,

rather than relying on real-time note taking that is inevitably selective. Screen recording also captures a much more detailed record of the user's interactions than a diary or journal study (e.g., [2]) and with less user effort. These videos could be captured and viewed using standard software without requiring any modification to the users' applications. Screen recording enabled us to unobtrusively collect detailed recordings focused on people's collaborations through their computer while doing their everyday work in their natural work settings.

Screen recording also affords more flexibility in terms of *where* work activity can be recorded, especially for laptop users. Data recording can keep up with today's nomadic work practices by following wherever the user takes the laptop, which would be much more difficult using a video camera for recording. In our study, the flexibility of using screen recording software allowed us to capture data in offices, homes, a college dormitory room, and even in meetings to which users had brought their laptop.

An important aspect of screen recording is that it allows the participant to have control over what is being recorded. Camtasia gives appropriately visible feedback on the computer screen when it is recording and offers an easy interface for pausing, restarting, and ending recording using computer hotkeys. Participants' control over data collection is an important enabler for establishing the trust required to participate in this kind of study.

3.2 Disadvantages and Limitations

The biggest disadvantage to screen recording is its invasiveness. Since computer screen recording generates an exact replica of what the participants see on their screen, everything that they do on their computers is exposed to the researchers and can also be replayed to others.

Furthermore, participants realized that they were not only exposing their own activities, but also interactions with the people with whom they communicate via their computer (e.g., email, IM). While participants understood the concept of informed consent regarding their own privacy, the inability to get informed consent from their communication partners is one reason why a few potential sites refused to participate in the study. Some potential sites were also not comfortable with the sensitive or confidential information that screen recording might expose. In some cases, video observation or shadowing would be less of a concern, as it would not capture as detailed a record of the information.

In general, it appears to be more difficult to do these kinds of rich empirical recording studies because of the increased awareness of digital privacy and surveillance implications. Most employees are already subjected to some sort of corporate monitoring to detect unwanted uses of the computing infrastructure, which has been recognized as a source of workplace stress [8]. Indeed, finding teams who were willing to agree to this level of detailed observation was problematic. While we had initially planned to conduct studies on both the East and West Coasts of the U.S., no East Coast sites were willing to participate in the study.

As would occur with other observation methods (e.g., video-based observation, shadowing), we did see evidence that being observed altered the participants' behavior [6]. The recordings contained some isolated examples, such as a warning in a personal IM, "can't be goofy, I'm being taped". Some self-reports of altering their behavior emerged in the post-interviews, such as one participant who consciously limited the amount of time viewing a particular shared workspace due to the business-confidential information that it contained.

Another limitation of screen recording is that it can only capture the interactions participants have with their computers and excludes other surrounding context. Direct observation and video-based observation could be framed to capture offline work and collaboration activities outside of the computer (e.g., paper notes, visitors). While the accompanying audio allows some inferences for these interactions external to the computer, the main data record is limited to what happens within the computer screen. Our research focus was mainly on the user's interactions with and through the computer, which is consistent with what screen recording captures. This methodology may unintentionally highlight computer-mediated work while de-emphasizing other work, and therefore may not be suitable for recording behavior that relies more on resources outside of the computer.

Other potential disadvantages of using screen recording in the field arise around practical issues with installing software on people's computers over which the researcher has no control. Screen recording software depends on the capability and limitations of the participant's computer, such as its processing performance, available hard disk space, and access rights. Some of the older computers we encountered required updating some system software components (e.g., the DirectX graphics library) to meet Camtasia's requirements. Computer performance degradation associated with the recording software was also more noticeable on older computers. When recording for more than a couple hours on older machines, the audio drifted out of synchrony with the video over time. Closing the lid of laptops also introduced offsets between the audio and video (an apparent issue in how video and audio recording interacted with how laptops suspended operation when closing the lid).

While we are not aware of any instances where the screen recording directly interfered with users' computer interactions, the participants often suspected it might have caused any computer problems encountered during the study. For example, one participant mistakenly accepted a virus because she thought she was accepting a dialog box presented by Camtasia. Also, if the participant's computer crashed, all data being recorded up to that point was lost (which did occur during our study). We encouraged our participants to save the data to a file a few times a day to minimize potential data loss. Also, since we gave the participants control over recording, there is the risk of missing data because they forgot to record, so we occasionally followed up with email and IM reminders, especially when they first started recording.

4. REFLECTIONS ON USING SCREEN RECORDING

Once the screen recorded data are collected, any of the video-based qualitative analysis methods can be applied to analyze them. While our analysis of this data set is still ongoing, we present one example of an analytical issue that emerged from our study that illustrates both the research potential and invasiveness concerns of this methodology.

We saw several examples of users struggling to find the exact references to people needed to address email, add to IM lists, include in calendar appointments, etc. (see video figure). Users often had to look back for prior email messages, calendar appointments, etc. to find the reference, and then copy and paste it

into where they needed it. While modern operating systems offer user interface mechanisms for quickly accessing recently used computer *files*, they generally do not offer similar affordances for recent references to *people*. That is, frequently or recently used files might be easily left on the computer desktop or accessed across applications on the computer through OS-level mechanisms such as "My Recent Documents" or the taskbar. However, there is no corresponding functionality for easily accessing references to people across applications. We used our data to collect and analyze all examples of searching for references to people to understand the problems that arise and identify design opportunities to address them.

This observation hits at the very nerve of concern that several people expressed when declining to participate in the study. They did not want to expose third parties with whom they interact to being recorded in our study without their consent. Our focus on understanding collaborative activities meant that we wanted to record participants' email, IM, and other computer-mediated interactions for our study. These communication partners may not have consented to being recorded, especially if they were not part of the team that was the focus of the study. Yet, if we had not recorded the synchronous and asynchronous communications that our participants had with others (especially those they interact with only occasionally), it is unlikely we would have observed their difficulty in finding references to other people in their collaborative work.

The invasive nature of clearly seeing and recording all the user's interactions on their computer made it difficult to solicit participation in our studies. Most of the groups who participated in our studies did so largely based on trust from existing relationships with a member of the research team. One exception was the group of volunteers who were planning a community service project, for which our research team volunteered service in return for their participation. Perhaps this method works best when the research team has something of practical value to offer in return (such as reciprocal volunteer help, or improving the efficiency of the group's work based on the observations).

Based on our experience, we believe that screen recording is a valuable method for unobtrusively collecting rich, empirical data on actual computer usage in the field. This approach enabled us to focus on users' interactions with and through their computers with minimal modification to their computers or applications. It also created a record that we could review with the participants to elicit their reactions. We analyzed the data to examine the issues surrounding finding references to people and other resources (files, groups of people, etc.), which led to the design of the Recent Shortcuts prototype to help users quickly find and re-use recently used resources [9]. Beyond the Recent Shortcuts analysis, the screen recording data could be used to investigate how users accomplish their collaborations, what problems they encounter, and what design innovations could improve their experience.

While the privacy concerns around video-based observation are not new [5], our experiences update the issues using contemporary screen recording technology with respect to the evolving climate of concern around abuses of digital surveillance. We believe that our experiences have shown the value of collecting the rich empirical record that screen recording affords, especially for nomadic work and computer-mediated collaborations.

Obtaining such a rich record of users' computer activities therefore relies on negotiating a sense of trust with the participants regarding how they can control the recording and how the data will be used by the research team. In our case, that meant giving users control of what data were recorded, limiting who could access to the screen recorded videos, and getting approval for any anonymized video clips for public presentation. It becomes the ethical responsibility of the researchers to follow through on the spirit of those commitments based on trust. Issues of confidentiality for communication partners must still be addressed, and different privacy concerns would arise in personal (rather than business) settings of computer usage. By sharing our experiences with the advantages and limitations of this approach, we hope that others can discern further opportunities and refinements for using this methodology.

5. ACKNOWLEDGEMENTS

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