

# Remote Review Meetings on a Tabletop Interface

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## ABSTRACT

We consider the problem of remote review meetings, in which geographically-separated colleagues review text documents. We review the affordances of paper documents on a meeting table and present a novel multi-user tabletop interface designed to afford similar properties. Our interface allows participants to review text documents with collaborators in a way that previously has not been investigated. The system extends naturally to provide a shared workspace to allow a remote group of participants to join the collaboration.

## Categories and Subject Descriptors

H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces – *Computer-supported cooperative work*

## General Terms

Design, Experimentation, Human Factors

## Keywords

Remote collaboration, large displays, virtual paper

## 1. INTRODUCTION

We consider the problem of remote review meetings, in which geographically-separated colleagues review text documents. As an example, consider two co-authors of a paper, working in different countries, meeting to review each other's draft contributions.

Sellen and Harper [5] reported that many knowledge workers spend a great deal of time discussing draft documents with their colleagues, and found that this activity is predominantly carried out using paper documents on physical meeting tables, rather than using electronic documents.

Why move away from paper documents? Paper is currently the best and most widely used technology for supporting review meetings. However, it does not afford full text searches, interactive content or easy distribution; and in particular it does not support remote collaboration. The co-authors in our example can print out each other's draft contributions and hold an audio-conference or video-conference, but they cannot see each other gesturing at the text because there is no shared visual workspace. Prior work shows that absence of a shared workspace leads to less efficient and less accurate collaboration in remote instruction tasks [e.g. 2].

In this poster we review the problems of electronic and paper documents (Section 2). Based on the affordances of paper, we design a novel multi-user tabletop interface to support remote

review meetings, and we present a prototype interface (Section 3).

## 2. PAPER DOCUMENTS

We begin by reviewing the shortcomings of electronic documents. Sellen and Harper [5] report that, for review meetings, paper is preferred over electronic documents because it affords:

*Easier navigation.* We navigate paper documents using effective bimanual actions, while we typically navigate electronic documents using only one hand. Scrolling is disruptive to reading and confounds spatial search. When we read from screen, we often have difficulty determining our location in the document.

*Richer and easier annotations.* On paper we use a stylus to make rich annotations without interrupting our reading.

*Side-by-side comparison of multiple documents.* Using paper on a large table we can make side-by-side comparisons of multiple documents with frequent shifts of attention between them.

*A shared visual workspace.* The meeting table allows collaborators to be aware of each other's actions, gestures and attention.

*Discussion in parallel with reading and annotating.* Paper documents become the focus of discussion without distracting from it, unlike electronic documents on a screen.

Their studies suggest that we can support remote review meetings more effectively by presenting electronic documents in a way that affords these properties. Prior work in document interfaces has tended to focus on augmenting paper [e.g. 4], which does not permit remote collaborators to navigate documents.

## 3. VIRTUAL PAPER ON A TABLETOP

We now present our design of an interface based around virtual paper on a multi-user tabletop interface. We have created a prototype of the interface and are currently completing the full implementation.

Tabletop interfaces have been the subject of considerable research in recent years, and the CSCW literature abounds with a diverse range of tabletop applications. However, very few projects [1] have investigated tabletop interfaces as a way to present text documents and, to the best of our knowledge, no research has been conducted into review meetings or multi-page documents on tabletop interfaces. Furthermore, investigating this application of tabletops allows us to prototype ideas that may eventually be available to the mass market using the cheap, thin, flexible "e-paper" displays currently under development.

Our design is based around *virtual paper documents*: electronic documents are projected onto the tabletop surface as life-sized sheets of virtual paper. Documents show two pages at once, resembling an open book (Figure 1).

The ability to display small legible text on a large tabletop display is key to our design. We need to be able to present text at a font size comparable to the text we read in paper documents, on a display the size of a meeting table. Using six projectors in a tiled array, we can project legible text at font size 12pt over an area of 0.5m<sup>2</sup>. We are not aware of other tabletop systems that permit such a high resolution over a wide area.

We now describe how our design supports review meetings by affording:

*Navigation.* As with real paper documents, electronic documents on the tabletop show two pages at once, and participants use hand gestures to flick through pages. This eliminates the need for scrolling. A multi-touch surface would allow bimanual hand gestures such as marking pages while flicking. Page edges shown at the side of the page indicate the user's current location within the document.

*Annotation.* Each participant has a high-resolution digital stylus with which they can draw freeform annotations with virtual ink onto the electronic documents, permitting easy annotation and a rich variety of symbols.

*Side-by-side comparison of multiple documents.* The display covers an area of 0.5m<sup>2</sup>, allowing plenty of room to view virtual paper documents side-by-side. Participants use hand gestures to position documents on the display.

*A shared visual workspace.* Co-located collaborators can sit around the tabletop and hold a review meeting using virtual paper documents, just as they would using a normal meeting table. The virtual paper on the tabletop interface provides a shared visual workspace into which collaborators can gesture, and in which collaborators are aware of each other's actions and attention.

*Discussion in parallel with reading and annotating.* Navigation and annotation mimic the corresponding processes on real paper and hence we expect that they will not distract from the conversation at hand. A multi-touch surface and multiple digital styluses would allow multiple collaborators to navigate and annotate different documents simultaneously, eliminating the need for a tight coupling of actions between collaborators.

Remote or mixed-presence collaboration is possible between two geographically-separated groups. Each group sits around its own tabletop interface, and an audio channel connecting the two sites allows the collaborators to hear each other. The two tabletops are

linked so that both always show the same shared view of the task, and thus all collaborators can see each other's documents and annotations.

Collaborators are represented at the remote site by empty seats at the meeting table, and bright telepointer traces [3] (Figure 1) that follow their hand and pen gestures. Thus the traces convey spatial presence, indicate each participant's focus of attention, and allow participants to gesture remotely to each other and to parts of the text. We do not use a head-and-shoulders video view of each collaborator; prior work [6] shows that today's videoconference technology tends to offer benefits only in negotiation tasks, doesn't aid turn-taking and can be distracting, and so we avoid it here.

## 4. CONCLUSIONS AND FUTURE WORK

We have reviewed the affordances of paper documents and presented a tabletop interface designed to afford similar properties in order to support effective remote review meetings.

Observations with our preliminary system indicate that participants are comfortable using hands and a stylus to gesture to remote participants via telepointer traces, and that hand gestures are likely to be an effective way to navigate long documents.

Future work will involve qualitative evaluations to compare co-located, remote and mixed presence groups. Participants in mixed presence groups often feel a greater affinity towards collaborators that are physically co-present than towards remote collaborators. However, mixed presence evaluations are rare and so it is difficult to predict the extent to which the interface supports these scenarios.

Finally, our design was based on replicating as closely as possible the affordances of physical paper and meeting room tables, while still permitting effective remote collaboration. Future work will investigate designs beyond just replicating physical paper, with the aim of better supporting review meetings. Moving beyond a strict WYSIWIS interface for remote collaboration would allow collaborators to create private workspaces and to orient virtual paper documents at the optimum viewing angle for themselves without regard for their collaborators, but would require collaborators to resolve the disparity between different perspectives of the workspace.

## 5. ACKNOWLEDGEMENTS

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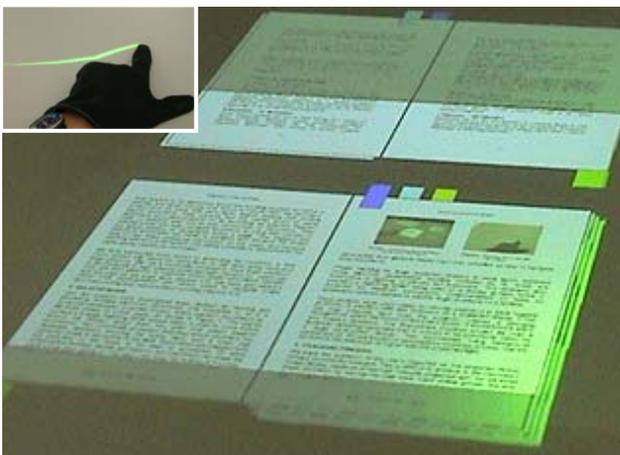


Figure 1. Virtual paper interface and telepointer trace.