

# Remote Review Meetings on a Tabletop Interface

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## ABSTRACT

I consider the problem of remote review meetings, in which geographically-separated colleagues review text documents. Paper is widely used to present text, but does not support remote collaboration. This research investigates the extent to which multi-user tabletop interfaces can support these remote review meetings. Prior work has shown that tabletop interfaces offer benefits to groups collaborating over digital artifacts, but has not investigated text documents. I present an interface for remote review meetings and outline my contributions to the field.

## 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

My research investigates 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 [e.g. 3] shows that absence of a shared workspace leads to less efficient and less accurate collaboration in remote instruction tasks.

My research investigates the extent to which we can support remote review meetings using multi-user tabletop interfaces. This approach allows us to prototype ideas that may eventually be available to the mass market using the thin, flexible "e-paper"

displays currently under development. I present the design of an interface for remote review meetings (Section 2) and outline my contributions to the field (Section 3).

## 2. VIRTUAL PAPER ON A TABLETOP

The design is motivated by 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*: bimanual actions; good awareness of location within the document; and it avoids scrolling, which confounds spatial search.
- *Richer and easier annotation* using a stylus.
- *Side-by-side comparison of multiple documents* on a large table.
- *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 on a tabletop interface in a way that affords these properties.

Tabletop interfaces have been the subject of considerable research in recent years. However, very few projects [1] have investigated tabletop interfaces as a way to present text documents and, to the best of my knowledge, no research has been conducted into review meetings or multi-page documents on tabletop displays.

My 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). Text is presented at a font size comparable to the text we read in paper documents. In order to support review meetings, the design affords:

- *Navigation*. A multi-touch surface would allow users to flick through pages using bimanual hand gestures. 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, permitting easy, rich annotation.
- *Side-by-side comparison of multiple documents*. The display is the size of a small meeting table, allowing plenty of room to view virtual paper documents side-by-side.
- *A shared visual workspace*. Co-located collaborators sit around the tabletop and hold a review meeting using virtual paper documents, as they would using a normal meeting table. 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, suggesting 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.

The interface supports remote participants as well as co-located participants, i.e. mixed-presence collaboration. Each co-located subgroup 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 tabletop by empty seats at the meeting table, and bright telepointer traces [4] (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.

### 3. CONTRIBUTIONS AND PROGRESS

#### 3.1 A High-Resolution Tabletop and Toolkit

Almost all prior tabletop projects have used a single projector to create a table-sized display, resulting in a low display resolution that severely limits the range of applications. Using six projectors and a single desktop PC, my system is able to project legible text at font size 12pt over an area of 0.5m<sup>2</sup>. Digital styluses provide multi-user input, and the system could easily be extended to incorporate a multi-touch surface.

The widely-used DiamondSpin toolkit [6] allows CSCW researchers to build prototype applications for low-resolution tabletop interfaces, but cannot easily be extended to high-resolution tabletops that use multiple projectors. To address this problem I have created T3, a Java toolkit that enables researchers to build prototype multi-user applications for this high-resolution tabletop interface. T3 is versatile and I am currently using it to prototype further applications such as collaborative web browsing. I shall soon license it freely to CSCW researchers at other institutions and aim for it to become a mainstream CSCW

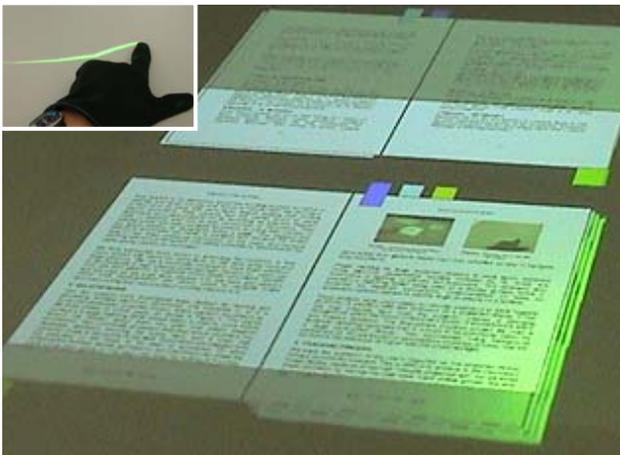


Figure 1. Virtual paper interface and telepointer trace.

research platform.

#### 3.2 Virtual Paper Interface

The implementation of the tabletop virtual paper interface is nearing completion. Early observations indicate that participants are comfortable using the interface to read, annotate, and collaborate remotely. The first evaluation will examine quantitatively the extent to which the design affords *navigation*, *annotation* and *side-by-side comparison*, using a single-user controlled experiment with a reading task such as a comprehension exercise.

#### 3.3 Supporting Remote Review Meetings

A second evaluation will then investigate the extent to which the virtual paper interface affords *a shared visual workspace* and *discussion in parallel with reading and annotating*, both for co-located and remote participants. This evaluation will use a typical review meeting task, such as reviewing draft contributions for a single report. It will compare a co-located group, and a mixed-presence group whose members are split into two geographically-separated subgroups.

Surprisingly few projects have investigated mixed presence groupware [7], and even fewer have used large displays. Participants often feel a greater affinity towards collaborators that are physically co-present than towards remote collaborators [2]. On the basis of prior work, I anticipate that the key issues will be the orientation of documents and conveying presence.

Further work may 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.

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