Synchronous Use of Paper by Co-Located Friends

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ABSTRACT
The results of a study into co-located friends' use of paper for a text based and a graphics based task, are presented. The results illustrate how diverse such usage is, and we look at space, ownership, and roles to demonstrate this. The study shows that people will simultaneously input into the same text document or drawing surface when the technology (in this case paper) allows them to.

Keywords
Paper, shoulder to shoulder, single display groupware, co-located collaboration, multi-person interfaces, multiple input devices

INTRODUCTION
As its name suggests the Personal Computer was designed with a single user interaction model in mind. Often multiple people do use a PC concurrently, for example friends browsing the web together, a couple doing the family finances, a group watching a PowerPoint presentation, or a colleague helping another colleague. Few technologies make interaction possible in such settings (multiplayer facilities on games consoles are one example). The PC does not: there is only one focus for the keyboard and one focus for the mouse. Hooking up multiple keyboards and mice still relies on users taking turns to enter text or manipulate the pointer.

Groupware researchers have proposed a number of UI innovations to enable synchronous shoulder to shoulder computing, i.e. interactions that do not require turn taking. These are mainly confined to meeting rooms, children's applications, and mixed reality systems, though there are general guidelines too. Overviews of shoulder-to-shoulder computing are contained in Stewart et al. [2] and Inkpen et al. [1].

When people use a technology that allows multiple simultaneous inputs do they use it simultaneously? Is there a problem that requires fixing? For example, an interesting 'technology' that enables rich interactions from multiple input foci simultaneously is paper. So do people use paper simultaneously? If so, then computer based interactions that seek to simulate and improve on paper, for example the Tablet PC, should allow multiple input foci. If not, then shoulder to shoulder research may require rethinking.

In [3] Sellen and Harper look at several workplaces where paper is used collaboratively, but in none is a single sheet used synchronously, with several colleagues inputting simultaneously.

THE STUDY
We wanted to know how people would use paper together on a collaborative task. In particularly would they take it in turns to draw or write, or would they find other mechanisms to allow more fluid input styles?

Study Setup: 34 participants (17 female and 17 male) from the greater Puget Sound area were recruited from our company's usability database to participate in the study. Having recruited one participant we asked them to recommend a friend for us to recruit to join them in the study. (Note that these participants completed two studies in a session, the paper one was the second study they participated in during their session.)

Our task involved these paired participants completing two paper based tasks, one text based and one graphical:
1) Write a poem about life in the Pacific Northwest, and
2) Design the floor-plan for an ideal holiday cottage for the participants to spend a two week vacation at.

In each task the two participants had to produce one output, but we did not specify how that would be achieved, i.e. they could each write a poem and submit their favorite, or they could collaborate and write a single poem jointly.

In one task the participants were allowed to use as many pieces of paper as they wanted while in the other they could only write on one piece of paper at a time. So in one case the participants could each work on their own piece of paper and in the other case they could not. The study was within subjects so that each pair completed both tasks. The order of the tasks and the paper availability was balanced.

Study Results: We will cover three observations around the ownership of areas of the paper, the ownership of space, and the roles people adopted.

Figure 1 shows the three main ways that participants used to distribute the ownership of a sheet of paper:
1) Take the sheet in its entirety and prevent the other participant marking it. This way presents very clear ownership of the paper and removes the need to constantly negotiate who draws or writes where. The downside is that the participant who is not involved in writing or drawing quickly became bored (see the first pane of Figure 1).
2) Partition the sheet and each write or draw on their own part (see the second pane of Figure 1).

3) Share ownership of the sheet. We saw some participants draw and write on the same areas of paper at the same time (see the third pane of Figure 1). This mode of sharing may only be transitory, for example Figure 2 shows one participant leaning over to draw on a sheet of paper that had previously been only drawn on by the other participant. The way that the participants managed personal space was interesting. We expected protection of personal space to prevent some modes of interaction, but this was not the case. For example the second pane of Figure 3 shows participants both drawing simultaneously with their arms crossed. Space was also used to negotiate ownership and roles. For example in the first pane of Figure 3 one participant has physically moved herself around the table to share the editing process rather than ask to have the paper sheet moved between them.

We have touched on the partitioning of the paper as a mechanism to manage this collaboration. Another is to assign or adopt complementary roles. We saw this happening repeatedly. Three illustrative examples are:

1) Taking turns being the editor. The first pane of Figure 4 shows one participant pushing the paper to the other participant to signal that it is now their turn to edit the poem. He had clearly adopted the coordinating role, since when he felt it was his turn to resume editing he pulled the paper back.

2) The second pane of Figure 4 shows how one participant has taken the role of director, using her finger to direct the other participant on where and what they should draw.

3) A common role division for the graphical task was between draughtsman and annotator. One participant would draw the floor-plan in consultation with the other, thus adopting the role of draughtsman. The other participant would simultaneously add text annotations to the floor-plan.

CONCLUSIONS

The diversity of ways that the paired participants drew on or wrote on sheets of paper together supports researchers in their work on enhancing PCs with shoulder to shoulder facilities. I.e. given a technology that supports multiple input foci, people will use it synchronously. This is particularly important for applications like those for the Tablet, which are often intended to add computer support to many of the scenarios paper is used in now.

Our future work should include an analysis of professions and leisure activities where paper is used by multiple people simultaneously, and a repeat experiment including paired subjects who are not already established friends.

REFERENCES

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Figure 1: Ownership of Paper

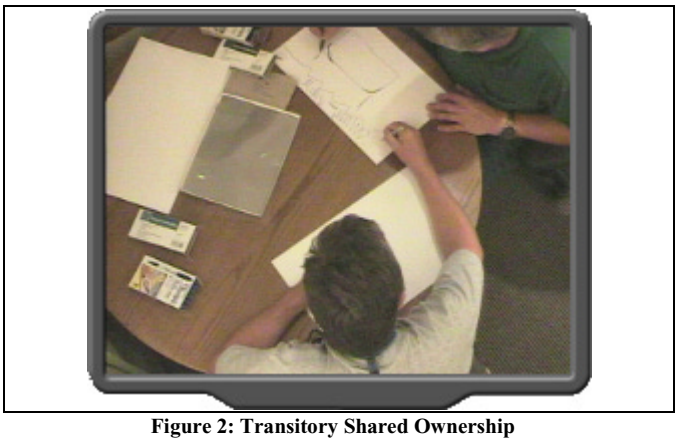

Figure 2: Transitory Shared Ownership

Figure 3: Participants' Space

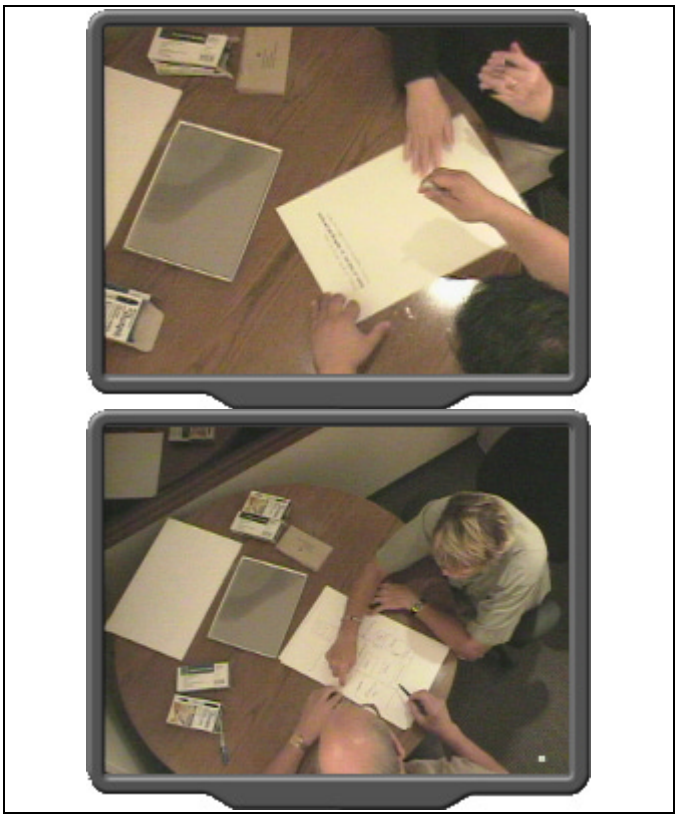

Figure 4: Participants' Role