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Simulating Additional Area on Tele-Board's Large Shared Display

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Abstract. Digital whiteboard systems can simulate an infinite amount of surface area on a single display; however the hardware's limited size necessitates supplementary virtual tools to navigate the area. In what ways does this less convenient setup hinder established collaborative workflows? Participants in our pilot study were asked to synthesize data on either a traditional whiteboard setup with multiple touch displays or a single display that had to be navigated virtually. Results show that working under the restrictions of a single display required slightly more time, yet workflows could continue. Users accepted the visual restriction as a condition of working with a digital system. Team members were also impelled to work more closely together, which both helped and hurt collaboration.

Keywords: CSCW, whiteboards, simulated space, shared displays, creativity support tools, design thinking

1 Introduction

Tele-Board is our digital whiteboard software system, designed to support collaborative creativity as ubiquitously as possible. It runs primarily on a single, large touch display, the most popular models of which currently only support a maximum resolution of 1280x960 pixels, yet it is meant for projects that take up a lot of space.

Our original approach to simulating more area was to make a virtual 3200x2400 pixel surface available and use the display as a window into this area. As more space was needed, users could pan the window in any direction to branch out their work. We assumed this behavior was appropriate for the fluid nature of creative processes. However, from observations during user testing, we noticed that when a window of area would fill up with sticky notes, drawings and other whiteboard artifacts, users would inevitably jump to an arbitrary blank location for a fresh slate. This corresponds to the physical action of fetching another whiteboard. To better support this convention we enabled users to manage multiple separate surfaces, or *panels*. (Users can more easily navigate through the history of an individual panel or share content with others on a per-panel basis.) Supplementary virtual tools are needed to navigate these panels while working. This raises the following questions, which we answer here by means of an experiment and analysis.

- Can team members continue their established workflows despite having visually restricted access to their information?
- To what degree do the restrictions frustrate users?
- How else might the extra tool set required to view all needed information influence team dynamics?

Display interaction research generally deals with extensions of traditional desktop features, such as enhancements to window management systems [5]. Research on creative tasks with large displays tends to focus on ideation exercises such as brainstorming [3] where only one shared display is needed. However, activities exist where people use segregated spaces in analog environments that could be replaced by digitally enhanced counterparts, for example organizing information and making sense of collected data. Recent research by Andrews et al. [1] explores how new meaning is added as users manage their content freely on a large display space. We are interested in whether the spatial relationships remain useful in the context of collaboration when access to this space is restricted by "coupled navigation" [6].

2 Experiment

Students of the HPI School of Design Thinking in Potsdam, Germany, volunteered in teams of one male and one female. The pairs were presented with 49 digital sticky notes. Each one contained a single fact or statement based on real interview results on the topic of trusting health information on the internet. The number of sticky notes along with their size was carefully selected so participants would be forced to use more space than the initial view provided, yet could easily manage within twice as much area. This forced teams to make a logistical decision on where to obtain it.

The participants were asked to *cluster* the sticky notes into meaningful groups, in order to deduce the most important insights. Every participant had practiced clustering before and knew what the result should look like, namely groups of two or more sticky notes, separated by whitespace or marker lines, each with a common theme. This provided a good balance between a mutually expected outcome and room for variability without needing to measure anything too abstract, such as levels of creativity. Also, clustering is an open activity done as a team. No personal space is required for individual work.

2.1 Conditions

In one out of two conditions, the *variable,* two panels were accessible on a single touch board, one showing the initial sticky notes and the other blank. To switch between them, users tapped a button on the bottom left of the display which contained a miniature snapshot of the other panel's content. Each panel had an available area of 1810x1358 pixels, or twice that of 1280x960, so at any given time only half of the panel's area was visible on the screen. Users could pan the space with a *move tool*, similar to the hand tool in Adobe Photoshop. A collapsible overview map showing the current screen's entire content was provided on the bottom right. See figure 1. We

expected participants to decide early on how to obtain additional space, either by switching between panels or by spreading out on the first panel and ignoring the second. Either approach offered the same amount of area to work with.

In the other condition, the *control*, two touch board displays were set up next to each other, each with a resolution of 1280x960 pixels. One was filled with the sticky notes, and the other stood blank. Everything was visible, the user needed not think about navigating the area, and the extra tools to do so were removed. This is akin to traditional whiteboard setups.

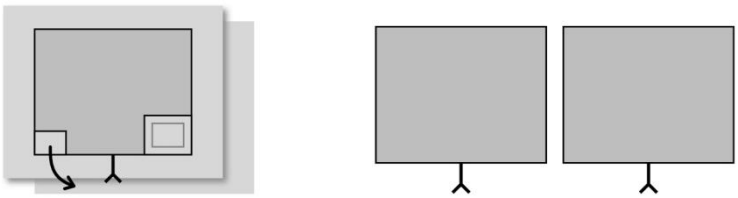

Fig. 1. Left: *Variable condition* with a button to switch between panels and an overview map for the current panel. Right: *Control condition* without navigational tools.

3 Results and Discussion

Ten participating teams were randomly assigned to one of either condition. Four out of the five groups who tested the variable condition immediately opted to obtain additional space by switching between panels. They hardly used the move tool.

3.1 Content, Performance and Satisfaction

Between conditions, the groups' approach to clustering and themes for clusters did not differ appreciably. The average number of clusters in the variable conditions was 7.8, and in the control condition 6.8. No reason for this difference could be concluded.

Control groups needed an average of 32.8 minutes for task completion and variable groups 36.0 (10% more). Even so, as measured by a questionnaire on a 5-point Likert scale, as well as subjectively observed, the average levels of satisfaction with their results, amount of fun had and feeling of preparedness for the next step in the design thinking process did not differ substantially between the conditions.

3.2 Teamwork

In the variable condition, both participants physically stood closer together to work on the same touch board. Every time one participant wanted to see something not currently visible, before changing the view he or she naturally felt compelled to make sure the other's train of thought would not be broken. This resulted in much more verbal dialog between participants which kept them focused on the same action, like

deciding whether a sticky note belonged in a certain cluster. Birnholtz et al. [4] achieved similar results by limiting input devices. The three individuals who recognized this phenomenon viewed it as advantageous. We see it as an opportunity to impel users to focus together on a given decision, ensuring the outcome is a product of true collaboration.

However, at times this setup excluded one of the team members. In the exceptional group from the variable condition that used the move tool instead of switching between panels, the male essentially completed the entire task by himself. As he moved the board and the sticky notes across it, he verbalized his actions as if to assuage his teammate's possible disagreement while she tried to keep up. During another group's experiment, the female twice lost focus and sat down for a few minutes, seemingly uninterested in her teammate's continuation of the task. (When this happens it is immediately obvious which person has receded. This could serve as useful information to an observer, for example in a teaching environment.)

In the control condition, no participants became this disengaged. Some pairs tacitly separated themselves into roles. For example, one person would *pick* (cut) the sticky notes that fit to an established theme, while the other would rapidly *drop* (paste) them on the other board and organize them into clusters. Here, content-based decisions were being made by one individual, while the other made presentation-based decisions. The roles would switch back and forth, often depending upon which board each person was closest to. At other times, the participants would work separately for several seconds or minutes and then reconvene and explain what they had just done.

3.3 Memory Retention

Only two individuals in the variable condition explicitly addressed the issue of not being able to see all their sticky notes at the same time. The female mentioned earlier, whose partner completed most of the task with the move tool, stated "at first it was difficult to assess the space, but then it was okay [with the overview map]." Another participant commented, “Normally you can turn your head to see whatever you need to. Here I had to make sure [my team member] was okay with moving the board."

Participants from the variable condition were able to recall an average of 4 clusters (by names and relative locations on the panel) after the task, while those from the control condition remembered 5.5 (38% more). Aside from the two quotes above, no effects of this difference in memory retention were palpable. This suggests that throughout the task, content left in the non-visible areas by the users did not need to be as prevalent in their memories to complete the overall task equally as well.

3.4 Ease of Use

The tool's perceived ease of use, as measured by various questions on a 5-point Likert scale, remained relatively constant between conditions. Users did not show frustration from having restricted visual access to their information. We infer that widespread acceptance of having restricted access to simulated space through a personal computer's monitor carries over to larger, shared displays.

Participants who used the move tool to achieve more space remarked that it was burdensome to change their stylus's function by means of virtual buttons on the display. Sharing the user's only input device between the marker and the move tool caused a lot of inconvenient switching back and forth. Newer touch display hardware that differentiates between finger and stylus input is becoming ever more available. We plan on mapping each of these mechanisms to the move and marker tools, respectively, as they are by far the most used functions on our whiteboard.

4 Conclusion

Replacing physical navigation with virtual navigation is generally believed to correlate with a slight decrease in performance [2]. However, our qualitative measures were intended to determine whether conventional workflows are severely interrupted in the context of whiteboards. We did not observe this to be the case. The relatively consistent level of satisfaction and experience across both conditions prompts us to further develop Tele-Board to take advantage of multiple larger, simulated spaces.

It remains to be studied precisely what effects the setup has on content and performance. More of such experiments are planned with more panels and methods to navigate them and tasks from different stages of creative processes. In the future, our team will focus more closely on how managing space can be utilized to enhance teamwork and ensure all users are contributing to the given collaboration.

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