Surface Use in Meeting Room Collaboration

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ABSTRACT

Meeting rooms are increasingly being augmented with large-format digital displays (e.g. digital whiteboards and tabletops); however, successful deployment of groupware applications and tools for such environments has been limited. This problem stems in part from a poor understanding of how teams will collaboratively make use of such digital displays. Since these digital *displays* are designed to replace traditional surfaces like whiteboards and tables, my approach is to study how teams make use of traditional meeting room *surfaces* for collaborative work. My research develops a framework that identifies the activities carried out on large surfaces (what they are used for) and the roles these surfaces play in these activities (how are they used). This framework will provide a means to aid the design and evaluation of applications and tools for large digital displays by providing a vocabulary for describing and understanding collaborative use of meeting room surfaces.

Keywords

Large display groupware, meeting room collaboration

1. INTRODUCTION

For over two decades, researchers have investigated how large displays can augment our work practices, producing a wealth of novel interaction techniques and applications to support work [1]. These researchers have addressed input and usability issues, developed novel interaction techniques, and demonstrated clear cognitive benefits for using large displays [8]. It is no longer difficult to build these displays or drive them computationally; instead, the question is now: how can we use large displays to support *real collaborative work?* Furthermore, how can a large display environment, such as a meeting room with multiple displays, be used to augment collaborative activities?

My approach to addressing this design problem is to understand how teams use shared *surfaces* in meeting rooms to support their collaborative work (Figure 1). Since digital *displays* (e.g. SMARTBoards) replace these surfaces, we need to respect and support teams' existing work practices involving surfaces (the traditional flat surfaces used in meeting rooms such as whiteboards, walls, flipcharts, bulletin boards, countertops, and tables). Supporting these work practices facilitates positive transfer, thereby reducing the barrier to large display groupware usage [2]. For example, my observations of meeting room surface use suggest that generally, given surfaces are used for particular activities: e.g. the projection screen is *typically* used to *present* information, not to *write* an action list. There are of course exceptions, but this finding is important since it points toward a very specific direction for application design and research: by studying particular surfaces, we can uncover the specific affordances that surface provides to support given activities. I therefore focus on two specific questions in my research:

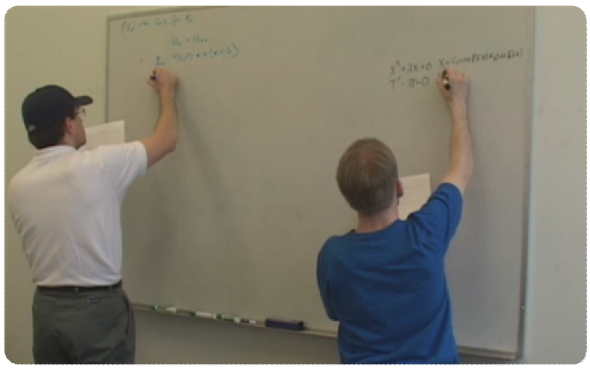

Figure 1. How should digital displays be built to support this type of typical meeting room activity?

1. What *activities* are large surfaces used for?
2. How are these large surfaces used for these activities, or what *role* do the surfaces play in facilitating the activities?

Intuitively, we have some sense for what these activities and roles may be; however, articulating these in a systematic framework allows us to decompose activities into a series of *interactions* people have with surfaces (e.g. adding, moving or changing surface content; viewing vs. monitoring surface content; interaction distance; gesturing, pointing at or with the surface, etc.). By classifying and understanding these interactions, we can predict how introducing new interaction techniques or tools will influence collaboration. For example, "visibility of action" (the ability to see another collaborator's activities) has been identified as a reason to use stylus or touch-based input for large displays over indirect input devices such as mice [7]; however, if a particular large display is simply being used in a presentation role (where information is fairly static, and the main interaction is "viewing" and "gesturing"), then pen or stylus input is superfluous. My research goal is therefore to produce an understanding of how surfaces are used in meeting room collaboration to support the design of large display groupware.

My research will contribute to the fields of Human-Computer Interaction and Computer Supported Cooperative Work in three major ways:

1. It will provide a descriptive framework of the roles that surfaces play in traditional meeting room collaboration.
2. The framework will provide a means to analyze the design of current large display groupware.

3. The framework will provide design guidance for new large display groupware technologies by informing application areas and disqualifying inappropriate designs.

The remainder of this proposal is as follows. Section 2 describes the observation, design, and evaluation activities I will engage in to address my research questions. Section 3 discusses work that I have completed to date, summarizing two completed studies, a published paper, and a paper in preparation. Finally, Section 4 discusses the next study and design steps for my research.

2. PROPOSED RESEARCH ACTIVITIES

I propose three activities to achieve my research goal: (1) observation of teamwork; (2) design of prototype tools to support collaborative work, and (3) evaluation of those tools in a meeting room setting. In practice, these activities will overlap, but for the purpose of coherency, I have elected to present them as distinct units.

2.1 Observation of Teamwork

I will conduct observations of teamwork in meeting rooms, paying close attention to how the meeting room surfaces are used in collaborative work. I aim to generate a taxonomy of *activities* for which surfaces are used, and in so doing, identify the nature of the *roles* that the surfaces play in this collaborative work. This taxonomy of meeting room activities will be informed by McGrath's work [4], and focus on activities involving meeting room surfaces. Together with an analysis of people's interactions with surfaces, this taxonomy will form the basis for my framework.

For instance, an *upright* surface (e.g. a whiteboard) plays a role in *making activities more visible*, thereby facilitating participation of a larger group; conversely, a *horizontal* surface (e.g. the table in Figure 2) *personalizes activities*, allowing one to work more independently. This understanding of activities and roles gives insight to the kinds of large display tools and application areas that will be meaningful for collaborative groups.

2.2 Designing Prototype Tools

In the second phase, I will use the framework from phase one to guide the design of a new prototype system for large digital displays to support an *activity* that was identified in the first phase. For instance, a common collaborative activity is for a group to discuss and consolidate knowledge from independent contributors (*sensemaking*); thus, one might design a system that allows ideas to be moved seamlessly from independent displays (such as laptops or even paper) to a large display (say by simply gesturing at the display, or through some other means). WinCuts supports this activity by allowing arbitrary regions of application windows to be placed on a shared surface [9]. The framework would suggest many natural extensions to further support such an activity (see "ideation role" in Table 1), including: (1) facilitating dynamic, *unstructured annotations* on the large display surface (to facilitate content dynamicism); (2) smooth arbitrary scaling of the "cut" window areas (to support both rich information density and flow of ideation); (3) direct interaction (e.g. with stylus-based input) with the "cut" window areas on the large display (to support change awareness), and even (4) support for horizontal surfaces (i.e. tables) for further independent work.

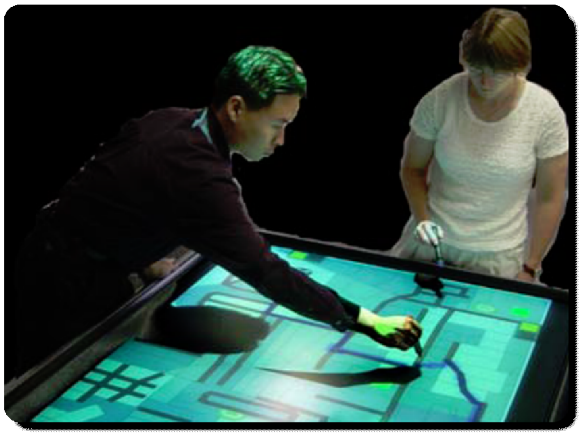

Figure 2. Tabletop users appear to gravitate toward only six distinct styles of collaborative use.

Beyond guiding design, the framework can disqualify poor design choices based on the *roles* upright surfaces play. For example, an upright display does not need to support simultaneous independent workspaces, since upright surfaces typically have socially implicit floor-control; in contrast, horizontal (table) surfaces are often used for parallel independent work, and so should support simultaneous independent workspaces. To demonstrate how my framework can be used in this way, I will contextualize observations from existing work (e.g. [3]) within the framework. In so doing, I aim to demonstrate that problems or patterns of use could have been predicted in part by the framework.

2.3 Deploying and Evaluating Prototype Tools

In the final phase of the work, I will evaluate the prototype system deployed in a real-world context (e.g. placed in a meeting room to replace the whiteboard). The purpose of this evaluation would be to observe the system in real-world use to understand three things: (1) what aspects of system design suited the needs of teams using the system; (2) what design choices were inappropriate, and (3) what aspects of the framework need modification. Beyond system-specific aspects of this evaluation, I will use this opportunity to codify workgroups' reactions to digital displays as a replacement to whiteboards. Learning about digital displays' shortcomings allows us to further understand how whiteboard surfaces are used.

Although the details have not yet been worked out, there is a good possibility of deploying this system into an architecture firm. Researchers I have worked with in the past have built a good working relationship with a local architecture/contracting firm that has expressed interest in using large digital displays for their meeting room activities. As such, they would be ideal real-world users of a prototype system as I build and iterate on it.

3. WORK COMPLETED

I have completed a significant measure of the first phase of my Ph.D. (Observation of Teamwork), and am in the process of designing and prototyping tools for large displays. I describe the progress in the first phase of my work here, which involved two

	Content Dynamicism	Content Size/Density	Attentional Focus	Interaction Distance
Presentation Role	largely static	large	focus	viewed from distance
Ideation Role	largely dynamic	medium/dense	focus	within reach
Reference Role	static	medium-large	ambient	distant

Table 1. The *roles* that upright surfaces play in collaboration (along the left) can be described using the collaborative *dimensions of use* (along the top). This table exemplifies part of the framework I have developed in phase 1.

studies, a paper published at the ACM SIGCHI conference on Human factors in computing systems (CHI 2006), and a paper in preparation.

3.1 Finding Patterns in Collaborative Work

I have designed and conducted two studies to identify patterns of collaborative work in collocated scenarios. These patterns ground design ideas for large display groupware, and inform my framework for collaborative surface use. In one study, I observed pairs of participants completing independent and shared tasks on a digital tabletop display (Figure 2). We discovered that individuals frequently and fluidly engage and disengage with group activity through several distinct, recognizable states with unique characteristics. We presented this work at CHI 2006 [11].

Since this first study focused primarily on tabletop use, I designed and ran a second study where I conducted a case study of three six-person teams. These teams were engaged in a competitive five-week term project, and worked in dedicated lab and meeting spaces. I collected and analyzed (using a spatial-temporal approach, as in [6]) over 60 hours of video of the teams designing and building magnetically propelled trains. Taken together, these two studies have formed the basis of my framework. I am currently preparing a paper about this framework for the 2007 European Conference on Computer Supported Cooperative Work.

3.2 Understanding Collaborative Roles of Upright Surfaces

To provide some insight into the types of findings my work has produced, I briefly highlight three distinct roles that *upright surfaces* play in collaborative work (presentation, ideation, and reference), and show how this knowledge informs the design of large display groupware. Although a given surface could play multiple roles, we found that surfaces did not play more than two at any given time. Each role captures a set of team and individual behaviours, and reflects some aspect of teams' work practices with meeting room surfaces.

- ***Presentation Role***: Information is displayed for the purpose of dissemination to the group.
- ***Ideation Role***: Problems are worked out in a visible manner, and often with others.
- ***Reference Role***: Ideas are posted as ambient external memory, and may become the focus of discussion.

For example, when surfaces are used in the *Presentation role*, the content on the surface is typically static, large, the focus of a group's attention, and "interacted" with from a distance: team members only gesture at the display without being able to change its content. A wall or projection screen will often play this role when information is being disseminated to a group.

Underlying these roles is a space of "parameters" or "dimensions" that describe surface properties and the team's interactions with the surfaces. I describe four here: the first two relating specifically to content on the surface, and the latter two referring to the nature of individuals' interactions with the surface.

- ***Content Dynamicism***: Is this information something that is prepared in advance, or is it modified by an individual on the surface?
- ***Content Size/Density***: How large is the information on this surface? Is the content on the surface fairly dense?
- ***Attentional Focus***: Are teams paying close attention to this information, or does it reside in the periphery?
- ***Interaction Distance***: What kind of distance is typical for "interaction" with this surface? Interaction includes viewing as well as modifying the information.

We can describe each role using these dimensions (Table 1). For example, surfaces playing the *Ideation role* are typically involved in collaborative idea generation or organization tasks; thus, the surface content is dynamic, typically medium-sized (visible from some distance), and teams are often within closer proximity of the surface. Thus, these *roles* suggest typical ways that upright surfaces are used, reflecting conventional work practices involving upright surfaces. Designers of large upright display applications would therefore be wise to design toward these roles since users naturally use *upright surfaces* in these ways. Introducing applications that drastically deviate from these roles need to provide *significant* benefits or risk being perceived as being too taxing to use [2].

3.3 Pick-and-Point: Seamlessly Moving Data across Display Surfaces

The framework has already begun to motivate some design activity. As a simple example, I recently designed and built a prototype interaction technique called Pick-and-Point (Figure 3), which extends Pick-and-Drop [5] by incorporating features of the presentation role (viewing and gesturing at large content from a distance) [10]. Pick-and-Point facilitates smooth multi-display information transfer (e.g. from TabletPC to large display), by allowing users to simply point at a display to redirect information.

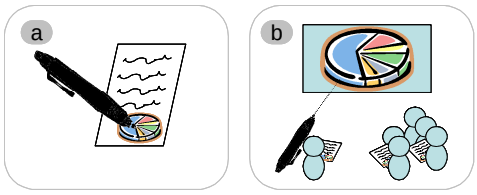

Figure 3: In step (a), one Picks an entity from a tablet. In step (b), one Points at a large display, where it is placed.

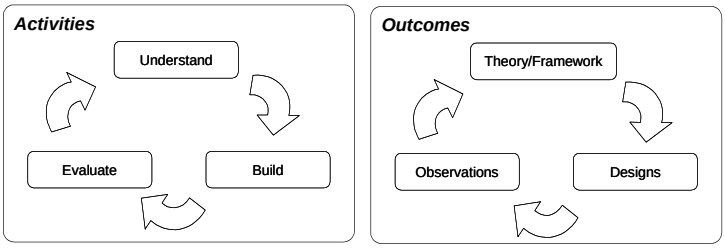

Figure 4. My research process has three major research activities (left) that produce three outcomes (right).

This pointing gesture places the "picked" object onto the pointed display, and maximizes it immediately, saving the user from painstaking window management. Its implementation uses the 6-DOF Polhemus Fastrak device, providing spatially-aware gestures and a smooth, socially acceptable means of floor control. This simple technique was designed to explore how conventional gestures might be augmented in digital meeting rooms.

4. CONTINUING WORK

I am moving into the second phase of my work, beginning to prototype systems for large displays. While this design work is informed by the framework, it is also allowing me to understand aspects of the framework that need to be modified.

Beyond the design work, I am also about to engage in another study with a collaborator where we will observe groups of participants who will be performing classification tasks over tabletops. While this study is primarily to motivate design of collaborative systems for information visualization, I will also use it as a means to evaluate my current framework. By evaluating my collaborative surface framework in different contexts, I can iterate on the framework to ensure its applicability to different environments.

5. CLOSING COMMENTS

I see my work as a natural extension on the already large body of work involving large display research [1]. I hope to consolidate the existing literature under a descriptive umbrella that will allow us to understand and predict collaborative behaviour in environments with large displays. I view my research process as having three primary activities with three corresponding outcomes (Figure 4):

- *understanding* the nature of people's interactions with large surfaces in meeting room collaboration;
- *building* representative prototypes of software for large display environments (interactive workrooms) to support collaborative activities, and
- *evaluating* the prototypes and theory.

I have also discussed the three corresponding outcomes of these activities:

- a *framework* that describes the interactions inside a meeting room between the people, tools and the environment;
- *designs* that link the theory to actual tangible outcomes, and
- *observations* of people's interactions within a workroom or with software that can be used to further inform theory development.

My work will contribute to the field of human-computer interaction by providing a framework to understand groups' interactions with surfaces in meeting room collaboration. This framework will guide the design of future software products for large digital displays in two ways: first, by *informing* application areas and choices during application design, and second, by *disqualifying* inappropriate designs. Ultimately, this work will benefit teams and individuals that will use large digital displays for collocated collaboration.

6. REFERENCES

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