Tables in Context:
Integrating Horizontal Displays with Ubicomp Environments

Meredith Ringel Morris
Stanford University
Department of Computer Science
353 Serra Mall
Stanford, CA 94305 USA
merrie@cs.stanford.edu

CHI 2006, April 22–27, 2006, Montreal, Canada.
ACM 1-xxxxxxxxxxxxxxxxx.

Abstract
Our work on supporting effective interaction with tabletop groupware has included the development of novel interaction techniques for tabletop displays as well as experimental comparisons of tabletop user interface designs. Because interactive tables are still an emerging form-factor, the majority of research on tabletop interfaces (including our own prior work) explores tables in isolation, in order to better understand the unique affordances and design constraints of this new class of devices. A promising area for further research that we plan to pursue is the integration of these devices into multi-device and ubiquitous computing environments.

Keywords
Tabletop interfaces, co-located CSCW, multi-display environments

ACM Classification Keywords
H5.3. Information interfaces and presentation (e.g., HCI): Group and Organization Interfaces.

Introduction

In this abstract, we discuss our motivation for participating in the CHI 2006 workshop on "Information Visualization and Interaction Techniques for Collaboration across Multiple Displays." We summarize our previous research efforts regarding user interfaces and interaction techniques for tabletop displays. We then discuss our interests in expanding this line of work to explore the integration of interactive tables into multi-display and ubiquitous computing environments, and describe some preliminary research we have done in this latter area.

Tabletop Groupware Research

Our recent research efforts have focused on supporting co-located cooperative work around tabletop displays. We have explored the properties of group interaction with interactive tables and their associated design challenges by building and evaluating a series of novel prototypes. These systems and studies have addressed three key design challenges for tabletop interfaces: integrating access to public and private information, managing display elements, and mediating group dynamics. The contributions of this work include interaction techniques for tabletop systems and comparative evaluations of user interface designs for interactive tables.

Among our novel tabletop interaction techniques are *multi-user coordination policies* [5], a set of interaction techniques for preventing and resolving document- and application-level conflicts on shared display groupware. Coordination policies include gestures (*release*, *relocate*, *reorient*, and *resize*) for dynamically altering the access permissions of tabletop documents [7]. We have also supplemented a shared tabletop system with individually-targeted audio [2] as a means for displaying private or personalized content to individual group members and for decreasing visual clutter. Another class of tabletop interactions we introduced are *cooperative gestures* [1], multi-user gestural interactions that can be used to enhance users' sense of teamwork, increase awareness of important system events, or facilitate reachability and access control on large, shared displays (figure 1).

figure 1. Four users execute a cooperative gesture to organize digital documents on an interactive table.

Our tabletop interface design comparisons include an evaluation of the impact of centralized versus replicated control layouts on a shared tabletop display on issues including clutter reduction, orientation/legibility, reachability, and impact on collaborative processes [3]. We have also developed educational tabletop groupware and evaluated the impact of several design variations (feedback privacy, feedback modality, spatial

configuration, and the presence of interaction visualizations) on participation equity [4].

Tables in Multi-Display Environments

Meeting rooms, classrooms, and homes of the future are likely to contain a large number of augmented walls and horizontal surfaces, as well as a wide array of mobile computing devices including phones, cameras, and PDAs. Because the hardware necessary to create multi-user interactive tables has only recently become available (e.g., the introduction of Mitsubishi's DiamondTouch device in 2001), current research on tabletop interfaces has focused mainly on exploring tabletops in isolation, in order to better understand the unique affordances and design constraints of this new class of devices. A promising area for further research that we plan to pursue is the integration of these devices into multi-device and ubiquitous computing environments.

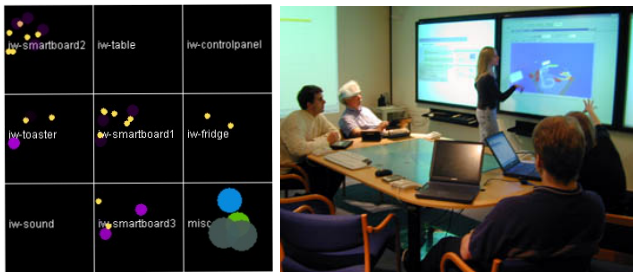

figure 2. The Event Heap Visualizer (left) is an ambient information display that runs on the table in the iRoom (right) and shows information about the state of other iRoom devices.

We have made some preliminary forays into this area. Our work on the Event Heap Visualizer [6] explores the use of a tabletop display as a source of peripheral visual information reflecting the state of information flow between machines in the Stanford iRoom, a prototype ubicomp meeting space (figure 2).

Our work on the Multi-User Piles Across Space system [8] integrates personal digital devices with a shared tabletop display, allowing users to "teleport" piles of multimedia content between their private devices and the table's large display to enable collaborative information browsing (figure 3).

figure 3. Multi-User Piles Across Space allows people to teleport piles of multimedia content between their PDAs and a shared interactive tabletop.

We plan to expand our current work on tabletop groupware to more broadly address issues relating to computer support for co-located cooperative activities in environments containing a variety of input devices and displays. We are interested in exploring architectures and interactions for seamlessly transferring and transforming information among the

disparate devices in ubicomp settings. Creating software development paradigms that simplify developing applications and prototyping interaction techniques for these heterogeneous, multi-display environments is a key challenge that we plan to address. We look forward to participating in the CHI 2006 workshop on "Information Visualization and Interaction Techniques for Collaboration across Multiple Displays" as an opportunity to learn more about ongoing research efforts in this domain.

Acknowledgements

We would like to thank Mitsubishi Electric Research Laboratories for donating a DiamondTouch table and other related equipment to our lab.

References

[1] Morris, M.R., Huang, A., Paepcke, A., and Winograd, T. Cooperative Gestures: Multi-User Gestural Interactions for Co-located Groupware. *Proceedings of CHI 2006*, in press.

[2] Morris, M.R., Morris, D., and Winograd, T. Individual Audio Channels with Single Display Groupware: Effects on Communication and Task Strategy. *Proceedings of CSCW 2004*, 242-251.

[3] Morris, M.R., Paepcke, A., Winograd, T., and Stamberger, J. TeamTag: Exploring Centralized versus Replicated Controls for Co-located Tabletop Groupware. *Proceedings of CHI 2006*, in press.

[4] Morris, M.R., Piper, A.M., Cassanego, A., and Winograd, T. Supporting Cooperative Language Learning: Issues in Interface Design for an Interactive Table. *Stanford UniversityTechnical Report*, 2005.

[5] Morris, M.R., Ryall, K., Shen, C., Forlines, C., and Vernier, F. Beyond "Social Protocols": Multi-User Coordination Policies for Co-located Groupware. *Proceedings of CSCW 2004*, 262-265.

[6] Morris, M.R. Visualization for Casual Debugging and System Awareness in a Ubiquitous Computing Environment. *Adjunct Proceedings of UbiComp 2004*.

[7] Ringel, M., Ryall, K., Shen, C., Forlines, C., and Vernier, F. Release, Relocate, Reorient, Resize: Fluid Interaction Techniques for Document Sharing on Multi-User Interactive Tables. *Proceedings of CHI 2004 Extended Abstracts*, 1441-1444.

[8] Wang, Q., Hsieh, T., Morris, M.R., and Paepcke, A. Multi-User Piles Across Space. *Stanford UniversityTechnical Report*, 2005.