# Interactive Workspaces: Multi-user, Multi-touch, Multi-device

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## ABSTRACT

In multi-user and multi-device environments, users want to focus on the task at hand, while taking full advantage of group dynamics and different interaction styles. Multi-touch surfaces are well-known to support such collaboration, and while most users are barely familiar with multi-touch interaction, expectations are always high. Depending on their deployment, multi-touch systems impose specific requirements on the accessibility of the user interface. In public spaces, for example, users typically interact with the interface over a short time-span, and therefore have limited time to explore the new ways of interacting. Our research primarily focuses on creating this kind of multi-user, multi-touch and multi-device setups and enhancing their accessibility.

## 1. INTRODUCTION

Traditional desktop environments make use of standardized graphical user interfaces and are mainly targeting one user at a time. A user can rely on prior knowledge of other applications when confronted with a new interface and rarely has to be concerned about other users. In contrast, multi-user, multi-device and multi-touch interaction is often unknown to the public. As a result of their novelty, the development and accessibility of such interfaces needs sufficient attention.

A first point of interest is the development of suitable interaction techniques. Designing and testing new techniques for different applications and devices can be very time-consuming. Therefore, we developed *NiMMiT*, a graphical notation to model multimodal interaction techniques [5]. The notation was extended with support for usability evaluation and successfully employed in a framework to create 3D virtual environments [3].

While moving towards multi-user interaction, we noticed a need for floor control. Allowing multiple people, either co-located or remote, to interact with a shared workspace simultaneously, gives rise to several kinds of conflicts, such as several people trying to manipulate a shared resource at the same time or one user closing a document while someone else still needs it. We developed a *Focus+Roles* policy, which provides socio-organizational conflict resolution in collaborative user interfaces, which we discuss in more detail in Section 2.

Multi-touch surfaces are well-known to support multi-user interaction, but introduce specific requirements on the accessibility of the user interface. Traditional widgets in desktop environments provide affordances, “suggesting” how an object may be interacted with, while the visibility principle states that designers should make the important aspects of a system visible to the user. Ideally, which actions a user can perform on an interface and how the actions can be executed, should be obvious just by looking at the interface. Multi-touch user interfaces, on the other hand, allow multiple concurrent points of control that are often not visually represented in the interface. Due to this characteristic design of multi-touch user interfaces, visibility and affordances are severely lacking and users have a difficult time figuring out what can be done with the interface and how it can be done. In Section 3, we propose *TouchGhosts*: visual guides that demonstrate available interaction techniques to the user.



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## 2. SOCIO-ORGANIZATIONAL CONFLICT RESOLUTION

A popular approach to floor control is to assume that “social protocols” (such as polite behaviour and social standards) are adequately observed and suffice to coordinate the actions of a collaborating group of users. Even though social protocols perform well in some cases, users frequently fail to realize the side-effects of their actions, or become confused when others operate on a shared resource simultaneously.

To provide conflict handling in a collaborative environment, our approach introduces *Focus+Roles* [6]. Throughout a collaborative session, participants can adopt various organizational roles (e.g. project leader, software engineer, etc.) and may switch from one dynamic role (e.g. speaker, attendee, chairperson, etc.) to another at any time. The floor control policy dynamically adjusts to the users and their ongoing activities, thereby preventing the majority of conflicts. The organizational hierarchy is employed in combination with document properties such as content type and sensitivity to avoid malpractices through a simple access control mechanism.

In real life circumstances, a person's physical presence provides numerous indications relating to that person's centre of attention, which is important to avoid conflicts. However, in a collaborative environment that allows users to participate both co-located and remote, the natural sense of mutual awareness is inadequate. Tracking the users’ focus (for example by analyzing the users’ input) provides a means of improving the mutual awareness within a multi-user setting. As a result, various types of conflicts can be avoided.

To validate our approach, we added an initial Focus+Roles policy to an existing collaborative environment, iConnect [1]. We applied the approach to a co-located group of users, interacting simultaneously on a collaborative shared display, which resulted in graceful conflict handling and access to shared data (Figure 1).

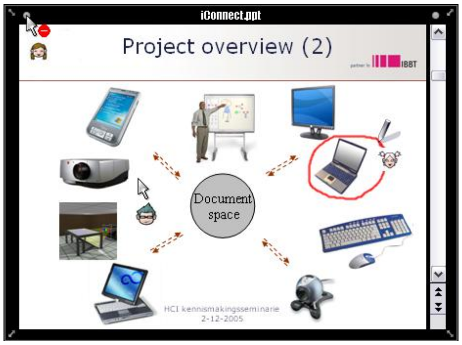


**Figure 1. Multiple users interacting simultaneously: one user tries to close the window, while others are active on it. The system discreetly notifies the users of a conflict (by means of a miniature stop sign) and does not allow the closing.**

## 3. GUIDES FOR INSTANT MULTI-TOUCH INTERACTION

In public spaces, users typically interact with a multi-touch setup over a short time-span, and therefore have limited time to explore the interface. Although a multi-touch interface is assumed to support intuitive interaction through gestures that come rather close to real-world interaction, users experience difficulties finding out how to interact with such an interface due to the amount of gestures and the lack of visibility and familiarity. In early deployments of large multi-touch displays in public spaces [2], users often try to operate the interface with just one index finger. Only after some time they try to use their second index finger.

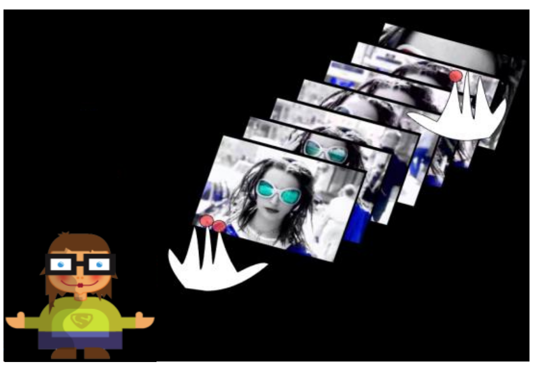

**Figure 2. Illustration of a TouchGhost guide, demonstrating how to interact with a picture collection by animating two virtual hands that manipulate the actual user interface.**

To improve the accessibility of multi-touch interfaces, we introduce *TouchGhosts*: meta-level interface objects, embedding visual guides in a multi-touch interface to demonstrate available interaction techniques to the user. TouchGhosts are activated while operating an interface, providing guidance on the fly and within the context-of-use. A TouchGhost can associate visual guides to every action supported by a single user interface component (e.g. moving, rotating or scaling a picture widget), a set of components sharing certain properties (e.g. arranging icons on a desktop), or a relationship between components (e.g. using a controller to pilot a slideshow). Our approach uses reconfigurable strategies to decide how a TouchGhost should be activated: by touching an avatar or hovering your finger above a widget, after hesitant or erroneous actions, etc.

We used the COMETs toolkit [3], which allows us to query the underlying semantics of a user interface, to implement an initial prototype of a TouchGhost interface. Two animated, virtual hands demonstrate how to use multi-touch interaction techniques by manipulating the actual user interface (Figure 2). We are currently evaluating alternatives to COMETs, to make our solutions more accessible to others.

## 4. ENVISIONED ROADMAP

Our work presents graceful (e.g. correct in a socio-organizational context) conflict handling in collaborative environments and a reconfigurable, easy to understand help system for multi-touch user interfaces.

We are currently examining how to deal with a help system that targets multiple users at once. Problems may arise when several users need different TouchGhost guides at the same time. For example, if the visualization is based on animated virtual hands, multiple instances may be demonstrating interaction techniques simultaneously, which can lead to cluttering and confusion.

Another point of interest is modelling multi-touch interaction techniques in a multi-user environment. NiMMiT focuses on multimodal interaction in 3D virtual environments, but could be extended to multi-touch surfaces, since the framework is event driven and provides facilities for sequential and simultaneous input. Whether it is possible to support multiple users interacting at once still needs to be examined.

## Acknowledgments

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