# Interaction Techniques for Continuous Information Spaces

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## Abstract
When computers move beyond the desktop, they enter our working and living environments. A continuous information space is overlaid to the physical space. Interaction in such a space can involve physical as well as digital objects and new techniques are needed to account for this mix of physical and digital world. In my work I try to investigate and propose new interaction techniques for interaction with multi media content in environments that mix physicality and virtuality.

## Keywords
Multi-User Large-Scale Displays, Interaction Techniques, Hybrid Widgets, Bi-Manual Interaction, Immediate Interaction.

## Problem Statement and Research Question
Along with the introduction of ubiquitous technology in our everyday live, an increasing mismatch of requirements and availability of interaction styles and techniques can be observed. While display and sensor techniques develop further away from the desktop settings, the interaction techniques frequently used are merely adaptations of the traditional WIMP paradigm. A different style of thinking about systems that are embedded in our environment is needed to come up

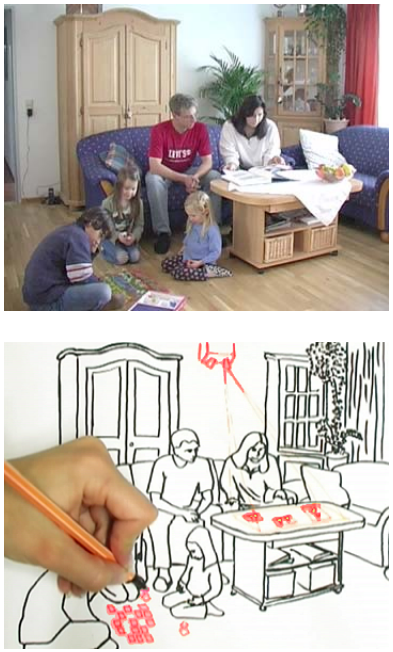

**Figure 1:** Continuous information spaces blending into the home environment.

with interaction styles that match the requirements implied by such systems.

In my research I try to address two main issues. 1) I try to establish a mental model for interaction in instrumented environments and their perception by users. 2) I try to investigate and propose new interaction techniques that are specifically suited for domestic environments (enhanced by ubiquitous displays) and multi-media content (e.g. pictures, music, video).

In Instrumented Environments such as the FLUIDUM [1] instrumented room a large number of displays in various dimensions and resolutions are built into the fabric of the users' surroundings. Among them table-top, wall-mounted and projection based displays. In addition, different mobile devices such as handheld computers or tablet PCs are used frequently.

As technologies will become, in practice, more present in our daily lives, they should also be physically less obtrusive and integrated into our environments in a natural way. This can, for example, be accomplished by incorporating them into home interiors, such as the very walls of a house; or furniture, for example, enabling a coffee table to double as an interactive display area (see Figure 1).

## Emerging Challenges within Continuous Information Spaces

The various display technologies built into the fabric of our everyday surroundings are not only distinguished by type, size and capabilities (e.g. electronic ink, table-top displays or projection) but also by the way in which they are related to each other and used by the inhabitants. They require a different approach for presenting, accessing and manipulating information. Two problems are obvious: 1) Displays built into our every day environments lack the standard input controls desktop systems offer. 2) It is problematic to still think of single display units, since we expect information to spread over a range of devices. Instead I propose to consider the whole environment as a *continuous information space* where physical and virtual information blends into each other.

A number of technical assumptions which are valid for desktop screens, become inappropriate in *continuous information spaces*. One of these is the assumption of a limited and well defined screen real estate, which makes controls (e.g. start menu) with globally fixed positions a good idea. If walls and tables become displays and users roam the area, it makes more sense to adopt the users' relative coordinate system and provide menus (or whatever their equivalent will be) to the user where appropriate.

A second implication of multiple users sharing displays and information is that information cannot be manipulated on a global scope by one user without potential interference with the interests of other users. Hence data manipulation should be limited to a local scope without restricting collaboration amongst users.

Another invalidated assumption is the single-user paradigm. *Continuous information spaces* are inhabited by many people and several of them will interact with the superimposed information simultaneously, either in collaboration or concurrently. On the desktop, only one person can interact with a standard PC and all the other

collaborators are degraded to merely follow the leaders' actions. New interaction paradigms, enabling parallel interaction, have to explicitly support collaboration. The inhabitants of a continuous information space share resources and interact with them in a truly parallel way. They might work concurrently or occasionally join their efforts to reach common goals.

The current interaction with desktop PCs and their GUIs is mostly goal-driven and office- or work-related. Thus, efficiency is a major criterion for its evaluation. *Continuous information spaces*, in contrast, will enter our daily living environments. They need to support informal use and will be assessed on additional qualities beyond efficiency and usability. Visible objects as well as physical artifacts might have to be decorative, enjoyable or likable.

## Approach and Methodology

I plan to conduct my research on both levels, theoretical and practical where the practical part is clearly dominant. But I have a strong background (and interest) in psychology which I try to use for some interdisciplinary projects and collaborations.

In the near future I plan to build several prototypical systems using an iterative rapid prototyping approach and agile software development methods. I see the biggest problems in terms of validation and evaluation because my work focuses strongly on aspects that are very hard to assess e.g. enjoyability, likeability, fostering of communication and social implications.

## Related Work

In order to support simultaneous input on a shared information space, one needs to cope with two main issues: 1) enable users to simultaneously open a personal working area and interact with information within the shared referential information space; 2) free users from spatially pre-defined interactive areas.

With the peephole metaphor [2] a conceptual model for information overlaid to physical spaces has been described. Each unit of information has a specific position in space. Although information units might reside all over the environment, they only become visible within restricted areas, the so-called peepholes. Peepholes can be system-initiated (e.g. through a steerable projector) or user-initiated (e.g. by putting a mobile display in a certain location).

Guiard [3] introduced a model for integrated, skilled bi-manual interaction, called the kinematic chain. Where 1) the two hands form a serialized chain of two abstract motors and the motion of the non-dominant hand is the input for the dominant hand's motion. Thus the one hand serves as a reference point for the other hand's movement. And 2) both hands have different roles and skills. While the non-dominant hand mostly initiates interactions and positions the actions' context (e.g. the paper in handwriting), it is, in general, less skilled for fine-grained work. In contrast, the dominant hand is superior in executing tasks on a finer scale.

The Toolglasses/Magic Lenses technique [4] allows users to retrieve different visual representations of the data within defined portions of the visual information. It is a metaphor for holding a drawing palette with one hand and using a brush with the other.

Based on this insight several interaction techniques have been developed that make use of our trained

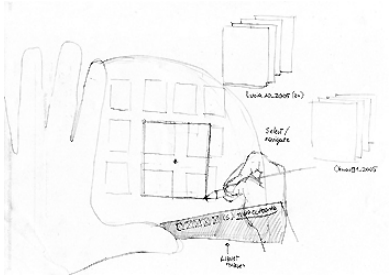

**Figure 2:** Mock-Up of a personalized interface for shared media collections

everyday skills. However, all of them are geared towards single-user, single-display setups and do not account for the specific requirements that arise with shareable instrumented environments.

The proposed technique is a direct descendant of the Toolglass[4] and Peephole metaphors but it is specifically tailored towards multi-user and multi-display environments.

## Preliminary Results

I try to address the issues outlined above by utilizing *personalized interfaces* (Figure 2) as views onto *continuous information spaces*. These interfaces are portable and can be freely positioned by each user. Currently I plan to use physical handles which, upon contact with a display surface, extend into a virtual, semi-transparent overlay. Thus they serve as a reference point both for perception and cognition as well as for interaction.

First of all can we address the spatial limitations with which traditional menus have to cope. Since every user has her own personalized view all controls she needs are always in place and the actions can be applied in a fluid manner. In contrast to WIMP controls no additional movement of the hand (to and from a menu) is necessary. Also the positioning, orientation and order of access problems can be addressed by personalizing the controls instead of having a centralized menu. Even more important is that the current task does not have to be interrupted in cognitive aspects by changing the mode of the application, but instead every action is carried out in place by clicking through the control. Thus making the action mentally more integrated and coherent.

Second, the concept of personalized interfaces can support collaboration by offering explicit ways of communication. In the same manner as the one hand is a reference frame for the other, the personalized interface can serve as a reference frame for communication as well. The position of one's workspace gives clues to others what the current task is, and also helps them understand which parts of the information are currently being contemplated.

## Conclusions and Future Steps

Currently the described approach is in a very early stage. I have explored some ideas with paper prototypes and interactive mock-ups. During the next few months we will gradually implement and evaluate the described approach in different scenarios and settings, starting with a picture-browsing scenario. Other scenarios include browsing, organizing and annotating other kinds of multimedia collections (e.g. music, videos). A critical piece of my work will be to learn new assessment and measurement methods for the so called soft-features of the described settings.

## References

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