Applying Embodied Cognition Theory to the Design of Collaborative Design Tools

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ABSTRACT

In this paper we describe our approach for designing collaborative design tools based on embodiment theory. We present the motivation and rationale behind our work as well an exemplary design study. We argue that when designing for embodiment, it is not only crucial to have a firm understanding of embodied practice but also for the consequences that are introduced with specific decisions between preserving or giving up embodied practice when designing digital tools.

Author Keywords

Embodied cognition, reality-based interaction, design tools

INTRODUCTION

From our research and from that of others, we found that collaborative design activities are inherently characterized by embodied cognition. Designers frequently use bodily movements for expressing their judgments and as a tool to think and reflect [5]. Within cooperative design sessions, tangible artifacts and the physical environment are also used as an active tool for thinking. Physical work surfaces are used to communicate design knowledge in an informal and spatial way that facilitates cooperative creativity (e.g. paper collages on tables or walls). Nonetheless, implicit social interactions and verbal communication are also crucial characteristics of design work that need to be taken care of when designing tools or techniques to support designers [6]. Consequently, in our research we focus on exploring the design of digital design tools with the goal to fully respect the embodied nature of design practice by bringing together tangible and social computing. One of the key issues we were confronted with when beginning our research was the need for a proper foundation and methodological approach to the design process. We were looking for a structured way that may guide us in making adequate design decisions. Thereby, our goal is to preserve important characteristics of embodied practice, while still being able to explore possible benefits that are made possible by using technology in a complementary way.

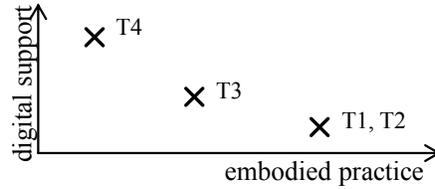## DESIGNING WITH TRADEOFF DECISIONS

Theoretical frameworks such as Embodied Interaction [2] and Reality-based Interaction (RBI) [4] can provide guidance for designing user interfaces that build upon the knowledge and experiences of people in the "real world". They are based on the assumptions that people's interactions in the real world are highly practiced and robust and thus require little effort to learn and perform. Jacob et al. [4] propose the use of *tradeoffs* between preserving physical practice and digital features when designing tangible and social interface elements. However, in many related research projects, decisions to give up or preserve embodied practice are made implicitly. We argue that by making these tradeoff decisions explicit, we can learn more about the consequences of our designs in relation to embodied practice. We would like to support this argument by describing a design study that had the goal to examine important characteristics of embodied practice as a foundation to explicit tradeoff decisions. These tradeoffs were eventually used in an iterative design process and a user study.

DESIGN STUDY

We conducted an extensive design study to explore the utility of using explicit tradeoff decisions as a foundation to design and evaluation. We chose to focus on the collaborative design technique Affinity Diagramming since embodied actions and physical artifacts are known to be crucial factors for the success of this technique [1].

Observation

From an observational study of traditional practice (see Figure 1, left), we examined crucial characteristics of physical and bodily interactions as well as social and environmental awareness according to the four domains proposed by RBI. From a quantitative and qualitative analysis we could identify embodied interactions that we considered crucial for the success of the activity. However, we could also identify areas of possible improvement with the use of technology. From this knowledge, we decided on explicit design tradeoffs that we classified along a digital support vs. embodiment spectrum (see Figure 1, center). While some of our tradeoffs have the goal to preserve embodied practice as closely as possible (T1, T2), we also

T1: Preserve physical workspace setting
T2: Preserve ideation with paper artifacts
T3: Support handling of digital artifacts
T4: Increase accessibility of artifacts

Figure 1: In our design study, we derived explicit tradeoff decisions from observations of embodied practice. We further used these tradeoffs in an iterative design process and as a foundation to a user study.

introduced tradeoffs that significantly depart from practice in order to benefit from digital support (T3, T4). All these tradeoff decisions were then translated to concrete design concepts and interaction techniques in an iterative process (see Figure 1, right).

Iterative Process

As a first step in our design process, we designed a physical workspace setting (Table, Board, Paper) based on those tradeoffs that were identified as crucial for preserving embodied practice (T1, T2). In a second step we designed interaction techniques for supporting the basic activity with digital artifacts (T3), which is a prerequisite for further tradeoffs towards more sophisticated digital support (T4). Using this approach, we could increase digital support gradually without violating crucial properties of embodied practice. Furthermore, by iterating this process, we could compare different design variants derived from our tradeoff decisions along the spectrum. Thereby, each design alternative itself sets foundations for possible interaction techniques that are further along the spectrum towards digital support. This ensures that envisioned designs are adequate and do not conflict with characteristics of embodied practice throughout the course of the design process.

User Study

While we think that our approach was helpful in designing adequate interaction techniques, we also found that explicit tradeoffs can be used for evaluating the proposed designs in user studies. Accordingly, we observed the effects of a prototype implementation along each tradeoff decision. Therefore, each tradeoff was translated into claims. The user study then placed focus on the questions if these claims were effectively implemented in a prototype and if they really did achieve the intended outcome in relation to practice. As a result, we learned about the consequences of our design decisions in relation to embodiment theory.

CONCLUSION

We described our approach for designing collaborative design tools based on embodiment theory. We argue for

using explicit tradeoff decisions as a foundation to a structured design process. These tradeoff decisions - applied in an iterative process - can be used to ensure that novel concepts or interaction techniques meet our goal to preserve important characteristics of embodied practice. Nevertheless, they can also be used in user studies for learning about the consequences of the designs.

WORKSHOP INTERESTS

As researchers we are interested in sharing and discussing our experiences with peers that work on similar issues. We are also eager to learn about similar work and alternative approaches. Therefore, participation in this workshop would be valuable to us. We will also present the described design study in more detail at the conference [3].

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