Thesis Proposal

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How can physical interfaces support group collaboration?
MouseHaus Table: a study of a physical interface in an urban design context

Abstract

The skill of design is honed through everyday experience, supported also by the specialized abilities of an individual and various social values. Through the design process, designers apply their own skills to fulfill the program requirements. Most of the time designers need to work together and communicate with clients. Therefore, group collaboration and group evaluation are also essential elements of the design process.

Historically, the design process was physical and designers would draw on the paper and construct scale models. Designers have also utilized tools such as cognitive mapping (by drawing the map or using paper cut outs) to facilitate the design process. After computer technology boomed in the 70s, many Human Computer Interaction (HCI) researchers also have developed a widespread interest in applying technology to the design process and group collaboration.

Recently, the concept of tangible user interface has sprung up in HCI applications. MouseHaus Table, a working prototype of a pedestrian simulation with a physical interface, is a proof of concept example of using everyday objects in the design process. Also, MouseHaus Table tries to bridge physical objects manipulation, group activity, and computer simulation of pedestrian behavior.

Although many tangible projects have already sampled the design space of tangible user interface, few went beyond the proof of concept. Thus, the goal of MouseHaus Table is to further examine the question of how group collaboration can benefit from a physical interface with computational design software. To investigate group activity using a MouseHaus Table, a task was designed for usability testing. This task requires four people work as a unit to interact with MouseHaus Table. The users will use paper and scissors to construct an urban layout of a college campus. The observations will be categorized into two groups: (1) user interaction during the task and (2) the effects of physical objects manipulation in group use. A better understanding of group activity in the MouseHaus Table could lead to insights that may ultimately improve the design process.

Introduction

MouseHaus Table is a working prototype of a pedestrian simulation with a physical interface. The goal of the system is to facilitate an urban design discussion of pedestrian behavior at a conceptual design level.

MouseHaus Table has two parts: simulation model and physical interface. The simulation model addresses the issue of pedestrian behavior in urban design. The underline notion of this model is that a physical environment effects pedestrian behavior. Pedestrian behavior study is essential in urban design and planning. Noted
urban sociologist Jane Jacobs started to argue for paying attention to design details that mattered to people [4]. Based on Jacob’s observation, Whyte initiated a Street Living Project, taking a quantitative approach of observing people in urban plazas [9].

The simulation of MouseHaus Table is based on Therakomen’s model [6]. In this model, pedestrian movement is based on the concept of artificial life. When the simulation starts, each agent in this model select a random destination as the initialized internal state. The agent also takes blocks and food that users construct on its way as external stimuli. Combining the internal and external status, the agent generates the behavior flow. All the moving paths produce a pedestrian pattern.

The physical interface enables the input of dimension and location information into the simulation program. The interface includes a web cam, color paper, scissors, a custom keypad and a table with projected display. One can cut color paper with scissors to decide the block sizes and place them on the table. The keypad provides a button to capture the layout, a sliding bar to set up the time, and buttons to active the pedestrian movement and display resulting patterns. The video camera mounted on the top of the table captures the layout and convert it as the input for the simulation. The simulated pedestrian animation is then projected on the table. The patterns of pedestrian flow can also be displayed at any given moment.

In contrast to the pedestrian simulation, the main focus of this thesis is investigating how people interact with physical interfaces as well as comparing physical interfaces with conventional ones. The number of users, interface, and task complexity are the independent variables. I will employ usability research techniques to further my investigation.

The preliminary testing will be aimed on the question that can the physical interface enhance people’s communication in group collaboration. The verbal interaction, gesture interaction, and the task satisfaction will be the main collected data. Other data such as user’s physical positions, errors, etc will be recorded as well. The first analysis will be matching events on a timeline and looking for patterns. Based on the findings of the preliminary study, further tests will probably extend to more details.

**Related Work**

Conventional planning follows an orthodox cycle of survey, analysis, and plan. However, this top-down practice is often in favor of project officials, businessman, contractors and development works [3]. In order to reveal the heterogeneous interests and demands of the community, action planning emerges as an alternative practice.

In the action planning process, games and role playing are sometimes strategically applied. Most games have physical components involved. Some games are designed to simulate potential outcome, some are used to build the awareness, and some helps people to be familiar with planning. W. Mike Martin also use paper cut outs to facilitate cognitive mapping in programme development [3].

MouseHaus Table also brings physical object manipulation into the design process. Moreover, MouseHaus Table adds computational feedback to physical manipulation. This interface, a physical interface, is defined in which the manipulation of physical
object(s) by a user’s hand gestures are detected through a computer system and as a result, provides responsive feedback.

In the MouseHaus, a user can use a paper cutout to represent the dimension and location information. Tangible paper cutouts, captured by a video camera, are used as a physical interface. The physical interaction of MouseHaus Table is based on the model of DigitalDesk [8], using a video camera to capture the input from user and projecting the computer generated feedback onto the table with a projector. Urp and Illuminating Clay also apply the concept of tangible user interface for urban planning and analysis of landscape models [7, 5].

In addition to providing input information, the physical interface in the MouseHaus Table is also an interface to engage group collaboration. Arias et al. addressed the complementary synergies of integrating physical and computational media for design and provided InterSim project as example [1]. However, the lack of follow up development and evaluation make it difficult to support the advantage of integration. EDC also applied physical object manipulation to a computational simulation on a table, but the weak connection between physical objects and simulation led to the result that computer did not offer much support [2]. Therefore, MouseHaus Table attempts to clarify how a physical interface can affect group collaboration.

**Methodology**

Usability is an industry based research method to assess the use of a product. Usability research requires fewer subjects than other scientific research practices and allows less strictly controlled test conditions. Although a formal usability testing suits best when a product is near the end of development cycle, usability testing is still applicable for a less finished product. Usability testing reflects interface problems. Therefore, usability testing is most suitable for MouseHaus Table, a working prototype of a physical interface for group collaboration, to explore user behaviors.

Before the usability testing, defining target audience and task is essential. Due to the experimental nature of the MouseHaus Table system, the current target audience is students in the Department of Architecture or Urban Design and Planning at the University of Washington.

Identifying possible members of this study involves finding students in the department who are willing to participate.

The preliminary study will be run with three participants who do not know each other. The participants will work together to solve a given task.

**Task**

I design a specific building layout. With gradually added parks, the pedestrian patterns are different (Table 1). The pattern in layout 1, the center looks like two “x”. The pattern in layout 2, there are dense pattern along the building, but there is still an “x” between the lower left two buildings. Pattern for layout 3 increase the density along the edge of lower left two buildings. The pattern in layout 4, it has a dense point on the upper right corner. All the patterns are the results of 2 minute simulation.
Participants will try different layout and run the simulation for each setup for two minute. The goal for the participants is to construct a pattern most like the pattern 4. After the testing, participants will answer a questionnaire and some open end question.

Table 1. Design sequence for task pattern

<table>
<thead>
<tr>
<th>Layout</th>
<th>Block</th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1.png" alt="Block 1" /></td>
<td><img src="image2.png" alt="Pattern 1" /></td>
</tr>
<tr>
<td>2</td>
<td><img src="image3.png" alt="Block 2" /></td>
<td><img src="image4.png" alt="Pattern 2" /></td>
</tr>
<tr>
<td>3</td>
<td><img src="image5.png" alt="Block 3" /></td>
<td><img src="image6.png" alt="Pattern 3" /></td>
</tr>
<tr>
<td>4</td>
<td><img src="image7.png" alt="Block 4" /></td>
<td><img src="image8.png" alt="Pattern 4" /></td>
</tr>
</tbody>
</table>

**Future work**

Based on the result of preliminary testing, the task design will be revised. The hypothesis that physical interface can enhance group communication could be build and justified through usability testing. At such condition, the fact that if participants know each other beforehand might need to be considered as an independent variable.
Also, in the preliminary testing I also want to know if any supporting function is necessary. I will provide several physical tokens for participant to capture the layout, run the simulation, and record their layout.

**Thesis Outline**

1. Introduction  
   i. Using physical interface to urban design simulation in a group setting  
   ii. Tangible user interface  
2. Group Interaction  
   i. The framework of group collaboration  
   ii. Using physical interface in the group  
3. System Architecture of MouseHaus Table  
4. Research Method: Usability Research  
   i. The evolution of usability research  
   ii. Why usability research is valid?  
5. Result  
6. Conclusion  

**Reference**


**Appendix**
1. Participant profile
2. Questionnaire
3. Post-test interview