BEING THERE: FROM THE PHYSICAL TO VIRTUAL ENVIRONMENTS

MAO-LIN CHIU, RUI-LUNG WU
Department of Architecture, National Cheng Kung University, Tainan, Taiwan
mc2p@mail.ncku.edu.tw

RUI-ZHANG PENG, CHIH-CHUN HUANG
Department of Architecture, National Cheng Kung University
rui.zhang@msa.hinet.net, chewiehuang@yahoo.com.tw

Abstract. The creation of virtual environments is becoming an important issue in digital design. The purpose of this paper is therefore to explore the transformation from the physical to the virtual environment from a social and behavioral point of views, and the process is demonstrated by a museum exhibition project. We had built both the physical and virtual environment, and studied the human behaviors and experiences from their presence at both environments. Agent-based interface is adopted in the virtual environment to enhance people-to-people and people-to-place interactions. The development process, the observation, the interface agent, and discussion based on the findings are presented.

1. Introduction

The emergence of information technologies clearly affects our daily activities as well as the physical environments (Grosz, 2002, Chiu et al. 2000). Being based on our visual perception, current digital media and virtual reality technique draws attention especially for changing the way we present architectural objects in cyberspace. Virtual environment or architecture that comprises designed virtual places that support a broad range of human activities has become the alternative for spatial creation and experience (Chiu and Lan, 2001).
The crucial question that the virtual continually poses on the real: How can the real expand itself? Previous attempts include the increase of immersion and interaction with the virtual environment enhanced by digital media and the creative content. However, these attempts do not necessarily get more information or experience than the reality. On the contrary, the virtual environment often lacks the sense of place and people. The purpose of this paper is therefore to explore the transformation from the physical to the virtual environment from a social and behavioral point of view, and the process is demonstrated by a museum exhibition project. This research had built both the physical and virtual environment, and studied the human behaviors and experiences from their presence at both environments. Furthermore, interface agents are computer programs that employ Artificial Intelligence (AI) techniques to provide active assistance to a user with computer-based tasks (Wooldridge, 2002). The following sections will address the development process, the observations, the implementation of interface agent, and discussion based on the findings.

2. Being There and Episodic Memories

Basiclly, spatial design in exhibition space is to create a scene to raise user involvement or participation. In the unique circumstance, the environment not only provides visual or acoustic performance but requires personal association and imagination. “Being there” reveals the personal spatial experience caused by their presence at places in a unique way.

2.1. THE DEVELOPMENT PROCESS

In this study, the physical environment is referred to an exhibition project of demonstrating the life cycle of a historical building, the formal Tainan Governmental Buildings and now the National Museum of Taiwanese Literature, represented by photos, maps, illustrations, scale models, and building components. In the development process, the physical environment is transformed to a virtual environment, Figure 1. At the beginning, we studied the physical configuration and the spatial requirement to create a virtual working model, and then implemented it in a physical exhibition gallery to display the artifacts and information about the history of the building and related subjects. Five exhibition themes or stories are used to illustrate the events about the building. In the exhibition period (about 2 months), we had observed the interactions among the people-to-people and people-to-place, and use the finding to create a virtual exhibition gallery. In the following sections, the design and observation of both environments are explored.
2.2. PHYSICAL AND VIRTUAL PRESENCE

At a physical place such as an exhibition gallery collecting all kinds of information in regarding with display objects or themes, an individual can relate himself to a particular scene or artifacts at the nearest location based on his familiarity or association. The distance between the observer and the artifact, the lighting, and the atmosphere are important to visual quality of exhibition as well as human perception. The physical presence of human being is both physically and psychologically situated.

While in the virtual environment, we can represent it digitally by similar contents, and at the same time provide better interface to create atmosphere and new experience for users. The virtual does not refer to distinct elements, but rather to how they can be related. In the creation of virtual environments, previous studies indicate the importance to situate people in constructing memories by spatial characteristics and atmosphere (Lin and Chiu, 2002; Chiu et al., 2000). Kalay (2003) indicates that if we consider cyberspace as a place, then designers have to change the metaphor of the virtual environment. Therefore, this study will take a different approach to design the virtual environment as a place of containing or recalling memories.
2.3. EPISODIC MEMORIES

Story-telling is one of the most popular approaches in exhibition design. Stories about events, people and places are collected and organized into narratives, while these are gradually transformed by a new logic of information technology. When the content is represented, human memories are recalled and augmented at the physical space due to the people-to-people and people-to-place interactions. It is important to enhance these interaction or experience in both physical and virtual environments.

Furthermore, from an individual point of view, human memories are related to its context, and often contain the mixture of physical experience related to the subject and imagination caused by personal involvement at various events. The term ‘episodic memory’ refers to our memory for unique, personal experience (Baddeley et al., 2002). If we can record episodic memories by their sensor-perceptual relationships, then we can recreate similar experience by digital media.

2.4. AGENTS

The agent-based research is initiated from the AI concept from 1990s (Maes, 1994). Agent-based systems have been applied to design in many aspects such as assist users to search information on the web or perform design tasks. Agents are rule-based entities, triggered by events, and run autonomously. Rules specify actions (create, move, mail, delete, save, etc.) to be taken by agents on entities (messages, hypertext links, etc.) when certain events occur. Because users can share objects, databases, or files, agents communicate through these shared entities to perform certain tasks and behaviors. If the people-to-people and people-to-place interaction can be simulated, then applying agents to create the interface to enhance interaction for the virtual environment will be feasible, Figure 2. The implementation will be elaborated in the designing the virtual environment.

---

Figure 2. Relationship among user, application and agent
3. Being in the Physical Environment

In this section, it introduces how the physical environment is created and observed in the exhibition period. The observation will be the foundation for creating the virtual environment.

3.1. DESIGNING THE PHYSICAL ENVIRONMENT

We first analyzed the collection of information and developed a script consisting of five themes or stories to illustrate the events about the history of the building and related subjects. We then studied the physical conditions of an exhibition room, and then built a scene or a physical setting to display the artifacts and information about the building. Because of the nature of historical building configuration, we created a continuous free-standing form and implemented the concept in physical settings to avoid any new fixtures that may affect the existing building configuration, Figure 3. When the exhibition space was completed, it became a test site for observing people-to-place and people-to-people interaction. At this exhibition site, digital media performed as visual aids for describing the architectural stories.

![Figure 3. Observers / Users in Physical Environment](image)

3.2. OBSERVING USERS IN THE PHYSICAL ENVIRONMENT

In the exhibition period (2 months), we had observed and recorded various visitors’ behaviors and people interactions by web-cameras or videos, Figure 4. By analyzing how they access information from the physical place, user
behaviors can be classified into basic actions. Observers are responding to the display objects and the other people including the narrator, assistants and other observers. Single observers often faced the display boards, and occasionally inquired questions and take notes. For person who had been the building, he/she could raise questions related to specific time and subjects, and described their unique experience. As a group such as a family, observers might talk to each other or chatted among few people.

![Observers / Users in the Physical Environment](image)

**Figure 4. Observers / Users in the Physical Environment**

Exhibitive objects can be considered as reflection of user minds or memories while they cannot react in the physical environment. If the user can “talk” to the exhibitive objects, then the agent behind the scene will be able to “respond” to the action or “answer” the question. What function is missed in the physical environment can be enhanced in the virtual world by adopting agents. Learning from the user is the best strategy to create agents. In the sensor-perception relationship, a visitor’s position and his/her duration at certain locations are becoming useful for situation detection. Therefore, agents can react to provide better explanation of the background information because the exhibitive object cannot react itself, Figure 5. Furthermore, in the group visitor situations, a reactive agent can become a proactive agent to extend the functions in addition to story-telling.
In this paper, two types of agents are proposed for the functional and social purposes: (1) the reactive agent: it "reacts" to users' inquiries or pre-defined actions, such as provides building information or stories to supplement the rich visual environment of a city about its historical background; (2) the proactive agent: it "pro-acts" to undefined actions with scene-driven interaction derived from people-to-people and people-to-place activities. Based on the observation of human behaviors in the physical exhibition project, scenarios are developed to define the relationship between people and places. Thus, the interactions may be occurred among virtual visitors and physical visitors.

4. Being in the Virtual Environment

The presence of users in a virtual environment involves social and psychological effects. The study attempts to imitate the interactions among user and objects, and transform into the virtual environment by observing user behaviors in the physical environment.

4.1. DESIGNING THE VIRTUAL ENVIRONMENT

The virtual environment consists of the scenes and artifacts. While creation of 3D models for historical buildings or city modeling are becoming common for visualization purposes, however, to extend the uses of models is far more than the original uses. Our previous studies started from creating scenes and atmosphere to developing scenarios and roles in plays in creating virtual environments by adding visual and sound effects (Lin and Chiu, 2002; Lin and Chiu, 2001; Chiu et al. 2000).
4.1.1. The Scenes
The scenes consist of the main scenes and smaller scenes. The virtual environment serves as a story box as well as a memory container to organize types of narratives. The content is gradually transformed from the artifacts into people and places, and into collective episodic memories. Meanwhile, the virtual environment is transformed into a new structure of memories combined with existing information and physical settings. We then analyze the observation of uses in the virtual environment and compare it with the physical environment.

4.1.2. The Scenarios
A scenario is used for describing state transitions. Scenarios can be called from other scenarios or functions. Each state is defined as a guarded command, but can include conditions in addition to cues. Although a scenario is written in the form of simple state transitions, since any form can be evaluated in the body of states, it is easy to describe fairly complex tasks. Scenarios can be called recursively, Scheme functions can be called in scenarios, and any scenario can be called in Scheme functions. For example,

(defscenario reception (message)
 (scene1 ((?hear "Hello" :from $x) (!speak "Hello" :to $x) (go scene2))
   ( (? hear "Bye") ( go scene3 )))
 (scene2 ((?hear "Hello" :from $x)
   (!speak "Yes, may I help you?" :to $x))
   ( otherwise ( go scene3 )))
 (scene3 !D))

4.1.3. The Agents
Interface agents are computer programs that employ AI techniques to provide active assistance to a user with computer-based tasks. Curiosity is the motivation to discover new knowledge when faced with an unfamiliar situation, and provide the opportunity to study the reaction of agents. Saunders and Gero (2001) applied the Spirograph to build an agent system and the curious agent can react on the basis of the Spirograph patterns. Based on the distance or radius, an agent can communicate with the user or another agent, Figure 6. From the interface point of view, the agent learns in four different ways: (1) it observes and imitates the user's behavior, (2) it adapts based on user feedback, (3) it can be trained by the user on the basis of examples, and (4) it can ask for advice from other agents assisting other users.
While an agent can perform many tasks, the basic task in the exhibition space is to provide the recommendation for the user, such as the next step or interesting objects. To enhance the visitors’ understanding and interests, we need to develop the user interface about how to increase interactions in virtual environments and an agent can be created as a narrator for visitors.

Ideally, the society of agents should consist of various agent types or heterogeneous agents. However, the relationships of heterogeneous agents are more complex and unable to perform. Currently, we are focusing on homogeneous agent type, i.e. agents perform similar reactions or actions. The agent’s action is defined by states/events, Table 1. Therefore, rules can be applied to certain states and consequently action can be applied.

### Table 1. An Agent’s Movement

<table>
<thead>
<tr>
<th>T</th>
<th>Space (A-E)</th>
<th>State_a (observe/face)</th>
<th>State_b (inquiry)</th>
<th>State_c (talk/chat)</th>
<th>Applied Rule</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>sA</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>R1</td>
<td>T1</td>
</tr>
<tr>
<td>2</td>
<td>sA</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>R2</td>
<td>T2</td>
</tr>
<tr>
<td>3</td>
<td>sA</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>R3</td>
<td>T3</td>
</tr>
<tr>
<td>4</td>
<td>sA</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>R4</td>
<td>T4</td>
</tr>
<tr>
<td>5</td>
<td>sB</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>R5</td>
<td>T5</td>
</tr>
<tr>
<td>6</td>
<td>sB</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>R6</td>
<td>T5</td>
</tr>
<tr>
<td>7</td>
<td>sB</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>R7</td>
<td>T5</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

The human behaviors in visiting galleries are complicated than just watching a portrait or modern sculpture. Our early study is focusing on the
tracing of eye and body movement per individual. Because the visitor’s position is highly related to the setting, therefore, we can trace his position in terms of body and eye movement, Figure 7. Each individual activity zone can be defined as a sensorial zone. For example, when a visitor moves from point A, B, C to D, his eye may target different objects or artifacts at each position. The sensorial zone can be defined as shaded area, while the perception is limited to observe exhibitive artifacts. When the duration at certain position is longer than a predefined time span, then an agent will show up and talk to a visitor.

![Figure 7. Tracing Eye and Body Movement in a Virtual Gallery](image)

When there are more than 2 visitors in space, their positions and distance become critical for defining their relation and interactions. The social patterns are summarized on the basis of previous observation from the physical site. The action is then occurred when there is overlapped activity zone.

4.2. BEING IN THE VIRTUAL ENVIRONMENT

The system prototype and interface is implemented by Director MX to examine the feasibility of scenarios. Then a revised version is built by Java and Microsoft agent system interface. While there are 1-to-1, 1-to-many, many-to-1 and many-to-many relationships among the user and the display objects, the system is currently restricted to 1-to-1 or many-to-1 relationships. At each scene, various reactions can be recorded for further studies. For example, the scene (a virtual gallery) is the representation of the physical environment, Figure 8. Visitors or users are shown on screens. An artifact agent or wall agent will respond to certain situations by detecting user position or duration at certain “hot” zone or points. When finishing the tour, agents can assist the direction or jump to another galleries.
5. Discussion

By observing the visitors in both environments, we are concerned about what the physical place cannot express as well as what virtual places can add the values. Basic findings include: (1) the contents, (2) the user behaviors, and (3) the agent interfaces. The findings from the above study raise the questions for further discussion.

5.1. WHAT ARE INTERESTING TO USERS

It is clear that the exhibitive contents are the foci of an exhibition, and consequently the preparation and selection of right content are important. While digital media can contribute to the interactivity and represent the display objects in an interesting manner, the audience still prefers the personal narrator. Story-telling by experts or a person having previous experience can provide the most persuasive way to guide the users to understand the essence of exhibition. Therefore, agent’s roles become critical in the virtual environment. Ideally, the smart agents are both curious and sensitive to user behaviors, and can assist the demonstration of an exhibition.

5.2. WHAT CAN USERS PERCEIVE FROM THE VIRTUAL ENVIRONMENT

It is found that users or observers can perceive more than the representation of display objects and the surrounding environment but also the interaction from the others. By converting the physical into the virtual environment, we must carefully consider the scenarios or scripts developed for guiding users and enhancing their experience in both the mental and physical spaces. “Being there” is involved with design issues, design style and user interfaces in respond to the content of information, spatial conditions and user
interaction. “Being there” presents the important meaning of presence to exhibitors as well as visitors. The observation from the physical environment can add another dimension of information to the virtual exhibition.

The dynamics of social interactions make the creation of virtual environments more meaningful to the creators and users. However, current practices of virtual environment are mainly created as place infrastructure with associated behaviors predefined by designers. In the future, the content as well as a content-sensitive agent system should be enhanced.

5.3. WHAT CAN AN AGENT DO

As computers are used for more tasks and become integrated with more services, users will need help dealing with the information and work overload. Interface agents radically change the style of human-computer interaction. The user delegates a range of tasks to personalized agents that can act on the user's behalf. We have modeled an interface agent after the metaphor of a personal assistant. The agent gradually learns how to better assist the user by:

- observing and imitating the user
- receiving positive and negative feedback from the user
- receiving explicit instructions from the user
- asking other agents for advice

Maes (1994) indicates that the agents have been shown to tackle two of the hardest problems involved in building interface agents, i.e. whether the agents are competent: they become more helpful, as they accumulate knowledge about how the user handles certain situations; and whether they can be trusted: the user is able to gradually and incrementally build up a model of the agent's competencies and limitations.

In terms of creating the agent environment, many of the languages proposed for describing agent behavior and inter-agent protocols are based on agent internal mechanisms (Smith, Maher, Gero, 2003). For further implementation, we chose a script language for describing interaction between agents and users based on agent external roles (Ishida, 2002). It does not depend on agent internal mechanisms; its goal is to describe how scenario writers should be able to request agents to behave. The scenarios contribute to establish a bridge between agent designers (computer professionals) and application designers (scenario writers).

An event that triggers interaction is called a cue. Cues are used to request agents to observe their environment. No cue is permitted to have any side effect. Cues keep on waiting for the event specified until the observation is completed successfully. Comparable to cues, actions are used to request
agents to change their environment. Unlike functions in programming languages, the semantics of cues and actions are not defined in scenarios. Since cues and actions are executed differently by different agents, their semantics fully depend on the agent. An example of cues (starting with ?) and actions (starting with !) are as follows:

```lisp
(?hear "Hello" :from Jacky)
(!walk :from entry :to point_A)
(!speak "Hello" :to Jacky)
(?see point_A :direction "south")
```

Even though the results obtained with this first generation of agents are encouraging, many open questions for future research remain. Some of these are user interface issues: Should there be one or many agents? Should agents use facial expressions and other means of personification? What is the best metaphor for interface agents? Other questions are more algorithmic and technical: How can heterogeneous agents built by different developers and using different techniques? Most importantly, how can a system of incentives be devised, so that users are motivated to share the knowledge their experienced agents have learned?

6. Conclusion

The study demonstrates the potential approach of presenting user experience in a museum exhibition project. “Being there” means that the person is physically and psychologically situated, and therefore can perceive the sense of places that is caused by a sensor-perception relationship. The study indicates the importance of observing people-to-people and people-to-place interactions in the transformation from the physical environment into the virtual environment. To perform recommendation or story-telling capability by a reactive agent can initiate social interactions. The people-to-people and people-to-place interaction in the virtual environment can be enhanced through proactive agents. However, the human experience often presents various relationships among the person and his/her surrounding environment, and the experience is difficult to be represented. Both individual and group behaviors require further investigations. It also requires in-depth studies to define the appropriateness of story-telling skills by various kinds of agents. To enhance the emotional or other performance capability of intelligent agents will be a potential direction for future development.
Acknowledgements

This project is funded by the National Science Council research grant NSC 92-2211-E-006-080. The authors express the gratefulness for who assisted the preparation of exhibition at National Museum of Taiwanese Literatures.

References


