From Chinese Gardens to Virtual Environments

A Gateway to Cyberspace

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Abstract: Chinese gardens provide situated portals through which poets or artists can enter their imaginary worlds. Similarly, a visual interface (virtual environment) of a cyberspace provides entrances to this potentially infinite space. Derived from design principles of Chinese gardens, we propose a design method for creating virtual environments. We use this method to design and visualize several cyberspaces, including web sites, virtual Chinese gardens and 3D computer games. We conduct empirical studies and find virtual environments, created by the proposed method, provide users with experience correlated to the expected result.

1 INTRODUCTION

Cyberspace is becoming an integral part of our life as envisioned by Negroponte (1994) and Mitchell (1996). Although it is not a physical environment as the world we live in, as architects, most of us believe that this type of environments may be further enriched if architectural design principles were employed during its creation. We find many discussions from this perspective in CAAD related conferences (e.g., see Alvarado et al. 2000; and Bourdakis and Charitos 2002).

Our research into the design of virtual environments has revealed that these environments are very similar to the Chinese gardens. From the eyes of artists, poets, painters, or scholars, the scenes of Chinese gardens are situated portals through which they can enter their imaginary worlds. Similarly, the visual interface of a cyberspace provides entrances to a potentially infinite space.

Given that the design of Chinese gardens has evolved through decades of practices, we hypothesize that compositional principles used to design these gardens may benefit the design of cyberspace. In this paper, we present a design method for creating virtual environments based on compositional principles of Chinese gardens. We employ the method to create several virtual environments and conduct empirical studies to understand the effects of these virtual environments.

2 CHINESE GARDENS AND VIRTUAL ENVIRONMENTS

Chinese gardens, with origins date back 2500 years, were created as the escapes from the real world (Cao 1993). In a Chinese garden, scenes are arranged for inspiration and reflection. Each scene in a garden is a gateway into a world outside of our reality. For example, a famous Chinese garden "Chou Cheng Yuan" (or dumb governor's garden, in literal translation) was built by an able scholar who failed to achieve political success. The name of the garden reflected the irony experienced by its owner. The overall arrangement of this garden mimics countryside with free and easy spirit to provide a strong contrast to the owner's previous caged-like political life (see Figure 1). In a way, a Chinese garden is a visualization of a spiritual world. In this visualization, there are many gateways through which one can step into one's spiritual world.

Figure 1. Chou Cheng Yuan Site Plan (Pon 1993)

Cyberspace cannot be grasped without visualizing it. However, no visualization of a cyberspace can present its full extend. To explore a cyberspace, it is necessary to construct a visual interface that contains portals through which one can travel around this space. For the purpose of this research, we call *a visual interface of a cyberspace a virtual environment* (just as a Chinese garden is an interface of a spiritual world). The design of a virtual environment thus involves two key issues: the visualization of the environment and the interaction with users.

3 A METHOD TO DESIGN VIRTUAL ENVIRONMENTS

We propose a design method that includes a set of design elements and compositional principles, and a three-step process. The set of design elements and compositional principles are derived from design principles of Chinese gardens (Cao 1993; Pon 1993). The three-step process begins with organizing the structure of the target virtual environment into a network of nodes and links. In the second step, for each node and link, design elements are arranged according to appropriate compositional principles to form a visible space. And in the third step, interactive triggers are added to provide user interactions in the virtual environment.

There are ten design elements: rock, shrub, column, tree, trail, plate, wall, window, door, and place. These are conceptual elements rather than a set of fixed (pre-existing or pre-defined) objects. Rocks are objects of arbitrary shape and size that block viewers' line of sight. Shrubs have low height and spread horizontally. Columns are vertically elongated objects. Trees are columns with caps that spread horizontally. Trails are thin linear objects with certain width. Plates are horizontally arranged thin plans. Walls are vertical plates. Windows are punched holes in walls. Doors are windows that have very low or no sills. Places are voids enclosed by objects.

The design elements, in turn, should be organized according to six compositional principles in order to provide expected experience in a virtual environment (Table 1). The compositional principles include "spatial contrast", "hide and show", "guide and hint", "scatter and compact", "twist and turn" and "depth and layer".

Table 1. Compositional principles to provide expected experience.

Compositional Principle	Applicable Design Elements	Expected Experience
spatial contrast	wall, place	compressed to expanded, small to large
hide and show	rock, tree, wall	direct blockage and secondary blockage
guide and hint	column, door	indicating direction and path
scatter and compact	rock, place	rhythms of arrangement
twist and turn	shrub, column	depths of scenes
depth and layer	window, door	frame of view

Because the design elements can be realized in various ways, there are potentially infinite possibilities of visualizing a virtual environment. Nevertheless, with the compositional principles, every visualization result will maintain a coherent style. For example, Figure 2 presents an example realization of a set of design elements. Using these design elements with appropriate compositional principles, possible visualization results are illustrated in Table 2.

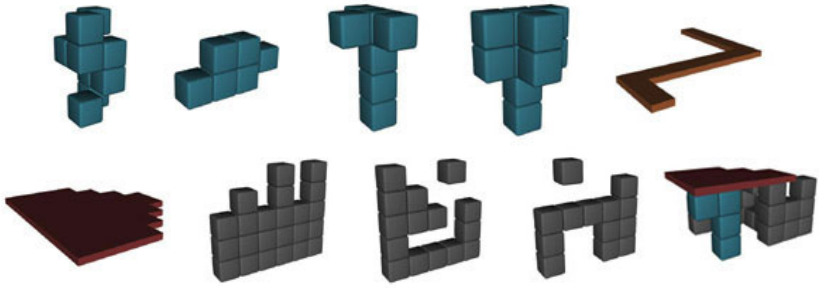
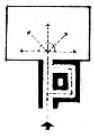
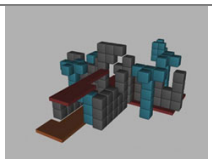
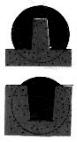
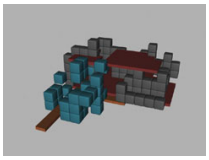
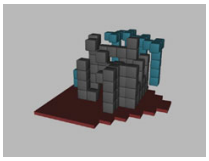
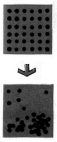
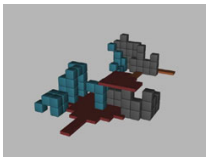
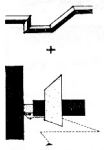
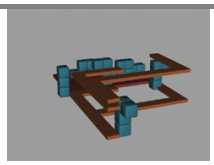
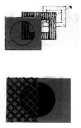
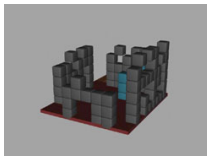


Figure 2. Illustrations of design elements (top row from left to right: a rock, a shrub, a column, a tree and a trail; bottom row from left to right: a plate, a wall, a window, a door and a place)

Table 2. Sample visualization results of various compositional principles

Compositional Principle	Concept Diagrams[1]	Possible Results
spatial contrast		
hide and show		
guide and hint		
scatter and compact		

[1] These concept diagrams are redrawn from Pon (1993).

twist and turn		
depth and layer		

4 EMPIRICAL STUDIES

We employ the proposed design method to create three virtual environments. Design elements are realized in the style presented in Figure 1. Furthermore, each design element is generated according to control rules to prevent repetition of identical design elements (e.g., identical rocks or trees). The first virtual environment, the virtual Chou Cheng Yuan shown in Figure 3, is a virtual representation of a real world environment. The second virtual environment is a web site (Figure 4) and the third a representation of a scene from a 3D computer game.

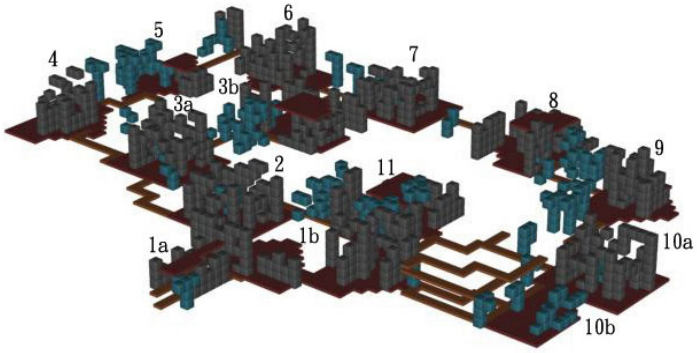


Figure 3. A visualization of virtual Chou Cheng Yuan

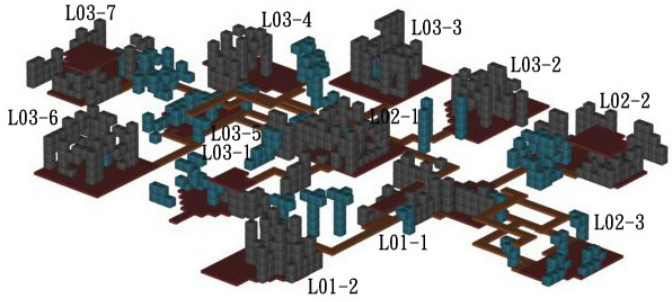


Figure 4. A visualization of NTUST Architecture web site

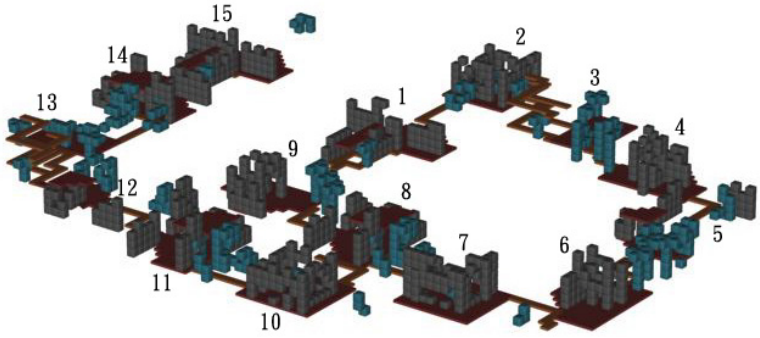


Figure 5. A visualization of a scene in "Return to Castle Wolfestein"

To learn the actual effects of these virtual environments, we conduct empirical studies. Two virtual environments, virtual Chou Cheng Yuan (Figure 3) and NTUST Architecture web site (Figure 4), are tested in the studies. Twelve people participated in the studies. All of them are graduate level students; six have spatial design (architecture) trainings and the other six have not; also among them, six play little or no 3D games and the other six play often. Participants perform tasks of navigating through assigned virtual environment. At specific points during the navigation task, hints popup up on the computer screen and instruct participants to answer spatial experience related questions. All experiments are conducted using a desktop computer system with a joystick (Figure 6).

Figure 6. The system set up for empirical studies

The results indicate that the two virtual environments provide spatial experience as intended. The background training of participants does not show strong influence in the studies. Also in our observations, participants with 3D gaming experience seemed to navigate the virtual environments much more easily than those with little or no gaming experience.

5 CONCLUSION

We present a design method of virtual environments based on the design principles of Chinese gardens. We demonstrate the method through the creation of three virtual environments. In addition, we report results from empirical studies to show the effects of two virtual environments. In the demonstrations, we visualize the virtual environments in three-dimensional spaces. It is because in such environment users may directly relate their experience in the physical world without having to learn new ways of interaction. And it helps us to define our empirical studies in a manageable scope. Furthermore, it addresses a more "conventional" or "engineering-oriented" discussion of virtual environment design, where the term virtual environment is analogous to "virtual reality environment" (e.g., Darken and Sibert 1996; Dieberger 1998; Ingram et al. 1996).

Nevertheless, the design method itself does not restrict the visualization into a particular way. This research is inspired by discussions raised by architects and designers (e.g., Benedikt 1991; Bourdakis and Charitos 1999; Fencott and Isdale 2001; Gu and Maher 2001). We plan the future development to focus on studying various ways of realizing/visualizing the design elements. This in turn will drive the realization/visualization of virtual environments to allow further exploration of cyberspaces.

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