The Design of Spatial Sequence Based on the User Experience and the Virtual Reality in Interactive Environments

Jing Zhao[1],*

[1]1st School of Computer Software, Tianjin University, Yaguan Road 135, Jinnan District, Tianjin, China

Abstract

The paper explores the design of spatial sequence on the basis of the user experience and the virtual reality technology in interaction environments. First, for people's physiological and psychological feelings in the process of experiencing the space, the paper analyses the thought about five senses and the abstract thought from the thought field. Then it analyses the balance of the psychological field and physical field, and emotional experience. After that, the paper puts forward how to control spatial sequence from three points: the experience design of perception, the experience design of touring route and the experience design of speed. Finally, the paper presents a new method for designing spatial sequence. The research results could be widely used in environmental design, game design, animation design, film and television, and other design and innovation fields.

1. Introduction

Spatial design of interaction environments cannot lack of controlling the spatial sequence, it gives the space life, happiness and energy. The sequence and the sense of movement in environmental space mainly comes from the spatial relationship between each element. The organization and formation of space are divided into two domains: material and spiritual domains. The former one is based on the natural conditions and artificial landscape space design, affected by natural, history and culture factors, aesthetic ideas, implementation technologies, etc. The latter one is the psychological aspect which is based on users' feelings of the space and recreates the space again. It not only contains subjective emotions of people, but also contains objective environmental space where the people are in.

The service object in spatial design is the person. So the design should exploit fully humans' physiological and psychological feelings in the process of experience. The external environmental stimuli could lead to some physiological and psychological reactions, which come from user's experience behaviour. People feel the environment through their experience and need the help of physical and mental feelings and observations of the environment. At the same time, the environmental space itself is the place where experience behaviours act. The user experience can also drive the change of space sequence.

The involvement of the virtual reality technology increases timeless and incorporeal properties on the basis of the traditional environmental space design. The space which is created by this way itself has more abundant connotations and information, and thus it can convey more meanings of the space to people. In turn, it promotes the arrival of the new design method and improves the

---

*Corresponding author. Email:zhaojingliz@163.com

design of spatial sequence in interaction environments. This paper analyses and puts forward a new method for designing the spatial sequence, which is based on the user experience and virtual reality technology.

2. Theoretical Foundation of the User Experience in the Design of Spatial Sequence

2.1. Thought Field

First, the thought about five senses. Five senses includes vision, hearing, touch, taste and smell. Rudolf Arnheim refers the relationship among thought, perception and creation in Art and Visual Perception [1]. The creative visual perception accounts for 90% in the five senses. Today, the usage of virtual reality and augmented reality technology not only brings technology innovation to the space creation, but also presents a new thought and innovative way by five senses to convey information. At the same time, the current development of virtual reality technology focuses on the research and development of five senses experience and interactive equipment. Through five senses, media, behaviors of thinking, the observation of things around, cognitive and analysis method are affected. Traditional way of people's experience, distances, habits can only mobilize humans one or two cognitive modes, while the thought about five senses leads a new thinking view and creates a new experience way. In addition, the traditional design form is confined to one-way transmission, users cannot participate and the design's attraction decreases. The usage of virtual reality technology has high immersion, interactivity and perceptual characteristics, and enhances the user experience feelings.

Second, the abstract thought. By using unconventional thoughts to design in an opposite direction, which makes the perspective multidimensional and makes the object in a two-dimensional plane to present the characteristics of stereoscopic effect. Such as cubism style, it extends the observation point from fixed and single angle to more angles and breaks the conventionality of the traditional perspective science's observation. It makes the same object's front view, side view, back view and other views in one plane. Picasso's painting, Les Demoiselles d'Avignon, uses geometry to describe the object and makes geometric space of the background form a whole space. Nowadays, this visual presentation surpasses a single form and has been confirmed as humans' objective visual perception. The real environment which people can observe is based on the vision that can be apperceived from multiple dimensions, then on the basis of model processing. Finally, it gets a stereo image. The space concept and the time dimension of this thought just reflects the characteristics of the spatial design.

2.2 Psychological Field

First, the balance between psychological field and physical field. People's judgment of new things is based on their experience and subjective forecast, and on the basis of the current situation and experience association, then makes inferences jointly. When personal experience and objective reality is not unified, psychological suggestion would use wrong image in current image perception. Visual illusion is produced. They are also a set of corresponding concepts in Gestalt psychology: psychological field and physical field. The former one is people's perception of reality, the latter one is perceived reality. Gestalt psychology has confirmed that when people are facing no order creative raw material, people would sort them according to their own preferences. This suggests that visual art behaviour is not objective behavior which is based on the subjective vision. It is different from the photograph which could represent their original state objectively and be accepted passively. It gets the innovation of visual illusion through visual stimulation, subjective deviation and experience projection. In the design of spatial sequence, using the contradiction between two concepts with the destination can achieve amazing visual effect.

Second, emotional experience. In addition to having a certain entertainment value, every environmental design should meet the affective demand of audience and take the task of their self-identity. As many avant-garde and experimental animation works, they transcend the traditional and mainstream art forms. The visual center focuses on non-mainstream form, seeking the audience emotional appeal. Kandinsky discusses the image, color and other visual symbols deeply. He believes that only with emotions, artists and audiences can move on together. Persist in a certain form would be into a dead end inevitably. Only let feelings express unlimitedly, work could obtain infinite freedom. Because the former one would be confined itself to the existence of the substance, the latter one follows the spirit. As one form of the experience design, environmental design needs to meet the demand of people's sensory and emotional experience, which also makes users understand the value of the design for humans' psychology by the works.

3 The Mastery of Spatial Sequence

3.1 Experience Design of Perception

Based on the above thought about five senses, the experience in communication of the spatial design has remarkable effect. Nowadays, with the development and application of sensor technology, sensory interaction is becoming more and more common. At the same time, perception mode has changed from one or two into the combination of multiple modes. Especially with the development and extensive usage of virtual reality

technology, many interactive perceptions don't need to rely on the objective existence of a variety of sensory stimulations. It could be replaced by the digital virtual interactive perception. Spatial design changes into virtual experience and real material experience changes into virtual experience. Different designs and experience have the same experience effect with the true stimulus in the human's psychology. On the basis of this technique, as people's growing demand for space interaction, the design of spatial sequence needs to break the traditional fixed and default mode. The introduction of multi-sensory experience control mechanism would realize the comprehensive perception and experience of five senses. In the process of design, techniques and devices should be introduced appropriately, such as sensors, data transmission, program process, feedback mechanism and many other various technologies and ideas. Through the color, lighting, sound, smell, touch and many other ways, it could stimulate the willingness of people's exploration, attract people to interact with the environmental space, create atmosphere of the space and strengthen people's immersive experience [2].

In addition, the corresponding behavior change and psychological change could also be produced by conditional reflex when people are facing different spatial sequence, which reacts on the space. At the moment, changes of people's experience are collected by the sensor of the space and be converted into the data which is handled by the program. Finally, it is transmitted to the display equipment, form the final interaction effect and feedback to people. As that cycle repeats, the spatial sequence could be changed in the interactive process between users and the space freely, producing positive achievement of "Human-Computer Interaction" (Figure 1).
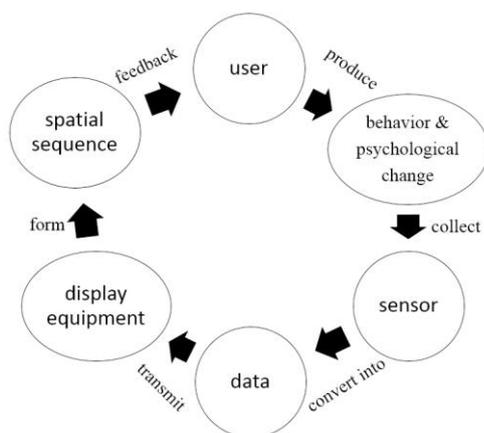

Figure 1. The process of Human-Computer Interaction

For example, the design of space installation, Displaced Resonance by John Fillwalk (USA, 2012), consists of sixteen sculpture forms, networked in a responsive grid controlling light and sound, based on visitor proximities. Full-range internal loudspeakers drive sound through the sculptures. A computer system using an infrared camera, tracks the movement of visitors and responds by controlling the distribution of sound to the tubes, while also controlling LED lighting associated with the sculptural forms. The prototyping process included both physical and virtual models to design and build both the form and the interaction. The physical prototypes were interpreted in a virtual model, investigating the spatial interaction of the structure with an avatar-where the sculpture interacted with avatar proximity and presence. The interactive functionality was scripted in the virtual world and again modeled in the sensored version in physical reality. After several virtual iterations, the form was recently re-interpreted and fabricated to have a physical form and be interacted with in a public context [3].

Another example is the design of China National Film Museum's atrium space. It is with the help of controlling colors by user experience. In the design, there are a large number of film montage processing techniques. Using black as the space's main color to create serious and introverted space atmosphere, interspersed with stained glasses. Exhibition Area, Expo Area, Cinema Area, Service Area, these four different functional spaces are represented by red, green, blue, yellow, respectively. There is an area of interactive experience on the central ring wall. People could receive different information of buildings through changes of space colors and interactive mechanism. The color of the wall could be different according to the requirement of the exhibition and the performance.

Bill Seaman and Todd Berreth (USA), design an outdoor architecture named A China Many Senses (VR) (2012). The work explores aspects of programmed mechanic creativity via a generative emergent computational system and draws on an extensive database of specific models, video materials, digital stills, audio materials, and textual materials that are combined and recombined in an ongoing intelligent manner, via authored proprietary code (written in C++/OpenGL/Open Frameworks). The image of the art work is put into the real space by using three projectors at the same time and presents different architectural spaces [4].

3.2 Experience Design of Touring Route

The design process of spatial experience also need to rely on a certain touring route to implement and complete. Route control is divided into behavior route control and technological route control generally. Behavior route can be interpreted as "path" simply. In the progress of designing the spatial sequence, behavior route design is the main route to complete experience process for users, but it is not the only route. Designers can design multiple routes for users to choose according to different interactive plots of landscapes. Then different effects of landscape spatial experience could be realized. At the same time, the sense of mystery and attraction in space exploration can also be increased.

Technological route control could be understood as a technology media for users to complete their experience process. Different media of the technology directly affects the effect of user experience and the result. For instance, when you visit a city square, you can walk, or by bike, or by sightseeing car. And the selection of these technical application modes affects the selection of subsequent experience routes directly, which means people's experience of the landscape would be different and the experience of the space by different technological routes would be different. In the experience of the environmental space supported by the virtual reality technology, people could obtain completely different feelings of the immersion experience, because technical equipment (naked-eye stereoscopic display, multi-channel stereoscopic projection, headpiece and digital glove, etc.) they choose are totally different. Take choosing naked-eye stereoscopic display as an example, although it is easy to operate relatively, the access to getting immersive feeling is the lowest. Relying on digital headpiece and digital glove, and even joined with the trajectory gyroscope and other external devices can improve immersive feelings to the top. The technology development has already could support this experience design of the space, but due to the expensive price of equipment, the technology is still mainly used in the virtual museum visiting.

The Parc de la Villette is a typical case which uses the route design to change user experience. The route system of the park is the representative work which the designer pays tribute to the film art. The whole route be made up of long corridors, avenues and theme gardens. The theme garden route is also called Film Walking Way. This path is like a roll of film. The road itself is a track, scenes consist of theme gardens are video tracks, theme gardens are connected by Film Walking Way. There are several intersections which are introduced by trees and avenues in the whole route, which breaks the sequence of linear combination and forms the "editing" effect that is used in film editing. Therefore, when people are walking on the Film Walking Way, they could choose different paths and feel different versions of the theme gardens' series: they could visit every garden along the trail, could also skip one theme garden directly into the next topic by an avenue, and could come back quickly to the starting point through the circular avenue. For another example, the spatial design of one square in Italy named IT Tree is a playful interactive installation. At the top of the tree, there are 3 ultrasonic sensor installations which could be used to measure the position of the human body. And the outcome transmits to the LED lighting system through open source microprocessors to control lights of IT Tree [5]. When people walk among them, the tree will be lighted. People's behavior and the touring route can affect the light effect of the forest [6].

3.3 Experience Design of Speed

In the design of spatial sequence, speed control is one of the important factors that affect users' experience. Speed factor in space generally consists of two parts: one part is the sequence of the space, another part is the speed of people's visiting and playing in it. The overall effect by two parts directly forms the overall sequence of the space. Controlling the sequence of environmental space could be with the help of the following means: the change and the transition of visual elements, the intensity of the sound, ups and downs of spatial form, speed transformation of light and darkness and feedback's frequency of people's interaction, etc. [7]. By controlling these elements, the control and the setting of the environmental spatial sequence could be realized. Conveying information of the space and decorating the space are more effective. Finally, make people involved in the interaction space actively and visit according to the designer's design idea.

In the process of designing people's visiting speed, there also has are some problems. When a person experiences the sequence of the same space repeatedly, he would form a corresponding feeling of the experience generally and be used to it. If the feeling and the sequence of the space remain the same or don't change significantly, people would feel tired. The attraction of the environmental space decreases. For this phenomenon, designers could strengthen greater control of the sequence in the design of space.

The model of time and space about people's sense of the experience could be introduced in the progress of the design. The design of the environmental space's organization is according to users' whole feelings of space. From the aspect of space, people's overall feelings is not a sum of their feelings of each space. The overall feelings should be more than the sum of the each part. From the aspect of time, people's overall feelings is equal to the sum of persistent feelings and instant feelings about all the space. This is due to human feeling of new space would be affected by the feeling of existing space, then they would have instant feeling (Figure 2). Therefore, users' overall feelings should be more than the sum of the each part. And Instant feeling is the key to leading people to visit in the space and designer can set appropriate visual stimulation in a short time to increase people's instant feelings [8].
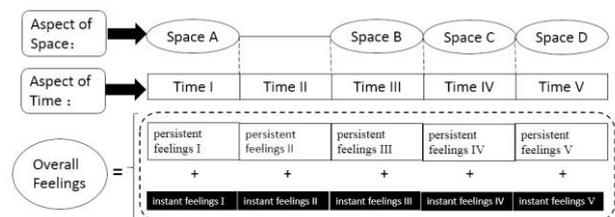

Figure 2. The model of time and space about people's sense of the experience

With speeding up the sequence of space, the continuity of spatial sequence strengthened gradually. The distant view is relatively stable and the nearby view is blurred. For example, the advertisement in subway appears

continuously, which is easy to make the audience be tired of watching. So the sequence and the content in subway's space should be changed in accordance with the certain sequence. The speed of changing scenes should be in charge of the speed of the passengers' movement. By the combination of the real scene and the virtual scene, the speed of changing scenes is controlled and it brings passengers immersive experience. People would experience fresh feelings constantly.

4 Conclusion

The creation concept, space design and daily life all emphasize user experience and user centered design. The cognition and understanding of spatial sequence could help designers design space in interactive environment better. Through the experience of environmental space, people could obtain different interesting feelings from the space to meet their emotional appeals. At the same time, combining with the concept of virtual reality, designers introduce corresponding control mechanism for the sequence of experience and produce different design solutions [9]. By combining with other elements of spatial design, the comprehensive construction of environmental space would be realized and give people immersive, interactive and diverse experience.

References

[1] ARNHEIM, R. (1954) *Art and Visual Perception: A Psychology of the Creative Eye,* 1st ed. (Berkeley and Los Angeles: University of California Press).

[2] PSARRA, S. (2009) A*rchitecture and Narrative: The formation of space and cultural meaning,* 1st ed. (London: Routledge).

[3] ARMSTRONG, K.M. (2012) Re-imagining Static Utopias: Unraveling the Bat/Human Problem. In *Art and Science: Thesis Collection of the 3rd Art & Science International Symposium*, China, 2012 (Beijing: China Architecture and Building Press), 38–47.

[4] Vision Union, http://www.visionunion.com

[5] Environment, Ecology and Economic, http://www.ela.cn

[6] MARTGOT, L. (2004) *Digital Currents: Art in the Electronic Age*, 1st ed. (New York: Routledge).

[7] NASAR, J.L. (1987) The Effect of Sign Complexity and Coherence on the Perceived Quality of Retail Scenes. *Journal of the American Planning Association* **53**(4): 499-509.

[8] Liu, B.Y., Zhang, T. (2010) Landscape Space Sequence Organization Based on Visual Sense 基于视觉感受的景观空间序列组织. *Chinese Landscape Architecture* **26** (11): 31-35.

[9] KOUTSABASIS, P., VOSINAKIS. S., MALISOVA. K., PAPAROUNAS, N. (2012) On the Value of Virtual Worlds for Collaborative Design. *Design Studies* **33**(4): 357-390.