Research on Application of Assembling Parts Method Based on Virtual Reality Technology in Interior Design

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Abstract. The research of this article originated from the reflection on the methods of interior design training after the intervention of new technologies. Due to the wide application of virtual reality technology, it can intuitively display the material, texture, color and other very concrete things of interior design. It helps designers form a good spatial perception ability, thereby solving the problem that traditional design tools cannot solve the problem of insufficient expressiveness of hand drawings and models. However, the designer always pays attention to the description of the details. This kind of interior design usually has a good partial decorative effect. At this time, the internal abstraction order is often ignored by us. As a result, there is a contradiction between the concrete perception and the abstract order, and the effect of interior design based on VR technology is out of touch. Therefore, how to harmonize and unify the concrete perception and abstract order of interior design based on virtual reality technology is my focus. In this paper, the assembly method is applied to the interior design involving virtual reality technology. Through the operability, repeatability, and strong logic of the assembly method, the contradiction between the above-mentioned concrete perception and the abstract order is solved, and the application of virtual reality technology is realized.

Keywords. Virtual reality technology; interior design; assembly component training method.

1. The Problem Is Raised: The Contradiction after VR Technology Intervenes in Interior Design
In recent years, the use of VR technology in interior design has become more and more extensive [1]. With its three major characteristics of immersion, interactivity, and conception, the technology is intuitive to the spatial logic, form composition, texture organization, and furniture styles of interior design. The display makes up for the insufficiency of the two-dimensional performance of the drawing, and increases the realism based on the data model. VR technology meets the urgent need for direct observation of the spatial state, promotes the perceptual recognition of material texture and color, and enables fuzzy design imagination to be quickly presented and corrected. This technology, which can greatly improve spatial perception, induces a wealth of design imagination, and at the same time exposes another shortcoming of the design process: the control over the overall order. Because when VR technology intervenes in interior design, many things, multiple horizontal spaces, and multiple floors in the space are in the vertical space, and the split and cutting off are exposed during VR roaming. For example: in the design of the A5 comprehensive building on the University Town campus of South China University of Technology, VR technology solves the design and matching of furniture and display racks, and then proposes materials, colors and furniture matching schemes for different functional rooms, but the disconnection lacks overall order, making The entire reconstruction design project is designed to be modified again after the functional spaces are determined, in order to unify the overall formal order. So how to deal with the contradiction between the concrete perception
and the overall order brought by the VR technology to solve the interior design perception is the focus of our research [2].

At present, the focus of theoretical and applied research is usually after the introduction of VR technology in interior design. Due to the perception of the scene, furniture or materials are the focus, such as how to choose the right cabinet or sofa, how to match the shape of the wall and ceiling, and there is a lack of research on "VR technology moving towards the overall order". According to the research, it can be concluded that the current virtual reality technology has been widely used in the field of interior design. It is usually used to transform design ideas into a real three-dimensional environment that can be interacted. Contradictions, there is still a lack of further understanding. The current interior design fails to solve the problems caused by the intervention of VR, which leads to the embarrassing situation of being unable to adapt to the new technology.

2. Problem Analysis

2.1. The Relationship Between Material Perception and Spatial Awareness

In the book “Four Elements of Architecture”, Gottfried Semper discussed two key concepts about space: enclosure and covering [3]. After materializing it, the four components of the building are formed: the enclosure wall, the roof, the abutment, and the stove. He believes that the architectural space is an introverted whole, which is defined by the combination of the above elements. This is the initial manifestation of "space awareness" in modern architecture. After that, he further developed the “enclosure” intention into the original motive of architecture in “Technology and Style Issues in Constructive Art”, and pointed out that weaving is the original technical means of wall enclosure [4]. Semper made a bold conclusion: the origin of architecture and the origin of weaving are the same. However, only by considering the constituent elements of architecture can we understand the primacy of weaving. He insisted on the principle of “wall” not only to limit the space, but also to express the space clearly, because it not only envelops the scene, but also provides a visual content for the scene. In other words, this architectural element not only encloses the space, but itself can be presented, or it is both spatial and visual [5]. In short, Semper’s theoretical claim can be expressed in the origin of architecture. Fabric is very important because it constitutes the visual space limiting element in architecture. It means that light-weight opaque coatings or transparent or translucent enclosures are the fundamental elements in the space limitation, and the motivation for enclosure is to obtain internal space.

Semper’s view has led many contemporary architects to regard space limitation as the basic issue of architectural design [6]. Compared with Semper, Luz explores space more in practice, and tends to pay attention to the surface properties of materials. The meaning of space volume. Classic concepts such as Raumplan and principle of cladding proposed by Adolf Loos have influenced a series of modern architects such as Le Corbusier. Luss said: “I did not design planes, facades, or sections. I design space.” Luss’ words expressed an attempt to transcend the concept of “space enclosure” in the abstract cognition on the plane, and in the three-dimensional latitude. The integration of the space has a certain tendency towards concreteness. Take the Muller house in Luz as an example: the apartment is divided into six parts and is relatively regular, but in conjunction with figure 1a, it can be seen that the space is very different from the traditional interior design. The living room is a “box”. Not as an “independent space”, but to distinguish different space composition through height difference, ceiling form changes, and furniture groupings. There is no absolute independence but a rich and flowing outward-looking space to stay in it. From the perspective of people, distinguish the interface of enclosed space and the interface of space transformation. Figure 1b, as the reception area of the hostess’s room, also implies such a more private space through the change of height difference and the drop board at the top. People move in different sceneries inside the house, and when residents move in the room, they feel the sense of space penetration and intricate changes in perspective brought by the walls, furniture and materials. This is undoubtedly a concrete transformation of revolutionary significance in the gradual process of the concept of space.
2.2. Space Form Experiment Proves the Feasibility of Integrity

In the 1950s, a group of young people from the Texas School of Architecture in the United States gathered together to discuss and develop new teaching plans. They reviewed the basis of modern architectural space forms and explored the methods of systematically teaching modern architecture. Mutual influence and stimulation, and innovate an architectural design model centered on establishing a spatial form [7].

In previous formal training, Hejduk saw the possibility of a grid composed of nine cubes as the spatial structure of the building: the intersection of the grid is erected in the vertical direction to become a column; the horizontal connection between the columns is it is a beam; in this frame, the bottom surface becomes the ground, the vertical slab becomes the wall, and the horizontal slab becomes the floor [8], such an abstract spatial form of “point-line-surface”. The elements are connected with specific building components such as “beam-column-slab”. As a result, the Jiugongge exercise has become a classic exercise for the introduction of architectural design (figure 2). The Jiugongge exercise in architecture teaching uses pre-set elements and frameworks to clearly define the form and space of the building, so it fully realizes the grasp of the spatial integrity during the exercise.

Under the exercise of Jiugongge, students begin to explore the meaning of planes, elevations, sections and details, and begin to understand the relationship between two-dimensional pictures and
three-dimensional (model) forms [9]. To enable students to continuously convert between drawings and models, between two-dimensional planes and three-dimensional spaces, and between corresponding abstract forms and classic objects. Because students are unable to focus on style, decoration and function under the preset elements of “rods, plates, and blocks”, familiarity with and mastering the methods of building space operation becomes the primary focus of learning. Natural students’ grasp of the overall order of space will be rapidly improved, and they can understand architectural space from different dimensions and different levels of abstraction.

2.3. Exploring New Ways to Resolve This Contradiction:
Moving from material perception to spatial awareness is actually a process from scene perception to scene order conversion. After VR intervention, this contradiction has not been resolved or even intensified. The foothold of this training method lies in the functional layout of the place, and the content expressed will also fall on the figurative level of graphic effects, specific functional forms, styles and decorations. The result is often a good drawing effect, a formal, and partial decoration effect, but the actual spatial experience and abstract order are not as desired. The training methods currently used by designers cannot achieve the overall unity of the abstract order in the application of VR technology, and even because of the intuitive experience of 1:1, the contradiction between the concrete perception and the abstract order is intensified.

3. Method Reference: The Characteristics and Transplantation of the Training Method of Assembly Parts
The assembly component training method is a design method centered on the study of space problems. Because concrete things are more easily perceivable by our human eyes, in order to focus on the spatial form, it is temporarily ignored in the design process. All the figurative factors such as decoration, style and construction are taken into consideration. Professor Zhu Lei of Southeast University defined the assembly component training method to design correspondingly with a set of predetermined elements. The classic of the assembly component training method is that it avoids the interference of all visual decoration factors in an abstract form. The abstract components and intuitive component operations are conducive to focusing the research on the space problem itself. The improvement of traditional interior design teaching provides important enlightenment on methodology. The assembling component method has been successfully applied in the basic teaching of architectural design in both theory and application practice. In an abstract form, it avoids the interference of visual decoration factors, and focuses the design focus on the overall order itself, which is the training method of traditional interior design. Improvements provide important inspiration.
This design training method can not only remove style and decoration through abstract components, and focus the design on the formal order of the space, but also use the immersive, interactive and conceptual characteristics of virtual reality technology to improve the details of the interior design, so that the overall order is coordinated. On the basis of the design, the detailed design is also worthy of our scrutiny. Therefore, this research hopes to solve the contradiction between the intensified concrete perception and abstract order of interior design based on VR technology through the introduction of the assembly method.

4. Problem Solved

4.1. Method: Abstraction and Organization
The three abstract elements commonly used in the assembly method are rods, plates, and blocks, which correspond to beams, columns, walls, floors, and rooms, as shown in figure 3 below. The above three abstract elements also have different restrictions on space due to the volume: the volume of the rod is the smallest, so the effect on the space restriction is the weakest; the volume of the plate is moderate, so the restriction on the space is also Medium level; the volume of the volume is generally very large, so the restriction on the space is the strongest [10].
Figure 3. Real architecture uses abstract element representation diagram.

In interior design, there are not only architectural components, but also many furniture facilities. The decoration and style of furniture facilities are more diverse. When abstracting, you can still follow the three abstract elements of rods, plates, and blocks, such as the bed. The volume is large and can be abstracted as a volume; the table can be abstracted as a combination of rods and plates, etc. The ultimate goal is to remove the decorative perception factors, leaving only the most fundamental form. Affect the formal order of space. In terms of influencing the form of space, a large volume has a strong role in limiting the space, and a small volume has a weak role in limiting the space, basically showing a proportional relationship. For example, when a huge wardrobe is abstracted into a volume by us, its limitation of space is clear and obvious, and a certain clear space can be divided. And some screens are abstracted into plates by us, which are relatively weak when the space is limited, so we can only simply distinguish the order of the space.

With the operation of abstract components, the second point of the method of assembling components is to manipulate abstract elements to achieve spatial changes, with rods—adjusting function, plates—defining function, and volume—occupying function. Because the volume of the rod is small, it is mostly used as an adjustment space in the tissue space. Different space states can be realized by adjusting the thickness, density, and so on. The role of the plate in defining the space is moderate, so it has a defining effect. The plate can be used to define two spaces, but the state of the space cannot be completely closed. Because the volume is large and the consciousness of occupying the limited space is very clear, the volume has an occupying role. It can clearly and clearly define an introverted space, and at the same time clearly distinguish the inside and outside of the space. Although these abstract elements do not have complicated decorations and styles, they can be combined to form a rich space experience. It is this characteristic that can be used as an effective method to solve space problems.

4.2. Design Practice

In order to verify whether the assembly component training method can solve the contradiction between the concrete perception and the overall order after VR access, I conducted experiments in the A5 teaching building renovation project of the University City campus of South China University of Technology. The project is located in the University City campus of South China University of Technology, at the end of the north-south axis of the campus. It was originally used as a public
teaching building and later used as classrooms, offices and exhibition halls of the School of Design. Therefore, the project mainly focused on transforming functions as the first priority.

Figure 4 is a functional area map. The first step: Plane function consideration. The area of the first and second floors of A5 is about 2500m². In this limited area, it is necessary to accommodate 3 professional environmental design classrooms, a model making room, an exhibition hall, and 2 teaching and research rooms for teachers. Teachers and students of design majors need to carry out classes, academic exchanges, workshops, model making, exhibitions and other uses in these two spaces, which has great demand for the area of the venue. Then, under limited site conditions, I finally decided to use the multifunctional transformation of space to solve the problem of insufficient area when designing, and to cleverly integrate the functions, so that a site can be used in different time periods and different usage scenarios. Changes in furniture or different ways of use can be achieved.

The following figure 5 is a real-time screenshot considered in VR. Because the angle of the screenshot is distorted, the rendering effect is low in clarity, and it is not easy to review, so all subsequent pictures in the article are VR renderings, not real-time screenshots of VR operations.

The second step: facility componentization. The wall interface and furniture facilities are the two key factors in the interior design. Under the specific functional requirements, the interface and furniture are complex and diverse in types and presentation forms. Therefore, when we are doing design, the first step is to focus on the interface and furniture. How to abstract and organize these complex and diverse components is the key point of method transplantation [11]. After the intervention of the assembly parts method, the complex parts in real life are abstracted according to the preset parts of rods, plates and blocks, and abstracted according to their volume size, external form, and functional requirements. For example, walls and floors can be abstracted as slabs, pillars and railings can be abstracted as rods, beds and rooms can be abstracted as blocks, etc. The abstract and simplified parts make us ignore the decoration and surface style and focus on the organization of the space (figure 6).
Figure 6. Schematic diagram of abstract components.

The third step: organize the space. First adjust the parts so that the “empty” area is continuous and there is a sense of graphics in it; secondly, put the actual function into each part, think about the function and streamline, and then do the “empty” part again Adjustment. Such a spiral of scrutiny enables us to obtain a good spatial order in the organizational space stage, and at the same time a reasonable result in the functional layout. The picture shows that the refinement was made in the previous stage, and the plates in front of the academic ladder were changed to rods, which made the space more fluid and strengthened the spatial connection. The core tube is surrounded by a layer of plates, which can not only increase the exhibition function, but also realize the unity and integrity of the interface (figure 7).

Figure 7. Schematic diagram of organizational space.

The fourth step: rich colors and textures in VR. After using VR technology, a distinction is made between the elements of the original single material. Distinguishing means difference and contrast, it means establishing an order between new elements and spaces on the basis of the original order, and seeking richer expression content on the basis of abstract forms and expressions of space. We mainly consider three characteristics of materials in VR: material texture, such as the contrast of wood and metal materials; color and lightness, such as the contrast of various colors of walls; material transparency, such as transparent materials, translucent materials and Contrast of opaque materials. Through immersive observation, we can perceive the influence of material distinction on space perception (see figure 8 for the results).
5. Conclusion
The wide application of virtual reality technology, with the help of its three characteristics of immersion, interactivity and conception, has an intuitive display of the spatial logic, form composition, texture organization, furniture styles, etc. of interior design, which helps designers to form a good the space perception ability solves the problem of insufficient expressiveness of hand-drawn drawings and models of traditional design aids. However, students focus more on concrete perception, such as: material craftsmanship, furniture styles, lighting effects, etc. This kind of interior design often has better concrete effect, but the abstract spatial order is not so ideal. Therefore, after VR intervenes in interior design, how to realize the conversion of concrete perception to abstract order is a difficult problem for us. As an effective space design exercise, the method of assembling parts has been successfully applied in the basic teaching of architectural design. Its abstraction, preset elements, and component operations make the research of spatial forms more targeted and help to make complex designs. The process is completed in a more clear and intuitive way, which can play an effective auxiliary role in cultivating logical design thinking and rational design decisions. In view of this, this article attempts to transplant the assembly component training method into the interior design of VR intervention, and proposes corresponding improvement strategies to guide the design practice for a series of problems faced in space research after VR intervention.

This research firstly draws a strategy for the assembly method to solve the contradiction of interior design based on VR technology, and deeply analyzes the VR intervention interior from the perspectives of the development of “space” awareness in interior design and the neglect of the original training method of interior design on the order of space. After the space design, the contradiction between the concrete perception and the abstract order brought about; then analyzed the characteristics of virtual reality technology, the application status, the scope of application in interior design, and further analyzed the reasons for the original contradiction and how it aggravated after the intervention of VR. This contradiction; then through the analysis of the general situation of the assembly method, the feasibility of applying it to interior space design, and the analysis of two practical application cases, the focus of the main solution of this research is finally reached. Secondly, we obtained the application of the assembly method based on VR technology to the interior design results. By using this strategy for design practice, the results of the A5 teaching building renovation project realized the use of VR technology in concrete perception, and the abstract order of the effect space presented at the
same time complete and clear, and achieved the original design goals. At the same time, this design practice also verified that the assembly method can solve the contradiction between the concrete perception and abstract order of interior design based on virtual reality technology. It provides a reference for methodologies and system strategies for interior design to adapt to new technologies, and provides a strategy for resolving contradictions for designers who subsequently use virtual reality technology for interior design.

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