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## Virtual Simulation Technology Research of Energy Saving Building

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**Abstract:** The virtual simulation technology is applied to energy saving building to solve the problem of public's energy awareness is weak and inadequate knowledge of energy conservation. Taking the "Tian Di Hui Cheng" residential area in Zhengzhou as study subject, according to the Zhengzhou climate conditions and base location of residential area for energy saving design, using the SketchUP software complete energy-saving design show, 3dsmax in modeling, rendering and animation production, VRP software used in virtual reality production, so that the general public could "personally on the scene" understanding of energy-saving building, be helpful for energy saving principle, energy saving knowledge publicity and popularization.

**Key words:** Virtual simulation, virtual reality, 3D visualization, energy-saving building, double skin curtain wall

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### INTRODUCTION

Energy has been paid great attention after the oil crisis in the early 1970s. Even though countries across the world have done researches and adopted various countermeasures, the increasing of the overall consumption in the world keeps rising. Among the continuing energy consumptions, be it in a developing country or in a developed country, construction energy consumption relatively accounts for a big proportion in a country's overall energy consumption. Construction energy consumption consists of such energy consumptions as in the production of building materials, in the building operations, in the construction operations and in the demolition of the buildings. Among all these, the biggest energy consumption (about more than 80%) comes from the construction operations (mainly from heating system, air-conditioning, hot-water system, lighting and household appliances) (Jiang and Lin, 2006). Therefore, many countries take saving energy consumption of construction as a key emphasis in work. As one of the basic strategies of the sustainable development in china, construction energy saving has accomplished remarkable achievements in standard establishment, the research, development and promotion of products and implementation of projects. However, there are still many problems concerning construction energy saving in china. The public's weak awareness of and shortage of knowledge about energy saving is an

important factor blocking the energy development in china. The public is the terminal consumer of the residential buildings, whose awareness leads to his actions and further has an influence on the kinds of buildings a real-estate will design and develop. Thus, the shortage of awareness of energy saving and the shortage of demand for energy saving building, together with the real-estate's consumer orientation lead to a shortage of enthusiasm for energy saving buildings. If a systematic and clear platform of design, research, communication and management can be created, it can help with the promotion of notion, technology and products of energy saving buildings, but also the overall design of a construction plan. With regard to this, together with application analysis of a practical project, this thesis proposes that virtual simulation technology should be applied in energy saving buildings, therefore, explores a new method to combine the design and research of energy saving buildings.

3dsMax can realize a three-dimension virtual simulation of a construction to create a visual and interactive platform of construction design. Through 3dsMax, a three-dimension virtual simulation of a energy saving construction can be realized. the proposed building, especially the components greatly influencing energy saving, can be shown clearly in front of the designers, researchers and users. Virtual simulation technology can bring people into the real scene of a construction. Only by watching on a computer, can a

person learn clearly about the outlook, building materials and influence on energy saving of a construction, which has important guiding significance on the design and research of the energy saving of a construction.

**APPLICATION OF VIRTUAL SIMULATION  
TECHNOLOGY TO CONSTRUCTIONS  
APPLICATION OF VIRTUAL SIMULATION  
TECHNOLOGY TO ENERGY SAVING OF  
CONSTRUCTIONS**

Energy saving of a construction, in a word, is to realize the energy saving in the process of manufacturing building materials, building a construction and using a construction under the guidance of polices and based on energy saving technology and products. Energy saving of a construction is not just an accumulation and display of energy saving techniques, but a whole range of researches including site selection and layout of a construction, energy saving techniques of enclosure and maintenance of a construction, ventilation and energy saving design, energy saving of lighting, the utilization and design of solar system, heating and air-conditioning system and operation and management of a construction. At present, the research of energy saving of a construction involves the promotion of heat insulation, heating and air-conditioning system (Zhao, 2009).

There are two important application of virtual simulation technology to energy saving. One is energy consumption simulation and the other is the virtual simulation of a construction. Through virtual simulation, when designing a construction, an architect can get a vivid and living experience, which will arouse his creativity and inspiration, largely reflecting the spatiality of a construction on the designing stage. By doing so, the spatial experience in a construction design is more interactive and flexible, thus enhancing authenticity. Energy saving, as a major target of modern architecture, melts gradually into the design of a construction plan. The existing virtual simulation software can realize the three-dimension virtual simulation, making the overall design of a construction, especially the components influencing energy saving in a construction, vividly show themselves in front of the designers and researchers. Based on virtual simulation technology, people can personally on the scene and have a full eye on the overall effect of energy saving, which has important guiding significance on the design and research of energy saving constructions. Meanwhile, the application of virtual simulation technology can be utilized to propagandize energy saving, which is helpful to popularize knowledge of energy saving constructions to the public.

**VIRTUAL SIMULATION DISPLAY OF “TIAN DI HUI  
CHENG”**

Tian Di Hui Cheng residential area locates 300 meters to the north of intersection of Changjiang Road and Lianyun Road in the city of Zhengzhou, a second phase of the overall project. To north of the site location lies a park named Shuangxiu, which makes the place beautiful and a proper place for people to take a walk.

Zhengzhou lies in a cold area according to thermal partition, having four distinct seasons with hot, rainy summers and cold, dry winters. It has longest winter and shortest spring and summer with summer in between. Different climates demand different designs for energy saving. Thus, the energy saving design in Zhengzhou need firstly satisfy the needs of heat preservation in winters and meanwhile heat proof in summers. Based on the climate of Zhengzhou and site location of Tian Di Hui Cheng, the energy saving buildings of Tian Di Hui Cheng adopts “double skin”curtain wall, inverted roof and solar system to save energy. Thesis lays great emphasis on the virtual simulation display of the “double skin”curtain wall.

In constructions, natural light and ventilation are greatly adopted to save energy. Natural ventilation is a kind of ventilation adopted largely in modern eco-constructions to replace mechanical ventilation and air-conditioning (Zhang and Yao, 2010). However, while curtain walls made of glass provides good lighting, it bring the high energy consumption of heating and air-conditioning. From the angel, it is obvious that there lies a contradiction between natural lights and energy saving, but “double skin” curtain walls can solve it. “Double skin”curtain walls have good effect of heat preservation and proof (Cen and Kou, 2010). In winters, the closure of exits of the outer curtain wall will make a warm housing in the ventilation passages. The sunlights in the day heats the air in the house and temperature rises, which lower the temperature differences of inner curtain wall to prevent the hot air from discharging. At night the temperature outside the house falls, the hot air preserved in the curtain wall passage compensates the heat to the outer curtain wall to keep the heat in the house. Night or day, “double skin”curtain walls can preserve the heat. In summer, when the entrance of the curtain wall is open, air flow principle of hot pressing and chimney effect make the curtain wall draw air into the passage. The air in the passage absorbs heat, resulting in a bottom-up thermal motion to bring the hot air in the double skin wall out of the double skin wall, which lowers the temperature in the inner curtain wall and achieve the effect of heat proof. In addition, “double skin”curtain wall has very good sound insulation effect.

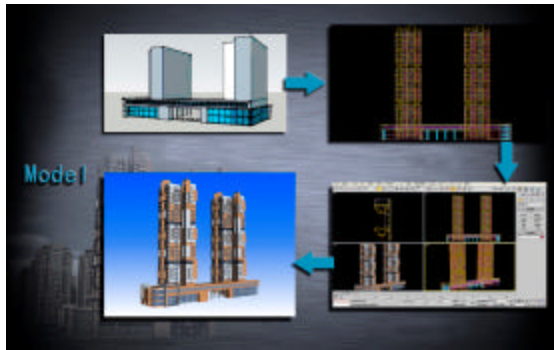


Fig. 1: Process of modeling

The thesis take advantage of SkechUP to display the conceptual design of constructions, 3dsMax to make three-dimension models, rendering and animation, VRP to virtualize the reality and After Effect to complete post-production.

### CREATION OF THREE DIMENSION MODELS

Modeling is a process of creating stereoscopic models in a three dimension environment. In order to present the design notion, SkethUP is firstly used to create a draft model, depicting the main layout and the distribution of function areas, which is very convenient. After the plan is determined, 3dsMax is applied to create elaborate models and render. In modeling, the principle of bottom-up, general-specific and far-near is adopted. In terms of objects far from viewpoint, details can be simplified to reduce faces in order to lay a solid foundation for rendering and animation in post-production. Figure 1 is the process of modeling.

### VIRTUAL ANIMATION PRODUCTION

After modeling, the correspondent materials should be appointed according to the model and parameters need to be adjusted to achieve the authenticity in the model. Then, lighting should be applied to the environment for an object show its stereoscopic shape in a proper light and the light determines the effect of the whole scene. Before lighting, the light and dark proportions should be arranged well based on the principle of key light, fill light and background light. After that, rendering comes along. In fact, rendering appears in the whole process of modeling. In modeling, rendering is needed to observe the effect of the model and adjust parameters. Yet, the final rendering is a very important step, for the project mentioned in the thesis has a very large scene, it needs a relatively long period. Figure 2 is the process of rendering

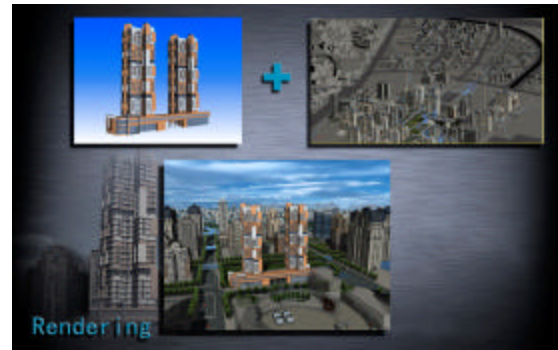


Fig. 2: Process of rendering



Fig. 3: Animation and the process of post-production



Fig. 4: Visual effect

and Fig. 3 is the animation and the process of post-production. Figure 4 and 5 are the visual effect and bird-view effect respectively of Tian Di Hui Cheng.

Finally, the three dimension model completed can be channeled into VRP platform to examine the construction by zooming in or out, rotating or locating.



Fig. 5: Bird-view effect

### SUMMARY

Taking Tian Di Hui Cheng residential area as the research target, by analyzing and discussing the application of virtual simulation technology to energy saving construction, the thesis draws the following conclusions:

- Energy saving of a construction should be solely designed based on the specific location and climate, not just a display of energy saving techniques
- “Double skin”curtain walls have a better quality concerning heat preservation, thermal insulation, sunshade, natural ventilation and sound insulation than single skin curtain walls, which is much suitable in cold areas

- Virtual simulation technology has the qualities of vividness, interaction, intuition and super-reality. When it is combined with architect, be it in the plan, design, construction or application, it can greatly promote the develop of construction industry
- Virtues of virtual simulation technology determines the combination of virtual simulation technology and energy saving construction, which has a important significance on the propaganda of energy saving constructions
- Thesis just discusses the application of virtual simulation technology to the design of energy saving constructions. In the following researches, BIM can be absorbed in to apply virtual simulation technology to the whole phases of constructions

### ACKNOWLEDGEMENT

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