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Comparative Analysis on the Building Design Process Between Traditional Technique and the One Based on BIM Technology

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Abstract: This study described the traditional building design process and its main design content and also concludes its characters. And then, the building design process based on BIM and its content and characters, compared with the traditional technique, are analyzed. It suggests that the building design process based on BIM is better than the traditional one. But designers, contractors and clients need time, as transition period, to accept and use this new technique.

Key words: Building design, design process, 2D design technology, BIM technology

INTRODUCTION

Now one of serious problem for building design industry is all the information in the Entire Building Life Circle (BLC) is extremely fragmented. With a long-term history, building design industry has been developing a mature and popular traditional design pattern, which is two dimensional Computer Aided Design (CAD). Because of the fragmented information, the cooperation inside the minor project and activity is effective and efficient but the working efficiency of the whole building design team is extremely expected to increase. Individual designer works with high efficiency but, as a part of the team, every designer feel powerless to increase the team-work efficiency. Each designer, who works on different areas and takes part in the building design process, suffers inconvenience and inefficiency from this problem.

BIM (building information modeling) technology, based on the three dimensional digital technology, is a brand new building design model. It collects and manages effectively all kinds of information in the entire building life circle. Thus BIM technology, through integrating the process of the whole project, is capable of increasing the project efficiency, lowering the risk, decreasing the negative effects to environment and achieving sustainable building design. However currently, the applications of BIM technology are mostly focused on three dimensional browse and pipelines collision inspection and a quick BIM's benefit pattern have not been established. Therefore, this study discussed the two building design processes and find out the better one which develop with times.

TRADITIONAL BUILDING DESIGN

Design process: Construction project design commonly contains several phases including scheme, project design, preliminary design, detailed design and construction design, etc. During the concept design, preliminary design and detailed design phases, the thoughts of architects have been visualizing and specifying. In traditional design where two dimensional drawings were manually generated, the formal construction design drawings have to be regenerated after the conception design drawings. As for construction design, prior conception design drawings are hardly of use and the building model needs to be rebuilt through SketchUp software. Thus the whole design process is separated to two parts without too many connections. In addition, related analysis on building performances requires rebuilding other building models by other analysis software. As can be seen, low efficiency comes into being by repetitive work (Table 1).

Characters of 2D design: Currently, philosophy and process of 2D design has been accepted and widely used in the main institutes of architectural design. And independent brands, core business, technologies, managements, staff and facilities of each institute get developed and improved under this design process. Its business is stable and the benefit percentage is high. As for the construction project, designers from all related majors cooperate smoothly, use the software skilled and reference standards explicitly. Thus, for 2D design, the drawing efficiency is high but it's inevitable to come across mistakes, neglects, pipelines collisions and

Table 1: Contents of traditional building design

Design process	Main contents
Background investigations of the construction project	According to the design objections, to deeply investigate and analyze the project information and the environment about the project's location.
Concept design	To express the designer's thoughts and ideas by concept drawings and models of mass design
Project design	With the aid of CAD and SketchUp, to quantify the concept design and achieve accurate design
Preliminary design	To finish detailed design for building space and specific parts and further control the design
Construction design	To deliberately design and control the building with CAD plus designers' cooperation from all the related majors and make the design available for construction
Final outcomes	Submit drawings

Table 2: Contents of design process based on BIM

Design process	Main contents
Concept design	In this phase, the mass design of BIM can display and express perfectly designers' ideas and make area analysis, shape factor analysis, benefit analysis of commercial real estate, visibility analysis and solargraphy analysis
Project design (preliminary design)	In this phase, BIM plays an important role not only on design modification, plans comparison (such as rationalized design of curved surface) and feasibility analysis of plans but also on performances analysis, energy consumption analysis, lighting analysis solargraphy analysis and evacuation analysis of buildings, especially the buildings with complex shape (Ma, 2010)
Construction design	In this phase, BIM will finish and display the detailed design for complex shape and detailed construction progress. At the same time the floor plans, cross-section drawings and profile drawings get finished
Comprehensive design of professional tubes and lines	In this phase, BIM will finish professional pipeline design for large public buildings and inspect the mistakes, neglects, pipeline collisions and scarcity of building design before the construction operating
Visual design	Project display like renderings, flashes, real-time roaming and virtual reality system will be expressed by BIM
Final outcomes	Submit drawings

scarcity which make the quality of drawings low. However, the gains brought by the high efficient drawing are quite fast and direct, while that brought by the high-quality drawings are slow and indirect. That's the reason why most institutes of architectural design don't choose the new design technique that lower the drawing efficiency while increases the drawing quality.

For architects and engineers, much work is done by alternately using several software tools and its effect can't be visualized immediately because technology drawings are separated from visual drawings, which makes building design efficiency low. We analyzed and concluded the defects of building design with CAD are as follows. Firstly, 2D drawings restrict designers' imagination and they can't focus on design for imagining its 3D effects. Usually, the renderings are different with the design drawings, which cause lots of modification then. Secondly, it can create only a geometry model of building by those common 3D modeling design software. No matter walls, floors, girders, columns, stairs, door or windows are combined simply by some geometrical objects, which can't contain and display their properties. Thirdly, the 3D model of buildings can't help architect analyze the performances of buildings, nor support the structural engineers finishing their structure calculation or the construction personnel organizing the construction progress and statics except that it expresses information about building size. It will waste tremendous time especially when it comes to an urgent project. In conclusion, the limit of 2D design process is its powerless

integration of information about the buildings, which pushes new design technology emerging out.

BUILDING DESIGN PROCESS BASED ON BIM TECHNOLOGY

Design process: Assisted by BIM software, the design work during the whole process is approached by BIM. And designers work on bilateral auxiliary design in every design phase and they express and weight against the design ideas and design plans only based on BIM. While the floor plans, cross-section drawings and profile drawings become ramifications of building models. Furthermore, once information about some elements of the models gets modified, the information about other related elements will get modified automatically. In that case, the whole process becomes simple and clean. The redundancy and the loss of building information will be reduced much and then the design efficiency becomes higher. So as to speak, BIM affords a better and more overall smart technology platform for building design. The whole process is supposed to use BIM technology from the beginning. But for now, as a transition period, Liu (2009) said it's common to use it in partial projects, some professional areas and several sections of the design process because the full range use of BIM is not available. Thus according to the demands of the project, BIM teams status, design cycle, the designers can decide which section they use BIM technology in and the usage of BIM in each section is presented in Table 2.

Pros and cons of design process based on BIM: BIM technology integrates and uses available social resources at utmost, which increase efficiency and control ability of building design. And it helps architects realize theory of sustainable design and green building design. Besides it owns special priority on complex shape modeling and modifying, which also brought more possible choice for building design. Compared with the traditional design, BIM technology has advanced philosophy and huge advantages, such as follows.

Parameterized design: Simplex 2D design (nodes-lines-surfaces model) is replaced by elements design of buildings like walls, doors, windows, girders and columns etc.

Correlations design of elements: It is attached to parameterized design. Change of parameters of elements will make the parameters of other related elements in the whole building model changed correlatively, which will solve the information loss among design drawings.

Distributed models: Designers can't finish all the design work by BIM, individual design model, construction model and construction progress (the fourth dimension) needs to be done by design institutes and construction companies. Those distributed models can be combined by data base and then BIM can form a virtue construction model and inspect the mistakes, neglects, pipeline collisions and scarcity of building design (Xiao and Wu, 2012).

Cooperative design: By non-collision and cooperative style, designers co-work under one platform that gets information exchanged normalized and assure of smooth of information exchange inside the system. From this point of view, cooperation isn't simplex drawings reference any more but a cooperative design under this uniform platform involved several majors and professions. In conclusion, BIM can save design time and reduce lead-time range. Through integrated data base, it affords better interactive cooperation, prevents mistakes happening, increases qualities of drawings and cut the design cost. Then, it will bring new profits and business opportunities.

However, there have been some obstacles during the spread and progress of BIM technology, which make it popularized slow. There are two main obstacles as follows.

Subjective obstacles: Designers don't quite accommodate the logic change brought by BIM and then resist it. They hold a negative attitude in sharing resource and data of projects without a fierce exterior motive. So far, the design process based on BIM hasn't built up completely. Strong interactive cooperation of BIM doesn't carry into execution well. The way dealing with disputes in BIM projects isn't mature (Pan and Zhao, 2012).

Objective obstacles: So far, the building design industry lacks of BIM standards issued by government and industry society, guidance, model contracts and laws and regulations that protect BIM's property. In addition, BIM products developed by China is less, thus hiring experts and consultations brings extra design expense.

CONCLUSION

The building design process based on BIM owns great advantages compared with the traditional design process but some obstacles are still in the way of BIM's development. It's not realistic to abandon the traditional design tools and process and the new design process and the traditional one will coexist for a while. But with the further applications of BIM, the traditional design process will be abandoned step by step. This brand new design philosophy and logic is a big revolution in design industry.

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