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The Application of Building Information Modeling (BIM) in Landscape Architecture Engineering

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Abstract With the recently rapid development of engineering information construction in China, building information modeling (BIM) has become increasingly widely used in engineering field, but its application in landscape architecture engineering is still in its infancy, which needs further research. This study introduced the operating mechanism of BIM, focused on the application of BIM in the whole life cycle of landscape architecture engineering, and pointed out the problems of the application of BIM in landscape architecture engineering, with a view to providing theoretical support for the scientific construction management of landscape architecture engineering.
Keywords BIM, Landscape architecture engineering, Life cycle
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With the continuous development of the society and the growing demands of garden landscape, landscape architecture engineering is becoming increasingly complex, covering not only large-scale landscape planning, but small-scale design of garden buildings, garden ornaments, sites, and construction drawings. Landscape architecture engineering is unique in design and type-selection, the computer-aided design (CAD) drawing is rich in information, the drawing modification process is complicated, and the three-dimensional engineering shape can only be obtained through the professional analysis. Thus the design cycle is increased, and the design quality is difficult to control. Building information modeling (BIM), as a three-dimensional framework that integrates the complete digital information of the building, can realize the related modification of the visual query and design of landscape architecture engineering. BIM is a working system that covers geometry, spatial relationships, geographic information systems, and the nature and quantity of various building components, such as vendor details. Presently, BIM has been widely applied in many fields, and has become the support of many topics in the construction industry. He Guanpei[1] proposed the development trend of BIM technology route of construction enterprises in different stages of BIM application through the analysis of several possible technical routes; Yalcinkaya et al.[2] analyzed abstracts of 975 academic papers related to BIM, and pointed out the patterns and trends of BIM research at this stage; Zhang Jianping[3] independently developed the BIM system for construction engineering and the 4D construction project management software based on BIM. These studies have certain guiding significance for construction engineering, but research results of these studies are not completely applicable to landscape architecture engineering because landscape architecture engineering is distinct from construction engineering.

Using BIM to model the terrain and related structures of the landscape architecture engineering, can realize the visual query of the relevant structures and the quality control of the key nodes, simplify the general layout optimization process, and complete the rapid and accurate calculation of the earthwork volume, so that engineering management and information technology are highly integrated, which is of great significance for improving the informationization rate of landscape architecture engineering and facilitating the later operation management.

1 Operating mechanism of BIM

BIM is a simulation of information contained in the building in the form of digital representation, involving three-dimensional model of building, materials, mechanics, structure, equipment, various physical properties and data statistics. It is characterized by visualization, coordination, simulation, optimization, and graphics.

BIM represents a new concept and idea. It integrates big data of various majors through existing engineering information, and establishes a virtual three-dimensional engineering model through software on the Internet platform. As an information sharing platform, BIM can modify the various objects in the garden through the parameterized modification engine, which greatly improves the quality and efficiency of the design. First of all, through the professional design of the design unit, each profession can read the information under the same platform. All the professions work around a unified model, which can avoid the waste of time and manpower in garden design. Then, the collision between various majors can be checked with the aid of the relevant functions of the software. Different designers and landscape architecture engineering with different majors often have conflicting problems. In the traditional graphic design, such as landscape architecture engineering, when the hard landscape is arranged, some components may hinder the pipeline laying. In BIM, collision inspection can be performed to generate coordination data to minimize errors in construction drawings. In addition, the drawings drawn by 2D CAD can never be intelligently analyzed and simulated. Often separate modeling and calculation are required in the relevant analysis software, which will take a lot of time, and the rough modeling will cause errors in the calculation. Through the parametric 3D model built by BIM, the material data is automatically generated, and the landscape gardening construction process can be simulated to reduce the cost accounting error.

2 Application of BIM in landscape architecture engineering

Currently, BIM has begun to gradually integrate into all aspects of the entire life cycle of

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landscape architecture engineering, ranging from the preliminary preparation, planning and design, graphing, to the specific construction process and construction management. Therefore, BIM enables landscape architecture engineering to take a new step, and gives landscape architecture engineering a new look, which is beneficial for the development of landscape architecture engineering. The application of BIM in landscape architecture engineering is mainly reflected in the following aspects.

2.1 Application of BIM information linkage in garden design

The landscape industry and the construction industry are different in design. The consumption of water, electricity, gas and other resources and energy is much less than that of large buildings. Therefore, its application advantages lie in the overall layout of landscape architecture. The transformation of terrain shaping, water treatment, landscape arrangement from two dimensions to three dimensions achieves a more intuitive overall control effect. In the design process of landscape architecture engineering, due to some human errors or coordination errors and coordination difficulties, the drawings have been repeatedly modified, the work efficiency is low, the designer's efforts and time are wasted, but the landscape effect is unsatisfactory.

Collaborative design is the collaborative work of data and file interaction, and communication among the majors of the design institute. Collaborative operation is the collaborative work of data and file interaction, and communication among project owners, design team, construction team, supervisors, material suppliers, operators and other project-related parties. In the past, the project adopted a professional division of work mode. There are problems such as untimely updating of professional information and incomplete information transmission, resulting in major errors in drawing rework or design. With the collaborative work of BIM, multi-professional and multi-level building information can be embodied in a BIM collaborative platform, which can share information, modify linkages, and ensure timely and accurate information transmission.

2.2 Application of management informationization in landscape architecture engineering management

The construction process is a typical collaborative operation, which needs information sharing and communication between construction subjects with different professions and different responsibilities. Similarly, a large amount of information will be generated in the process of landscape architecture engineering construction and management. The parties participating in the project lack coordination, resulting in information islands and information faults, serious loss of information at all stages of the engineering life cycle, and low level of information sharing management. The use and expression of information cannot effectively reflect the current status of landscape architecture engineering. The emergence of building information models (BIMs) can completely solve these problems in landscape architecture engineering. The information contained in BIMs can realize visualization, correlation, and efficient management of engineering files, and provide an effective platform for information exchange, sharing, and integrated management in the course of project construction. With the aid of BIM, the landscape architecture construction site planning can be made into three-dimensional to accurately simulate the on-site changes of different construction stages, thus ensuring the quality, safety, and progress of the landscape architecture construction. Fig.1 shows the information management platform based on BIM. According to the different stages of the project, the BIM information platform is classified into three sub-platforms: design management information platform, project implementation information platform, and project acceptance and operation and maintenance information platform. The design management information platform contains information on project proposal, feasibility research report, and preliminary design; the project implementation information platform contains information about construction drawing design and construction technology disclosure; the project acceptance and operation and maintenance information platform contains information about completion inspection and acceptance, as well as operation and maintenance. Therefore, using BIM to build a project's central repository can completely change the information management model of the project's entire life cycle. Landscape architecture engineering has a long service life, long maintenance period, and large staff turnover, and some concealed works have serious information loss. The information management platform based on BIM can ensure the integrity, accuracy, and traceability of the information.

2.3 Application of technical informationization in landscape architecture engineering construction

The construction conditions of landscape architecture engineering are complex, the amount of engineering is large, and there are

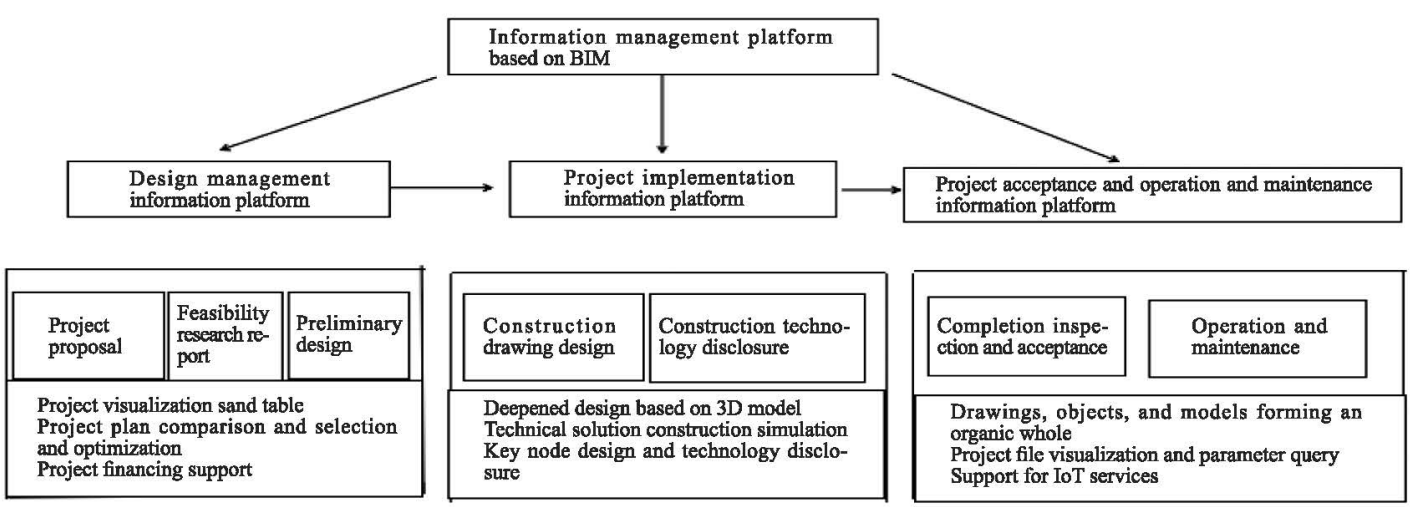


Fig.1 The information management platform based on BIM

many construction difficulties. At present, the construction technology level of landscape architecture engineering in China is generally low. BIM is a process involving the generation and management of digital representations of physical and functional characteristics of places. BIMs support multiple applications in engineering design and construction. For engineering that uses BIM completely, it should include visual construction tasks and construction sequences, in addition to virtual three-dimensional models[4]. This information will play a crucial role in the arrangement of the construction tasks and the determination of the construction schedule. At the same time, the quantitative information of the places contained in the models will directly link to the relevant cost database, which is beneficial for the investment control in the early stage of project construction. The finer the model is, the more accurate the project's cost estimation. Table 1 shows the building information model containing information of different stages.

2.4 Application of BIMs in the calculation of earthwork volume in landscape architecture engineering

BIMs combine cost-related fivedimensional parameters such as time, space, and process. Terrain is one of the four elements that constitute the garden entity. It is the skeleton that constitutes the whole garden landscape. In the modern garden design, the reshaping of the original terrain can enhance the landscape effect of local areas, increase the greening scale, and improve the garden microclimate, increase the surface area, and control the sight of visitors. Landscape architecture engineering generally has complex topographical conditions, and the volume of excavated and filled earthwork is large, so the accuracy of earthwork calculation has great influence on the calculation of engineering quantity. The digital terrain model can be used to visually view the three-dimensional effects of the site and perform design and calculation functions such as earthwork calculation and drawing of vertical and horizontal sections. The earthwork volume is calculated by taking the earthwork volume excavated and filled between the design elevation and the natural ground measured elevation within a certain area. At present, there are two main types of software and systems for earthwork volume calculation: AutoCAD series and GIS, remote sensing series. The earthwork volume calculation method provided by BIM technology is built on the building information model which is completely consistent with the actual terrain. The original terrain surface model and the design surface model are drawn. The two spatial three-dimensional surfaces will generate intersection points and connect them into lines. The intersecting line is the line generated by the intersection of the original terrain surface and the construction design surface, and the volume of space enclosed is the earthwork volume that needs to be excavated or filled to generate a volumetric surface. The original terrain surface and the design terrain surface, which are based on BIM, are dynamically related. In the project selection stage, the excavation and filling experiments of the earthwork can be quickly carried out on the basis of the model to accurately calculate the volume of excavated and filled earthwork, thereby selecting the best earthwork excavation plan.

3 Deficiency of and suggestions for the application of BIM in landscape architecture engineering

This study mainly discussed the various applications of BIM in the construction management process of landscape architecture engineering. Although it has achieved certain management efficiency in the practice process, there are many shortcomings in both theoretical bases and practical applications because the application of BIM in landscape architecture engineering is not populous. The theory and technology of BIM are based on the construction industry as a template, so it has considerable limitations. In the process of analyzing BIM application, this paper studied its defects and summarized them, with a view to providing some guidance and reference for future related research.

(1) This paper is directed against the construction level of landscape architecture engineering project, and the scientific research process needs a complete and complete system. Due to the limitations of project materials and experience, this paper did not analyze and discuss the data in the design process in depth. In the actual application project, only simple data analysis is carried out, this paper did not much involved with analysis of sunshine, thermal environment, and soil composition, and further research is needed.

(2) BIM is not a piece of software. To be precise, BIM is not a type of software, and the choice of each type of software is not just a product. This is because BIM is a new methodology, and its foundation has to be attributed to the computer's digital simulation platform[5]. Therefore, secondary development and application based on the application of existing software should be the top priority of technology application and industry development. Although some professional software development in the construction industry has improved slightly, software development in the landscape architecture industry is still in its infancy. Much software cannot integrate and manage data on the same platform, which needs to be improved by professionals in related industries.

(3) Domestically, the role of in BIM in landscape architecture engineering is gradually being taken seriously. Many companies recognize that BIM is a digital way of creating technical information, managing information, and sharing information and that it is the development trend of digital management in the garden industry and the entire construction industry. However, it will have a far-reaching impact on the entire landscape architecture industry. Therefore, the promotion and use of BIM are conducive to improving the construction technology and management level of landscape architecture engineering. For most enterprises, perhaps this is a good opportunity to achieve technological innovation and management breakthroughs.

4 Conclusions

Landscape architecture as an ancient discipline has been given new vitality in the

Table 1 Application of a building information model in various stages of landscape architecture engineering

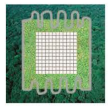
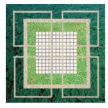
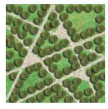
Stage	Extractable information	Model application
Project design	Appearance and relative position of a model	Overall layout effect display, program optimization, and project promotion and introduction
Extended preliminary design	Accurate position, exact size, and material type of each component	Design deepening, collision check, system coordination, and specification verification
Construction	Detailed dimensions, materials, locations, equipment parameters, operation and maintenance information of each component	Video simulation, schedule control, quantity calculation, preform processability, quality management, and safety management

(To be continued in P10)

Table 1 Deconstruction of square space

Deconstruction	Subclass	Diagrammatic presentation
Reducing the integration of the square plane	Toothed edge	
	Edge penetration	
Iterative space—heterogeneous inlay	Arbor inlay	
	Water body inlay	
	Multi-element inlay	

Table 2 Methods to increase landscape obstruction

Method	Diagrammatic presentation
Line topology of roads	
	
Increasing the intersection of roads	
	
Sharpening the angle of roads	

for electric sightseeing vehicles and emergency rescue. Under the premise of ensuring the quality and width of the loop, the method of restricting the occupation of the road by the long queue is very limited, mainly to increase the landscape resistance through the artificial obstacle, and to interfere with the speed of the long-distance running group and the uniform coordination of the action, so as to cut and decompose the formation.

There are three main methods (Table 2): ① increasing the wrinkle of the loop in individual sections, encrypting the frequency of the runway turn, delaying the speed of the team in the roundabout, and increasing the self-interference during the team's travel; ② increasing the intersection of the secondary park road and the circular runway, enhancing the chance of the team's own cross, enhancing the chance of cross between the team and other activity routes, and increasing the resistance of team activities; ③ sharpening the turning angle of the loop, and increasing the resistance and self-interference of the team's travel process under the premise of giving consideration to the turning radius. These design measures that do not affect people's daily fitness activities aim to restrict organized group activities, gain more space for free individual activities, and ensure that individuals choose their own rhythm of exercise.

4 Conclusions

All of these methods are expedient measures under site constraints and are conservative treatments for special age groups. If the venue conditions are loose, it is best to open special activity space in the park, such as singing area, gymnastics area, dance area, and exercise fitness area to control the release of noise, or to plan special event parks. However, it is not realistic for urban blocks with tight land use. Even if there are some special event venues, these amateur activity groups will not go to the professional venues. Moreover, due to low greening rates, some thematic activity places are unattractive to people.

The problem of uneven distribution of public space in urban parks is not only an environmental issue but a social issue. Human's behavioral habits are rooted in a specific social and historical background. Different social groups have different life experiences, educational levels, and values, leading to differences in lifestyle habits, behavioral psychological habits, recreational forms, and collective preferences. People, the main body of the park activity and the service object of park design, are diachronic groups, and will have a generational difference in behavioral habits in each historical stage. In a multi-inclusive social environment, if the collective preference of a certain age group is not considered at all, the original intention of building a park is lost. In the environmental constraints, how to balance the generational differences in the behavioral habits of different age groups, how to balance the collective preferences of special groups and the rights enjoyed by free individual resources is an eternal topic.

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collision with BIM. In terms of subject composition, landscape architecture needs to use science to analyze and establish all the objective elements related to it, and also to use art to describe and carry specific site semantics. Although the application of BIM in landscape architecture engineering is very feasible in terms of spatial layout and overall design, its limitations are also obvious, especially in terms of humanities and art. Therefore, it is proposed that prudent choices are made according to concrete analysis.

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