Research on Building Information Model (BIM) Technology

Tianqi Yang[1*] and Lihui Liao[2]
[1]Desheng Engineering Consulting Co. Ltd., Dongguan, Guangdong 523008, China
[2]Lihui Law Firm, Dongguan, Guangdong 52300, China

ABSTRACT All above this paper gives a scientific definition of the BIM; describes the BIM six technical characteristics; pointed out the essence of BIM technology; the paper puts forward nine mature BIM technology standard BIM technology; describes the development tools and implementation feasibility of the technical route of other technology integration and development; to show the construction of BIM life cycle management strategies and methods based on two dimensions; from qualitative and quantitative BIM technology and energy consumption analysis tools are examples of symbiotic fusion; to focus attention on the advantages of BIM technology, intelligent green and sustainable design problems; extension of related technology for guidance and discussion; finally, the application prospect of BIM technology in China Engineering practice is discussed.

At present, from the overall perspective, development and application of building information model (BIM) technology starts late in our country, construction procedures, the scale is not perfect, system and technology policy, laws and regulations system has yet to be established; localization of single key technical reserves and integrated technical system of building a body of research and application are required to further deepen, the concept of BIM design needs further guidance, Bim and technological cooperation and exchange at home and abroad to be in full swing, the popularization and application of BIM Technology, still need to strengthen the propaganda, vigorously support, actively promote. I stand in the big data, cloud computing information new era and intelligent society cusp, shoulder BIM Technology dissemination, enablers historical mission.

*Corresponding author: Desheng Engineering Consulting Co. Ltd., Dongguan, Guangdong 523008, China. E-mail: dgdsgycjh@163.com

1. The scientific definition of BIM

BIM The full name of the English language is Building Information Modeling，The construction information model is more consistent in China. The United States National BIM standard for BIM is defined as follows:

(1) BIM is a facility (construction) of the physical and functional characteristics of digital expression;

(2) BIM is a shared knowledge resources, is a sharing of information about this facility, to provide reliable basis for the establishment of the facility from the construction to the demolition of the whole life cycle of the process;

(3) In the different stages of the project, the stakeholders through the BIM to insert, extract, update and modify information in order to support and reflect the respective responsibilities of the collaborative work.

BIM's inner function has a narrow and broad sense. Narrow definition: static building information model can be interpreted from three aspects of Information Modeling Building:

(1) Building is representative of the BIM industry attributes, BIM service object is the construction industry rather than other industries;

(2) Information is the soul of BIM, BIM is the characteristics

of different organizations at different stages of the project to provide a variety of information related to the construction of products;

(3) Model is the form of BIM information creation and storage, information of construction facilities can be expressed as a diversified form of expression.

Generalized definition: BIM is a cloud computing and data technology and visualization technology of database based, integration and management of the construction project life cycle related geometry information and non-geometry information, project planning, design, construction, operation, and maintenance provide bearing information and support.

Building information modeling is to 3D digital even n-dimensional technology based, integrated construction project all relevant information and engineering data model, information related to the project detailed expression.

2. BIM technical features

2.1. Visualization

BIM visualization is a form of income of what you see is what you, so that people will be the formation of the previous line of component form a three-dimensional and even n-dimensional various stereo image to show in front of people, is a isomorphism between the formation of interaction and feedback of visual. Project design, construction and operation of the whole process in the visual environment for a high degree of virtualization of the simulation, the project is a detailed expression of the relevant information.

2.2. Coordination

BIM building information model can be used in the construction of the early construction of the professional collision issues to coordinate, generate and provide coordination data.

2.3. Simulation

In the design phase, energy simulation, emergency evacuation simulation, to simulate the sunlight and heat conduction simulation; in the bidding stage and construction stage, 3D models even n-dimensional model of project development time, construction organization design, cost control, determine the reasonable construction plan to guide the construction; in the phase of project operation. Simulation for daily emergency treatment based on typical such as earthquake light simulation and fire evacuation simulation.

2.4. Coordination

(1) Optimization of project scheme, the project design and return on investment analysis are combined, the value of optimized project and design proposal which conforms to the needs of the owners themselves; (2) Special project scheme optimization for like a podium, curtain wall, roof, large space the specific design project, the whole building a small proportion, but investment and jobs is relatively large, great construction difficulty and the construction more problems, to the design and construction scheme optimization, can bring a significant time and cost improvement.

2.5. Be out of the graph

Can BIM through the building visual display, coordination, simulation, optimization, can help owners to gain the drawing results are as follows: (1) integrated pipeline (after collision checking, design and modification, fire diagram the corresponding error); (2) comprehensive structural holes left graph (pre buried sleeve Figure); (3) to check for collisions debug report and recommends improvement.

2.6. The completeness of information

Parametric primitives as digital building components all information is embodied in BIM Technology of engineering objects, three-dimensional and even n-dimensional geometric information and topological relation description and complete engineering information retrieval.

3. The essence of BIM technology -- a design method of virtual architecture based on IFC standard

IFC（Industry Foundation Classes）Standard is by the International Cooperative Alliance (IAI international aliance for Interaperability) formulation of the international construction industry engineering data exchange standard, and is the only accredited to ISO standard building information, through the IFC text format conversion, the structure design software, fluid analysis software, software model checking, assessment software, all software interface with compatibility, scalability. From the design to the beginning of the expansion design and then to the construction drawing design of various stages, different organizations involved in the basic model of the information required by the basic model. To complete their professional model, and then through the IFC format exchange reaction to the information model, transfer the next stage for the use and reference, BIM system currently used in most of the federated database segment model, and the final information rely on specialized software to realize, the system can rely on strong, and the model in the whole life cycle can make full use of it.

BIM is "building information model" (Information Modeling Building), is based on Object Modeling Technology (based - Modeling Object) [1]. A distributed database model based on IFC standard, and its technical implementation logic is as Figure 1.

The use of BIM technology, architects as a design process, is to build a real building process. The virtual building model

Figure 1. BIM distributed database model technology logical framework model diagram.
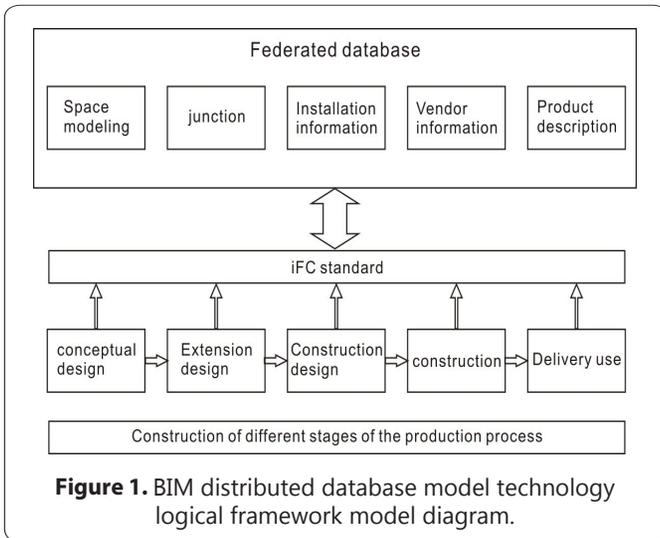
contains a lot of building materials and building component characteristics information is a contains all the information in the construction of distributed electronic databases, in such a real intelligent building model, the architects can be arbitrary output plane, elevation and details of various detail, building materials, doors, windows, tables, you can also output the budget report, the construction schedule sheet, and so on. This design method we call the virtual architecture design method, it will be the architect from the traditional 2D lines in the liberation of the virtual architecture in the design [2].

4. The measure of mature BIM need to have the following nine standards

4.1. Multi-dimensional

Model is 3D or even nD, can be better from the legislative, sectional, and prone to different angles to express complex construction scenarios.

4.2. The structure of modular and graphic

Good BIM in the design and development process to ensure that each subsystem, in the subsystem of the function and even each application program is highly modular, graphical. System can be realized freely cut and re configuration, to achieve the different needs of different types of users to configure the system for individual purposes.

4.3. Multiplex distributed application system

The future of green living BIM software is a hypertext link, support distributed applications and distributed database, BIM should support the implementation of Internet information access, and multi group server to achieve multiplexing technology.

4.4. Support a variety of question bank

Different types of background database can be directly modified and edited to achieve the design data transfer and conversion between different systems, to achieve the link is not sewn.

4.5. Support multi language hypertext links

Different language users can change the use of the system output interface on the use of terms, in different users show different language interface, use their own familiar with the localization of language, providing efficient and convenient professional services.

4.6. Availability

Different participating parties in the project can obtain the required data through cooperative work. Using intelligent (computer can be identified) and digital way to express building components, the data in the model need to be quantitative; measurable dimensions; accessibility. The information contained in the component can express the properties and behavior of the component, and support the digital analysis work. It can simulate the design and construction process. All of the information in the model can be uniformly correlated, and the model of the database will be used as the sole source of product information in the process of construction.

4.7. Scalability

In different stages of project construction, not only to add and improve the geometric information, physical information, functional information, price information, etc..

4.8. Can be adjusted dynamically

Emphasis on the application of research results in practice, through the practice of testing its feasibility, timely adjustment of BIM design.

4.9. Can be persistent

BIM project follows the principle of sustainability, the model of information can be permanent circulation application in each stage of the project, in place, participation, comprehensive balance principle, explore in the total amount of resources sustainable development mode, in order to, to the maximum extent reduce the future fire effects, and further to create the space of future development and a variety of possibilities [3].

5. BIM technology development tools to achieve the line

3D technology is basic technology for realization of visual space, BIM 4D (four-dimensional), Nd (n - dimensional), virtual construction (virtual construction, VC) and virtual prototyping (virtual prototyping VP) implementation of the foundation.

4D, namely the four-dimensional (3D+time), is the introduction of three-dimensional model of time dimension to achieve dynamic display method.

Nd, the n-dimensional, introduction of 4D construction project cost, material, machine and manpower, space, safety, nd is similar to the virtual construction, extension of the application of BIM, auxiliary construction analysis and management.

Virtual construction (VC), is based on 3D visualization and nD+ schedule planning + human + machinery, the implementation process of Construction Comprehensive Simulation and analysis, the VC is BIM extension in the construction stage is thought of virtual prototype (VP), in the construction industry is a kind of practice show.

6. BIM technology and other technology integration development to achieve the line

6.1. BIM and cloud computing technology integration

The cloud computing technology is awarded computer technology a new expansion, it unified management a lot of physical resources and these resources virtualization, the formation of a huge virtual resource pool. The main features of the cloud computing technology: virtualization technology, dynamic scalable, on-demand deployment, high flexibility, high reliability and high cost. BIM can by cloud computing technologies to support the huge demand of computing power, make full use of cloud computing technology's powerful computing ability, three-dimensional and even n-dimensional architectural design in various performance of correlation analysis, allows architects to concepts in the project design stage to fully understand the project, and the complex surface treatment on the final result; II changes work mode in cooperative design, to achieve inter temporal model of collaborative work, through the cloud computing support architectural design and coordination, the architect, structural engineer and so on various aspects to be able to use the most simple, the most economical way achieve synergy. Ensure the high performance motor, anywhere can access to the cloud, enabling high performance graphics workstations, the BIM model real-time upload to the cloud server, the participants can anytime, anywhere can have different mobile terminals and desktop terminal for synchronous access, analysis and modification, and used to guide the design and management, procurement management, construction management, operation and production delivery management.

6.2. BIM and Internet of things technology integration

Two fusion can assist building operations and maintenance, BIM property management system for intelligent, visualization, integration to provide basic support. The combination of Internet technology can be from a BIM model called the needed information and data, and to achieve a visual display, so as to avoid the trouble of finding drawings; spatial orientation of design and lighting, fire and other systems, and the original number or the text table into a three-dimensional 3D position and even n-dimensional said, even the n-dimensional visualization view; the original equipment and operation independent operation, through the radio frequency identification (RFID) techniques to a unified platform, management and control, process monitoring on the running status of electrical and mechanical

equipment; the cumulative, statistics and analysis of real time operation and maintenance data, timely detection of problems and hidden dangers of existing property management, optimization and improvement of the existing management system and measures.

6.3. BIM and geographic information system integration

Will the organic integration of GIS and BIM can be 1 to assist visualization monitoring of construction supply chain management process, material flow and resource flow for; secondly, building the information itself and external management information (such as terrain, neighboring buildings, pipelines) effective integration, to provide to the outside of buildings and information of is external information to assist in building design. BIM and cloud computing technology, Internet technology, geographic information systems integration and development is a new trend in the future development of the comprehensive application of BIM.

7. Based on the BIM construction life cycle management

Building life cycle management（Building Lifecycle Management，That is BLM）Building life cycle management runs through the whole process from planning, design, construction, operation to dismantling and then to the use of digital methods to create, manage and share the construction of the basic asset information management model. The core purpose of BIM is to solve the problem of information creation, information management and information sharing in the whole life cycle of construction engineering. It embodies the idea of digital design information management and sharing. BIM using virtual prototype technology as the key technology, the establishment of the information sharing model of the whole life cycle of construction project. BLM uses BIM technology to integrate and manage the integrity of construction project information. Including project planning information; II project design information; (3) project cost information; (4) information on the progress of the project; the project quality information; the project contract information, the project equipment information; information of the project material; the project maintenance maintenance information; mutual relevance of information through BIM platform at each stage of the project, each participant sharing, realize the sharing of economic projects. The function of BIM in each stage of the building life cycle is shown in the Figure 2.

8. BIM technology and energy consumption analysis tool for the integration of symbiotic applications typical example

Green building studio (GBS) is a free web service based energy analysis tool, at present GBS technical Archi CAD, Revit and MicroStation and BIM software create virtual building model, simplified energy analysis of operation process, is the architect of green building design, there is an
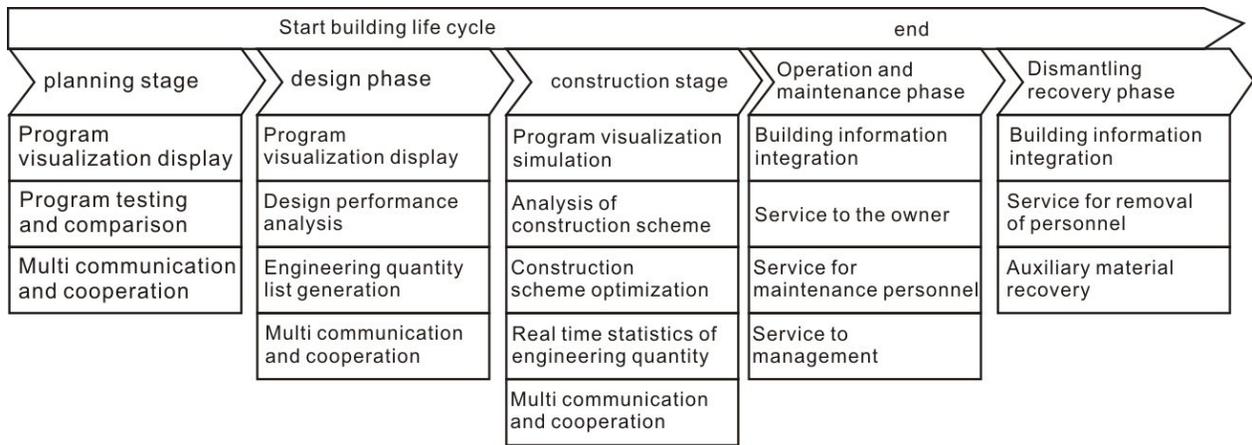
Figure 2. The function of BIM in each stage of the building life cycle.

urgent need to solve, the U. S. green building studio can meet the needs of architects.

GBS directly from the BIM software into the building model, which contains a large number of building information to establish an accurate thermal model (including a reasonable partition and orientation). And convert it into XML format (gbxml is an open XML format, has been rapid acceptance of HVAC software industry, as the data exchange standard), and according to local building codes and regulations, to the different type of architectural space intelligent assumption. Finally, combined with the typical local climate data, the DOE2.2 simulation engine by simulation, annual energy consumption, expenses and a series of building heating refrigeration load, system (such as lighting, HVAC, space heating electricity and natural gas energy use data can show up immediately [3].

BIM uses the dynamic simulation technology to carry on the detailed calculation of heat, electricity and cooling load of building, and fully uses various energy saving measures to reduce the building energy consumption.

Scheme design stage, it is necessary to the building load dynamic simulation techniques to predict the annual cooling and heating load situation, forecast results should not only include the different seasons (winter, summer, transitional season) typical day load hours changes, also should have annual heat, electricity, cooling load duration curve. Figure 3 and 4 shows a hospital building in the summer of the typical day of the load change and the annual load change. Obtaining these data is an important prerequisite for the design of distributed energy systems.

The operation mode of BIM distributed energy system is generally the following: (1) to meet the operation mode of electric load (in order to heat). To meet the heat load operation mode (in order to heat power). Third, optimize the operation mode, namely according to the electric and thermal load of dynamic balance of demand of real-time control units, when a substantial reduction in nighttime power load, generators stop running. The following is the

BIM distributed energy system operation decision strategy simulation diagram under different beta(which represents the ratio of gas to electricity prices, the annual energy consumption of the system for distributed energy systems is proportional to the reduction of conventional energy systems).
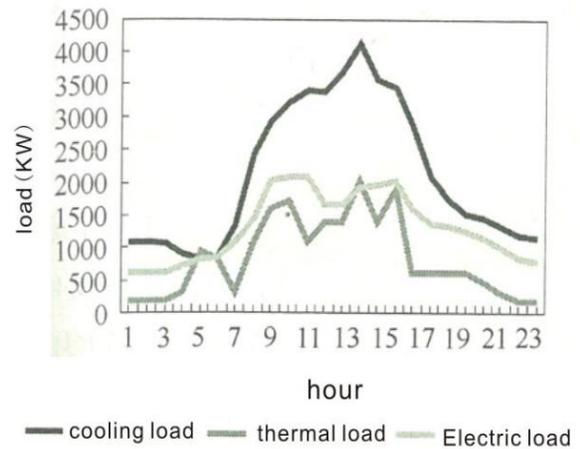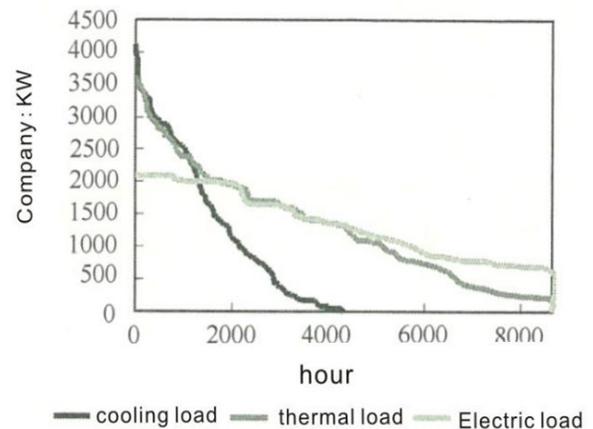

Figure 3. Typical daily hourly load.

Figure 4. Annual time delay thermoelectric cooling load curve.

Seen from the Figure 5, located at the top of the curve for the optimization of the operation of the curve, regardless of how the changes in the three programs, and always maintain the best economy. In *a*=0.7, the thermal power and the two curves are given at a point, which shows that the results of these two different operation strategies are consistent. When the alpha is less than 0.7, the strategy of the electric heat is more dominant than the thermal power, and it is just the opposite after more than 0.7. Empirical data show that the *a*=0.7 is known as the economic decision-making of the energy distribution system (in the heat of production or in the production of heat) valve value. It shows that the operation strategy of distributed energy system is restricted by the load level, energy price and other factors which are not absolute, and the operation strategy of distributed energy system is not absolute.
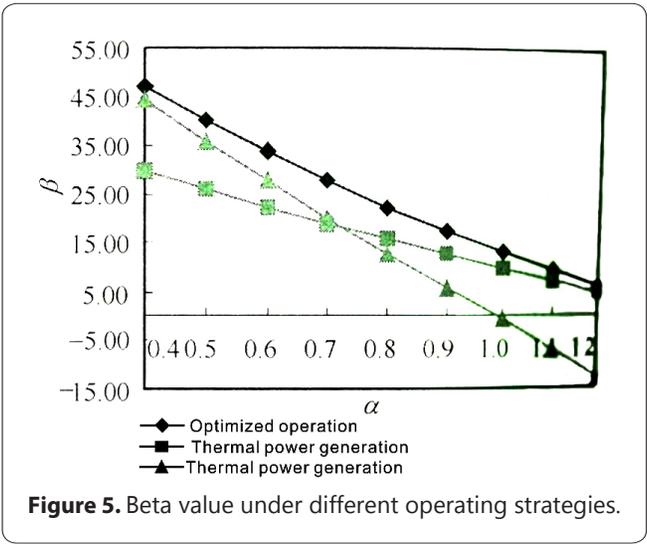

Figure 5. Beta value under different operating strategies.

As Lawrence Berkeley National Laboratory LMNL Vladimir Bazjanac said: "we Archi architecture CAD virtual building model, you can immediately to building energy performance simulation, without the need for simulation to build a new model is created. This will save both time and cost, and you can get the results immediately, as well as the expression of the design options" [4].

BIM technology in the maintenance of structural engineering has been a good show and verification, the Fingure 6 and 7 are the maintenance of the structure of the program.

9. Based on the IFC standard, BIM technology in the realization of green design, sustainable design advantages

Through the IFC Standard, obtained in the process of the architectural design of the virtual building model can be used in engineering structure, HVAC, electrical equipment, fire fighting pipe, elevator system, assessment
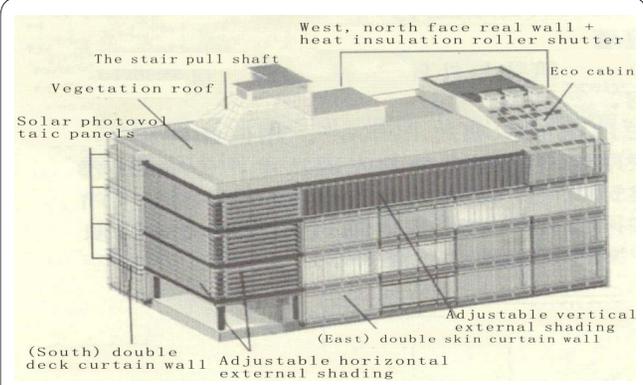

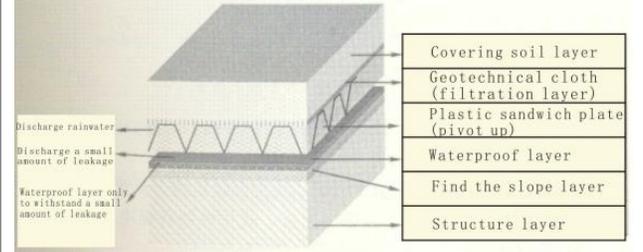**Figure 6.** Technical scheme of enclosure steel structure.

Figure 7. Sketch map of green residential area.

and other professional is combined in the IFC this generic data on the basis of the standard, the BIM Technology and building energy analysis software and practice of green building design has theoretical feasibility and practical on the operability.

BIM method can be used to include an analysis of the affecting conditions green lighting, energy efficiency and sustainable materials and other building performance; analysis to achieve the lowest energy consumption, and with the help of ventilation, lighting, airflow organization and visual psychological feeling of control, to achieve energy saving and environmental protection. Using BIM concept, the project can be completed at the same time, the calculation of sunshine, simulated wind environment for the architectural design of the "green exploration" innovation driven development driven into high-tech force.

Intelligent green building is with characteristics in the information era of new green building, also known as the green and intelligent building, it relates to the system is a multi-objective system must be application of modern information science and technology, the application of intelligent building system, to ensure the realization of the goal of the project, this is of the green and intelligent building characteristics of the times.

Green intelligent building technology to environmental technology, energy-saving technology, information technology and network technology to penetrate the building and used in all aspects of household life, with the new ideas and the most advanced technology to solve ecological health and comfort of living. To solve the problem of sustainable development, to solve the problem

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of sustainable development. In order to realize the construction requirements of green intelligent building, the environmental energy, ecological security, information security, information processing and other monitoring management systems are set up, and the requirements and level of building intelligence to a higher level.

10. BIM technology advantages and application of the development of the future development of the problem

Green intelligent building design theory, method and practice, including intelligent and green building development at home and abroad the latest developments, the overall design of the new theory and practical scheme; the second is intelligent building technology, including the related policy and industry management. The research and application of key technologies, digital community, digital building and new product; the third is the construction of energy-efficient technologies and products, including building energy-saving, maintenance structure technology and application, construction energy-saving design and assessment technology of heat metering control technology and new energy utilization technology and products; the fourth is ecological construction technology, including environment greening of technology, technology of water environment, indoor environmental technology; the fifth is green building materials technology, including building materials, new process and new technology, development of new low consumption, environmentally friendly building materials, construction materials recycling and reuse, green building assessment technologies and standards.

11. BIM technology in the development of China's engineering practice prospects

Formulated by the Ministry of housing and urban rural development of the on promoting the building information model of the application of the guidance "for BIM Technology in 45 during the planning period, the establishment of the development goals: by the end of 2020, the building industry first class survey design units and extra, a level of building engineering construction enterprises should be mastered, and implementation of Bim

and the enterprise management system and other information technology integrated application, dominated by state-owned investment funds are large and medium-sized construction. At the end of 2020, declaration of the engineering and construction of green building and green ecological demonstration area. In the newly established project survey and design construction operation and maintenance, the integrated application of BIM project proportion reached 90%. From above the recent planning can be seen: BIM Technology in the proportion of China's engineering practice application in the future a significant jump, more extensive application scope and field, comprehensive utilization of BIM Technology and building energy consumption analysis of green building design and technology, will be more and more perfect and mature, BIM Technology in green building design plays more and more important role.

Can foreknow, intelligent of promote the development of green building technology, energy conservation, promote the popularization and application of the new technology of new energy, reduce the consumption of resources and waste, enhance work efficiency, reduce pollution, the direction and goals of the development of intelligent building, BIM Technology of intelligent and green building provided for the solid, theoretical basis and practical and practical support, the green is the objective, direction and general programme, intelligence is means, measures and technologies, a personal home environment friendly, natural ecological beauty China will 20000 yds are made in the world of the Orient.

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