

A study of the classification and main functions of BIM software

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Abstract. This paper starts by studying the seven characteristics of BIM and the essential functions of BIM software and divides BIM software into three categories, modelling software, functional software, and platform software. The definitions and basic applicable requirements of the three classifications of software are given, the detailed functions of the commonly used software in the three classifications are introduced, and the classification of commonly used BIM software in China is summarized to solve the problem of correct selection of BIM software in practical applications by engineers and technicians, and to facilitate the understanding and learning of relevant BIM software by engineers.

Keywords: Building Information Modelling; BIM Software; Classification; Function.

1. Introduction

BIM (Building Information Modelling) is increasingly used in China as a new technology that can be shared and transmitted throughout the life cycle of project planning, operation and maintenance by integrating data and information models of buildings, enabling engineers and technicians to properly understand and effectively respond to a variety of building information, and providing a basis for collaborative work between design teams and other construction objects, including construction and operation units. BIM technology is vital in improving productivity, saving costs, and reducing schedules, and software is the foundation of BIM technology. To better understand and apply BIM software, this paper classifies BIM software and describes its primary functions.

2. BIM and its characteristics

BIM (Building Information Modelling) is the process of using digital models for the design, construction, and operational management of construction projects, the main components of which are shown in Figure 1. Suppose we quote the definition of BIM from the US National BIM Standard (NBIMS). BIM will be able to consist of three parts.

(1) BIM is the digital representation of the physical and functional characteristics of a facility (building project);

(2) BIM is a shared knowledge resource, a process of sharing facility information to provide a reliable basis for all decisions throughout the lifecycle of a facility, from conception to demolition;

(3) The collaborative work of different stakeholders in different phases of the facility by inserting, extracting, updating, and modifying information in the BIM to support and reflect their respective responsibilities.

BIM is a complete description of the project objects and can be widely used by all construction project participants. The basis of BIM is the model. The core is professional information (building, structure, materials, prices, specifications, standards), the main application points are 3D building models, automatic calculation of quantities and database-based scheduling of progress plans, etc., and the connotation is to connect data, processes, and resources in different phases of the building life cycle. The critical point of BIM is that it is based on 3D models, and there is a correlation between the constructed model objects. In the 3D model, in addition to geometric information, various other engineering information is included, geared towards information sharing and transmission throughout the building life cycle, with accurate and unique data. This information data serves as a particular

data source for engineering projects on which all relevant parties work together. The single engineering data source established by BIM solves the problem of consistency and global sharing between distributed and heterogeneous engineering data and supports the creation, management, and sharing of dynamic engineering information during the building lifecycle (Zhenzhong Hu 2017).

BIM has seven main features: visualization, integration, parametric, simulation, coordination, optimization, and programmability. Design visualization means that the building and construction are visually presented in the design stage in a three-in-one way; integration means that BIM technology can carry out integrated management of the whole life cycle of the project from construction to operation; parametric modelling implies that the model is built and analyzed by parameters (variables) instead of numbers, and a new model can be built and analyzed by simply changing the values of the parameters in the model; simulation means that the building performance analysis and simulation (energy analysis, light analysis, equipment analysis, green analysis); coordination includes design coordination and overall equipment analysis. (energy analysis, fair analysis, equipment analysis, green analysis); coordination includes design coordination, overall schedule planning coordination, cost budget, volume estimation coordination, and operation and maintenance coordination; optimization refers to the continuous optimization through accurate information of the building during the whole design, construction, and operation process; drawing availability means that BIM technology can be used for building plan, elevation, section, detail drawing, and even collision report and component The picture can be produced.

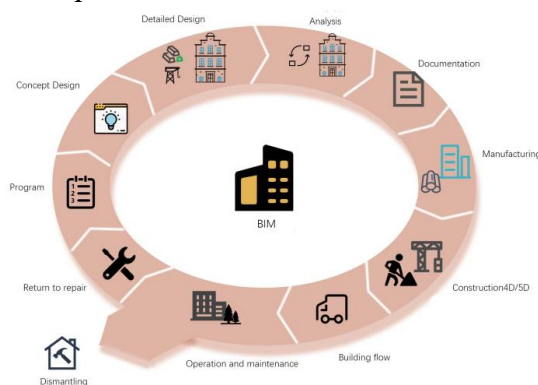


Figure 1. Key elements of BIM

3. BIM software classification

The application and maximum value of BIM are closely related to BIM software. The current mainstream BIM software products are characterized by more foreign products, fewer domestic products, more design products, and fewer management products. According to the characteristics of BIM and the different functions of software products, this paper divides BIM software into three categories: modelling software, functional software, and collaboration platform software.

3.1 Modelling software

BIM modelling software is the core foundation software of BIM and is mainly used for 3D design; the generated model is the basis of subsequent BIM applications. BIM foundation software generally has three features: 1 based on 3D graphics technology, support for 3D solid wake creation and editing, two support shared building components library, including slabs, beams, columns, walls, stairs, elevators, and other building components, convenient for users to apply built-in features three support 3D data exchange standards, BIM modelling software to create 3D models, through the IFC and other international standards output, for other BIM applications.

Commonly used modelling software are Revit, Bentley, Rhino, SketchUp, Affinity, Tekla Structure, CATIA, ArchiCAD, Allplan, Vectorworks, Digital project, and so on. According to the list of software users, the following four applications are widely used: Autodesk's Revit, Bentley's

Bentley series (Bentley Architecture, Bentley Structural, Bentley Building Mechanical Systems), Graphisoft's ArchiCAD, and Gery Technology's Digital project (Bo He 2013).

3.1.1 Revit

Revit is a synonym for BIM in China. It was the first modelling software to propose the concept of BIM, proposing to turn the idea of conventional lines (straight lines, curves) into the image of components.

Revit is the Autodesk the name of a family of software from the company that is separate from its AutoCAD and utilizes a different code base as well as file structure. The Revit family of software is designed Building information modelling (BIM) built to help architects design, build, and maintain better quality, more energy-efficient buildings. Autodesk Revit is offered as an application that combines the functionality of Autodesk Revit Architecture, Autodesk Revit MEP, and Autodesk Revit Structure software features.

Revit's comprehensive and innovative conceptual design features bring easy-to-use tools for free-form and parametric design, as well as the ability to analyze early strategies. These features allow free drawing, rapid creation of 3D shapes, and interactive handling of each form. Built-in tools are available for conceptual clarification of complex conditions to prepare models for construction and construction. As the design evolves, Autodesk Revit Architecture automatically builds parametric frameworks around the most complex shapes, providing greater creative control, accuracy, and flexibility. Its entire design process, from conceptual models to construction documents, is done in an intuitive environment. Revit has large memory requirements, requires reading all models to recall them, and runs slowly for buildings over 20,000 square meters. It has three main functions.

The architecture features the ability to design to the mindset of architects and designers so that you can deliver higher quality and more accurate building designs. Use tools built specifically to support building information modelling workflows to capture and analyze concepts and maintain the designer's vision through design, documentation, and architecture. The powerful architecture design tools help designers capture and explore ideas and maintain consistency at all stages, from design to architecture.

MEP Features: Provides tools for HVAC, electrical, and water supply (MEP) engineers to design more complex building systems. Export building conceptual modelling, BIM support, and analysis systems more efficiently from Revit. Support building systems throughout the building lifecycle with information-rich models. Tools explicitly built for HVAC, electrical, and plumbing (MEP) engineers help designers design, analyze, and document efficient building systems.

Structure Features: Provides structural engineers and designers with tools to more accurately design and build efficient building structures. Designed to support Building Information Modelling (BIM), Revit helps designers use intelligent models to gain insight into projects through simulation and analysis and predict performance before construction. Use the coordinates and consistent information inherent in intelligent models to improve the accuracy of documented designs. Tools built specifically for structural engineers help designers more accurately plan and build efficient building structures.

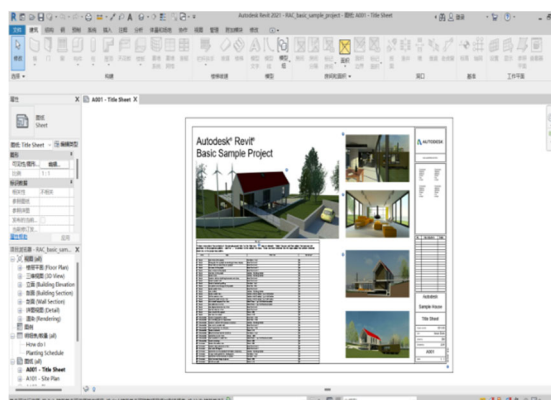


Figure 2. Revit2021 interface

3.1.2 Bentley

Bentley Architecture, Bentley Structural, Bentley Building Mechanical Systems from Bentley for road and bridge, plant design, municipal and water engineering design, and construction. Covering all trades of construction, Bentley Building simulation completion can be passed to Bentley Structural, plumbing, and heating-related software, etc., for automatic calculation generation. Bentley Architecture combines an intuitive user experience interface, conceptual and schematic design capabilities, flexible and convenient 2D/3D workflow modelling and mapping tools, extensive data sets, and a standard component library of custom technologies that are part of an integrated suite of BIM applications, providing seamless integration between design and design, facilities throughout the lifecycle of engineering management, analysis, construction, and operations. During the design process, architects can not only directly use many international or international standards regional engineering industry normative standards can be easily customized or extended to meet the needs of different projects in the actual work, thus enabling architects to have all the tools needed for project design, document management, and design presentation. It is currently widely used in a number of large and complex construction projects, infrastructure, and industrial projects and can also be applied to computing cars.

3.1.3 ArchiCAD

ArchiCAD is a product of Graphisoft. ArchiCAD provides architects with unparalleled WYSIWYG graphic design tools based on complete 3D model design, powerful automatic generation of the plan, vertical and section construction design, parametric calculations, and easy project presentation and graphic rendering. Its workflow is centralized, and other software can be involved in the creation and analysis of virtual building data. ArchiCAD has an open architecture and supports IFC standards, making it easy to connect and use various software. ArchiCAD-based building solutions make extensive use of virtual building data and cover all aspects of the building workflow. As a product for the global market, ArchiCAD is arguably one of the first core BIM modelling software with market impact.

3.1.4 Digital Project

Digital Project is an engineering and construction industry application (secondary development software) developed by Gery Technology on the basis of CATIA to design models of any geometry and to support import-type components for hand-made complex parametric molds, such as the Knowledge Expert component to support rule-based design reviews; Optimizer widget to optimize the functional requirements according to the desired Parametric design project engineers are developing the Optimizer widget; Project Manager widget for tracking and managing models. In addition to this, Digital Project software supports powerful applications; for those in many developed countries that have established construction project coding systems in the domestic construction industry, construction project codes such as Unifomat and Master format can be imported into Digital Project to facilitate project budgeting. It also has some degree of application in the aerospace field, such as simulation modelling of aircraft and engines.

Table 1 shows the characteristics of the four most popular modelling software. It describes the advantages and disadvantages of Revit, Bentley, ArchiCAD, and Digital Project and discusses the specialized features and areas of expertise (Jianing Jiang, Xiong Wu, Yixiong Huang 2015).

3.2 Functional software

This section must be in one column. BIM functional software refers to the software that uses BIM data provided by BIM base software to carry out various tasks, including BIM-based structural, energy consumption, daylighting analysis and engineering calculation software, earthwork analysis software, etc (Li Zhang, LiXia Jiang 2019). This paper mainly introduces the domestic use of more collision check software, calculation software, mechanical and electrical deepening design software, and design calculation software - PKPM.

Table 1. Characteristics of the four most popular modelling software

BIM Modeling Software	Revit	Bentley	ArchiCAD	Digital Project
strengths	The software is less challenging to get started, with a simple UI interface, a more mature third-party object library development, easy and free modeling, full functionality, high integration, and strong marketing efforts.	Smooth to use, suitable for construction design of large commercial buildings; involves the construction of mechanical and electrical, site and geographic information, with multidisciplinary solid design and collaboration capabilities; MicroStation has an excellent design platform and strong design modeling capabilities.	The software interface is intuitive and easy for beginners to start. There are a large number of the object library, memory systems, no real-time calculation, low hardware requirements, and extension plug-in rich support for a variety of platforms.	Large, complex structures can be created directly, with wireless scalability to create 4D sequences; interoperability and digital projects with import and export capabilities
disadvantageous	The view is basically a real-time operation, which runs slowly and requires a high hardware environment; the layers in AutoCAD are eliminated, which is more challenging for beginners to adapt to, and it is impossible to distinguish between internal walls and external walls, etc. when exporting files.	High software learning costs, few teaching resources, backward promotion; software using CAD design concept is relatively backward; object library is less.	(shaped surfaces) Irregular surface modeling is less convenient than Revit; it does not support preview when printing; the non-architectural design is weaker.	The complex user interface, initial investment, limited object library, and lack of architectural design drawing capabilities
Professional Features	building structure machinery and power-generating equipment	machinery and power-generating equipment steelwork Coordinated management construct operations and maintenance	construct	Large building structures infrastructure machinery and power-generating equipment
Areas of Expertise	Civil construction (single-specialty construction)	Plant model design and equipment facilities (Single-specialty construction)	Single Professional Construction	Project complexity Structural shaped items

3.2.1 Collision checking software

Since the 3D model obtained by using BIM technology is almost the same as the actual product, collision checking software can be used to check different models placed on a unified platform. The pre-buried and pre-determined pre-determined reservation of M&E and structure, the collision between M&E and reinforcement, and the clash between the model itself and its surrounding are the focus of collision detection.

More widely used in China are Autodesk's Navisworks and Quanta BIM review software. Autodesk Navisworks software can combine design data created by applications such as the AutoCAD and Revit families with geometry and information from other design tools as a complete 3D project for real-time review in multiple Navisworks software products to help all parties involved see the project as a whole, optimizing everything from design decisions, building implementation, performance prediction and planning, and even facilities management and operations. Quanta BIM

reviews software, which has a good interface with Quanta's calculation software, a dedicated plug-in interface with Revit, support for IFC standards, the ability to import model data from ArchiCAD, Magi CAD, Tekla, and other software, and in addition to determining collisions between entities ("hard collisions"), It also supports the detection of whether the model conforms to the specification and the construction requirements ("soft collision").

3.2.2 Calculation software

Calculation software is the leading software in the bidding stage; based on BIM technology. The calculation software can automatically follow the list of local quota rules, use three-dimensional space technology, and refine the number of automatic statistics, deduction operations, and automatic report statistics. Domestic widely used BIM application software mainly includes Quanlianda, Luban, Shenji Miaoquan, etc. The three companies have developed corresponding software for civil calculation, steel calculation, installation calculation, finishing calculation, and steel calculation.

3.2.3 Electromechanical deepening design software

Deepening design software using BIM technology because of its intuitive image of space expression ability can meet the detailed design and high precision structural design above the basic requirements. More domestic mechanical and electrical deepening design software is PKPM equipment series software, Hongye-related software, Magi CAD, etc.

3.2.4 Design calculation software - PKPM

PKPM is currently the most widely used functional software series in China. In addition to an integrated CAD system for building, structure, and equipment (water supply and drainage, heating, ventilation, and air conditioning, electrical) design, PKPM currently has a construction budgeting series (steel calculation, quantity calculation, project pricing), construction series software (bidding series, safety calculation series, construction technology series), construction enterprise Informationization (At present, many enterprises with special qualifications nationwide are using PKPM's informationization system (Sheng Wang 2016). The series of software provides informatization solutions for all kinds of enterprises and project management. On the collaborative work platform supplied by the system, the four controls and four management of the project are completed, namely cost control, schedule control, quality control, safety control and contract management, and production factors (human, material, machine, technology, capital) management, site management project information management PKPM has three main functions.

1) PK module with two-dimensional structural calculation and reinforced concrete beam and column construction drawing functions:

The module itself provides a structural calculation software for planar rod systems, suitable for various regular and complex types of frame structures in industrial and civil buildings frame-bent structures, row frame structures, shear walls simplified into wall frame structures, and continuous beams, arched structures, trusses, etc. The scale is up to 30 stories and 20 spans.

Throughout the PKPM system, PK undertakes reinforced concrete beams In the whole PKPM system, PK takes over the work of construction, drawing auxiliary design of the reinforced concrete frame, column, and continuous beam. In addition to relaying PK two-dimensional calculation results, it can complete the construction by drawing additional designs of the reinforced concrete structure, row frame, and constant beam. It can also forward the calculation results of multi-story three-dimensional analysis software TAT, SATWE, PMSAP and the calculation results of the brick bottom frame and frame support beam, and can provide users with four ways to draw beam and column construction drawings, including beam and column overall drawing, beam and column separate drawing, beam and column reinforcement plan representation and Guangdong area beam table column table construction drawing, drawing beam and column construction drawings for high-rise buildings below 100 stories.

2) Building energy-saving design calculations, the software can help designers to complete all relevant thermal calculations, providing a large number of different insulation systems for wall, roof,

and floor types, which can easily query the scope of application and characteristics of various insulation systems. The software will automatically calculate parameters such as the building's form factor and window-to-wall ratio, directly read the architect's design parameters for multiple doors, windows, walls, roofs, columns, rooms, etc. in the building design, perform energy-saving design, and automatically check and verify the calculation according to the Energy Conservation Design Standard Code.

3) Dynamic energy consumption analysis and calculation, the dynamic energy consumption analysis and calculation program adopted by CHEC, according to the "Energy-saving Design Standard for Residential Buildings in Hot Summer and Cold Winter Areas" JGJ134-2001, calculates the annual heating and air-conditioning cooling heat index and electricity consumption index for each square meter of building area, based on the yearly meteorological data of each place, and carries out hour-by-hour energy consumption analysis and calculation for buildings for 8760 hours throughout the year. Furthermore, they are automatically based on the Energy-saving design standards for residential buildings in hot summer and cold winter areas for judgment and comparison. When the calculation results do not meet the requirements of energy-saving design standards, the maintenance structure design function of the software can be used to make the design meet the needs of energy-saving design quickly.

3.3 Collaboration platform software

BIM collaboration platform software is mainly construction platform software, including construction management software and operation management software. It combines BIM with the construction site and connects different BIM software through the Internet and database to meet the needs of all parties for collaborative work.

BIM construction management software is widely used in the whole life cycle of engineering projects. Take Quanta Construction Platform software as an example. Its 5D construction management software based on BIM technology supports the modelling and layout of the site, construction measures, and construction machinery. Construction flow sections and work surfaces can be divided (engineering projects are complex, and to ensure the effective use of labor, construction sites are often divided into several plumbing sections or construction sections to ensure sufficient construction work surfaces so that construction labor can be fully deployed), and the project entity model can also be correlated with the construction plan and the layout of the construction model at different time nodes. The software's construction simulation feature simulates the construction process, allowing the user to identify problems and optimize the construction plan prior to construction. The construction simulation includes the simulation of the actual project progress over time, the arrangement of large-scale construction measures and ground simulations for different time nodes (conditions), the arrangement of water simulations for different time periods and work surfaces, and the analysis of capital, labor, and material requirements by asking about the timing of various phases, such as monthly and weekly construction content and construction plans. The software platform also enables the tracking and recording of the results of the construction process, such as construction progress, daily construction reports, and quality and safety records.

The operation and maintenance management software combine GIS and BIM and is connected to the maintenance management plan to achieve intelligent and visualized management that integrates building management and real-time monitoring of building equipment. The BIM-based smart management system for electromechanical equipment can realize equipment maintenance and emergency management. Through BIM technology, it can also carry out energy consumption analysis and energy-saving control in the operation phase. The advantage also lies in the ability to analyze and test building safety and durability in relation to environmental impact and disaster damage in the operation phase and for structural damage and material aging. The ordinary operation management software is Archi bus.

Most of the collaboration software used for the construction management platform is self-developed primarily, such as intelligent supervision platform, with video monitoring, labor

supervision, environmental supervision, progress supervision, video conferencing, and equipment monitoring functions, but also for each sensor information query.



Figure 3. Basic functions of the intelligent supervision platform

Intelligent supervisory platform, making full use of advanced information technology, combined into the construction industry business production, interpretation of the concept of construction voyage Internet +. It uses BIM technology, GIS technology, big data, intelligence, mobile communication, cloud computing, the Internet of things, and other means to achieve the refined management of construction projects and the monitoring of construction site safety, quality, and progress. Bim + GIS command and control system is suitable for relatively large building groups. Most of the platforms only fight to control a single building; multiple buildings are associated with complex, intelligent supervision platforms that can not only realize the management of the park but also manage the alien structure. The system can realize GPS positioning queries, such as the realization of cars, real-time personnel positioning, and track query. System integration function is vital; it's loaded in the form of layers, can realize any open platform linkage, and can realize energy monitoring. The openness of the system is critical; it adopts C language, the function can be developed arbitrarily, it can recognize the late loading of the model, and it can set the permission of the personnel.

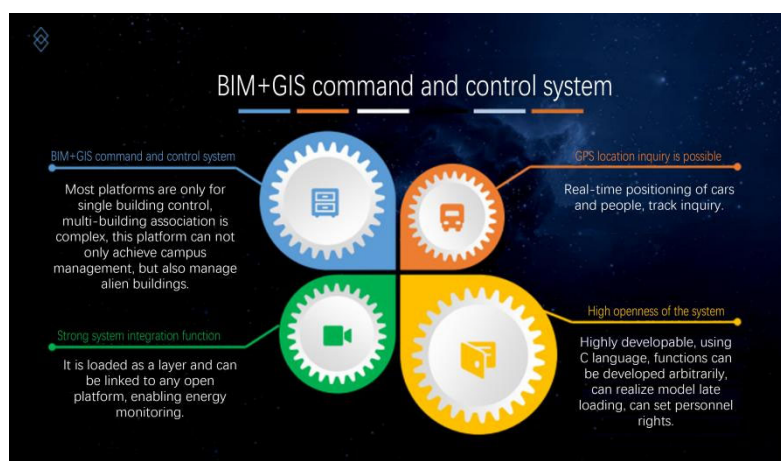


Figure 4. BIM+GIS command and control system

The Smart Supervision Platform consists of a decision-aid side (C-side), a business platform side (B-side), and a mobile phone mobile side (A-side). The decision-aid end can be used for the reporting of project results in large scenarios, Gis+BIM project display, and video conference review and signing. The business platform side is responsible for project information interaction, transaction processing, and business/transaction analysis. The mobile phone end can collect data and situations

on-site and carry out proxy transaction processing and the flow and query of standard business information.



Figure 5. Components of an innovative regulatory platform

4. Conclusions

BIM is recognized as the second information revolution in the construction field. Its applicability to the whole life cycle of engineering construction has promoted the development of the construction industry and the engineering field. BIM software is the root and foundation of BIM development, and according to the characteristics of different BIM software, it can be divided into three major categories.

1 BIM modelling software: The primary function of modelling software lies in 3D model design and establishing various data used for functional software.

2 BIM functional software: The primary function of available software is to use the data from the direct software modelling to perform various analyses, calculations, and other tasks.

3 BIM Collaboration Platform Software: The primary function of the collaboration platform software is to manage and apply the data generated by the BIM modelling and functional software.

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