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The Application and Management of BIM

BIM应用与管理

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BIM is increasingly being used in the architecture and engineering industries. Its three-dimensional representation, digital information management, as well as the platform model-sharing mode, brings fresh opportunities to the entire industry, domestically and internationally. The PAFC project uses BIM as an important approach to its project technology and management. In the process of project practice, PAFC conducted a series of BIM application explorations, and effectively formed a set of BIM management systems.

BIM (Building Information Modeling 建筑信息模型) 作为一项新技术与方法，越来越多地被用于建筑工程领域，其三维化、信息数据化、平台共享化的优势，给建筑工程尤其是以超高层为代表的复杂高难建筑工程，带来了不同以往的建设全程新变化。平安金融中心在借鉴国内外经验的基础上，将BIM技术作为项目技术和管理的一个重要手段。在项目实践过程中，进行了一系列的BIM应用探索，并形成了一套BIM管理的有效体系。

Drivers of BIM Implementation

Overall Control of a Complex, Difficult Project
Like many high-rise projects, PAFC faces both project management and technical difficulties. On a basic level, BIM is a great approach to help engineers solve these problems in a better way.

Space Utilization and Layout
It is hard to express complex spatial sections in a high-rise building with traditional two-dimensional floor plans. By using BIM technology, "what you see is what you get." The three-dimensional model can help engineers improve the space usage effectively. Collision detection and comprehensive pipeline layout are typical engineering problems that can be solved using BIM.

Project Technical Control Assistance
Because of several excellent features of BIM technology, (ie. high levels of accuracy and recognition, data sharing within the project schedule, etc.), items such as construction technical disclosure, preparation of scheduling, technical data archives allowing search and analysis of quantities, can be manipulated within the BIM application and finalized while still in the technical proposal phase. BIM can help the participants reach their goals more accurately and efficiently through developing a project management and project delivery plan more effectively.

Coordination of Multi-Disciplinary Professionals
Regardless of design or construction, the disciplines are becoming more specialized. This degree of specialization is beneficial to the professional to improve his technical level; but at the same time, it raises the overall need for coordination and management of professionals. As a collaborative technical tool between the various disciplines, BIM fulfills its role as an information sharing platform, which makes each project player put forth their own requirements independently, while also fully learning the needs and requests of the other project players in all stages of project implementation. For the owner or general contractor, information transmission and management can be much more reasonable and effective through BIM.

使用BIM应用原因

复杂高难项目的整体管控
平安金融中心作为超高层工程项目，其技术和管理难点，具有超高层项目的普遍特性，而BIM技术的特点，与超高层项目的这些难点，在基本层面具有很高的吻合性，能够有助于更好地解决这些问题。

空间利用与布局
利用BIM技术的三维方式，通过所见即所得的优势，借助计算机的帮助，可以充分提高空间使用的有效性和合理性。在BIM应用中常见的碰撞检测和管线综合，即属于借助BIM解决此类问题的典型方式。

辅助项目技术管控
借助BIM的高精准度和良好辨识性，以及与进度计划 (WBS) 之间的共享等特性，将BIM应用于技术方案的讨论定案、施工技术交底、进度计划的编制、技术资料的存档追溯、工程量计量辅助等方面。这些BIM应用，能够帮助参与方在制定项目管理方案、进行工程信息传递时，更清晰准确地达成目标。

多专业协调配合
BIM作为一种协同各专业之间关系的技术工具，能够充分发挥其共享平台的作用，在确保专业分工深度和精度的同时，使各参与方在项目实施的各个阶段，既能充分

The Application of BIM Contents and Requirements

BIM application in the PAFC project mainly concentrated in the following areas:

1. Assisted the pipeline layout comprehensive design, in the late construction drawing design stage
2. Provided a deeper and more detailed design for the main steel structure, as well as the MEP and curtain wall drawings
3. Assisted construction engineering measurements, civil engineering quantities used for the construction scheme compilation, electrical and mechanical quantities used for collecting equipment statistics, and steel structure quantities used for the component process
4. Simulated the construction schedule and the overall project schedule used for site and roads at different stages of planning, and different sector schedule simulation and schedule adjustments
5. Simulated clash detection for complicated areas or technology difficulties in the project, by helping explore construction schemes and technical disclosures
6. Delivered the completed model, which can be used for data retention and further digital operations

The Basic Principles of BIM Management

Consistency Principle of Contract Correspondence

Consistent with the principles of the contract, all kinds of project instructions are issued by the owners or issued by the professional BIM consultants who have been authorized by the owners. All contractors shall be operate in accordance with the instructions.

Figure 6.1. Detailed section rendering (Source: Ping An)
图6.1 平安金融中心局部的精细渲染 (来源: 平安)

提出自身的要求，也充分满足其他人对自己的要求。作为统筹全局的业主或总承包商，借助BIM可以更合理有效地进行信息传递和管理。

BIM应用内容与要求

平安金融中心的BIM应用，主要集中在以下几个方面:

1. 施工图后期，以管线综合为主的BIM设计辅助
2. BIM深化设计，主要为主体钢结构、机电、幕墙的深化设计
3. 辅助工程量计量，土建工程量用于施工方案的编制、机电工程量用于设备统计、钢结构工程量用于构件加工
4. 施工进度计划模拟，整体进度计划模拟用于场地、道路不同阶段的策划，不同区段进度计划用于进度安排调度
5. 对于复杂区域或工艺的模拟，用于探讨、验证施工方案、进行技术交底
6. 竣工模型交付，用于资料留存以及进一步的数字化运营

Principles of the Implementation Process Synchronization
In the implementation process, the actual progress of the building project should keep pace with the BIM project schedule. Also, the BIM model should be updated to ensure that it is available to, and accurate for all of the project participants in a perfect state.

Consistent with the Principles of Management Responsibilities
During the implementation process, the main contractor, sub-contractors and general contractor should all be corresponding on project management responsibilities and are obligated to the contractor.

Figure 6.2. The building under construction (Source: Ping An)
图6.2 平安金融中心正在施工 (来源: 平安)

BIM管理基本原则

合同对应的一致原则
各参与方所负责的BIM工作内容，与其承担的实体工作内容相一致。

实施过程的同步原则
在实施过程中，工程的实际进度须与BIM工作保持同步。同样BIM模型和模型信息应同步更新保证，确保模型处于完美可用状态。

管理职责的一致原则
在实施过程中，总承包商、分包商和主承包商应承担各自的项目管理责任，并对业主负责。

可持续更新原则
根据实施过程中的反馈意见，并且随着BIM技术的发展，进行更新。

BIM管理实例

BIM合同中约束的责任与权利针对BIM顾问的合同约定
针对BIM顾问在设计过程中的角色
负责模型的建立以及模型与施工图之间的互检、保证二维三维设计成果间的一致性、保证设计成果的质量。BIM顾问在施工过程中的角色:负责监督管理各参与方的BIM应用、落实BIM在项目中的执行、审核各参与方的BIM应用成果、提供相应的技术支持。

针对承包商的合同约定
平安金融中心项目在施工过程中的模型操作和BIM应用，是由承包商作为主控责任人，因此对于承包商上BIM要求以及执行管理就显得极为重要。为确保承包商在这一过程中的执行效果，项目从一开始的招标文件中就明确了相关的BIM要求，包括技术要求和管理要求。进而在与承包商的合同中，也明确了BIM的工作内容和成果标准。

建立精细的管理结构

1. 业主: 作为本项目的最终决策者，推动在本项目中运用BIM技术和管理手段，提高工程管理水平和技术水准 (见图6.3) 。
2. BIM 咨询顾问: 经业主授权，作为本项目BIM实施的管理者，同时也是BIM技术标准和实施规则的

The Principles of Sustainable Updates
Keep sustainable updates based on the feedback from the implementation process and consistent with the development of BIM technology.

Case Study for BIM Management

The Responsibilities, Rights, And Constraints in the BIM Contract

For BIM Consultants
In the design process of a project, the BIM consultant is responsible for modeling and inspection checks between the construction drawing and the model to achieve mutual agreement and consistency between the 2D and 3D design plans. BIM consultants make every effort to guarantee the quality of design results during the whole process. In the construction process of a project, the BIM consultant is in charge of supervision and management of the BIM applications for participants who are involved in the project. The consultant should also audit the BIM application results and provide technical support.

For the General Contractor
The general contractor takes charge of the model implementation and the BIM application. To ensure of the general contractor's executive efficiency, every BIM requirement was provided in the contract, including technical and management demands. Additionally, all BIM work content and contractor's output evaluation guidelines were also provided in the contract.

Establish a Sophisticated Management System

1. Owners, as the ultimate decision-makers for this project, should promote the use of BIM technology in this project for improved construction management quality and technical standards, in order to better complete the project and lay a good foundation for future operations (see Figure 6.3).

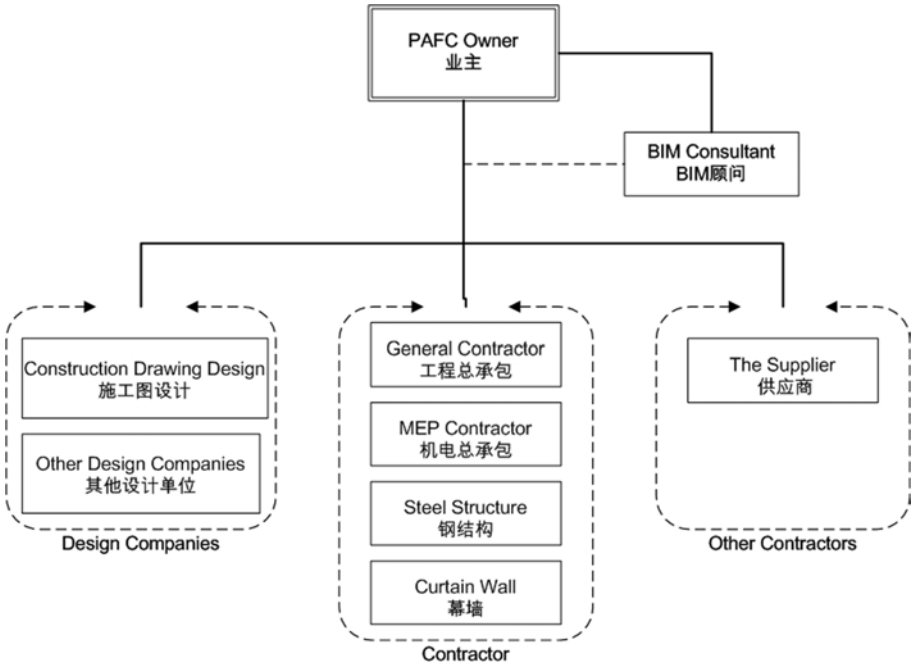

Figure 6.3. PAFC BIM Organization Structure Chart.
图6.3 组织架构图

制订者，负责项目BIM工作的整体规划、监督、指导和实施管理。

3. 设计单位: 负责及时向BIM顾问团队提供准确的图纸信息，对施工图及各级承包商或和专项设计单位提交的深化设计、设计变更等进行相应的审核，并根据业主和BIM顾问的修改建议及时更新图纸。
4. 承包商: 与业主签订合同 (包括三方协议) 并参与BIM工作的，需根据自身的工程内容建立模型直至竣工。模型的标准和使用，按照项目的BIM实施导则要求执行。总承包商应组织协调全体相关参建单位参与使用BIM进行综合技术和工艺协调。总承包商完成的BIM成果及模型应提交给BIM咨询顾问和业主，且上传至共享平台供项目各方使用 (见表6.1) 。

优化模型操作流程

模型操作与BIM应用的关联与区别

模型操作指针对模型及模型信息的建立、修改、完善、存储等一系列工作内容; 模型操作本身是BIM应用的基础，但模型操作并不能为项目带来业务上的直接帮助。BIM应用是指利用模型进行进一步的工作，通过计算机或者人工方式，获得对项目有直接帮助的成果，用以解决业务问题或辅助项目管理。这二者之间的关系，模型操作是由管理体系规定的参与方完成，而其完成的模型，可能会由多个参与方用于不同的BIM应用。而这些BIM应用，也对模型操作的标准提出了相应的要求。例如，钢结构、幕墙的模型操作分别由各自的承包商负责，而钢结构与幕墙的之间的碰撞检测这一BIM应用，以及进一步的协调指令下达，是由总承包商负责完成。

模型操作管理的难点

在实际的模型操作过程中，有几个难点应与重视:

- 非一次性交付: 很多模型操作的成果并非一次性交付后就不再改动或变化，而是有可能由于业主需求变化和工程进展，有调整或有深化。
- 动态交付物: 很多模型本身是作为项目管理辅助工具，用于项目某些决策过程的研究，尤其在施工阶段，3D模型更易于施工方案的表达说明。因此，这些模

2. BIM consultants are authorized by owners as the project managers to implement BIM technology, as well as to set technical standards and rules. The BIM consultants are responsible for the overall planning of the project BIM work, supervision and guidance, and implementation management.
3. The design consultant is responsible for providing accurate and timely drawings to the BIM team. The design consultants are also responsible for auditing the detailed design, construction drawings and any design alterations from the contractors, all the way through to the owner's modified proposal update drawing.
4. Contractors who signed a contract with the owners (including a tripartite contract), and who are involved in BIM work must continue to undertake corresponding modeling work till the model is completed. The model standard and usage should apply according to the project BIM Implementation Guideline. The General Contractor should organize and coordinate the participation of all relevant integrated construction units using BIM technology and process coordination. The general contractor should submit the BIM model to the BIM consultants and owners. Also, it must be uploaded to the BIM platform for use of the various participants in the project. (see Table 6.1).

PAFC BIM Participator and Responsibilities Division Table (excerpt) 平安金融中心BIM主要参与方职责分工表 (节选)					
MARK 标注	M = MODELING 模型操作				
	A = APPLY 应用				
	C = CHECK 审核				
	R = RATIFY 审批				
	P = PARTAKE 参与辅助				
BIM work BIM工作	Owner 业主	BIM Consultant BIM顾问	Design 施工图设计	General contractor 工程总承包商	MEP Contractor 机电总承包商
Guideline Compiled 策划与导则编制					
Comply BIM Implementation Guideline 编制实施导则	R	M	P	P	P
Comply BIM Implementation according to participants' requirements 编制各参与方BIM实施要求	R	M			
Comply BIM Work Schedule 编制项目BIM工作流程	R	M	P	P	P
Comply BIM Evaluation Regulation编制项目BIM 评审标准	R	M			
Construction Drawing Design 施工图设计阶段					
Modeling 施工图模型	R	M	P		
Update Model 模型更新	R	M	P		
BIM Design BIM设计	R	P	A		
Design Collaboration 设计协调	R	P	A		
Pipeline Layout 管线综合	R	A	P		
BIM Output Drawing BIM出图	R	A	P		
Construction 施工阶段					
Deepen Design Modeling 深化设计模型	R	C	C	M	M
Update Model 模型更新	R	C	C	M	M
BIM Construction Schedule Stimulation BIM施工进度模拟	R	C	C	A	A
BIM Construction Technology Stimulation BIM 施工工艺模拟	R	C	C	A	A

Table 6.1. PAFC BIM Responsibilities Division Chart
表6.1. 平安金融中心BIM职责分工表

Operating and Optimizing the Model

Model Operations and Differences Associated with the Application

"Model operations" refer to a series of work tasks which include modeling, model modification, optimization, storage, etc. Although model operations are the basics

of a BIM application, from a business aspect, they cannot be directly implemented project. The user can achieve beneficial results from applying BIM through the computer or manually, which help the project by solving business issues and assisting project management. The model operation and model application are bound together by a mutual suppression agreement. For example, the model operation of the steel structure and the curtain wall are provided by the respective contractors. In the meantime, the general contractor will be in charge of the collision detection between the steel structure and curtain wall, and also give participants further coordinating instructions.further coordinating instructions.

Difficulties in Model Operations Management

There are several difficulties that should be mentioned in the process of model operation, as follows:

- *Non-Disposable Delivery*: Most models will be changed frequently; additionally, the results will be alternated with the owner's changing demands or the project progress.
- *Dynamic Delivery*: Many models are simply considered an auxiliary management tool, only to be used to help professionals make better decisions. Especially in the construction stage, the 3-D model expresses the construction plan more understandably. As a result, these models are always in the dynamic state. In other words, there is no "final version" of the BIM model.
- *The Influence to All Participants*: Since model operation is a multi-lateral activity, every participant should be clear on his/her responsibilities and should consider his/her impact on others' work.
- *The Meaning of Real-Time Operation*: The model should be constantly

型是处于动态的状态，并不存在真正意义上的终版交付物。

- 对多参与方的影响: 模型操作在多参与方的情况下，必须明确各参与方负责的部分，也必须考虑每各参与方对其他参与方的影响。
- 实时的意义: 模型操作应及时，尤其是反映工程现状 (实体已完工) 的整体模型和设计定案模型。如果无法保证实时更新，就有可能出现在错误的模型上讨论问题的情况，使得讨论变得无意义或增加错误。

优化模型操作流程

由于地区差异、项目特点的差异和业主管理差异，不同的项目有着不同的管理体系与架构。在遵循BIM自身特点的基础上，根据现实的项目管理体系，优化和确定模型操作的

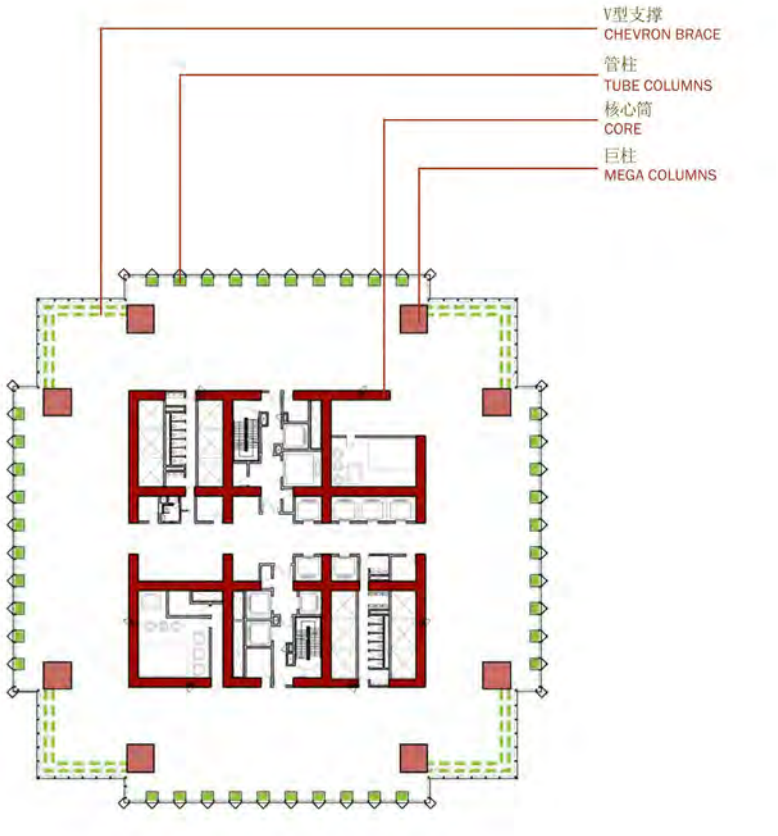

Figure 6.4. Typical office floor plan showing the location of the mega-columns (Source: Ping An)
图6.4 办公标准层平面与巨型柱的位置 (来源: 平安)

Figure 6.5. Construction workers following management standards during construction (Source: Ping An)
图6.5 平安金融中心建造过程中工人依照管理规范施工 (来源: 平安)

updated, especially the portions which reflect real construction situations (or completed parts) and the final design. If real-time updates cannot be guaranteed, the project discussion using an old model is a waste of time and is meaningless.

The Process of Optimizing the Operation Model

Due to regional disparity and project characteristics discrepancies, each project has its own management system and organization. It is important to optimize and finalize model operation procedures that are dependent on the actual project management system and to follow BIM's own characteristics. The reasonability of the whole procedure affects BIM implementation results.

CCDI, as the BIM consultant, fully considered the owner's requirements. According to the management system of PAFC, the consultant considered the supervision range and depth, contract relationship and business associations, as well as the practical technical ability of all participants. Referring to different BIM applications, we optimized the model operation procedure which ensures the quality, effectiveness, and timeliness of the model.

The Improved Effects of Using the BIM Application

In order to ensure the BIM implementation effect of the PAFC and consistency of participants in the BIM process, the BIM consultant compiled the "BIM Implementation Guidelines of PAFC" with the proprietor. The main content of the guidelines is divided into three parts. The first part is the management standards, which includes the project organization and structure, division of responsibilities, and operation flow of the BIM model. The purpose of this part is to build and define guidelines for all project participants. The second part is the technical standards, including the BIM software, model and information files, etc. The purpose of this part is to stipulate all technology requirements and regulations of BIM. The third part is the standards of BIM achievements evaluation, which concentrates on stipulating accuracy and quality of output, as well as clarifying expected achievement from different BIM applications. "BIM Implementation Guidelines of PAFC", as a programmatic document and unified standard, requires participants to work under a common framework. More importantly, it ensures that the BIM model works as an allocating instrument of management methods.

The process management under BIM. The process management at PAFC promotes the following three changes emphatically:

流程极为重要。这一流程的设置是否合理，直接影响到项目BIM实施的成效。

CCDI作为项目BIM顾问，充分考虑了业主的需求。依照平安金融中心的实际管理体系，考虑到管理幅度、管理深度、合同关系和业务关联，也考虑到不同参与方的实际技术能力，针对不同的BIM应用，优化了项目的模型操作流程，确保了模型的质量、有效性和及时性。

提高BIM应用的效果

BIM实施导则的编制。为确保平安金融中心项目中BIM实施的效果，也为了确保BIM实施过程中多参与方的一致性，CCDI作为BIM顾问，与业主一同编制了《平安金融中心BIM实施导则》。导则的主要内容包括三个部分。第一部分是管理标准，前述的组织架构、分工职责、模型操作流程等都是管理标准的一部分。这部分的目的是规定项目所有BIM参与者的行动准则。第二部分是技术标准，包括BIM软件、模型文件、模型信息等。这部分的目的是规定项目所有BIM实施的技术准则。第三部分是BIM成果的标准，规定了不同的BIM应用应达成的具体成果，以及这些成果的表达方式和质量准则。《平安金融中心BIM实施导则》作为纲领性文件和统一标准，使多参与方的工作能在共同的标准下进行，确保了BIM作为统筹工具和管理方法的实现。

1. First two–dimensional, and then three-dimensional: BIM as a technical method should be used as a direct tool in the project instead as a two-dimensional inspection tool. The BIM application is a vehicle which moves a traditional two-dimensional expression into a three-dimensional condition.
2. Move from comprehensive to individual: Multiple disciplines and many participants involved in a project will bring a variety of problems. After gathering the entire brief, use BIM as a direct tool to find a comprehensive solution. Get rid of the old mode, which assigned in the order of points to total. Establish a new "total to points" mode. Only after determining an overall solution, extract a specific method that meets all of the participants' requirements.
3. Verify first, then finalize: BIM as an auxiliary project management tool should be used to validate and refine project management methods. Break beyond the limitation, in which BIM only used as a final expression model in the past.

Conclusions

The implementation of BIM in a project, especially when multiple disciplines are participating in the project, provides effective organization and management.

In a project, the organization management form should be kept consistent, whether it is applied in the model alone or in the overall project.

- A project contract is an effective and necessary tool that can guarantee that all the participants apply BIM technology and make sure the BIM effect matches the expectation.
- To sum up, a project should have its own complete and feasible BIM implementation guidelines as a common technical regulation, and management standards for each of the participants.

BIM应用的过程管理。在平安金融中心项目的BIM应用的过程管理中，在工作过程中的实践中着重促进了以下三个转变:

1. 先三维后二维: BIM作为技术手段，本质上不应是做为二维的检查手段，而是作为直接的工具进行使用。BIM应用是基于三维条件下的应用，传统的二维方式将转变为三维的特殊表达形式。
2. 先综合后单项: 多专业多参与方的综合性的问题，在收集各方要求齐备后，直接先通过BIM方式进行整体考虑和解决。转变过去从分到总的模式，树立从总到分的模式，只有在确定了整体解决方案后，再从中摘取对各专业各参与方各自的要求，分别予以表达和执行。
3. 先验证后定案: BIM作为项目管理辅助工具，应在进行管理方案的过程中用于验证和推敲，转变过去仅用来做最终表达的局限。

结论

BIM在一个项目中的实施，尤其是负责多参与方参与时，其组织管理是使BIM技术应用获得成效的必要保证。

BIM的在项目中组织管理形式，应与项目总体的组织管理形式保持一致。

- 通过合同等方式，保证各参与方在项目中应用BIM技术及效果，是一种行之有效的手段，也是一种必要的管理手段。
- 项目应有自身完整、可行的BIM实施导则，作为各参与方工作的共同技术规范和管理准则。