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## Research on Construction Schedule Management Based on BIM Technology

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### Abstract

The construction schedule management in the traditional mode will be affected by the natural environment, the objective environment and the subjective environment, leading to the interruption or obstruction in the construction process. But in the actual construction process, through assisting the BIM model and BIM5D software in the construction schedule management, not only ahead of schedule can be aware of the next step schedule of the required resource requirements, equipment demand and capital requirements; but also in the actual construction process Timely monitoring the progress of the completion of the percentage of the plan, the actual use of the amount of funds accumulated and the amount of budgetary funds deviation and so on; at the same time in the actual construction process can form a set of complete construction schedule management mode that timely supervising the construction quality and safety issues, recording defects on the spot, integrating data and associating model, timely rectifying or Repairing defects, and then checking the project.

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**Key words:** BIM schedule management BIM5D association model

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## 1. introduction

The earliest research on project management in the United States, there are many sufficient theoretical knowledge and a lot of practical experience after a long period of development. With Chain's development of economy and improvement of science and technology continuously, the concept of project management also has been introduced in the field of construction projects. Project management in the progress of management directly affects the economic benefits of the project, so the importance and application value of progress management that one of the three objectives of the project management can't be ignored. At present BIM technology is developing rapidly, the application of BIM technology makes the progress of the efficiency of management, progress management of the content of information.

## 2. The major problems encountered in the implementation of the construction schedule

### 2.1. Inadequate problem in the pre-preparation phase

There are a lot of preparations to be made in the progress management, developing a sound organizational system and grading schedule, and ensuring that funds, materials, materials and so on to be able to supply in time. Simultaneously, it is necessary to predict the weather conditions in the implementation of the schedule ahead of time and make reasonable arrangements for the construction content according to the actual situation. Doing a good job on the construction site control and making a construction site layout plan in advance, and making good preparations for large machinery to approach in the construction. In addition, the planning for construction materials, small machinery, lifting equipment and others should be made safely and reasonably.

Actually, it is usual for the construction team and the relevant management staff to ignore the time of these preparations in the construction process, so in the progress of the plan also need to rework, work and even work stoppage to solve these problems should be arranged, Resulting in the delay of construction period, the increase of cost and quality defects finally.

### 2.2. The defects of plan design, implementation, inspection, control process

Scheduling is to follow the process that first design, and then implementation, inspection and control after, in which the process once the error of which links will affect the progress of the whole process. The development of the schedule is the most important part of the whole process. As the saying goes, a good start is half the battle. However, in fact, it is construction units, construction units and others that will always be perfunctory, fail to take it seriously and not realize that the progress of the implementation plan is the lifeblood of the plan, which results in ineffective implementation of the situation. The progress planning process is interlocking, closely linked, each stage of interrelationship and influence.

### 2.3. The opposition and reunification of Duration, cost and quality

In the schedule, not only to ensure that the construction period is in accordance with the contract, but also it needs to make the final project safe, applicable, perfect, no quality defects, and to ensure that minimizing construction costs and achieving the economic benefits without exceeding the budget price of the contract.

The duration can effectively be advanced if the budget is estimated high between the duration and cost; the cost need to subsidize in case of the delay of schedule .Between the duration and quality, duration of the process block, the quality will be damaged; to ensure quality and safety of the project, it is necessary to lose the duration. Quality and cost, as long as problems of the quality arise, you need funds to remedy; the quality will decline if funds shrink. The relationship between the three needs the management staff to control well, so the staff whose experience is lacking, professional knowledge is not perfect and skill level is not in place can't do a good job scheduling management.

### **3. Application Advantages of BIM Technology Compared with Traditional Technology**

#### *3.1. Three-dimensional model*

The traditional schedule management process in the drawings of the trial, construction and other work are based on two-dimensional drawings and peace map atlas; BIM technology can display the project three-dimensional visualization in the present stage, not only does it display of the project model through the three-dimensional, but also it shows that the construction of the project management, Three-dimensional arrangement of steel effect. At the same time under the traditional technology of the site layout model is only two-dimensional plane, BIM technology can achieve three-dimensional site layout effect.

#### *3.2. Model Integration*

In the traditional mode, the collision problem between the structural members and each professional will be displayed in the construction or after construction, which directly affects the smooth progress of the construction period; the three-dimensional model between different professionals can be integrated by BIM technology, achieving the collision check before the construction and finding out the design imperfections caused by part of the collision problem.

#### *3.3. The association model*

In the traditional mode, the prepared schedule is only expressed by writing the papers, only the checkpoint is selected and the actual construction progress is marked on the schedule when the progress monitoring is carried out. However, it is impossible to correlate the schedule planning with model under the BIM technology, in which case not only does the construction animation simulation be realized, but also the actual work start time and end time are entered to achieve the actual construction animation simulation. At the same time BIM technology will list the associated model, achieving real-time capital comparison and monitor between resource and cost.

#### *3.4. Information Management*

In the traditional construction schedule management mode, if the project quality and safety problems are encountered, it will be recorded in written form, and the latter will not be managed after the completion of the later repair. However, BIM technology will directly link the quality and safety issues to the designation in the 3D model Location, not only can do a good job pre-record, but also it does a good job in the late "dressing", "not finishing", "finishing the end of" state management.

### **4. BIM application value**

Dodge Data & Analytics is a leading company which provides data, analytics, news and intelligence for the commercial building industry. The company has been tracking the impact of technological progress on the enterprise through the "Smart Market" since 2007. The new report in 2015 analyzes Chinese design firms and construction companies that currently use BIM and have not yet applied BIM.

The main findings of the report are as follows:

#### 4.1. BIM application rate is increasing every year

As of the end of the survey report, the number of enterprises that use BIM technology is already 30%, which is expected to double after two to three years (design units increased by 89%, construction enterprises increased by 108%).



Fig.1. the survey of BIM application rate - "Smart Market" research report.

#### 4.2. BIM can produce huge commercial benefits

Sixty-four percent of Chinese respondents indicated that their projects benefited from the applications to BIM technology that shorten customer approval cycles. It is well acknowledged that faster customer approvals help reduce the delivery times of overall project and improve engagement of owner in project design and construction.

#### 4.3. Non-BIM users are positive about BIM

89% of non-BIM users in China are positive about the future of BIM, and none (0%) say that they have applied BIM but decided not to apply it.

As is also shown in the report that the global construction companies on the application of BIM benefits arising from the project are: to reduce the construction drawings in the wrong, to promote communication and collaboration with other project participants to reduce engineering rework repair and adjustment, enhance Cost control and reduce construction costs, shorten the project duration, improve project safety.

Listed below are a few "Smart Market" research projects that have been built using BIM technology in China, and list the BIM application points in the project. They are: Shanghai Center Building, Phoenix International Media Center, Shanghai Disneyland Resort.

Table1. BIM technology in China's typical application of the project

Shanghai Center Building	Phoenix International Media Center	Shanghai Disney Resort
Rotation from Curtain wall design	Curve shell shape design	The professional collaboration to complete information interaction
Coordinate the design and delivery of projects within the team Project technical	Assessment the difficulties of BIM4D schedule planning model	
Collision checking reduces rework	BIM model to two-dimensional mapping	Immersive stereo visualization technology

## 5. The composition of BIM 5D model

### 5.1. The function of BIM5D model

BIM5D integrated solid model, site model, temporary model, progress data, drawings and information as a whole, integrated under the unified .igms standard, while in-depth integrated standards for. Icc TEKLA steel model, in addition, the standard for .Mpp schedule plan Project is also integrated for data and model maintenance and management.

First of all, it is important to improve information of the project BIM5D including project information, the parties involved in the project and the terms of the contract and other information through the form of data input.

The BIM5D-compliant model files are then imported into each standard type, including inventory valuation documents, civil and electromechanical subject models, and site models. The main point of the model is integrated on the BIM5D platform, and file is preserved well. In this case, it is impossible to achieve roaming, taking pictures and simulation entities through the BIM5D plug-in function in the integrated model interface.

Secondly, according to the construction process and construction logic in theory, the construction water flow section and the flow section correlation model are divided, and then the simulation of flowing water construction without time constraints is formed.

Once again, in the model display interface, import the project design of the Project schedule plan, each with a clear start and end time of the work tasks and the theoretical segmentation of the water associated.

Finally, associate the inventory with the model, and carry out the construction process of change management, quality and safety management, materials management and so on.

BIM5D in the realization of the functions can be divided into technical management, production management and business management.

### 5.2. BIM5D model block

Functional blocks in BIM5D are mainly divided into two aspects: data import and data management. Subdivision can be divided into different forms according to different standards. The detailed forms are project data, data import, model view, pipeline view, construction simulation, material query, contract management and report management.

Project information: Mainly carry out the project overview and project information management.

Data import: Integrate the main model, the site model and other models with the base point.

**Model view:** It can realize the view of the integrated model, and it can display the layers, sub-specialty and sub-component selectively. At the same time, it can carry out the roaming on the platform and between the layers and collision analysis.

**Flowing view:** it needs to divide the professional floor and components of the water segment, and to relate the water directly to the model data, which can be carried out in the water section of the project statistics. After the schedule being imported, it can be achieved between the planned construction and the actual construction of the amount of comparison in the flowing view.

**Construction simulation:** to begin with, importing the schedule Project in this interface, then achieving the task of the associated model, and finally achieving the construction process under the constraints of the construction schedule dynamic simulation. In the actual construction process, the actual task of start time and end time are carrying out. At the same time it can also achieve the dynamic display of funds, resource curves, components, inventory engineering statistics, progress, quality and safety tracking summary of the function in this function block.

**Material query:** the professional can achieve the summary information of engineering materials and engineering quantity under the determined period when time, progress, floor, flowing segment and custom mode are determined.

**Contract management:** through the import of the successful bid list, budget bill of quantities table, it can implement the three-count comparison list when processed through the BIM5D background, including in the price, the cost of budget and the actual cost of comparison; in addition, it can achieve the three-count comparison of resources.

**Report Management:** After selecting the range of the report manually, the material quantity summary table of each specialty is realized.

### *5.3. BIM5D to assist in the construction schedule management*

In the progress management, the main content is engineering construction based on the duration, reasonable arrangements for the materials and others, the import and export of the amount of large machinery, good management for contract and change, guarantee for the project quality and safety, control for the project budget. The BIM5D can be used for construction simulation, engineering metering, material handling, piping views, contract management and quality safety.

BIM5D can be made with the preparation of a good schedule before the construction, forming the dynamic process simulation of project progress. What's more, the collision of different professionals will be checked in the early to reduce the late work of change correction. It can also predict the next phase of the required materials in the pre-construction project, that is to say, it need to make a good procurement plan and limit the requisition list and capital plan.

The use of BIM5D software is to assist the work all the time from the beginning of the project to the end of the project, after all the preparatory work is completed, the project starts in accordance with the scheduled start time of the construction period, in the individual projects such as excavation, construction drainage, the diaphragm wall and so on until the planned start time in the schedule, the actual construction start time and the construction end time are recorded in the BIM5D. If the construction defects are encountered during the construction process, the corresponding position in the BIM5D can be marked in time, in order to find and correct defects in the future.

It is important to make records well of the time, safety and quality of information in the process of the actual construction, and ultimately do the work before the start of preparation, after the beginning of the records and statistics, after the end of the contrast and feedback. It is real to make the building information model assist in the progress of the construction process dynamic management process.

## 6. Application of BIM 5D Example - Taking Central Grand View as an Example

### 6.1. Project Overview

In this paper, we carry out the introduction and application of BIM5D combined with the frame - seismic wall structure engineering. We take Central Grand view as an example that the case works is the city of Zhengzhou City, Qiantang Road and food street intersection southeast corner. The number of layers of building is 19, including a total of 16 layers on the ground and 3 layers on the floor. Negative three-story, negative two-story for the garage and equipment space, a layer of commercial space, and the ground are commercial buildings. The average building area of single layer of basement covered more than 11,000 square meters, the ground floor area of single-layer also reached more than 7,500 square meters.

After the material is ready, it is necessary to adjust the document format (.igms), so that the material files are combined and associated under the same benchmark criteria. After doing the construction simulation in BIM5D, the BIM5D can be used to assist in the process of any engineering data management in the actual construction process, so as to realize the construction schedule management under BIM technology. Fig. 2 is the model combination process.

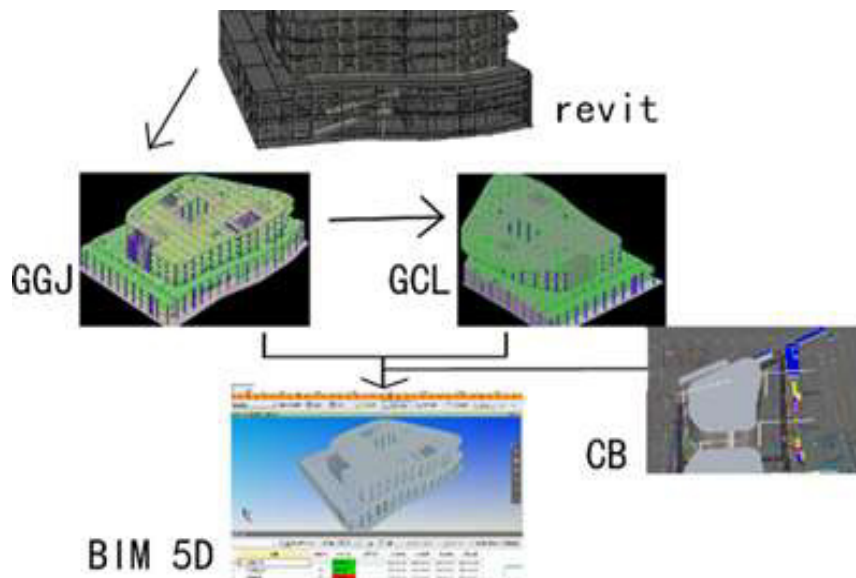


Fig.2. the implementation flow chart of BIM5D

### 6.2. The preparation of the schedule

The preparation of the preparation of the schedule before the organization is doing a good job of division of labor, it should be recognized that the quality of the construction team is the key factors to ensure the construction schedule and quality. The construction team of the project selected is a long-term cooperation with the construction of enterprises in good standing, performance and strong, first-class construction team to ensure that the quality of labor and on-time organization in place.

In the construction, we need to divide the work team by different types of work and different construction sites firstly, making the professional team do the same nature of the work and improving the operation of proficiency

and labor productivity to ensure the quality of construction and construction progress. At the same time, in order to ensure the quantity and quality of the labor force to meet the construction progress and quality and safety needs of the project, the project department set up a labor force management team headed by the project manager, project production manager and project safety director, deputy production manager. Responsible for the quantity and quality of labor, project safety director is mainly responsible for the protection of the legitimate rights and interests of workers supervision, the relevant departments are involved in the labor force management, as shown in Fig.3 below.

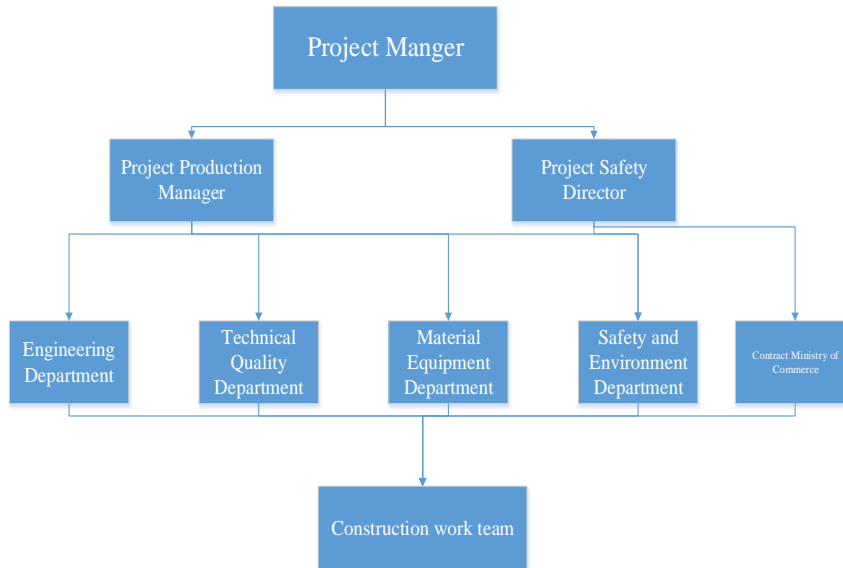


Fig.3. Management organization system diagram

The main content of the schedule plan is to determine the phase of the project in the timeline and the corresponding process of the planned use of human resources. First of all, determining the progress of the construction schedule milestone plans from the macro, and then following the principle of balanced distribution of resources to develop a detailed and complete schedule in accordance with this map, with the amount of material.



Task Name	Duration	Starting Time	Completion Time
Foundation started	0	2013/10/1	2014/10/1
Block B foundation engineer	144	2013/10/1	2014/4/18
Foundation Completion	0	2014/4/18	2014/4/18
Negative layer 3 underground	74	2014/4/18	2014/7/30
Negative 3-layer completion	0	2014/7/30	2014/7/30
Negative layer 2 underground	74	2014/7/7	2014/10/16
Negative 2-layer completion	0	2014/10/16	2014/10/16
Negative layer 1 underground	74	2014/9/23	2015/1/2
Negative 1-layer completion	0	2014/1/2	2015/1/2
Ground negative 1 layers	64	2015/1/2	2015/3/9
1-layer completion	0	2015/3/9	2015/3/9
Ground negative 2 layers	64	2015/2/16	2015/5/14
2-layer completion	0	2015/5/14	2015/5/14
Ground negative 3 layers	64	2015/5/14	2015/8/11
3-layer completion	0	2015/8/11	2015/8/11

Fig.4. Project milestones - the Grand Central as an example

Project scheduling using the Project is a list of forms of expression, there is a clear plan to start and end time, and can automatically generate the schedule of the bar chart. However, the use of resources planning information can't be expressed in such a detailed, so using this software to prepare the progress of the schedule is the milestone - bar chart schedule. But the use of resources can be linked in the BIM5D look, and then automatically export resources to use the table plan.

Because the project is a single layer of large quantities, so the construction team stratified four teams work, the design schedule as shown in Fig.5.

Task Name	Duration	Starting Time	Completing Time
Underground negative 3 layers	74	2014/4/18	2014/7/30
The first construction area	32	2014/4/18	2014/6/2
Bundled wall and column reinforcement and template	15	2014/4/18	2014/5/8
Cast-in-place concrete	2	2014/5/8	2014/5/9
Bundled beam plate and support the template	16	2014/5/9	2014/5/30
Cast-in-place concrete	2	2014/5/30	2014/6/2
The second construction area	32	2014/5/8	2014/6/20
Bundled wall and column reinforcement and template	15	2014/5/8	2014/5/28
Cast-in-place concrete	2	2014/5/28	2014/5/29
Bundled beam plate and support the template	16	2014/5/29	2014/6/19
Cast-in-place concrete	2	2014/6/19	2014/6/20
The third construction area	32	2014/5/28	2014/7/10
Bundled wall and column reinforcement and template	15	2014/5/28	2014/6/17
Cast-in-place concrete	2	2014/5/28	2014/6/18
Bundled beam plate and support the template	16	2014/7/7	2014/7/8
Cast-in-place concrete	2	2014/7/8	2014/7/29
Negative three-tier completion	0	2014/7/29	2014/7/30

Fig.5. Project Bar chart schedule - Take Central Grand as an example

### 6.3. Construction process simulation

The main content of this section is the schedule planning associated model. Because the previous section has been doing a good job of the water division, as long as the work schedule under the work of each paragraph by paragraph, and the flow of the water division of the water or water partition area of one or more categories of components can be associated. As shown in the left side of Fig.6. So you can get in accordance with the preparation of a good schedule of dynamic construction simulation animation. As shown in Fig.6 on the right side of the puzzle.

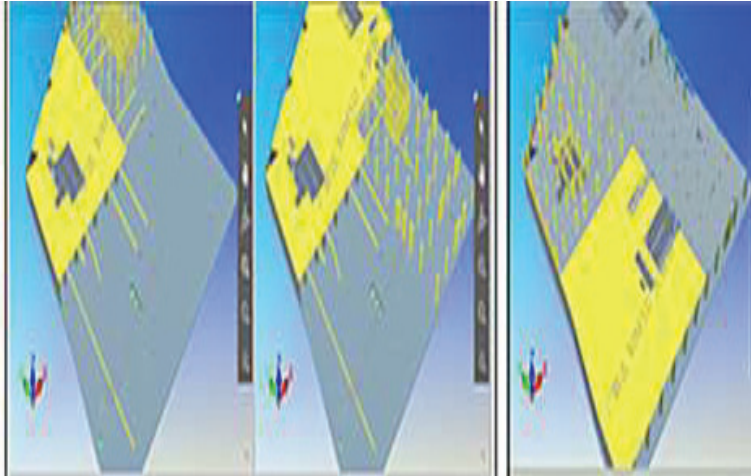


Fig.6. Comparison of actual construction and planned construction

### 6.4. List Correlation Model

Because the bill of quantities has been imported into the BIM5D, as long as the inventory items directly associated with the corresponding model components, you can get a detailed resource usage schedule. As shown in Figure 14 below. Then take a construction period of time in the construction simulation interface, and you can display requirements for civil works, steel material in this period of time; at the same time you can achieve the corresponding resource data according to material, floor summary and the water section of the summary of in the summary interface. As shown in Fig. 7 below.

BIM5D software also has a report output function, material procurement schedule, materials required schedule, limit requisition form, capital schedule, reinforced concrete masonry materials, such as the need to use the table can be batch output in order to do a good job pre-construction of the procurement plan and the latter part of the verification.

## 7. Conclusions

The application of BIM technology contributes to the construction schedule management. With the development of science and technology and information age, more and more new technologies can be introduced in the construction schedule management of the project. For example, the 3D scanning and printing technology can achieve the building components of replication and remodeling, applying the energy - saving environmental protection materials to construction. The use of total station can facilitate the construction of pre-construction measurement, but also to assist in the construction of coordinate detection; virtual reality technology (VR) to achieve the BIM technology can be achieved in the Visualization and immersion experience. The application of

radio frequency identification (RFID) technology in construction projects can facilitate the management of material entry, construction schedule control and operation and maintenance management; the realization of aerial photography technology can facilitate the construction of the preparatory stage of engineering measurement, construction progress in the progress of the inspection and placement of concrete reinforcement before the review.

In the construction industry, BIM technology and advanced technology products with the help of the building in the early stages of the project can be designed to express the perfect shape and use of buildings in the construction of professional collision avoid the problem and unnecessary design changes, in the Construction operation and maintenance phase to meet the management of the systematic operation and maintenance personnel and the use of intelligent operation.

## References

- [1] Yang Yajun. Construction progress management of civil engineering project. [J]Jiangxi Building Materials, 2013, (18): 289-289. [J]
- [2] Wang Zhijian. Analysis of construction project schedule control [J]. Engineering Science and Technology, 2011, (01) 268-268
- [3] Chen Wenjian, Wang Jingran, He Lianglin. Discussion on construction schedule management of construction project [J].Journal of Qinghai Communications Science and Technology, 2011, (6): 16-20.
- [5] HUANG Pu-sheng. Construction Schedule Control of Engineering Project [J]. Coastal Enterprises and Technology, 2010, (7): 102-104
- [6] Liu Guoqing. Civil engineering construction schedule control and management [J]. Architecture and Construction, 2010 (23): 75-75.
- [7] Zhang Qizhi. Discussion on construction progress and plan management [J] .Progress Management, 2009, (S2): 84-85
- [8] Liu Mian. Talking about project construction schedule management [J]. Construction & Management, 2011,41 (S1): 1037-1039[J]. Shanxi Architecture, 2015,41 (31): 245-247.
- [9] Liu Bin. Civil engineering construction schedule management and control
- [10] ZHU Sheng. Study on Construction Schedule Control in Construction Engineering [J]. Engineering Management, 2013, (35): 154-156
- [11] Laiserin Jerry. Comparing pommes and naranjas [EB / OL], [Http://www.laiserin.com/features/issue15/feature01.Php](http://www.laiserin.com/features/issue15/feature01.Php), 2002-12-16
- [12] Guanglian of the official website. [Http:// www.glodon.com](http://www.glodon.com).20161979.